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(54) **PUMP DEVICE AND VEHICLE**

PUMPVORRICHTUNG UND FAHRZEUG

DISPOSITIF DE POMPE ET VÉHICULE

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Description

FIELD

[0001] An embodiment of the present invention relates to the technical field of pump devices, in particular, to a pump device and a vehicle.

BACKGROUND

[0002] In general, the pump device comprises a motor portion and a pump portion, and the rotating shaft of the motor portion can drive the pump portion to rotate, thereby realizing the compression function of the pump device. However, the rotating shaft will have other structural friction problems with the pump device during high-speed rotation. In order to reduce the wear of the rotating shaft, the oil of the pump portion is usually used to lubricate the rotating shaft. However, how to ensure that the lubrication requirements of the rotating shaft are met without significantly affecting the displacement of the pump device has become an urgent problem to be solved.

[0003] Document JP 2014 173587 A discloses an oil pump including: an inner rotor having external teeth and rotationally driven by a driving shaft; and an outer rotor installed in a loose-fit state in a pump housing hole formed at a first housing and having internal teeth which engage with the external teeth. An oil introduction groove which introduces a pump discharge pressure is provided at a circumferential predetermined position in an inner periphery of the pump housing hole.

[0004] CN 110 469 502 A discloses an air gap non-oil-immersed inside engaged gear motor pump. The air gap non-oil-immersed inside engaged gear motor pump comprises a shell, a stator, a rotor, a composite rotor shaft, a pump core seat, a driving gear, a driven gear, an inner end cover, an outer end cover and an oil outlet gland. The composite rotor shaft and the rotor are integrated through hot fitting and are supported on the shell and the inner end cover through a first bearing and a second bearing. The driving gear is connected with the composite rotor shaft through a flat key, and the driving gear and the driven gear are both mounted in the pump core seat in a plug-in mode. An observable exhaust device is mounted on an air bleeding hole formed in the shell.

[0005] CN 206 668 608 U discloses an inserted motor pump set noise reduction structure, including oil pump, motor, oil pump rotor shaft, motor rotor shaft, oil pump rotor shaft inserted into the inner hole of the motor rotor shaft, oil pump rotor shaft and motor rotor shaft to form a rotor shaft connection chamber, the oil pump and the motor using the locking screw fastened to the body, the oil pump and the motor connected to the fitting surface of the sealing ring, the motor rotor shaft at the outer diameter of the skeleton oil seal is set up, the rotor shaft connection chamber Through the sealing ring, the skeleton oil seal becomes a closed chamber, the low pressure side of the oil pump is processed with a flow channel, the flow channel is connected with the rotor shaft connection chamber, the inner wall surface of the motor rotor shaft bore is set with a number of equalization groove.

[0006] US 10 337 513 B2 discloses a liquid pump having a housing with a suction connection, a pressure connection and a electric motor for rotationally driving a conveying device that has a suction inlet and pressure outlet which communicate with the suction connection and the pressure connection respectively. An electronic power unit for the electric motor is adjacent to the motor and extends transversely to the axis of rotation and is on the rear side of the partition wall of the housing. The suction inlet is arranged at a height smaller than an inner radius of an annular gap between the stator and rotor, whereas a rotor passage extends at a constant height, so that a liquid inducted by way of the suction connection is guided in part via the annular gap and undergoes a deflection at the partition wall, cooling the latter before it passes through the rotor passage to the suction inlet.

SUMMARY

[0007] In order to solve at least one of the above-mentioned technical problems, one purpose of the embodiment of the present invention is to provide a pump device.

[0008] Another purpose of the embodiment of the present invention is to provide a vehicle having the above-mentioned pump device.

[0009] In order to achieve the above-mentioned purposes, the embodiment of the present invention first aspect provides a pump device, comprising: a casing, comprising a cavity; a motor portion, comprising a rotating shaft rotating around a central axis of the motor portion; a pump portion, the pump portion is arranged on an axial side of the motor portion and in contact with the rotating shaft, and can be driven by the rotating shaft to rotate; the pump portion comprises a first pressure chamber and a second pressure chamber, the pressure that the first pressure chamber bears is greater than the pressure that the second pressure chamber bears; a first bearing, connected with the casing and sleeved on the rotating shaft, the first bearing being located between the motor portion and the pump portion; a first oil groove, arranged on a first end surface of the first bearing facing the pump portion, and communicating with the first pressure chamber; and a throttle groove, provided on the first end surface, and communicating with a gap between the first oil groove and the first bearing, and the rotating shaft.

[0010] According to an embodiment of a pump device provided by the present invention, the pump device comprises a casing, a motor portion, a pump portion, a first bearing, a first oil groove and a throttle groove. The casing has a cavity, and the motor portion and the pump portion are set in the cavity, to ensure that the motor portion and the pump portion are not affected by the external environment and can operate normally through the casing. The motor portion comprises a rotating shaft that rotates around the central axis of the motor portion, the pump portion is arranged on an axial side of the motor portion, and the pump portion is in contact with the rotating shaft. Specifically, the pump portion has an interference fit with the rotating shaft, and the pump portion can be driven by the rotating shaft to rotate. It can be understood that the motor portion drives the pump portion to rotate through the rotating shaft. The pump portion comprises a first pressure chamber and a second pressure chamber, the pressure of the first pressure chamber is greater than that of the second pressure chamber, furthermore, the first pressure chamber can be a high pressure chamber, and the second pressure chamber can be a low pressure chamber.

[0011] In addition, the first bearing is connected with the casing, the first bearing is located between the motor portion and the pump portion, the first bearing is sleeved on the rotating shaft, and the first bearing can support the rotating shaft to a certain extent. It is worth noting that the first bearing can provide lubricating support to the rotating shaft. Since the axes of the first bearing and the rotating shaft coincide, in the actual working process, the rotating shaft drives the pump portion to rotate. Therefore, the pump portion will exert a radial force on the rotating shaft, and the rotating shaft will push the first bearing to one side while receiving the radial force. At this time, the rotating shaft is in contact with the first bearing, and the first bearing will provide support for the rotating shaft, the clearance of the rotating shaft can be controlled within a reasonable range, to facilitate the control of the axis of the rotating shaft.

[0012] It is worth noting that the first bearing is a sliding bearing, and the sliding bearing refers to a bearing that works under sliding friction. Compared with the form of rolling bearing, the sliding bearing works smoothly, reliably and without noise. Under the condition of liquid lubrication, the sliding surface is separated by the lubricating oil without direct contact, which can greatly reduce the friction loss and surface wear. And the gap between the sliding bearing and the rotating shaft is filled with lubricating oil, and the lubricating oil on the sliding surface will form an oil film to realize fluid lubrication. The oil film also has a certain vibration absorption capacity, which improves the service life of the first bearing and the rotating shaft.

[0013] Furthermore, the first oil groove is arranged on the first end surface of the first bearing facing the pump portion, and the first oil groove communicates with the first pressure chamber. Due to the high pressure in the first pressure chamber, a portion of the oil will flow from the first pressure chamber to the first oil groove, and then flow into the gap between the rotating shaft and the first bearing, to ensure the lubrication performance between the first bearing and the rotating shaft.

[0014] Furthermore, the throttle groove is arranged on the first end surface, that is, the throttle groove is arranged on the first end surface of the first bearing facing the pump portion, and the throttle groove is used to communicate with the first oil groove and the gap between the first bearing and the rotating shaft. That is, the oil in the first pressure chamber first flows to the first oil groove, and then flows to the gap between the first bearing and the rotating shaft through the throttle groove. The throttle groove can effectively avoid excessive oil flowing into the gap between the first bearing and the rotating shaft, and then affect the displacement of the pump device.

[0015] Therefore, in order to ensure the fluid lubrication performance between the first bearing and the rotating shaft, it is to provide sufficient lubricating oil to the gap between the first bearing and the rotating shaft, at the same time, make sure that the displacement of the pump portion will not leak seriously, that is, the displacement of the pump portion will not be significantly affected by the oil used for lubrication. Through the combination of first oil groove and throttle groove, the lubrication requirements between the first bearing and the rotating shaft can be achieved, and the flow rate in the first bearing will not be too large to reduce the displacement of the pump device.

[0016] Specifically, the first oil groove can balance the pressure between the cavities in the high pressure side of the pump portion, and then the pressures of the cavities on the high pressure side are similar, thereby reducing the noise and mechanical vibration during operation.

[0017] Furthermore, the flow cross-sectional area of the throttle groove is smaller than the flow cross-sectional area of the first oil groove, so the flow rate of the lubricating oil in the gap between the first bearing and the rotating shaft can be controlled by the throttle groove.

[0018] In addition, the above-mentioned embodiment provided by the present invention may also have the following additional technical features.

[0019] In the above-mentioned embodiment, furthermore, a portion of an inner side wall of the first bearing is recessed away from the rotating shaft to form a first lubrication groove, which communicates with the throttle groove.

[0020] In this embodiment, the first lubrication groove is formed by the depression of a portion of the inner side wall of the first bearing away from the rotating shaft, and the first lubrication groove communicates with the throttle groove. Due to the pressure difference, the oil in the first pressure chamber flows into the gap between the first bearing and the rotating shaft through the first oil groove and the throttle groove in turn, and can also be filled in the first lubrication groove. As the rotating shaft rotates, the oil in the first lubrication groove will coat the surface of the rotating shaft. Here, the first lubrication groove acts as a short-term storage of lubricating oil, and then a fluid lubricating oil film can be formed between the inner wall of the first bearing and the rotating shaft, which further ensures the reliable lubricity between the rotating shaft and the bearing. Furthermore, the first lubrication groove is arranged axially through the first bearing, the first lubrication groove communicates with the shaft hole of the first bearing, one end of the first lubrication groove communicates with the throttle groove, and another end of the first lubrication groove extends toward the motor cavity. Furthermore, the number of first lubrication grooves is at least one, which can be flexibly set according to actual lubrication requirements.

[0021] In any one of the embodiments, furthermore, a ratio of a flow cross-sectional area of the throttle groove to a flow cross-sectional area of the first lubrication groove is greater than or equal to 0.1 and less than or equal to 0.4.

[0022] In this embodiment, $0.1 \leq (S1/S2) \leq 0.4$, by controlling the flow cross-sectional area of the throttle groove, the flow cross-sectional area of the throttle groove will not be too large, to ensure that the oil on the high pressure side of the pump portion will not leak too much and affect the normal compression of the pump portion. That is, the oil will not flow into the first lubrication groove too much through the throttle groove, and will not have a significant impact on the displacement of the pump portion. By limiting the flow cross-sectional area of the first lubrication groove, the flow cross-sectional area of the first lubrication groove will not be too small. This ensures that sufficient flow of lubricating oil can form an oil film between the first bearing and the rotating shaft to meet the fluid lubrication requirements.

[0023] In any one of the embodiments, furthermore, a ratio of the flow cross-sectional area S2 of the first lubrication groove to a cross-sectional area S0 of a shaft hole of the first bearing is greater than or equal to 0.02 and less than or equal to 0.08.

[0024] In this embodiment, $0.02 \leq (S2/S0) \leq 0.08$, the flow cross-sectional area of the first lubrication groove is limited; the flow cross-sectional area of the first lubrication groove is not too small. It can ensure that the lubricating oil has enough flow rates to form an oil film between the first bearing and the rotating shaft to meet the fluid lubrication requirements. The flow cross-sectional area of the first lubrication groove will not be too large, resulting in an excessively thick oil film formed between the first bearing and the rotating shaft, increasing the power consumption of the rotating shaft.

[0025] Furthermore, the cross-sectional area of the shaft hole of the first bearing is limited, it is in a suitable range, and it will not affect the oil entering the gap between the rotating shaft and the first bearing because it is too small. Similarly, the strength of the first bearing itself will not be affected because the cross-sectional area of the shaft hole of the first bearing is too large. Specifically, the shaft diameter of the first bearing is greater than or equal to 6mm and less than or equal to 12mm. According to the relationship between the shaft diameter of the first bearing and the deformation of the first bearing, and the relationship between the shaft diameter of the first bearing and the power consumption, it can be seen that when the shaft diameter is less than 6mm, the deformation of the bearing is large, which is not conducive to the bearing to support the rotating shaft. When the shaft diameter is greater than 12mm, the power consumption of the bearing increases sharply. Therefore, if the shaft diameter of the first bearing meets the above range, it not only meets the power consumption requirements of the bearing, but also avoids the excessive deformation of the bearing.

[0026] In any one of the embodiments, furthermore, the pump device further comprises: a sealing member, connected to one side of the first bearing away from the pump portion, the sealing member is sleeved on the rotating shaft, the sealing member, the first bearing and the rotating shaft form a liquid passage chamber, the liquid passage chamber communicates with the first lubrication groove.

[0027] In this embodiment, the first bearing is connected to the casing, and the first bearing can separate the cavity enclosed by the casing into the motor cavity and the pump cavity, which can make the space layout more reasonable. The motor portion is located in the motor cavity, and the pump portion is located in the pump cavity. The sealing member is connected on one side of the first bearing away from the pump portion and the sealing member is sleeved on the rotating shaft. Specifically, the sealing member can isolate the motor cavity from the pump cavity, the working medium will not flow into the motor cavity, and will not affect the normal use of the stator, rotor, controller and other components in the motor cavity. There is no need to set other structures in the motor cavity to ensure that the components in the motor cavity are not corroded, which makes the sealing performance of the pump device better, and at the same time, the structure is simpler, which is conducive to reducing costs.

[0028] It is worth noting that a portion of the first bearing extends away from the pump portion to construct the installation position. Since the installation position and the first bearing are integral structures, compared with the post-processing method, the integral structure has better mechanical properties, thus can improve connection strength. In addition, the first bearing can be mass-produced to improve the processing efficiency of the product, reduce the processing cost of the product, improve the integrity of the pump device, reduce the number of parts, reduce the installation process, and improve the installation efficiency. In addition, the installation position for installing the sealing member is formed by a portion of the first bearing, the installation accuracy of the sealing member can be ensured, the assembly is simple, the sealing performance is good, and the cost is low.

[0029] Furthermore, the sealing member, the first bearing and the rotating shaft form a liquid passage chamber, and the liquid passage chamber communicates with the first lubrication groove. The liquid passage chamber formed by the sealing member, the first bearing and the rotating shaft can store a portion of the lubricating oil, and the liquid passage chamber is used to store the lubricating oil from the first lubrication groove. By controlling the connection strength between the sealing member and the first bearing, that is, the pressure that the sealing member can bear, the liquid passage chamber can play a buffering role, the oil in the liquid passage chamber, the first lubrication groove, and the throttle groove can be in a state of pressure equalization. On the premise of ensuring the position stability of the sealing member, it is beneficial to ensure the fluid lubrication performance of the rotating shaft and the first bearing.

[0030] In any one of the embodiments, furthermore, the pump device further comprises: a pressure relief groove, arranged on the first bearing, and communicating with the liquid passage chamber and the second pressure chamber.

[0031] In this embodiment, the pressure relief groove is arranged on the first bearing, and the pressure relief groove is used to communicate with the liquid passage chamber and the second pressure chamber. Here, the pressure relief groove can be in the form of a through hole, both ends of the through hole can communicate with the second pressure chamber and the liquid passage chamber. Since the pressure in the second pressure chamber is small, the pressure in the liquid passage chamber can be better released, and the pressure of the oil is not only buffered by the liquid passage chamber itself.

[0032] Furthermore, by setting the pressure relief groove on the first bearing, a complete lubricating oil circuit of the first bearing can be formed. That is, the oil in the first pressure chamber (high pressure chamber) enters the first oil groove, and then flows into the gap between the first bearing and the rotating shaft and the first lubrication groove through the throttle groove, to fully lubricate the rotating shaft and the first bearing and form an oil film, to meet fluid lubrication requirements. After that, the lubricating oil will flow into the liquid passage chamber, and further flow from the pressure relief groove into the second pressure chamber (low pressure chamber), to ensure that the pressure in the entire lubricating oil circuit will not be too high. That is, the pressure in the liquid passage chamber will not be too high, avoid the pressure being higher than the limit value of the pressure that the sealing member can bear, ensure the reliability of the position of the sealing member, and effectively prevent the sealing member from detaching from the first bearing under high pressure, resulting in the leakage of lubricating oil, and the sealing performance between the motor cavity and the pump cavity cannot be ensured.

[0033] In any one of the embodiments, furthermore, a ratio of the flow cross-sectional area of the pressure relief groove to the flow cross-sectional area of the first lubrication groove is greater than or equal to 1 and less than or equal to 4.

[0034] In this embodiment, $1 \leq (S3/S2) \leq 4$, by limiting the flow cross-sectional area of the first lubrication groove, the flow cross-sectional area of the first lubrication groove will not be too small to ensure that the lubricating oil has enough flow rate, to form an oil film between the first bearing and the rotating shaft, to meet the fluid lubrication requirements. At the same time, the flow cross-sectional area of the first lubrication groove will not be too large, resulting in an excessively thick oil film formed between the first bearing and the rotating shaft, which increases the power consumption of the rotating shaft.

[0035] In addition, by limiting the flow area of the pressure relief groove, it can ensure that the pressure of the oil seal cavity is not too high, ensure the sealing effect of the oil seal, and avoid the oil seal detaching from the first bearing due to the high pressure in the liquid passage chamber. The present invention takes into account the flow cross-sectional area of the throttle groove, the flow cross-sectional area of the first lubrication groove and the flow cross-sectional area of the pressure relief groove, the three satisfy the above-mentioned relationship, this ensures that there is sufficient oil flow in the first lubrication groove to ensure the lubrication of the first bearing and rotating shaft. At the same time, it can ensure that the pressure in the liquid passage chamber is low enough, without affecting the sealing connection between the sealing member and the first bearing, effectively reducing oil leakage.

[0036] According to the invention, furthermore, the pump device further comprises: a buffer chamber, arranged on an end surface of the first bearing away from the pump portion.

[0037] According to the invention, the buffer chamber is arranged on the end surface of the first bearing away from the pump portion, specifically, the buffer chamber can be a tapered-shape. That is, the buffer chamber can be a tapered cavity; the buffer chamber can reduce the rigidity of the first bearing and provide flexible support for the rotating shaft. It can reduce the surface pressure on the axial end surface of the first bearing away from the pump portion, which can effectively improve the wear of the first bearing and the rotating shaft.

[0038] Furthermore, an opening area of the buffer chamber is larger than a bottom wall area of the buffer chamber. The buffer chamber comprises: a first wall surface, the first wall surface is a wall surface of the buffer chamber close to the rotating shaft, from an open end of the buffer chamber to a bottom wall of the buffer chamber, a distance between the first wall surface and the rotating shaft increases. It can be understood that the first wall surface is inclined and the position of the first wall surface located at the opening end of the buffer chamber is closer to the rotating shaft, and the distance between the first wall surface and the rotating shaft is smaller at the opening. The distance between the first wall surface and the rotating shaft is larger at the position located at the bottom of the cavity, which also makes a right-angle structure not formed between the first wall surface and the groove bottom of the groove body. Since the first bearing is usually made of aluminum alloy material, when the rotating shaft is in contact with the end of the first bearing, the first bearing will be deformed. If the connection between the first wall surface and the bottom wall of the conical cavity is a right-angle structure, stress concentration will occur at the connection between the first wall surface and the groove bottom of the groove body. When the first bearing is under the pressure of the rotating shaft, the first bearing is easily broken at the connection structure between the first wall surface and the bottom wall of the buffer chamber. When the first wall surface is inclined relative to the axial direction of the rotating shaft, the structure between the first wall surface and the bottom wall of the buffer chamber is not a right-angle structure, which can effectively reduce the damage rate of the first bearing.

[0039] According to the invention, furthermore, the buffer chamber comprises: a second wall surface, the second wall surface is arranged face the first wall surface, from an opening end of the buffer chamber to a bottom wall of the buffer chamber, a distance between the second wall surface and the rotating shaft decreases.

[0040] Therefore, the second wall surface is inclined relative to the axial direction of the rotating shaft, the second wall surface faces the first wall surface, and the distance between the second wall surface and the rotating shaft decreases from the open end of the buffer chamber to the bottom wall of the buffer chamber. Therefore, the second wall surface and the first wall surface can be arranged axially symmetrically with respect to the center line of the buffer chamber. That is, the buffer chamber can have a regular cone shape, which can better provide flexible support for the rotating shaft. It can be understood that, in the axial direction away from the motor portion, the distance between the first wall surface and the rotating shaft increases, the gap between the second wall surface and the rotating shaft decreases, and the buffer chamber is constructed as an inverted cone shape. In the process of processing the buffer chamber, the inverted tapered buffer chamber is conducive to drafting.

[0041] Furthermore, the buffer chamber is constructed as an annular structure, that is, the buffer chambers are arranged in the circumferential direction of the first bearing. When the rotating shaft rotates, the radial force on the first bearing may change at any time. That is, the first bearing will be subjected to radial forces that change in multiple directions, and no matter which direction the radial force received by the first bearing faces, the existence of the annular buffer chamber enables the first bearing to deform to a certain extent. Therefore, the rotating shaft and the first bearing are connected flexibly, and the first bearing has a buffering effect on the radial force of the rotating shaft, avoiding the problem that the first bearing is easily damaged due to the rigid connection between the rotating shaft and the first bearing.

[0042] In any one of the embodiments, furthermore, the pump device further comprises: a second bearing, the second bearing is connected with the casing and sleeved on the rotating shaft, and the second bearing is located on one side of the pump portion away from the first bearing.

[0043] In this embodiment, the second bearing is connected with the casing, and the second bearing is sleeved on the rotating shaft, and the second bearing is located on one side of the pump portion away from the first bearing, that is, the first bearing and the second bearing are located on both sides of the pump portion in the axial direction. And the first bearing is closer to the motor portion than the second bearing. The first bearing and the second bearing can support the rotating shaft. Through the cooperative use of the rotating shaft, the first bearing and the second bearing, the load of the pump portion can be evenly shared by the rotating shaft, the first bearing and the second bearing, avoiding the possible damage to the rotating shaft caused by the load being concentrated on the rotating shaft.

[0044] Specifically, the first bearing and the second bearing are sliding bearings. Compared with the form of double rolling bearings, the sliding bearings work smoothly, reliably and without noise. Under the condition of liquid lubrication, the sliding surfaces are separated by lubricating oil without direct contact, which can greatly reduce friction loss and surface wear. And the gap between the sliding bearing and the rotating shaft is filled with lubricating oil, and the lubricating oil on the sliding surface will form an oil film to realize fluid lubrication. The oil film also has a certain ability to absorb vibration, which improves the service life of the first bearing, the second bearing and the rotating shaft. Two sliding bearings support the rotating shaft, the clearance of the rotating shaft is small, and the position of the axis of the rotating shaft can be controlled within a reasonable range. Compared with the combination of double rolling bearing and sliding bearing, only two sliding bearings are used in this embodiment, which can not only simplify the support structure, but also reduce the cost.

[0045] Furthermore, the first bearing has a first bearing surface close to the rotating shaft, the second bearing has a second bearing surface close to the rotating shaft, and the axial height of the second bearing surface is less than or equal to the axial height of the first bearing surface, that is, not greater than it. When the distance between the first bearing and the pump portion is equal to the distance between the second bearing and the pump portion, the loads from the pump portion carried on the first bearing and the second bearing are equal. However, since the first bearing is closer to the motor portion than the second bearing, during the rotation of the rotor in the motor portion, a radial force is generated between the stator and the rotor, and a load is also generated on the rotating shaft. Therefore, the first bearing also needs to carry the load from the motor portion. By making the second bearing surface less than or equal to the first bearing surface, the first bearing and the second bearing are more suitable for different loads at different positions of the rotating shaft. And on the premise of ensuring the lubrication reliability of the rotating shaft, the power consumption of the rotating shaft can be reduced to a minimum level.

[0046] In any one of the embodiments, furthermore, a portion of an inner side wall of the second bearing is recessed away from the rotating shaft to form a second lubrication groove, which communicates with the first pressure chamber.

[0047] In this embodiment, the second lubrication groove is formed by the depression of a portion of the inner side wall of the second bearing away from the rotating shaft, and the second lubrication groove communicates with the first pressure chamber. Due to the pressure difference, the oil in the first pressure chamber flows into the gap between the first bearing and the rotating shaft through the second lubrication groove. As the rotating shaft rotates, the oil in the second lubrication groove will coat the surface of the rotating shaft. Here, the second lubrication groove can play a role of short-term storage of lubricating oil; a fluid lubricating oil film can be formed between the inner wall of the second bearing and the rotating shaft, to further ensure the lubricating performance between the rotating shaft and the bearing.

[0048] In any one of the embodiments, furthermore, the pump device further comprises: an anti-push lubrication groove, provided on an end surface of the second bearing close to the pump portion, and communicating with a shaft hole of the second bearing.

[0049] In this embodiment, the anti-push lubrication groove is arranged on the end surface of the second bearing close to the pump portion, and the anti-push lubrication groove communicates with the shaft hole of the second bearing. When the rotating shaft rotates at high speed, the lubricating oil in the matching gap with the second bearing will be sheared, and the lubricating oil will enter the anti-push lubrication groove through the second bearing oil groove under the action of shearing force, forming a certain speed and pressure. There is relative motion between the end surface of the inner gear and the end surface of the pump cover, and the lubricating oil in the anti-push lubrication groove can form an oil film, the fluid lubrication condition is formed between the end surface of the inner gear and the end surface of the pump cover. By lubricating the gears, noise can be reduced, and an anti-push force can be formed on the gears, which can greatly improve the power consumption and wear of the anti-push surface, that is, the sliding surface between the inner gear and the pump cover.

[0050] Specifically, the anti-push lubrication groove is arranged on the end surface of the second bearing close to the pump portion, and the anti-push lubrication groove communicates with the second bearing and the shaft hole of the second bearing. There is lubricating oil in the matching gap between the second bearing and the rotating shaft. During the high-speed rotation of the rotating shaft, the rotating shaft will shear the lubricating oil in the matching gap between itself and the second bearing. Under the action of shearing force ω, the lubricating oil will enter the anti-push lubrication groove from the matching gap, and the lubricating oil entering the anti-push lubrication groove has a certain speed and pressure at this time. The end surface clearance between the second bearing and the pump portion is small, and the lubricating oil in the anti-push lubrication groove can flow to the end surface clearance between the second bearing and the pump portion. At the same time, due to the relative motion between the pump portion and the second bearing, the condition of fluid lubrication is formed between the contact end surfaces of the pump portion and the second bearing. That is, an oil film is formed at the contact end surface between the second bearing and the pump portion, the boundary lubrication between the second bearing and the pump portion is transitioned to fluid lubrication, the wear of the contact end surface between the pump portion and the second bearing can be greatly improved, and the power consumption can be reduced. In addition, it can reduce the running noise of the pump device.

[0051] Furthermore, the notch area of the anti-push lubrication groove in the axial direction is larger than the groove bottom area of the anti-push lubrication groove.

[0052] In this embodiment, the anti-push lubrication groove comprises two notches with different orientations, one towards the pump portion and another towards the rotating shaft. In this design, the area of the notch toward the pump portion is defined to be larger than the area of the groove bottom. That is, in the axial direction away from the pump portion, that is, in the top-down direction, the anti-push lubrication groove has a constricted shape, that is, the groove wall of the anti-push lubrication groove has an inclined shape. At this time, on the one hand, the lubricating oil entering the anti-push lubrication groove has a certain speed and pressure, and on the other hand, due to the small gap between the end surfaces of the second bearing and the pump portion in contact, the groove wall of the anti-push lubrication groove has an inclined shape. Then, there is a convergent wedge-shaped angle between the anti-push lubrication groove and the end surface clearance, and the lubricating oil in the anti-push lubrication groove will flow along the inclined groove wall to the end surface clearance between the pump portion and the second bearing, that is, the lubricating oil from "big port" to "small port". It is worth noting that the "big port" refers to the anti-push lubrication groove, and the "small port" refers to the gap between the second bearing and the pump portion. Thus, the lubrication between the pump portion and the second bearing can be enhanced, and the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0053] In addition, during the high-speed rotation of the rotating shaft and the pump portion, the oil film between the contacting surfaces between the pump portion and the second bearing will generate a force F that pushes the pump portion upward, and then the lubricating oil located in the end surfaces of the second bearing and the pump portion acts as a floating seal, which can further reduce the leakage of the end surfaces. According to relevant literature, the end surface leakage of the pump device accounts for 75%~80% of the total leakage of the pump device. Therefore, it is very important to improve the leakage between the contacting end surfaces of the pump device. It is worth noting that lubricating oil has a certain viscosity.

[0054] Furthermore, the anti-push lubrication groove comprises an anti-push wall, the anti-push wall comprises at least one anti-push segment, at least one anti-push segment comprises a first anti-push segment, and in the axial direction away from the pump portion, the first anti-push segment extends close to the center of the anti-push lubrication groove.

[0055] In this embodiment, the anti-push lubrication groove comprises an anti-push wall; the anti-push wall is an inclined wall. In the axial direction away from the pump portion, that is, in the top-down direction, the anti-push wall extends close to the center of the anti-push wall. The anti-push wall comprises at least one anti-push segment, at least one anti-push segment comprises a first anti-push segment, and the first anti-push segment extends in the axial direction away from the pump portion and close to the center of the anti-push lubrication groove. At this time, an end surface clearance is formed between the anti-push lubrication groove and the end surface of the pump portion and the second bearing, and a convergent wedge-shaped angle is formed between the two, then the lubricating oil in the anti-push lubrication groove will flow along the inclined first anti-push segment to the end surface clearance between the pump portion and the second bearing, that is, the lubricating oil enters the "small port" from the "large port". It is worth noting that the "big mouth" refers to the anti-push lubrication groove, and the "small mouth" refers to the gap between the second bearing and the pump portion. Therefore, the lubrication between the pump portion and the second bearing can be enhanced, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0056] It should be noted that the first anti-push segment can be composed of at least one straight segment and at least one curved segment, and the first anti-push segment has a first end close to the pump portion and a second end away from the pump portion. The second end of the first anti-push segment extends close to the center of the anti-push lubrication groove. That is, if the inclined extension trend of the first anti-push segment satisfies the above-mentioned relationship, the flow of lubricating oil can be facilitated. The first anti-push segment can be composed of multi-segment curved surfaces or multi-segment arcs.

[0057] Furthermore, the angle α between the first anti-push segment and the axial end surface of the second bearing is greater than 0° and less than 90°.

[0058] In this embodiment, the axial end surface of the second bearing refers to the axial end surface of the second bearing close to the pump portion. The angle between the first anti-push segment and the axial end surface satisfies $0° < \alpha < 90°$. Therefore, the first anti-push segment can better drain the lubricating oil into the end surface clearance between the second bearing and the pump portion, ensuring that the lubricating oil can enter the end surface clearance through its own velocity and pressure, and is guided by the first anti-push segment, a converging wedge-shaped angle is formed between the anti-push lubrication groove and the end surface clearance. Then the lubricating oil in the anti-push lubrication groove will flow along the inclined groove wall to the end surface clearance of the pump portion and the second bearing, that is, the lubricating oil enters the "small port" from the "big port". Therefore, the lubrication between the pump portion and the second bearing can be enhanced, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two. Furthermore, the angle α between the first anti-push segment and the axial end surface of the second bearing is 45°. It is worth noting that the inclined first anti-push segment can be machined on the end surface of the second bearing close to the pump portion by using the forming tool. Specifically, the longitudinal section (along the axial direction) of the anti-push lubrication groove can be an inverted triangle, a semicircle, etc.

[0059] Furthermore, at least one anti-push segment further comprises a second anti-push segment, which extends axially and connects between the first anti-push segment and the groove bottom of the anti-push lubrication groove.

[0060] In this embodiment, the at least one anti-push segment further comprises a second anti-push segment, and the second anti-push segment extends along the axial direction to be connected between the first anti-push segment and the bottom of the groove. The second anti-push segment cooperates with the first anti-push segment to form an anti-push wall, thereby ensuring that the volume of the anti-push lubrication groove meets the lubrication requirements. It is worth noting that, during the machining process, a straight groove is machined on the end surface of the second bearing toward the pump portion, and then chamfering is machined, the first anti-push segment and the second anti-push segment can be formed. Through the above processing sequence, the processing difficulty of anti-push lubrication groove can be reduced.

[0061] Furthermore, the number of anti-push walls is at least two.

[0062] In this embodiment, the number of anti-push walls is at least two, and each anti-push wall in the at least two anti-push walls comprises at least one anti-push segment. At least one anti-push segment comprises a first anti-push segment. At least one anti-push segment further comprises a second anti-push segment. It is worth noting that the structures of at least two anti-push walls can be equal or unequal. When the number of anti-push walls is three, the structures of the three anti-push walls can be partially equal and partially unequal.

[0063] Furthermore, at least two anti-push walls include a first anti-push wall, and the first end of the first anti-push wall is connected to the inner side wall of the second bearing. The tangent plane where the connection point between the first anti-push wall and the inner side wall of the second bearing is located is the first reference plane. The angle $\beta 1$ between the first anti-push wall and the first reference plane is greater than or equal to 0° and less than 90°.

[0064] In this embodiment, the first end of the first anti-push wall is the start end of the first anti-push wall, the second end of the first anti-push wall is the termination end of the first anti-push wall. The first end is connected with the inner side wall of the second bearing, and the inner side wall of the second bearing is the side wall of the shaft hole of the second bearing. The tangent plane where the connection point between the first end and the second bearing is located is the first reference plane, and the angle $\beta 1$ between the first anti-push wall and the first reference plane is greater than or equal to 0° and less than 90°. During the high-speed rotation of the rotating shaft, the rotating shaft will shear the lubricating oil in the matching gap between itself and the second bearing, and the lubricating oil will enter the anti-push lubrication groove from the matching gap under the action of the shearing force ω. At this time, the lubricating oil entering the anti-push lubrication groove has a certain speed and pressure. Since the first anti-push wall is biased towards the rotating direction of the rotating shaft, the lubricating oil in the anti-push lubrication groove will have shaft shearing and surface shearing. Thus, a negative pressure is formed at the position of the anti-push lubrication groove close to the shaft hole, to suck the lubricating oil between the rotating shaft and the second bearing. However, if the pressure in the anti-push lubrication groove is higher at the position away from the shaft hole, the lubricating oil in the anti-push lubrication groove will flow into the end surface clearance between the second bearing and the pump portion along the inclined anti-push wall. Therefore, the lubrication between the pump portion and the second bearing can be enhanced, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0065] Furthermore, the at least two anti-push walls also include a second anti-push wall, the second anti-push wall is set opposite to the first anti-push wall, and the first end of the second anti-push wall is connected to the inner side wall of the second bearing. The tangent plane where the connection point between the second anti-push wall and the inner side wall of the second bearing is located is the second reference plane, and the angle $\beta 2$ between the second anti-push wall and the second reference plane is greater than 0° and less than 90°.

[0066] In this embodiment, the at least two anti-push walls also include the second anti-push wall, and the first end of the second anti-push wall is the starting end of the second anti-push wall. The second end of the second anti-push wall is the termination end of the second anti-push wall, the second end is connected to the inner side wall of the second bearing, and the inner side wall of the second bearing is the side wall of the shaft hole of the second bearing. The tangent plane of the connection point between the first end and the second bearing is the second reference plane, and the angle $\beta 2$ between the second anti-push wall and the second reference plane is greater than or equal to 0° and less than 90°. During the high-speed rotation of the rotating shaft, the rotating shaft will shear the lubricating oil in the matching gap between itself and the second bearing, and the lubricating oil will enter the anti-push lubrication groove from the matching gap under the action of the shearing force ω. At this time, the lubricating oil entering the anti-push lubrication groove has a certain speed and pressure. Since the second anti-push wall is biased towards the rotating direction of the rotating shaft, the lubricating oil in the anti-push lubrication groove will have shaft shearing and surface shearing. Thus, a negative pressure is formed at the position of the anti-push lubrication groove close to the shaft hole, to suck the lubricating oil between the rotating shaft and the second bearing. However, if the pressure in the anti-push lubrication groove is higher at the position away from the shaft hole, the lubricating oil in the anti-push lubrication groove will flow into the end surface clearance between the second bearing and the pump portion along the inclined anti-push wall. Therefore, the lubrication between the pump portion and the second bearing can be enhanced, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0067] Furthermore, the at least two anti-push walls also include a third anti-push wall, and the third anti-push wall is respectively connected with the second end of the first anti-push wall and the second end of the second anti-push wall.

[0068] In this embodiment, the at least two anti-push walls also include a third anti-push wall, and the third anti-push wall is respectively connected with the second end of the first anti-push wall and the second end of the second anti-push wall. That is, the anti-push lubrication groove is composed of the first anti-push wall, the second anti-push wall and the third anti-push wall, which can facilitate the shape design of the anti-push lubrication groove.

[0069] It is worth noting that the projection of the first anti-push wall, the second anti-push wall and the third anti-push wall on the axial end surface of the second bearing can be a straight segment or a curved segment.

[0070] Furthermore, the third anti-push wall of the anti-push lubrication groove is an arc-shaped wall.

[0071] In this embodiment, the third anti-push wall is an arc-shaped wall, that is, the projection of the third anti-push wall on the axial end surface of the second bearing is an arc-shaped segment. Since the position corresponding to the third anti-push wall is the position away from the shaft hole in the anti-push lubrication groove, the lubricating oil pressure in the anti-push lubrication groove corresponding to this position is higher. By making the third anti-push wall an arc-shaped wall, the flow of lubricating oil in the anti-push lubrication groove can be facilitated, it can facilitate lubricating oil from the "big port" into the "small port", and can enhance the lubrication between the pump portion and the second bearing, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0072] In any one of the embodiments, furthermore, the casing comprises: a machine shell, surrounded outside the motor portion and the pump portion and connected with the first bearing; and a pump cover, the pump cover is connected on the machine shell, the pump cover and the machine shell form the cavity, the pump cover is connected to the second bearing, a portion of the pump cover extends away from the pump portion to construct out an extension portion being used for forming an oil pool, a shaft hole of the second bearing is an axial through hole, one end of the through hole is communicated with the anti-push lubrication groove, and another end of the through hole is used to communicate with the oil pool.

[0073] In this embodiment, the casing comprises a machine shell and a pump cover connected on the machine shell, the pump cover and the machine shell form a cavity, and the machine shell surrounds outside the motor portion and the pump portion. The machine shell is connected with the first bearing, and the pump cover is connected with the second bearing. The first bearing and the machine shell can be integrally formed, and the machine shell and the first bearing can be integrally formed. Compared with the post-processing method, the connection strength is higher; it can save space, reduce the height of the whole machine, and can reduce the difficulty of the preparation process and reduce the production cost. The pump cover and the second bearing can be integrally formed, saving more height space, not only reducing the height of the whole machine, but also reducing the cost.

[0074] Furthermore, the extension portion is formed by an extension structure of a portion of the pump cover away from the pump portion. Therefore, the extension portion and the pump cover are integrally formed, and the connection strength is higher than the post-processing method. The extension portion is used to form an oil pool, which can store the lubricating oil. The shaft hole on the second bearing is an axial through hole, and the two ends of the through hole are connected to the anti-push lubrication groove and the oil pool respectively.

[0075] Specifically, during the high-speed rotation of the rotating shaft, the rotating shaft will shear the lubricating oil in the matching gap between itself and the second bearing. The lubricating oil will enter the anti-push lubrication groove from the matching gap (through hole) under the action of shearing force. At this time, the lubricating oil entering the anti-push lubrication groove has a certain speed and pressure. The lubricating oil in the anti-push lubrication groove will undergo shaft shearing and surface shearing, thereby forming a negative pressure in the anti-push lubrication groove close to the shaft hole, to suck the lubricating oil between the rotating shaft and the second bearing. However, the pressure in the anti-push lubrication groove is higher at the position away from the shaft hole, and the lubricating oil in the anti-push lubrication groove can be better pushed into the end surface clearance between the second bearing and the pump portion. Therefore, the lubrication between the pump portion and the second bearing can be enhanced, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0076] Furthermore, the oil is drawn into the anti-push lubrication groove to lubricate the contact surface between the pump portion and the second bearing, and then enters the gap between the second bearing and the pump portion, and then enters the oil pool of the low pressure area under the action of pressure difference and gravity.

[0077] Specifically, the lubricating oil circuit of the second bearing is as follows: the oil enters the gap between the second bearing and the rotating shaft through the oil pool (through hole, second lubrication groove) and then enters the anti-push lubrication groove. Under the action of the anti-push lubrication groove, the oil enters the end surface clearance between the pump portion and the second bearing, and enters the low pressure oil pool under the action of pressure difference and gravity. By forming a complete lubricating oil circuit for the second bearing, it is beneficial to ensure the lubricating performance between the second bearing and the rotating shaft.

[0078] Furthermore, the pump cover and the second bearing are integrally formed. Compared with the post-processing method, the connection strength is higher; it can save space, reduce the height of the whole machine, and can reduce the difficulty of the preparation process and reduce the production cost.

[0079] In any one of the embodiments, furthermore, the casing comprises: a machine shell, surrounded outside the motor portion and the pump portion, and the machine shell is connected with the first bearing; and a pump cover, the pump cover is connected on the machine shell, the pump cover and the machine shell form the cavity, and the pump cover is connected to the second bearing, the shaft hole of the second bearing is a blind hole with one end open; and a communication groove, opened on the second bearing and/or the pump cover, and communicating the first pressure chamber and the blind hole.

[0080] In this embodiment, the casing comprises a machine shell and a pump cover connected on the machine shell, the pump cover and the machine shell form a cavity, and the machine shell surrounds outside the motor portion and the pump portion. The machine shell is connected with the first bearing, and the pump cover is connected with the second bearing. The first bearing and the machine shell can be integrally formed, and the machine shell and the first bearing are integrally formed. Compared with the post-processing method, the connection strength is higher; it can save space, reduce the height of the whole machine, and can reduce the difficulty of the preparation process and reduce the production cost. The pump cover and the second bearing can be integrally formed, saving more height space, not only reducing the height of the whole machine, but also reducing the cost.

[0081] Furthermore, the shaft hole of the second bearing is a blind hole with one end open, and the communication groove is opened on the second bearing and/or the pump cover, and the communication groove is used to communicate with the first pressure chamber and the blind hole. Specifically, the lubricating oil circuit of the second bearing is: the pressurized oil enters the blind hole (the gap between the second bearing and the rotating shaft, the second lubrication groove) from the first pressure chamber (high pressure chamber) through the communication groove and then returns to the low pressure area through the gap between the second bearing and the pump portion, where the low pressure area specifically refers to the oil inlet and the second pressure chamber. By forming a complete lubricating oil circuit for the second bearing, it is beneficial to ensure the lubricating performance between the second bearing and the rotating shaft.

[0082] In any one of the embodiments, furthermore, the pump portion comprises: a first rotation member, matched with the rotating shaft; and a second rotation member, the second rotation member is arranged on an outside of the first rotation member, and the first rotation member can drive the second rotation member to rotate, the second rotation member and the first rotation member construct out the first pressure chamber and the second pressure chamber, the pump device further comprises: an oil inlet, axially opened on the pump cover and/or the second bearing, and the oil inlet communicating with the second pressure chamber; an oil outlet, radially opened on the pump cover and the second bearing, and the oil outlet communicating with the first pressure chamber of the pump portion.

[0083] In this embodiment, the pump portion comprises a first rotation member and a second rotation member, the first rotation member is matched with the rotating shaft, the second rotation member is arranged outside the first rotation member, and the first rotation member can drive the second rotation member to rotate. It can be understood that the rotating shaft can drive the second rotation member to run through the first rotation member. The first pressure chamber and the second pressure chamber are formed by setting the first rotation member and the second rotation member, and the first pressure chamber is a high pressure chamber, and the second pressure chamber is a low pressure chamber.

[0084] It is worth noting that the first rotation member is an inner gear, and the second rotation member is an outer gear, that is, the pump portion is a gear pump. Specifically, during the meshing process of the gear pump, the former pair of teeth has not yet been disengaged, and the latter pair of teeth has entered meshing, and each inner tooth surface is in contact with the outer tooth surface to form a closed cavity, with the rotation of the inner gear, the volume of the closed cavity will change, and if the unloading channel cannot be connected, the trapped oil volume will be formed. Due to the small compressibility of the liquid, when the trapped oil volume changes from large to small, the liquid in the trapped oil volume is squeezed, and the pressure rises sharply, which greatly exceeds the working pressure of the gear pump. At the same time, the liquid in the trapped oil volume is also forcibly squeezed out from all leakable gaps, that the rotating shaft and bearing will bear a large impact load. This will increase power loss and cause oil to heat up causing noise and vibrations that reduce the smoothness and life of the gear pump. When the trapped oil volume changes from small to large, a vacuum is formed, which causes the air dissolved in the liquid to separate out and generate bubbles, which bring about hazards such as cavitation, noise, vibration, flow and pressure pulsation. The method of eliminating the trapped oil is to open the unloading groove on both ends of the gear, when the closed volume decreases, the unloading groove communicates with the oil pressure chamber, and when the closed volume increases; it communicates with the oil suction chamber through the unloading groove.

[0085] Specifically, the inner gear meshes with the tooth profile of the conjugate curve of the outer gear, and each tooth is in contact with each other, driving the outer gear to rotate in the same direction. The inner gear divides the inner cavity of the outer gear into multiple working chambers. Due to the offset of the center of the inner and outer gears, the volumes of the multiple working chambers change with the rotation of the rotor, and a certain vacuum is formed in the area where the volume increases. The oil inlet is set at this position, the pressure increases in the area where the volume decreases, and the oil outlet is set here accordingly.

[0086] Furthermore, the pump device further comprises an oil inlet and an oil outlet, the oil inlet is axially opened on the pump cover and/or the second bearing, and the oil inlet communicates with the second pressure chamber. Since the second pressure chamber is a low pressure chamber, there is a pressure difference with the outside of the chamber, so the oil will enter the second pressure chamber through the oil inlet. The oil outlet is radially opened on the pump cover and the second bearing, and the oil outlet communicates with the first pressure chamber. Since the first pressure chamber is a high pressure chamber, there is a pressure difference with the outside of the chamber, so the oil in the first pressure chamber will flow out through the oil outlet. That is, the main oil circuit of the pump device is: the negative pressure that can be generated at the second pressure chamber and the oil inlet and under the action of the negative pressure, the oil in the oil pool is attracted to the oil inlet, and then enters the second pressure chamber (low pressure chamber), and then the oil entering the second pressure chamber enters the high pressure chamber under the action of the first rotation member and the second rotation member to be pressurized, and the pressurized oil is discharged through the oil outlet.

[0087] It is worth noting that the design principle of the oil inlet and the oil outlet: in the process of ensuring the rotation of the gear, the oil inlet and the teeth of the first rotation member and the second rotation member are connected as soon as possible, before the inner gear and the outer gear form the maximum volume, the gear volume cavity is always communicated with the oil inlet, and the oil filling time should be prolonged as much as possible, the volume cavity between the inner and outer teeth is filled with oil, thereby ensuring the oil absorption. The oil outlet should also be connected to the high-pressure oil between the teeth as soon as possible, to reduce the excessive compression work between the teeth, and close as late as possible to make full use of the inertia of the fluid to drain the oil between the teeth, thereby improving the volumetric efficiency of the inner gear oil pump. However, it should be noted that when the inner and outer gears form the maximum volume, they cannot communicate with the oil inlet to avoid affecting the volumetric efficiency of the pump device at low speed.

[0088] In any one of the embodiments, furthermore, the motor portion further comprises: a rotor, connected with the rotating shaft; and a stator, sleeved on an outside of the rotor, the stator including a stator core and a stator winding, and the stator winding is arranged on the stator core, the pump device further comprises: a controller, arranged on one side of the motor portion away from the pump portion, and connected on the casing and located in the cavity, and one end of the stator winding being electrically connected to the controller.

[0089] In this embodiment, the motor portion further comprises a rotor and a stator. The rotor and the rotating shaft are connected, in some embodiments, the rotor and the rotating shaft can be coaxially arranged, and the matching mode of the rotor and the rotating shaft can be interference fit. In some embodiments, the rotor and rotating shaft can be set on different shafts, but the two are connected by transmission, which can be flexibly set according to the actual situation. The stator is sleeved on the outer side of the rotor, the stator comprises the stator core and the stator winding, and the stator winding is set on the stator core.

[0090] In addition, the pump device further comprises a controller, and the controller is arranged on one side of the motor portion away from the pump portion, that is, the controller is arranged at a position of the motor portion away from the pump portion. Since the vibration near the pump portion is more obvious during the working process, and the load is larger, the controller is far away from the pump portion, which can protect the controller to a certain extent and improve the service life of the controller.

[0091] Furthermore, the controller is connected on the casing and located in the cavity, and the end of the stator winding is electrically connected to the controller.

[0092] Specifically, during the working process of the pump device, the controller controls the current of the stator winding in the stator to change according to a certain law, thereby controlling the stator to generate a changing excitation magnetic field. The rotor rotates under the action of the excitation magnetic field, thereby driving the first rotation member in the pump portion to rotate through the rotating shaft, thereby making the second rotation member move. When the first rotation member and the second rotation member in the pump portion rotate, due to the eccentric movement of the second rotation member, the volume of the compression cavity formed between the first rotation member and the second rotation member changes. Thus, the working medium entering the compression chamber is pressed out to the oil outlet to generate flow power.

[0093] The embodiment of the second aspect of the present invention provides a vehicle, including a pump device in any one of the above-mentioned embodiments.

[0094] According to the embodiment of the vehicle of the present invention, including the pump device, furthermore, the vehicle can be a special vehicle, and the vehicle has all the advantages of the pump device.

[0095] It is worth noting that the vehicle can be a traditional fuel vehicle or a new energy vehicle. New energy vehicles include pure electric vehicles, extended-range electric vehicles, hybrid electric vehicles, fuel cell electric vehicles, hydrogen engine vehicles, etc.

[0096] In the above-mentioned embodiment, the vehicle comprises: a vehicle body; a pump device set in the vehicle body; an engine set in the vehicle body, the engine comprises a mounting seat, and the mounting seat is connected with the extension portion of the pump device.

[0097] In this embodiment, the vehicle comprises a vehicle body and an engine. Both the pump device and the engine are set in the vehicle body, the engine comprises a mounting seat, and the mounting seat is connected with the extension portion of the pump device, the engine and the pump device can be connected through the cooperation of the mounting seat and the extension portion.

[0098] Since the vehicle comprises any one of the pump devices in the above-mentioned first aspect, it has the beneficial effects of any one of the above-mentioned embodiments, which will not be repeated here.

[0099] Additional aspects and advantages of the present invention will become apparent in the following description or will be learned by practice of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0100]

FIG. 1 shows a schematic structural diagram of a pump device of an embodiment according to the present invention.

FIG. 2 shows a partial enlarged view at A of a pump device of an embodiment shown in FIG. 1 according to the present invention.

FIG. 3 shows a partial schematic structural diagram of a pump device of an embodiment according to the present invention.

FIG. 4 shows a schematic structural diagram of a pump device of another embodiment according to the present invention.

FIG. 5 shows a schematic structural diagram of a pump cover and a second bearing of the pump device in an embodiment according to the present invention.

FIG. 6 shows a schematic structural diagram of a vehicle in an embodiment according to the present invention.

[0101] The corresponding relationship between the reference signs and component names in Fig. 1 to Fig. 6 is as follows:

[0102] 100 pump device, 110 casing, 111 cavity, 112 machine shell, 113 pump cover, 114 extension portion, 115 oil pool, 120 motor portion, 121 rotating shaft, 122 rotor, 123 stator, 130 pump portion, 131 first pressure chamber, 132 second pressure chamber, 133 first rotation member, 134 second rotation member, 140 first bearing, 141 first oil groove, 142 throttle groove, 143 first lubrication groove, 144 pressure relief groove, 150 sealing member, 151 liquid passage chamber, 160 buffer chamber, 161 first wall surface, 162 second wall surface, 170 second bearing, 171 second lubrication groove, 172 anti-push lubrication groove, 181 oil inlet, 182 oil outlet, 190 controller, 200 vehicle, 210 vehicle body, 220 engine, 221 mounting seat.

DETAILED DESCRIPTION OF THE INVENTION

[0103] In order that the above-mentioned objectives, features and advantages of the present invention can be understood more clearly, a further detailed description of the present invention will be given below in connection with the accompanying drawings and specific embodiments. It should be noted that the embodiments of the present invention and the features in the embodiments can be combined with each other if there is no conflict.

[0104] In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, the present invention can also be implemented in other manners than those described herein. Therefore, the protection scope of the present invention is not limited to the specific embodiments disclosed below.

[0105] The pump device 100 and the vehicle 200 provided according to some embodiments of the present invention are described below with reference to Figs. 1 to 6.

Embodiment 1

[0106] The embodiment of the present invention first aspect provides a pump device 100, as shown in Figs. 1, 2 and 3, comprising: a casing 110, comprising a cavity 111; a motor portion 120, comprising a rotating shaft 121 rotating around a central axis of the motor portion 120; a pump portion 130, the pump portion 130 is arranged on an axial side of the motor portion 120 and in contact with the rotating shaft 121, and can be driven by the rotating shaft 121 to rotate; the pump portion 130 comprises a first pressure chamber 131 and a second pressure chamber 132, the pressure that the first pressure chamber 131 bears is greater than the pressure that the second pressure chamber 132 bears; a first bearing 140, connected with the casing 110 and sleeved on the rotating shaft 121, the first bearing 140 is located between the motor portion 120 and the pump portion 130; a first oil groove 141, arranged on a first end surface of the first bearing 140 facing the pump portion 130, and communicating with the first pressure chamber 131; and a throttle groove 142, provided on the first end surface, and communicating with a gap between the first oil groove 141 and the first bearing 140, and the rotating shaft 121.

[0107] According to an embodiment of a pump device 100 provided by the present invention, the pump device 100 comprises a casing 110, a motor portion 120, a pump portion 130, a first bearing 140, a first oil groove 141 and a throttle groove 142. The casing 110 has a cavity 111, and the motor portion 120 and the pump portion 130 are set in the cavity 111, to ensure that the motor portion 120 and the pump portion 130 are not affected by the external environment and can operate normally through the casing 110. The motor portion 120 comprises a rotating shaft 121 that rotates around the central axis of the motor portion 120, the pump portion 130 is arranged on an axial side of the motor portion 120, and the pump portion 130 is in contact with the rotating shaft 121. Specifically, the pump portion 130 has an interference fit with the rotating shaft 121, and the pump portion 130 can be driven by the rotating shaft 121 to rotate. It can be understood that the motor portion 120 drives the pump portion 130 to rotate through the rotating shaft 121. The pump portion 130 comprises a first pressure chamber 131 and a second pressure chamber 132, the pressure of the first pressure chamber 131 is greater than that of the second pressure chamber 132, furthermore, the first pressure chamber 131 can be a high pressure chamber, and the second pressure chamber 132 can be a low pressure chamber.

[0108] In addition, the first bearing 140 is connected with the casing 110, the first bearing 140 is located between the motor portion 120 and the pump portion 130, the first bearing 140 is sleeved on the rotating shaft 121, and the first bearing 140 can support the rotating shaft 121 to a certain extent. It is worth noting that the first bearing 140 can provide lubricating support to the rotating shaft 121. Since the axes of the first bearing 140 and the rotating shaft 121 coincide, in the actual working process, the rotating shaft 121 drives the pump portion 130 to rotate. Therefore, the pump portion 130 will exert a radial force on the rotating shaft 121, and the rotating shaft 121 will push the first bearing 140 to one side while receiving the radial force. At this time, the rotating shaft 121 is in contact with the first bearing 140, and the first bearing 140 will provide support for the rotating shaft 121, the clearance of the rotating shaft 121 can be controlled within a reasonable range, to facilitate the control of the axis of the rotating shaft 121.

[0109] It is worth noting that the first bearing 140 is a sliding bearing, and the sliding bearing refers to a bearing that works under sliding friction. Compared with the form of rolling bearing, the sliding bearing works smoothly, reliably and without noise. Under the condition of liquid lubrication, the sliding surface is separated by the lubricating oil without direct contact, which can greatly reduce the friction loss and surface wear. And the gap between the sliding bearing and the rotating shaft 121 is filled with lubricating oil, and the lubricating oil on the sliding surface will form an oil film to realize fluid lubrication. The oil film also has a certain vibration absorption capacity, which improves the service life of the first bearing 140 and the rotating shaft 121.

[0110] Furthermore, as shown in Fig. 3, the first oil groove 141 is arranged on the first end surface of the first bearing 140 facing the pump portion 130, and the first oil groove 141 communicates with the first pressure chamber 131. Due to the high pressure in the first pressure chamber 131, a portion of the oil will flow from the first pressure chamber 131 to the first oil groove 141, and then flow into the gap between the rotating shaft 121 and the first bearing 140, to ensure the lubrication performance between the first bearing 140 and the rotating shaft 121.

[0111] Furthermore, as shown in Fig. 3, the throttle groove 142 is arranged on the first end surface, that is, the throttle groove 142 is arranged on the first end surface of the first bearing 140 facing the pump portion 130, and the throttle groove 142 is used to communicate with the first oil groove 141 and the gap between the first bearing 140 and the rotating shaft 121. That is, the oil in the first pressure chamber 131 first flows to the first oil groove 141, and then flows to the gap between the first bearing 140 and the rotating shaft 121 through the throttle groove 142. The throttle groove 142 can effectively avoid excessive oil flowing into the gap between the first bearing 140 and the rotating shaft 121, and then affect the displacement of the pump device 100.

[0112] Therefore, in order to ensure the fluid lubrication performance between the first bearing 140 and the rotating shaft 121, it is to provide sufficient lubricating oil to the gap between the first bearing 140 and the rotating shaft 121, at the same time, make sure that the displacement of the pump portion 130 will not leak seriously, that is, the displacement of the pump portion 130 will not be significantly affected by the oil used for lubrication. Through the combination of first oil groove 141 and throttle groove 142, the lubrication requirements between the first bearing 140 and the rotating shaft 121 can be achieved, and the flow rate in the first bearing 140 will not be too large to reduce the displacement of the pump device 100.

[0113] Specifically, the first oil groove 141 can balance the pressure between the cavities in the high pressure side of the pump portion 130, and then the pressures of the cavities on the high pressure side are similar, thereby reducing the noise and mechanical vibration during operation.

[0114] Furthermore, as shown in Fig. 3, the flow cross-sectional area of the throttle groove 142 is smaller than the flow cross-sectional area of the first oil groove 141, so the flow rate of the lubricating oil in the gap between the first bearing 140 and the rotating shaft 121 can be controlled by the throttle groove 142.

[0115] Furthermore, as shown in Figs. 1 to 3, a portion of an inner side wall of the first bearing 140 is recessed away from the rotating shaft 121 to form a first lubrication groove 143, which communicates with the throttle groove 142.

[0116] In this embodiment, the first lubrication groove 143 is formed by the depression of a portion of the inner side wall of the first bearing 140 away from the rotating shaft 121, and the first lubrication groove 143 communicates with the throttle groove 142. Due to the pressure difference, the oil in the first pressure chamber 131 flows into the gap between the first bearing 140 and the rotating shaft 121 through the first oil groove 141 and the throttle groove 142 in turn, and can also be filled in the first lubrication groove 143. As the rotating shaft 121 rotates, the oil in the first lubrication groove 143 will coat the surface of the rotating shaft 121. Here, the first lubrication groove 143 acts as a short-term storage of lubricating oil, and then a fluid lubricating oil film can be formed between the inner wall of the first bearing 140 and the rotating shaft 121, which further ensures the reliable lubricity between the rotating shaft 121 and the bearing. Furthermore, the first lubrication groove 143 is arranged axially through the first bearing 140, the first lubrication groove 143 communicates with the shaft hole of the first bearing 140, one end of the first lubrication groove 143 communicates with the throttle groove 142, and another end of the first lubrication groove 143 extends toward the motor cavity. Furthermore, the number of first lubrication groove 143s is at least one, which can be flexibly set according to actual lubrication requirements.

[0117] Furthermore, a ratio of a flow cross-sectional area S1 of the throttle groove 142 to a flow cross-sectional area S2 of the first lubrication groove 143 is greater than or equal to 0.1 and less than or equal to 0.4.

[0118] In this embodiment, $0.1 \leq (S1/S2) \leq 0.4$, by controlling the flow cross-sectional area of the throttle groove 142, the flow cross-sectional area of the throttle groove 142 will not be too large, to ensure that the oil on the high pressure side of the pump portion 130 will not leak too much and affect the normal compression of the pump portion 130. That is, the oil will not flow into the first lubrication groove 143 too much through the throttle groove 142, and will not have a significant impact on the displacement of the pump portion 130. By limiting the flow cross-sectional area of the first lubrication groove 143, the flow cross-sectional area of the first lubrication groove 143 will not be too small. This ensures that sufficient flow of lubricating oil can form an oil film between the first bearing 140 and the rotating shaft 121 to meet the fluid lubrication requirements.

[0119] Furthermore, a ratio of the flow cross-sectional area S2 of the first lubrication groove 143 to a cross-sectional area S0 of a shaft hole of the first bearing 140 is greater than or equal to 0.02 and less than or equal to 0.08.

[0120] In this embodiment, $0.02 \leq (S2/S0) \leq 0.08$, the flow cross-sectional area of the first lubrication groove 143 is limited, the flow cross-sectional area of the first lubrication groove 143 is not too small. It can ensure that the lubricating oil has enough flow rates to form an oil film between the first bearing 140 and the rotating shaft 121 to meet the fluid lubrication requirements. The flow cross-sectional area of the first lubrication groove 143 will not be too large, resulting in an excessively thick oil film formed between the first bearing 140 and the rotating shaft 121, increasing the power consumption of the rotating shaft 121.

[0121] Furthermore, the cross-sectional area of the shaft hole of the first bearing 140 is limited, it is in a suitable range, and it will not affect the oil entering the gap between the rotating shaft 121 and the first bearing 140 because it is too small. Similarly, the strength of the first bearing140 itself will not be affected because the cross-sectional area of the shaft hole of the first bearing 140 is too large. Specifically, the shaft diameter of the first bearing 140 is greater than or equal to 6mm and less than or equal to 12mm. According to the relationship between the shaft diameter of the first bearing 140 and the deformation of the first bearing 140, and the relationship between the shaft diameter of the first bearing 140 and the power consumption, it can be seen that when the shaft diameter is less than 6mm, the deformation of the bearing is large, which is not conducive to the bearing to support the rotating shaft 121. When the shaft diameter is greater than 12mm, the power consumption of the bearing increases sharply. Therefore, if the shaft diameter of the first bearing 140 meets the above range, it not only meets the power consumption requirements of the bearing, but also avoids the excessive deformation of the bearing.

[0122] Furthermore, as shown in Figs. 1, 2 and 4, the pump device 100 further comprises: a sealing member 150, connected to one side of the first bearing 140 away from the pump portion 130, the sealing member 150 is sleeved on the rotating shaft 121, the sealing member 150, the first bearing 140 and the rotating shaft 121 form a liquid passage chamber 151, the liquid passage chamber 151 communicates with the first lubrication groove 143.

[0123] In this embodiment, the first bearing 140 is connected to the casing 110, and the first bearing 140 can separate the cavity 111 enclosed by the casing 110 into the motor cavity and the pump cavity, which can make the space layout more reasonable. The motor portion 120 is located in the motor cavity, and the pump portion 130 is located in the pump cavity. The sealing member 150 is connected on one side of the first bearing 140 away from the pump portion 130 and the sealing member 150 is sleeved on the rotating shaft 121. Specifically, the sealing member 150 can isolate the motor cavity from the pump cavity; the working medium will not flow into the motor cavity, and will not affect the normal use of the stator 123, rotor 122, controller 190 and other components in the motor cavity. There is no need to set other structures in the motor cavity to ensure that the components in the motor cavity are not corroded, which makes the sealing performance of the pump device 100 better, and at the same time, the structure is simpler, which is conducive to reducing costs.

[0124] It is worth noting that, as shown in Figs. 1, 2 and 4, a portion of the first bearing 140 extends away from the pump portion 130 to construct the installation position. Since the installation position and the first bearing 140 are integral structures, compared with the post-processing method, the integral structure has better mechanical properties, thus can improve connection strength. In addition, the first bearing 140 can be mass-produced to improve the processing efficiency of the product, reduce the processing cost of the product, improve the integrity of the pump device 100, reduce the number of parts, reduce the installation process, and improve the installation efficiency. In addition, the installation position for installing the sealing member 150 is formed by a portion of the first bearing 140, the installation accuracy of the sealing member 150 can be ensured, the assembly is simple, the sealing performance is good, and the cost is low.

[0125] Furthermore, as shown in Fig. 2, the sealing member 150, the first bearing 140 and the rotating shaft 121 form a liquid passage chamber 151, and the liquid passage chamber 151 communicates with the first lubrication groove 143. The liquid passage chamber 151 formed by the sealing member 150, the first bearing 140 and the rotating shaft 121 can store a portion of the lubricating oil, and the liquid passage chamber 151 is used to store the lubricating oil from the first lubrication groove 143. By controlling the connection strength between the sealing member 150 and the first bearing 140, that is, the pressure that the sealing member 150 can bear, the liquid passage chamber 151 can play a buffering role, the oil in the liquid passage chamber 151, the first lubrication groove 143, and the throttle groove 142 can be in a state of pressure equalization. On the premise of ensuring the position stability of the sealing member 150, it is beneficial to ensure the fluid lubrication performance of the rotating shaft 121 and the first bearing 140.

[0126] Furthermore, as shown in Figs. 1, 2, 3 and 4, the pump device 100 further comprises: a pressure relief groove 144, arranged on the first bearing 140, and communicating with the liquid passage chamber 151 and the second pressure chamber 132.

[0127] In this embodiment, the pressure relief groove 144 is arranged on the first bearing 140, and the pressure relief groove 144 is used to communicate with the liquid passage chamber 151 and the second pressure chamber 132. Here, the pressure relief groove 144 can be in the form of a through hole, both ends of the through hole can communicate with the second pressure chamber 132 and the liquid passage chamber 151. Since the pressure in the second pressure chamber 132 is small, the pressure in the liquid passage chamber 151 can be better released, and the pressure of the oil is not only buffered by the liquid passage chamber151 itself.

[0128] Furthermore, by setting the pressure relief groove 144 on the first bearing 140, a complete lubricating oil circuit of the first bearing 140 can be formed. That is, the oil in the first pressure chamber 131 (high pressure chamber) enters the first oil groove 141, and then flows into the gap between the first bearing 140 and the rotating shaft 121 and the first lubrication groove 143 through the throttle groove 142, to fully lubricate the rotating shaft 121 and the first bearing 140 and form an oil film, to meet fluid lubrication requirements. After that, the lubricating oil will flow into the liquid passage chamber 151, and further flow from the pressure relief groove 144 into the second pressure chamber 132 (low pressure chamber), to ensure that the pressure in the entire lubricating oil circuit will not be too high. That is, the pressure in the liquid passage chamber 151 will not be too high, avoid the pressure being higher than the limit value of the pressure that the sealing member 150 can bear, ensure the reliability of the position of the sealing member 150, and effectively prevent the sealing member 150 from detaching from the first bearing 140 under high pressure, resulting in the leakage of lubricating oil, and the sealing performance between the motor cavity and the pump cavity cannot be ensured.

[0129] Furthermore, a ratio of the flow cross-sectional area S3 of the pressure relief groove 144 to the flow cross-sectional area S2 of the first lubrication groove 143 is greater than or equal to 1 and less than or equal to 4.

[0130] In this embodiment, $1 \leq (S3/S2) \leq 4$, by limiting the flow cross-sectional area of the first lubrication groove 143, the flow cross-sectional area of the first lubrication groove 143 will not be too small to ensure that the lubricating oil has enough flow rate, to form an oil film between the first bearing 140 and the rotating shaft 121, to meet the fluid lubrication requirements. At the same time, the flow cross-sectional area of the first lubrication groove 143 will not be too large, resulting in an excessively thick oil film formed between the first bearing 140 and the rotating shaft 121, which increases the power consumption of the rotating shaft 121.

[0131] In addition, by limiting the flow area of the pressure relief groove 144, it can ensure that the pressure of the oil seal cavity is not too high, ensure the sealing effect of the oil seal, and avoid the oil seal detaching from the first bearing 140 due to the high pressure in the liquid passage chamber 151. The present invention takes into account the flow cross-sectional area of the throttle groove 142, the flow cross-sectional area of the first lubrication groove 143 and the flow cross-sectional area of the pressure relief groove 144, the three satisfy the above-mentioned relationship, this ensures that there is sufficient oil flow in the first lubrication groove 143 to ensure the lubrication of the first bearing 140 and rotating shaft 121. At the same time, it can ensure that the pressure in the liquid passage chamber 151 is low enough, without affecting the sealing connection between the sealing member 150 and the first bearing 140, effectively reducing oil leakage.

[0132] According to the simulation data, it is determined that the flow rate of the lubricating oil in the lubricating oil circuit of the first bearing 140 should not be lower than 3ml/s, and the shaft diameter of the first bearing 140 is 8mm. After checking the strength of the bearing by simulation, it is determined that the flow cross-sectional area $S2=1.57mm^2$ of the first lubrication groove 143 is the best choice. Then design the different structure of the flow cross-sectional area S1 of throttle groove 142 and the flow cross-sectional area S3 of the pressure relief groove 144 to obtain the simulation data shown in Table 1 below:

Table 1

Serial No.	$S1/mm^2$	$S2/mm^2$	$S3/mm^2$	flow rate of oil in the first lubrication groove 143 (ml/s)	pressure in the liquid passage chamber 151 (kPa)
1	2	1.57	3.14	14.4	214
2	1.1	1.57	3.14	9.3	122
3	0.4	1.57	3.14	7.3	112
4	0.01	1.57	3.14	1.8	91.3
5	0.4	1.57	1.57	5.9	159
6	0.4	1.57	6.28	9.1	108

[0133] According to the simulation data in Table 1, it can be determined that the scheme in No. 3 is the optimal scheme, that is, the flow cross-sectional area S1 of the throttle groove 142 is $0.4mm^2$, the flow cross-sectional area S2 of the first lubrication groove 143 is $1.57mm^2$, the flow cross-sectional area S3 of the pressure relief groove 144 is $3.14mm^2$. At this time, the oil flow rate in the first lubrication groove 143 is 7.3ml/s, which can meet the lubrication requirement without the oil flow rate in the first bearing 140 being too large and reducing the displacement of the pump device 100. At the same time, the pressure in the liquid passage chamber 151 is 112kPa, and the pressure will not be too high, and then serious leakage of oil can be avoided.

Embodiment 2

[0134] On the basis of embodiment 1, this embodiment explains the specific structure of the first bearing 140, as shown in Fig. 2, the pump device 100 further comprises a buffer chamber 160, and the buffer chamber 160 is disposed on the end surface of the first bearing 140 away from the pump portion 130.

[0135] In this embodiment, the buffer chamber 160 is arranged on the end surface of the first bearing 140 away from the pump portion 130, specifically, the buffer chamber 160 can be a tapered-shape. That is, the buffer chamber 160 can be a tapered cavity; the buffer chamber 160 can reduce the rigidity of the first bearing 140 and provide flexible support for the rotating shaft 121. It can reduce the surface pressure on the axial end surface of the first bearing 140 away from the pump portion 130, which can effectively improve the wear of the first bearing 140 and the rotating shaft 121.

[0136] Furthermore, an opening area of the buffer chamber 160 is larger than a bottom wall area of the buffer chamber 160. The buffer chamber 160 comprises: a first wall surface 161, the first wall surface 161 is a wall surface of the buffer chamber 160 close to the rotating shaft 121, from an open end of the buffer chamber 160 to a bottom wall of the buffer chamber 160, a distance between the first wall surface 161 and the rotating shaft 121 increases. It can be understood that the first wall surface 161 is inclined and the position of the first wall surface 161 located at the opening end of the buffer chamber 160 is closer to the rotating shaft 121, and the distance between the first wall surface 161 and the rotating shaft 121 is smaller at the opening. The distance between the first wall surface 161 and the rotating shaft 121 is larger at the position located at the bottom of the cavity, which also makes a right-angle structure not formed between the first wall surface 161 and the groove bottom of the groove body. Since the first bearing 140 is usually made of aluminum alloy material, when the rotating shaft 121 is in contact with the end of the first bearing 140, the first bearing 140 will be deformed. If the connection between the first wall surface 161 and the bottom wall of the conical cavity is a right-angle structure, stress concentration will occur at the connection between the first wall surface 161 and the groove bottom of the groove body. When the first bearing 140 is under the pressure of the rotating shaft 121, the first bearing 140 is easily broken at the connection structure between the first wall surface 161 and the bottom wall of the buffer chamber 160. When the first wall surface 161 is inclined relative to the axial direction of the rotating shaft 121, the structure between the first wall surface 161 and the bottom wall of the buffer chamber 160 is not a right-angle structure, which can effectively reduce the damage rate of the first bearing 140.

[0137] Furthermore, the buffer chamber 160 comprises: a second wall surface 162, the second wall surface 162 is arranged face the first wall surface 161, from an opening end of the buffer chamber 160 to a bottom wall of the buffer chamber 160, a distance between the second wall surface 162 and the rotating shaft 121 decreases.

[0138] In this embodiment, the second wall surface 162 is inclined relative to the axial direction of the rotating shaft 121, the second wall surface 162 faces the first wall surface 161, and the distance between the second wall surface 162 and the rotating shaft 121 decreases from the open end of the buffer chamber 160 to the bottom wall of the buffer chamber 160. Therefore, the second wall surface 162 and the first wall surface 161 can be arranged axially symmetrically with respect to the center line of the buffer chamber 160. That is, the buffer chamber 160 can have a regular cone shape, which can better provide flexible support for the rotating shaft 121. It can be understood that, in the axial direction away from the motor portion 120, the distance between the first wall surface 161 and the rotating shaft 121 increases, the gap between the second wall surface 162 and the rotating shaft 121 decreases, and the buffer chamber 160 is constructed as an inverted cone shape. In the process of processing the buffer chamber 160, the inverted tapered buffer chamber 160 is conducive to drafting.

[0139] Furthermore, the buffer chamber 160 is constructed as an annular structure, that is, the buffer chambers 160 are arranged in the circumferential direction of the first bearing 140. When the rotating shaft 121 rotates, the radial force on the first bearing 140 may change at any time. That is, the first bearing 140 will be subjected to radial forces that change in multiple directions, and no matter which direction the radial force received by the first bearing 140 faces, the existence of the annular buffer chamber 160 enables the first bearing 140 to deform to a certain extent. Therefore, the rotating shaft 121 and the first bearing 140 are connected flexibly, and the first bearing 140 has a buffering effect on the radial force of the rotating shaft 121, avoiding the problem that the first bearing 140 is easily damaged due to the rigid connection between the rotating shaft 121 and the first bearing 140.

Embodiment 3

[0140] On the basis of the aforementioned embodiment, this embodiment explains the supporting structure of the rotating shaft 121 in the pump device 100, furthermore, as shown in Figs. 1, 4 and 5, the pump device 100 further comprises: a second bearing 170, the second bearing 170 is connected with the casing 110 and sleeved on the rotating shaft 121, and the second bearing 170 is located on one side of the pump portion 130 away from the first bearing 140.

[0141] In this embodiment, the second bearing 170 is connected with the casing 110, and the second bearing 170 is sleeved on the rotating shaft 121, and the second bearing 170 is located on one side of the pump portion 130 away from the first bearing 140, that is, the first bearing 140 and the second bearing 170 are located on both sides of the pump portion 130 in the axial direction. And the first bearing 140 is closer to the motor portion 120 than the second bearing 170. The first bearing 140 and the second bearing 170 can support the rotating shaft 121. Through the cooperative use of the rotating shaft 121, the first bearing 140 and the second bearing 170, the load of the pump portion 130 can be evenly shared by the rotating shaft 121, the first bearing 140 and the second bearing 170, avoiding the possible damage to the rotating shaft 121 caused by the load being concentrated on the rotating shaft 121.

[0142] Specifically, the first bearing 140 and the second bearing 170 are sliding bearings. Compared with the form of double rolling bearings, the sliding bearings work smoothly, reliably and without noise. Under the condition of liquid lubrication, the sliding surfaces are separated by lubricating oil without direct contact, which can greatly reduce friction loss and surface wear. And the gap between the sliding bearing and the rotating shaft 121 is filled with lubricating oil, and the lubricating oil on the sliding surface will form an oil film to realize fluid lubrication. The oil film also has a certain ability to absorb vibration, which improves the service life of the first bearing 140, the second bearing 170 and the rotating shaft 121. Two sliding bearings support the rotating shaft 121, the clearance of the rotating shaft 121 is small, and the position of the axis of the rotating shaft 121 can be controlled within a reasonable range. Compared with the combination of double rolling bearing and sliding bearing, only two sliding bearings are used in this embodiment, which can not only simplify the support structure, but also reduce the cost.

[0143] Furthermore, the first bearing 140 has a first bearing surface close to the rotating shaft 121, the second bearing 170 has a second bearing surface close to the rotating shaft 121, and the axial height of the second bearing surface is less than or equal to the axial height of the first bearing surface, that is, not greater than it. When the distance between the first bearing 140 and the pump portion 130 is equal to the distance between the second bearing 170 and the pump portion 130, the loads from the pump portion 130 carried on the first bearing 140 and the second bearing 170 are equal. However, since the first bearing 140 is closer to the motor portion 120 than the second bearing 170, during the rotation of the rotor 122 in the motor portion 120, a radial force is generated between the stator 123 and the rotor 122, and a load is also generated on the rotating shaft 121. Therefore, the first bearing 140 also needs to carry the load from the motor portion 120. By making the second bearing surface less than or equal to the first bearing surface, the first bearing 140 and the second bearing 170 are more suitable for different loads at different positions of the rotating shaft 121. And on the premise of ensuring the lubrication reliability of the rotating shaft 121, the power consumption of the rotating shaft 121 can be reduced to a minimum level.

[0144] Furthermore, as shown in Fig. 5, a portion of an inner side wall of the second bearing 170 is recessed away from the rotating shaft 121 to form a second lubrication groove 171, which communicates with the first pressure chamber 131.

[0145] In this embodiment, the second lubrication groove 171 is formed by the depression of a portion of the inner side wall of the second bearing 170 away from the rotating shaft 121, and the second lubrication groove 171 communicates with the first pressure chamber 131. Due to the pressure difference, the oil in the first pressure chamber 131 flows into the gap between the first bearing 140 and the rotating shaft 121 through the second lubrication groove 171. As the rotating shaft 121 rotates, the oil in the second lubrication groove 171 will coat the surface of the rotating shaft 121. Here, the second lubrication groove 171 can play a role of short-term storage of lubricating oil; a fluid lubricating oil film can be formed between the inner wall of the second bearing 170 and the rotating shaft 121, to further ensure the lubricating performance between the rotating shaft 121 and the bearing.

Embodiment 4

[0146] On the basis of the aforementioned embodiment, this embodiment explains the specific structure of the second bearing 170, furthermore, as shown in Fig. 5, the pump device 100 further comprises: an anti-push lubrication groove 172, provided on an end surface of the second bearing 170 close to the pump portion 130, and communicating with a shaft hole of the second bearing 170.

[0147] In this embodiment, the anti-push lubrication groove 172 is arranged on the end surface of the second bearing 170 close to the pump portion 130, and the anti-push lubrication groove 172 communicates with the shaft hole of the second bearing 170. When the rotating shaft 121 rotates at high speed, the lubricating oil in the matching gap with the second bearing 170 will be sheared, and the lubricating oil will enter the anti-push lubrication groove 172 through the second bearing 170 oil groove under the action of shearing force, forming a certain speed and pressure. There is relative motion between the end surface of the inner gear and the end surface of the pump cover 113, and the lubricating oil in the anti-push lubrication groove 172 can form an oil film, the fluid lubrication condition is formed between the end surface of the inner gear and the end surface of the pump cover 113. By lubricating the gears, noise can be reduced, and an anti-push force can be formed on the gears, which can greatly improve the power consumption and wear of the anti-push surface, that is, the sliding surface between the inner gear and the pump cover 113.

[0148] Specifically, the anti-push lubrication groove 172 is arranged on the end surface of the second bearing 170 close to the pump portion 130, and the anti-push lubrication groove 172 communicates with the second bearing 170 and the shaft hole of the second bearing 170. There is lubricating oil in the matching gap between the second bearing 170 and the rotating shaft 121. During the high-speed rotation of the rotating shaft 121, the rotating shaft 121 will shear the lubricating oil in the matching gap between itself and the second bearing 170. Under the action of shearing force ω, the lubricating oil will enter the anti-push lubrication groove 172 from the matching gap, and the lubricating oil entering the anti-push lubrication groove 172 has a certain speed and pressure at this time. The end surface clearance between the second bearing 170 and the pump portion 130 is small, and the lubricating oil in the anti-push lubrication groove 172 can flow to the end surface clearance between the second bearing 170 and the pump portion 130. At the same time, due to the relative motion between the pump portion 130 and the second bearing 170, the condition of fluid lubrication is formed between the contact end surfaces of the pump portion 130 and the second bearing 170. That is, an oil film is formed at the contact end surface between the second bearing 170 and the pump portion 130, the boundary lubrication between the second bearing 170 and the pump portion 130 is transitioned to fluid lubrication, the wear of the contact end surface between the pump portion 130 and the second bearing 170 can be greatly improved, and the power consumption can be reduced. In addition, it can reduce the running noise of the pump device 100.

[0149] Furthermore, the notch area of the anti-push lubrication groove 172 in the axial direction is larger than the groove bottom area of the anti-push lubrication groove 172.

[0150] In this embodiment, the anti-push lubrication groove 172 comprises two notches with different orientations, one towards the pump portion 130 and another towards the rotating shaft 121. In this design, the area of the notch toward the pump portion 130 is defined to be larger than the area of the groove bottom. That is, in the axial direction away from the pump portion 130, that is, in the top-down direction, the anti-push lubrication groove 172 has a constricted shape, that is, the groove wall of the anti-push lubrication groove 172 has an inclined shape. At this time, on the one hand, the lubricating oil entering the anti-push lubrication groove 172 has a certain speed and pressure, and on the other hand, due to the small gap between the end surfaces of the second bearing 170 and the pump portion 130 in contact, the groove wall of the anti-push lubrication groove 172 has an inclined shape. Then, there is a convergent wedge-shaped angle between the anti-push lubrication groove 172 and the end surface clearance, and the lubricating oil in the anti-push lubrication groove 172 will flow along the inclined groove wall to the end surface clearance between the pump portion 130 and the second bearing 170, that is, the lubricating oil from "big port" to "small port". It is worth noting that the "big port" refers to the anti-push lubrication groove 172, and the "small port" refers to the gap between the second bearing 170 and the pump portion 130. Thus, the lubrication between the pump portion 130 and the second bearing 170 can be enhanced, and the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0151] In addition, during the high-speed rotation of the rotating shaft 121 and the pump portion 130, the oil film between the contacting surfaces between the pump portion 130 and the second bearing 170 will generate a force F that pushes the pump portion 130 upward, and then the lubricating oil located in the end surfaces of the second bearing 170 and the pump portion 130 acts as a floating seal, which can further reduce the leakage of the end surfaces. According to relevant literature, the end surface leakage of the pump device 100 accounts for 75%~80% of the total leakage of the pump device 100. Therefore, it is very important to improve the leakage between the contacting end surfaces of the pump device 100. It is worth noting that lubricating oil has a certain viscosity.

[0152] Furthermore, the anti-push lubrication groove 172 comprises an anti-push wall, the anti-push wall comprises at least one anti-push segment, at least one anti-push segment comprises a first anti-push segment, and in the axial direction away from the pump portion 130, the first anti-push segment extends close to the center of the anti-push lubrication groove 172.

[0153] In this embodiment, the anti-push lubrication groove 172 comprises an anti-push wall; the anti-push wall is an inclined wall. In the axial direction away from the pump portion 130, that is, in the top-down direction, the anti-push wall extends close to the center of the anti-push wall. The anti-push wall comprises at least one anti-push segment, at least one anti-push segment comprises a first anti-push segment, and the first anti-push segment extends in the axial direction away from the pump portion 130 and close to the center of the anti-push lubrication groove 172. At this time, an end surface clearance is formed between the anti-push lubrication groove 172 and the end surface of the pump portion 130 and the second bearing 170, and a convergent wedge-shaped angle is formed between the two, then the lubricating oil in the anti-push lubrication groove 172 will flow along the inclined first anti-push segment to the end surface clearance between the pump portion 130 and the second bearing 170, that is, the lubricating oil enters the "small port" from the "large port". It is worth noting that the "big mouth" refers to the anti-push lubrication groove 172, and the "small mouth" refers to the gap between the second bearing 170 and the pump portion 130. Therefore, the lubrication between the pump portion 130 and the second bearing 170 can be enhanced, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0154] It should be noted that the first anti-push segment can be composed of at least one straight segment and at least one curved segment, and the first anti-push segment has a first end close to the pump portion 130 and a second end away from the pump portion 130. The second end of the first anti-push segment extends close to the center of the anti-push lubrication groove 172. That is, if the inclined extension trend of the first anti-push segment satisfies the above-mentioned relationship, the flow of lubricating oil can be facilitated. The first anti-push segment can be composed of multi-segment curved surfaces or multi-segment arcs.

[0155] Furthermore, the angle α between the first anti-push segment and the axial end surface of the second bearing 170 is greater than 0° and less than 90°.

[0156] In this embodiment, the axial end surface of the second bearing 170 refers to the axial end surface of the second bearing 170 close to the pump portion 130. The angle between the first anti-push segment and the axial end surface satisfies $0° < \alpha < 90°$. Therefore, the first anti-push segment can better drain the lubricating oil into the end surface clearance between the second bearing 170 and the pump portion 130, ensuring that the lubricating oil can enter the end surface clearance through its own velocity and pressure, and is guided by the first anti-push segment, a converging wedge-shaped angle is formed between the anti-push lubrication groove 172 and the end surface clearance. Then the lubricating oil in the anti-push lubrication groove 172 will flow along the inclined groove wall to the end surface clearance of the pump portion 130 and the second bearing 170, that is, the lubricating oil enters the "small port" from the "big port". Therefore, the lubrication between the pump portion 130 and the second bearing 170 can be enhanced, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two. Furthermore, the angle α between the first anti-push segment and the axial end surface of the second bearing 170 is 45°. It is worth noting that the inclined first anti-push segment can be machined on the end surface of the second bearing 170 close to the pump portion 130 by using the forming tool. Specifically, the longitudinal section (along the axial direction) of the anti-push lubrication groove 172 can be an inverted triangle, a semicircle, etc.

[0157] Furthermore, at least one anti-push segment further comprises a second anti-push segment, which extends axially and connects between the first anti-push segment and the groove bottom of the anti-push lubrication groove 172.

[0158] In this embodiment, the at least one anti-push segment further comprises a second anti-push segment, and the second anti-push segment extends along the axial direction to be connected between the first anti-push segment and the bottom of the groove. The second anti-push segment cooperates with the first anti-push segment to form an anti-push wall, thereby ensuring that the volume of the anti-push lubrication groove 172 meets the lubrication requirements. It is worth noting that, during the machining process, a straight groove is machined on the end surface of the second bearing 170 toward the pump portion 130, and then chamfering is machined, the first anti-push segment and the second anti-push segment can be formed. Through the above processing sequence, the processing difficulty of anti-push lubrication groove 172 can be reduced.

[0159] Furthermore, the number of anti-push walls is at least two.

[0160] In this embodiment, the number of anti-push walls is at least two, and each anti-push wall in the at least two anti-push walls comprises at least one anti-push segment. At least one anti-push segment comprises a first anti-push segment. At least one anti-push segment further comprises a second anti-push segment. It is worth noting that the structures of at least two anti-push walls can be equal or unequal. When the number of anti-push walls is three, the structures of the three anti-push walls can be partially equal and partially unequal.

[0161] Furthermore, at least two anti-push walls include a first anti-push wall, and the first end of the first anti-push wall is connected to the inner side wall of the second bearing 170. The tangent plane where the connection point between the first anti-push wall and the inner side wall of the second bearing 170 is located is the first reference plane. The angle β1 between the first anti-push wall and the first reference plane is greater than or equal to 0° and less than 90°.

[0162] In this embodiment, the first end of the first anti-push wall is the start end of the first anti-push wall, the second end of the first anti-push wall is the termination end of the first anti-push wall. The first end is connected with the inner side wall of the second bearing 170, and the inner side wall of the second bearing 170 is the side wall of the shaft hole of the second bearing 170. The tangent plane where the connection point between the first end and the second bearing 170 is located is the first reference plane, and the angle β1 between the first anti-push wall and the first reference plane is greater than or equal to 0° and less than 90°. During the high-speed rotation of the rotating shaft 121, the rotating shaft 121 will shear the lubricating oil in the matching gap between itself and the second bearing 170, and the lubricating oil will enter the anti-push lubrication groove 172 from the matching gap under the action of the shearing force ω. At this time, the lubricating oil entering the anti-push lubrication groove 172 has a certain speed and pressure. Since the first anti-push wall is biased towards the rotating direction of the rotating shaft 121, the lubricating oil in the anti-push lubrication groove 172 will have shaft shearing and surface shearing. Thus, a negative pressure is formed at the position of the anti-push lubrication groove 172 close to the shaft hole, to suck the lubricating oil between the rotating shaft 121 and the second bearing 170. However, if the pressure in the anti-push lubrication groove 172 is higher at the position away from the shaft hole, the lubricating oil in the anti-push lubrication groove 172 will flow into the end surface clearance between the second bearing 170 and the pump portion 130 along the inclined anti-push wall. Therefore, the lubrication between the pump portion 130 and the second bearing 170 can be enhanced, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0163] Furthermore, the at least two anti-push walls also include a second anti-push wall, the second anti-push wall is set opposite to the first anti-push wall, and the first end of the second anti-push wall is connected to the inner side wall of the second bearing 170. The tangent plane where the connection point between the second anti-push wall and the inner side wall of the second bearing 170 is located is the second reference plane, and the angle β2 between the second anti-push wall and the second reference plane is greater than 0° and less than 90°.

[0164] In this embodiment, the at least two anti-push walls also include the second anti-push wall, and the first end of the second anti-push wall is the starting end of the second anti-push wall. The second end of the second anti-push wall is the termination end of the second anti-push wall, the second end is connected to the inner side wall of the second bearing 170, and the inner side wall of the second bearing 170 is the side wall of the shaft hole of the second bearing 170. The tangent plane of the connection point between the first end and the second bearing 170 is the second reference plane, and the angle β2 between the second anti-push wall and the second reference plane is greater than or equal to 0° and less than 90°. During the high-speed rotation of the rotating shaft 121, the rotating shaft 121 will shear the lubricating oil in the matching gap between itself and the second bearing 170, and the lubricating oil will enter the anti-push lubrication groove 172 from the matching gap under the action of the shearing force ω. At this time, the lubricating oil entering the anti-push lubrication groove 172 has a certain speed and pressure. Since the second anti-push wall is biased towards the rotating direction of the rotating shaft 121, the lubricating oil in the anti-push lubrication groove 172 will have shaft shearing and surface shearing. Thus, a negative pressure is formed at the position of the anti-push lubrication groove 172 close to the shaft hole, to suck the lubricating oil between the rotating shaft 121 and the second bearing 170. However, if the pressure in the anti-push lubrication groove 172 is higher at the position away from the shaft hole, the lubricating oil in the anti-push lubrication groove 172 will flow into the end surface clearance between the second bearing 170 and the pump portion 130 along the inclined anti-push wall. Therefore, the lubrication between the pump portion 130 and the second bearing 170 can be enhanced, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0165] Furthermore, the at least two anti-push walls also include a third anti-push wall, and the third anti-push wall is respectively connected with the second end of the first anti-push wall and the second end of the second anti-push wall.

[0166] In this embodiment, the at least two anti-push walls also include a third anti-push wall, and the third anti-push wall is respectively connected with the second end of the first anti-push wall and the second end of the second anti-push wall. That is, the anti-push lubrication groove 172 is composed of the first anti-push wall, the second anti-push wall and the third anti-push wall, which can facilitate the shape design of the anti-push lubrication groove 172.

[0167] It is worth noting that the projection of the first anti-push wall, the second anti-push wall and the third anti-push wall on the axial end surface of the second bearing 170 can be a straight segment or a curved segment.

[0168] Furthermore, the third anti-push wall of the anti-push lubrication groove 172 is an arc-shaped wall.

[0169] In this embodiment, the third anti-push wall is an arc-shaped wall, that is, the projection of the third anti-push wall on the axial end surface of the second bearing 170 is an arc-shaped segment. Since the position corresponding to the third anti-push wall is the position away from the shaft hole in the anti-push lubrication groove 172, the lubricating oil pressure in the anti-push lubrication groove 172 corresponding to this position is higher. By making the third anti-push wall an arc-shaped wall, the flow of lubricating oil in the anti-push lubrication groove 172 can be facilitated, it can facilitate lubricating oil from the "big port" into the "small port", and can enhance the lubrication between the pump portion 130 and the second bearing 170, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

Embodiment 5

[0170] On the basis of the aforementioned embodiment, this embodiment explains a lubricating oil circuit of the second bearing 170, furthermore, as shown in Fig. 4, the casing 110 comprises: a machine shell 112, surrounded outside the motor portion 120 and the pump portion 130 and connected with the first bearing 140; and a pump cover 113, the pump cover 113 is connected on the machine shell 112, the pump cover 113 and the machine shell 112 form the cavity 111, the pump cover 113 is connected to the second bearing 170, a portion of the pump cover 113 extends away from the pump portion 130 to construct out an extension portion 114 being used for forming an oil pool 115, a shaft hole of the second bearing 170 is an axial through hole, one end of the through hole is communicated with the anti-push lubrication groove 172, and another end of the through hole is used to communicate with the oil pool 115.

[0171] In this embodiment, the casing 110 comprises a machine shell 112 and a pump cover 113 connected on the machine shell 112, the pump cover 113 and the machine shell 112 form a cavity 111, and the machine shell 112 surrounds outside the motor portion 120 and the pump portion 130. The machine shell 112 is connected with the first bearing 140, and the pump cover 113 is connected with the second bearing 170. The first bearing 140 and the machine shell 112 can be integrally formed, and the machine shell 112 and the first bearing 140 can be integrally formed. Compared with the post-processing method, the connection strength is higher; it can save space, reduce the height of the whole machine, and can reduce the difficulty of the preparation process and reduce the production cost. The pump cover 113 and the second bearing 170 can be integrally formed, saving more height space, not only reducing the height of the whole machine, but also reducing the cost.

[0172] Furthermore, the extension portion 114 is formed by an extension structure of a portion of the pump cover 113 away from the pump portion 130. Therefore, the extension portion 114 and the pump cover 113 are integrally formed, and the connection strength is higher than the post-processing method. The extension portion 114 is used to form an oil pool 115, which can store the lubricating oil. The shaft hole on the second bearing 170 is an axial through hole, and the two ends of the through hole are connected to the anti-push lubrication groove 172 and the oil pool 115 respectively.

[0173] Specifically, during the high-speed rotation of the rotating shaft 121, the rotating shaft 121 will shear the lubricating oil in the matching gap between itself and the second bearing 170. The lubricating oil will enter the anti-push lubrication groove 172 from the matching gap (through hole) under the action of shearing force. At this time, the lubricating oil entering the anti-push lubrication groove 172 has a certain speed and pressure. The lubricating oil in the anti-push lubrication groove 172 will undergo shaft shearing and surface shearing, thereby forming a negative pressure in the anti-push lubrication groove 172 close to the shaft hole, to suck the lubricating oil between the rotating shaft 121 and the second bearing 170. However, the pressure in the anti-push lubrication groove 172 is higher at the position away from the shaft hole, and the lubricating oil in the anti-push lubrication groove 172 can be better pushed into the end surface clearance between the second bearing 170 and the pump portion 130. Therefore, the lubrication between the pump portion 130 and the second bearing 170 can be enhanced, the lubrication state between the two transitions from boundary lubrication to fluid lubrication, thereby effectively reducing the wear rate between the two.

[0174] Furthermore, the oil is drawn into the anti-push lubrication groove 172 to lubricate the contact surface between the pump portion 130 and the second bearing 170, and then enters the gap between the second bearing 170 and the pump portion 130, and then enters the oil pool 115 of the low pressure area under the action of pressure difference and gravity.

[0175] Specifically, the lubricating oil circuit of the second bearing 170 is as follows: the oil enters the gap between the second bearing 170 and the rotating shaft 121 through the oil pool 115 (through hole, second lubrication groove 171) and then enters the anti-push lubrication groove 172. Under the action of the anti-push lubrication groove 172, the oil enters the end surface clearance between the pump portion 130 and the second bearing 170, and enters the low pressure oil pool 115 under the action of pressure difference and gravity. By forming a complete lubricating oil circuit for the second bearing 170, it is beneficial to ensure the lubricating performance between the second bearing 170 and the rotating shaft 121.

[0176] Furthermore, the pump cover 113 and the second bearing 170 are integrally formed. Compared with the post-processing method, the connection strength is higher; it can save space, reduce the height of the whole machine, and can reduce the difficulty of the preparation process and reduce the production cost.

Embodiment 6

[0177] On the basis of the aforementioned embodiment, this embodiment explains another lubricating oil circuit of the second bearing 170, furthermore, as shown in Fig. 1, the casing 110 comprises: a machine shell 112, surrounded outside the motor portion 120 and the pump portion 130, and the machine shell 112 is connected with the first bearing 140; and a pump cover 113, the pump cover 113 is connected on the machine shell 112, the pump cover 113 and the machine shell 112 form the cavity 111, and the pump cover 113 is connected to the second bearing 170, the shaft hole of the second bearing 170 is a blind hole with one end open; and a communication groove, opened on the second bearing 170 and/or the pump cover 113, and communicating the first pressure chamber 131 and the blind hole.

[0178] In this embodiment, the casing 110 comprises a machine shell 112 and a pump cover 113 connected on the machine shell 112, the pump cover 113 and the machine shell 112 form a cavity 111, and the machine shell 112 surrounds outside the motor portion 120 and the pump portion 130. The machine shell 112 is connected with the first bearing 140, and the pump cover 113 is connected with the second bearing 170. The first bearing 140 and the machine shell 112 can be integrally formed, and the machine shell 112 and the first bearing 140 are integrally formed. Compared with the post-processing method, the connection strength is higher; it can save space, reduce the height of the whole machine, and can reduce the difficulty of the preparation process and reduce the production cost. The pump cover 113 and the second bearing 170 can be integrally formed, saving more height space, not only reducing the height of the whole machine, but also reducing the cost.

[0179] Furthermore, the shaft hole of the second bearing 170 is a blind hole with one end open, and the communication groove is opened on the second bearing 170 and/or the pump cover 113, and the communication groove is used to communicate with the first pressure chamber 131 and the blind hole. Specifically, the lubricating oil circuit of the second bearing 170 is: the pressurized oil enters the blind hole (the gap between the second bearing 170 and the rotating shaft 121, the second lubrication groove 171) from the first pressure chamber 131 (high pressure chamber) through the communication groove and then returns to the low pressure area through the gap between the second bearing 170 and the pump portion 130, where the low pressure area specifically refers to the oil inlet 181 and the second pressure chamber 132. By forming a complete lubricating oil circuit for the second bearing 170, it is beneficial to ensure the lubricating performance between the second bearing 170 and the rotating shaft 121.

Embodiment 7

[0180] On the basis of the aforementioned embodiment, this embodiment explains the specific structure of the pump portion 130, furthermore, as shown in Figs. 1 and 4, the pump portion 130 comprises: a first rotation member 133, matched with the rotating shaft 121; and a second rotation member 134, the second rotation member 134 is arranged on an outside of the first rotation member 133, and the first rotation member 133 can drive the second rotation member 134 to rotate, the second rotation member 134 and the first rotation member 133 construct out the first pressure chamber 131 and the second pressure chamber 132, the pump device 100 further comprises: an oil inlet 181, axially opened on the pump cover 113 and/or the second bearing 170, and the oil inlet 181 communicating with the second pressure chamber 132; an oil outlet 182, radially opened on the pump cover 113 and the second bearing 170, and the oil outlet 182 communicating with the first pressure chamber 131 of the pump portion 130.

[0181] In this embodiment, the pump portion 130 comprises a first rotation member 133 and a second rotation member

134, the first rotation member 133 is matched with the rotating shaft 121, the second rotation member 134 is arranged outside the first rotation member 133, and the first rotation member 133 can drive the second rotation member 134 to rotate. It can be understood that the rotating shaft 121 can drive the second rotation member 134 to run through the first rotation member 133. The first pressure chamber 131 and the second pressure chamber 132 are formed by setting the first rotation member 133 and the second rotation member 134, and the first pressure chamber 131 is a high pressure chamber, and the second pressure chamber 132 is a low pressure chamber.

[0182] It is worth noting that the first rotation member 133 is an inner gear, and the second rotation member 134 is an outer gear, that is, the pump portion 130 is a gear pump. Specifically, during the meshing process of the gear pump, the former pair of teeth has not yet been disengaged, and the latter pair of teeth has entered meshing, and each inner tooth surface is in contact with the outer tooth surface to form a closed cavity, with the rotation of the inner gear, the volume of the closed cavity 111 will change, and if the unloading channel cannot be connected, the trapped oil volume will be formed. Due to the small compressibility of the liquid, when the trapped oil volume changes from large to small, the liquid in the trapped oil volume is squeezed, and the pressure rises sharply, which greatly exceeds the working pressure of the gear pump. At the same time, the liquid in the trapped oil volume is also forcibly squeezed out from all leakable gaps, that the rotating shaft 121 and bearing will bear a large impact load. This will increase power loss and cause oil to heat up causing noise and vibrations that reduce the smoothness and life of the gear pump. When the trapped oil volume changes from small to large, a vacuum is formed, which causes the air dissolved in the liquid to separate out and generate bubbles, which bring about hazards such as cavitation, noise, vibration, flow and pressure pulsation. The method of eliminating the trapped oil is to open the unloading groove on both ends of the gear, when the closed volume decreases, the unloading groove communicates with the oil pressure chamber, and when the closed volume increases; it communicates with the oil suction chamber through the unloading groove.

[0183] Specifically, the inner gear meshes with the tooth profile of the conjugate curve of the outer gear, and each tooth is in contact with each other, driving the outer gear to rotate in the same direction. The inner gear divides the inner cavity of the outer gear into multiple working chambers. Due to the offset of the center of the inner and outer gears, the volumes of the multiple working chambers change with the rotation of the rotor 122, and a certain vacuum is formed in the area where the volume increases. The oil inlet 181 is set at this position, the pressure increases in the area where the volume decreases, and the oil outlet 182 is set here accordingly.

[0184] Furthermore, the pump device 100 further comprises an oil inlet 181 and an oil outlet 182, the oil inlet 181 is axially opened on the pump cover 113 and/or the second bearing 170, and the oil inlet 181 communicates with the second pressure chamber 132. Since the second pressure chamber 132 is a low pressure chamber, there is a pressure difference with the outside of the chamber, so the oil will enter the second pressure chamber 132 through the oil inlet 181. The oil outlet 182 is radially opened on the pump cover 113 and the second bearing 170, and the oil outlet 182 communicates with the first pressure chamber 131. Since the first pressure chamber 131 is a high pressure chamber, there is a pressure difference with the outside of the chamber, so the oil in the first pressure chamber 131 will flow out through the oil outlet 182. That is, the main oil circuit of the pump device 100 is: the negative pressure that can be generated at the second pressure chamber 132 and the oil inlet 181 and under the action of the negative pressure, the oil in the oil pool 115 is attracted to the oil inlet 181, and then enters the second pressure chamber 132 (low pressure chamber), and then the oil entering the second pressure chamber 132 enters the high pressure chamber under the action of the first rotation member 133 and the second rotation member 134 to be pressurized, and the pressurized oil is discharged through the oil outlet 182.

[0185] It is worth noting that the design principle of the oil inlet 181 and the oil outlet 182: in the process of ensuring the rotation of the gear, the oil inlet 181 and the teeth of the first rotation member 133 and the second rotation member 134 are connected as soon as possible, before the inner gear and the outer gear form the maximum volume, the gear volume cavity is always communicated with the oil inlet 181, and the oil filling time should be prolonged as much as possible, the volume cavity between the inner and outer teeth is filled with oil, thereby ensuring the oil absorption. The oil outlet 182 should also be connected to the high-pressure oil between the teeth as soon as possible, to reduce the excessive compression work between the teeth, and close as late as possible to make full use of the inertia of the fluid to drain the oil between the teeth, thereby improving the volumetric efficiency of the inner gear oil pump. However, it should be noted that when the inner and outer gears form the maximum volume, they cannot communicate with the oil inlet 181 to avoid affecting the volumetric efficiency of the pump device 100 at low speed.

Embodiment 8

[0186] On the basis of the aforementioned embodiment, this embodiment explains the specific structure of the motor portion 120, furthermore, as shown in Figs. 1 and 4, the motor portion 120 further comprises: a rotor 122, connected with the rotating shaft 121; and a stator 123, sleeved on an outside of the rotor 122, the stator 123 including a stator core and a stator winding, and the stator winding is arranged on the stator core, the pump device 100 further comprises: a controller 190, arranged on one side of the motor portion 120 away from the pump portion 130, and connected on the casing 110 and located in the cavity 111, and one end of the stator winding is electrically connected to the controller 190.

[0187] In this embodiment, the motor portion 120 further comprises a rotor 122 and a stator 123. The rotor 122 and the rotating shaft 121 are connected, in some embodiments, the rotor 122 and the rotating shaft 121 can be coaxially arranged, and the matching mode of the rotor 122 and the rotating shaft 121 can be interference fit. In some embodiments, the rotor 122 and rotating shaft 121 can be set on different shafts, but the two are connected by transmission, which can be flexibly set according to the actual situation. The stator 123 is sleeved on the outer side of the rotor 122, the stator 123 comprises the stator core and the stator winding, and the stator winding is set on the stator core.

[0188] In addition, the pump device 100 further comprises a controller 190, and the controller 190 is arranged on one side of the motor portion 120 away from the pump portion 130, that is, the controller 190 is arranged at a position of the motor portion 120 away from the pump portion 130. Since the vibration near the pump portion 130 is more obvious during the working process, and the load is larger, the controller 190 is far away from the pump portion 130, which can protect the controller 190 to a certain extent and improve the service life of the controller 190.

[0189] Furthermore, the controller 190 is connected on the casing 110 and located in the cavity 111, and the end of the stator winding is electrically connected to the controller 190.

[0190] Specifically, during the working process of the pump device 100, the controller 190 controls the current of the stator winding in the stator 123 to change according to a certain law, thereby controlling the stator 123 to generate a changing excitation magnetic field. The rotor 122 rotates under the action of the excitation magnetic field, thereby driving the first rotation member 133 in the pump portion 130 to rotate through the rotating shaft 121, thereby making the second rotation member 134 moves. When the first rotation member 133 and the second rotation member 134 in the pump portion 130 rotate, due to the eccentric movement of the second rotation member 134, the volume of the compression cavity formed between the first rotation member 133 and the second rotation member 134 changes. Thus, the working medium entering the compression chamber is pressed out to the oil outlet 182 to generate flow power.

Embodiment 9

[0191] As shown in Fig. 6, the embodiment of the second aspect of the present invention provides a vehicle 200, including a pump device 100 in any one of the above-mentioned embodiments. Since the vehicle 200 provided by the present invention comprises the pump device 100 in any one of the above-mentioned embodiments, it has the beneficial effects of any one of the above-mentioned embodiments, which will not be repeated here.

[0192] It is worth noting that the vehicle 200 can be a new energy vehicle. New energy vehicles include pure electric vehicles, extended-range electric vehicles, hybrid electric vehicles, fuel cell electric vehicles, hydrogen engine vehicles, etc. Of course, the vehicle 200 also can be a traditional fuel vehicle.

[0193] In a specific embodiment, the vehicle 200 comprises a vehicle body 210 and an engine 220. The pump device 100 and the engine 220 are both arranged in the vehicle body 210, and the engine 220 comprises a mounting seat 221. The mounting seat 221 is connected with the extension portion 114 of the pump device 100, the oil pool 115 is formed by the cooperation of the mounting seat 221 and the extension portion 114, and then the oil pool 115 can be communicated with the oil source of the engine 220 to realize the oil passage.

[0194] In specific applications, when the vehicle 200 is a new energy vehicle, the engine 220 is an electric motor; when the vehicle 200 is a fuel vehicle, the engine 220 is a fuel engine.

[0195] In the present invention, the terms "first", "second", and "third" are used for the purpose of description only, and cannot be understood as indicating or implying relative importance; and the term "plurality" means two or more, unless otherwise expressly defined. The terms "installing", "connected", "connection", "fixing" and the like should be understood in a broad sense. For example, "connection" may be a fixed connection, a removable connection or an integral connection; and "connected" may refer to direct connection or indirect connection through an intermediary. A person of ordinary skills in the art could understand the specific meaning of the terms in the present invention according to specific situations.

[0196] In the description of the present invention, it should be understood that the orientation or position relationships indicated by the terms "upper", "lower", "left", "right", "front", "back" and the like are the orientation or position relationships based on what is shown in the drawings, are merely for the convenience of describing the present invention and simplifying the description, and do not indicate or imply that the device or unit referred to must have a particular direction and is constructed and operated in a specific orientation, and thus cannot be understood as the limitation of the present invention.

[0197] In the description of the present specification, the descriptions of the terms "one embodiment", "some embodiments" and "specific embodiments" and the like mean that specific features, structures, materials or characteristics described in conjunction with the embodiment(s) or example(s) are included in at least one embodiment or example of the present invention. In the specification, the schematic representation of the above terms does not necessarily refer to the same embodiment or example. Moreover, the specific features, structures, materials or characteristics described may be combined in a suitable manner in any one or more embodiments or examples.

Claims

1. A pump device (100), comprising:

a casing (110), comprising a cavity (111);
a motor portion (120), comprising a rotating shaft (121) rotatable around a central axis of the motor portion (120);
a pump portion (130), wherein the pump portion (130) is arranged on an axial side of the motor portion (120) and in contact with the rotating shaft (121), wherein the pump portion (130) can be driven by the rotating shaft (121) to rotate; the pump portion (130) comprises a first pressure chamber (131) and a second pressure chamber (132), the pressure that the first pressure chamber (131) bears is greater than the pressure that the second pressure chamber (132) bears;
a first bearing (140), connected with the casing (110) and sleeved on the rotating shaft (121), the first bearing (140) being located between the motor portion (120) and the pump portion (130);
a first oil groove (141), arranged on a first end surface of the first bearing (140) facing the pump portion (130), and communicating with the first pressure chamber (131); and
a throttle groove (142), provided on the first end surface, and communicating the first oil groove (141) with a gap between the first bearing (140) and the rotating shaft (121),
characterized in that the pump device further comprises a buffer chamber (160) arranged on an end surface of the first bearing (140) away from the pump portion (130)[1],
wherein the buffer chamber (160) comprises:

a first wall surface (161), wherein the first wall surface (161) is a wall surface of the buffer chamber (160) close to the rotating shaft (121); from an end of an opening of the buffer chamber (160) to a bottom wall of the buffer chamber (160), a distance between the first wall surface (161) and the rotating shaft (121) increases[2], and the buffer chamber (160) further comprises a second wall surface (162), wherein the second wall surface (162) is arranged to face the first wall surface (161), from an end of the opening of the buffer chamber (160) to the bottom wall of the buffer chamber (160), a distance between the second wall surface (162) and the rotating shaft (121) decreases[3].

2. The pump device (100) according to claim 1, wherein
a portion of an inner side wall of the first bearing (140) is recessed away from the rotating shaft (121) to form a first lubrication groove (143), which communicates with the throttle groove (142).

3. The pump device (100) according to claim 2, wherein

a ratio of a flow cross-sectional area of the throttle groove (142) to a flow cross-sectional area of the first lubrication groove (143) is greater than or equal to 0.1 and less than or equal to 0.4;
and/or,
a ratio of the flow cross-sectional area of the first lubrication groove (143) to a cross-sectional area of a shaft hole of the first bearing (140) is greater than or equal to 0.02 and less than or equal to 0.08.

4. The pump device (100) according to claim 2 or 3, further comprising:
a sealing member (150), connected to one side of the first bearing (140) away from the pump portion (130), wherein the sealing member (150) is sleeved on the rotating shaft (121), the sealing member (150), the first bearing (140) and the rotating shaft (121) form a liquid passage chamber (151), the liquid passage chamber (151) communicates with the first lubrication groove (143), the pump device (100) preferably further comprising:
a pressure relief groove (144), arranged on the first bearing (140), and communicating with the liquid passage chamber (151) and the second pressure chamber (132).

5. The pump device (100) according to claim 4, wherein
a ratio of the flow cross-sectional area of the pressure relief groove (144) to the flow cross-sectional area of the first lubrication groove (143) is greater than or equal to 1 and less than or equal to 4.

6. The pump device (100) according to any one of claims 1 to 5, wherein an opening area of the buffer chamber (160) is larger than a bottom wall area of the buffer chamber (160).

7. The pump device (100) according to any one of claims 1 to 6, wherein the pump device (100) further comprises:
a second bearing (170), wherein the second bearing (170) is connected with the casing (110) and sleeved on the

rotating shaft (121), and the second bearing (170) is located on one side of the pump portion (130) away from the first bearing (140).

8. The pump device (100) according to claim 7, wherein
a portion of an inner side wall of the second bearing (170) is recessed away from the rotating shaft (121) to form a second lubrication groove (171), which communicates with the first pressure chamber (131).

9. The pump device (100) according to claim 7 or 8, further comprising:
an anti-push lubrication groove (172), provided on an end surface of the second bearing (170) close to the pump portion (130), and communicating with a shaft hole of the second bearing (170).

10. The pump device (100) according claim 9, wherein the casing (110) comprises:

a machine shell (112), surrounding the motor portion (120) and the pump portion (130), wherein the machine shell (112) is connected with the first bearing (140); and
a pump cover (113), wherein the pump cover (113) is connected on the machine shell (112), the pump cover (113) and the machine shell (112) form the cavity (111), the pump cover (113) is connected to the second bearing (170), a portion of the pump cover (113) extends away from the pump portion (130) to form an extension portion (114), wherein the extension portion (114) being used for forming an oil pool (115),
the shaft hole of the second bearing (170) is an axial through hole, one end of the through hole is communicated with the anti-push lubrication groove (172), and another end of the through hole is used to communicate with the oil pool (115).

11. The pump device (100) according to any one of claims 7 to 9, wherein the casing (110) comprises:

a machine shell (112), surrounding the motor portion (120) and the pump portion (130), and connected with the first bearing (140); and
a pump cover (113), wherein the pump cover (113) is connected on the machine shell (112), the pump cover (113) and the machine shell (112) form the cavity (111), and the pump cover (113) is connected to the second bearing (170), the shaft hole of the second bearing (170) is a blind hole with one end open; and
a communication groove, arranged on the second bearing (170) and/or on the pump cover (113), and communicating the first pressure chamber (131) and the blind hole.

12. The pump device (100) according to any one of claims 1 to 11, wherein the pump portion (130) comprises:

a first rotation member (133), matched with the rotating shaft (121); and
a second rotation member (134), wherein the second rotation member (134) is arranged on an outside of the first rotation member (133), and the first rotation member (133) can drive the second rotation member (134) to rotate, the second rotation member (134) and the first rotation member (133) form the first pressure chamber (131) and the second pressure chamber (132),
the pump device (100) further comprises:

an oil inlet (181), arranged on the pump cover (113) and/or the second bearing (170) along an axial direction, wherein the oil inlet (181) communicating with the second pressure chamber (132); and
an oil outlet (182), arranged on the pump cover (113) and the second bearing (170) along a radial direction, wherein the oil outlet (182) communicating with the first pressure chamber (131) of the pump portion (130).

13. The pump device (100) according to any one of claims 1 to 12, wherein the motor portion (120) further comprises:

a rotor (122), connected with the rotating shaft (121); and
a stator (123), sleeved on the rotor (122), wherein the stator (123) comprises a stator core and a stator winding, and the stator winding being arranged on the stator core,
the pump device (100) further comprises:
a controller (190), arranged on one side of the motor portion (120) away from the pump portion (130), and connected on the casing (110) and located in the cavity (111), and one end of the stator (123) winding being electrically connected to the controller (190).

14. A vehicle (200), comprising a pump device (100) according to any one of claims 1 to 13.

Patentansprüche

1. **1.** Pumpvorrichtung (100), umfassend:

   ein Gehäuse (110), umfassend einen Hohlraum (111);
   einen Motorbereich (120) umfassend eine Drehwelle (121), die um eine zentrale Achse des Motorbereichs (120) drehbar ist;
   einen Pumpbereich (130), wobei der Pumpbereich (130) auf einer axialen Seite des Motorbereichs (120) und in Kontakt mit der Drehwelle (121) angeordnet ist, wobei der Pumpbereich (130) durch die Drehwelle (121) angetrieben werden kann, so dass er sich dreht; der Pumpbereich (130) eine erste Druckkammer (131) und eine zweite Druckkammer (132) umfasst, der Druck, den die erste Druckkammer (131) trägt, größer ist als der Druck, den die zweite Druckkammer (132) trägt;
   ein erstes Lager (140), das mit dem Gehäuse (110) verbunden ist und auf der Drehwelle (121) ummantelt ist, wobei sich das erste Lager (140) zwischen dem Motorbereich (120) und dem Pumpbereich (130) befindet;
   eine erste Ölnut (141), die an einer ersten Endfläche des ersten Lagers (140) angeordnet ist, die dem Pumpbereich (130) zugewandt ist, und die mit der ersten Druckkammer (131) in Verbindung steht; und
   eine Drosselnut (142), die an der ersten Endfläche vorgesehen ist und die erste Ölnut (141) mit einem Spalt zwischen dem ersten Lager (140) und der Drehwelle (121) verbindet,
   dadurch gekennzeichnet, dass die Pumpvorrichtung ferner eine Pufferkammer (160) umfasst, die an einer Endfläche des ersten Lagers (140) weg von dem Pumpbereich (130) angeordnet ist,
   wobei die Pufferkammer (160) Folgendes umfasst:

   eine erste Wandfläche (161), wobei die erste Wandfläche (161) eine Wandfläche der Pufferkammer (160) nahe der Drehwelle (121) ist; von einem Ende einer Öffnung der Pufferkammer (160) zu einer Bodenwand der Pufferkammer (160) ein Abstand zwischen der ersten Wandfläche (161) und der sich drehenden Welle (121) zunimmt, und
   die Pufferkammer (160) ferner eine zweite Wandfläche (162) aufweist, wobei die zweite Wandfläche (162) so angeordnet ist, dass sie der ersten Wandfläche (161) zugewandt ist, und von einem Ende der Öffnung der Pufferkammer (160) zu der Bodenwand der Pufferkammer (160) ein Abstand zwischen der zweiten Wandfläche (162) und der Drehwelle (121) abnimmt.

2. Pumpvorrichtung (100) gemäß Anspruch 1, wobei
ein Bereich einer inneren Seitenwand des ersten Lagers (140) von der Drehwelle (121) weg zurückgesetzt ist, um eine erste Schmiernut (143) auszubilden, die mit der Drosselnut (142) in Verbindung steht.

3. Pumpvorrichtung (100) gemäß Anspruch 2, wobei

ein Verhältnis einer Strömungsquerschnittsfläche der Drosselnut (142) zu einer Strömungsquerschnittsfläche der ersten Schmiernut (143) größer als oder gleich 0,1 und kleiner als oder gleich 0,4 ist;
und/oder,
ein Verhältnis der Strömungsquerschnittsfläche der ersten Schmiernut (143) zu einer Querschnittsfläche eines Wellenlochs des ersten Lagers (140) größer oder gleich 0,02 und kleiner oder gleich 0,08 ist.

4. Pumpvorrichtung (100) gemäß Anspruch 2 oder 3, ferner umfassend:

ein Dichtungselement (150), das mit einer Seite des ersten Lagers (140) weg von dem Pumpbereich (130) verbunden ist, wobei das Dichtungselement (150) auf der Drehwelle (121) ummantelt ist, das Dichtungselement (150), das erste Lager (140) und die Drehwelle (121) eine Flüssigkeitsdurchgangskammer (151) bilden, die Flüssigkeitsdurchgangskammer (151) mit der ersten Schmiernut (143) in Verbindung steht, wobei die Pumpvorrichtung (100) vorzugsweise ferner Folgendes umfasst:
eine Druckentlastungsnut (144), die an dem ersten Lager (140) angeordnet ist und mit der Flüssigkeitsdurchgangskammer (151) und der zweiten Druckkammer (132) in Verbindung steht.

5. Pumpvorrichtung (100) gemäß Anspruch 4, wobei
ein Verhältnis der Strömungsquerschnittsfläche der Druckentlastungsnut (144) zu der Strömungsquerschnittsfläche der ersten Schmiernut (143) größer oder gleich 1 und kleiner oder gleich 4 ist.

6. Pumpvorrichtung (100) gemäß einem der Ansprüche 1 bis 5, wobei eine Öffnungsfläche der Pufferkammer (160) größer ist als eine Bodenwandfläche der Pufferkammer (160).

7. Pumpvorrichtung (100) gemäß einem der Ansprüche 1 bis 6, wobei die Pumpvorrichtung (100) ferner Folgendes umfasst:
ein zweites Lager (170), wobei das zweite Lager (170) mit dem Gehäuse (110) verbunden ist und auf der Drehwelle (121) gelagert ist, und das zweite Lager (170) auf einer Seite des Pumpbereichs (130) weg von dem ersten Lager (140) angeordnet ist.

8. Pumpvorrichtung (100) gemäß Anspruch 7, wobei ein Bereich einer inneren Seitenwand des zweiten Lagers (170) von der Drehwelle (121) weg zurückgesetzt ist, um eine zweite Schmiernut (171) auszubilden, die mit der ersten Druckkammer (131) in Verbindung steht.

9. Pumpvorrichtung (100) gemäß Anspruch 7 oder 8, ferner umfassend:
eine Anti-Push-Schmiernut (172), die an einer Endfläche des zweiten Lagers (170) nahe dem Pumpbereich (130) vorgesehen ist und mit einem Wellenloch des zweiten Lagers (170) in Verbindung steht.

10. Pumpvorrichtung (100) gemäß Anspruch 9, wobei das Gehäuse (110) Folgendes umfasst:

ein Maschinengehäuse (112), das den Motorbereich (120) und den Pumpbereich (130) umgibt, wobei das Maschinengehäuse (112) mit dem ersten Lager (140) verbunden ist; und
einen Pumpendeckel (113), wobei der Pumpendeckel (113) mit dem Maschinengehäuse (112) verbunden ist, der Pumpendeckel (113) und das Maschinengehäuse (112) den Hohlraum (111) ausbilden, der Pumpendeckel (113) mit dem zweiten Lager (170) verbunden ist, ein Bereich des Pumpendeckels (113) sich von dem Pumpbereich (130) weg erstreckt, um einen Verlängerungsbereich (114) auszubilden, wobei der Verlängerungsbereich (114) zur Ausbildung eines Ölreservoirs (115) verwendet wird, das Wellenloch des zweiten Lagers (170) ein axiales Durchgangsloch ist, ein Ende des Durchgangslochs mit der Anti-Push-Schmiernut (172) in Verbindung steht und ein anderes Ende des Durchgangslochs verwendet wird, um mit dem Ölreservoir (115) in Verbindung zu stehen.

11. Pumpvorrichtung (100) gemäß einem der Ansprüche 7 bis 9, wobei das Gehäuse (110) Folgendes umfasst:
ein Maschinengehäuse (112), das den Motorbereich (120) und den Pumpbereich (130) umgibt und mit dem ersten Lager (140) verbunden ist; und einen Pumpendeckel (113), wobei der Pumpendeckel (113) mit dem Maschinengehäuse (112) verbunden ist, der Pumpendeckel (113) und das Maschinengehäuse (112) den Hohlraum (111) ausbilden und der Pumpendeckel (113) mit dem zweiten Lager (170) verbunden ist, wobei das Wellenloch des zweiten Lagers (170) ein Sackloch mit einem offenen Ende ist; und eine Verbindungsnut, die an dem zweiten Lager (170) und/oder an dem Pumpendeckel (113) angeordnet ist und die erste Druckkammer (131) und das Sackloch miteinander verbindet.

12. Pumpvorrichtung (100) gemäß einem der Ansprüche 1 bis 11, wobei der Pumpbereich (130) Folgendes umfasst:

ein erstes Drehelement (133), das an die Drehwelle (121) angepasst ist; und ein zweites Drehelement (134), wobei das zweite Drehelement (134) an einer Außenseite des ersten Drehelements (133) angeordnet ist und das erste Drehelement (133) das zweite Drehelement (134) in Drehung versetzen kann, wobei das zweite Drehelement (134) und das erste Drehelement (133) die erste Druckkammer (131) und die zweite Druckkammer (132) ausbilden,
die Pumpvorrichtung (100) ferner Folgendes umfasst:

einen Öleinlass (181), der an dem Pumpendeckel (113) und/oder dem zweiten Lager (170) entlang einer axialen Richtung angeordnet ist, wobei der Öleinlass (181) mit der zweiten Druckkammer (132) in Verbindung steht; und
einen Ölauslass (182), der auf dem Pumpendeckel (113) und dem zweiten Lager (170) entlang einer radialen Richtung angeordnet ist, wobei der Ölauslass (182) mit der ersten Druckkammer (131) des Pumpbereichs (130) in Verbindung steht.

13. Pumpvorrichtung (100) gemäß einem der Ansprüche 1 bis 12, wobei der Motorbereich (120) ferner Folgendes umfasst:

einen Rotor (122), der mit der Drehwelle (121) verbunden ist; und einen Stator (123), der auf den Rotor (122) aufgeschoben ist, wobei der Stator (123) einen Statorkern und eine Statorwicklung umfasst, und die Statorwicklung auf dem Statorkern angeordnet ist,

die Pumpvorrichtung (100) ferner Folgendes umfasst:
eine Steuerung (190), die auf einer vom Pumpbereich (130) abgewandten Seite des Motorbereichs (120) angeordnet und mit dem Gehäuse (110) verbunden ist und sich in dem Hohlraum (111) befindet, und wobei ein Ende der Statorwicklung (123) elektrisch mit der Steuerung (190) verbunden ist.

14. Fahrzeug (200), umfassend eine Pumpvorrichtung (100) gemäß einem der Ansprüche 1 bis 13.

Revendications

1. Dispositif de pompe (100), comprenant :

un carter (110), comprenant une cavité (111) ;
une partie de moteur (120), comprenant un arbre de rotation (121) pouvant tourner autour d'un axe central de la partie de moteur (120) ;
une partie de pompe (130), dans lequel la partie de pompe (130) est disposée sur un côté axial de la partie de moteur (120) et en contact avec l'arbre de rotation (121), dans lequel la partie de pompe (130) peut être entraînée en rotation par l'arbre de rotation (121) ; la partie de pompe (130) comprend une première chambre de pression (131) et une deuxième chambre de pression (132), la pression que la première chambre de pression (131) supporte est supérieure à la pression que la deuxième chambre de pression (132) supporte ; un premier palier (140), relié au carter (110) et emmanché sur l'arbre de rotation (121), le premier palier (140) étant situé entre la partie de moteur (120) et la partie de pompe (130) ;
une première rainure d'huile (141), disposée sur une première surface d'extrémité du premier palier (140) faisant face à la partie de pompe (130), et communiquant avec la première chambre de pression (131) ; et une rainure d'étranglement (142), prévue sur la première surface d'extrémité, et faisant communiquer la première rainure d'huile (141) avec un espace entre le premier palier (140) et l'arbre de rotation (121),
caractérisé en ce que le dispositif de pompe comprend en outre une chambre tampon (160) disposée sur une surface d'extrémité du premier palier (140) à distance de la partie de pompe (130),
dans lequel la chambre tampon (160) comprend :

une première surface de paroi (161), dans lequel la première surface de paroi (161) est une surface de paroi de la chambre tampon (160) proche de l'arbre de rotation (121) ; depuis une extrémité d'une ouverture de la chambre tampon (160) à une paroi inférieure de la chambre tampon (160), une distance entre la première surface de paroi (161) et l'arbre de rotation (121) augmente, et
la chambre tampon (160) comprend en outre une deuxième surface de paroi (162), dans lequel la deuxième surface de paroi (162) est disposée de manière à faire face à la première surface de paroi (161), depuis une extrémité de l'ouverture de la chambre tampon (160) à la paroi inférieure de la chambre tampon (160), une distance entre la deuxième surface de paroi (162) et l'arbre de rotation (121) diminue.

2. Dispositif de pompe (100) selon la revendication 1, dans lequel une partie d'une paroi latérale intérieure du premier palier (140) est évidée à distance de l'arbre de rotation (121) pour former une première rainure de lubrification (143), qui communique avec la rainure d'étranglement (142).

3. Dispositif de pompe (100) selon la revendication 2, dans lequel

un rapport d'une zone de section transversale d'écoulement de la gorge d'étranglement (142) sur une zone de section transversale d'écoulement de la première rainure de lubrification (143) est supérieur ou égal à 0,1 et est inférieur ou égal à 0,4 ;
et/ou
un rapport de la zone de section transversale d'écoulement de la première rainure de lubrification (143) sur une zone de section transversale d'un trou d'arbre du premier palier (140) est supérieur ou égal à 0,02 et est inférieur ou égal à 0,08.

4. Dispositif de pompe (100) selon la revendication 2 ou 3, comprenant en outre : un élément d'étanchéité (150) relié à un côté du premier palier (140) à distance de la partie de pompe (130), dans lequel l'élément d'étanchéité (150) est emmanché sur l'arbre de rotation (121), l'élément d'étanchéité (150), le premier palier (140) et l'arbre de rotation (121) forment une chambre de passage de liquide (151), la chambre de passage de liquide (151) communique avec la première rainure de lubrification (143), le dispositif de pompe (100) comprend en outre de préférence :

une rainure de relâchement de pression (144) disposée sur le premier palier (140), et communiquant avec la chambre de passage de liquide (151) et la deuxième chambre de pression (132).

5. Dispositif de pompe (100) selon la revendication 4, dans lequel un rapport de la zone de section transversale d'écoulement de la rainure de relâchement de pression (144) sur la zone de section transversale d'écoulement de la première rainure de lubrification (143) est supérieur ou égal à 1 et est inférieur ou égal à 4.

6. Dispositif de pompe (100) selon l'une quelconque des revendications 1 à 5, dans lequel une zone d'ouverture de la chambre tampon (160) est plus grande qu'une zone de paroi inférieure de la chambre tampon (160).

7. Dispositif de pompe (100) selon l'une quelconque des revendications 1 à 6, dans lequel le dispositif de pompe (100) comprend en outre :
un deuxième palier (170), dans lequel le deuxième palier (170) est relié au carter (110) et est emmanché sur l'arbre de rotation (121), et le deuxième palier (170) est situé sur un côté de la partie de pompe (130) à distance du premier palier (140).

8. Dispositif de pompe (100) selon la revendication 7, dans lequel une partie d'une paroi latérale intérieure du deuxième palier (170) est évidée à distance de l'arbre de rotation (121) pour former une deuxième rainure de lubrification (171), qui communique avec la première chambre de pression (131).

9. Dispositif de pompe (100) selon la revendication 7 ou 8, comprenant en outre : une rainure de lubrification anti-poussée (172), prévue sur une surface d'extrémité du deuxième palier (170) à proximité de la partie de pompe (130), et communiquant avec un trou d'arbre du deuxième palier (170).

10. Dispositif de pompe (100) selon la revendication 9, dans lequel le carter (110) comprend :

une coque de machine (112) entourant la partie de moteur (120) et la partie de pompe (130), dans lequel la coque de machine (112) est reliée au premier palier (140) ; et
un couvercle de pompe (113), dans lequel le couvercle de pompe (113) est relié sur la coque de machine (112), le couvercle de pompe (113) et la coque de machine (112) forment la cavité (111), le couvercle de pompe (113) est relié au deuxième palier (170), une partie du couvercle de pompe (113) s'étend à distance de la partie de pompe (130) pour former une partie d'extension (114), dans lequel la partie d'extension (114) est utilisée pour former un réservoir d'huile (115),
le trou d'arbre du deuxième palier (170) est un trou traversant axial, une extrémité du trou traversant communique avec la rainure de lubrification anti-poussée (172), et une autre extrémité du trou traversant est utilisée pour communiquer avec le réservoir d'huile (115).

11. Dispositif de pompe (100) selon l'une quelconque des revendications 7 à 9, dans lequel le carter (110) comprend :

une coque de machine (112) entourant la partie de moteur (120) et la partie de pompe (130), et reliée au premier palier (140) ; et
un couvercle de pompe (113), dans lequel le couvercle de pompe (113) est relié sur la coque de machine (112), le couvercle de pompe (113) et la coque de machine (112) forment la cavité (111), et le couvercle de pompe (113) est relié au deuxième palier (170), le trou d'arbre du deuxième palier (170) est un trou borgne avec une extrémité ouverte ; et
une rainure de communication disposée sur le deuxième palier (170) et/ou sur le couvercle de pompe (113), et mettant en communication la première chambre de pression (131) et le trou borgne.

12. Dispositif de pompe (100) selon l'une quelconque des revendications 1 à 11, dans lequel la partie de pompe (130) comprend :

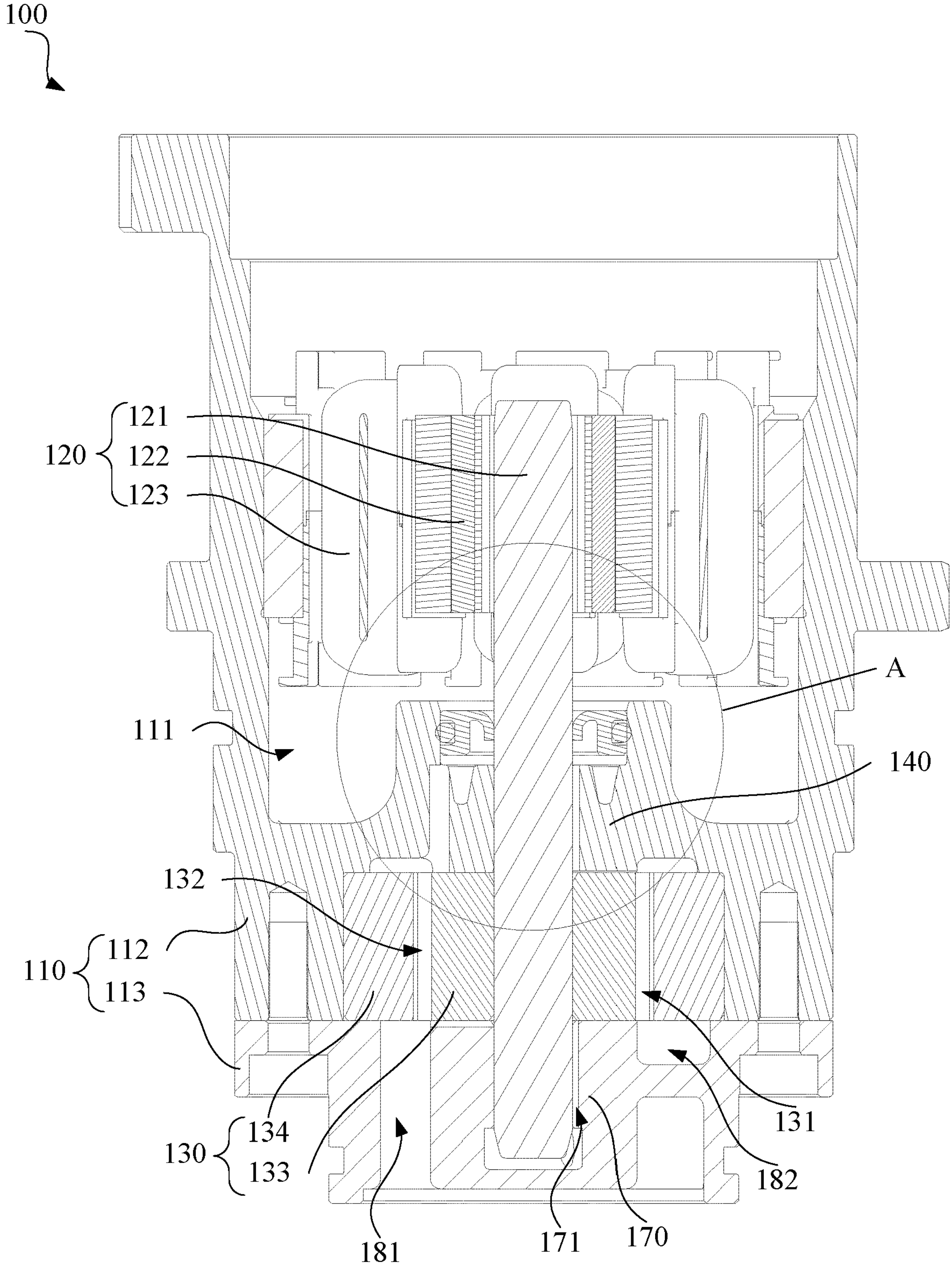
un premier élément de rotation (133) correspondant à l'arbre de rotation (121) ; et
un deuxième élément de rotation (134), dans lequel le deuxième élément de rotation (134) est disposé sur un extérieur du premier élément de rotation (133), et le premier élément de rotation (133) peut entraîner le deuxième élément de rotation (134) en rotation, le deuxième élément de rotation (134) et le premier élément de rotation (133) forment la première chambre de pression (131) et la deuxième chambre de pression (132),
le dispositif de pompe (100) comprend en outre :
une entrée d'huile (181) disposée sur le couvercle de pompe (113) et/ou le deuxième palier (170) le long d'une

direction axiale, dans lequel l'entrée d'huile (181) communique avec la deuxième chambre de pression (132) ; et une sortie d'huile (182) disposée sur le couvercle de pompe (113) et le deuxième palier (170) le long d'une direction radiale, dans lequel la sortie d'huile (182) communique avec la première chambre de pression (131) de la partie de pompe (130).

13. Dispositif de pompe (100) selon l'une quelconque des revendications 1 à 12, dans lequel la partie de moteur (120) comprend en outre :

un rotor (122) relié à l'arbre de rotation (121) ; et
un stator (123) emmanché sur le rotor (122), dans lequel le stator (123) comprend un noyau de stator et un enroulement de stator, et l'enroulement de stator étant disposé sur le noyau de stator,
le dispositif de pompe (100) comprend en outre :
un dispositif de commande (190) disposé sur un côté de la partie de moteur (120) à distance de la partie de pompe (130), et relié sur le carter (110) et situé dans la cavité (111), et une extrémité de l'enroulement de stator (123) étant connectée électriquement au dispositif de commande (190).

14. Véhicule (200) comprenant un dispositif de pompe (100) selon l'une quelconque des revendications 1 à 13.


100
120
121
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123
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111
140
132
110
112
113
131
182
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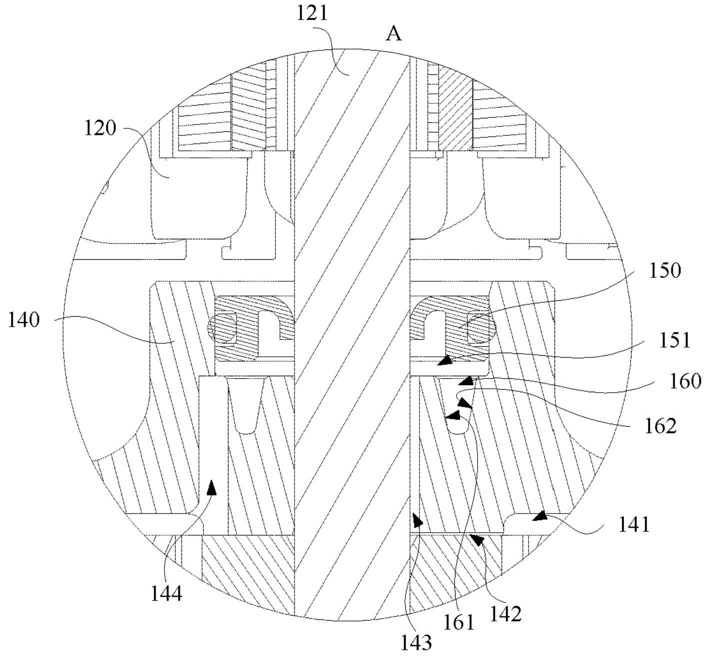
181
171
170

Fig. 1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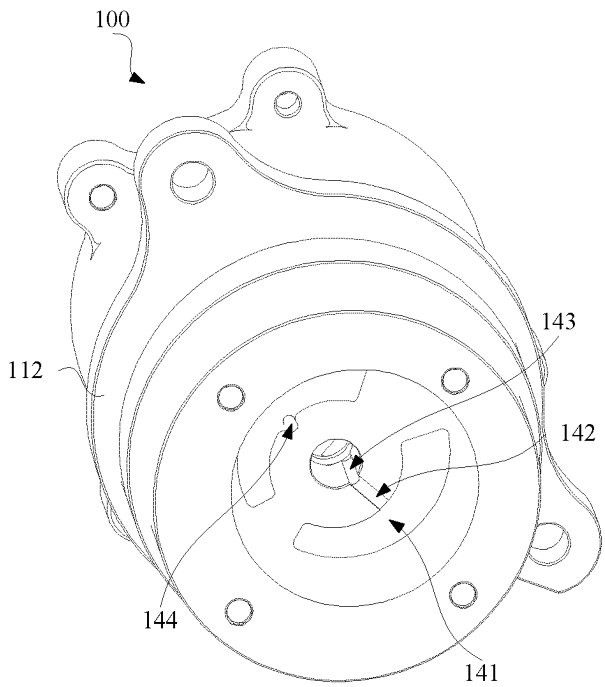
161
142
143

Fig. 2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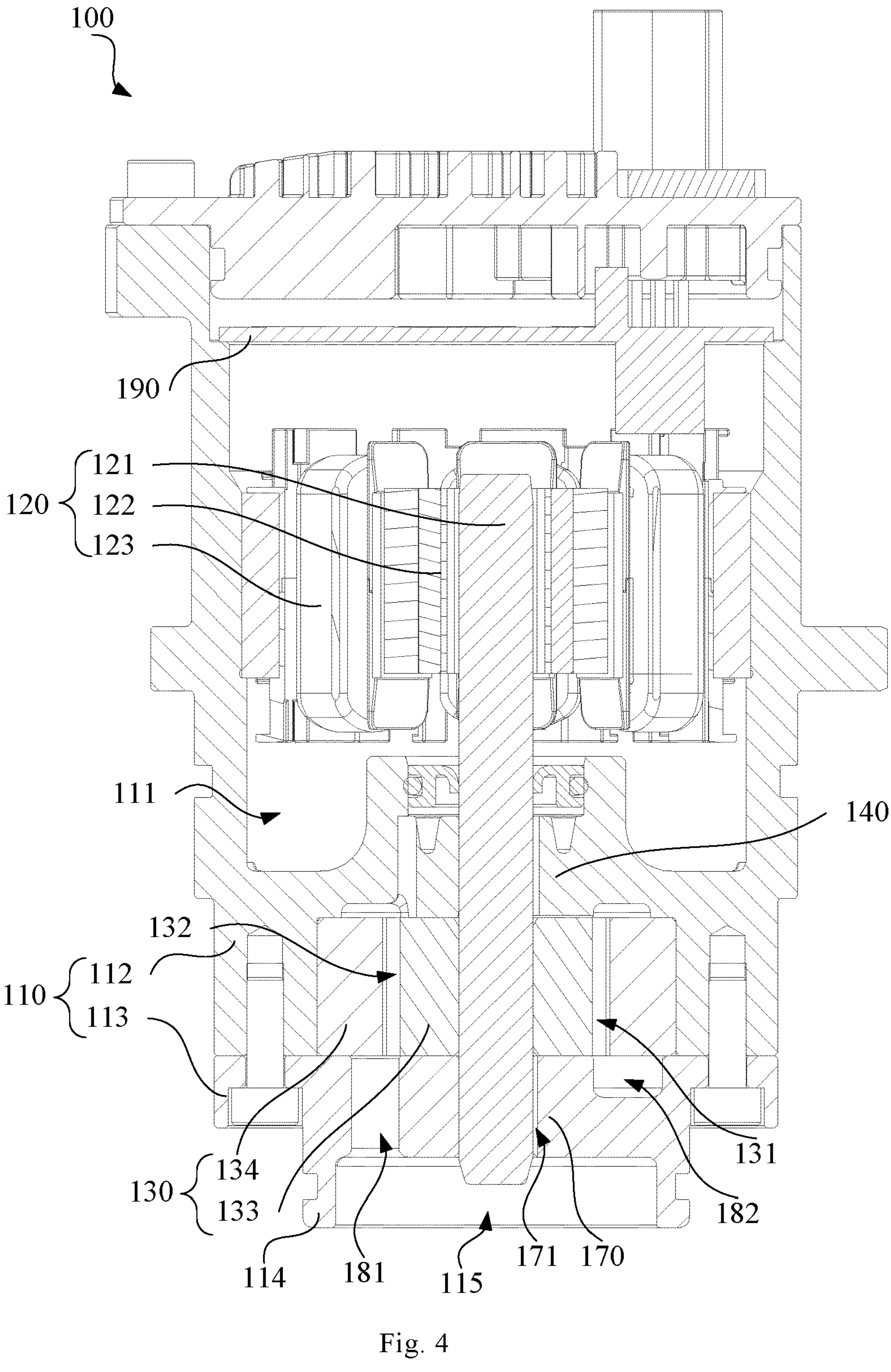
141

Fig. 3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121
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171
170

Fig. 4

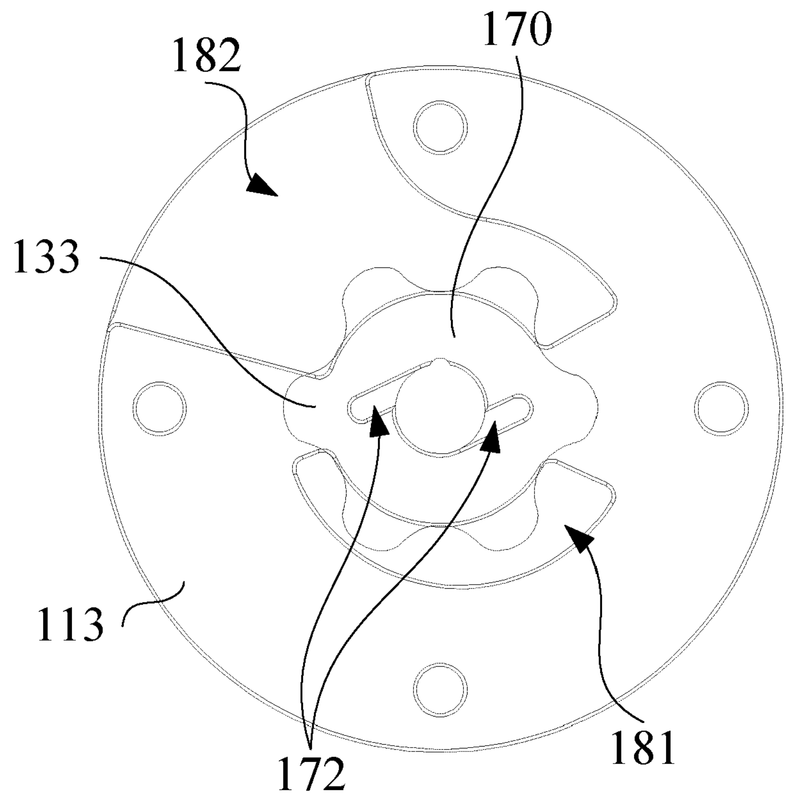

Fig. 5

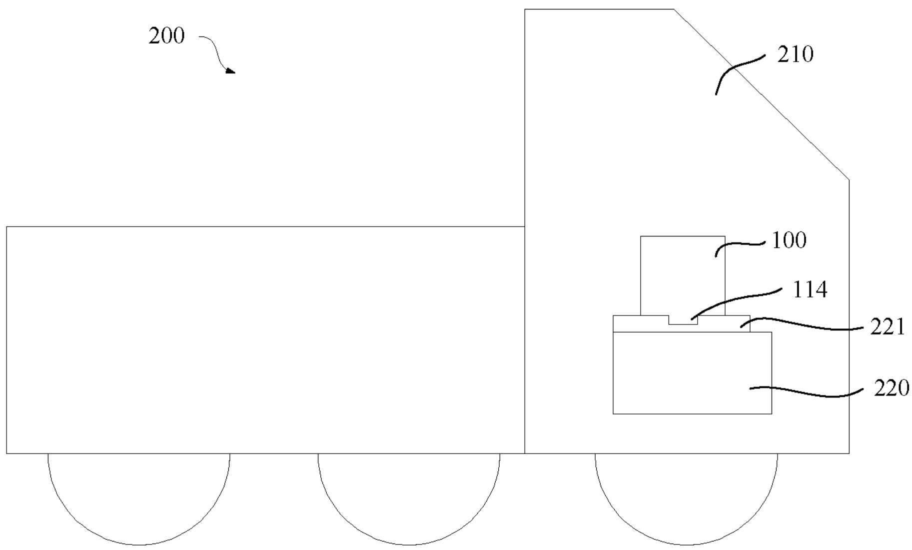

Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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