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

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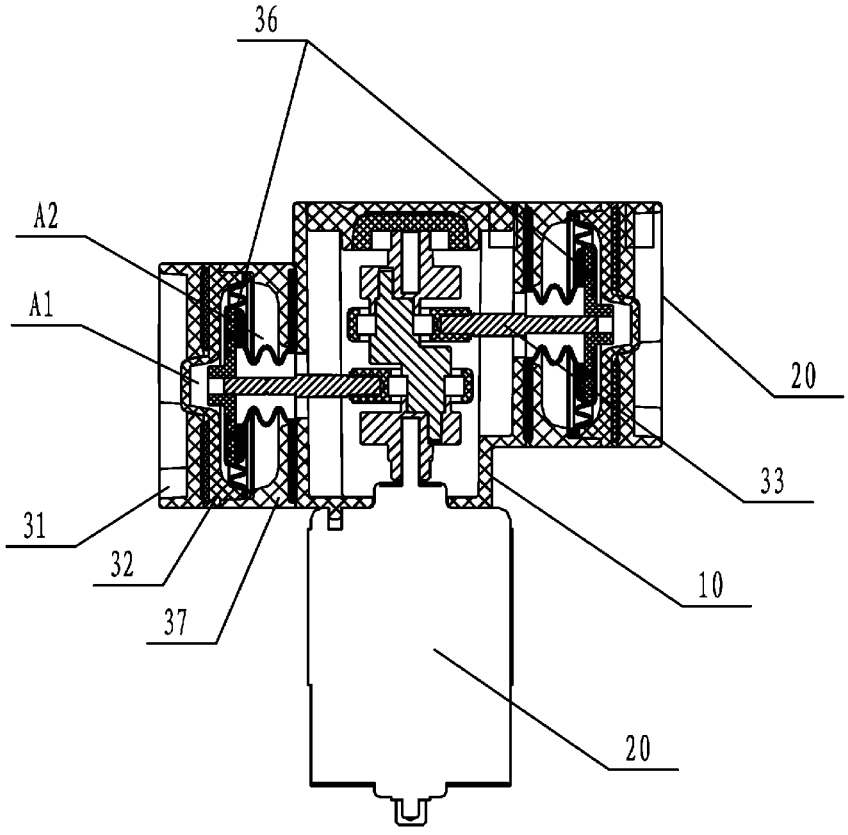
(57) **ABSTRACT**

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.



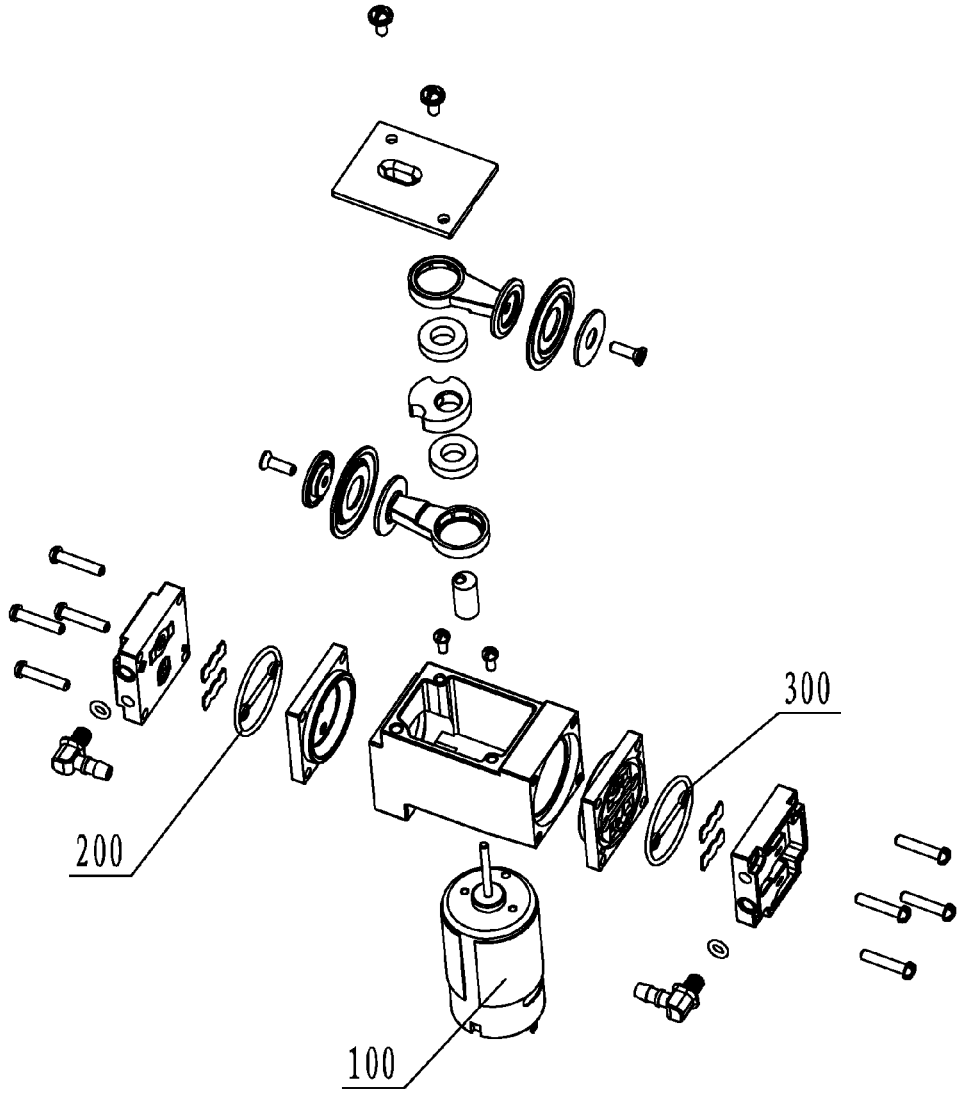


Fig. 1

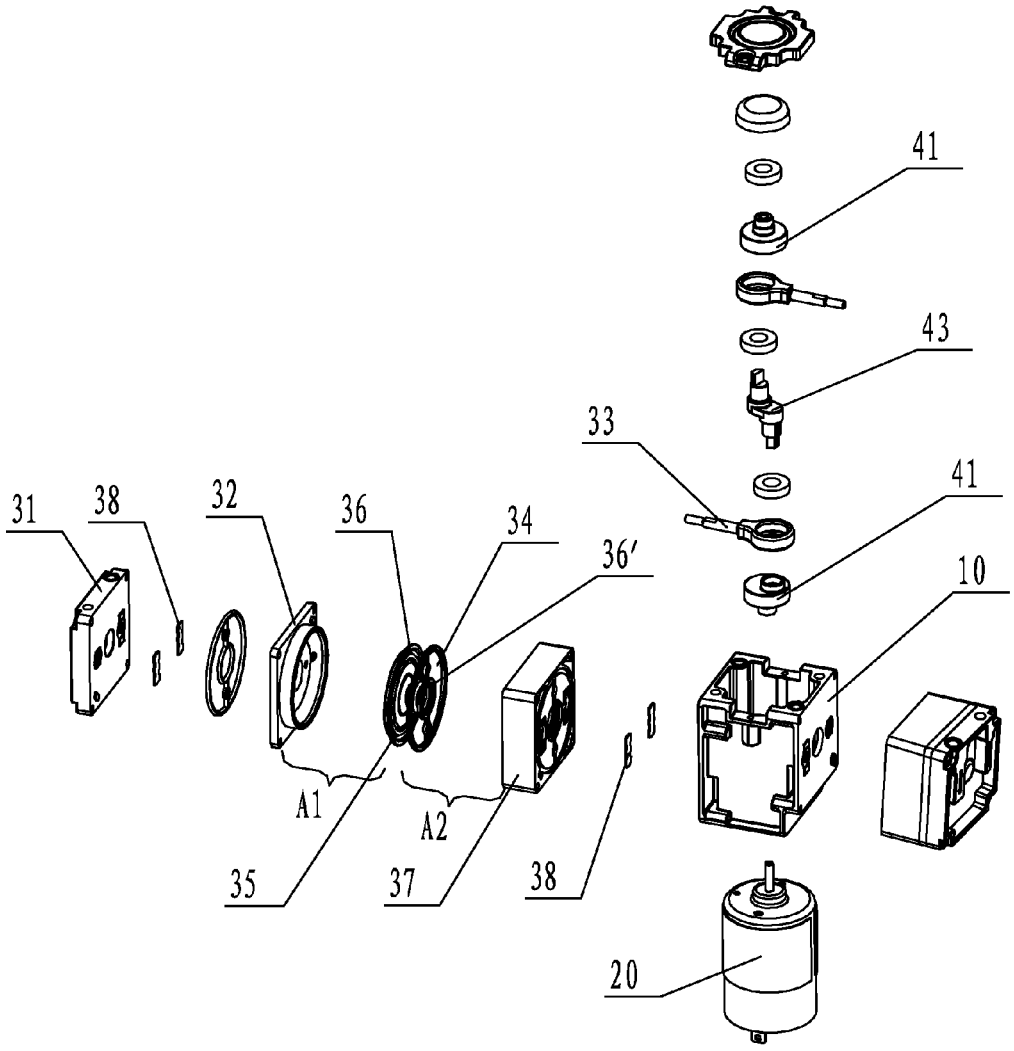


Fig. 2

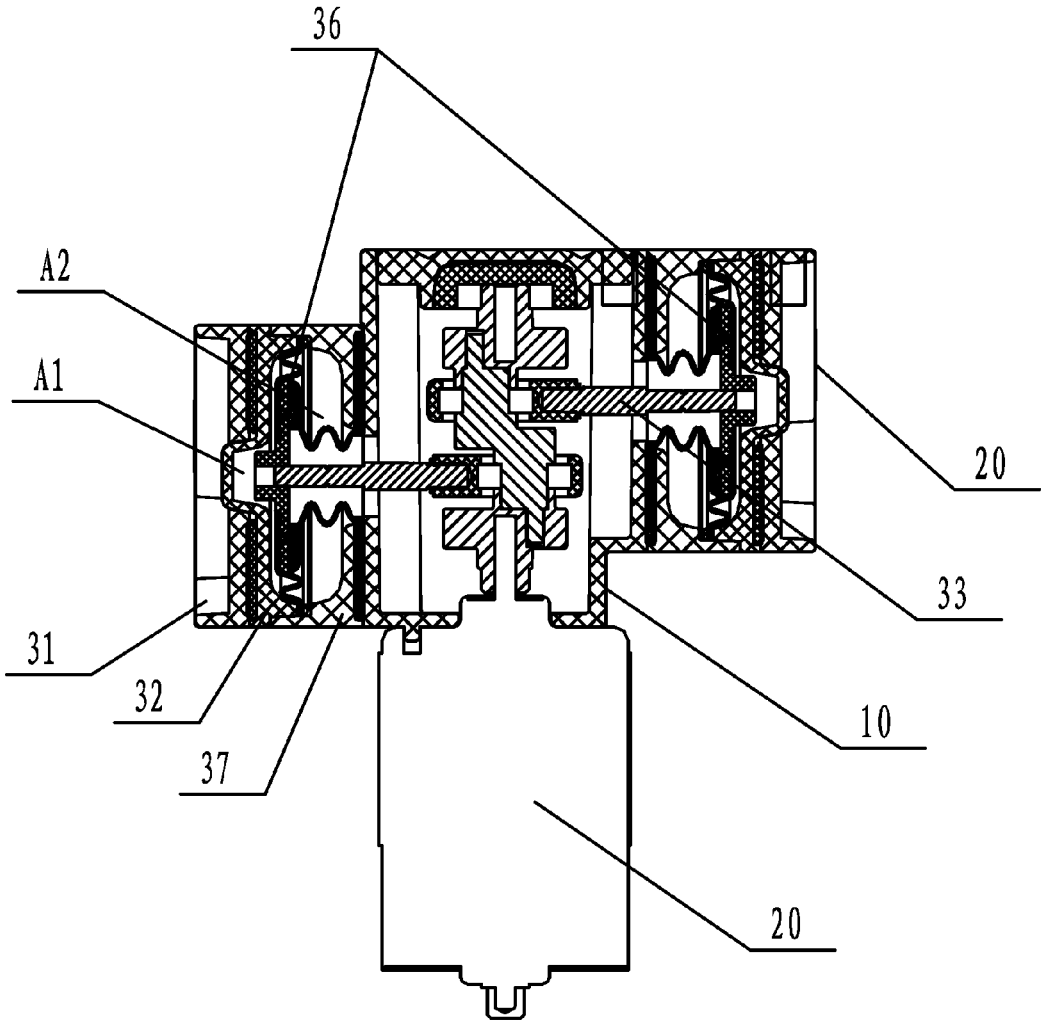


Fig. 3

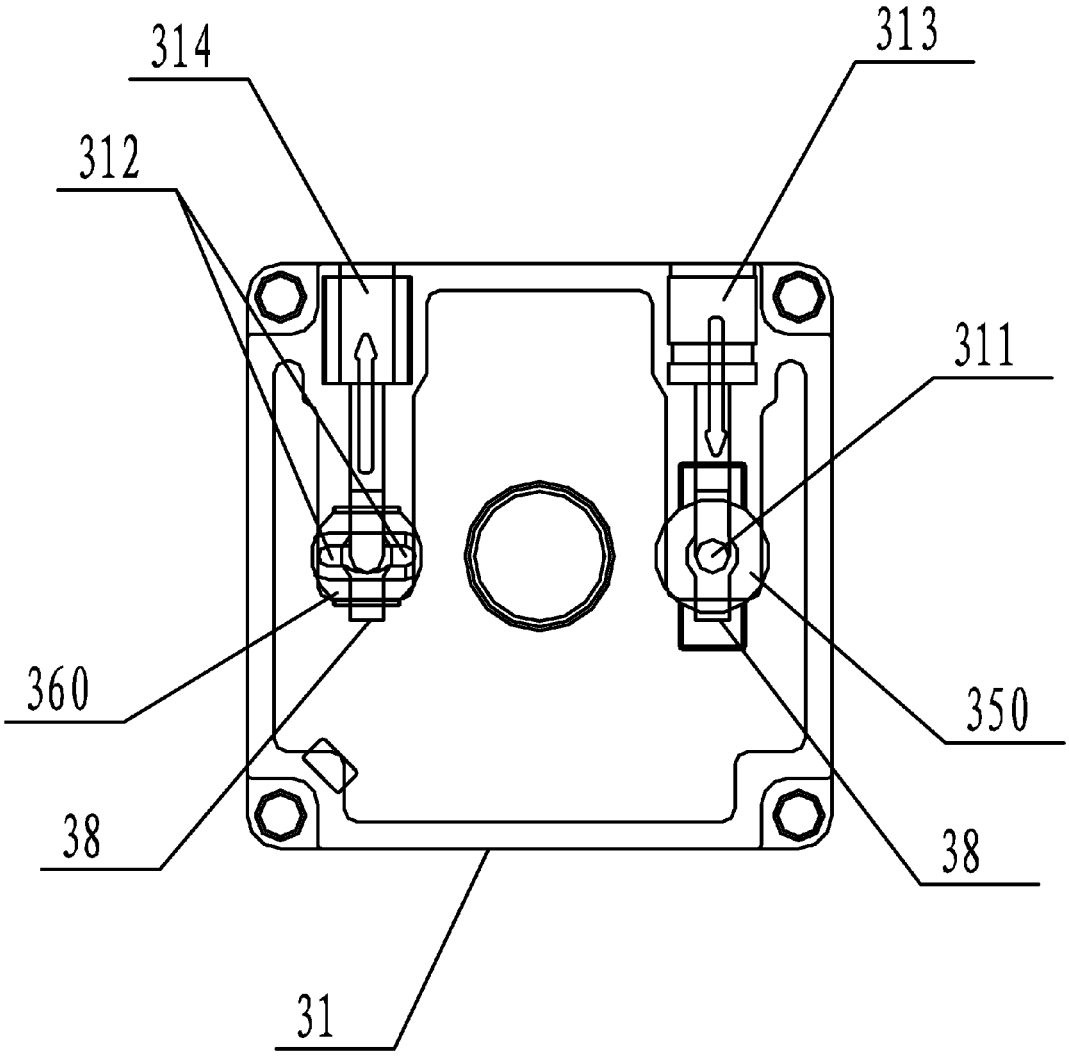


Fig. 4

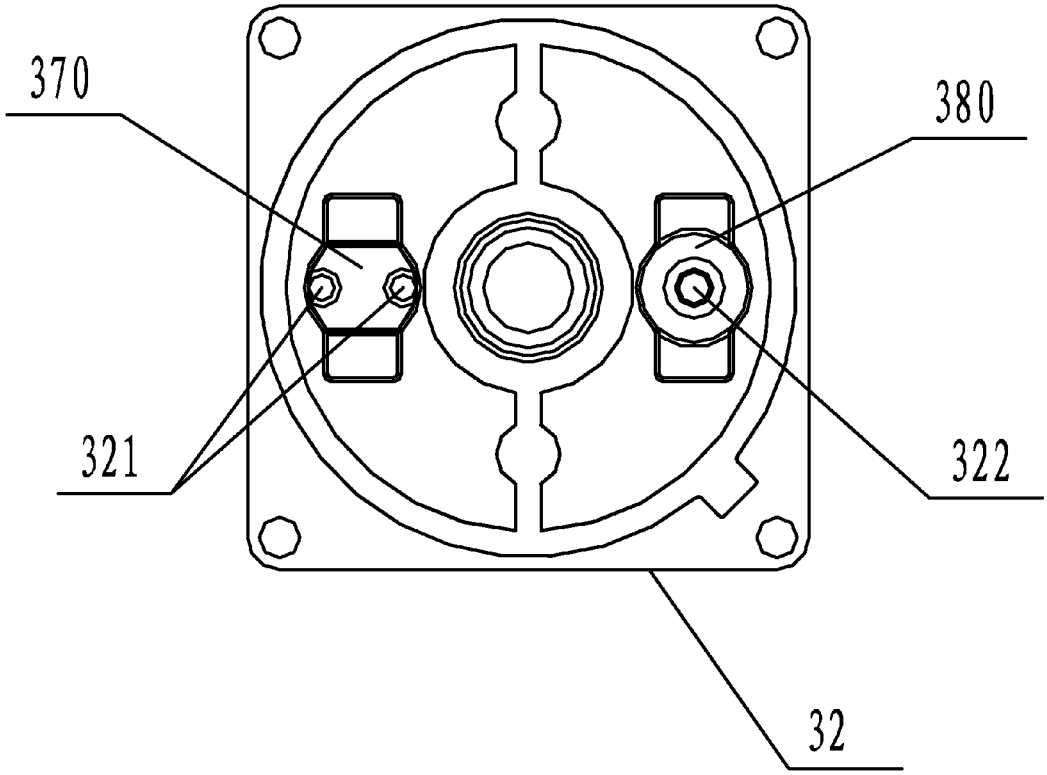


Fig. 5

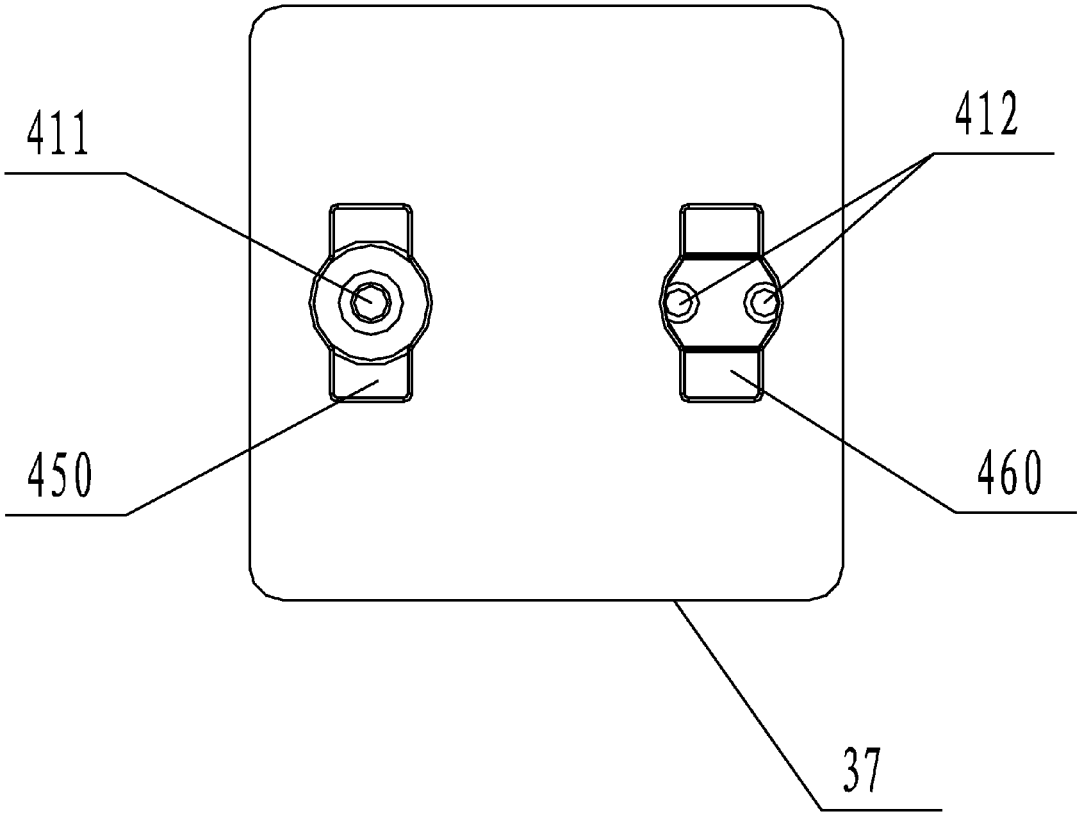


Fig. 6

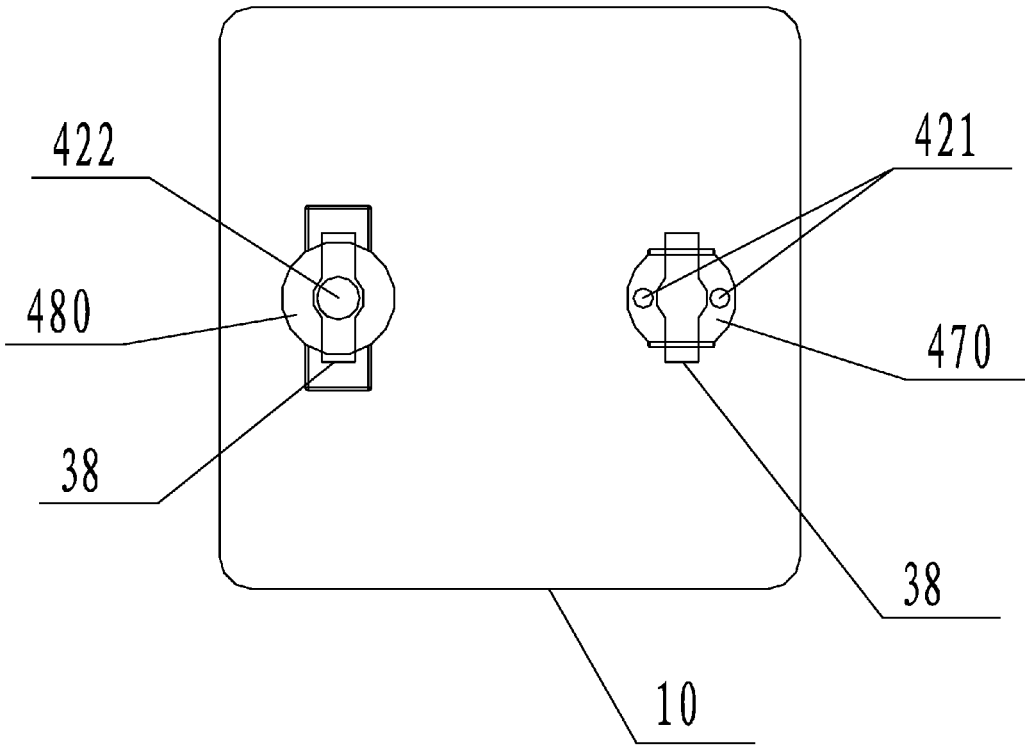


Fig. 7

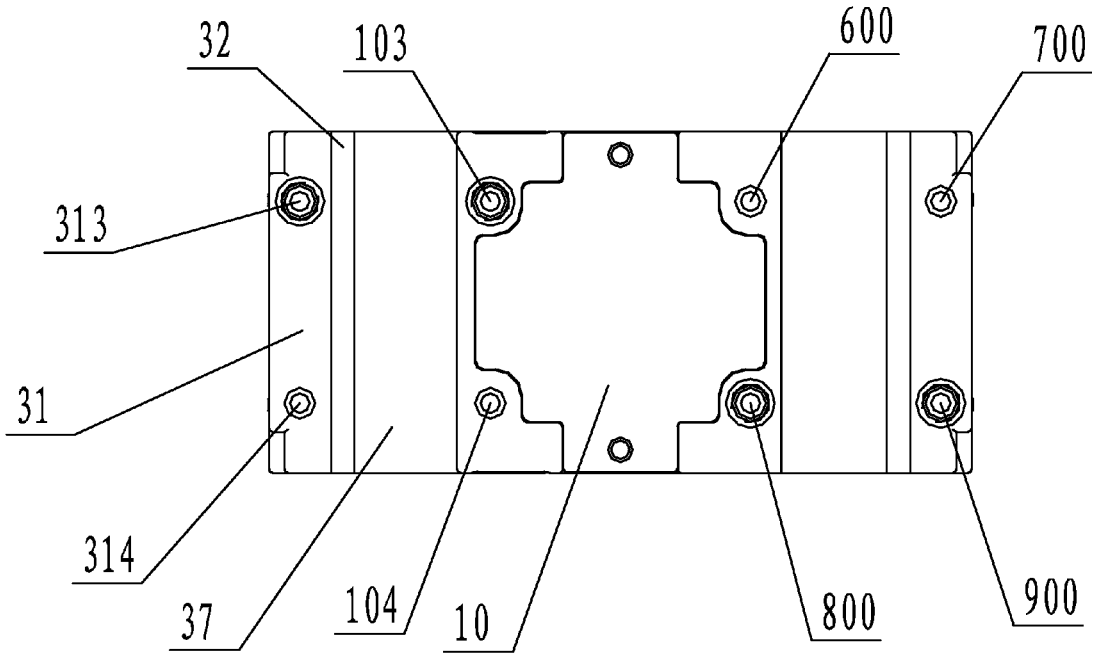


Fig. 8

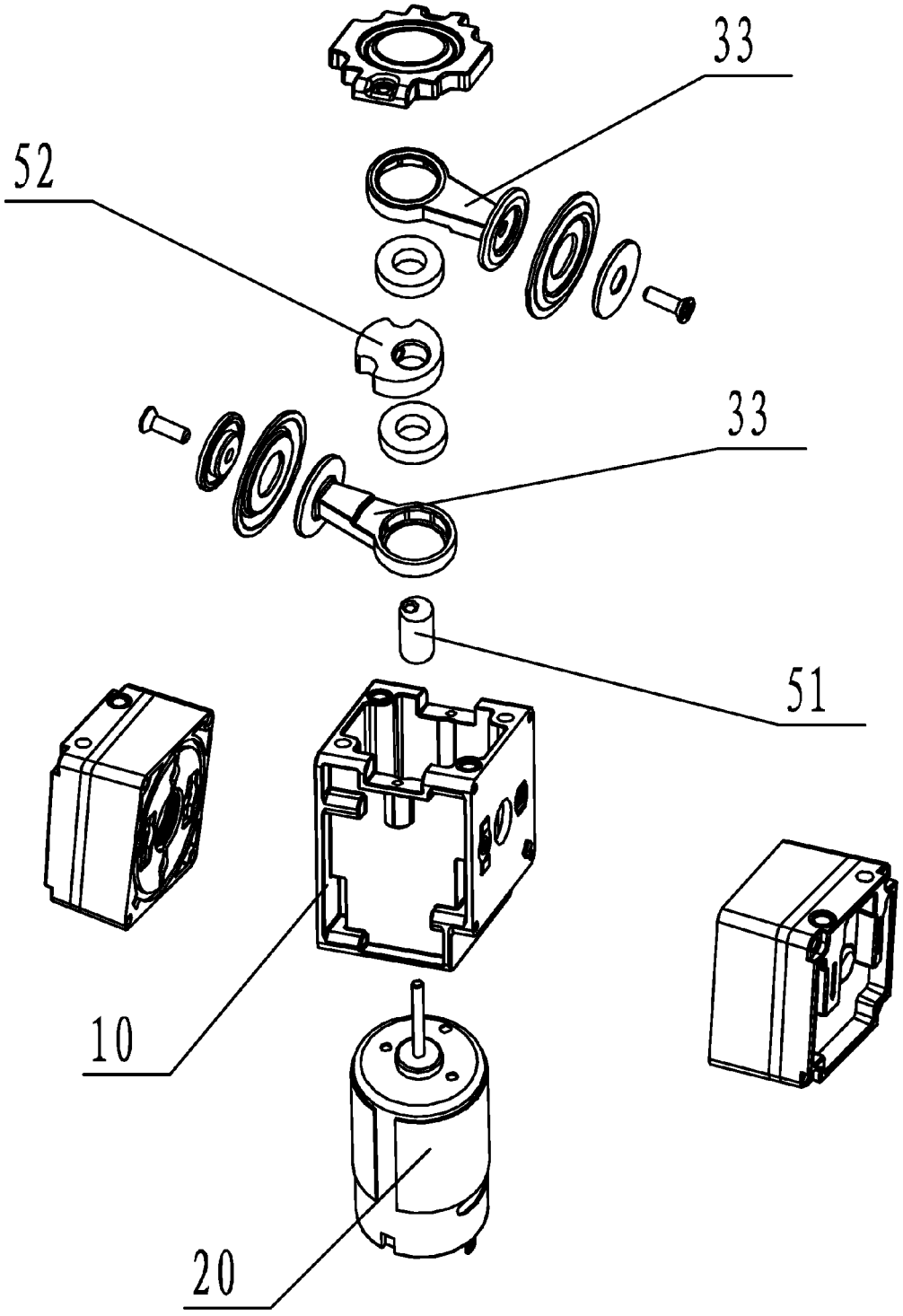


Fig. 9

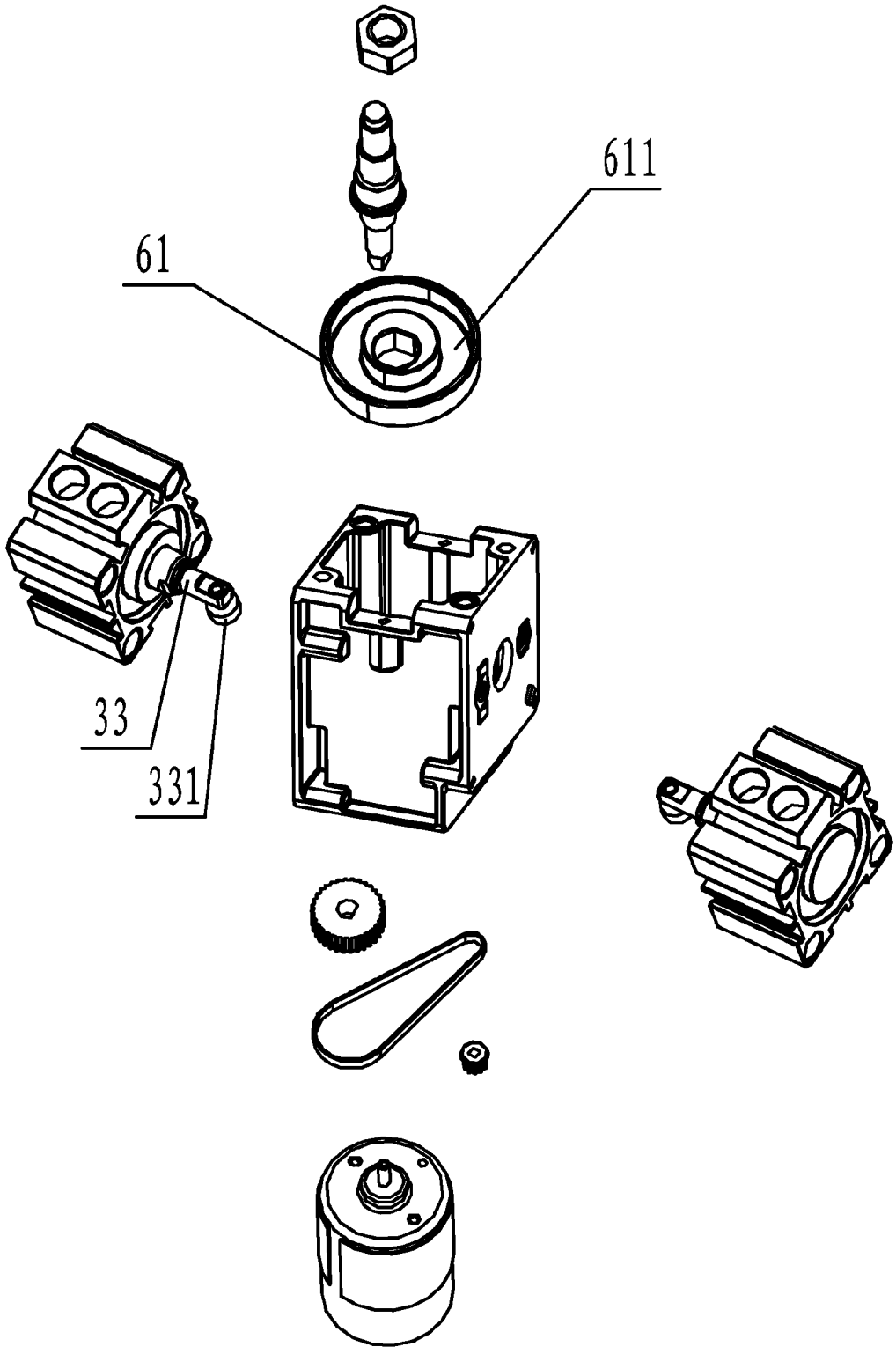


Fig. 10

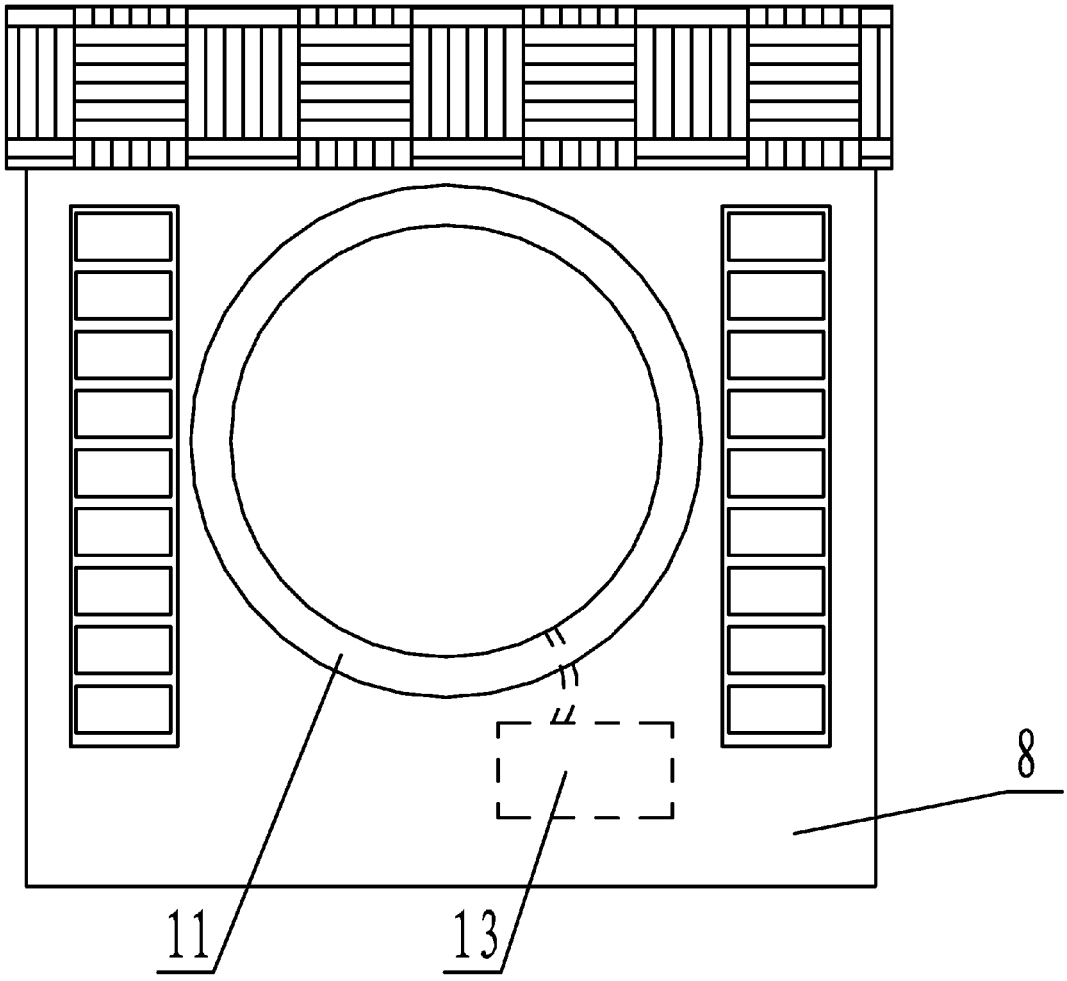


Fig. 11

DUAL-CHAMBER DUAL-ACTION AIR PUMP AND GLASS-WIPING ROBOT HAVING THE AIR PUMP

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is the national stage entry of PCT Application No. PCT/CN2014/072973 filed Mar. 6, 2014, the disclosure of which is incorporated herein by reference in its entirety for all purposes.

FIELD OF THE INVENTION

[0002] 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

[0003] 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

[0004] 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.

[0005] The object of the present invention is achieved by the following technical solutions.

[0006] 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 second chamber simultaneously inhale air and exhaust air.

[0007] 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 bump 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.

[0008] The sealing element is a soft gum membrane, and the soft gum membrane is connected with the piston rod in a sealed manner.

[0009] 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.

[0010] 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.

[0011] 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.

[0012] Or, the inlet holes are provided symmetrically on both sides of the central line of the inlet room and are oppo-

sitely 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.

[0013] The diameter of the inlet holes and the outlet holes is the same as the width of the sealing pads.

[0014] 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.

[0015] 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.

[0016] 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.

[0017] 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.

[0018] The present invention also provides a glass-wiping robot comprising a machine body and a suction cup provided on the machine boy, 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.

[0019] 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.

[0020] 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 DRAWINGS

[0021] FIG. **1** is a schematic view of the overall structure of a vacuum air pump in the prior art.

[0022] FIG. **2** is an exploded view of the overall structure of the present invention.

[0023] FIG. **3** is a sectional view of a body and cylinders provided at both sides thereof in an air pump of the present application.

[0024] FIG. **4** is a structural view of inlet and outlet holes on an air pump end cover of the present invention.

[0025] FIG. **5** is a structural view of inlet and outlet holes on the air pump middle frame cover of the present invention.

[0026] FIG. **6** is a structural view of inlet and outlet holes on an air pump middle frame of the present invention.

[0027] FIG. **7** is a structural view of inlet and outlet holes on an air pump body of the present invention.

[0028] FIG. **8** is a structural view illustrating arrangement positions of inlet and outlet pipes of respective chambers of the present invention.

[0029] FIG. **9** is a structural view of a transmission apparatus having an eccentric shaft mechanism of the second embodiment of the present invention.

[0030] FIG. **10** is a structural view of a transmission apparatus having an eccentric wheel mechanism of the third embodiment of the present invention.

[0031] FIG. **11** is a structural view of a glass-wiping robot of the present invention.

DETAILED DESCRIPTION

[0032] First embodiment. 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 A**1**, 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 A**2**, 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 A**1** and the second chamber A**2** located both sides of the soft gum membrane respectively.

[0033] 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 A**1**, A**2** 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 A**1**, A**2** to simultaneously inhale air and exhaust air.

[0034] 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**.

[0035] 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.

[0036] 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.

[0037] 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**.

[0038] 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.

[0039] Referring to FIGS. **2-8**, the operation process of the dual-chamber dual-action air pump according to this embodiment is described below.

[0040] 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 A**1** 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 A**1** inhales air through the inlet pipe **313** of the air pump end cover **31**. Meanwhile, the volume of the second chamber A**2** 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 opened and the inlet hole on the air pump body **10** is closed. The second chamber A**2** exhausts air through the outlet pipe **104** of the air pump body.

[0041] 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 A**1** exhausts air through the outlet pipe **314** of the air pump end cover **31**. Meanwhile, the volume of the second chamber A**2** 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 A**2** 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.

[0042] 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 second 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

[0043] 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.

[0044] Other features in this embodiment can be consulted from the first embodiment, and will not be described herein.

Third Embodiment

[0045] 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.

[0046] Other features in this embodiment can be consulted from the first embodiment, and will not be described herein.

[0047] 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.

[0048] 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.

[0049] 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.

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 (A**1**) and a second chamber (A**2**), the first chamber (A**1**) and the second chamber (A**2**) 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 (A**1**) and the second chamber (A**2**) 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 (A**1**), the air pump middle frame cover (**32**) and the air bump end cover (**31**) form the first one-way valve, a soft gum membrane and the air pump middle frame form the second chamber (A**2**), 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**).

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**).

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.

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.

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 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 boy, characterized in that, the suction cup is connected with the dual-chamber dual-action air pump according to claim **1**, 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.

13. The glass-wiping robot according to claim **12**, 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 (A**1**), the air pump middle frame cover (**32**) and the air bump end cover (**31**) form the first one-way valve, a soft gum membrane and the air pump middle frame form the second chamber (A**2**), and the air pump middle frame (**37**) and the air pump body (**10**) form the second one-way valve.

14. The glass-wiping robot according to claim **12**, 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.

15. The glass-wiping robot according to claim **14**, 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**).

16. The glass-wiping robot according to claim **13**, 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.

17. The glass-wiping robot according to claim **16**, 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**).

18. The glass-wiping robot according to claim **13**, 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**)

19. The glass-wiping robot according to claim **13**, 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. The glass-wiping robot according to claim **13**, characterized in that, the transmission apparatus is a crankshaft mechanism connected with an output shaft of the drive apparatus.

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