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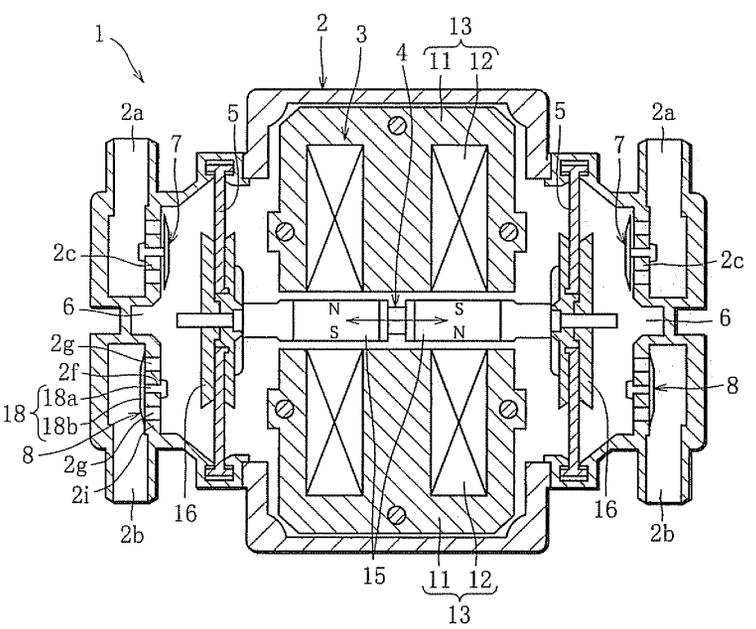
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(54) **Diaphragm pump**

(57) A diaphragm pump comprising a pressure chamber arranged such that the volume of the pressure chamber is expanded and contracted by oscillation of a diaphragm (5), a suction-side check valve (7) for sucking air into the pressure chamber and a discharge-side check valve (8) for discharging air from the pressure chamber. The suction-side check valve is arranged to close by a valve body (17) being elastically deformed and brought into close contact with a valve seat, and open by the valve body elastically returning to the normal shape and coming out of contact with the valve seat. The discharge-side check valve is arranged to open by a valve body (18) being elastically deformed and producing a space relative to a valve seat, and close by the valve body elastically returning to the normal shape and coming into close contact with the valve seat.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to a diaphragm pump having a pressure chamber arranged such that the volume of the pressure chamber is expanded and contracted by oscillation of a diaphragm.

Description of the Related Art

[0002] A diaphragm pump comprises, as a wall of a pressure chamber, a diaphragm which is driven, for example, by an electromagnet to oscillate so that the oscillation of the diaphragm expands and contracts the volume of the pressure chamber alternately. The diaphragm pump sucks a fluid (air, for example) into the pressure chamber through a suction-side check valve when the volume of the pressure chamber is expanded, and pressurizes and discharges the air from the pressure chamber through a discharge-side check valve when the volume of the pressure chamber is contracted.

[0003] Generally, when the discharge pressure of the diaphragm pump is raised, the discharge quantity thereof tends to decrease. When the operating pressure of the diaphragm pump is raised to obtain a high discharge pressure, however, a high pressure in the pressure chamber makes it difficult for the diaphragm to oscillate. This easily causes variation in the time for which the suction-side check valve is open, and thereby makes the amount of a fluid sucked into the pressure chamber unstable. Thus, as characteristic curve A in FIG. 6 shows, a phenomenon that the discharge quantity of the diaphragm pump becomes unstable at operating pressures of 40kPa and higher is produced.

[0004] In order to remove such instability phenomenon, Japanese Unexamined Patent Publication No. 2003-269339 has proposed providing a hole that connects a pressure chamber and a sealed space (casing) which is located behind a diaphragm and contains an electromagnet for driving the diaphragm to oscillate, so that the pressure in the pressure chamber is applied to the diaphragm as a back pressure. The adoption of such arrangement, however, causes a problem that the casing (sealed space) containing the electromagnet requires a complicated structure.

[0005] For an alternate diaphragm pump which has diaphragms provided at the opposite ends of a rod-like shaft driven by an electromagnet to move back and forth so that the volumes of paired pressure chambers are expanded and contracted in a complementary manner by means of the diaphragms, a particularly complicated structure is required, since a device for preventing the paired pumping chambers from becoming connected through the casing (sealed space) containing the electromagnet is required.

SUMMARY OF THE INVENTION

[0006] The primary object of this invention is to provide a diaphragm pump that can remove operational instability at high operating pressures, without requiring a complicated structure.

[0007] In order to achieve this object, a diaphragm pump according to this invention comprises a diaphragm driven to move back and forth, a pressure chamber arranged such that the volume of the pressure chamber is expanded and contracted by the oscillation of the diaphragm, a suction-side check valve fitted to a suction port for the suction chamber and arranged to open and suck a fluid from the suction port into the pressure chamber when the volume of the pressure chamber is expanded, and a discharge-side check valve fitted to a discharge port for the suction chamber and arranged to open and discharge the fluid from the pressure chamber to the discharge port when the volume of the pressure chamber is contracted, and is characterized in that
the suction-side check valve includes a valve body of an elastic material fitted to a valve seat provided near the suction port, with a space between, and is arranged to close by the valve body being elastically deformed and brought into close contact with the valve seat, and open by the valve body elastically returning to the normal shape and coming out of contact with the valve seat, and the discharge-side check valve includes a valve body of an elastic material fitted to a valve seat provided near the discharge port, in close contact with the valve seat, and is arranged to open by the valve body being elastically deformed and producing a space relative to the valve seat, and close by the valve body elastically returning to the normal shape and coming into close contact with the valve seat.

[0008] Desirably, the diaphragm is connected to an oscillator driven by an electromagnet to move back and forth so that the diaphragm is driven by the electromagnet to oscillate.

[0009] In a preferred aspect of this invention, the diaphragm pump comprises a rod-like oscillator driven by an electromagnet to move back and forth in the axial direction, diaphragms provided at the opposite ends of the oscillator, respectively, and paired pressure chambers each including one of the diaphragms and arranged such that the volumes of the paired pressure chambers are expanded and contracted in a complementary manner.

[0010] In the diaphragm pump having the above structure, the suction-side check valve is arranged to have a space between the valve body and the valve seat, and hence functions as a normally-open check valve. By using this suction-side check valve in combination with the discharge-side check valve which functions as a normally-closed check valve, the time for which the suction-side check valve is open in the process of expanding the volume of the pressure chamber for sucking air from the suction port into the pressure chamber can be made long-

er, so that a load on the diaphragm can be reduced.

[0011] Since the load on the diaphragm is reduced, it is not necessary to apply part of the pressure in the pressure chamber to the diaphragm as a back pressure as in the conventional case, and hence, a complicated structure is not required. Further, even when the diaphragm pump is operated at a high operating pressure, the diaphragm can be caused to oscillate with certainty, since the load on the diaphragm is reduced as mentioned above. Thus, also when the diaphragm pump is operated at a high operating pressure, stable operational characteristics can be guaranteed.

[0012] Also in the alternate diaphragm pump having paired pressure chambers arranged such that their volumes are expanded and contracted in a complementary manner, it can be ensured that a sufficient amount of air is sucked into the paired pressure chambers, alternately. Consequently, mutual interference of the paired pressure chambers, or in other words, unstable operation of one pressure chamber affecting the operation of the other pressure chamber can be prevented. Thus, the operational balance between the paired pressure chambers can be prevented from becoming unstable, and the pressure difference liable to be produced between the paired pressure chambers can be removed. Since it can be ensured that a stable amount of air is sucked into the paired pressure chambers even when the diaphragm pump is operated at a high operating pressure, the discharge pressure of the diaphragm pump can be easily kept constant and the above-mentioned instability phenomenon can be prevented effectively.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 is a cross-sectional view schematically showing the structure of an electromagnetic diaphragm pump in an embodiment of this invention,

FIG. 2 is an enlarged view of a suction-side check valve shown in FIG. 1;

FIG. 3 is an enlarged view of a discharge-side check valve shown in FIG. 1;

FIG. 4 is a characteristic diagram showing an example of change of pressure in a pressure chamber of a conventional electromagnetic diaphragm pump, over time;

FIG. 5 is a characteristic diagram showing an example of change of pressure in a pressure chamber of an electromagnetic diaphragm pump according to this invention, over time; and

FIG. 6 is a characteristic diagram where an example of an air-volume against pressure characteristic for a conventional electromagnetic diaphragm pump and an example thereof for an electromagnetic diaphragm pump according to this invention are shown for comparison.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Referring to the drawings, an embodiment of this invention will be described, using an example of an electromagnetic diaphragm pump which is driven by an electromagnet to compress and discharge air.

[0015] FIG. 1 is a cross-sectional view schematically showing the structure of an electromagnetic diaphragm pump in an embodiment of this invention. The electromagnetic diaphragm pump 1 comprises a frame 2, an electromagnet 3 enclosed in the frame 2, a rod-like oscillator 4 driven by the electromagnet 3 to move back and forth in the axial direction, two diaphragms 5, 5 provided at the opposite ends of the oscillator 4, and paired pressure chambers 6, 6 provided outside the frame 2, each having one of the diaphragms 5, 5 as a wall. As described later, the paired pressure chambers 6, 6 are formed by paired casings 2c, 2c which are fitted to the frame 2 on both sides, in a manner covering each diaphragm 5.

[0016] Each casing 2c has a suction port 2a and a discharge port 2b each connected with the pressure chamber 6, where a suction-side check valve 7 is arranged between the suction port 2a and the pressure chamber 6 and a discharge-side check valve 8 is arranged between the discharge port 2b and the pressure chamber 6. The suction-side check valve 7 allows air to flow from the suction port 2a into the pressure chamber 6 when opened, and prevents air from discharging from the pressure chamber 6 when closed. The discharge-side check valve 8 allows air to discharge from the pressure chamber 6 to the discharge port 2b when opened, and prevents air from flowing into the pressure chamber 6 when closed.

[0017] The electromagnet 3 comprises paired electromagnets 13, 13 each comprising an E-shaped core 11 and a coil 12 formed by winding a wire on the core 11. The two electromagnets 13, 13 are arranged to face each other, a specified distance apart, with the exposed surfaces of the coils 12, 12 facing each other. Between the electromagnets 13 and 13, a rod-like oscillator 4 is arranged such that it can move back and forth in the axial direction. The oscillator 4 includes two permanent magnets 15 in the middle part which extends across magnetic field lines produced by the electromagnets 13, 13. At the opposite ends of the oscillator 4, diaphragms 5, 5 of an elastic material such as rubber in the form of a disc are fitted. Each diaphragm 5 is fixed to the frame 2, air-tightly all around, and fixed to the end of the oscillator 4, using a center plate 16 arranged in the center. The center plate 16 has also a function of air-tightly closing the center of the diaphragm 5.

[0018] Thus, the oscillator 4 is arranged between the electromagnets 13, 13, being supported by the diaphragms 5, 5 fixed to the frame 2, at both ends, where the oscillator 4 can move back and forth in the axial direction by bending the diagrams 5, 5.

[0019] Outside each diagram 5, a hollow (deep-dish-

like) casing 2c is provided to form a pressure chamber 6 having the diagram 5 as a wall. Each casing 2c is fixed to the frame, air-tightly all around, and thereby integrated with the frame 2. The casing 2c separates the space between the casing 2c and the diaphragm 5, air-tightly from the outside, and makes the space function as a pressure chamber 6 whose volume expands and contracts as the oscillator 4 moves back and forth so that the diaphragm 5 bends in the direction perpendicular to the diaphragm plane.

[0020] To each casing 2c which forms the other wall of the pressure chamber 6 than the wall formed by the diaphragm 5, a suction-side check valve 7 is fitted at a location corresponding to the air suction port 2a, and a discharge-side check valve 8 is fitted at a location corresponding to the air discharge port 2b.

[0021] As shown in FIG. 2 on an enlarged scale, the suction-side check valve 7 is a so-called poppet valve comprising a valve body 17 of an elastic material such as rubber in the form of a disc and a shaft 17a provided at the center on one side of the valve body 17. The suction-side check valve 7 having such structure is fixed to the casing 2c with the shaft 17a fitted in a shaft hole 2d in the casing 2c, from the inside of the pressure chamber 6.

[0022] In each casing 2c, around the shaft hole 2d, a plurality of pores (suction pores) 2e connecting the pressure chamber 6 and the suction port 2a are formed equally apart from each other on a circle centered on the shaft hole 2d. The disc-shaped valve body 17 of the suction-side check valve 17 has a size (diameter) that can cover all the pores (suction pores) 2e together. When elastically bent, the valve body 17 covers all the pores (suction pores) 2e concentrically, with the peripheral part 17b of the valve body 17 in close contact with the casing 2a, from the inside of the pressure chamber 6. Thus, the part of the casing 2c with which the peripheral part of the valve 17 comes into close contact serves as a valve seat 2h for the suction-side check valve 7.

[0023] As shown in FIG. 2, in particular, in the suction-side check valve 7 used in this embodiment, the length of the shaft 17a is determined such that when the suction-side check valve 7 is fitted to the casing 2c, the peripheral part 17b of the valve body 17 faces the valve seat 2h (inner surface of the casing 2c) with a specified space (clearance) d between.

[0024] The suction-side check valve 7 fitted to the casing 2c in this state functions as a normally-open check valve which is, in the normal state, slightly open, leaving the specified space d between the valve body 17b and the valve seat 2h (inner surface of the casing 2c). The suction-side check valve 7 closes, when the pressure in the pressure chamber 6 elastically bends the valve body 17 and brings the valve body 17 into close contact with the valve seat 2h. Although the optimal value for the space d varies depending on the size and number of the pores 2e, or in other words, the effective suction area, the volume of the pressure chamber 6, the air suction quantity, the air discharge quantity, the frequency of oscillation of the diaphragm 5, etc., the space d is determined between about 0.2mm and 1.0mm, for example.

[0025] Meanwhile, as shown in FIG. 3 on an enlarged scale, the discharge-side check valve 8 is a so-called poppet valve fundamentally similar in structure to the suction-side check valve 7, comprising a valve body 18 of an elastic material such as rubber in the form of a disc and a shaft 18a provided at the center on one side of the valve body 18. The discharge-side check valve 8 is, however, fixed to the casing 2c with the shaft 18a fitted in a shaft hole 2d in the casing 2c, from the outside of the pressure chamber 6.

[0026] Further, the length of the shaft 18a of the discharge-side check valve 8 is determined to be almost equal to the thickness of the casing 2c. Thus, when fitted to the casing 2c, the discharge-side check valve 8 is closed with the valve body 18 in close contact with the valve seat 2h (outer surface of the casing 2c), and hence functions as a normally-closed check valve. The discharge-side check valve 8 opens, when the pressure in the pressure chamber 6 elastically bends the valve body 18 and thereby produces a space between the valve body 18 and the valve seat 18.

[0027] When an alternating voltage is applied to the electromagnet 3 of the electromagnetic diaphragm pump 1 having the above-described structure, a magnetic field alternating according to the frequency of the alternating voltage emerges from the exposed end face (oscillator-4-side end face) of each E-shaped iron core 11. Due to this alternating magnetic field and the magnetic field produced by each permanent magnet 15, an attracting force and a repulsing force are produced between each E-shaped iron core 11 and the oscillator 4, so that the oscillator 4 reciprocates (oscillates) in the axial direction as indicated by an arrow. As the oscillator 4 reciprocates, the two diaphragm 5, 5 connected at the opposite ends of the oscillator 4 oscillate in the direction perpendicular to the diaphragm plane, so that the volumes of the two pressure chambers 6, 6 on the left and right sides repeat expansion and contraction in a complementary manner.

[0028] When the volume of the pressure chamber 6 expands, the pressure in the pressure chamber 6 decreases, so that the suction-side check valve 7 opens and the discharge-side check valve 8 closes, so that air is drawn from the suction port 2a into the pressure chamber 6. Meanwhile, when the volume of the pressure chamber 6 contracts, the pressure in the pressure chamber 6 increases, so that the suction-side check valve 7 closes and the discharge-side check valve 8 opens, so that air is discharged (emitted) from the pressure chamber 6 to the discharge port 2b. The pumping actions, namely the sucking of air into the pressure chamber 6 and the compressing and discharging of air from the pressure chamber 6 are performed in the two pressure chambers 6, 6 in a complementary manner, so that pressurized air is discharged from the two pressure chambers 6, 6 alternately.

[0029] Here, as mentioned above, the suction-side check valve 7 is arranged such that the peripheral part 17b of the valve body 17 is separated from the valve seat 2h by the space d, so that it functions as a normally-open check valve which is open unless the pressure exerted thereon is increased by contraction of the volume of the pressure chamber 6 and which opens to a greater degree when the volume of the pressure chamber 6 expands. Thus, the time for which the suction-side check valve 7 is open in the process of expanding the volume of the pressure chamber 6 can be made sufficiently longer, compared with the time for which it is closed in the process of contracting the volume of the pressure chamber 6. Meanwhile, as mentioned above, the discharge-side check valve 8 is a normally-closed check valve which is closed with the peripheral part 18b of the valve body 18 in close contact with the valve seat 2h and which opens only when the pressure exerted thereon is increased by contraction of the volume of the pressure chamber 6.

[0030] Thus, while the diaphragm 5 oscillates so that the volume of the pressure chamber 6 expands and contracts alternately, the suction-side check valve 7 closes and the discharge-side check valve 8 opens when the volume contracts. When the pressure chamber 6 transfers from the volume-contracting process to the volume-expanding process, the pressure exerted on the suction-side check valve 7 and the discharge-side check valve 8 in the pressure chamber 6 decreases, so that the suction-side check valve 7 slightly opens and the discharge-side check valve 8 closes. Then, when the volume of the pressure chamber 6 expands, the pressure exerted on the suction-side check valve 7 and the discharge-side check valve 8 in the pressure chamber 6 decreases to a great degree, so that the suction-side check valve 7 opens to a great degree while the discharge-side check valve 8 is kept in the closed state.

[0031] When the pressure chamber 6 transfers from the volume-expanding process to the volume-contracting process, the pressure exerted on the suction-side check valve 7 and the discharge-side check valve 8 in the pressure chamber 6 increases, so that the suction-side check valve 7 returns to the slightly open state while the discharge-side check valve 8 is kept in the closed state. In this way, the time for which the suction-side check valve 7 is open is made longer so that a sufficiently large amount of air can be sucked into the pressure chamber 6 in the process of expanding the volume of the pressure chamber 6.

[0032] Then, when the volume of the pressure chamber 6 contracts, the suction-side check valve 7 closes again and the discharge-side check valve 8 opens. After this, the above-described opening and closing actions of the suction-side check valve 7 and discharge-side check valve 8 are repeated, where the complementary volume-expansion and contraction of the two pressure chambers 6, 6 connected at the opposite ends of the oscillator 4 causes air to be drawn into the pressure chambers 6, 6 alternately and causes compressed air to be discharged from the pressure chambers 6, 6 alternately.

[0033] In the electromagnetic diaphragm pump 1 having the above-described structure, since the normally-open valve is used for the suction-side check valve 7, the phenomenon that air sucked produces an excessive load in one 6 of the paired pressure chambers 6, 6 having the diaphragms 5, 5 connected by the oscillator 4, which hinders the discharging of compressed air from the other pressure chamber 6 does not happen. Specifically, since it can be arranged that the time for which the suction-side check valve 7 is open in one 6 of the paired pressure chambers 6, 6 operating in a complementary manner is longer than the time for which the discharge-side check valve 8 is open in the other pressure chamber 6, the diaphragm 5 of the former pressure chamber 6 can be caused to oscillate with certainty, without applying a back pressure to the diaphragm 5. Thus, mutual interference of the two pressure chambers 6, 6 can be prevented, a sufficient amount of air can be drawn into each pressure chamber 6, and hence, pressure difference between the pressure chambers 6, 6 can be removed. Consequently, even when the diaphragm pump is operated at a high operating pressure, the phenomenon that the discharge quantity of the diaphragm pump (amount of air discharged from the diaphragm pump) becomes unstable can be effectively prevented.

[0034] FIG. 4 shows an example of change of pressure in a pressure chamber 6 of an electromagnetic diaphragm pump of a conventional common structure. FIG. 5 shows an example of change of pressure in a pressure chamber 6 of an electromagnetic diaphragm pump according to the present invention. In these diagrams, time is plotted on the horizontal axis and pressure in the pressure chamber 6 is plotted on the vertical axis.

[0035] As shown in FIG. 4, in the conventional diaphragm pump, in the process of sucking air into the pressure chamber 6, the time for which the pressure (P1) in the pressure chamber 6 is equal to the atmospheric pressure is momentary. Meanwhile, as shown in FIG. 5, in the diaphragm pump according to the present invention, in the process of sucking air into the pressure chamber 6, the time for which the pressure (P2) in the pressure chamber 6 is equal to the atmospheric pressure can be made sufficiently long, for example, about 50 milliseconds. When, in the process of sucking air into the pressure chamber 6, the time for which the pressure chamber 6 is open to the outside air is made long this way, a sufficient amount of atmosphere can be sucked into the pressure chamber 6, so that the volume-expanding and volume-contracting operations of the pressure chamber 6 can be stabilized. Consequently, pressure difference between the two pressure chambers 6, 6 operating in a complementary manner can be removed.

[0036] FIG. 6 shows examples of air-volume against pressure characteristic, where characteristic curve A connecting marks ○ is for a conventional electromagnetic diaphragm pump and characteristic curve B connecting marks Δ is for an electromagnetic diaphragm pump

according to the present invention. As seen from the comparison in FIG. 6, in the conventional electromagnetic diaphragm pump (characteristic curve A), the air volume is unstable at high operating pressures of 40kPa and higher, for example, which causes variation in discharge pressure. Meanwhile, in the electromagnetic diaphragm pump according to the present invention (characteristic curve B), the air volume is stable also at high operating pressures of 40kPa and higher, so that variation in discharge pressure is not caused. The reason for this is that the time for which the suction-side check valve 7 for drawing air into the pressure chamber 6 is open is made longer, as mentioned above.

[0037] Further, in the electromagnetic diaphragm pump 1 according to the present invention, it is possible to remove pressure difference between the two pressure chambers 6, 6 operating in a complementary manner and prevent the above-mentioned instability phenomenon effectively, without impairing the pump performance and the durability of the diaphragm 5, etc.

[0038] The present invention is not limited to the above-described embodiment. Although the electromagnetic diaphragm pump 1 for compressing and discharging air has been described here by way of example, the present invention is likewise applicable to a diaphragm pump for discharging another gas. Further, a drive source other than the electromagnet 3 can be used for the diaphragm 5. Further, the present invention is applicable to a diaphragm pump provided with only one pressure chamber 6.

[0039] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

[0040] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. A diaphragm pump comprising a diaphragm driven to move back and forth, a pressure chamber arranged such that the volume of the pressure chamber is expanded and contracted by the oscillation of the diaphragm, a suction-side check valve fitted to a suction port for the pressure chamber and arranged to open and suck a fluid from the suction port into the pressure chamber when the volume of the pressure chamber is expanded, and a discharge-side check valve fitted to a discharge port for the pressure chamber and arranged to open and discharge the fluid from the pressure chamber to the discharge port when the volume of the pressure chamber is contracted, **characterized in that**
the suction-side check valve includes a valve body of an elastic material fitted to a valve seat provided near the suction port, with a space between, and is arranged to close by the valve body being elastically deformed and brought into close contact with the valve seat, and open by the valve body elastically returning to the normal shape and coming out of contact with the valve seat, and
the discharge-side check valve includes a valve body of an elastic material fitted to a valve seat provided near the discharge port, in close contact with the valve seat, and is arranged to open by the valve body being elastically deformed and producing a space relative to the valve seat, and close by the valve body elastically returning to the normal shape and coming into close contact with the valve seat.

2. The diaphragm pump according to claim 1, **characterized in that**
the diaphragm is connected to an oscillator driven by an electromagnet to move back and forth.

3. The diaphragm pump according to claim 1, **characterized in that**
the diaphragm is provided at each end of a rod-like oscillator driven by an electromagnet to move back and forth in the axial direction, and the pressure chamber is a pair of pressure chambers each including one of the diaphragms, where the volumes of the paired pressure chambers are expanded and contracted in a complementary manner.

FIG. 1

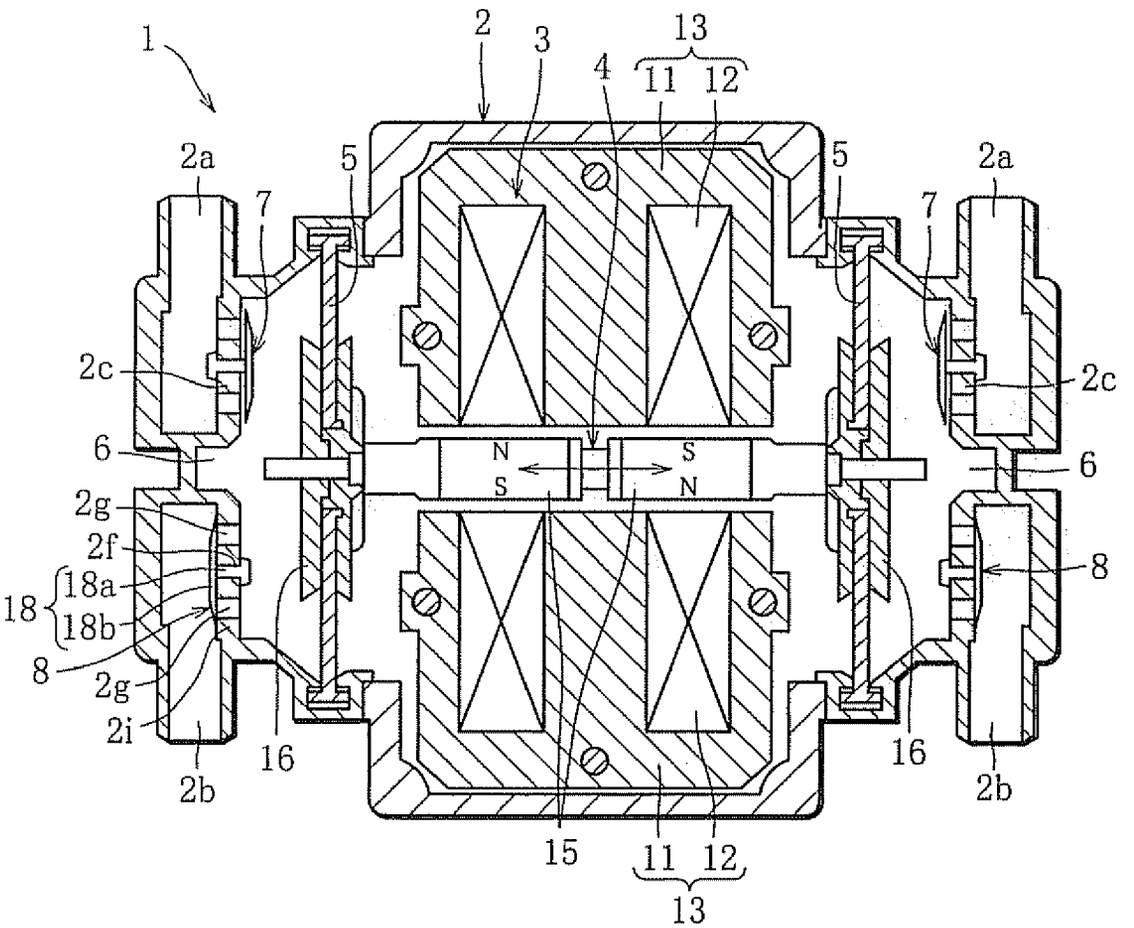


FIG. 2

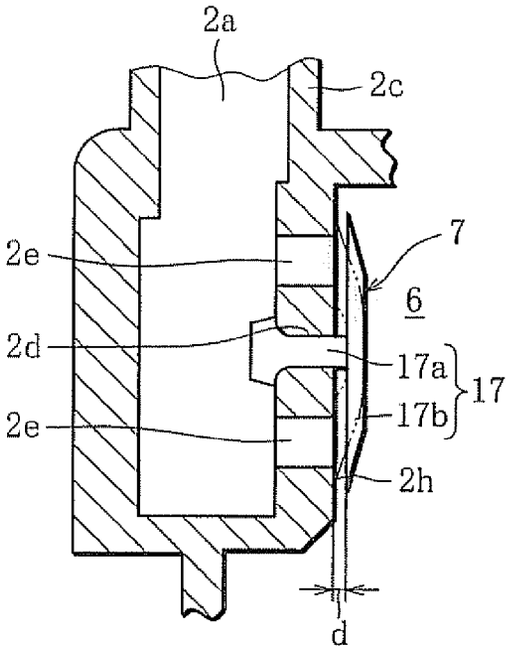


FIG. 3

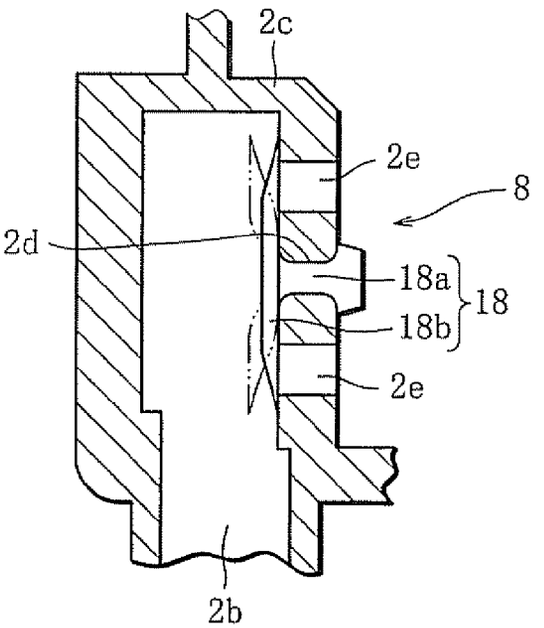


FIG. 4

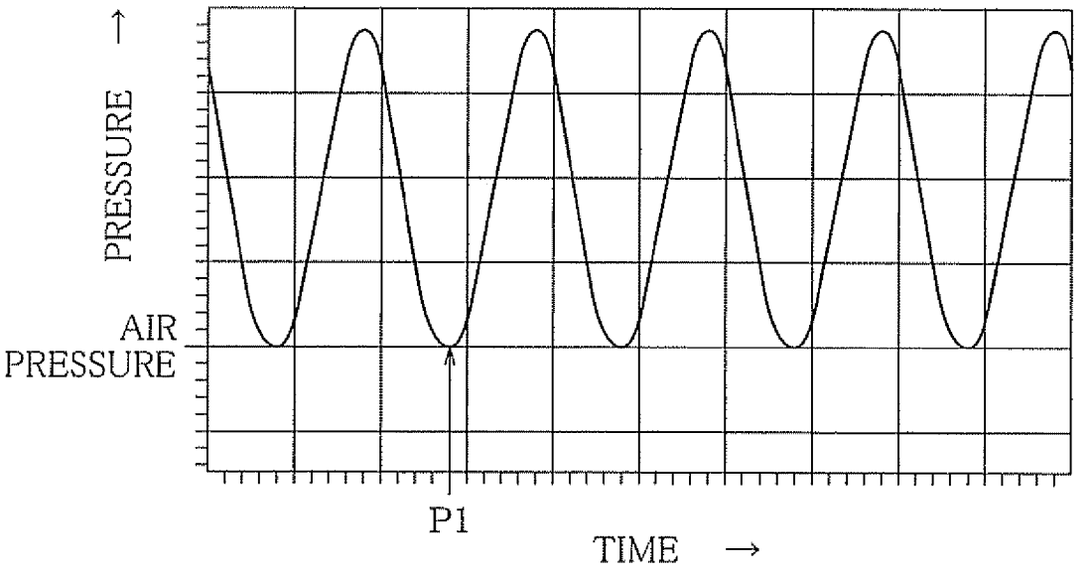

PRESSURE
AIR
PRESSURE
P1
TIME

FIG. 5

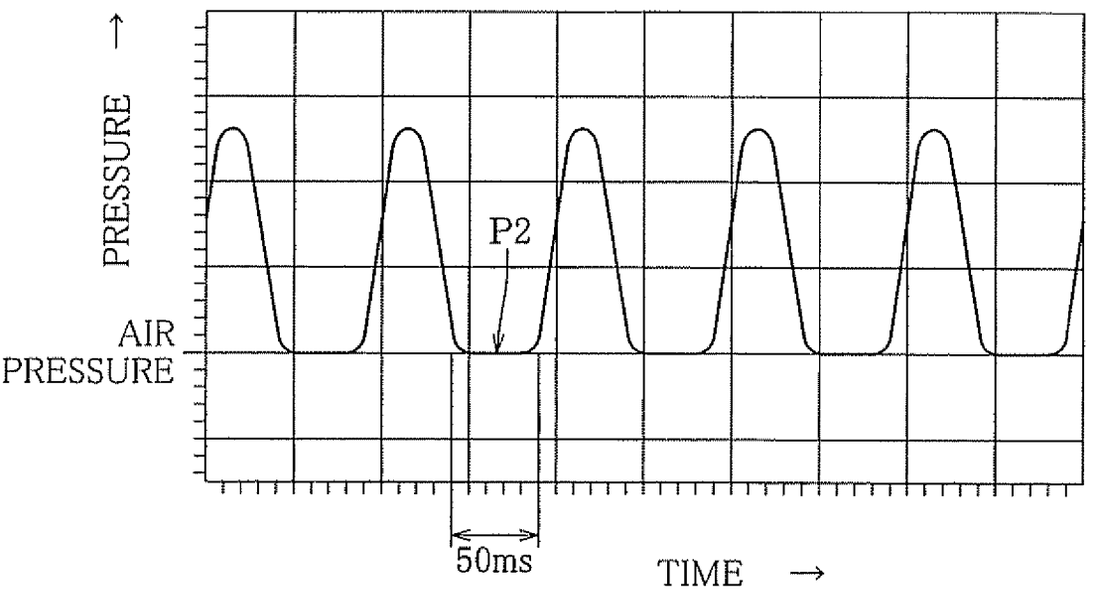
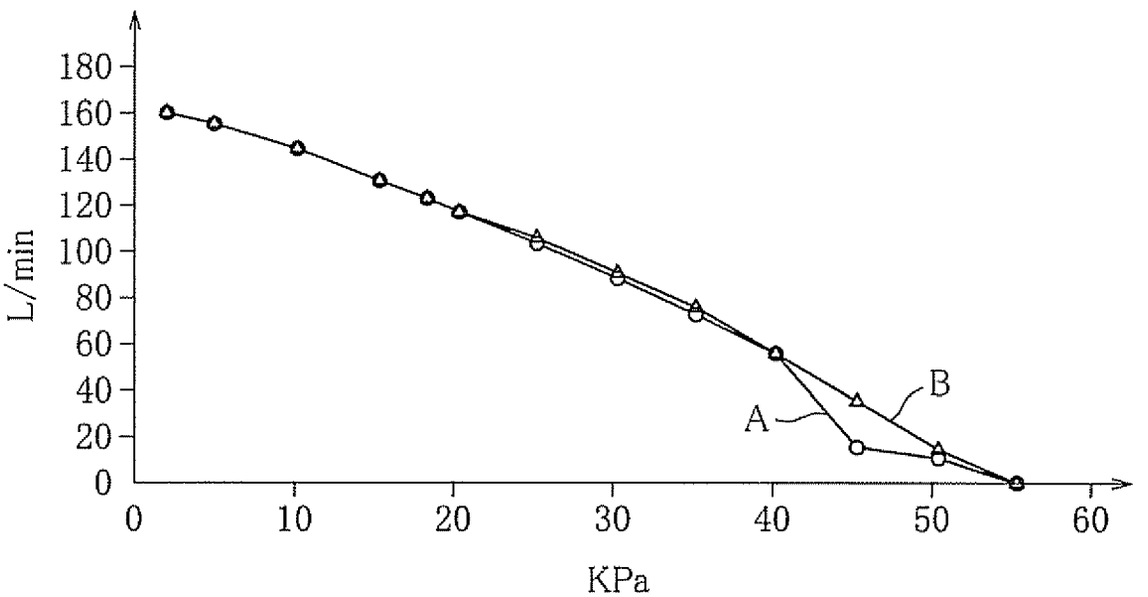

PRESSURE
P2
AIR
PRESSURE
50ms
TIME

FIG. 6



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 11 2980

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2003/082056 A1 (OHYA IKUO ET AL) 1 May 2003 (2003-05-01) * the whole document * * figure 1 *	1-3	INV. F04B39/10 F04B35/04 F04B45/04
Y	US 4 978 285 A (DA COSTA ET AL) 18 December 1990 (1990-12-18) * the whole document * * column 1, line 46 - line 50 *	1-3	
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A	WO 99/20903 A (SCHULZ S.A; BRAESCHER FILHO, PAULO, PAIM) 29 April 1999 (1999-04-29) * figure 1 *	1-3	
A	US 4 642 037 A (FRITCHMAN ET AL) 10 February 1987 (1987-02-10) * the whole document *	1	TECHNICAL FIELDS SEARCHED (IPC) F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 September 2006	Ingelbrecht, Peter

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 11 2980

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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22-09-2006

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