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(54) **DUAL-CHAMBER DUAL-ACTION AIR PUMP AND GLASS-WIPING ROBOT HAVING THE AIR PUMP**

(57) A dual-chamber dual-action air pump and a glass-wiping robot having the air pump. The air pump comprises a cylinder and, connected to the cylinder, a drive apparatus and a piston. The drive apparatus drives the piston via a transmission apparatus to perform reciprocating movement in the cylinder. A sealing element fixedly connected to the piston rod is arranged within the cylinder. The sealing element partitions the cylinder into a first chamber (A1) and a second chamber (A2). Both the first chamber and the second chamber respectively are provided with a first one-way valve and a second one-way valve. When the piston rod drives the sealing element to perform reciprocating movement, the first chamber and the second chamber simultaneously inhale air and exhaust air. The dual-chamber dual-action air pump is compact in structure, and provides doubled air flow rate and doubled efficiency. The glass-wiping robot having the air pump provides a suction cup with a vacuum suction force via the air pump, and allows for great air evacuation to be ensured for the suction cups even if the suction cup comes in contact with a crack or bump on a glass surface, thus reducing the risks of the damage of the glass-wiping robot due to falling, and eliminating possible security hazards.

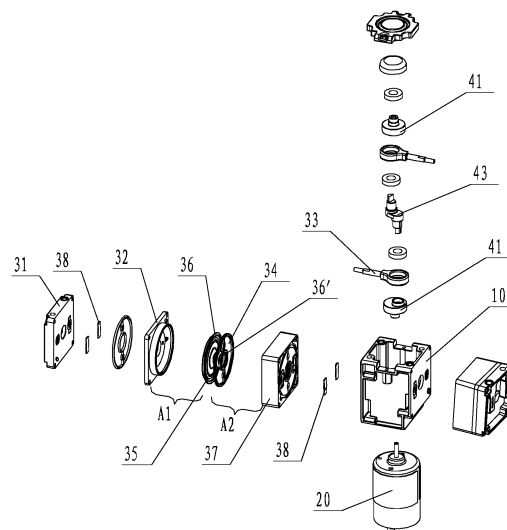


Fig. 2

Description

Field of the Invention

[0001] The present invention relates to an air pump and a glass-wiping robot having the air pump, and more particularly to a dual-chamber dual-action air pump and a glass-wiping robot having the air pump, which belongs to the technical field of mechanical manufacturing.

Background art

[0002] Fig. 1 is a schematic view of the overall structure of a vacuum air pump in the prior art. As illustrated in Fig. 1, the vacuum air pump in the prior art performs vacuum-pumping such that a motor 100 drives soft gum membranes 200, 300 connected therewith via a shaft to perform reciprocating movement. The volume of the air suction pump is relatively small, and when the motor 100 rotates once, the unilateral soft rubber membranes 200, 300 of the vacuum air pump perform reciprocating movement for one time, and thus the vacuum-pumping motion is performed only for one time. Its disadvantages lie in that the pumped air amount is too small and the vacuum-pumping speed is relatively low, and that if there is a slight air leakage, the vacuum degree would be reduced immediately. In particular, when a glass-wiping robot provides a suction cup with a vacuum suction force via the vacuum air pump, if the air leakage occurs in the case where the suction cup comes in contact with a crack or bump on a glass surface, the vacuum-pumping speed of the vacuum air pump having a too small pumped air amount is much less than the air leakage speed of the suction cup, which easily results in the damage of the glass-wiping robot due to falling or causes potential safety hazards.

Summary of the Invention

[0003] With respect to the deficiencies in the prior art, the object of the present invention is to provide a dual-chamber dual-action air pump that is compact in structure and provide doubled operation efficiency of the vacuum air pump.

[0004] The object of the present invention is achieved by the following technical solutions.

[0005] A dual-chamber dual-action air pump comprises a cylinder and a drive apparatus and a piston that are connected with the cylinder, the drive apparatus drives the piston via a transmission apparatus to perform reciprocating movement in the cylinder, a sealing element fixedly connected with the piston rod is provided in the cylinder, the sealing element partitions the cylinder into a first chamber and a second chamber, the first chamber and the second chamber are respectively provided with a first one-way valve and a second one-way valve, and when the piston rod drives the sealing element to perform reciprocating movement, the first chamber and the sec-

ond chamber simultaneously inhale air and exhaust air.

[0006] To be specific, the air pump comprises an air pump body, the drive apparatus is connected with the air pump body, and two cylinders are provided on both sides of the air pump body in a sealed manner; the cylinders comprise an air pump end cover, an air pump middle frame cover and an air pump middle frame connected in a sealed manner from the inside out, the air pump middle frame is connected with the air pump body in a sealed manner, the sealing element is provided between the air pump middle frame and the air pump middle frame cover, the sealing element and the air pump middle frame cover form the first chamber, the air pump middle frame cover and the air pump end cover form the first one-way valve, a soft gum membrane and the air pump middle frame form the second chamber, and the air pump middle frame and the air pump body form the second one-way valve.

[0007] The sealing element is a soft gum membrane, and the soft gum membrane is connected with the piston rod in a sealed manner.

[0008] To be specific, the soft gum membrane comprises a support and a membrane part, the membrane part consists of inner sealing rings and outer sealing rings provided on both sides of the support and connected via a retractable middle portion, the inner sealing rings and the outer sealing rings are attached to both sides of the air pump middle frame respectively, the outer sealing rings are fixed connected with the support, and the support is fixed connected with the piston rod.

[0009] The first one-way valve comprises an inlet room and an outlet room provided on the air pump end cover and an inlet room and an outlet room provided on the air pump middle frame cover; when the air pump end cover and the air pump middle frame cover are engaged, their inlet rooms and the outlet rooms form closed spaces in each of which sealing pads are provided; inlet holes are provided in the inlet rooms, outlet holes are provided in the outlet rooms, and the sealing pads perform reciprocating movement in the closed spaces under the action of airflow of the inlet holes and the outlet holes; the inlet holes and the outlet holes are arranged symmetrically in an intersecting manner on both sides of the closed spaces, and when the sealing pads are attached on one of the air pump end cover side and the air pump middle frame cover side, air flows through one of the inlet holes or the outlet holes; the second one-way valve comprises an inlet room and an outlet room provided on the air pump middle frame and an inlet room and an outlet room provided on the air pump body; when the air pump middle frame and the air pump body are engaged, their inlet rooms and outlet room form closed spaces in each of which sealing pads are provided; inlet holes are provided on the inlet rooms, outlet holes are provided on the outlet rooms, and the sealing pads perform reciprocating movement in the closed spaces under the action of airflow of the inlet holes and the outlet holes; the inlet holes and the outlet holes are arranged symmetrically in an intersecting manner on both sides of the closed spaces, and

when the sealing pads are attached on one of the air pump middle frame side and the air pump body side, air flows through one of the inlet holes or the outlet holes.

[0010] If necessary, the inlet hole is provided at the center of the inlet room and its number is one, and the outlet holes are provided symmetrically on both sides of the central line of the outlet room and are oppositely located on both sides of the inlet hole.

[0011] Or, the inlet holes are provided symmetrically on both sides of the central line of the inlet room and are oppositely located on both sides of the inlet hole, and the outlet hole is provided at the center of the outlet room and its number is one.

[0012] The diameter of the inlet holes and the outlet holes is the same as the width of the sealing pads.

[0013] An inlet pipe and an outlet pipe of the first chamber are provided on the air pump end cover, and an inlet pipe and an outlet pipe of the second chamber are provided on the air pump body.

[0014] The transmission apparatus is an eccentric shaft fitted over the output shaft, and an end of the piston rod is fitted over on the eccentric shaft.

[0015] The transmission apparatus is a crankshaft mechanism connected with the output shaft of the transmission apparatus. The crankshaft mechanism comprises lower and upper eccentric wheels and a crankshaft, the crankshaft comprises a crankshaft body and two shaft portions, the two shaft portions extend upward and downward on the left and right sides of the crankshaft body respectively; the shaft portions of the crankshaft comprise connection portions for the piston rods and connection portions for the eccentric wheels, the piston rods are fitted over the connection portions for the piston rods via bearings, and the connection portions for the eccentric wheels are inserted into eccentric holes of the eccentric wheels so as to be fixed.

[0016] The transmission apparatus is an eccentric wheel mechanism, the eccentric wheel mechanism comprises an eccentric wheel fixed on an output shaft, and a ring-shaped limitation groove is provided on one side surface of the eccentric wheel; the end of the piston rod of each piston air pump assembly is provided with a roller wheel, the roller wheel is embedded in the ring-shaped limitation groove, the output shaft drives the eccentric wheel to rotate, the roller wheel rolls along the circumference direction of the output shaft in the ring-shaped limitation groove and drives the piston rod to perform reciprocating movement.

[0017] The present invention also provides a glass-wiping robot comprising a machine body and a suction cup provided on the machine body, characterized in that, the suction cup is connected with the dual-chamber dual-action air pump as described above, and the inlet pipe of the first chamber and the inlet pipe of the second chamber are connected with the suction cup respectively.

[0018] In sum, the dual-chamber dual-action air pump of the present invention is compact in structure and provide doubled operation efficiency of the vacuum air

pump; the glass-wiping robot using such dual-chamber dual-action air pump can provide a greater air pumping efficiency for the suction cup and reduce the risks of the damage of the glass-wiping robot due to falling or possible security hazards.

[0019] Hereinafter, the detailed description of the technical solutions of the present invention are provided in conjunction with the accompanying drawings and the specific embodiments.

Description of accompanying drawings

[0020]

Fig. 1 is a schematic view of the overall structure of a vacuum air pump in the prior art.

Fig. 2 is an exploded view of the overall structure of the present invention.

Fig. 3 is a sectional view of a body and cylinders provided at both sides thereof in an air pump of the present application.

Fig. 4 is a structural view of inlet and outlet holes on an air pump end cover of the present invention.

Fig. 5 is a structural view of inlet and outlet holes on the air pump middle frame cover of the present invention.

Fig. 6 is a structural view of inlet and outlet holes on an air pump middle frame of the present invention.

Fig. 7 is a structural view of inlet and outlet holes on an air pump body of the present invention.

Fig. 8 is a structural view illustrating arrangement positions of inlet and outlet pipes of respective chambers of the present invention.

Fig. 9 is a structural view of a transmission apparatus having an eccentric shaft mechanism of the second embodiment of the present invention.

Fig. 10 is a structural view of a transmission apparatus having an eccentric wheel mechanism of the third embodiment of the present invention.

Fig. 11 is a structural view of a glass-wiping robot of the present invention.

Detailed Description of Preferred Embodiments

First embodiment

[0021] The present invention provides a dual-chamber dual-action air pump, in general, comprising a cylinder

and a drive apparatus and a piston that are connected to the cylinder. The drive apparatus drives the piston via a transmission apparatus to perform reciprocating movement in the cylinder. A sealing element fixedly connected to the piston rod is arranged within the cylinder. The sealing element partitions the cylinder into a first chamber and a second chamber. The first chamber and the second chamber are provided with a first one-way valve and a second one-way valve respectively. When the piston rod drives the sealing element to perform reciprocating movement, the first chamber and the second chamber simultaneously inhale air and exhaust air. Fig. 2 is an exploded view of the whole structure of the present invention. Fig. 3 is a sectional view of the air pump body and the cylinders at both sides thereof. As shown in Fig. 2 in combination with Fig. 3, specifically, the dual-chamber dual-action air pump of this embodiment comprises an air pump body 10, a drive apparatus connected to the air pump body 10, and cylinders symmetrically provided at both sides of the air pump body 10 in a sealed manner. A transmission apparatus is fixedly connected on an output shaft of the drive apparatus. According to the requirement of pumped air amount, more cylinders may be provided in the periphery of the air pump body 10. Specifically, each cylinder comprises an air pump end cover 31, an air pump middle frame cover 32, and an air pump middle frame 37 connected in this order, wherein the air pump middle frame 37 is connected with the air pump body 10 in a sealed manner. A sealing element is provided between the air pump middle frame 37 and the air pump middle frame cover 32 for sealing the air pump chambers, and may use rubber, soft gum membrane or the like. In this embodiment, the soft gum membrane is used. One end of a piston rod 33 is connected to the transmission apparatus and performs reciprocating movement by the driving of the transmission apparatus. The other end of the piston rod 33 is fixedly connected with the soft gum membrane. The soft gum membrane and the air pump middle frame cover 32 form a first chamber A1, the air pump middle frame cover 32 and the air pump end cover 31 form a first one-way valve, the soft gum membrane and the air pump middle frame 37 form a second chamber A2, and the air pump middle frame 37 and the air pump body 10 form a second one-way valve. That is to say, the space formed by the air pump middle frame 37 and the air pump middle frame cover 32 is divided into two portions by the soft gum membrane provided within the air pump middle frame 37, hereby resulting in the formation of the first chamber A1 and the second chamber A2 located both sides of the soft gum membrane respectively.

[0022] As shown in Fig. 2, the soft gum membrane comprises a support 34 and membrane parts 35. The membrane part 35 have inner sealing rings 36' and outer sealing rings 36 provided on both sides of the support 34 and connected via a retractable middle portion. The middle portion passes through a central hole of the air pump middle frame 37, and the inner and outer sealing rings

36', 36 are perfectly attached to both sides of the air pump middle frame 37 in a sealed manner. The outer sealing rings 36 are fixedly connected with the support 34, and the support 34 is fixedly connected with one end of the piston rod 33. When the air pump middle frame cover 32 is connected with the left side of the air pump middle frame 37, the first and second chambers A1, A2 are formed on the left and right sides of the outer sealing rings 36, respectively. When the piston rod 33 performs reciprocating movement, it drives the outer sealing rings 36 to move left and right, so as to allow the sealing pads 38 in the first and second one-way valves to move left and right, and allow the first and second chambers A1, A2 to simultaneously inhale air and exhaust air.

[0023] Fig. 4 is a structural view of inlet and outlet holes on the air pump end cover of the present invention. Fig. 5 is a structural view of inlet and outlet holes on the air pump middle frame cover of the present invention. As shown in Fig. 4 in combination with Fig. 5, the first one-way valve comprises an inlet room 350 and an outlet room 360 provided on the air pump end cover 31 and an inlet room 370 and an outlet room 380 provided on the air pump middle frame cover 32. When the air pump end cover 31 and the air pump middle frame cover 32 are engaged, their inlet rooms 350, 370 and outlet rooms 360, 380 form closed spaces in each of which sealing pads 38 are provided. An inlet hole 311 is provided in the inlet room 350, inlet holes 321 are provided in the inlet room 370, outlet holes 312 are provided in the outlet room 360, and an outlet hole 322 is provided in the outlet room 380. Further, the sealing pads 38 perform reciprocating movement within the closed spaces under the action of the air flow of the inlet holes and outlet holes. The inlet holes 311, 321 and outlet holes 312, 322 are arranged symmetrically at both sides of the closed spaces in an intersecting manner. When the sealing pads 38 are attached on one of the air pump end cover 31 side or the air pump middle frame cover 32 side, air flows through only one of the inlet holes 311, 321 or outlet holes 312, 322.

[0024] Fig. 6 is a structural view of inlet and outlet holes on the air pump middle frame of the present invention, and Fig. 7 is a structural view of inlet and outlet holes on the air pump body of the present invention. As shown in Fig. 6 in combination with Fig. 7, likewise, the structures and operations of the inlet and outlet rooms and inlet and outlet holes provided on the air pump middle frame 37 and the air pump body 10 are similar to those as described above. Specifically, the second one-way valve comprises an inlet room 450 and an outlet room 460 provided on the air pump middle frame 37 and inlet room 470 and an outlet room 480 provided on the air pump body 10. When the air pump middle frame 37 and the air pump body 10 are engaged, their inlet rooms 450, 470 and outlet rooms 460, 480 form closed spaces in each of which sealing pads 38 are provided. Inlet holes 411, 421 are provided in the inlet rooms 450, 470, and outlet holes 412, 422 are provided in the outlet rooms 460, 480.

Further, the sealing pads 38 perform reciprocating movement within the closed spaces under the action of the air flow of the inlet holes and outlet holes. The inlet and outlet holes are arranged symmetrically at both sides of the closed spaces in an intersecting manner.

[0025] As shown in Figs. 4-5 in combination with Figs. 6-7, the shown symmetrical arrangement in an intersecting manner means that the inlet hole is provided at the center of the inlet room and its number is one, and the outlet holes are symmetrically provided on both sides of the central line of the outlet room and are oppositely located on the both sides of the inlet hole, or that the inlet holes are symmetrically provided on both sides of the central line of the inlet room and are oppositely located on the both sides of the inlet hole, and the outlet hole is provided at the center of the outlet room and its number is one. The diameters of the inlet and outlet holes are the same as the width of the sealing pads. By this, when the sealing pads 38 are biased toward one side under the action of airflow, among the holes provided on this side,

one central hole is blocked and two other side holes remain connectedness, while among the holes provided the opposite side, both one central hole and two other side holes remain connectedness, hereby ensuring that when the sealing pads 38 are attached on one of the air pump end cover 31 side or the air pump middle frame cover 32 side and are attached on one of the air pump middle frame 37 side or the air pump body 10 side, air flows through only one of the inlet holes or outlet holes.

[0026] Fig. 8 is a schematic view illustrating arrangement positions of inlet pipes and outlet pipes of respective chambers of the present invention. As shown in combination with Fig. 4, the inlet pipe 313 is in communication with the inlet hole 311 on the inlet room 350, and the outlet pipe 314 is in communication with the outlet holes 312 on the outlet room 360. The inlet pipe 103 and the outlet pipe 104 of the second chamber are provided on the air pump body 10.

[0027] As shown in combination with Fig. 2, the present invention provides the dual-chamber dual-action air pump powered by the drive apparatus (i.e., motor 20), in which the transmission apparatus connected with the motor output shaft drives the piston rods 33 to perform reciprocating movement, so as to realize the air pump operation process. The transmission apparatus may use various structural forms to realize the transfer of the motor power. In this embodiment, the transmission apparatus is a crankshaft mechanism. Specifically, the crankshaft mechanism comprises lower and upper eccentric wheels 41 and a crankshaft 43. The crankshaft 43 comprises a crankshaft body and two shaft portions extending from left and right sides of the crankshaft body upward and downward respectively. The shaft portions of the crankshaft comprise connection portions for the piston rods 33 over which the piston rods 33 are fitted via bearings and connection portions for the eccentric wheels which are inserted into eccentric holes of the eccentric wheels so as to be fixed.

[0028] Referring to Figs. 2-8, the operation process of the dual-chamber dual-action air pump according to this embodiment is described below.

[0029] The motor 20 rotates, and its output shaft drives the piston rods 33 to move toward the right side via the eccentric wheels 41 and the crankshaft 43. The piston rod 33 pulls the outer sealing rings 36 to move toward the right side via the support 34, and the volume of the first chamber A1 increases and the pressure reduces.

The formed pressure difference pushes the sealing pads 38 between the air pump end cover 31 and the air pump middle frame cover 32 to move toward the right side. The outlet holes 312 and the inlet hole 311 are opened. The sealing pads 38 blocks between the two inlet holes 321, and the outlet hole 322 is closed. The first chamber A1 inhales air through the inlet pipe 313 of the air pump end cover 31. Meanwhile, the volume of the second chamber A2 decreases and the pressure increases, and the formed pressure difference pushes the sealing pads 38 between the air pump middle frame 37 and the air pump body 10 to move toward the right side. The inlet hole and the outlet holes on the air pump middle frame 37 are opened, and the outlet hole on the air pump body 10 is closed. The second chamber A2 exhausts air through the outlet pipe 104 of the air pump body.

[0030] The motor keeps on rotating, and the motor output shaft drives the piston rod 33 to move toward the left side. The piston rod 33 pulls the outer sealing rings 36 to move toward the left side via the support 34. The formed pressure difference pushes the sealing pads 38 between the air pump end cover 31 and the air pump middle frame cover 32 to move toward the left side. The inlet hole 311 is blocked, the outlet holes 312 are opened, the inlet holes 321 and the outlet hole 322 are opened, and the first chamber A1 exhausts air through the outlet pipe 314 of the air pump end cover 31. Meanwhile, the volume of the second chamber A2 increases and the pressure reduces, and the formed pressure difference drives the sealing pads 38 between the air pump middle frame 37 and the air pump body 10 to move toward the left side. The inlet hole of the air pump middle frame 37 is opened and the outlet holes on the air pump middle frame 37 are blocked, both the inlet holes and the outlet hole of the air pump body 10 are opened, and the second chamber A2 inhales air through the inlet pipe 103 of the air pump body 10. That is to say, in the one-way valves formed by the air pump end cover 31 and the air pump middle frame cover 32 and by the air pump middle frame 37 and the air pump body 10, the inlet holes merely inhale air, and the other outlet holes merely exhaust air, so as to maintain the vacuum degree within the vacuum inner spaces.

[0031] As shown in Fig. 2 in combination with Fig. 8, the above motion process is the operation process of the first chamber and the second chamber formed on one side of the air pump body during one rotation of the motor. At the same time, another first chamber and another sec-

ond chamber having the same structures and operating in the same manner are also formed on the other side of the air pump body. As shown in Fig. 2, when the air pump operates, the motor rotates once, and it drives each air pump soft gum membrane connected with the motor via a shaft to perform reciprocating movement in one round trip. At the time of the first half rotation of the motor, the soft gum membranes at both sides all move toward the left side, the inlet pipes 313, 800 are blocked, and the originally inhaled gas is exhausted through the outlet pipes 314, 600; while the inlet pipes 103, 900 draw off the air within the spaces which need vacuum-pumping, and the outlet pipes 104, 700 are blocked. At the time of the last half rotation of the motor, the soft gum membranes at both sides all move toward the right side, the inlet pipes 103, 900 are blocked, and the originally inhaled gas is exhausted through the outlet pipes 104, 700; while the inlet pipes 313, 800 draw off the air within the spaces which need vacuum-pumping, and the outlet pipes 314, 900 are blocked. As a result, for one rotation of the motor, the vacuum-pumping motion is performed for four times, and compared with the vacuum air pump which achieves the vacuum-pumping motion twice for one rotation of the motor, it provides doubled air flow rate and doubled efficiency.

Second embodiment

[0032] The dual-chamber dual-action air pump according to this embodiment has substantially the same structure as that according to the first embodiment, and their difference lies in the structure of the transmission apparatus. Fig. 9 is a structural view of the transmission apparatus with an eccentric shaft mechanism of the second embodiment. As shown in Fig. 9, the transmission apparatus in the air pump of this embodiment is an eccentric shaft mechanism fitted over the motor output shaft, and the end of the piston rod 33 is fitted over the eccentric shaft 51. In order to balance the eccentric force generated during the rotation of the eccentric shaft 51, generally, an air pump counterweight ring 52 or the like is provided on the motor output shaft.

[0033] Other features in this embodiment can be consulted from the first embodiment, and will not be described herein.

Third embodiment

[0034] The dual-chamber dual-action air pump according to this embodiment has substantially the same structure as that according to the first embodiment, and their difference lies in the structure of the transmission apparatus. Fig. 10 is a structural view of the transmission apparatus with an eccentric wheel mechanism of the third embodiment. As shown in Fig. 10, the transmission apparatus in the air pump of this embodiment is an eccentric wheel mechanism connected with the motor output shaft. The eccentric wheel mechanism comprises an eccentric

wheel 61 fixed on the output shaft, and a ring-shaped limitation groove 611 is provided one side surface of the eccentric wheel 61. A roller wheel 331 is provided on the end of the piston rod 33 of each piston air pump assembly, and is embed into the ring-shaped limitation groove 611. The output shaft drives the eccentric wheel 61 to rotate, and the roller wheel 331 rolls along the circumference direction of the output shaft within the ring-shaped limitation groove 611 and drives the piston rod 33 to perform reciprocating movement. With the configuration of the transmission apparatus in this embodiment, it is possible to ensure that the reciprocal motions of respective piston rods 33 driven by the motor output shaft are located in the same plane, hereby effectively reducing the entire height of the air pump and making its structure more compact.

[0035] Other features in this embodiment can be consulted from the first embodiment, and will not be described herein.

[0036] Obviously, in the above three embodiments, since the structures of the transmission apparatuses differ from each other, the description focuses on the main structure features of the transmission apparatuses themselves. In order to obtain the stable connection between the transmission apparatuses having different structures and air pump housing, piston rod and other components, some conventional mechanical connection parts are needed, and are adjusted adaptively according to the different structures of the transmission apparatuses. For persons skilled in the art, the selection of these conventional mechanical connection parts can be easily conceived of, and will be described herein. In addition, it should be pointed out that the main operation principle of the present invention lies in that the first chamber and the second chamber of the cylinder operate to inhale air and exhaust air respectively so as to enhance the pumping efficiency of the air pump, and the air pump, one-way valve, drive structure, transmission structure and the like may be implemented using various other structures in the prior art.

[0037] As shown in Fig. 11, the present invention also provides a glass-wiping robot including a machine body 8 and a suction cup 11 provided on the machine body. The suction cup 11 is connected with the dual-chamber dual-action air pump 13 as described above. To be specific, the inlet pipe of the first chamber and the inlet pipe of the second chamber are connected with the suction cup respectively. During the operation process of the glass-wiping robot, the motor of the air pump rotates once, and the first and second chambers respectively formed on both sides of the air pump body simultaneously operate in the same manner. Compared with the prior art, it provides doubled air flow rate and doubled efficiency. Thus, the pumped air amount is greatly increased, and the vacuum-pumping speed is increased. Even if in the case where a slight air leakage occurs, the glass-wiping robot would not drop from the glass surface being processed due to the immediate decrease of the vacuum

degree.

[0038] In sum, the dual-chamber dual-action air pump according to the present invention is compact in structure, can increase the flow rate of the vacuum air pump, and provide doubled operation efficiency of the vacuum air pump. Meanwhile, the glass-wiping robot using such dual-chamber dual-action air pump can have a stable and safe operation state.

Claims

1. A dual-chamber dual-action air pump comprising a cylinder, and a drive apparatus and a piston that are connected with the cylinder, the drive apparatus drives the piston via a transmission apparatus to perform reciprocating movement in the cylinder, **characterized in that:** a sealing element fixedly connected with the piston rod is provided in the cylinder, the sealing element partitions the cylinder into a first chamber (A1) and a second chamber (A2), the first chamber (A1) and the second chamber (A2) are respectively provided with a first one-way valve and a second one-way valve, and when the piston rod drives the sealing element to perform reciprocating movement, the first chamber (A1) and the second chamber (A2) simultaneously inhale air and exhaust air.
2. The dual-chamber dual-action air pump according to claim 1, **characterized in that,** the air pump comprises an air pump body (10), the drive apparatus is connected with the air pump body (10), and two said cylinders are provided on both sides of the air pump body (10) in a sealed manner, the cylinders each comprise an air pump end cover (31), an air pump middle frame cover (32) and an air pump middle frame (37) connected in a sealed manner from the outside to inside, the air pump middle frame (37) is connected with the air pump body (10) in a sealed manner, the sealing element is provided between the air pump middle frame (37) and the air pump middle frame cover (32), the sealing element and the air pump middle frame cover (32) form the first chamber (A1), the air pump middle frame cover (32) and the air pump end cover (31) form the first one-way valve, a soft gum membrane and the air pump middle frame form the second chamber (A2), and the air pump middle frame (37) and the air pump body (10) form the second one-way valve.
3. The dual-chamber dual-action air pump according to claim 1, **characterized in that,** the sealing element is a soft gum membrane, and the soft gum membrane is connected with the piston rod in a sealed manner.
4. The dual-chamber dual-action air pump according

to claim 3, **characterized in that,** the soft gum membrane comprises a support (34) and a membrane part (35), the membrane part (35) has inner sealing rings and outer sealing rings (36) provided on both sides of the support (34) and connected via a retractable middle portion, the inner sealing rings and the outer sealing rings (36) are attached to both sides of the air pump middle frame (37) in a sealed manner respectively, the outer sealing rings (36) are fixedly connected with the support (34), and the support (34) is fixedly connected with the piston rod (33).

5. The dual-chamber dual-action air pump according to claim 2, **characterized in that,** the first one-way valve comprises an inlet room (350) and an outlet room (360) provided on the air pump end cover (31) and an inlet room (370) and an outlet room (380) provided on the air pump middle frame cover (32); when the air pump end cover (31) and the air pump middle frame cover (32) are engaged, their inlet rooms and the outlet rooms form closed spaces in each of which sealing pads (38) are provided; inlet holes (311, 321) are provided on the inlet rooms (350, 370), outlet holes (312, 322) are provided in the outlet rooms (360, 380), and the sealing pads (38) perform reciprocating movement in the closed spaces under the action of airflow of the inlet holes and the outlet holes; the inlet holes and the outlet holes are arranged symmetrically in an intersecting manner on both sides of the closed spaces, and when the sealing pads (38) are attached on one of the air pump end cover (31) side and the air pump middle frame cover (32) side, air flows through one of the inlet holes or the outlet holes; the second one-way valve comprises an inlet room and an outlet room provided on the air pump middle frame (37) and an inlet room and an outlet room provided on the air pump body (10); when the air pump middle frame (37) and the air pump body (10) are engaged, their inlet rooms and outlet rooms form closed spaces in each of which sealing pads (38) are provided; inlet holes are provided on the inlet rooms, outlet holes are provided on the outlet rooms, and the sealing pads (38) perform reciprocating movement in the closed spaces under the action of airflow of the inlet holes and the outlet holes; the inlet holes and the outlet holes are arranged symmetrically in an intersecting manner on both sides of the closed spaces, and when the sealing pads (38) are attached on one of the air pump middle frame (37) side and the air pump body (10) side, air flows through one of the inlet holes or the outlet holes.
6. The dual-chamber dual-action air pump according to claim 5, **characterized in that,** the inlet hole is provided at the center of the inlet room and its number is one, and the outlet holes are provided symmetrically on both sides of the central line of the

outlet room and are oppositely located on both sides of the inlet hole; or the inlet holes are provided symmetrically on both sides of the central line of the inlet room and are oppositely located on both sides of the inlet hole, and the outlet hole is provided at the center of the outlet room and its number is one; the diameter of the inlet holes and the outlet holes is the same as the width of the sealing pads (38).

7. The dual-chamber dual-action air pump according to claim 2, **characterized in that**, an inlet pipe (313) and an outlet pipe (314) of the first chamber are provided on the air pump end cover (31), and an inlet pipe (103) and an outlet pipe (104) of the second chamber are provided on the air pump body (10). 10 15
8. The dual-chamber dual-action air pump according to claim 2, **characterized in that**, the transmission apparatus is an eccentric shaft (51) fitted over the output shaft, and an end of the piston rod (33) is fitted over on the eccentric shaft (51). 20
9. The dual-chamber dual-action air pump according to claim 2, **characterized in that**, the transmission apparatus is a crankshaft mechanism connected with an output shaft of the drive apparatus. 25
10. The dual-chamber dual-action air pump according to claim 9, **characterized in that**, the crankshaft mechanism comprises lower eccentric wheel, upper eccentric wheel (41) and a crankshaft (43), the crankshaft (43) comprises a crankshaft body and two shaft portions, the two shaft portions extend upward and downward on the left and right sides of the crankshaft body respectively; the shaft portions of the crankshaft comprise connection portions for the piston rods (33) and connection portions for the eccentric wheels, the piston rods (33) are fitted over the connection portions for the piston rods via bearings, and the connection portions for the eccentric wheels are inserted into eccentric holes of the eccentric wheels (43) so as to be fixed. 30 35 40
11. The dual-chamber dual-action air pump according to claim 2, **characterized in that**, the transmission apparatus is an eccentric wheel mechanism connected with an output shaft of the drive apparatus, the eccentric wheel mechanism comprises an eccentric wheel (61) fixed on the output shaft, and a ring-shaped limitation groove (611) is provided on one side surface of the eccentric wheel (61); the end of the piston rod (33) of each piston air pump assembly is provided with a roller wheel (331), the roller wheel (331) is embedded in the ring-shaped limitation groove (611), the output shaft drives the eccentric wheel (61) to rotate, the roller wheel (331) rolls along the circumference direction of the output shaft in the ring-shaped limitation groove (611) and drives 45 50 55

the piston rod (33) to perform reciprocating movement.

12. A glass-wiping robot, comprising a machine body and a suction cup provided on the machine body, **characterized in that**, the suction cup is connected with the dual-chamber dual-action air pump according to any one of claims 1-11, and the inlet pipe (313) of the first chamber and the inlet pipe (103) of the second chamber are connected with the suction cup respectively.

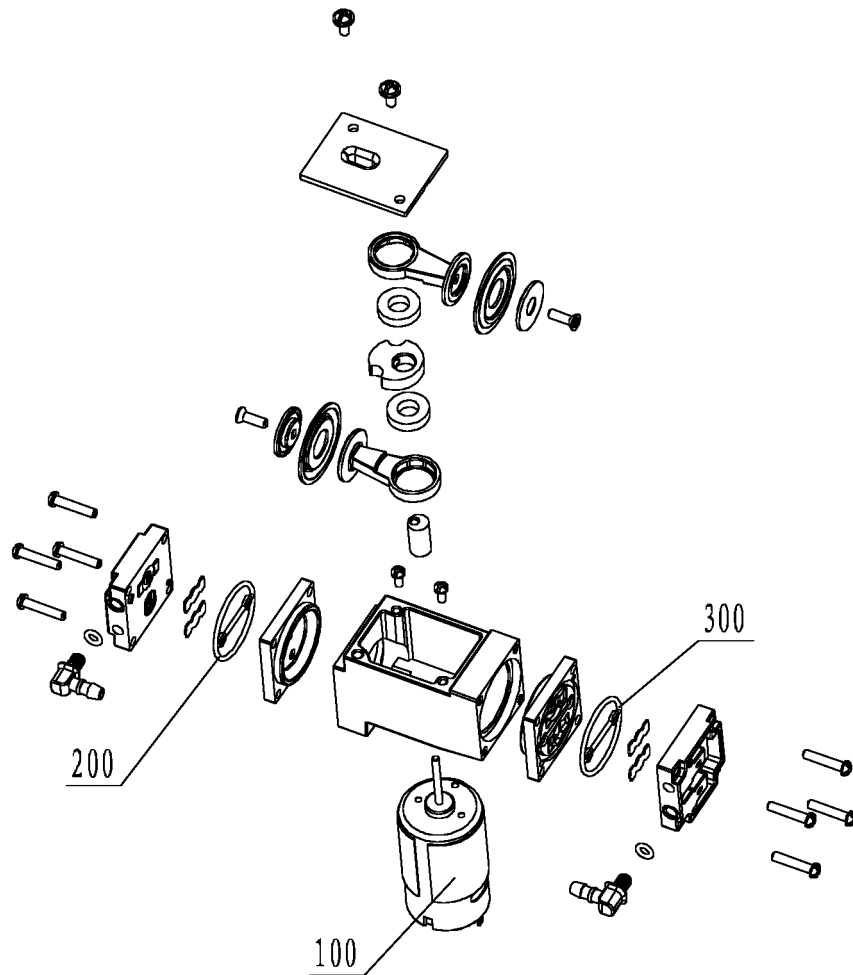


Fig. 1

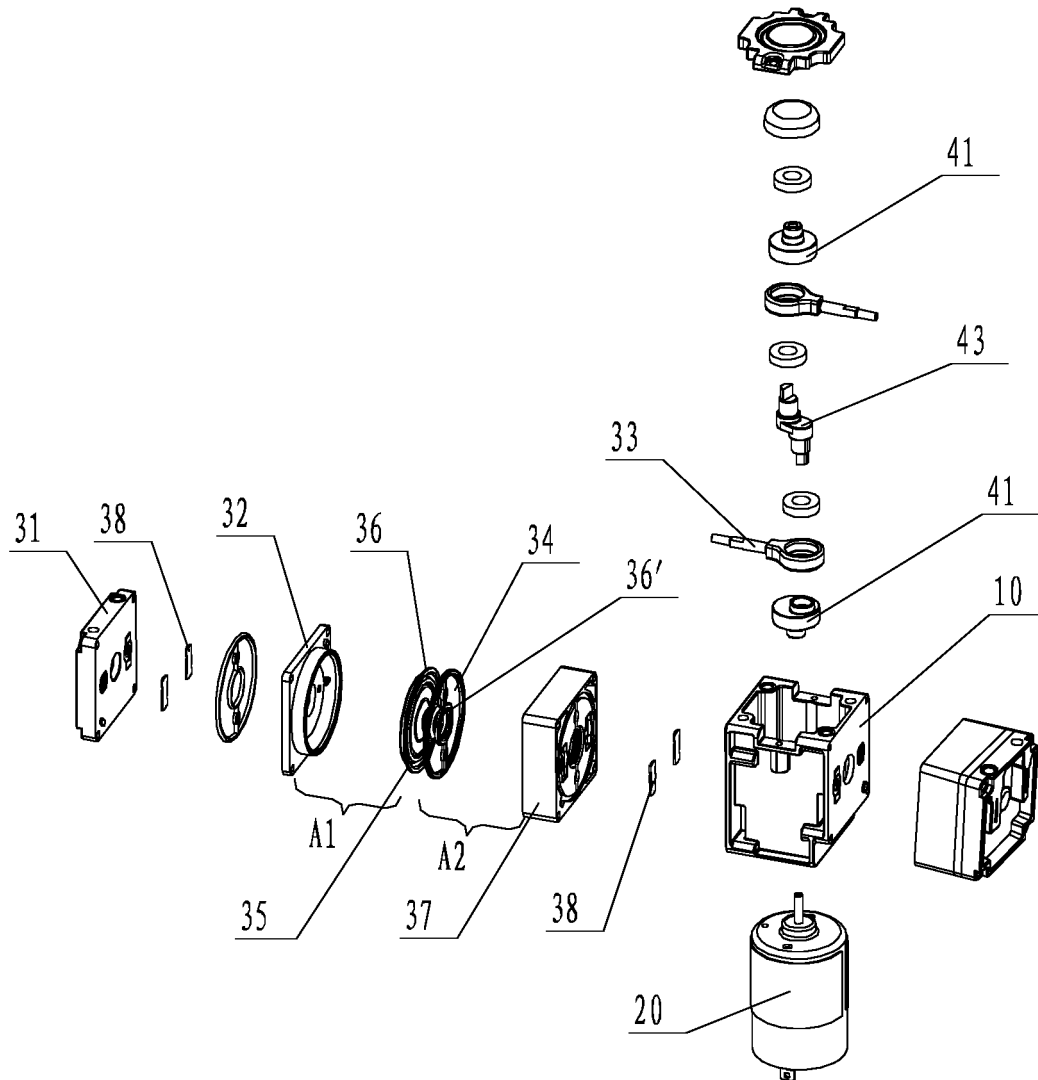


Fig. 2

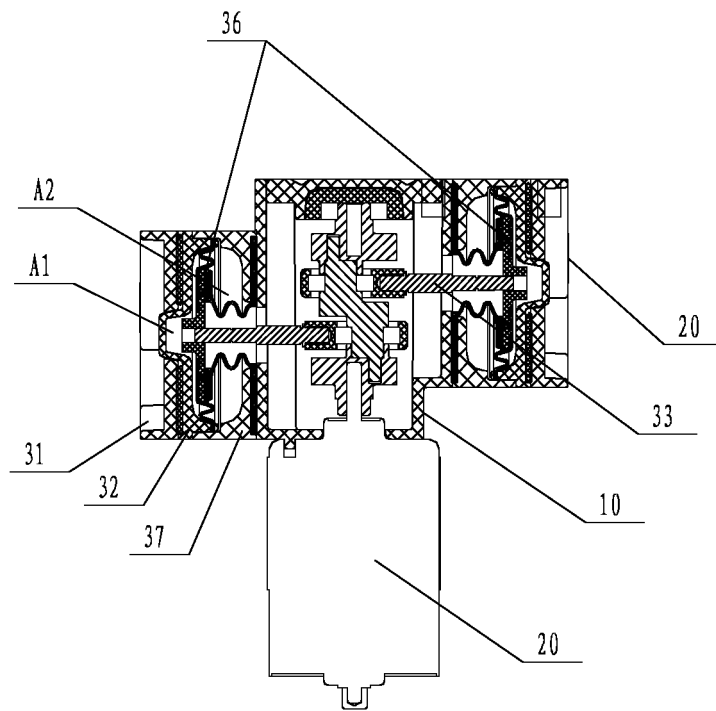


Fig. 3

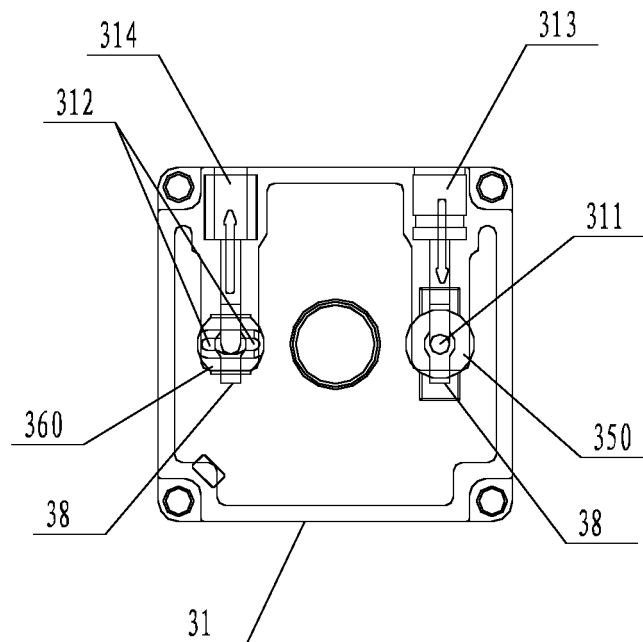


Fig. 4

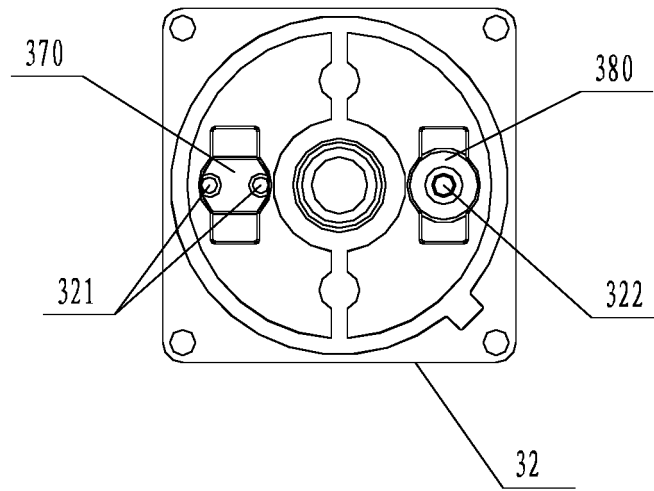


Fig. 5

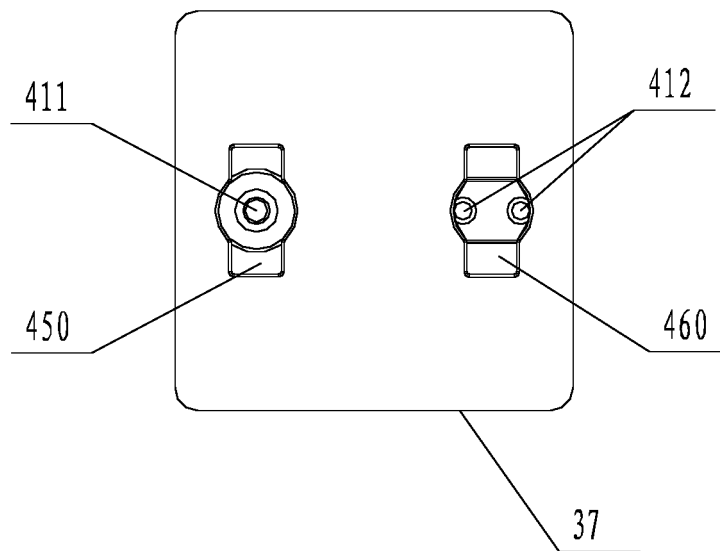


Fig. 6

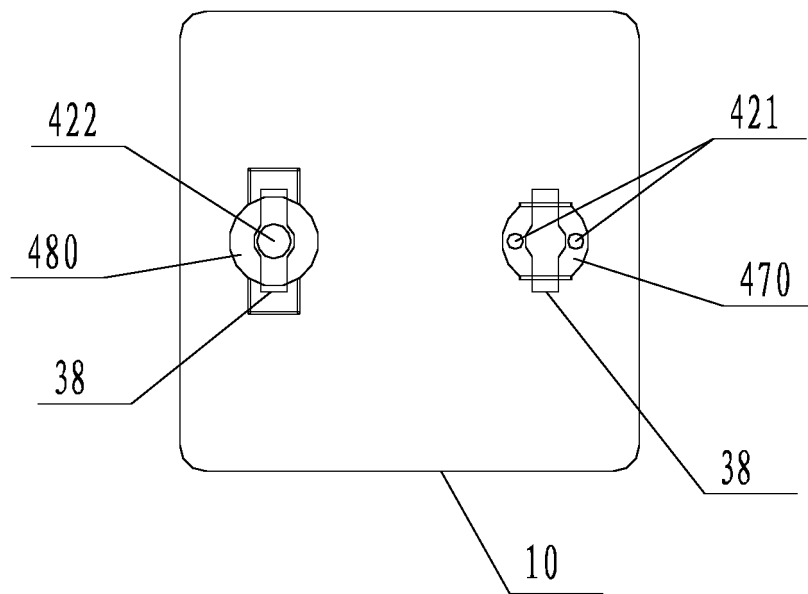


Fig. 7

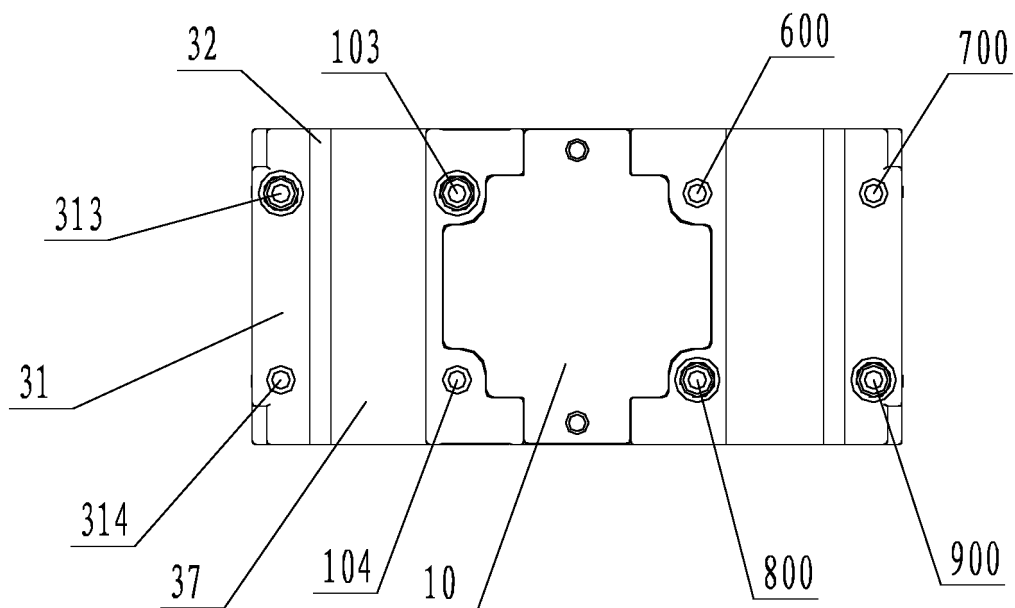


Fig. 8

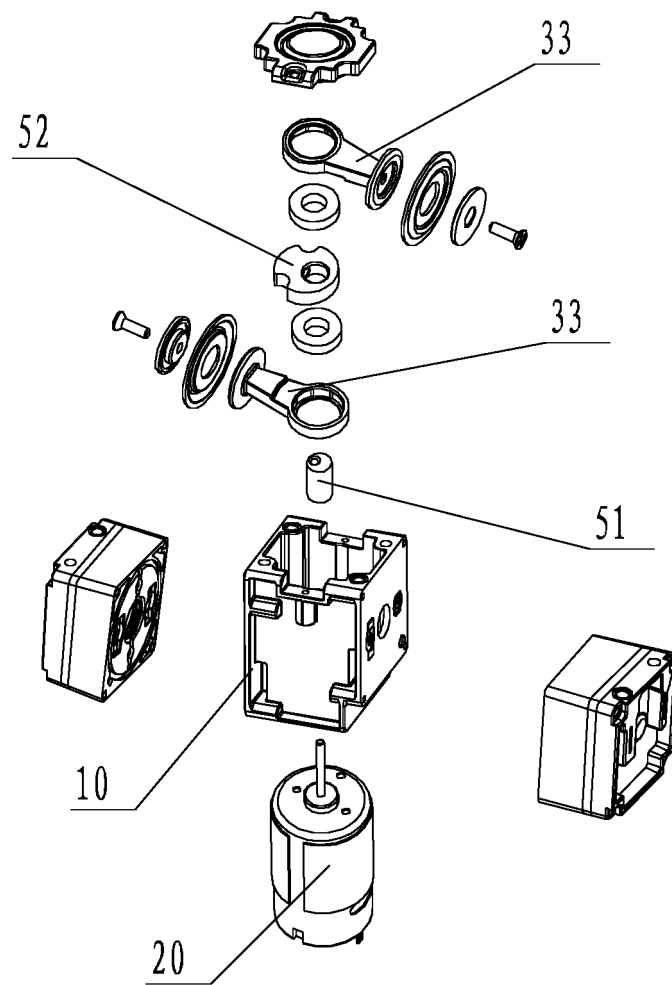


Fig. 9

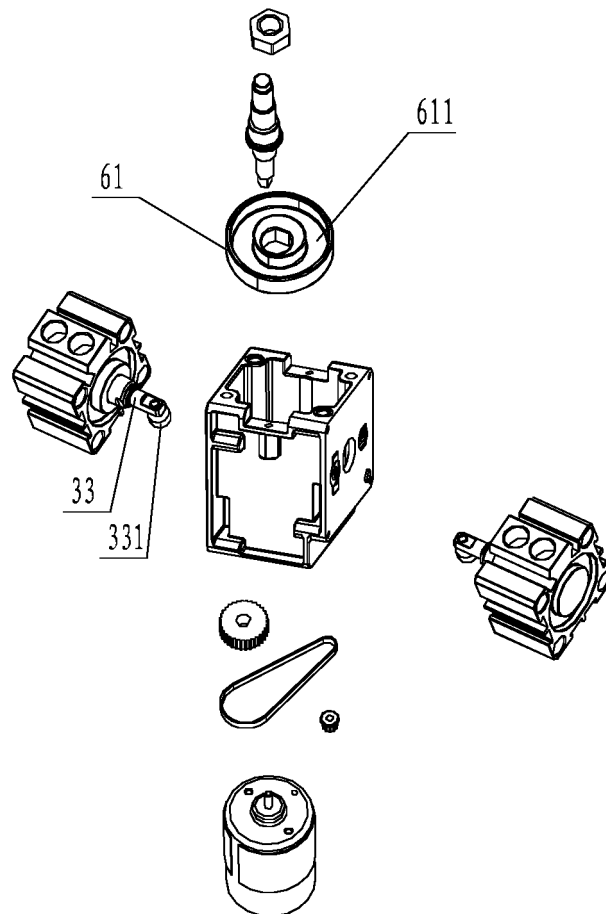


Fig. 10

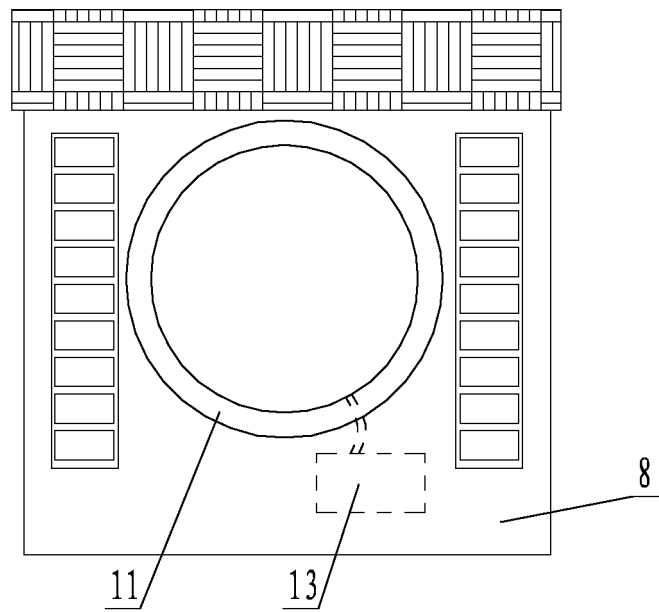


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2014/072973

A. CLASSIFICATION OF SUBJECT MATTER

F04B 37/14 (2006.01) i; A47L 1/02 (2006.01) i; F04B 39/00 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F04B; A47L; B25J

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

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

VEN, CNABS, CNKI: ECOVACS, air pump, pump, cylinder, cavity, double, two, dual, membrane

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 203201745 U (ECOVACS ROBOTICS (SUZHOU) CO., LTD.), 18 September 2013 (18.09.2013), claims 1-12	1-12
X	CN 201212465 Y (XIAMEN AJK TECHNOLOGY CO., LTD.), 25 March 2009 (25.03.2009), description, page 1, line 3 to page 5, line 6, and figures 1-7	1, 3
Y	CN 201212465 Y (XIAMEN AJK TECHNOLOGY CO., LTD.), 25 March 2009 (25.03.2009), description, page 1, line 3 to page 5, line 6, and figures 1-7	12
Y	CN 202665434 U (ECOVACS ROBOTICS (SUZHOU) CO., LTD.), 16 January 2013 (16.01.2013), description, paragraph 0019, and figure 1	12
X	CN 102345582 A (FOURTH MILITARY MEDICAL UNIVERSITY), 08 February 2012 (08.02.2012), description, paragraphs 0004-0014	1
A	CN 101839234 A (NINGBO TUOPU BRAKING SYSTEMS CO., LTD.), 22 September 2010 (22.09.2010), the whole document	1-12

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
13 May 2014 (13.05.2014)Date of mailing of the international search report
05 June 2014 (05.06.2014)Name and mailing address of the ISA/CN:
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2014/072973

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 203201745 U	18.09.2013	None	
CN 201212465 Y	25.03.2009	None	
CN 202665434 U	16.01.2013	None	
CN 102345582 A	08.02.2012	None	
CN 101839234 A	22.09.2010	None	

Form PCT/ISA/210 (patent family annex) (July 2009)