

(19)



(11)

EP 4 772 781 A1

(12)

EUROPEAN PATENT APPLICATION

published in accordance with Art. 153(4) EPC

(43) Date of publication:

08.07.2026 Bulletin 2026/28

(51) International Patent Classification (IPC):

F16K 15/02 ^(2006.01) **F04B 15/08** ^(2006.01)(21) Application number: **23950506.8**

(86) International application number:

PCT/CN2023/136587(22) Date of filing: **05.12.2023**

(87) International publication number:

WO 2025/043938 (06.03.2025 Gazette 2025/10)

(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 ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA

Designated Validation States:

KH MA MD TN• **HE, Guangli****Beijing 102211 (CN)**• **LI, Xuan****Beijing 102211 (CN)**• **ZHANG, Xin****Beijing 102211 (CN)**• **XIONG, Xue****Beijing 102211 (CN)**• **CAI, Xingye****Beijing 102211 (CN)**• **CUI, Xin****Beijing 102211 (CN)**• **DU, Wandou****Beijing 102211 (CN)**• **GAO, Haohua****Beijing 102211 (CN)**• **WANG, Xiaohuan****Beijing 102211 (CN)**(30) Priority: **30.08.2023 CN 202311107952**

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(74) Representative: **Forresters IP LLP****Skygarden****Erika-Mann-Straße 11****80636 München (DE)**(54) **CHECK VALVE, LIQUID INTAKE FLANGE, PISTON PUMP AND APPLICATION OF CHECK VALVE IN LIQUID HYDROGEN PUMP**

(57) Disclosed in the present application are a check valve, a liquid intake flange, a piston pump and an application of the check valve in a liquid hydrogen pump. The check valve comprises: a limiting frame, which comprises a limiting body and at least two supporting legs evenly distributed on the limiting body, wherein a gap is formed between adjacent supporting legs, and the limiting body is arranged opposite a position to be sealed; and a valve body, which can reciprocate between the limiting body and the position to be sealed. Also disclosed in the present application are the check valve, the liquid intake flange, the piston pump and the application of the check valve in the liquid hydrogen pump, which aim to solve the problem of a low response speed of a one-way valve or a check valve.

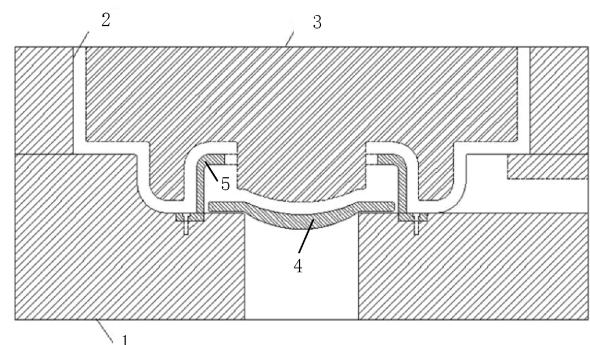


FIG. 3

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Description

FIELD

[0001] The present application relates to the technical field of a driving device, in particular, to a check valve, a liquid intake flange, a piston pump, and an application of the check valve in a liquid hydrogen pump.

BACKGROUND

[0002] The liquid hydrogen pump comprises a hydraulic end and a driving end, wherein the hydraulic end is placed in the liquid hydrogen storage tank, immersed into the liquid hydrogen; and the driving end is placed outside the liquid hydrogen storage tank. The liquid hydrogen end is a hydraulic cylinder structure. During the intake of the liquid hydrogen, an inlet one-way valve is opened and an outlet one-way valve is closed. During the compression of the liquid hydrogen, the inlet one-way valve is closed, and the outlet one-way valve is opened. In this way, upon the pushing of the piston, the liquid hydrogen is transmitted at high pressure via the outlet one-way valve. The response speed of the existing one-way valve is low due to its long distance of the movement and relatively complicated structure.

[0003] Therefore, there is a need for a check valve, a liquid intake flange, a piston pump, and an application of the check valve in a liquid hydrogen pump that can solve the above technical problems.

SUMMARY

[0004] In view of the above, the objects of the present application are to propose a check valve, a liquid intake flange, a piston pump, and an application of the check valve in a liquid hydrogen pump to solve the technical problem of the low response speed of a one-way valve or a check valve.

[0005] Based on the above objects, the present application provides a check valve comprising:

a limiting frame comprising a limiting body and at least two supporting legs evenly distributed on the limiting body, wherein a gap is provided between adjacent supporting legs; the limiting body is provided to be opposite to a position to be sealed; a valve body which can reciprocate between the limiting body and the position to be sealed.

[0006] Optionally, one end of the supporting leg away from the limiting body is provided with a flange, the flange is provided with a fixing member, and the fixing member is used for connecting the flange to an outer periphery of the position to be sealed.

[0007] Optionally, the limiting body is provided with at least one through hole running along an axial direction.

[0008] Optionally, the valve body comprises a main

body and an overlapped edge formed around the main body, the main body comprises a sealing surface, the sealing surface protrudes toward the side where the position to be sealed is located and can at least partially enter the position to be sealed, the overlapped edge can be overlapped with an edge of the position to be sealed.

[0009] Optionally, a thickness of a center of the main body is greater than a thickness of the overlapped edge.

[0010] Optionally, the valve body further comprises a pressure-bearing surface, the sealing surface and the pressure-bearing surface are provided back-to-back, and a distance between the sealing surface and the pressure-bearing surface gradually increases toward a center of the main body first and then gradually decreases.

[0011] Optionally, a gap is provided between the overlapped edge and the supporting legs.

[0012] Optionally, the overlapped edge is provided with at least two evenly distributed movable channels, and the movable channels are in clearance fit with the supporting legs.

[0013] The present application also provides a liquid intake flange comprising:

the check valve as described above;

a liquid intake flange main body provided with a liquid intake channel, wherein the check valve is connected with the liquid intake flange main body and can open and close the liquid intake channel.

[0014] The present application also provides a piston pump comprising:

the check valve as described above;

a liquid intake flange main body provided with a liquid intake channel, wherein the check valve is connected with the liquid intake flange main body;

a hydraulic cylinder, wherein the liquid intake flange main body is connected to the hydraulic cylinder, the hydraulic cylinder comprises an accommodating cavity, and the liquid intake channel is in communication with the accommodating cavity;

a piston movably provided in the accommodating cavity and movable to or away from the liquid intake flange main body; wherein the check valve can open and close the liquid intake channel to enable or disable the communication between the liquid intake channel and the accommodating cavity.

[0015] In addition, optionally, one end of the piston toward the check valve is provided with a concession hole, and the check valve at least partially enters the concession hole.

[0016] The present application also provides an application of the check valve as described above in a liquid hydrogen pump.

[0017] From the above description, it can be seen that, compared with the prior art, the check valve, the liquid

intake flange, the piston pump and the application of the check valve in the liquid hydrogen pump provided by the present application bring the following advantages: with the above check valve, the fluid force pushes the valve body away from the position to be sealed. When the hydraulic cylinder performs liquid intake, the limiting frame defines the farthest position of the movement of the valve body, shortening and reducing the distance for which the valve body moves in the hydraulic cylinder. Furthermore, when the hydraulic cylinder stops the liquid intake, the valve body is reset to the position to be sealed due to the gravity. The pressure in the hydraulic cylinder may be transmitted to the valve body by the liquid hydrogen. The valve body provides sufficient sealing pressure under the combined actions of the downward pressure and the gravity, realizing the sealing and the check functions. The check valve has a simple structure, reducing the driving difficulty and improving the response speed.

DESCRIPTION OF THE DRAWINGS

[0018] With describing the embodiments by referencing to the accompany drawings, the above-described technical features and advantages of the present application will become more apparent and easier to be understood.

FIG. 1 is a schematic view of a check valve in a first embodiment of the present application in a closed state.

FIG. 2 is a schematic view of the check valve shown in FIG. 1 in an open state.

FIG. 3 is a schematic view of the check valve shown in FIG. 1 and a piston which are in a cooperation state.

FIG. 4 is a schematic view of the valve body shown in FIG. 1.

FIG. 5 is a side view of the valve body shown in FIG. 4.

FIG. 6 is a schematic view of the limiting frame shown in FIG. 1.

FIG. 7 is a side view of the limiting frame shown in FIG. 6.

FIG. 8 is a schematic view of a check valve in a second embodiment of the present application and a piston which are in a cooperation state.

FIG. 9 is a schematic view of the valve body shown in FIG. 8.

FIG. 10 is a schematic view of a check valve in a third embodiment of the present application and a piston which are in a closed state.

FIG. 11 is a schematic view of the check valve shown in FIG. 10 in an open state.

FIG. 12 is a schematic view of the check valve shown in FIG. 10 and a piston which are in a cooperation state.

FIG. 13 is a schematic view of the valve body shown in FIG. 10.

FIG. 14 is a side view of the valve body shown in FIG. 13.

[0019] The reference signs are as below:

1. liquid intake flange main body; 1-1. first liquid intake flange main body; 2. hydraulic cylinder; 3. piston; 4. valve body; 4-1. first valve body; 4-2. second valve body; 5. limiting frame; 51. limiting body; 52. bolt hole; 53. through hole.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0020] In order to make the objects, the technical solutions, and the advantages of the present application clearer and more understandable, hereinafter, the present application will be described in details by reference to specific embodiments and the accompanying drawings. Like parts are denoted by like reference signs. It should be noted that, the wordings of "front", "rear", "left", "right", "upper", and "lower" used in the following description refer to the directions in the drawings. The wordings of "inner" and "outer" refer to a direction toward or away from the geometric center of a specific component, respectively.

[0021] FIG. 1 is a schematic view of a check valve in a first embodiment of the present application in a closed state. FIG. 2 is a schematic view of the check valve shown in FIG. 1 in an open state. FIG. 3 is a schematic view of the check valve shown in FIG. 1 and the piston which are in a cooperation state. FIG. 4 is a schematic view of the valve body shown in FIG. 1. FIG. 5 is a side view of the valve body shown in FIG. 4. FIG. 6 is a schematic view of the limiting frame shown in FIG. 1. FIG. 7 is a side view of the limiting frame shown in FIG. 6. As shown in FIGS. 1-7, the check valve comprises a limiting frame 5 and a valve body 4.

[0022] The limiting frame 5 comprises a limiting body and at least two supporting legs evenly distributed thereon. A gap is provided between adjacent supporting legs. The limiting body is provided to be opposite to the position to be sealed. The limiting frame 5 is connected to an outer periphery of the position to be sealed to define the maximum displacement of the movement of the valve body 4. For example, the limiting frame 5 is connected to the outer periphery of the position to be sealed by the supporting legs, so that the limiting frame 5 covers the exterior of the position to be sealed. The position where the supporting legs are installed will not have negative impact on the sealing effect. There is a gap between adjacent supporting legs for the liquid hydrogen to pass through, which facilitates the flow of the liquid hydrogen.

[0023] The valve body 4 may reciprocate between the limiting body and the position to be sealed. Generally, the valve body 4 is provided in the limiting frame 5. When the valve body 4 abuts on the position to be sealed, a sealing effect is realized; and when the valve body 4 moves away from the position to be sealed, an unsealing effect is realized.

[0024] The liquid intake flange main body 1 is connected between the hydraulic cylinder 2 and the liquid hydrogen storage tank. The liquid intake flange main body 1 is provided with a liquid intake channel. The liquid intake channel comprises an inlet end and an outlet end, wherein the inlet end is in communication with the liquid hydrogen storage tank, and the outlet end is in communication with the hydraulic cylinder 2. If the position to be sealed is the outlet end of the liquid intake channel, the check valve is provided at the position to be sealed. During the liquid intake, the check valve is opened by the fluid force when the piston 3 moves upward to draw in the liquid hydrogen; that is, when the hydraulic cylinder 2 starts to draw in the liquid hydrogen, the piston 3 in the hydraulic cylinder 2 is at the relative lower end of the hydraulic cylinder 2 and starts to move upward. The internal pressure of the hydraulic cylinder 2 gradually decreases, until the fluid force pushes the valve body 4 to move upward. The valve body 4 unseals the position to be sealed. The limiting frame 5 defines the maximum displacement of the valve body 4. After passing through the valve body 4, the liquid hydrogen automatically enters the hydraulic cylinder 2. When the piston 3 reaches the end point of the top end of the hydraulic cylinder 2, the liquid hydrogen no longer flows into the hydraulic cylinder 2. The valve body 4 drops under the gravity effect, and the valve body 4 seals the position to be sealed. When the piston 3 moves downward to compress the liquid hydrogen in the hydraulic cylinder 2, the pressure in the hydraulic cylinder 2 is transmitted to the valve body 4 by the filled liquid hydrogen, so that sufficient sealing pressure is generated between the valve body 4 and the position to be sealed, realizing the sealing and the check functions.

[0025] With the above check valve, the fluid force pushes the valve body 4 away from the position to be sealed. During the liquid intake of the hydraulic cylinder, the limiting frame 5 defines the farthest position of the movement of the valve body 4, shortening and reducing the distance for which the valve body 4 moves in the hydraulic cylinder 2. Furthermore, when the liquid intake of the hydraulic cylinder 2 stops, the valve body 4 is reset to the position to be sealed due to the gravity; the pressure in the hydraulic cylinder 2 may be transmitted to the valve body 4 by the liquid hydrogen. The valve body 4 provides sufficient sealing pressure under the combined effects of the downward pressure and the gravity, realizing the sealing and the checking functions. The check valve has a simple structure, reducing the driving difficulty and improving the response speed.

[0026] In one embodiment of the present application, the limiting frame 5 and/or the valve body 4 are made of metal materials resistant to hydrogen corrosion, improving the corrosion resistance and prolonging the service life of the check valve.

[0027] In one embodiment of the present application, the limiting frame 5 comprises a plurality of (such as 6-8) supporting legs, which are evenly distributed along the peripheral direction of the limiting body 51, wherein the

limiting body 51 and the supporting legs enclose to form a limiting cavity, which is a non-closed cavity. There is a gap between adjacent supporting legs for the fluid to pass through.

[0028] Optionally, one end of a supporting leg away from the limiting body is provided with a flange, wherein the flange is provided with a fixing member used for connecting the flange to the outer periphery of the position to be sealed. By providing the flange, the contact area between the supporting legs and the outer periphery of the position to be sealed is increased, and the installation stability of the limiting frame 5 is increased.

[0029] In one embodiment of the present application, the flange extends toward the side away from the limiting cavity to avoid blocking the position to be sealed. The flange is provided with a bolt hole 52. The fixing member comprises but is not limited to conventional parts such as bolts, screws, or the like. The fixing member passes through the bolt hole 52 to fix the flange.

[0030] Optionally, the limiting body is provided with at least one through hole running along the axial direction. Generally, the through hole 53 is provided to be opposite to the position to be sealed. The valve body 4 is located between the through hole 53 and the position to be sealed. The liquid hydrogen may act on the valve body 4 via the through hole 53, so as to provide a downward pressure for the valve body 4. In addition, a part of the piston 3 may enter the limiting frame 5 via the through hole 53, and the check valve and the piston 3 are embedded into each other in a small range, so that the requirement for the volume of the hydraulic cylinder 2 may be reduced.

[0031] In one embodiment of the present application, the diameter of the through hole 53 is greater than the diameter of the position to be sealed, and the diameter of the valve body 4 is greater than the diameter of the through hole 53.

[0032] In one embodiment of the present application, the through hole 53 is provided on the limiting body 51, the limiting cavity covers the exterior of the position to be sealed, and the supporting legs are connected to the outer periphery of the position to be sealed by the flanges; the valve body 4 reciprocates in the limiting cavity. The limiting cavity is in communication with the position to be sealed, and the limiting cavity is in communication with the hydraulic cylinder 2 via the through hole 53. The valve body 4 reciprocates in the limiting cavity, with the farthest position of its movement abutting on the limiting body 51. The above limiting frame 5 has a relatively simple and compact structure, which occupies a small space and is easy to be installed.

[0033] Optionally, the valve body comprises a main body and an overlapped edge formed around thereof. The main body comprises a sealing surface protruding toward the side where the position to be sealed is located. When the position to be sealed is a port of the liquid intake channel, the sealing surface may at least partially enter the port of the liquid intake channel, and the overlapped

edge may be overlapped with the edge of the position to be sealed. The main body is overlapped with the edge of the position to be sealed by the peripheral overlapped edge. The main body is sealed with the position to be sealed by the sealing surface. The sealing surface partially enters the position to be sealed, which may not only ensure the sealing effect in a manner of sealing by inserting, but also realize the self-positioning during the reciprocation.

[0034] In one embodiment of the present application, the valve body 4 is a disk shape protruding to one side, wherein the protruding portion is a main body, the protruding surface of the protruding portion is a sealing surface, and what surrounds the protruding portion is the overlapped edge.

[0035] Optionally, the thickness of the center of the main body is greater than the thickness of the overlapped edge. Generally, the thickness of the main body may be uniform or non-uniform. When the thickness of the main body is non-uniform, the thickness of the center of the main body is the greatest. The thickness of the main body is provided based on the pressure it is subjected to. The thickness of the overlapped edge is generally uniform. The thickness of the overlapped edge is provided in a way that meets the requirements of the sealing and the structural strength. By providing different thicknesses (that is, when the overlapped edge is overlapped with the edge of the position to be sealed), increasing the thickness of the center of the main body may ensure the sealing performance of the valve body 4 to the position to be sealed, realizing the self-positioning during the reciprocation. At the same time, reducing the thickness of the overlapped edge may meet the sealing performance requirements and avoid deformation.

[0036] In one embodiment of the present application, the thickness of the center of the main body is 1.5-3 times the thickness of the overlapped edge.

[0037] Optionally, the valve body 4 also comprises a pressure-bearing surface, wherein the sealing surface and the pressure-bearing surface are provided back-to-back, and the distance between the sealing surface and the pressure-bearing surface gradually increases toward the center of the main body first and then gradually decreases. The pressure-bearing surface is used for bearing the downward pressure provided by the liquid hydrogen or the piston 3. The pressure-bearing surface may be a horizontal surface, flushing with the upper surface of the overlapped edge. Alternatively, both the sealing surface and the pressure-bearing surface may be an arc-shaped surface protruding toward the same side. It should be ensured that, firstly the distance between the sealing surface and the pressure-bearing surface is gradually increased toward the center of the main body and then is gradually decreased, so as to ensure that, the thickness of the center of the main body is the maximum. By defining the thickness and the shape of the valve body 4, the sealing performance of the valve body 4 to the position to be sealed may be ensured, realizing the self-

positioning during the reciprocation, facilitating the self-positioning of the valve body 4 under the gravity. In this way, the central portion of the main body may enter the position to be sealed, realizing a sealing by inserting.

[0038] In one embodiment of the present application, the main body comprises a pressure-bearing surface and a sealing surface provided back-to-back, wherein the pressure-bearing surface and the through hole 53 are provided to be opposite to each other, the sealing surface protrudes from the side away from the pressure-bearing surface, and the liquid hydrogen may act on the pressure-bearing surface via the through hole 53.

[0039] FIG. 8 is a schematic view of a check valve in a second embodiment of the present application and a piston which are in a cooperation state. FIG. 9 is a schematic view of the valve body shown in FIG. 8. As shown in FIGS. 8 and 9, the valve body 4 adopts a first valve body 4-1, the shape of which is different from the shape of the valve body 4 in the first embodiment.

[0040] The first valve body 4-1 has a symmetrical structure, the closer to the center of the main body, the greater the distance between the sealing surface and the pressure-bearing surface is, that is, the greater the thickness; and the closer to the edge of the main body, the less the distance between the sealing surface and the pressure-bearing surface is, that is, the thinner the thickness. In one embodiment of the present application, the pressure-bearing surface of the first valve body 4-1 is a flat surface, and the sealing surface of the first valve body 4-1 is an arc-shaped surface.

[0041] Optionally, a gap is provided between the overlapped edge and the supporting legs. The gap should not affect the reciprocation of the valve body 4, and at the same time, the effective limitation to the valve body 4 should be ensured, so as to avoid wild movement. By providing a gap, no friction occurs between the overlapped edge and the supporting legs during moving, reducing the driving difficulty of the valve body 4, and improving the response speed of the valve body 4.

[0042] Optionally, the overlapped edge is provided with at least two evenly distributed movable channels, which are clearance fitted with the supporting legs. The movable channels are sleeved on the supporting legs, so that the overlapped edge may reciprocate along the supporting legs by means of the movable channels. The supporting legs provide a guiding function for the overlapped edge, and the clearance fit may reduce the friction between the overlapped edge and the supporting legs, ensuring the response speed of the valve body 4.

[0043] In one embodiment of the present application, if the supporting legs are cylindrical, the movable channels may be in the shape of a waist hole.

[0044] FIG. 10 is a schematic view of a check valve in a third embodiment of the present application and a piston which are in a closed state. FIG. 11 is a schematic view of the check valve shown in FIG. 10 in an open state. FIG. 12 is a schematic view of the check valve shown in FIG. 10 and the piston which are in a cooperation state. FIG. 13 is

a schematic view of the valve body shown in FIG. 10. FIG. 14 is a side view of the valve body shown in FIG. 13. As shown in FIGS. 10-14, the valve body 4 adopts a second valve body 4-2, and the shape of which is different from that of the valve body 4 in the first embodiment. The liquid intake flange main body 1 adopts the first liquid intake flange main body 1-1, the shape of which is different from that of the liquid intake flange main body 1 in the first embodiment.

[0045] The main body and the edge on both sides are integrally formed, that is, there is no obvious bending between the main body and the edges, instead, the transition is smooth. The second valve body 4-2 has a symmetrical structure, the closer to the center of the main body, the greater the distance between the sealing surface and the pressure-bearing surface is, that is, the greater the thickness; the closer to the edge, the less the distance between the sealing surface and the pressure-bearing surface is, and the less the distance between the overlapped edge and the pressure-bearing surface is, that is, the thinner the thickness.

[0046] The first liquid intake flange main body 1-1 is provided with a liquid intake channel, which comprises an inlet end and an outlet end, wherein the inlet end is in communication with the liquid hydrogen storage tank, and the outlet end is in communication with the hydraulic cylinder 2. If the position to be sealed is the outlet end of the liquid intake channel, the check valve is arranged at the position to be sealed. In order to realize a good cooperation with the second valve body 4-2, the end face of the outlet end is provided with an arc-shaped surface, which is a gradually changed surface, that is, the diameter of the arc-shaped surface gradually increases from the inlet end side to the outlet end side, and the arc-shaped surface and the edge of the second valve body 4-2 coincide with each other. That is, when the second valve body 4-2 is in a closed state, the main body enters the liquid intake channel, and the edge is overlapped on the arc-shaped surface, so as to realize the self-positioning function under the gravity and effectively seal the outlet end.

[0047] In addition, the arc-shaped surface of the outlet end is inclined downward, and the solid impurities in the liquid hydrogen are not easily deposited and stayed on the arc-shaped surface, so that the self-cleaning function may be realized, and an efficient and reliable sealing effect may be realized by the second valve body 4-2.

[0048] Generally, in order to ensure that, the valve body 4 may be correctly sealed and unsealed and the self-positioning function may be realized, the distance between the two ends of the valve body 4 (that is, the distance between the edges of the two sides) should be greater than the diameter of the inlet channel, and the distance between the two ends of the valve body 4 is less than the distance between the limiting frame 5 and the position to be sealed.

[0049] The use process of the check valve is introduced as below.

[0050] The liquid intake flange main body 1 is connected between the hydraulic cylinder 2 and the liquid hydrogen storage tank. The liquid intake flange main body 1 is provided with a liquid intake channel, which comprises an inlet end and an outlet end, wherein the inlet end is in communication with the liquid hydrogen storage tank, and the outlet end is in communication with the hydraulic cylinder 2. If the position to be sealed is an outlet end of the liquid intake channel, the check valve is provided at the position to be sealed. The limiting frame 5 covers the exterior of the position to be sealed and is connected with the exterior of the position to be sealed by the supporting legs, so that the limiting body is provided to be opposite to the position to be sealed, and the valve body 4 abuts on the position to be sealed via a sealing surface. During the liquid intake, the check valve is opened by the fluid force when the piston 3 moves upward to draw in the liquid hydrogen; that is, when the hydraulic cylinder 2 starts to draw in the liquid hydrogen, the piston 3 in the hydraulic cylinder 2 is at the relative lower end of the hydraulic cylinder 2 and starts to move upward. The internal pressure of the hydraulic cylinder 2 gradually decreases until the valve body 4 moves upward. The sealing surface of the valve body 4 moves away from the position to be sealed, realizing the unsealing of the position to be sealed. The limiting body defines the maximum displacement of the valve body 4, reducing the distance for which the valve body 4 moves. After passing through the valve body 4, the liquid hydrogen automatically enters the hydraulic cylinder 2 through the gap between the supporting legs. When the piston 3 reaches the end point of the top end of the hydraulic cylinder 2, the liquid hydrogen no longer flows into the hydraulic cylinder 2, the valve body 4 drops under the gravity and seals the position to be sealed. When the piston 3 moves downward to compress the liquid hydrogen in the hydraulic cylinder 2, the pressure in the hydraulic cylinder 2 is transmitted from the void between the through hole 53 and the supporting legs to the valve body 4 by the liquid hydrogen filled. Under the actions of the gravity of the valve body 4 itself and the downward pressure received, sufficient sealing pressure is produced between the valve body 4 and the position to be sealed, realizing the sealing and the check functions.

[0051] The present application also provides a liquid intake flange comprising a check valve and a liquid intake flange main body 1.

[0052] The liquid intake flange comprises a check valve as described above, which may be a check valve in any of the above embodiments and will not be described here.

[0053] The liquid intake flange main body 1 is provided with a liquid intake channel. The check valve is connected with the liquid intake flange main body 1 and may open and close the liquid intake channel. The liquid intake flange main body 1 is connected between the hydraulic cylinder 2 and the liquid hydrogen storage tank. The liquid intake channel comprises an inlet end and an outlet end,

wherein the inlet end is in communication with the liquid hydrogen storage tank, and the outlet end is in communication with the hydraulic cylinder 2. The liquid intake means that the liquid hydrogen provided by the liquid hydrogen storage tank enters the liquid intake flange main body 1 via the inlet end and enters the hydraulic cylinder 2 via the outlet end.

[0054] The check valve comprises a limiting frame 5 and a valve body 4, wherein the limiting frame 5 is connected on the liquid intake flange main body 1, the valve body 4 is provided between the liquid intake flange main body 1 and the limiting frame 5, and the limiting frame 5 is used for defining the maximum distance for which the valve body 4 moves. The liquid intake channel comprises an inlet end and an outlet end. The valve body 4 is provided on the side where the outlet end. If the valve body 4 abuts on the outlet end, the liquid intake channel is closed, the liquid intake and the liquid outtake stop. If the valve body moves away from the outlet end and moves toward the side where the limiting frame 5 is located; the liquid intake channel is opened, liquid intake via the liquid intake channel is allowed.

[0055] With the above liquid intake flange, the check valve has a simple structure and a quick response speed, so that the liquid intake channel of the liquid intake flange main body may be quickly opened and closed.

[0056] In one embodiment of the present application, the liquid intake flange main body 1 is provided with a liquid intake channel in the axial direction thereof. The liquid intake flange main body 1 is provided with a liquid outtake channel in the radial direction thereof. The liquid outtake channel is in communication with the liquid intake channels.

[0057] In one embodiment of the present application, the liquid intake flange main body 1 is detachably connected with the hydraulic cylinder 2, and/or the liquid intake flange main body 1 is detachably connected with the liquid hydrogen storage tank.

[0058] The present application further provides a piston pump comprising a check valve, a hydraulic cylinder 2, a piston 3, and a liquid intake flange main body 1.

[0059] The piston pump comprises a check valve as described above, which may be a check valve of any of the above embodiments and will not be described here.

[0060] The liquid intake flange main body 1 is provided with a liquid intake channel. The check valve is connected with the liquid intake flange main body 1, which may be the liquid intake flange main body 1 in any of the above embodiments and will not be repeatedly described here.

[0061] The liquid intake flange main body 1 is connected to the hydraulic cylinder 2, which comprises an accommodating cavity, to which the liquid intake channel is in communication with. The hydraulic cylinder 2 comprises a top end and a bottom end provided oppositely, wherein the accommodating cavity is provided between the top end and the bottom end. The liquid intake flange main body 1 is connected to the bottom end of the hydraulic cylinder 2.

[0062] The piston 3 is movably provided in the accommodating cavity and may moves to or away from the liquid intake flange main body 1. The check valve may open and close the liquid intake channels to enable or disable the communication between the liquid intake channel and the accommodating cavity. The piston 3 is movably connected in the accommodating cavity, and reciprocates between the top end and the bottom end. If the piston 3 moves away from the liquid intake flange main body 1, the check valve opens the liquid intake channel to enable the communication between the liquid intake channel and the accommodating cavity, realizing the liquid intake. If the piston 3 is close to the liquid intake flange main body 1, the check valve closes the liquid intake channel to disable the communication between the liquid intake channel and the accommodating cavity, stopping the liquid intake.

[0063] The liquid intake flange main body 1 is connected between the hydraulic cylinder 2 and the liquid hydrogen storage tank. The liquid intake flange main body 1 is provided with the liquid intake channel, wherein a liquid intake channel comprises an inlet end and an outlet end, the inlet end is in communication with the liquid hydrogen storage tank, the outlet end is in communication with the hydraulic cylinder 2, and the check valve is provided on the outlet end of the liquid intake channel. During the liquid intake, the piston 3 moves toward the top end, the liquid hydrogen enters the liquid intake channel from the inlet end, the fluid force pushes the check valve to move away from the outlet end. The liquid intake channel is in communication with the accommodating cavity, and the liquid enters the accommodating cavity. When the piston 3 moves to the end point of the top end, the liquid intake stops. The check valve is reset to the outlet end under the gravity and forms a seal to disable the communication between the liquid intake channel and the accommodating cavity. When the piston 3 moves toward the bottom end, the pressure in the hydraulic cylinder 2 is transmitted to the check valve by the liquid hydrogen, and the downward pressure is provided on the reset check valve to generate sufficient sealing pressure, realizing the sealing and the check functions. With the above piston pump, during the liquid intake, the piston 3 moves up, and the fluid force pushes the check valve to move away from the position to be sealed, enabling the communication between the liquid intake channel and the accommodating cavity. When the liquid intake stops, the check valve self-resets to the position to be sealed due to the gravity, disabling the communication between the liquid intake channel and the accommodating cavity. When the piston 3 moves downward, the pressure in the hydraulic cylinder 2 is transmitted to the check valve by the liquid hydrogen, and the check valve generates sufficient sealing pressure under the combination of the downward pressure and the gravity, realizing the sealing and the check functions. The check valve has a simple structure, reducing the driving difficulty and improving the response speed.

[0064] In addition, optionally, one end of the piston toward the check valve is provided with a concession hole, and the check valve at least partially enters the concession hole. When the piston 3 moves toward the check valve, the limiting frame 5 of the check valve may enter the concession hole. With the above piston 3, the structure may be more compact, and the limiting frame 5 enters the piston 3, so that the piston 3 has a smaller gap at the end point of the compression, which is beneficial for increasing the volume efficiency and improving the performance of the piston pump.

[0065] In one embodiment of the present application, an end face of one end of the piston 3 toward the limiting frame 5 is provided with a convex structure, and an end face of one end of the liquid intake flange main body 1 toward the piston 3 is provided with a recess structure, which is co-operationally used with the convex structure, wherein the convex structure may enter the recess structure. An edge of one end of the convex structure away from the piston 3 is provided with a smooth chamfer, and the bottom of the recess structure is also provided with a smooth chamfer.

[0066] In one embodiment of the present application, the middle portion of the convex structure is provided with a concession hole, the diameter of which is greater than the diameter of the limiting frame 5. The concession hole covers the exterior of the limiting frame 5. The limiting frame 5 may enter the concession hole. The bottom of the concession hole is provided with smooth chamfers, and the corners of the limiting frame 5 are provided with smooth chamfers.

[0067] In one embodiment of the present application, the concession hole on the piston 3 is in an annular shape, that is, the concession hole divides the convex structure into the edge portion on both sides and a convex portion on the middle portion. The limiting frame 5 is provided with a through hole 53, and the diameter of the convex portion is less than the diameter of the through hole 53. When the limiting frame 5 enters the concession hole of the piston 3, the edge portion enters the outer peripheral space of the limiting frame 5, and the convex portion enters the through hole 53. The piston 3 and the limiting frame 5 invade each other, so that the piston 3 has a smaller clearance at the end point of compression, which is beneficial for increasing the volume efficiency and improving the performance of the piston pump.

[0068] In one embodiment of the present application, the valve body of the check valve comprises a pressure-bearing surface, and the end face of one end of the convex portion away from the piston 3 and the pressure-bearing surface may coincide with each other. For example, when the pressure-bearing surface is in an arc shape, the end face of the driving head is in a matching arc shape. Alternatively, when the pressure-bearing surface is a flat surface, the end surface of the driving head is a flat surface.

[0069] The present application also provides an application of the check valve as described above in a liquid

hydrogen pump. The application may be realized by any of the above embodiments and will not be repeatedly described here.

[0070] From the above description and practice, it can be seen that, compared with the prior art, the check valve, the liquid intake flange, the piston pump and the application of the check valve in the liquid hydrogen pump provided by the present application bring the following advantages: with the above check valve, the fluid force pushes the valve body 4 away from the position to be sealed. When the hydraulic cylinder performs liquid intake, the limiting frame 5 defines the farthest position of the movement of the valve body 4, shortening and reducing the distance for which the valve body 4 moves in the hydraulic cylinder 2. Furthermore, when the hydraulic cylinder 2 stops the liquid intake, the valve body 4 is reset to the position to be sealed due to the gravity. The pressure in the hydraulic cylinder 2 may be transmitted to the valve body 4 by the liquid hydrogen. The valve body 4 provides sufficient sealing pressure under the combined actions of the downward pressure and the gravity, realizing the sealing and the check functions. The check valve has a simple structure, reducing the driving difficulty and improving the response speed.

[0071] Those skilled in the art should understand that, the above description is merely specific embodiments of the present application, and is not intended to limit the present application. Any modification, equivalent substitution, improvement, etc. made within the gist of the present application should be included within the protection scope of the present application.

Claims

1. A check valve comprising:

a limiting frame comprising a limiting body and at least two supporting legs evenly distributed on the limiting body, wherein a gap is provided between adjacent supporting legs; the limiting body is provided to be opposite to a position to be sealed; and

a valve body which can reciprocate between the limiting body and the position to be sealed.

2. The check valve according to claim 1, wherein: one end of the supporting leg away from the limiting body is provided with a flange, the flange is provided with a fixing member, and the fixing member is used for connecting the flange to an outer periphery of the position to be sealed.

3. The check valve according to claim 2, wherein: the limiting body is provided with at least one through hole running along an axial direction.

4. The check valve according to any of claims 1-3,

wherein:

the valve body comprises a main body and an overlapped edge formed around the main body, the main body comprises a sealing surface, the sealing surface protrudes toward the side where the position to be sealed is located and can at least partially enter the position to be sealed, the overlapped edge can be overlapped with an edge of the position to be sealed.

5. The check valve according to claim 4, wherein:
a thickness of a center of the main body is greater than a thickness of the overlapped edge.
6. The check valve according to claim 5, wherein:
the valve body further comprises a pressure-bearing surface, the sealing surface and the pressure-bearing surface are provided back-to-back, and a distance between the sealing surface and the pressure-bearing surface gradually increases toward a center of the main body first and then gradually decreases.
7. The check valve according to claim 4, wherein:
a gap is provided between the overlapped edge and the supporting legs.
8. The check valve according to claim 4, wherein:
the overlapped edge is provided with at least two evenly distributed movable channels, and the movable channels are in clearance fit with the supporting legs.
9. A liquid intake flange comprising:

the check valve according to any of claims 1-8;
a liquid intake flange main body provided with a liquid intake channel, wherein the check valve is connected with the liquid intake flange main body and can open and close the liquid intake channel.
10. A piston pump, comprising:

the check valve according to any of claims 1-8;
a liquid intake flange main body provided with a liquid intake channel; wherein the check valve is connected with the liquid intake flange main body;
a hydraulic cylinder, wherein the liquid intake flange main body is connected to the hydraulic cylinder, the hydraulic cylinder comprises an accommodating cavity, the liquid intake channel is in communication with the accommodating cavity;
a piston movably provided in the accommodating cavity and movable to or away from the liquid intake flange main body; wherein the check valve can open and close the liquid intake chan-

nel to enable or disable the communication between the liquid intake channel and the accommodating cavity.

11. The piston pump according to claim 10, wherein:
one end of the piston toward the check valve is provided with a concession hole, and the check valve at least partially enters the concession hole.
12. An application of the check valve according to any of claims 1-8 in a liquid hydrogen pump.

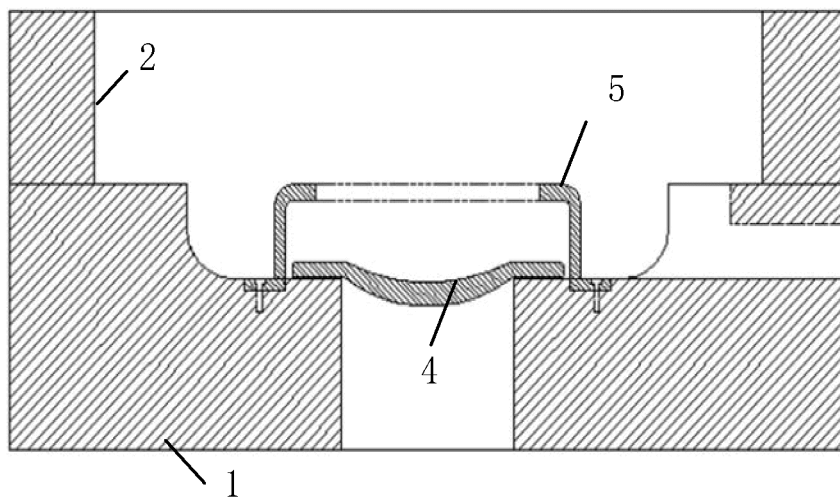


FIG. 1

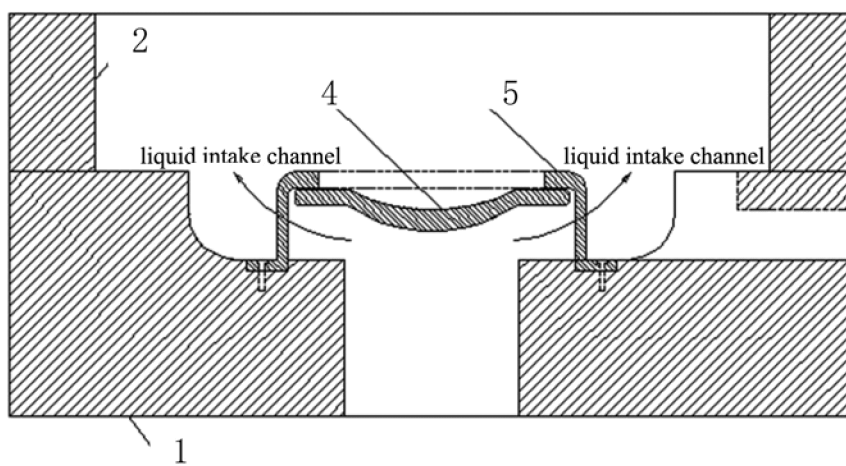


FIG. 2

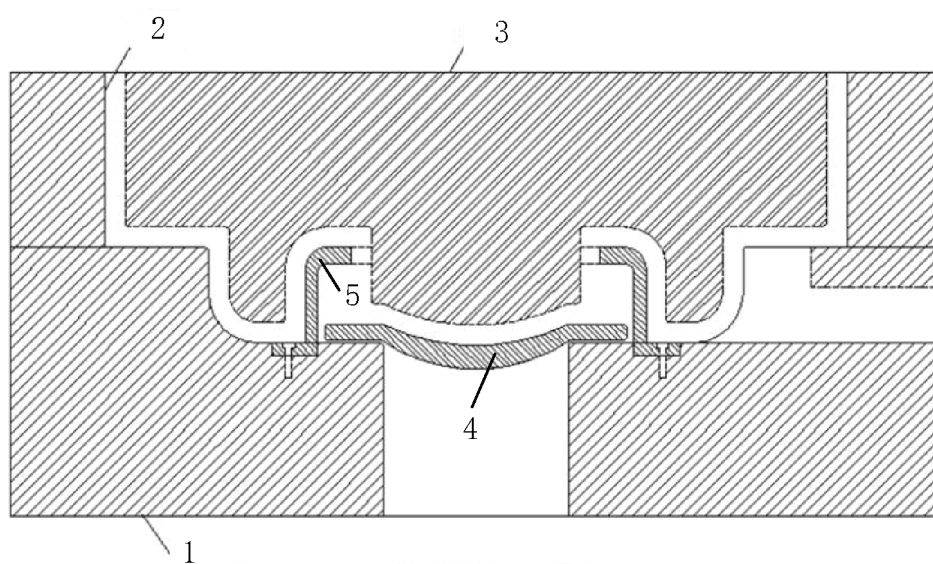


FIG. 3

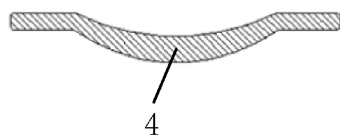


FIG. 4

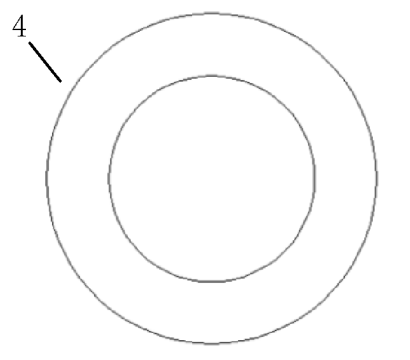


FIG. 5

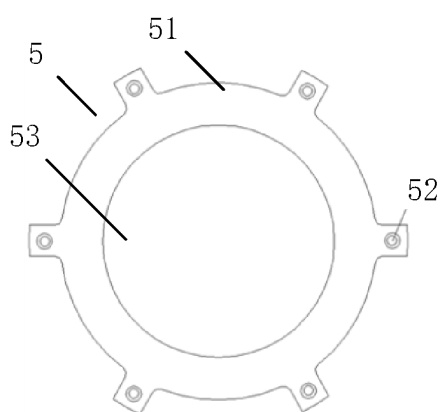


FIG. 6

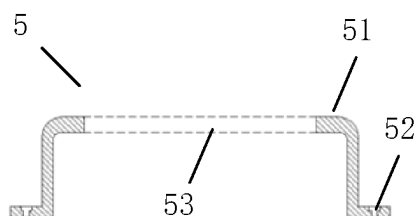


FIG. 7

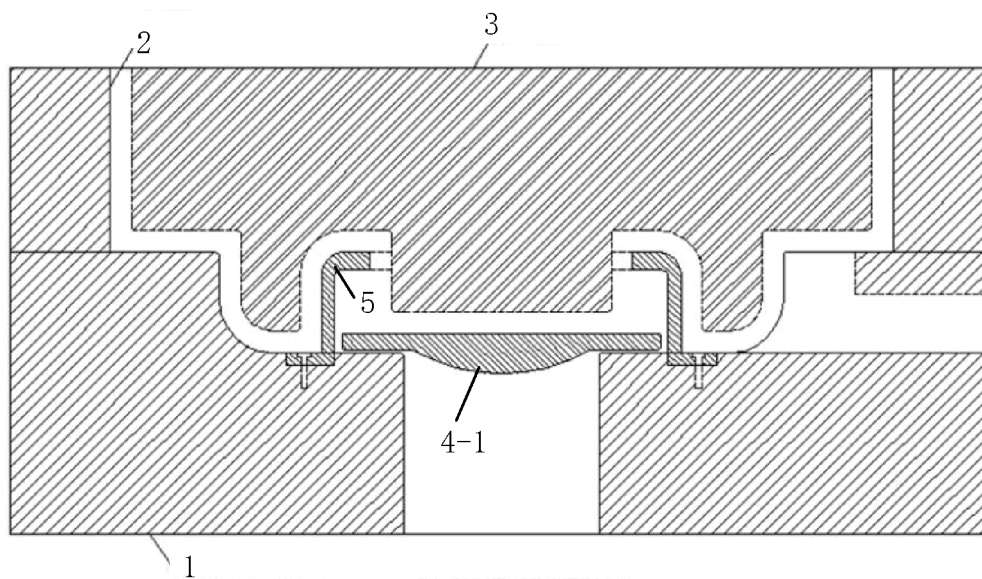


FIG. 8

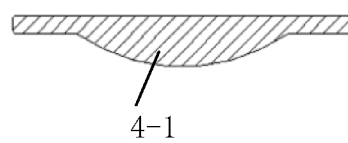


FIG. 9

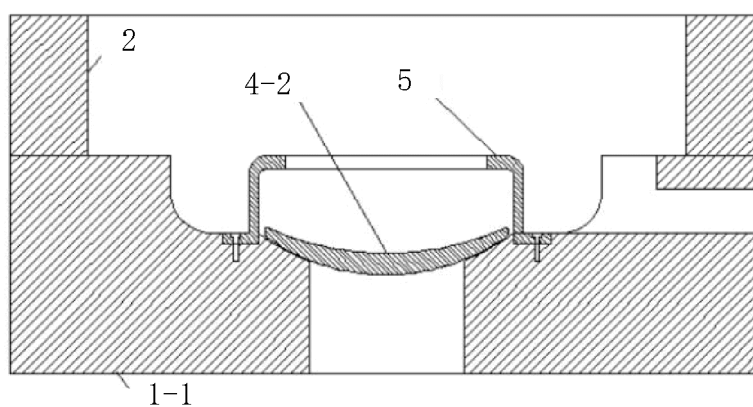


FIG. 10

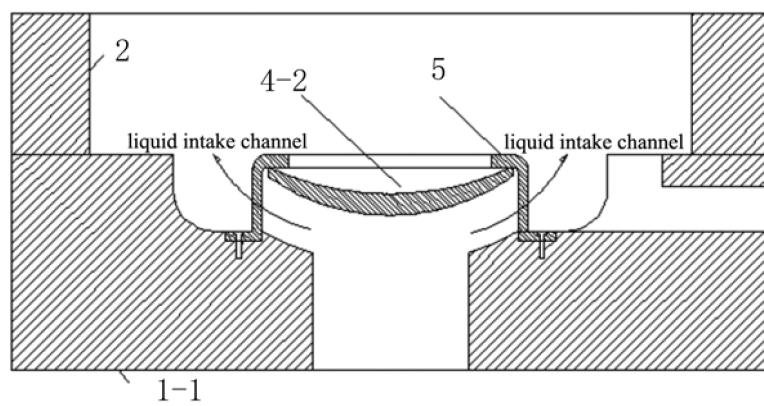


FIG. 11

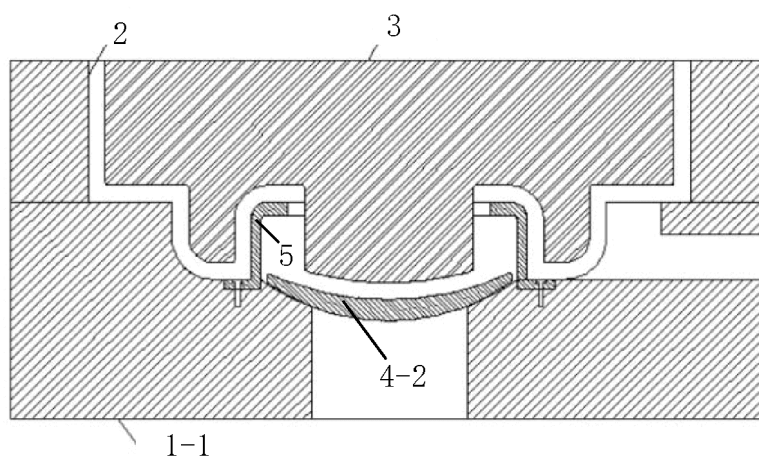


FIG. 12



FIG. 13

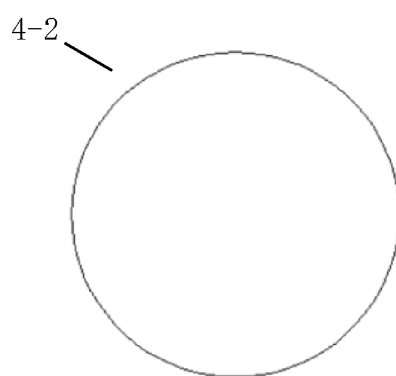


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/136587

A. CLASSIFICATION OF SUBJECT MATTER

F16K15/02(2006.01)i; F04B15/08(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:F16K: F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, ENTXTC, DWPI: 止回阀, 逆止阀, 单向阀, 阀座, 密封, 阀体, 阀芯, 阀板, 阀片, 限位架, 支架, 腿, 条, 法兰, 泵, 活塞, 柱塞, 进液, 吸液, 液, 氢, check, valve, one-way, base, body, core, plate, disc, frame, leg, flange, pump, piston, plunger, liquid, fluid, suck+, hydrogen

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2008223927 A (SAGINOMIYA SEISAKUSHO, INC.) 25 September 2008 (2008-09-25) description, paragraphs 15-29, and figures 1-6	1-8
Y	JP 2008223927 A (SAGINOMIYA SEISAKUSHO, INC.) 25 September 2008 (2008-09-25) description, paragraphs 15-29, and figures 1-6	9-12
Y	CN 2151334 Y (WANG DAYUN) 29 December 1993 (1993-12-29) description, page 2, lines 5-25, and figure 1	9
Y	CN 111997862 A (HEFEI GENERAL MACHINERY RESEARCH INSTITUTE CO., LTD. et al.) 27 November 2020 (2020-11-27) description, paragraphs 48-82, and figures 1-4	10-12
Y	CN 111594413 A (HEFEI GENERAL MACHINERY RESEARCH INSTITUTE CO., LTD.) 28 August 2020 (2020-08-28) description, paragraphs 33-58, and figures 1-3	10-12
X	CN 87214305 U (ZHOU SHITONG) 10 August 1988 (1988-08-10) description, page 1, paragraph 4-page 2, last paragraph, and figures 1-2C	1-8

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

25 April 2024

Date of mailing of the international search report

07 May 2024

Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
CN)
China No. 6, Xitucheng Road, Jimenqiao, Haidian District,
Beijing 100088

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/136587

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	CN 201013974 Y (ZHANG ZHENGDAO) 30 January 2008 (2008-01-30) entire document	1-12
A	CN 105697823 A (YANG CHENHUI) 22 June 2016 (2016-06-22) entire document	1-12

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2023/136587

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CN 111594413 A	28 August 2020	None	
CN 87214305 U	10 August 1988	None	
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CN 201013974 Y	30 January 2008	None	
CN 105697823 A	22 June 2016	None	