

TITLE OF THE INVENTION**DIAPHRAGM PUMP****BACKGROUND OF THE INVENTION****Field of the Invention**

The present invention relates to a diaphragm pump, and more particularly, relates to a diaphragm pump for effectively preventing pulsation of liquid by installing a first pump chamber for installing a diaphragm and by installing a second pump chamber for arranging a cylindrical partitioning plate having an opening area at a lower portion.

Background of the Related Art

Generally, a typical diaphragm pump pumps liquid by rotational movement of a motor into a reciprocating movement by devices such as a cam. Since the amount of the discharged liquid from the diaphragm pump fluctuates by small volume, the diaphragm pump is generally used for precisely instilling liquid chemicals or medicines.

Fig. 1A to 1E are cross sectional views illustrating one embodiment of a conventional diaphragm pump. As shown in Fig. 1A, a diaphragm 110 is supported by a supporting ring 120 to form a

9904155-0

23 AUG 1999

pump chamber 130 in an opening area of a pump head 100. A suction hole 105 and a discharge hole 106 are located at the upper portion and the lower portion of a body 102, respectively.

The suction hole 105 and the discharge hole 106 are opened/closed by a check ball 140. Referring to Fig. 1C, an opening-side valve seat 141 having a cross-shaped groove is formed on a suction end of the suction hole 105 of the pump head 100 and an end of a discharge-side connector 160. And, a closing-side valve seat 142 having tapered shape is formed at an end of a suction connector 150 and a discharge side of the discharge hole 106 of the pump head 100.

The following describes the operation of the diaphragm pump constructed in such a manner as mentioned above.

When a motor(not illustrated) is driven to operate the pump, the rotational movement of the motor is changed to the reciprocating movement of a diaphragm shaft 111 by devices such as an eccentric cam, and thereby the diaphragm 110 is driven back and forth. Fig. 1A illustrates a state of the diaphragm being driven back, that is, a suction process, and Fig. 1B illustrates a state of the diaphragm being driven forward, that is, a discharge process.

During the suction process, due to internal pressure, each check ball 140 of the suction side and the discharge side moves toward the center of the pump head 100. Subsequently, since there is the opening-side valve seat 141 is formed at the end of the suction hole 105 of the pump head 100, liquid is drawn to the

pump chamber through the cross-shaped groove. And, the discharge hole 106 is closed by the check ball 140. On the other hand, during the discharge process, each check ball 140 moves away from the pump head 100 to the outside such that the suction hole 105 is closed and only the discharge hole 106 is opened. Subsequently, the liquid in the pump chamber 130 is discharged through the cross-shaped groove formed at the discharge-side connector 160.

The advantage of such a conventional diaphragm pump in a long term is that the average amount of the discharged liquid is very constant. However, since the pumping operation is separated into the suction process and the discharge process, and it is intermittently performed, there is a fundamental problem of a pulsation of the discharged liquid, as shown in Fig. 1D.

In order to prevent such a pulsation of the discharged liquid, two or more pumps are connected in parallel and operated in different strokes, as shown in Fig. 1E. Referring to Fig. 2, another method is explained. By installing an air chamber 200 at the center of a liquid pipe passage, during the discharge process, the air in the air chamber 200 is pressurized, and thereby the amount of the discharging liquid from a discharge pipe 210 is reduced. During the suction process, due to the expansion force of the pressurized air, the liquid stored in the air chamber 200 during the discharge process is discharged through the discharge pipe 210.

For reference, the unmentioned reference numeral 201 is a

pressure gauge. And the unmentioned reference numeral 220 is a safety valve for receiving high-pressured liquid through a return pipe 230 by opening itself in case that the pressure of liquid surpluses a predetermined pressure value.

However, the benefit of using two more pumps being connected in parallel is significantly offset by the substantial increase in installation cost. Moreover, in the case of installing the air chamber at the center of the liquid pipe passage, it is difficult to perform the installation operation. Also, it is unsuitable to establish the air chamber when the connector of the pump or the liquid pipe passage is made of tube type. Furthermore, damages to the connector caused by the vibration of the air chamber when operating the pump are frequently occurred. Furthermore, since such method cannot fundamentally remove the pulsation of the discharged liquid, water hammering caused by the pulsation can be generated and it may destroy pipes, especially, at high pressure.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide a diaphragm pump having a simple structure for efficiently preventing the pulsation of a discharged liquid.

In order to accomplish the above-mentioned object, the diaphragm pump in which the discharge of the liquid is intermittently carried out, includes: a cylindrical body; a

dividing wall dividing the cylindrical body into a first pump chamber and a second pump chamber; a diaphragm located at an opening area of the first pump chamber; a driving means for driving the diaphragm back and forth; a cover plate connected to an opening area of the second pump chamber; a cylindrical partitioning plate formed as a cylindrical shape having an opened lower portion and arranged at an inside portion of the second pump chamber for forming a constant pressure chamber, in which pressurized air is received; a suction hole formed at the first pump chamber; a suction valve means for opening/closing the suction hole; a discharge path for connecting the first pump chamber and the second pump chamber; a discharge valve means for opening/closing the first discharge path and a discharge hole formed at the second pump chamber.

Preferably, the discharge valve means includes a valve body which has an opening area at one side portion and a protrusion at another side portion, wherein a plurality of perforating holes is formed around the protrusion; a check ball movably installed in the inner portion of the valve body and a valve seat installed on the opening area of the valve body. A valve installing hole is formed at the dividing wall for connecting to the discharge path. The discharge valve means is installed in the valve installing hole. When the protrusion of valve body is downwardly pushed by a lower surface of a cam, which cam is connected to an upper portion of the valve installing hole, the space around the protrusion in the valve installing hole forms a part of the discharge path.

Moreover, preferably, a pressure control hole and a high

pressurized liquid collecting hole are formed at the cover plate. A valve plate elastically supported by a spring is installed on the outside portion of the pressure control hole and the high pressurized liquid collecting hole. When the pressure in the second pump chamber surpasses a predetermined pressure, the spring is pressurized. Accordingly, the high pressurized liquid in the second pump chamber is discharged through the pressure control hole and the high pressurized liquid collecting hole.

BRIEF DESCRIPTION OF THE DRAWINGS

The above object and advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1A and 1B are cross sectional views showing the structure and operation of a conventional diaphragm pump;

Fig. 1C is a plan view of an opening-side valve seat having a cross-shaped groove;

Fig. 1D is a graph showing a pulsation of the amount of discharged liquid;

Fig. 1E is a graph showing a pulsation of the amount of the discharged liquid in the case of reducing the pulsation effect;

Fig. 2 a schematic view showing an air chamber and a safety valve being installed on a conventional liquid pipe passage;

Fig. 3 is a cross sectional view of a diaphragm pump according to a preferred embodiment of the present invention;

Fig. 4 is a front elevational view of a constant pressure

chamber cut from the line A to A' of Fig. 3;

Fig. 5 is an exploded perspective view of a diaphragm pump according to a preferred embodiment of the present invention;

Fig. 6 is a partially cutaway view showing a discharge-side valve body; and

Figs. 7 and 8 are cross sectional views illustrating another embodiments according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The objects, characteristics and advantages of the above-described invention will be more clearly understood via the preferable embodiments shown in the attached drawings.

Figs. 3 through 6 illustrates the structure and operation of the diaphragm pump according to one embodiment of the present invention. Fig. 3 is a cross sectional view, Fig. 4 is a front elevational view of a constant pressure chamber cut from the line A to A' of Fig. 3, wherein the constant pressure chamber is formed on a cylindrical partitioning plate having an opening area, Fig. 5 is an exploded perspective view of a diaphragm pump and Fig. 6 is a partially cutaway view of a discharge-side valve body.

A cylindrical body 11 is divided into right and left portions by a dividing wall 12 and forms a first pump chamber 13 and a second pump chamber 14.

A diaphragm 110 is compressively installed on an opening area of a first pump chamber 13 by a support ring 120. A cover plate 15 is connected to an opening area of a second pump chamber 14 by a gasket 75 as an intermediary. A cylindrical partitioning plate 21 having an opening area 22 in the lower portion is installed on an inner portion of the second pump chamber 14. In pumping operation, the air in the second pump chamber 14 is compressively stored in the cylinder partitioning plate 21 by the flowing liquid through an outside portion of the cylindrical partitioning plate 21 and forms the constant pressure chamber 23.

A suction hole 16 is formed on a lower portion of the first pump chamber 13. A suction valve means 30, which includes a suction-side valve body 32, a suction-side check ball 33 and a suction-side valve seat 34, is installed on an inside portion of a suction-side connector 31, wherein the suction-side connector 31 is connected to the suction hole 16. A discharge hole 18 is formed on an upper portion of the second pump chamber 14 and connected to a discharge-side connector 51.

In the mean time, a discharge path 17 is formed on the dividing wall 12 for connecting the first pump chamber 13 and the second pump chamber 14 and a discharge valve installing hole 45 is formed in the center portion of the discharge path 17. A discharge valve means, which includes a discharge-side valve body 42, a discharge-side check ball 43 and a discharge-side valve seat 44, is installed on an inside portion of a discharge valve installing hole 45. The discharge-side valve body 42 forms a ball guide hole 42c and a perforating hole 42b and forming the ball

guide hole 42c and the perforating hole 42b is the same to the suction-side valve body 32. But, the discharge-side valve body 42 forms a protrusion 42a on an upper portion. When a cap 41 is combined with the opening area of the discharge valve installing hole 45, the protrusion 42a is pressed by the upper surface of the cap 41. Accordingly, the discharge-side valve body 42 is tightly fixed to the inside portion of the discharge valve installing hole 45 and the space around the protrusion 42a forms a part of the discharge path 17.

By structuring the discharge valve means according to the present invention, the discharge valve means is more exactly operated compare to a conventional valve means as shown in Fig. 1C, can prevent the chattering and has increased durability of the valve seat portion.

The description related to the unmentioned reference numerals are as follows: 61 is a drain pipe; 62 is a drain valve; 71 through 74 are packing for preventing the leakage of air and liquid; and 76 is a bolt for connecting a cover plate, the cylindrical body and the support ring.

The following describes the operation of the diaphragm pump formed as the above-mentioned embodiment.

The state of the constant pressure chamber 23 in operation is shown in Fig. 4. Specifically, the liquid to be pumped is filled in the space between the cylindrical partitioning plate 21 and the cylindrical body 22 and in the lower portion of the

inside area of the cylindrical partitioning plate 21. The pressurized air filled in the constant pressure chamber, which is defined by the upper portion of the inside area of the partitioning plate 21, is isolated from the external environment by the gasket 75 and the liquid filled in the lower portion, and the amount of the air filled in the constant pressure chamber is always constant.

The state of the diaphragm 110 in forward movement, that is in the discharge process, is shown in Fig. 3. In the discharge process, the discharge-side check ball 15 moves up to open the discharge path 17. Simultaneously, the liquid previously flowed to the first pump chamber 13 during a previous suction process is discharged to the inside portion of the second pump chamber 14 via the discharge path 17. Simultaneously, as the liquid pressure increases an inside portion of the second pump chamber 14, the air in the constant pressure chamber 23 is more pressurized, thus the level of the liquid filled in the inside portion of the cylindrical partitioning plate 21 rises. In other words, all of the liquid flown to the inside portion of the second pump chamber 20 via the discharge path 17 is not discharged through a discharge hole 18. As a certain amount of liquid influences a rising level of the liquid inside portion of the partitioning plate 21 and increasing air pressure, a sudden change in the amount of liquid being discharged can be prevented.

In the other hand, during a suction process, the discharge valve means 40 is closed to prevent inverse flowing of liquid inside portion of the second pump chamber 14 to the first pump

chamber 13, and liquid discharged from the first pump chamber 13 to the second pump chamber 14 is stopped. However, due to air pressure inside portion of the constant pressure chamber 23 which is pressurized during the previous discharge process, the liquid inside portion of the second pump chamber 14 is continuously discharged through the discharge hole 18 and the discharge-side connector 51, and the liquid level inside portion of the cylindrical partitioning plate 21 gradually decreased. Accordingly, the amount of discharged liquid from the second pump chamber 14 is not decreased rapidly, and it is almost equal to the amount of the liquid during the discharge process of the first pump chamber 13.

Fig. 7 is a sectional view showing another embodiment of the present invention. With referring to Fig. 7, a pressure control hole 81 and a high pressurized liquid collecting hole 82 are formed on a cover plate 15, thereto the opening area of the second pump chamber 14 is connected. A valve plate 83 is installed on outside surface of the pressure control hole 81 and the high pressurized liquid collecting hole 82, wherein the valve plate 83 is elastically supported by a spring 85. Preferably, the valve plate 83 is made of an elastic material. The spring 85 is installed on an inside portion of a spring casing 84, wherein the spring casing 84 is connected to one side portion of the cover plate 15 by means of a screw. The valve plate is harmoniously operated by installing a push plate 86 between the spring 85 and the valve plate 83. A cap 88 is connected to an end portion of the spring casing 84 for controlling the elasticity of spring 85 by means of a screw. A spring seat 87 is formed between the cap

88 and the spring 85 for safe receiving the spring.

By structuring above-mentioned manner, when the pressure in the second pump chamber 14 surpluses a predetermined pressure, the valve plate 83 is elastically deformed and simultaneously, the spring 85 is compressed. Accordingly, the high pressurized liquid in the second pump chamber 14 is discharged through the pressure control hole 81 and the high pressurized liquid collecting hole 82. Accordingly, as shown in Fig. 2, the pump apparatus of the present invention can control the pressure in the pump and the discharge path below a predetermined pressure without installing an extra safety valve on the discharge path. Accordingly, the installation of the pump apparatus becomes much easier, thereby reducing the installing cost.

Differing from the embodiment of the Fig. 3, Fig. 8 is another embodiment of the present invention. The cylindrical body 11 is divided into a first pump chamber body 11a and a second pump chamber body 11b. And, the second pump chamber body 11b, the cover plate 15 and the cylindrical body 21 are integrally formed in the embodiment of the Fig. 8.

If the pump is not made of injection-molded resins but metal such as a stainless steel, the preferable embodiment of Fig. 8 is much profitable than that of Fig. 3 in the view point of the production process and the production cost. Then, the outside portion of the cylindrical body, which roles as a moving path of liquid, can be short.

As described above, the diaphragm pump of the present invention proficiently prevents the pulsation effect of the discharge liquid. Moreover, since there is no need for installing extra parts, such as an air chamber and pipes, the installation of the pump becomes much easier, thereby reducing the installation cost.

Furthermore, even if the air chamber is installed to reduce the pulsation of liquid according the conventional method, the liquid is still discharged intermittently from a diaphragm pump. As a result, the conventional diaphragm pump is noisy, and the pipes are frequently damaged due to the water hammering. However, since the diaphragm pump of the present invention reduces the pulsation of the liquid with the pump itself before discharging the liquid, the pipes are guarded from such damage, and the level of noisy can be reduced to a very adequate level.

Even though the present invention has been described in application to a certain type of diaphragm pump for convenience, it should be noted that the present invention can be applied to any other type of diaphragm pumps or any other type of pumps in which the pulsation of the liquid is occurring by the intermittent suction and discharge.

While the present invention has been described in connection with preferred embodiments, various modification and equivalent arrangements can be made without violating the scope and spirit of the invention.



WHAT IS CLAIMED IS

1. A diaphragm pump which pumps liquid intermittently by movement of a diaphragm back and forth comprising:

a cylindrical body;

a dividing wall for internally dividing said cylindrical body into a first pump chamber and a second pump chamber;

a diaphragm installed on an opening area of said first pump chamber;

a driving means for moving said diaphragm back and forth;

a cover plate connected to an opening area of said second pump chamber;

a cylindrical partitioning plate for forming a constant pressure chamber having pressurized air in an inside portion, wherein the cylindrical partitioning plate is a cylindrical form having an opening area on a lower portion and installed on an inside portion of said second pump chamber;

a suction hole formed on said first pump chamber;

a suction valve means for opening/closing said suction hole;

a discharge path for connecting said first pump chamber and said second pump chamber;

a discharge valve means for opening/closing said the first discharge path;

a discharge hole formed on said second pump chamber.

2. The diaphragm pump according to claim 1, further comprising:

said discharge valve means includes a valve body having an opening area at one side portion and a protrusion at another side



portion, wherein a plurality of perforating holes is formed around said protrusion, a check ball movably installed in an inner portion of said valve body and a valve seat installed on the opening area of said valve body; and

a valve installing hole is formed on for connecting said discharge path, said discharge valve means is arranged in said valve installing hole and a space around said protrusion in said valve installing hole forms a part of said discharge path if a protrusion of said valve body is downwardly pressed by a lower surface of a cap, which cap is connected to an upper portion of said valve installing hole.

3. The diaphragm pump according to claim 1, wherein a pressure control hole and a high pressurized liquid collecting hole are formed at said cover plate, a valve plate elastically supported by a spring is installed on the outside portion of said pressure control hole and said high pressurized liquid collecting hole and if the pressure in said second pump chamber surpluses a predetermined pressure, said spring is pressurized for discharging the high pressurized liquid in said second pump chamber through said pressure control hole and said high pressurized liquid control hole.