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(54) **GEAR PUMP COVER AND FOUR-QUADRANT OPERATING INTERNAL GEAR PUMP**

(57) Provided are a gear pump cover and a four-quadrant operating internal gear pump, relating to the technical field of hydraulic pumps. The gear pump cover includes a pump cover housing, a medium exchange opening, and a one-way valve. A medium passage is formed inside a four-quadrant operating internal gear pump cover. The medium exchange opening is located at a top of the pump cover housing. When the four-quadrant operating internal gear pump cover is connected to a pump body, the medium exchange opening is configured to exchange a medium with the outside. The one-way valve is configured to deliver a medium leaking within the medium passage to a low-pressure

medium cavity. During the operation of the internal gear pump, with the gear pump cover connected to the pump body, an axial compensation structure and a radial compensation structure designed between the pump body and the gear pump cover enable compensations, using mechanical structures, for an axial clearance and a radial clearance occurring when a high-pressure oil passes through an oil pumping assembly during the operation of the gear pump. Thus, oil leakage caused by such clearances during operation is reduced, thereby improving volumetric efficiency and low-speed performance.

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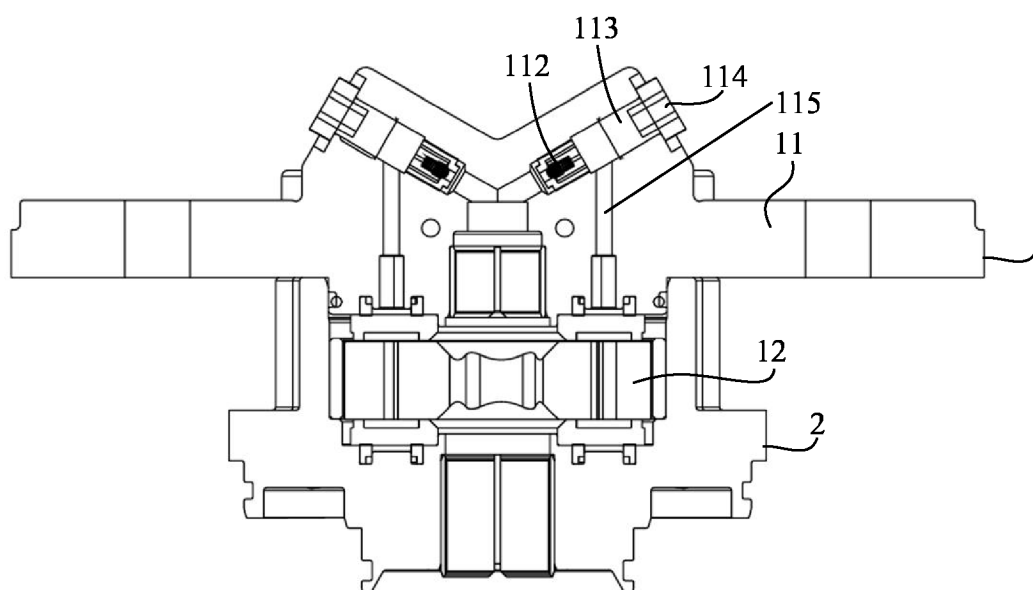


FIG. 2

Description

configured to selectively deliver a high-pressure medium leaking within the medium passage to a low-pressure medium cavity.

TECHNICAL FIELD

[0001] The present disclosure relates to the technical field of hydraulic pumps, and in particular, to a gear pump cover and a four-quadrant operating internal gear pump.

5 **[0007]** In an optional embodiment, the pump cover housing includes at least two medium exchange openings;

BACKGROUND TECHNOLOGY

[0002] Internal gear pumps are characterized by low noise, low flow pulsation, high efficiency, and the like. The axial and radial clearance compensation designs are adopted to further improve efficiency, and achieve excellent low-speed performance. Currently, internal gear pumps are widely used in the servo hydraulic field.

10 the at least two medium exchange openings include at least one medium inlet and at least one medium outlet;

[0003] In the related art, internal gear pumps are typically designed with radial clearance compensations so as to reduce leakage in radial clearances, improve volumetric efficiency, and improve low-speed performance. Furthermore, in addition to the design of oil inlet/outlet port, a gear pump requires an additional design of an oil return port to allow high-pressure leaking medium within the pump cavity to flow back to the oil tank through this oil return port.

15 the at least one medium inlet, the at least one medium outlet, and the one-way valve are located within the same medium passage;

[0004] However, in the related art, there is no technique for compensating for an axial clearance while compensating for a radial clearance. Moreover, the related art needs to design the oil return port, and add an oil pipe to a hydraulic system, thereby causing inconvenience in mounting and use.

20 the one-way valve is provided with a one-way valve mounting hole;

the one-way valve is located inside the one-way valve mounting hole;

25 a first end of the one-way valve is opposite to the medium passage, and a second end of the one-way valve is provided with a plug; and

the one-way valve mounting hole defines an outlet oil path that is communicated with the medium passage.

[0008] In an optional embodiment, the one-way valve is in interference fit with the medium exchange opening;

or

30 the one-way valve is in threaded connection with the medium passage and is provided with a sealing ring;

35 the sealing ring is in contact with the one-way valve and the medium passage; and

the sealing ring is configured to strengthen the connection of the one-way valve with the medium passage.

CONTENT OF THE INVENTION

[0005] The present disclosure relates to a gear pump cover and a four-quadrant operating internal gear pump that can achieve simultaneous axial compensation and radial compensation during oil pumping under operating conditions. Furthermore, a design of an oil return path is added. The leaking medium flows back to a low-pressure cavity through an internal flow passage within the pump. Thus, the design that the leaking medium flows back to the oil tank through a third oil port is omitted. The technical solutions are described as follows.

40 **[0009]** In another aspect, provided is a four-quadrant operating internal gear pump, including the gear pump cover as described in any of the foregoing embodiments, a pump body, and an oil pumping component;

[0006] In an aspect, provided is a gear pump cover, including a pump cover housing, a medium exchange opening, and a one-way valve, where a medium passage is formed inside a four-quadrant operating internal gear pump cover;

45 where the gear pump cover is connected to the pump body; a medium passage is formed within the pump body and is configured to allow a medium to pass therethrough when the four-quadrant operating internal gear pump cover operates;

50 an accommodating cavity is formed when the gear pump cover is connected to the pump body; the oil pumping component is located within the accommodating cavity and at a connection of the gear pump cover and the pump body; the oil pumping component is fixedly connected to each of the gear pump cover and the pump body;

the oil pumping component is provided with an axial compensation structure and a radial compensa-

the medium exchange opening is located at a top of the pump cover housing;

when the four-quadrant operating internal gear pump cover is connected to a pump body, the medium exchange opening is configured to exchange a medium with the outside; and the one-way valve is

55

tion structure;

the axial compensation structure is configured to compensate for an axial clearance of the oil pumping component when the four-quadrant operating internal gear pump operates; and

the radial compensation structure is configured to compensate for a radial clearance of the oil pumping component when the four-quadrant operating internal gear pump operates.

[0010] In an optional embodiment, the oil pumping component includes an internal gear and an external gear;

the external gear is engaged with the internal gear, and a radius of the external gear is smaller than a radius of the internal gear;

a volume cavity is formed between the external gear and the internal gear and is configured to allow the medium to pass therethrough when the four-quadrant operating internal gear pump operates;

the radial compensation structure and the axial compensation structure are located inside the volume cavity ; and

the radial compensation structure is in contact with the axial compensation structure.

[0011] In an optional embodiment, the axial compensation structure includes an axial plate, and the radial compensation structure includes a valve plate and a valve plate holder;

at least one through hole is formed in the axial plate;

a surface of the valve plate holder includes at least one slot, and the through holes correspond to the slots in terms of quantity and position;

the valve plate is fit with the surface of the valve plate holder that is provided with the slots, thereby defining an oil passage; and

when the four-quadrant operating internal gear pump operates, the medium passes through a passage defined by the through holes and the oil passage to push apart the valve plate and the valve plate holder.

[0012] In an optional embodiment, the axial plate is configured as an axisymmetric structure;

the axial plate includes a first through hole, a second through hole, a third through hole, a fourth through hole, and a recessed groove;

the first through hole is located at an axis of the axisymmetric structure and is axisymmetric in shape for positioning and mounting;

two recessed grooves, two second through holes, and two third through holes are arranged axisym-

metrically;

the second through holes and the third through holes are located inside the recessed grooves;

the recessed grooves have connection portions configured for the medium to pass therethrough;

the second through holes and the third through holes are configured for connection with an oil inlet/outlet port of the gear pump cover; and

the fourth through hole is located at the axis of the axisymmetric structure, and is configured for positioning and mounting and for forming the medium passage when the four-quadrant operating internal gear pump cover operates.

[0013] In an optional embodiment, the valve plates and the valve plate holders correspond to the recessed grooves in terms of quantity and position;

the radial compensation structure further includes stop pins;

the stop pins are in contact with the valve plates and the valve plate holders, and are configured to support the valve plates and the valve plate holders; and

the stop pins are configured to limit relative displacements of the valve plates and the valve plate holders.

[0014] In an optional embodiment, the radial compensation structure further includes a sealing roller and a spring leaf;

the sealing roller and the spring leaf are configured for contact with the valve plate; and

the sealing roller and the spring leaf are configured to strengthen the connection of the valve plate and the valve plate holder.

[0015] In an optional embodiment, when the gear pump cover is connected to the pump body, a pump cover cavity and a pump body cavity are formed;

the pump cover cavity, the pump body cavity, and the one-way valve are located within the same medium passage; and

the one-way valve is configured to maintain the flow of a leaking medium from the pump cover cavity through the medium passage.

[0016] In an optional embodiment, when the gear pump cover is connected to the pump body, a skeleton oil seal cavity is further formed at an end of the pump body; and

the skeleton oil seal cavity communicates with the pump body cavity, and is configured for cavity sealing so as to maintain a low sealing pressure of a skeleton oil seal.

[0017] The technical solutions provided in the embo-

diments of the present disclosure achieve at least the following beneficial effects:

(1) Regarding the pump cover structure, the leaking medium is delivered back to the low-pressure oil cavity through the one-way valve. This eliminates the need for an additional oil return port, simplifies the hydraulic system, and facilitates mounting and use by the user.

(1) During the operation of the internal gear pump, with the gear pump cover connected to the pump body, the axial compensation structure and the radial compensation structure designed between the pump body and the gear pump cover enable compensations, using mechanical structures, for the axial clearance and the radial clearance occurring when the high-pressure oil passes through the oil pumping component during the operation of the gear pump. Thus, oil leakage caused by such clearances during operation is reduced, thereby improving volumetric efficiency and low-speed performance.

DESCRIPTION OF THE DRAWINGS

[0018] In order to describe the technical solutions in the embodiments of the present disclosure more clearly, the accompanying drawings required for describing the embodiments are briefly described below. Apparently, the accompanying drawings described below are only some embodiments of the present disclosure. Those of ordinary skill in the art may further derive other drawings from these drawings without creative efforts.

FIG. 1 illustrates a schematic structural diagram of a gear pump cover provided by an exemplary embodiment of the present disclosure;

FIG. 2 illustrates a cross-sectional schematic diagram of a four-quadrant operating internal gear pump provided by an exemplary embodiment of the present disclosure;

FIG. 3 illustrates a cross-sectional schematic diagram of another four-quadrant operating internal gear pump provided by an exemplary embodiment of the present disclosure;

FIG. 4 illustrates a cross-sectional schematic diagram of an oil pumping component provided by an exemplary embodiment of the present disclosure;

FIG. 5 is a schematic structural diagram of an axial compensation structure provided by an exemplary embodiment of the present disclosure;

FIG. 6 is a schematic diagram of a combination of an axial compensation structure and a radial compensation structure provided by an exemplary embodiment of the present disclosure;

FIG. 7 is a schematic structural diagram of a cavity provided by an exemplary embodiment of the present disclosure; and

FIG. 8 is a schematic structural diagram of a cavity provided by an exemplary embodiment of the present disclosure from another perspective.

SPECIFIC IMPLEMENTATIONS

[0019] In order to make the objectives, technical solutions and advantages of the present disclosure clearer, embodiments of the present disclosure will be further described in detail below with reference to the accompanying drawings.

[0020] The gear pump cover and the four-quadrant operating internal gear pump involved in the embodiments of the present disclosure are applied to automotive and industrial scenarios. Optionally, the internal gear pump may be used in industrial transmission scenarios or in automotive active suspensions. The four-quadrant operating internal gear pump cover serves as a detachable oil supply component within the internal gear pump.

[0021] It should be noted that the four-quadrant operating internal gear pump cover and the internal gear pump involved in the embodiments of the present disclosure may each be implemented independently for use as a hydraulic pump motor.

[0022] FIG. 1 illustrates a schematic structural diagram of a gear pump cover provided by an exemplary embodiment of the present disclosure.

[0023] Referring to FIG. 1, the gear pump cover 1 includes pump cover housing 11, medium exchange opening 111, and one-way valve 112, and a medium passage is formed inside a four-quadrant operating internal gear pump cover.

[0024] The medium exchange opening 111 is located at a top of the pump cover housing 11.

[0025] When the four-quadrant operating internal gear pump cover is connected to a pump body, the medium exchange opening 111 is configured to exchange a medium with the outside. The one-way valve 112 is configured to selectively deliver a high-pressure medium leaking within the medium passage to a low-pressure medium cavity.

[0026] On the basis of the gear pump cover shown in FIG. 1, FIG. 2 and FIG. 3 show schematic diagrams of different cross sections of the four-quadrant operating internal gear pump. Referring to FIG. 1 to FIG. 3, the four-quadrant operating internal gear pump includes the gear pump cover 1, the pump body 2, and oil pumping component 12 as shown in FIG. 2.

[0027] The gear pump cover 1 is connected to the pump body 2. A medium passage is formed within the pump body 2 and is configured to allow a medium to pass therethrough when the four-quadrant operating internal gear pump cover operates.

[0028] An accommodating cavity is formed when the

gear pump cover 1 is connected to the pump body 2. The oil pumping component 12 is located within the accommodating cavity and at a connection of the gear pump cover 1 and the pump body 2. The oil pumping component 12 is fixedly connected to each of the gear pump cover 1 and the pump body 2.

[0029] In an embodiment of the present disclosure, the pump body refers to the assembly of all components of the pump module, excluding the four-quadrant operating internal gear pump cover, in practical application scenarios. In an example, the pump body refers to the assembly that is connected to the four-quadrant operating internal gear pump cover. In another example, the pump body denotes the entirety of the pump module including a control module and a motor module, excluding the four-quadrant operating internal gear pump cover. The present disclosure does not impose limitations on the specific structure or form of the pump body. In the present disclosure, the four-quadrant operating internal gear pump cover is configured to pump the medium into the pump body to enable subsequent energy conversion or energy transfer processes.

[0030] It should be noted that, with reference to FIG. 2 and FIG. 3, in an embodiment of the present disclosure, the pump cover housing 11 includes at least two medium exchange openings 111; the at least two medium exchange openings 111 include at least one medium inlet and at least one medium outlet; the at least one medium inlet, the at least one medium outlet, and the one-way valve 112 are located within the same medium passage; the one-way valve 112 is provided with one-way valve mounting hole 113; the one-way valve is located inside the one-way valve mounting hole 113; a first end of the one-way valve 112 is opposite to the medium passage, and a second end of the one-way valve 112 is provided with plug 114. The one-way valve mounting hole 113 defines an outlet oil path 115. The outlet oil path 115 is communicated with the medium passage.

[0031] It should be noted that, in an embodiment of the present disclosure, as shown in FIG. 2, the number of the one-way valve mounting holes 112 is 2. Oil passages defined by the two one-way valve mounting holes 112 may be parallel to each other or form an included angle. Optionally, the included angle may be at least one of an acute angle and an obtuse angle. Preferably, to make the structure compact, the included angle is implemented as the obtuse angle.

[0032] In this case, the one-way valve is in interference fit with the medium exchange opening; or, the one-way valve is in threaded connection with the medium passage. The one-way valve is provided with a sealing ring. The sealing ring is in contact with both the one-way valve and the medium passage. The sealing ring is configured to strengthen the connection of the one-way valve with the medium passage. In case that the medium passage is formed inside the four-quadrant operating internal gear pump, the oil return path where

the one-way valve is located is relatively separate from the main oil path. During the operation of the main oil path, the oil pumping component creates a high-pressure zone and a low-pressure zone, thereby circulating the medium inside the pump body. When high-pressure medium leaks, it will enter the oil return path where the one-way valve is located. The one-way valve controls the flow direction of the medium within the oil return path such that the leaking high-pressure medium is selectively delivered to the low-pressure zone.

[0033] In conclusion, in the device provided by the embodiments of the present disclosure, the leaking medium is delivered back to the low-pressure oil cavity through the one-way valve. This eliminates the need for an additional oil return port, simplifies the hydraulic system, and facilitates mounting and use by the user.

[0034] In an embodiment of the present disclosure, the oil pumping component is provided with an axial compensation structure and a radial compensation structure.

[0035] The axial compensation structure is configured to provide axial clearance compensation for the oil pumping component when the four-quadrant operating internal gear pump operates. The radial compensation structure is configured to provide radial clearance compensation for the oil pumping component when the four-quadrant operating internal gear pump operates.

[0036] The specific forms in which the axial compensation structure and the radial compensation structure are implemented are described hereinafter with reference to FIG. 4 to FIG. 6.

[0037] In an optional embodiment, the oil pumping component 12 includes internal gear 124 and external gear 123. The external gear 123 is engaged with the internal gear 124, and a radius of the external gear 123 is smaller than that of the internal gear 124. A volume cavity is formed between the external gear 123 and the internal gear 124 and is configured to allow the medium to pass therethrough when the four-quadrant operating internal gear pump operates. The radial compensation structure 122 and the axial compensation structure 121 are located inside the volume cavity. The radial compensation structure 122 is in contact with the axial compensation structure 121.

[0038] That is to say, in the embodiments of the present disclosure, the axial compensation structure and the radial compensation structure adapted to the internal gear pump are both located in the flow path of the pressurized medium.

[0039] In an optional embodiment, the axial compensation structure 121 includes axial plate 1211, and the radial compensation structure 122 includes valve plate 1221 and valve plate holder 1222. At least one oil groove 12116 is formed in the axial plate 1211. A surface of the valve plate holder 1222 includes at least one slot 12221, where the oil grooves correspond to the slots in terms of quantity and position. The valve plate 1221 is fit with the surface of the valve plate holder

1222 that is provided with the slots, thereby defining an oil passage. When the four-quadrant operating internal gear pump operates, the medium flows through a passage defined by the oil grooves and the oil passage.

[0040] In this case, the axial plate 1211 is configured as an axisymmetric structure. The axial plate includes first through hole 12111, second through hole 12112, third through hole 12113, fourth through hole 12114, and recessed groove 12115. The first through hole 12111 is located at the axis of the axisymmetric structure and is axisymmetric in shape for positioning and mounting. In practical application, the first through hole may be implemented as a circular through hole for matching with stop pin 1223. There are two recessed grooves 12115, two second through holes 12112, and two third through holes 12113, which are distributed axisymmetrically. The second through holes 12112 and the third through holes 12113 are located inside the recessed grooves 12115. The recessed grooves 12115 have connection portions configured for the medium to pass therethrough. The second through holes 12112 and the third through holes 12113 are configured for connection with an oil inlet/outlet port of the gear pump cover. The fourth through hole 12114 is located at the axis of the axisymmetric structure and is configured for positioning and mounting.

[0041] It should be noted that, in an embodiment of the present disclosure, the width of the oil groove 12116 is sufficient such that, when the medium passage is formed, high-pressure oil can push apart the valve plate 1221 and the valve plate holder 1222 under operating conditions. In this case, the gaps between the oil groove 12116 and the valve plate 1221 as well as the valve plate holder 1222 are interconnected. The valve plate holder is provided with the slots 12221 to accommodate this function.

[0042] In an optional embodiment, the valve plates 1221 and the valve plate holders 1222 correspond to the recessed grooves 12115 in terms of quantity and position, and the radial compensation structure 122 further includes the stop pin 1223. The stop pin 1223 is in contact with the valve plate 1221 and the valve plate holder 1222, and is configured to support the valve plate 1221 and the valve plate holder 1222 and limit the circumferential displacements of the valve plate 1221 and the valve plate holder 1222 under the action of the high-pressure medium.

[0043] Correspondingly, referring to FIG. 4, in order to reduce the leakage between the valve plate and the valve plate holder, the radial compensation structure 122 further includes sealing roller 1224 and spring leaf 1225. The sealing roller 1224 and the spring leaf 1225 are configured for contact with the valve plate 1222. The sealing roller 1224 and the spring leaf 1225 are configured for sealing, thereby preventing the leakage of the high-pressure medium between the valve plate and the valve plate holder.

[0044] Based on the illustration of the structure

above, when the external gear and internal gear are combined as the oil pumping component, the crescent-shaped chamber between the gears is filled with the radial compensation structure such that the crescent-shaped chamber between the gears is divided into two volume cavities, referred to as a first volume cavity and a second volume cavity. When the gears rotate clockwise, the first volume cavity acts as an oil suction cavity. The region of engagement of the gears expands in volume, drawing hydraulic oil into the first volume cavity. As the gears continue to rotate, the tooth space between two teeth of the gears delivers the hydraulic oil from the first volume cavity to the second volume cavity. At the second volume cavity, the region of engagement of the gears reduces in volume, creating a high-pressure cavity that discharges high-pressure hydraulic oil. When the gears rotate counterclockwise, the second volume cavity acts as a low-pressure oil suction cavity, while the first volume cavity acts as the high-pressure cavity. The tooth spaces of the gears then deliver the hydraulic oil from the second volume cavity to the first volume cavity. During this process, the medium, i.e. high-pressure oil or low-pressure oil, flows through the oil passages defined by the recessed grooves and the through holes.

[0045] To accommodate four-quadrant operation, the radial compensation structure is symmetrically designed. In an embodiment of the present disclosure, the radial compensation structure is composed of two valve plate holders, two valve plates, two sealing rollers, and a wavy spring leaf. During the operation of the internal gear pump, the high-pressure oil from the high-pressure cavity side enters the gaps between the valve plates and the valve plate holders, pressing the valve plates and the valve plate holders against the tip circles of the two gears, respectively. This reduces the clearance between the tip circles and reduces leakage of the high-pressure oil into the low-pressure cavity. The clearances between the valve plates and the valve plate holders are sealed by the sealing rollers. High-pressure hydraulic oil presses the sealing rollers against the tangential surfaces of the valve plates and the valve plate holders, preventing the hydraulic oil from leaking into the low-pressure zone. When pressure is not yet established, the wavy spring leaf presses the sealing rollers against the tangential surfaces of the valve plates and the valve plate holders to achieve sealing. The stop pin provides support to the valve plate and the valve plate holder, counteracting the hydraulic pressure acting on the valve plate and the valve plate holder and preventing axial displacements of the valve plate and the valve plate holder.

[0046] Moreover, in the axial direction, the internal gear pump is designed with two axial clearance compensation plates. To accommodate four-quadrant operation, the axial plates are also symmetrically designed. The axial plates are provided with oil grooves corresponding to the radial compensation structures in

terms of quantity and position. These oil grooves respectively communicate with the two volume cavities. Additionally, oil grooves are designed for the volume cavities to communicate with the oil inlet/outlet port of the gear pump cover.

[0047] The axial plates further include the second through holes and the third through holes that communicate with the oil passage defined by the slots in the valve plate holders. This allows the high-pressure oil to quickly fill the clearances between the valve plates and the valve plate holders, rapidly pushing apart the valve plates and the valve plate holders to achieve clearance compensation.

[0048] FIG. 7 illustrates a schematic diagram of an oil path structure of an internal gear pump provided by an exemplary embodiment of the present disclosure, and FIG. 8 illustrates a schematic diagram of the oil path structure from another perspective. As shown in FIG. 8, the accommodating space within the internal gear pump forms a pump cover cavity 610 and a pump body cavity 620, and the pump cover cavity 610 communicates with the pump body cavity 620. In this case, skeleton oil seal cavity 630 is further formed at an end of the pump body. The skeleton oil seal cavity communicates with the pump body cavity, and is configured for cavity sealing so as to maintain a low sealing pressure of a skeleton oil seal. The skeleton oil seal cavity communicates with the pump body cavity, and is configured for cavity sealing so as to maintain a low sealing pressure of the skeleton oil seal. In an embodiment of the present disclosure, the oil paths of the pump cover cavity and the pump body cavity and the oil path of the skeleton oil seal cavity form included angles of 90° with the oil path of the one-way valve.

[0049] It should be noted that, referring to FIG. 8, in an embodiment of the present disclosure, the medium from the pump cover cavity flows into the low-pressure cavity of the gear through the oil path corresponding to the one-way valve, while the high-pressure medium leaking in the oil pumping component will also enter the pump body cavity for circulation.

[0050] In conclusion, according to the internal gear pump provided in the embodiments of the present disclosure, during the operation of the internal gear pump, with the gear pump cover connected to the pump body, the axial compensation structure and the radial compensation structure designed between the pump body and the gear pump cover enable compensations, using mechanical structures, for an axial clearance and a radial clearance occurring when the high-pressure oil passes through the oil pumping component during the operation of the gear pump. Thus, oil leakage caused by such clearances during operation is reduced, thereby improving volumetric efficiency and low-speed performance.

[0051] It should be noted that, in an embodiment of the present disclosure, the internal gear pump is further equipped with essential internal components of the

pump body, such as a sliding bearing and a gear shaft. The present disclosure does not impose limitations on the specific positions and combination manners of the components described above.

[0052] The foregoing are merely descriptions of the optional embodiments of the present disclosure, and are not intended to limit the present disclosure. Any modifications, equivalent replacements and improvements made within the spirit and principle of the present disclosure should be included in the protection scope of the present disclosure.

Claims

1. A gear pump cover, **characterized by** comprising: a pump cover housing, a medium exchange opening, and a one-way valve, wherein a medium passage is formed inside a four-quadrant operating internal gear pump cover;

the medium exchange opening is located at a top of the pump cover housing; when the four-quadrant operating internal gear pump cover is connected to a pump body, the medium exchange opening is configured to exchange a medium with the outside; and the one-way valve is configured to selectively deliver a high-pressure medium leaking within the medium passage to a low-pressure medium cavity.

2. The gear pump cover according to claim 1, **characterized in that** the pump cover housing comprises at least two medium exchange openings;

the at least two medium exchange openings comprise at least one medium inlet and at least one medium outlet; the medium inlet, the medium outlet, and the one-way valve are located within the same medium passage; the one-way valve is provided with a one-way valve mounting hole; the one-way valve is located inside the one-way valve mounting hole; a first end of the one-way valve is opposite to the medium passage, and a second end of the one-way valve is provided with a plug; and the one-way valve mounting hole defines an outlet oil path, and the outlet oil path is communicated with the medium passage.

3. The gear pump cover according to claim 2, **characterized in that** the one-way valve is in interference fit with the medium exchange opening; or

the one-way valve is in threaded connection with the medium passage and is provided with a sealing ring;
the sealing ring is in contact with the one-way valve and the medium passage; and
the sealing ring is configured to strengthen the connection of the one-way valve with the medium passage.

4. A four-quadrant operating internal gear pump, **characterized by** comprising: the gear pump cover according to any one of claims 1 and 2, a pump body, and an oil pumping component;

wherein the gear pump cover is connected to the pump body; a medium passage is formed within the pump body and a medium is allowed to pass through the medium passage when the four-quadrant operating internal gear pump cover operates;

an accommodating cavity is formed when the pump cover is connected to the pump body; the oil pumping component is located within the accommodating cavity and at a connection of the pump cover and the pump body; the oil pumping component is fixedly connected to the pump cover and the pump body;
the oil pumping component is provided with an axial compensation structure and a radial compensation structure;
the axial compensation structure is configured to compensate for an axial clearance of the oil pumping component when the four-quadrant operating internal gear pump operates; and
the radial compensation structure is configured to compensate for a radial clearance of the oil pumping component when the four-quadrant operating internal gear pump operates.

5. The four-quadrant operating internal gear pump according to claim 4, **characterized in that** the oil pumping component comprises an internal gear and an external gear;

the external gear is engaged with the internal gear, and a radius of the external gear is smaller than a radius of the internal gear;
a volume cavity is formed between the external gear and the internal gear and the medium is allowed to pass through the volume cavity when the four-quadrant operating internal gear pump operates;
the radial compensation structure and the axial compensation structure are located inside the volume cavity; and
the radial compensation structure is in contact with the axial compensation structure.

6. The four-quadrant operating internal gear pump according to claim 4, **characterized in that** the axial compensation structure comprises an axial plate, and the radial compensation structure comprises a valve plate and a valve plate holder;

at least one through hole is formed in the axial plate;

a surface of the valve plate holder comprises at least one slot, and the through holes correspond to the slots in terms of quantity and position;

the valve plate is fit with the surface of the valve plate holder having the slots, thereby defining an oil passage; and

when the four-quadrant operating internal gear pump operates, the medium passes through a passage defined by the through holes and the oil passage to push apart the valve plate and the valve plate holder.

7. The four-quadrant operating internal gear pump according to claim 6, **characterized in that** the axial plate is configured as an axisymmetric structure;

the axial plate comprises a first through hole, a second through hole, a third through hole, a fourth through hole, and a recessed groove;

the first through hole is located at an axis of the axisymmetric structure and is axisymmetric in shape for positioning and mounting;

two recessed grooves, two second through holes, and two third through holes are arranged axisymmetrically;

the second through holes and the third through holes are located inside the recessed grooves; the recessed grooves have connection portions configured for the medium to pass there-through;

the second through holes and the third through holes are configured for connection with oil inlet/outlet ports of the gear pump cover; and

the fourth through hole is located at the axis of the axisymmetric structure, and is configured for positioning and mounting and for forming the medium passage when the four-quadrant operating internal gear pump cover operates.

8. The four-quadrant operating internal gear pump according to claim 7, **characterized in that** the valve plates and the valve plate holders correspond to the recessed grooves in terms of quantity and position;

the radial compensation structure further comprises stop pins;

the stop pins are in contact with the valve

plates and the valve plate holders, and are configured to support the valve plates and the valve plate holders; and
the stop pins are configured to limit relative displacements of the valve plates and the valve plate holders. 5

9. The four-quadrant operating internal gear pump according to claim 6, **characterized in that** the radial compensation structure further comprises a sealing roller and a spring leaf; 10

the sealing roller and the spring leaf are configured for contact with the valve plate; and
the sealing roller and the spring leaf are configured to strengthen the connection of the valve plate and the valve plate holder. 15

10. The internal gear pump according to claim 4, **characterized in that** when the internal gear pump cover is connected to the pump body, a pump cover cavity and a pump body cavity are formed; 20

the pump cover cavity, the pump body cavity, and the one-way valve are located within the same medium passage; 25
the one-way valve is configured to maintain a leaking medium from the pump cover cavity flowing through the medium passage;
when the internal gear pump cover is connected to the pump body, a skeleton oil seal cavity is further formed at an end of the pump body; and 30
the skeleton oil seal cavity communicates with the pump body cavity, and is configured for cavity sealing so as to maintain a low sealing pressure of a skeleton oil seal. 35

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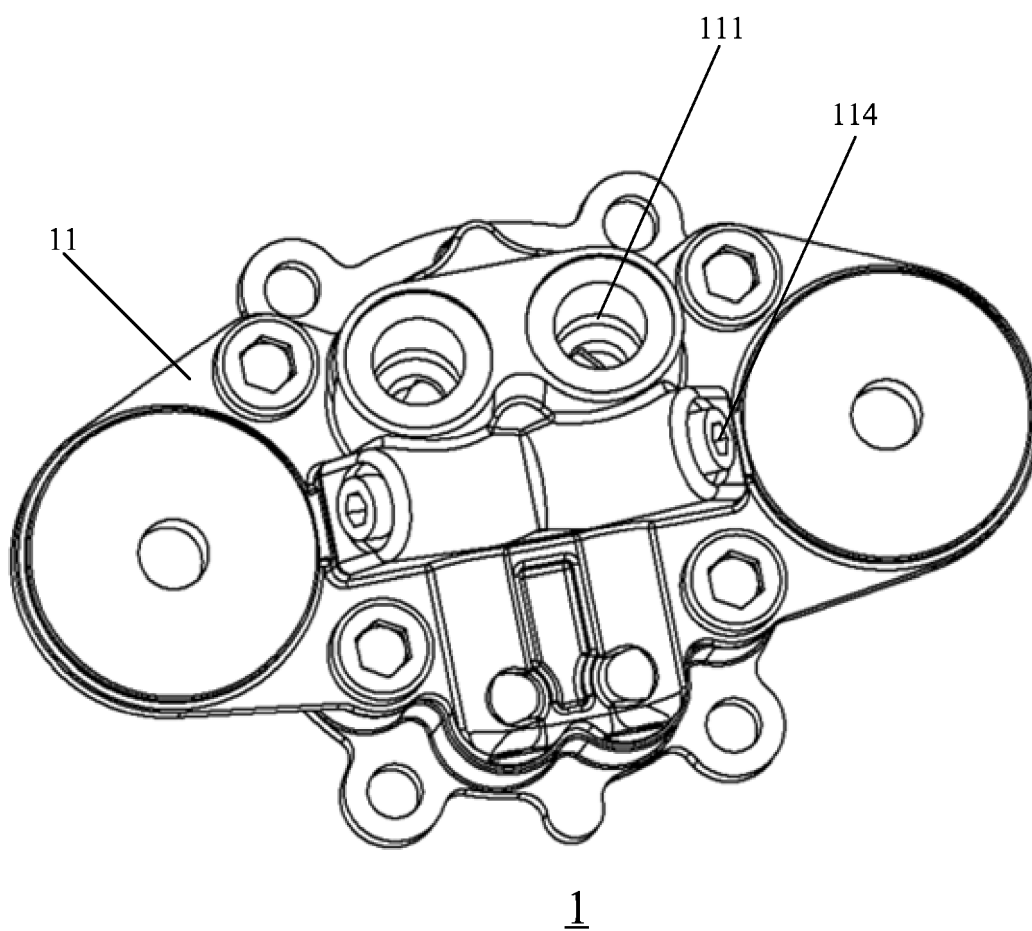


FIG. 1

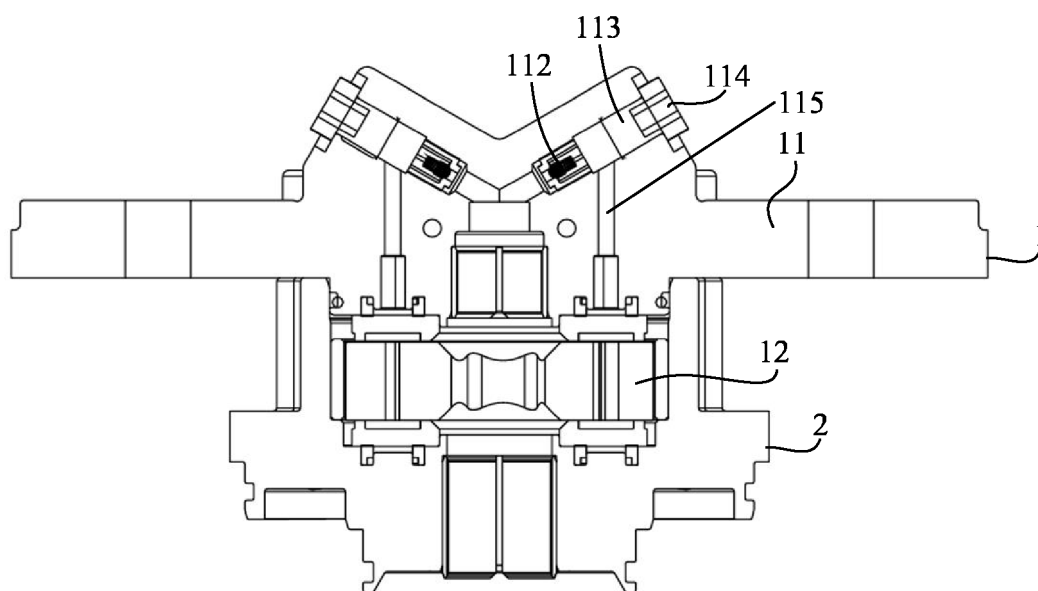


FIG. 2

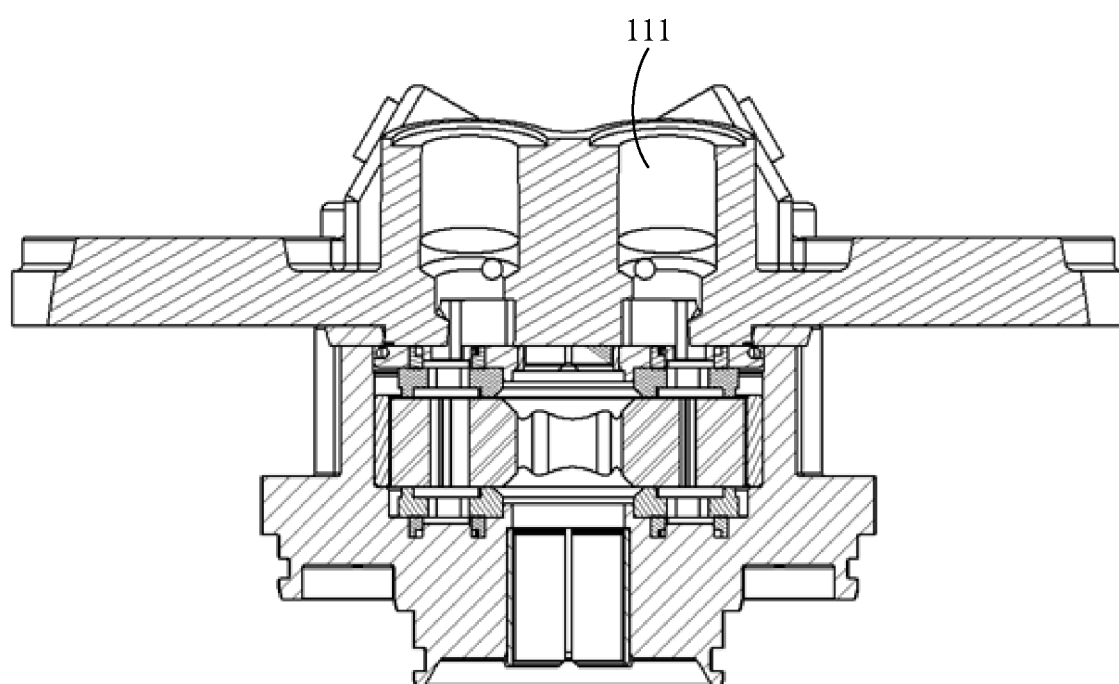


FIG. 3

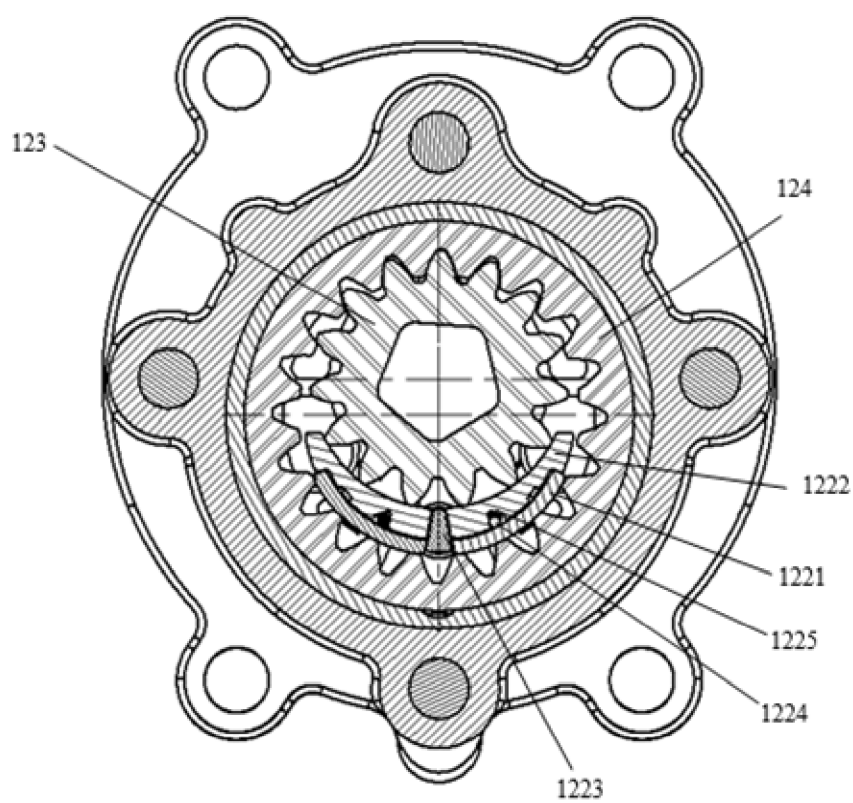


FIG. 4

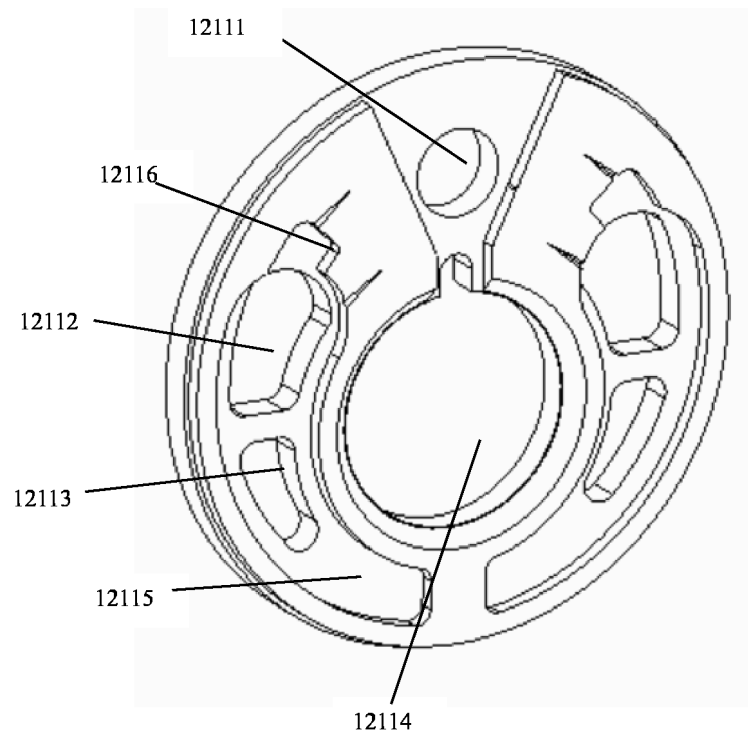


FIG. 5

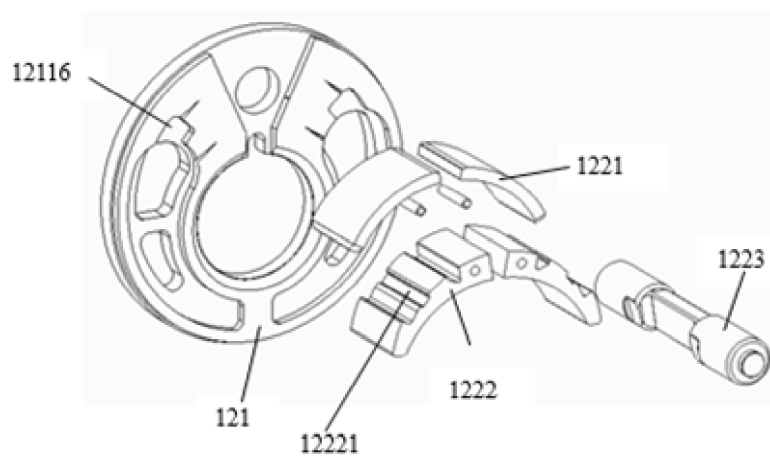


FIG. 6

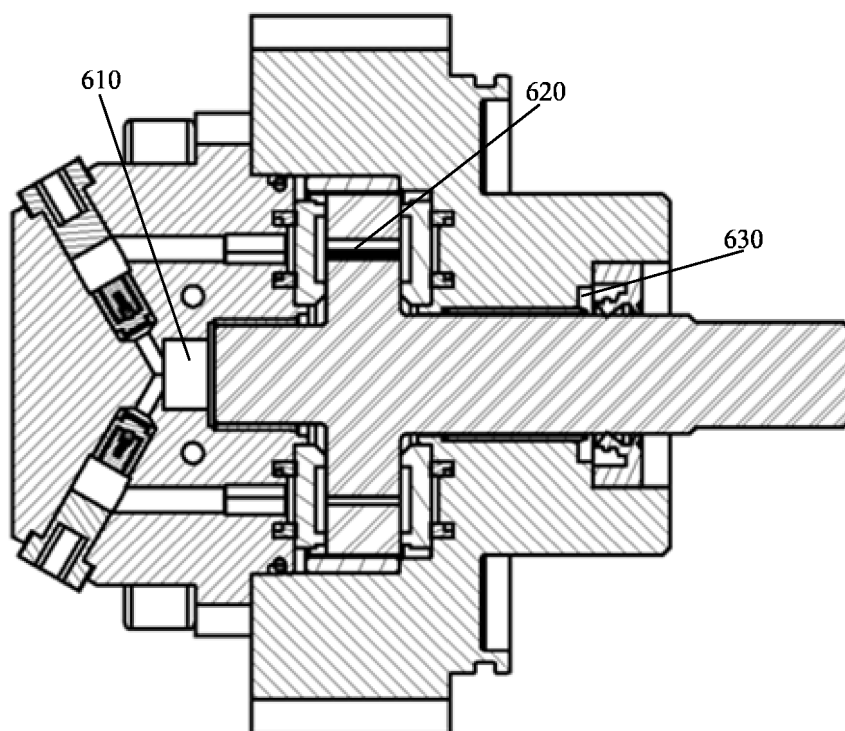


FIG. 7

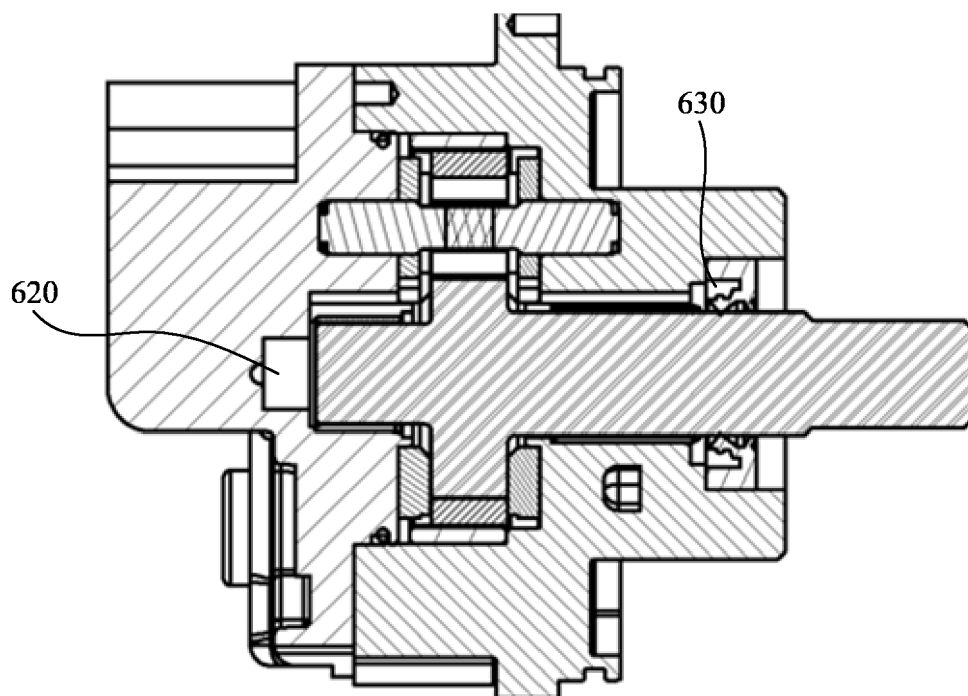


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2025/087037

A. CLASSIFICATION OF SUBJECT MATTER

F04C15/00(2006.01)i; F04C15/06(2006.01)i; F04C2/10(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: F04C

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, ENTXT, ENTXTC, WPABS, DWPI, CNKI: 泵盖, 泵体, 补偿, 齿轮泵, 单向阀, 四象限, 轴向, 径向, 间隙, 高压, 低压, 介质, 交换, gear, pump, cover, quadrant, shell, medium, exchange, valve, axial, radial, gap, high-pressure, low-pressure, clearance, compensation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 116163948 A (NANJING WEIFU JINNING CO., LTD.) 26 May 2023 (2023-05-26) description, specific embodiments, and figures 1-12	1-10
Y	CN 202165271 U (HANGZHOU XIAOSHAN FORKLIFT PARTS CO., LTD.) 14 March 2012 (2012-03-14) description, specific embodiments, and figures 1-4	1-10
A	CN 118309649 A (NANJING WEIFU JINNING CO., LTD.) 09 July 2024 (2024-07-09) entire document	1-10
A	CN 101158349 A (NINGBO HUAYE ELECTROHYDRAULIC CONTROLLING ENGINEERING STOCK CO., LTD.) 09 April 2008 (2008-04-09) entire document	1-10
A	CN 115773239 A (JIANGSU WEI BO HYDRAULIC CO., LTD.) 10 March 2023 (2023-03-10) entire document	1-10

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

* Special categories of cited documents:

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“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

22 September 2025

Date of mailing of the international search report

26 September 2025

Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
CN)
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Beijing 100088

Authorized officer

Telephone No.

International application No.

PCT/CN2025/087037

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015267699 A1 (ECKERLE INDUSTRIE-ELEKTRONIK GMBH) 24 September 2015 (2015-09-24) entire document	1-10

TRANSLATION

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2025/087037

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CN	118309649	A	09 July 2024	None				
CN	101158349	A	09 April 2008	None				
CN	115773239	A	10 March 2023	None				
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				US	10060432	B2	28 August 2018	
				EP	2921702	A2	23 September 2015	
				EP	2921702	A3	11 November 2015	
				EP	2921702	B1	16 June 2021	