MARINE CRYOGENIC CARGO PUMP

CROSS-REFERENCE TO THE RELATED APPLICATIONS

[1] The present invention claims priority to Chinese Patent Application No. 2024116510525, entitled "MARINE CRYOGENIC CARGO PUMP" filed with the China National Intellectual Property Administration on November 19, 2024, the entire content of which is incorporated herein by reference.

TECHNICAL FIELD

[2] The present invention relates to the field of cryogenic pumps, and more particularly, to a marine cryogenic cargo pump.

BACKGROUND

[3] A marine cryogenic cargo pump refers to a pump capable of withstanding low-temperature environments and configured to transport cryogenic liquid cargo on a ship, and is mainly configured to transport cryogenic media such as liquefied natural gas (LNG) and liquefied petroleum gas (LPG). During ship transportation, these cryogenic liquids need to maintain their low-temperature state to ensure safe transportation and storage. The structural construction of a marine cryogenic cargo pump mainly includes components such as a pump head, a cryogenic motor, an outlet flange, a cryogenic junction box, a pump base, and a suction strainer. Among them, the pump head is a core component of the marine cryogenic cargo pump, and is mainly composed of a suction section, an inducer, an impeller, a guide vane, a middle section, a cylinder body, an intermediate section, and an axial force balance mechanism. The marine cryogenic cargo pump is mainly applied in the field of ship transportation, particularly on LNG carriers and LPG carriers. With the adjustment of global energy structure and the development of clean energy, the transportation demand for liquefied natural gas and liquefied petroleum gas continues to increase, and the market demand for marine cryogenic cargo pumps is also constantly expanding.

[4] Existing cryogenic cargo pumps are directly connected and fixed to the steel plate at the bottom of a ship through bolts and a pump support. However, when the cryogenic cargo pump is in continuous operation, vibrations are generated, and prolonged operation can cause bolt loosening, which affects the service life of the cryogenic cargo pump and the safety during

operation, thereby causing wear between the connecting and fixing members, resulting in poor firmness and stability.

SUMMARY

[5] In order to improve the problem of unstable fixing due to shaking of a cryogenic cargo pump caused by vibration during long-term operation, the present invention provides a marine cryogenic cargo pump.

[6] The present invention provides a marine cryogenic cargo pump adopting the following technical solution:

[7] A marine cryogenic cargo pump includes a cryogenic cargo pump, wherein the cryogenic cargo pump includes an intermediate section, a cylinder body, a suction section, a motor housing, and a motor cover connected to one another and constituting an outer shell of the cryogenic cargo pump, a side wing is fixedly provided around a lower end of the motor cover, an arcuate mounting seat is fixedly provided at a lower end of each side wing, the arcuate mounting seat is fixed on a tank bottom through a pump support, and a gap for liquid flow is reserved between a lower end of the suction section and an interior of the tank bottom;

[8] stopper blocks corresponding to each other are fixedly provided at both ends of the intermediate section; and

[9] a clamping assembly, including main steel plates fixedly provided at both sides of an upper end of the arcuate mounting seat, wherein an L-shaped plate is arranged at each of both sides of each main steel plate, and a buffer pad configured to clamp and fix the stopper block is fixedly provided on a side of each L-shaped plate facing the other L-shaped plate.

[10] By adopting the above technical solution, the L-shaped plate is moved as needed, and simultaneously the buffer pad is brought into contact with and fixed to a surface of the stopper block, thereby achieving an effect of clamping and fixing the stopper block. The buffer pad itself achieves a buffering effect on the stopper block by its own properties, so as to reduce an amplitude of vibration of the cryogenic cargo pump during operation. Meanwhile, a distance between the two buffer pads can be adjusted to clamp stopper blocks of different sizes.

[11] Optionally, an adjusting hole is formed in a side of the L-shaped plate away from the buffer pad. A first bolt configured to fix the L-shaped plate and the main steel plate is movably inserted into the adjusting hole and the main steel plate. The buffer pad is made of a high-density polyethylene (HDPE) material.

[12] By adopting the above technical solution, the adjusting hole is configured to adjust a distance between the two L-shaped plates, so that the distance between the two buffer pads can be adjusted according to stopper blocks of different sizes. The first bolt is then tightened and fixed, thereby achieving a clamping and fixing effect.

[13] Optionally, a countersunk hole is formed in a middle portion of the buffer pad. A length and width dimension of the buffer pad is the same as a length and width dimension of one end of the L-shaped plate.

[14] By adopting the above technical solution, the countersunk hole facilitates the installation of a countersunk screw. The length and width dimension of the buffer pad is the same as the length and width dimension of the L-shaped plate, which can increase an aesthetic appeal of the device and avoid interference between structures that would affect normal use of the device.

[15] Optionally, the countersunk screw is movably inserted into the countersunk hole and is threadedly fixed to one end of the L-shaped plate. A head of the countersunk screw is recessed within the countersunk hole.

[16] By adopting the above technical solution, the head of the countersunk screw is located inside the countersunk hole so as to effectively prevent abnormal noise caused by friction when the buffer pad is in contact with a surface of the stopper block.

[17] Optionally, reinforcing ribs are fixed between both sides of a lower end of the side wing and a surface of the main steel plate.

[18] By adopting the above technical solution, the reinforcing ribs can effectively increase connection stability between the main steel plate and the side wing.

[19] Optionally, self-tightening assemblies configured to automatically clamp the two opposing buffer pads are arranged at both inner sides of the main steel plate facing the buffer pads.

[20] By adopting the above technical solution, the self-tightening can gradually reduce a distance between the two buffer pads to achieve an effect of automatically clamping the stopper block and preventing loosening.

[21] Optionally, the self-tightening assembly includes main sliding grooves formed at both ends of a side of the main steel plate. Middle sliding channels are formed at upper and lower sides of ends of the main sliding grooves facing each other. A side sliding groove is formed at a middle position of an opening of the main sliding groove.

[22] By adopting the above technical solution, the main sliding grooves and the middle sliding channels can guide and limit a force-receiving plate, and the side sliding groove can guide and limit a side slider.

[23] Optionally, a cylinder housing is fixedly provided at an end of an interior of the main sliding groove adjacent to the middle sliding channel and the side sliding groove. A second piston column and a first piston column are respectively slidably arranged at both ends of an interior of the cylinder housing. Sealing rings configured to seal are sleeved at ends of the second piston column and the first piston column located inside the cylinder housing. A clearance plate is movably arranged at a side of the first piston column on an inner wall of the main sliding groove.

[24] Under a normal state, a front surface of the clearance plate is in contact with a surface of the first piston column and a surface of a compensating strip respectively. A force-receiving plate sliding inside the middle sliding channel is fixedly provided at an end of the compensating strip.

[25] A side of the force-receiving plate away from the main steel plate is fixedly provided at a side of the buffer pad. An outer surface of the force-receiving plate is flush with an outer surface of the buffer pad and together is in contact with a surface of the stopper block.

[26] By adopting the above technical solution, the sealing rings can prevent oil leakage at connection portions between the second piston column and the cylinder housing, and between the first piston column and the cylinder housing, so as to achieve a sealing effect. Meanwhile, through movement of the first piston column, hydraulic oil is pushed to move the second piston column. The compensating strip can compensate for a distance between the force-receiving plate and the clearance plate, thereby increasing a contact area and making the force-receiving plate push the clearance plate more stably.

[27] Optionally, a connecting plate is fixedly provided at an end of the second piston column on a side away from the L-shaped plate. A rocker plate is rotatably arranged at an end of the connecting plate. A first shaft fixedly connected to the main steel plate is movably inserted through the rocker plate at a one-third position of the connecting plate. An end of the rocker plate away from the connecting plate is rotatably connected to a side of a side slider through a second shaft. Both ends of the side slider are slidably arranged in the side sliding groove. The side slider is located in the opening of the main sliding groove. The side slider is fixed to the L-shaped plate.

[28] Three mounting holes are formed in a side of the clearance plate away from the buffer pad. Springs fixedly connected to an interior of the main sliding groove are fixedly provided at bottoms of inner cavities of the mounting holes.

[29] By adopting the above technical solution, the side slider is driven by the rocker plate to move linearly in the side sliding groove. A moving distance between the two buffer pads is on the order of millimeters, so a long linear movement distance is not required for the side slider; a

movement length of 0-5 mm is sufficient. Meanwhile, a diameter of the mounting hole is set to be larger than a diameter of the spring, which can enable the clearance plate to fill a distance between the force-receiving plate and the first piston column in real time through the spring, thereby enabling the stopper block to drive the first piston column to move every time it vibrates.

[30] Optionally, two movable seats are fixedly provided at a side of the cylinder housing at the connecting plate. A third shaft is fixed between the two movable seats. A pawl is rotatably arranged at a middle portion of the third shaft. A torsion spring is sleeved outside the third shaft and is fixedly connected to the pawl and the movable seat respectively.

[31] A ratchet bar configured to engage and connect with the pawl is fixedly provided at a side of the connecting plate facing the pawl. Under the action of the torsion spring, the pawl is always in contact with the ratchet bar to achieve engagement and limit.

[32] By adopting the above technical solution, the movable seats and the third shaft serve to support and fix the pawl. Meanwhile, under the action of the torsion spring, the pawl is always in contact with the ratchet bar and can be engaged and locked for limiting and fixing, thereby enabling the connecting plate to achieve only unidirectional movement.

[33] In summary, the present invention includes at least one of the following beneficial technical effects:

[34] 1. The L-shaped plate can move on the main steel plate through the adjusting hole, thereby adjusting a distance between the two buffer pads, so that different stopper blocks can be mounted between the two buffer pads. Meanwhile, the buffer pad can achieve a buffering and shock-absorbing effect on the stopper block, thereby reducing vibration of the cryogenic cargo pump during operation to increase a service life of the cryogenic cargo pump.

[35] 2. With the cooperation of the self-tightening assembly with the main steel plate, the buffer pad, the L-shaped plate, and other structures, a distance between the two buffer pads can be gradually reduced when the stopper block vibrates, so that the stopper block is clamped in real time. Even if a surface of the buffer pad wears, a worn thickness can be compensated through movement of the L-shaped plate, thereby achieving an automatic locking capability of the present device and effectively increasing stability of the device during operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[36] FIG. 1 is a schematic front view of installation of a cryogenic cargo pump and a tank bottom according to the present invention;

[37] FIG. 2 is a schematic sectional view of the cryogenic cargo pump according to the present invention;

[38] FIG. 3 is a schematic top view of the cryogenic cargo pump according to the present invention;

[39] FIG. 4 is a schematic view of the clamping assembly according to the present invention;

[40] FIG. 5 is a schematic top sectional view of the clamping assembly according to the present invention;

[41] FIG. 6 is a schematic axonometric view of the self-tightening assembly of Embodiment 2 according to the present invention;

[42] FIG. 7 is a sectional top schematic view of the self-tightening assembly of Embodiment 2 according to the present invention;

[43] FIG. 8 is a schematic exploded axonometric view of the self-tightening assembly of Embodiment 2 according to the present invention;

[44] FIG. 9 is a schematic view of connection between the pawl and the ratchet bar of Embodiment 2 according to the present invention; and

[45] FIG. 10 is a schematic view of connection between the torsion spring and the pawl of Embodiment 2 according to the present invention.

[46] Reference numerals: 1, intermediate section; 2, cylinder body; 3, suction section; 4, stopper block; 5, motor housing; 6, motor cover; 7, side wing; 8, arcuate mounting seat;

[47] 9, clamping assembly; 901, main steel plate; 902, reinforcing rib; 903, L-shaped plate; 904, first bolt; 905, buffer pad; 906, countersunk screw; 907, adjusting hole; 908, countersunk hole;

[48] 9100, self-tightening assembly; 9101, main sliding groove; 9102, force-receiving plate; 9103, side slider; 9104, rocker plate; 9105, connecting plate; 9106, cylinder housing; 9107, clearance plate;

[49] 9108, side sliding groove; 9109, middle sliding channel; 9110, first shaft; 9111, compensating strip; 9112, mounting hole; 9113, spring; 9114, first piston column; 9115, sealing ring;

[50] 9116, second piston column; 9117, second shaft; 9118, movable seat; 9119, pawl; 9120, ratchet bar; 9121, torsion spring; 9122, third shaft;

[51] 10, pump support; 11, tank bottom; 12, liquid outlet pipe.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[52] The present invention is described in further detail below with reference to FIGS. 1-10.

[53] An embodiment of the present invention discloses a marine cryogenic cargo pump.

[54] Embodiment 1

[55] Referring to FIGS. 1 to 3, a marine cryogenic cargo pump is shown, and the cryogenic cargo pump is provided as a main cargo pump, and is mainly of a vertical submerged pump structure configured for discharge of LNG on a ship. The cryogenic cargo pump includes an intermediate section 1, a cylinder body 2, a suction section 3, a motor housing 5, and a motor cover 6 connected to one another and constituting an outer shell of the cryogenic cargo pump. Liquid outlet channels are formed inside the intermediate section 1 and the motor cover 6. A liquid outlet pipe 12 is fixedly connected between a liquid outlet channel at a top of the motor cover 6 and a liquid outlet channel of the intermediate section 1, and the liquid outlet pipe 12 is arranged at an outer side of the motor housing 5. A discharge outlet of the liquid outlet channel in the motor cover 6 is connected to an in-hold discharge pipeline. A lower end of the motor cover 6 and an upper end of the side wing 7 are fixed by bolts, and the side wing 7 is circumferentially arranged around the motor cover 6. Reinforcing ribs 902 arranged in a V-shape are fixed between both sides of a lower end of the side wing 7 and surfaces of corresponding main steel plates 901, thereby improving rigidity of connection between the main steel plates 901 and the side wing 7. A lower end of each side wing 7 is welded and fixed to an upper end of the arcuate mounting seat 8. The arcuate mounting seat 8 is fixed to a mounting end of the pump support 10 by bolts. A lower end of the pump support 10 is fixed on the tank bottom 11. The tank bottom 11 is arranged at a bottom of a ship hold, and a gap for liquid flow is reserved between a lower end of the suction section 3 and an interior of the tank bottom 11.

[56] External wires are connected to terminal blocks of the present cryogenic cargo pump. Meanwhile, the cryogenic cargo pump is fixedly supported through the side wing 7 and the pump support 10 so that the cryogenic cargo pump operates normally, with a suction section 3 of the cryogenic cargo pump facing downward. When the cryogenic cargo pump is powered on, an internal motor operates to drive a turbine to rotate, thereby drawing cryogenic liquid inside a ship hold into the cryogenic cargo pump and delivering the cryogenic liquid through a fluid passage, a discharge pipe, and a long connecting pipeline within the cargo hold to the outside, thereby achieving the intended pumping function.

[57] An inducer is arranged in the suction section 3. A set of ultra-low temperature rolling bearings is arranged behind the inducer, and then an impeller is mounted. Guide vanes are arranged outside the impeller. After being pressurized by the impeller, a medium flows from the guide vanes to a next-stage impeller. The guide vanes are arranged inside the cylinder body 2,

and the motor housing 5 serves as a pump housing. Liquid enters from the suction section 3, is pressurized inside the cylinder body 2, is discharged to the liquid outlet channel of the intermediate section 1, passes through the liquid outlet pipe 12 at an outer side of the motor housing 5, then flows through the liquid outlet channel of the motor cover 6, and finally is discharged from a long connecting pipeline on the motor cover 6.

[58] A middle bearing body is mounted on the intermediate section 1. A set of ultra-low temperature rolling bearings is mounted inside of the middle bearing body, and a balance drum chamber is arranged at a lower portion of the middle bearing body. A balance drum is mounted, and the balance drum and the balance drum chamber form a fixed gap. A balance plate is also mounted on the intermediate section 1, and a variable gap is formed between the balance plate and an impeller spacer on a pump shaft, together constituting an axial force balance mechanism of the cargo pump to perform an axial force balancing function.

[59] A pump and a motor are of a coaxial design. The impeller is connected by a taper sleeve. A cryogenic motor shaft is hollow, and the pump shaft passes through the motor shaft and transmits torque through a spline connection. No shaft sealing system is arranged between the cryogenic motor and the pump. Both a stator and a rotor of the cryogenic motor are immersed in the medium. Power cables and instrument cables of the cryogenic motor are led out from the motor cover 6 and exported to outside of the pump.

[60] The cryogenic cargo pump can also be mounted inside a B-shape hold through a pump base and a hold bottom base plate. A suction strainer is fixedly provided at an inlet of the suction section 3 of the cryogenic cargo pump to filter impurities in the medium and the like, facilitating safe and reliable operation of the pump as a whole.

[61] A pump inside the cryogenic cargo pump and the cryogenic motor are immersed together in liquid, so explosion will not occur, which is safe and reliable. An inducer is arranged at an inlet of the pump. A characteristic of low net positive suction head can discharge liquid in a cargo hold as much as possible, leaving a very small remaining amount. Bearing lubrication and motor cooling both utilize liquid forced lubrication treatment. A transport medium is an LNG medium, and a medium temperature is -163 °C. A number of stages of the cryogenic cargo pump is 2 stages, a flow rate is 500 m^3/h, and a head is 210 m. A shaft efficiency of the cryogenic cargo pump is 78%. A motor power of the cryogenic motor is 250 kW, a synchronous rotational speed is 3600 r/min, and a power supply is 440 V/60 HZ.

[62] Referring to FIGS. 1 to 3, stopper blocks 4 are fixed at both ends of an outer surface of the intermediate section 1 through screws. The two stopper blocks 4 correspond to each other, and

heads of the screws are located inside the stopper blocks 4 to avoid protruding and interfering with the main steel plates 901 to cause excessive friction. The stopper blocks 4 are rectangular and surfaces thereof are smooth.

[63] The stopper blocks 4 and the intermediate section 1 are fixed to achieve an integrated design. When the stopper blocks 4 are fixed, the cryogenic cargo pump is thereby fixed, achieving multiple fixing and further improving installation stability of the cryogenic cargo pump.

[64] Referring to FIGS. 3 to 5, the clamping assembly 9 includes main steel plates 901 welded at both sides of an upper end of the arcuate mounting seat 8. Relatively symmetrical L-shaped plates 903 are arranged at both sides of each main steel plate 901. Buffer pads 905 are fixedly provided on sides of the L-shaped plates 903 facing each other. The buffer pads 905 are made of a high-density polyethylene (HDPE) material. The buffer pads 905 are configured to clamp and fix the stopper blocks 4 and achieve buffering. A through countersunk hole 908 is formed in a middle portion of each buffer pad 905. A gap of 2 mm is left between a lower end of the buffer pad 905 and a surface of the arcuate mounting seat 8 to avoid excessive friction that would make movement of the L-shaped plate 903 inconvenient. A length and width dimension of the buffer pad 905 is the same as a length and width dimension of one end of the L-shaped plate 903. An adjusting hole 907 is formed in a side of the L-shaped plate 903 away from the buffer pad 905. A length of the adjusting hole 907 is much larger than a diameter of a rod portion of the first bolt 904, thereby achieving transverse movement adjustment to further adjust a distance between the two buffer pads 905. The first bolt 904 is movably inserted through the adjusting hole 907 and the main steel plate 901, and the first bolt 904 is configured to fix the L-shaped plate 903 and the main steel plate 901. A head of the first bolt 904 is much larger than a height of the adjusting hole 907, thereby achieving a limiting effect.

[65] The buffer pad 905 can also act when LNG is injected into a ship hold. During a process in which the temperature changes from normal temperature to low temperature, the buffer pad 905 resists vibration of the cryogenic cargo pump caused by thermal expansion and contraction performance of a metallic material.

[66] When the cryogenic cargo pump is fixed inside a ship hold by the pump support 10, preliminary fixing is achieved. Meanwhile, an installer also needs to place the stopper block 4 between the two buffer pads 905, and leave a gap between an end of the stopper block 4 and a surface of the main steel plate 901, avoiding the stopper block 4 hitting the main steel plate 901 when shaking to reduce fixing and buffering effects. Subsequently, the installer pushes the two L-shaped plates 903 to move toward each other by a clamping tool or by hand, bringing the

buffer pad 905 into contact with a surface of the stopper block 4. Meanwhile, the adjusting hole 907 slides on a surface of a rod portion of the first bolt 904. When moved to a suitable position, the installer tightens the first bolt 904 by a tool, thereby achieving a fixing effect on the L-shaped plate 903. Properties of the stopper block 4 itself is utilized to limit shaking and achieve buffering of the stopper block 4, which reduces vibration of the cryogenic cargo pump during operation. This further improves installation stability of the cryogenic cargo pump so that bolt connection positions are not easily loosened.

[67] Referring to FIG. 5, a countersunk screw 906 is movably inserted into the countersunk hole 908. A rod portion of the countersunk screw 906 is threadedly fixed to an internal threaded hole at one end of the L-shaped plate 903. A middle portion of one end of the L-shaped plate 903 is formed with the internal threaded hole. A head of the countersunk screw 906 is recessed within the countersunk hole 908.

[68] Through the countersunk screw 906, the buffer pad 905 can be firmly fixed on the L-shaped plate 903, thus facilitating maintenance and replacement.

[69] An implementation principle of a marine cryogenic cargo pump of an embodiment of the present invention is:

[70] an installer installs the arcuate mounting seats 8 at both sides of the cryogenic cargo pump on the pump support 10. Meanwhile, the stopper block 4 is inserted between the buffer pads 905 at both sides of the main steel plate 901. Subsequently, the installer pushes the two L-shaped plates 903 to drive the buffer pad 905 to move, achieving clamping and fixing of the stopper block 4, and then fastens by the first bolt 904. When the cryogenic cargo pump vibrates during operation, it vibrates between the two buffer pads 905, and energy is consumed through deformation of the buffer pads 905, thereby achieving a shock absorption and buffering effect.

[71] It should be noted that the number of the stopper blocks 4, the main steel plates 901, and the corresponding matching structures can be designed according to actual needs, and at least two sets thereof can be provided.

[72] Embodiment 2

[73] Referring to FIGS. 6 to 8, the difference between this embodiment and Embodiment 1 is that self-tightening assemblies 9100 configured to automatically clamp the two opposing buffer pads 905 are arranged at both inner sides of the main steel plate 901 facing the buffer pads 905. The self-tightening assembly 9100 includes main sliding grooves 9101 formed at both ends of a side of the main steel plate 901. The main sliding groove 9101 is not a through groove. Rectangular middle sliding channels 9109 are formed at upper and lower sides of ends of the main sliding

groove 9101 facing each other. One end of the middle sliding channel 9109 extends to an end of the main sliding groove 9101, and the other end extends to an end of the cylinder housing 9106. A rectangular side sliding groove 9108 is formed at a middle position of an opening of the main sliding groove 9101. One end of the side sliding groove 9108 extends to a side close to the buffer pad 905, and the other end extends to a position close to an end of the main sliding groove 9101, so that the side slider 9103 moves to a maximum position and a distance between the two buffer pads 905 is kept at a maximum. The cylinder housing 9106 is fixedly provided at an end of an interior of the main sliding groove 9101 adjacent to the middle sliding channel 9109 and at an end of the side sliding groove 9108. An oil cavity is arranged inside the cylinder housing 9106. A second piston column 9116 and a first piston column 9114 are respectively slidably arranged at both ends of the oil cavity of the cylinder housing 9106. Several annular grooves are formed at ends of the second piston column 9116 and the first piston column 9114 located inside the cylinder housing 9106. Sealing rings 9115 configured to seal are sleeved in the annular grooves. A clearance plate 9107 is movably arranged at a side of the first piston column 9114 on an inner wall of the main sliding groove 9101. A side of the clearance plate 9107 in contact with a surface of the first piston column 9114 is set as a plane, and a side in contact with the force-receiving plate 9102 and the compensating strip 9111 is set as an inclined plane.

[74] Under a normal state, a front surface at one side of the clearance plate 9107 is in contact with a surface of the first piston column 9114, and the other side is in contact with a surface of the compensating strip 9111. A force-receiving plate 9102 sliding inside the middle sliding channel 9109 is fixedly provided at an end of the compensating strip 9111. At this time, the clearance plate 9107 has a tendency to move forward under a reaction force of the spring 9113.

[75] An oil injection nozzle and an oil discharge nozzle configured to inject hydraulic oil are also arranged on a surface of the cylinder housing 9106 (not shown in the figures). The installer installs the stopper block 4 between the two buffer pads 905, and a surface of the stopper block 4 is in contact with a surface of the force-receiving plate 9102 and applies a force thereto, causing the surface of the force-receiving plate 9102 and the surface of the compensating strip 9111 to be pressed against a surface of the clearance plate 9107. It should be noted that, at this time, the installer needs to use a blade tool to push the clearance plate 9107 and squeeze the spring 9113, thereby reducing a distance between the force-receiving plate 9102 and a surface of the first piston column 9114 and increasing a distance between the two buffer pads 905. Meanwhile, the clearance plate 9107 has a capability to adjust a distance between the two buffer pads 905 to achieve a self-locking and tightening function.

[76] After preliminary installation is completed, a user tightens the first bolt 904 by a tool. Vibration generated during operation of the cryogenic cargo pump will constantly change a distance between the two opposing buffer pads 905, and also constantly cause the force-receiving plate 9102 to move frequently in the middle sliding channel 9109. When the stopper block 4 vibrates, the stopper block 4 squeezes the first piston column 9114 through the force-receiving plate 9102, the compensating strip 9111, and the clearance plate 9107, causing the first piston column 9114 to squeeze hydraulic oil and move toward the second piston column 9116. At this time, the second piston column 9116 is driven to move out of the cylinder housing 9106 by a distance. When the stopper block 4 vibrates and moves in a reverse direction, it is briefly separated from the force-receiving plate 9102. At this time, the force-receiving plate 9102 is not in contact with the stopper block 4, putting the stopper block 4 in a free movement stage. Therefore, the clearance plate 9107 loses a limiting function, and the clearance plate 9107 is pushed by a reaction force of the spring 9113 to move while pushing the force-receiving plate 9102 to move toward the stopper block 4, thereby filling a distance between the force-receiving plate 9102 and an end face of the first piston column 9114. This arrangement prevents the first piston column 9114 from being unable to contact the clearance plate 9107 as a length of the first piston column 9114 entering the interior of the cylinder housing 9106 becomes shorter. In summary, when the stopper block 4 performs reciprocating vibration movement, the force-receiving plate 9102 can be constantly squeezed, thereby constantly squeezing the first piston column 9114 through the compensating strip 9111 and the clearance plate 9107, causing the second piston column 9116 to move out from the interior of the cylinder housing 9106. The above operation can achieve a self-locking and tightening function of the two buffer pads 905, thereby clamping the stopper block 4 more firmly.

[77] Referring to FIG. 7, a side of the force-receiving plate 9102 away from the main steel plate 901 is embedded and fixed at a side of the buffer pad 905. An outer surface of the force-receiving plate 9102 is flush with an outer surface of the buffer pad 905 and together is in contact with a surface of the stopper block 4.

[78] When a distance between the two buffer pads 905 continuously decreases, the stopper block 4 is clamped, effectively avoiding a situation in which the stopper block 4 cannot be clamped due to wear and deformation of the buffer pad 905 that causes an increased distance. Meanwhile, the buffer pad 905 drives the force-receiving plate 9102 to move together, which leads to an increased distance between the force-receiving plate 9102 and the first piston column 9114, and this requires the clearance plate 9107 to fill.

[79] Referring to FIGS. 7 to 9, a connecting plate 9105 is fixedly provided at an end of the second piston column 9116 on a side away from the L-shaped plate 903. A rocker plate 9104 is rotatably arranged at an end of the connecting plate 9105 away from the second piston column 9116 through a rotating shaft. The rocker plate 9104 is movably inserted through a first shaft 9110 at a one-third position of the connecting plate 9105. An upper end of the first shaft 9110 is inserted through and fixed to an upper portion of the main steel plate 901. A lower end of the first shaft 9110 is fixedly connected to an inner wall of the main steel plate 901. An end of the rocker plate 9104 away from the connecting plate 9105 is movably inserted through a second shaft 9117. The second shaft 9117 is rotatably arranged in a notch at a side of the side slider 9103, and an upper portion of the second shaft 9117 is movably inserted through an upper portion of the side slider 9103. Both ends of the side slider 9103 are slidably arranged in the side sliding groove 9108. The side slider 9103 is entirely located in the opening of the main sliding groove 9101. A side of the side slider 9103 and a side of the L-shaped plate 903 are fixed by two screws.

[80] When the second piston column 9116 is driven by hydraulic oil to move outward, it drives the connecting plate 9105 and then pushes the rocker plate 9104 to rotate about the first shaft 9110 as an axis. Under a lever action, the side slider 9103 is driven to move in the side sliding groove 9108. When the side slider 9103 moves, the rocker plate 9104 rotates through the second shaft 9117, thereby making a movement direction of the side slider 9103 opposite to a movement direction of the second piston column 9116. At this time, the L-shaped plate 903 is driven to move by the side slider 9103, and then the two buffer pads 905 are driven to move toward each other under the action of the two L-shaped plates 903 arranged opposite to each other, thereby achieving a clamping effect.

[81] Referring to FIG. 8, three mounting holes 9112 arranged in an equally-divided array are formed in a side of the clearance plate 9107 away from the buffer pad 905. The number of the mounting holes 9112 is at least three, and the more the number, the more stable the connection of the clearance plate 9107. Springs 9113 are fixedly provided at bottoms of inner cavities of the mounting holes 9112. An end of each spring 9113 away from a bottom of the inner cavity of the mounting hole 9112 is fixed to a surface of an inner wall of the main sliding groove 9101.

[82] Since the spring 9113 is in a compressed state under a normal state, when a gap is generated between the force-receiving plate 9102 and the first piston column 9114, the force-receiving plate 9102 is pushed to move under a reaction force of the spring 9113, thereby filling a gap

between the force-receiving plate 9102 and the first piston column 9114, thereby enabling the force-receiving plate 9102 to squeeze the first piston column 9114 every time it vibrates.

[83] Referring to FIGS. 8 to 10, two symmetrically arranged movable seats 9118 are fixedly provided at a side of the cylinder housing 9106 at the connecting plate 9105. A third shaft 9122 is inserted through and fixed between the two movable seats 9118. A middle portion of the third shaft 9122 is movably inserted through an end of the pawl 9119. A torsion spring 9121 is sleeved outside the third shaft 9122. One end of the torsion spring 9121 is fixed to the pawl 9119, and the other end of the torsion spring 9121 is fixed to a side of the movable seat 9118. A ratchet bar 9120 is fixedly provided at a side of the connecting plate 9105 facing the pawl 9119. The ratchet bar 9120 is engaged and connected with the pawl 9119 to achieve limiting. Under the action of the torsion spring 9121, the pawl 9119 is always in contact with the ratchet bar 9120 to achieve engagement and limit.

[84] When the connecting plate 9105 moves, the ratchet bar 9120 is driven to move, thereby causing the pawl 9119 to move out of one tooth groove of the ratchet bar 9120 and slide on a surface of the ratchet bar 9120 to and abut against with another tooth groove under a reaction force of the torsion spring 9121, preventing the connecting plate 9105 from moving in a reverse direction, thereby achieving a limiting effect. Since an amplitude of vibration of the stopper block 4 is small, a precision of tooth grooves of the ratchet bar 9120 needs to be set on the order of millimeters, thereby improving a clamping precision between the two buffer pads 905.

[85] An implementation principle of Embodiment 2 is: first, the stopper block 4 is placed between the two buffer pads 905. Subsequently, an installer pushes the two L-shaped plates 903 to bring the buffer pads 905 into contact with the stopper block 4, and then fixes the L-shaped plates 903 on the side slider 9103 by screws.

[86] When the stopper block 4 vibrates, it reciprocally pushes the force-receiving plate 9102, thereby pushing the first piston column 9114 through the compensating strip 9111 and a side of the force-receiving plate 9102, and pushing the second piston column 9116 to move outward through hydraulic oil inside the cylinder housing 9106. During frequent movement of the force-receiving plate 9102, the clearance plate 9107 is gradually inserted into a gap between the first piston column 9114 and the compensating strip 9111 under the action of the spring 9113 to perform filling, so that the force-receiving plate 9102 and the compensating strip 9111 can always push the first piston column 9114. The second piston column 9116 drives the connecting plate 9105 to move under the action of the first piston column 9114, and simultaneously causes the pawl 9119 to rotate about the third shaft 9122 as an axis and slide on the ratchet bar 9120.

Meanwhile, the connecting plate 9105 pushes the rocker plate 9104 to rotate, thereby driving the side slider 9103 to move through the first shaft 9110. The side slider 9103 drives the L-shaped plate 903 and the buffer pad 905 to move toward each other. Since the pawl 9119 and the ratchet bar 9120 limit the connecting plate 9105 from retracting, a distance between the two buffer pads 905 gradually decreases under the action of the clearance plate 9107, thereby achieving an effect of self-locking and fixing the stopper block 4 and effectively preventing the stopper block 4 from loosening.

[87] The above are only optional embodiments of the present invention, and are not configured to limit the present invention. For those skilled in the art, the present invention can have various modifications and variations. Any modifications, equivalent replacements, improvements, and the like made within the spirit and principles of the present invention shall be included within the protection scope of the present invention.

INDUSTRIAL APPLICABILITY

[88] In summary, the present invention provides a marine cryogenic cargo pump having a capability of automatically locking during a process of clamping and fixing stopper blocks at both sides of the cryogenic cargo pump, thereby improving fixing and buffering effects on the stopper blocks and keeping the stopper blocks always in contact with the buffer pads.

CLAIMS

1. A marine cryogenic cargo pump, characterized by comprising a cryogenic cargo pump, wherein the cryogenic cargo pump comprises an intermediate section (1), a cylinder body (2), a suction section (3), a motor housing (5), and a motor cover (6) connected to one another and constituting an outer shell of the cryogenic cargo pump, a side wing (7) is fixedly provided around a lower end of the motor cover (6), an arcuate mounting seat (8) is fixedly provided at a lower end of each side wing (7), the arcuate mounting seat (8) is fixed on a tank bottom (11) through a pump support (10), and a gap for liquid flow is reserved between a lower end of the suction section (3) and an interior of the tank bottom (11);

stopper blocks (4) corresponding to each other are fixedly provided at both ends of the intermediate section (1); and

a clamping assembly (9), comprising main steel plates (901) fixedly provided at both sides of an upper end of the arcuate mounting seat (8), wherein an L-shaped plate (903) is arranged at each of both sides of each main steel plate (901), and a buffer pad (905) configured to clamp and fix the stopper block (4) is fixedly provided on a side of each L-shaped plate (903) facing the other L-shaped plate (903).

2. The marine cryogenic cargo pump according to claim 1, wherein an adjusting hole (907) is formed in a side of the L-shaped plate (903) away from the buffer pad (905), a first bolt (904) configured to fix the L-shaped plate (903) and the main steel plate (901) is movably inserted into the adjusting hole (907) and the main steel plate (901), and the buffer pad (905) is made of a high-density polyethylene (HDPE) material.

3. The marine cryogenic cargo pump according to claim 2, wherein a countersunk hole (908) is formed in a middle portion of the buffer pad (905), and a length and width dimension of the buffer pad (905) is the same as a length and width dimension of one end of the L-shaped plate (903).

4. The marine cryogenic cargo pump according to claim 3, wherein a countersunk screw (906) is movably inserted into the countersunk hole (908) and is threadedly fixed to one end of the L-shaped plate (903), and a head of the countersunk screw (906) is recessed within the countersunk hole (908).

5. The marine cryogenic cargo pump according to any one of claims 1 to 4, wherein reinforcing ribs (902) are fixed between both sides of a lower end of the side wing (7) and a surface of the main steel plate (901).

6. The marine cryogenic cargo pump according to any one of claims 1 to 5, wherein self-tightening assemblies (9100) configured to automatically clamp the two opposing buffer pads (905) are arranged at both inner sides of the main steel plate (901) facing the buffer pads (905).

7. The marine cryogenic cargo pump according to claim 6, wherein the self-tightening assembly (9100) comprises main sliding grooves (9101) formed at both ends of a side of the main steel plate (901), middle sliding channels (9109) being formed at upper and lower sides of ends of the main sliding grooves (9101) facing each other, a side sliding groove (9108) being formed at a middle position of an opening of the main sliding groove (9101).

8. The marine cryogenic cargo pump according to claim 7, wherein a cylinder housing (9106) is fixedly provided at an end of an interior of the main sliding groove (9101) adjacent to the middle sliding channel (9109) and the side sliding groove (9108), a second piston column (9116) and a first piston column (9114) are respectively slidably arranged at both ends of an interior of the cylinder housing (9106), sealing rings (9115) configured to seal are sleeved at ends of the second piston column (9116) and the first piston column (9114) located inside the cylinder housing (9106), a clearance plate (9107) is movably arranged at a side of the first piston column (9114) on an inner wall of the main sliding groove (9101);

under a normal state, a front surface of the clearance plate (9107) is in contact with a surface of the first piston column (9114) and a surface of a compensating strip (9111) respectively, a force-receiving plate (9102) sliding inside the middle sliding channel (9109) being fixedly provided at an end of the compensating strip (9111); and

a side of the force-receiving plate (9102) away from the main steel plate (901) is fixedly provided at a side of the buffer pad (905), an outer surface of the force-receiving plate (9102) is flush with an outer surface of the buffer pad (905) and together is in contact with a surface of the stopper block (4).

9. The marine cryogenic cargo pump according to claim 8, wherein a connecting plate (9105) is fixedly provided at an end of the second piston column (9116) on a side away from the L-shaped plate (903), a rocker plate (9104) is rotatably arranged at an end of the connecting plate (9105), a first shaft (9110) fixedly connected to the main steel plate (901) is movably inserted through the rocker plate (9104) at a one-third position of the connecting plate (9105), an end of the rocker plate (9104) away from the connecting plate (9105) is rotatably connected to a side of a side slider (9103) through a second shaft (9117), both ends of the side slider (9103) are slidably arranged in the side sliding groove (9108), the side slider (9103) is located in the opening of the main sliding groove (9101), and the side slider (9103) is fixed to the L-shaped plate (903); and

three mounting holes (9112) are formed in a side of the clearance plate (9107) away from the buffer pad (905), springs (9113) fixedly connected to an interior of the main sliding groove (9101) being fixedly provided at bottoms of inner cavities of the mounting holes (9112).

10. The marine cryogenic cargo pump according to claim 9, wherein two movable seats (9118) are fixedly provided at a side of the cylinder housing (9106) at the connecting plate (9105), a third shaft (9122) is fixed between the two movable seats (9118), a pawl (9119) is rotatably arranged at a middle portion of the third shaft (9122), a torsion spring (9121) is sleeved outside the third shaft (9122) and is fixedly connected to the pawl (9119) and the movable seat (9118) respectively; and

a ratchet bar (9120) configured to engage and connect with the pawl (9119) is fixedly provided at a side of the connecting plate (9105) facing the pawl (9119), and under the action of the torsion spring (9121), the pawl (9119) is always in contact with the ratchet bar (9120) to achieve engagement and limit.