

Description**Background and summary of the invention**

This invention relates to fluid flow systems, particularly to devices used in such systems to cause fluid to be pumped in a pulsatile manner. The invention is useful particularly, although not exclusively, in medical environments, such as in operating rooms, where sources of positive and vacuum pressure sources are readily available.

Various devices for causing pulsatile fluid flow have been known and have found increasing use in a variety of environments including medical and dental environments. Pulsating fluid jets are effective to remove surgical debris from a surgical site. The use of pulsating fluid jets has been demonstrated to be a very effective way of cleaning wounds or applying antibiotics, disinfectants and the like. The effectiveness of the pulsating fluid technique is the result of the repeated flexure of tissue and/or repeated dynamic impact from the pulsations which tend to materially assist in working loose of dirt particles and other debris. They are useful in orthopedic surgical procedures to clear away bone chips.

Pulsating water flow devices also have been available for some time for use in connection with dental and oral hygiene and maintenance to remove food particles from difficult to reach crevices as well as to stimulate gums and oral tissue.

In addition to use of pulsating jets, some medical and operating room techniques call for low flow, more gentle pulsatile or peristaltic pumps. For example, they can be used to draw fluids from closed wounds and to deliver the fluids to a storage receptacle. They may be used as stomach pumps. Such a device may be used to collect blood and/or to effect transfusion from a donor to a donee. Low pressure, pulsatile pumps also are useful in kidney dialysis techniques to transfer blood to and from the dialysis machine.

In general, the various pulsation flow systems which have been available utilize intermittent pumping devices of some complexity. Typically the device requires a pump mechanism which is driven by any of a variety of motors. The pump and motor systems may be electrically operated or, in some instances, may be operated in response to the fluid pressure and flow of the fluid which is to be pulsated.

While a number of devices which utilize a pulsatile flow device have enjoyed varying degrees of commercial success, they still are not free from difficulties. For example, they tend to be somewhat cumbersome and are not as portable as would be desired. When the fluid pulsatile device is used in a surgical or operating room environment, it is preferable that it be small, as compact and as light as is reasonably possible.

U.S. Patent specification No. 3039272 discloses a pulsatile pump operable to develop a filling stroke and an ejection stroke, the pump comprising a housing, an elastic member mounted within the housing to divide it into a first chamber and a

second chamber, the first chamber defining a pumping chamber having an inlet and outlet for the fluid to be pumped and the second chamber defining a driving chamber and having a gas inlet connectable to a source of gas under pressure and a gas exhaust port normally closed by the elastic member but movable away from sealing engagement therewith to provide the ejection stroke on supply of said gas under pressure to the second chamber.

While it would be desirable to have a prepackaged, presterilized disposable device, none has been available to date.

It is an object of the invention to provide an improved and greatly simplified fluid pulsatile pump.

The present invention provides an improved pump which is characterized by a raised wall provided about the exhaust port (96), the elastic member (66) being stretched over the rim of the raised wall (98) to bias it closed against the exhaust port (96) whereby the filling stroke is effected solely by the resilience of the elastic member (66).

The pump utilizes a two-stroke cycle including a filling stroke and an ejection stroke. Application of a pressure differential across the resilient member causes flexure of the resilient member in a first pumping stroke. The device is responsive to movement of the member in the first stroke to abruptly terminate the pressure differential. A biasing force applied to the elastic member causes itself to effect the second filling stroke. The device preferably includes means to enable the buildup of the pressure differential after the end of the second stroke thereby repeating the pumping cycle of the device. A check valve may be provided in the system to assure flow only in a direction from the inlet to the outlet.

The pumping action in the positive pressure stroke is effected by applying pneumatic pressure at the inlet to the driving chamber. The increased pressure in the pneumatic chamber causes flexure and expansion of that portion of the diaphragm which surrounds, but does not seal, the outlet port. Expansion of the diaphragm toward the pumping chamber in the first stroke causes a volume of fluid to be ejected out of the pumping chamber. The ejection continues until the expansion of the diaphragm overcomes the bias of the diaphragm against the outlet. At that point the diaphragm abruptly snaps to a configuration opening the outlet port thereby exhaust venting the driving chamber to atmosphere. The outlet port is preferably arranged to define a greater flow area than the inlet so as to provide minimal impedance to flow through the outlet. Once the outlet is opened the pressure across the diaphragm equalizes which enables the diaphragm to return in the second stroke to its normal position closing the outlet port. During the second stroke motion of the diaphragm the volume of the pumping chamber is re-expanded which ingests an additional volume of fluid from the fluid inlet into the pumping chamber to fill the

pumping chamber in readiness for the next oscillation. Means are provided for controlling the frequency and volume of pumping action.

The invention provides a pulsatile pump which has a gentle pumping action and is suited for use in those medical and surgical environments where delicacy of pumping action is among the prime considerations as well as where higher pulsatile forces are desired. It is also of simple, inexpensive construction and lends itself to disposable use.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings wherein:

Figure 1 is a cutaway perspective view of an illustrative embodiment of the invention;

Figure 2 is a diagrammatic illustration, in section, of the embodiment of the invention shown in Figure 1 as seen along the lines 7—7 of Figure 1;

Figure 3 is an illustration similar to Figure 1 showing the resilient element distended near the conclusion of the ejection stroke;

Figure 4 is an illustration of the device in Figure 1, illustrating diagrammatically the configuration of the pump as it shifts from the ejection stroke to the filling stroke;

Figure 5 is a diagrammatic illustration of the manner in which a pump in accordance with the invention may be used in surgical irrigation or debridement system;

Figure 6 is a side elevation of a pump adapted for quick connection and disconnection to a source of irrigation solution, such as might be employed in a system of the type shown in Figure 5;

Figure 7 is a sectional elevation of the pump as seen along the line 7—7 of Figure 6;

Figure 8 is a side elevation of the pump shown in Figure 6 and 7 as seen from the right side thereof; and

Figure 9 is an enlarged sectional illustration of the connection needle and integral check valve illustrated in Figure 7.

As shown in Figures 1 and 2 an illustrative embodiment of the invention includes a housing 60, the interior of which is divided into a variable volume pumping chamber 62 and a driving chamber 64, the chambers 62, 64 being defined and separated by a flexible, resilient member 66, such as an elastic diaphragm. The housing 60 may be formed in two sections 68, 70. The flexible resilient member 66 preferably is captured between the housing sections 68, 70 when the device is assembled. The periphery of the flexible resilient member may be provided with an enlarged rim 72 which can be received in a receptive groove formed in one or both of the sections 68, 70 to cooperatively grip the rim 72. The housing sections 68 and 70, and the periphery of the flexible resilient member 66 are sealed to assure hermetic isolation between the chambers 62, 64 as well as a complete seal to the atmosphere.

The housing 60 includes a fluid inlet 74 and a fluid outlet 76 leading to and from the pumping

chamber 62. The inlet 74 is connected by a tube 78 to a source of the fluid which is to be pumped such as, for example, a suitable sterile irrigation solution for use in surgical and debridement of wounds, surgical sites or the like. The device also includes means for maintaining unidirectional flow along the flow path defined by the inlet 74, pumping chamber 62 and outlet 76 and, to that end, a check valve 80 may be placed along the flow path, preferably in the inlet conduit 78. Although an additional check valve may be placed in the outlet line, the manner in which the device operates enables an outlet check valve to be omitted, as will be described.

The outlet 76 of the housing 60 is connected to an outlet tube 82 which may terminate in an outlet nozzle 84. A throttling valve, indicated generally at 86, is interposed along the flow path defined by the outlet tube 82 and nozzle 84. The type of throttling valve may vary with the intended use of the device. The throttling device may take the form of a simple adjustable clamp, as shown in Fig. 2, which is fitted onto the flexible tubing 82. Such a clamp can be located at the nozzle or at a more upstream location along the tube 82 as desired. In other embodiments the throttle valve may take other forms and may be incorporated into a hand held nozzle so as to be operated conveniently by the user. The clamp illustrated in Fig. 1 is a commercially available clamp formed from a unitary plastic defining a pair of compression pads 83 which grip and squeeze the flexible tube 82. The tube extends through apertures 85 formed in the clamp 86. One end of the clamp includes a ratchet surface 87 which cooperates with a relatively sharp edge 89 of another leg 91 of the clamp to lock the clamp in any of a variety of positions. The various positions in which the clamp may be locked determined the degree to which the tube 82 is throttled by the pads 83.

The pumping action is effected by oscillations of the elastic diaphragm 66. The device includes a two-stroke mode of operation, including an ejection stroke and a filling stroke. In the ejection stroke diaphragm 66 is caused to flex to decrease the volume of the pumping chamber 62, applying pressure to the fluid in the chamber 62. During the ejection stroke fluid is caused to flow from the pumping chamber 62 through the outlet tube 82 and is dispensed from the nozzle 84. Reverse flow is prevented by the check valve 80. As described below, the ejection stroke is terminated abruptly and in a manner to enable the elastic diaphragm 66 to return to its starting position in which the volume of pumping chamber 62 re-expands to its original volume. The re-expansion of the member 66 defines the filling stroke and causes fluid to be drawn from the fluid source through the inlet tube 78 and check valve 80 to the pumping chamber 62, in readiness for the next pumping stroke.

The flexible, resilient member 66 is constructed and mounted in the housing 60 so that it can oscillate under the influence of positive pneumatic pressure applied to the driving chamber. To that end the device includes an air inlet passage

88 and air outlet passage 90. Inlet passage 88 is connected to a source of air or other appropriate gas under pressure by an air inlet tube 92. Exhaust from the air outlet passage 90 may be communicated from the driving chamber by an exhaust tube 94. The air exhaust passage 90 leads from an exhaust port 96 which, in the illustrative embodiment, is located in registry with the center of the elastic element 66. Exhaust port 96 is arranged to communicate with the driving chamber 64. The diaphragm 66 is normally biased toward the exhaust port 96 so as to seal off the exhaust port from the driving chamber 64. In the embodiment illustrated in Figs. 1—4 the bias is accomplished by the elasticity of the diaphragm 66 and by providing a bearing member such as an upstanding wall 98 which surrounds the exhaust port 96 and over which the elastic diaphragm 66 is stretched. In this configuration of the device the height and location of the wall 98 is selected with respect to the manner in which the peripheral rim 72 of the diaphragm 66 is held in place. In the embodiment shown, the elastic diaphragm 66 is stretched into a dome shape and is maintained under an elastic tension which biases the diaphragm 66 toward the exhaust port 96 to close the port 96. Thus, in the embodiment shown in Figs. 1—4 the driving chamber 64 may be considered as somewhat annularly shaped, being bounded by the wall 98, the surface of the elastic diaphragm 66 and the surface 100 of housing section 70. The air inlet passage 88 communicates with the driving chamber 64 at an air inlet port 102 which opens through the wall surface 100 of the housing section 70.

The operation of the foregoing embodiment is illustrated with further reference to Figs. 3 and 4. The system first is primed so that fluid to be pumped completely fills the flow path from the reservoir, through the inlet tube 78, pump chamber 62 and outlet 82, 84. Priming is accomplished easily by opening the throttle valve 86 and allowing the liquid to flow, by gravity or under light pressure through the system. Once primed the throttle valve is closed in readiness for pumping operation. In the ejection stroke of the cycle pneumatic pressure is applied at air inlet tube 92. As the pressure builds up within the driving chamber 64 the elastic diaphragm 66 expands to form a domed annular configuration suggested diagrammatically in Fig. 3 in some exaggeration for purposes of clarity of illustration. The pressure built up within the driving chamber 64 is applied, through the diaphragm, to the fluid in the pumping chamber 62 thereby ejecting fluid through the outlet 76. The volume of fluid pumped in the ejection stroke is equal to the difference in volume in the driving chamber from its relaxed (Fig. 1) position to its position of maximum expansion (Fig. 3). The maximum expansion, as well as the force in the ejection stroke can be controlled and varied as will be described further below.

The ejection stroke continues as long as the flexible resilient element remains biased in sealed

relation against the exhaust port 96. In the embodiment shown in Figs. 1—4 in which the member 66 is an elastic diaphragm, biasing force is created by the inherent elasticity of the diaphragm and the manner in which it is stretched over the rim of the wall 98 which surrounds and defines the exhaust port 96. The central portion of the diaphragm which makes the seal against the rim of the wall 98 maintains that seal until the remaining portion of the diaphragm 66 has been flexed and expanded to a point in which the opening force applied to the central portion of the diaphragm by the expanding peripheral portions of the diaphragm exceeds the biasing force. The central portion of the diaphragm is maintained in seated sealed relation against the rim of the wall 98 not only under the influence of the bias of the elastic diaphragm but also under the influence of a pulse of increased pressure applied to the fluid in the pumping chamber. Thus, as the diaphragm expands into the annular dome-shaped configuration illustrated in Fig. 3 the pressure pulse applied to the liquid in the pumping chamber forces the central portion of the diaphragm more firmly into seated engagement on the rim of the wall 98. That additional pressure enables the diaphragm to expand to the annular domed configuration shown in Fig. 3, in which the central portion of the diaphragm remains depressed, in a dimpled configuration with respect to the annular expanding portion of the diaphragm during a portion of the ejection stroke. In this regard it should be noted that the impedance in the outlet line also has an effect on the timing of the unseating of the diaphragm from the air outlet port. The impedance of the outlet should be great enough to allow sufficient pressure to build up within the pumping chamber so as to maintain the central portion of the diaphragm in sealing engagement on the outlet port for a time sufficient to enable a desired volume of liquid to be pumped during the pumping stroke. As the ejection stroke nears completion the stretched diaphragm abruptly unseats the central portion of the diaphragm from its sealing engagement with the rim of the wall 98.

At the moment that the sealed, central portion of the diaphragm abruptly unseats from the rim of the wall 98 the elastic diaphragm immediately assumes a more uniform dome shape as suggested in Fig. 4 under the influence of the equalization of the internal elastic forces in the diaphragm. The internal elastic forces within the diaphragm 66 cause the diaphragm to contract which draws the diaphragm down into sealing engagement with the rim of the wall 98.

During the elastic contraction of the diaphragm the air which was in the driving chamber 64 is exhausted immediately and rapidly through exhaust port 96, air outlet passage 90 and exhaust tube 94. The immediate and rapid exhaust from the driving chamber 64 is assured by providing substantially larger outlet passages than those associated with the air inlet. Thus, outlet port 96, air outlet passage 90 and exhaust tube 94 are

arranged so as to prevent a minimum of back pressure which might impede rapid exhaust of air from the driving chamber.

In order to assure that the diaphragm will collapse rapidly it is important that the impedance in the air outlet line is substantially less than that in the air inlet. This may be accomplished by selectively proportioning the flow areas of the air inlet and air outlet. If desired, a fixed or variable flow restrictor (suggested diagrammatically at 95 in Fig. 2) can be placed at the air inlet. Use of a flow restriction device 95 at the air inlet also prevents development in the driving chamber of too high pressures and inlet flow rates which could stall the diaphragm in the open, domed configuration. The flow impedance in the fluid line 82 outlet should be greater than the flow impedance at the fluid inlet 74, including the effect of the inlet check valve 80.

As mentioned above it is not necessary to use a check valve in the fluid outlet. During the filling stroke, the contraction of the diaphragm reduces the pressure in the pumping chamber. Fluid is drawn in through the inlet 74 and check valve 80 at the inlet. Although there is no check valve in the outlet line the filling stroke does not draw liquid back into the pump chamber. That is believed to result from the inertial effect of the liquid flowing through the outlet during the pumping stroke. When the diaphragm abruptly unseats and substantially immediately begins to contract in a filling stroke, the action is too abrupt to decelerate and reverse the flow of the liquid flowing in the outlet tube. Additionally the inertial effect of the water in the outlet tube is affected by the length of the outlet tube as well as the impedance of the inlet check valve. The length of the outlet tube preferably should be great enough to present a substantial impedance to reverse flow. A tube at least one foot (30 cm) long and as long as about eight feet (244 cm) or more is satisfactory.

The throttling control 86 affects the frequency of pulsation as well as the pulse strength (the velocity of the emitted fluid jet). As the throttle valve is opened the frequency of the pulses increases and the velocity of the pulses increases.

Operation of the device is controlled manually by the user by controlling the throttle valve 86. When the valve is closed there is no flow through the system. As the valve is opened, the resulting differential pressure across the diaphragm initiates the pumping cycle. The cycle will repeat automatically and continuously as long as the throttle valve remains open. The delivery rate, exit velocity and pulse frequency increase from zero when the valve is fully closed to progressively higher values as the valve is fully opened.

An alternative mode of control can be achieved by regulating the air pressure at the inlet, as by a suitable throttling valve in the inlet line.

Figure 5 illustrates the manner in which a device in accordance with the invention may be incorporated into a fluid delivery system, for example as may be used in an operating room to

clean wounds, for debridement or to clear away bone chips or fragments as is common in orthopedic surgical procedures. The system includes the pump, indicated generally at 60. The pump 60 is connected to the air inlet tube 92 which may have a fitting 122 at its end for connection to an appropriate source of air or gas under pressure. The pump 60 also has a main outlet tube 94 connected as described above. The outlet tube 94 may be provided with a muffler chamber 126. The air outlet and inlet tubes 94, 92 may be bound together in a common harness as suggested at 126. The fluid outlet tube 82 is connected to the pump 60 in the manner described above. In this embodiment the inlet to the pump 60 may take the form of a hollow needle 128 which is adapted to pierce or otherwise connect with the bottle or other prepackaged reservoir of fluid to be pumped, indicated at 130 in Figure 5. The reservoir of 130 preferably may have a connector of puncturable neck indicated at 132 to receive the needle 128 and establish communication between the reservoir 130 and the pump inlet. The reservoir 130 may be suspended overhead to facilitate priming of the device under the influence of gravity by opening the throttle valve. The throttle valve preferably is incorporated into a handle 134 at the distal end of the outlet tube 82.

The device conveniently may be associated with a suction system for suctioning fluid away from the surgical site by mounting or incorporating the nozzle with a suction handle, thereby providing irrigating fluid and suction in a single composite device.

Figures 6—9 illustrate, somewhat diagrammatically, a pump having an integral needle 128 as may be used in a system described in connection with Figure 5. In this embodiment the pump housing has two sections including a pump section 136 and a pneumatic driving section 138. As with the previously described embodiments, the pump section 136 and pneumatic drive section 138 are secured together and in a manner which captures the periphery of the flexible resilient element 66. In the embodiment shown in Figures 6—9 the pneumatic drive section includes the air inlet tube 92 and air outlet 94 which operated in the manner as described above. The pump includes an outlet tube 82 similarly operating in the manner described above in connection with the previous embodiments. The inlet to the pump section may include a fitting, indicated at 140 shown in greater detail in Figure 9. Fitting 140 is formed from an appropriate material and includes a hollow needle 128. The needle 128 may be formed integrally with a hub 142 secured to the pump section 136. The hub 142 may include a one-way check valve 144. Check valve 144 may take any of a variety of well known configurations such as a duckbill or flat valve.

Claims

1. A pulsatile pump operable to develop a filling

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Claims

1. A pulsatile pump operable to develop a filling



stroke and an ejection stroke, the pump comprising a housing, an elastic member (66) mounted within the housing to divide it into a first chamber (62) and a second chamber (64), the first chamber defining a pumping chamber having an inlet and outlet for the fluid to be pumped and the second chamber (64) defining a driving chamber and having a gas inlet (88) connectable to a source of gas under pressure and a gas exhaust port (94) normally closed by the elastic member but movable away from sealing engagement therewith to provide the ejection stroke on supply of said gas under pressure to the second chamber characterised in that a raised wall (98) is provided about the exhaust port (96), the elastic member (66) being stretched over the rim of the raised wall (98) to bias it closed against the exhaust port (96) whereby the filling stroke is effected solely by the resilience of the elastic member (66).

2. A pump as claimed in claim 1 characterised in that the exhaust port (96) and exhaust lines associated therewith have a lower flow impedance than that of the gas inlet.

3. A pump as claimed in claim 2 characterised by a variable flow restrictor (95) for varying the flow rate at the gas inlet (92).

4. A pump as claimed in any preceding claim characterised in that a check valve (180) is provided in the flow path for the first chamber (62) for directing unidirectional flow along said flow path.

5. A pump as claimed in claim 4 characterised in that the check valve (80) is located at least at the inlet (74) to the first chamber (62).

6. A pump as claimed in claim 5 characterised in that a valve (86) is additionally provided in the outlet (82) to the first chamber (62).

7. A pump as claimed in claim 4 characterised in that the outlet (76) from the first chamber (62) includes an outlet tube (82) of sufficient length that it may contain a volume of fluid large enough so that when the elastic member (66) abruptly begins the filling stroke the inertial effect of the mass of fluid in the outlet tube (82) will be great enough to prevent reverse flow of liquid in the tube during the filling stroke whereby the first chamber (62) will fill from liquid from the inlet (74), the check valve (80) in the inlet having a lower impedance than that defined by the elongate outlet tube (82).

8. A pump as claimed in any preceding claim characterised in that the gas outlet (96) defines a relatively large flow area in comparison to the gas inlet (102) whereby the flow impedance at the gas outlet (96) will be substantially less than the flow impedance at the gas inlet (102).

9. A pump as claimed in any preceding claim characterised by means for connecting the housing to a source (130) of fluid to be pumped, said connecting means comprising a connector tube (128) secured to the pump housing (60) and adapted to be connected to said source of fluid.

10. A pump as claimed in claim 9 characterised in that the connector tube (128) comprises a hollow needle adapted to pierce a container reservoir for such fluid.

Patentansprüche

1. Pulsierende Pumpe, die im Betrieb einen Füllhub und einen Ausstoßhub ausführt, wobei die Pumpe ein Gehäuse und ein elastisches, innerhalb des Gehäuses angeordnetes Bauteil (66) zur Aufteilung des Gehäuses in eine erste Kammer (62) und eine zweite Kammer (64) aufweist, wobei die erste Kammer eine Pumpenkammer mit einem Einlaß und einem Auslaß für die zu pumpende Flüssigkeit abgrenzt und die zweite Kammer (64) eine Antriebskammer abgrenzt, sowie einen an eine Druckgasquelle anschließbaren Eingang (88) für das Gas und eine Gasauslaßöffnung (94) aufweist, die normalerweise durch das elastische Bauteil abgeschlossen ist, das aber zur Durchführung des Ausstoßhubs bei einer Zufuhr des Druckgases zu der zweiten Kammer aus der dichtenden Anlage davon wegbewegbar ist, dadurch gekennzeichnet, daß eine erhöhte Wand (98) um die Auslaßöffnung (96) herum angeordnet ist, wobei das elastische Bauteil (66) über den Rand dieser erhöhten Wand (98) ausgedehnt ist, um es dicht gegen die Auslaßöffnung (96) vorzuspannen, wobei der Füllhub ausschließlich durch die Spannkraft des elastischen Bauteils (66) bewirkt wird.

2. Pumpe nach Anspruch 1 gekennzeichnet dadurch, daß die Ausstoßöffnung (96) und die zugeordnete Ausstoßleitung einen niedrigeren Strömungswiderstand als der des Gaseinlasses aufweisen.

3. Pumpe nach Anspruch 2 gekennzeichnet durch einen variablen Strömungsbegrenzer (95) zur Veränderung der Durchflußrate am Gaseinlaß (92).

4. Pumpe nach irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß ein Rückschlagventil (80) im Strömungsweg für die erste Kammer (62) vorgesehen ist, um die Strömung in eine Richtung entlang des Strömungsweges zu leiten.

5. Pumpe nach Anspruch 4, dadurch gekennzeichnet, daß das Rückschlagventil (80) zumindest an dem Eingang (74) zu der ersten Kammer (62) angeordnet ist.

6. Pumpe nach Anspruch 5, dadurch gekennzeichnet, daß zusätzlich ein Ventil (86) im Auslaß (82) zur ersten Kammer (62) vorgesehen ist.

7. Pumpe nach Anspruch 4, dadurch gekennzeichnet, daß der Auslaß (76) von der ersten Kammer (62) einen Auslaßschlauch (82) von ausreichender Länge aufweist, daß er ein Flüssigkeitsvolumen aufnehmen kann, das groß genug ist, so daß, wenn das elastische Bauteil (66) schlagartig den Füllhub beginnt, der Trägheitseffekt der Flüssigkeitsmasse in dem Auslaßschlauch (82) groß genug sein wird, um einen Rückstrom der Flüssigkeit in dem Schlauch während des Füllhubes zu verhindern, wobei die erste Kammer (62) über den Einlaß (74) mit Flüssigkeit gefüllt wird, wobei das Rückschlagventil (80) im Einlaß einen kleineren Widerstand aufweist als der Widerstand, den der langausgestreckte Auslaßschlauch (82) aufweist.

8. Pumpe nach irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der



Gasauslaß (96) einen verhältnismäßig großen Durchflußbereich im Vergleich zu dem Gaseinlaß (102) definiert, wodurch der Strömungswiderstand an dem Gasauslaß (96) wesentlich kleiner ist als der Strömungswiderstand an dem Gaseinlaß (102).

9. Pumpe nach irgendeinem der vorhergehenden Ansprüche, gekennzeichnet durch Mittel zum Anschluß des Gehäuses an eine Quelle (130) einer zu pumpenden Flüssigkeit, wobei diese Anschlußmittel ein Anschlußrohr (128) umfassen, das sicher an dem Pumpengehäuse (60) befestigt und mit der Flüssigkeitsquelle verbunden werden kann.

10. Pumpe nach Anspruch 9, dadurch gekennzeichnet, daß das Anschlußrohr (128) eine Hohl-nadel aufweist, die so ausgebildet ist, daß sie einen Sammelbehälter für eine solche Flüssigkeit durchstoßen kann.

Revendications

1. Pompe pulsatoire pouvant fonctionner de manière à présenter une course de remplissage et une course d'éjection, la pompe comprenant un carter, un élément élastique (66) monté à l'intérieur du carter de manière à le subdiviser en une première chambre (62) et une seconde chambre (64), la première chambre définissant une chambre de pompage possédant une entrée et une sortie pour le fluide devant être pompé et la seconde chambre (64) définissant une chambre d'entraînement et possédant une entrée (88) pour un gaz, pouvant être raccordée à une source de gaz sous pression, et un orifice (94) d'évacuation du gaz, normalement fermé par l'élément élastique, mais pouvant être écarté de son application étanche contre cet élément de manière à permettre la course d'éjection lors de l'envoi dudit gaz sous pression à la seconde chambre, caractérisée en ce qu'une paroi verticale (98) est prévue autour de l'orifice d'évacuation (96), l'élément élastique (66) étant tendu par-dessus le bord de la paroi verticale (98) de manière à être repoussé contre l'orifice d'évacuation (96) pour fermer ce dernier, ce qui a pour effet que la course de remplissage est obtenue uniquement sous l'effet de l'élasticité de l'élément élastique (66).

2. Pompe selon la revendication 1, caractérisée en ce que l'orifice d'évacuation (96) et les canalisations d'évacuation associées à cet orifice présentent une résistance d'écoulement inférieure à celle de l'entrée du gaz.

3. Pompe selon la revendication 2, caractérisée par un dispositif (95) réalisant un étranglement variable de l'écoulement, servant à modifier le débit au niveau de l'entrée du gaz (92).

4. Pompe selon l'une quelconque des revendications précédentes, caractérisée en ce qu'une soupape antiretour (80) est disposée dans le trajet d'écoulement prévu pour la première chambre (62) de manière à envoyer un écoulement unidirectionnel le long dudit trajet d'écoulement.

5. Pompe selon la revendication 4, caractérisée en ce que la soupape antiretour (80) est disposée au moins dans l'entrée (74) de la première chambre (62).

6. Pompe selon la revendication 5, caractérisée en ce qu'une soupape (86) est prévue en supplément dans la sortie (82) de la première chambre (62).

7. Pompe selon la revendication 4, caractérisée en ce que la sortie (76) de la première chambre (62) comporte un tube de sortie (82) possédant une longueur suffisante pour qu'il contienne un volume de fluide suffisamment important pour que, lorsque l'élément élastique (66) commence brusquement la course de remplissage, l'effet d'inertie de la masse du fluide dans le tube de sortie (82) soit suffisamment élevé pour empêcher un écoulement inverse de liquide dans le tube pendant la course de remplissage, ce qui a pour effet que la première chambre (62) se remplit du liquide arrivant par l'entrée (74), la soupape antiretour (80) située à l'entrée possédant une impédance inférieure à celle définie par le tube de sortie allongé (82).

8. Pompe selon l'une quelconque des revendications précédentes, caractérisée en ce que la sortie du gaz (96) définit une zone d'écoulement relativement étendue par rapport à l'entrée du gaz (102), ce qui a pour effet que l'impédance d'écoulement au niveau de la sortie du gaz (96) est nettement inférieure à l'impédance d'écoulement à l'entrée du gaz (102).

9. Pompe selon l'une quelconque des revendications précédentes, caractérisée par des moyens servant à raccorder le carter à une source (130) d'un fluide devant être pompé, lesdits moyens de raccordement comprenant un tube de raccordement (128) fixé au carter (60) de la pompe et apte à être raccordé à ladite source de fluide.

10. Pompe selon la revendication 9, caractérisée en ce que le tube de raccordement (128) comporte une aiguille creuse apte à perforer le réservoir d'un récipient contenant un tel fluide.

