GAS-OPERATED POSITIVE DISPLACEMENT PUMP

BACKGROUND OF THE INVENTION

This invention relates to gas-operated positive displacement pumps.

Gas-operated pumps are known in which gas under pressure moves a wall of a gas chamber against a liquid chamber to squeeze the liquid chamber and thus expel liquid through an outlet. In such gas-operated pumps, the gas is alternatively pressurized and depressurized to squeeze the liquid chamber and expel liquid through a check valve at an outlet port of the pump while the inlet port is blocked and then to permit the liquid chamber to expand so new liquid enters it through an inlet port and inlet check valve.

One prior art pump of this general class is disclosed in U.S. Pat. No. 4,295,801. This patent discloses a pump having an elongated cylindrical body with a reciprocating, gas-driven piston within it to pump liquid from a liquid chamber. In this prior art pump, the piston is driven by expansion of gas chambers and the movement of the piston in pumping liquid switches the pressurized gas from one gas chamber to another to drive the piston in a reciprocating motion.

This prior art type of gas-operated positive displacement pump has a disadvantage in that it is expensive and contains a large number of parts, any one of which may malfunction or clog.

Another prior art type of gas-operated pump of this class is disclosed in U.S. Pat. No. 4,489,779 in which air under pressure is applied directly to the walls of a liquid tube to squeeze it so that it expels fluid. This prior art pump has a central liquid tube which is alternately filled by the hydrostatic head of water surrounding the pump and squeezed to expel water.

This prior art type of pump has a disadvantage in that it only operates in a satisfactory manner when positioned at great depth such as 10 feet so that it has sufficient hydrostatic head to refill the squeezed fluid chamber.

Still another type of prior art pump has been sold by Isco, Inc., 531 Westgate Boulevard, Lincoln, Neb., under the designation, Model 2600 pump. In this pump, air under pressure is alternately applied and removed from a central silicone rubber tube which is circumscribed by a stainless steel cylinder. Water is admitted into a location between the stainless steel cylinder and the expandable silicone rubber so that the alternating pressurizing and relaxing of the silicone rubber pumps liquid out of the pump. Because the silicone rubber is stretched, it snaps back and draws liquid into the liquid compartment, thus enabling it to pump with low hydrostatic pressure surrounding the pump inlet.

The prior art type of pump has a disadvantage in that the elastomeric silicone rubber is not sufficiently inert or chemically unreactive and thus may be damaged by corrosive liquids or hydrocarbon based liquids present in the water being pumped. Also, the silicone rubber may absorb or adsorb some constituents of the water sample thus lowering their concentration in the sample. These constitutents may later desorb which would again give a non-representative concentration of those constituents in the sample taken.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to provide a novel gas-operated positive displacement pump.

It is a further object of the invention to provide a novel gas-operated pump which is capable of pumping while under low hydrostatic pressure.

It is a still further object of the invention to provide a novel gas-operated positive displacement pump in which the liquid chamber is composed entirely of inert materials.

It is a still further object of the invention to provide a novel gas-operated positive displacement pump which has high flow-rate capabilities and is still durable.

In accordance with the above and further objects of the invention, a gas-operated positive displacement pump includes: (1) a gas chamber having at least a portion of it formed of an elastomeric material; (2) a liquid chamber having one rigid side and one flexible side, with the flexible side being positioned adjacent to the elastomeric material of the gas chamber for movement toward and away from the rigid side; and (3) means for alternately changing the pressure from a high value to a low value within the gas chamber, whereby liquid is pumped from the liquid chamber. In this specification, elastomeric material is considered a material which can undergo a large percentage strain above 50 percent and typically 200 percent before the elastic limit is reached. Flexible material is a material which can fold or bend without breaking.

The area of the contacting surfaces of elastomeric material and the flexible wall of the liquid chamber is at least four square centimeters. The space between the elastomeric material and the flexible wall of the liquid chamber communicates an intermediate chamber through a check valve during expansion of the elastomeric materials. The intermediate chamber communicates with the gas chamber through a second check valve during contraction of the elastomeric material.

In another embodiment, an expandable membrane and a first end of a spring-biased stainless steel piston extend into the chamber of a water cylinder and a second end of the piston extends into a gas chamber. The second end of the piston is moved by pressurized gas so that as gas pressure changes in the gas chamber, the piston moves upwardly and downwardly to pull and push the membrane and thus to pump liquid.

From the above description, it can be understood that the gas-operated positive displacement pump of this invention has several advantages such as: (1) it is simple in construction, containing few movable parts; (2) it is capable of high rates of pumping; (3) it is durable with few wearing parts; (4) it is capable of pumping liquid while only immersed to a shallow depth since it is capable of drawing liquid into the liquid chamber as well as forcing liquid out of the liquid chamber; and (5) the liquid chamber may be composed of inert materials such as stainless steel or polytetrafluoroethylene.

SUMMARY OF THE DRAWINGS

The above noted and other features of the invention will be better understood from the following detailed description when considered with reference to the accompanying drawings in which:

FIG. **1** is a block diagram of a pumping system in accordance with the invention;

FIG. **2** is a schematic diagram showing one manner in which the pumping system of FIG. **1** is utilized;