Sept. 23, 1958 J. N. BRUCE 2,853,024

PUMP FOR CORROSIVE AGENTS

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Fig. 1.

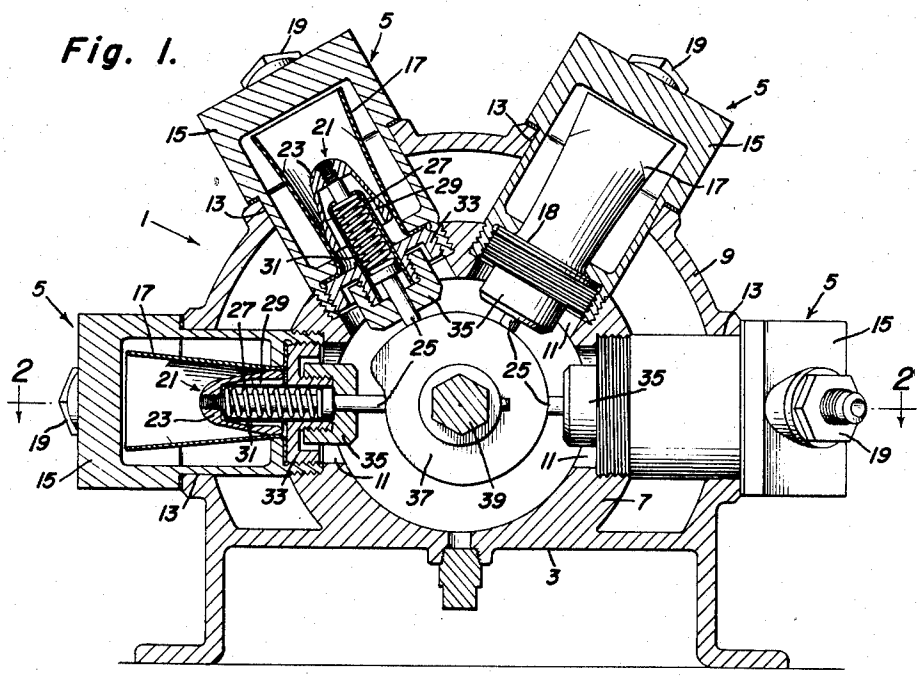
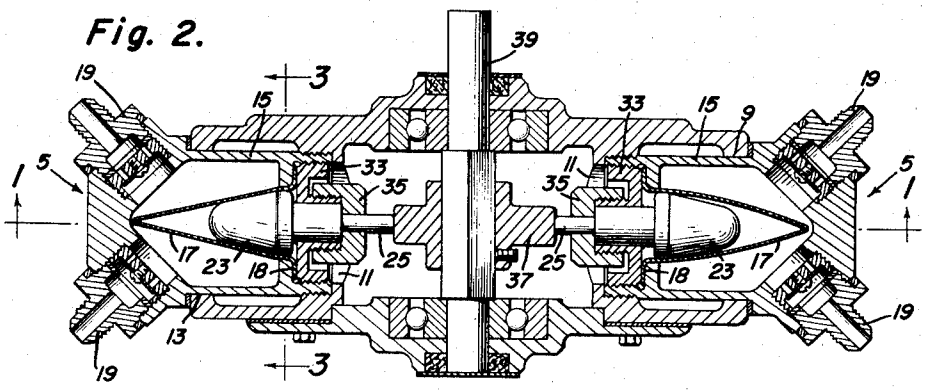


Fig. 2.



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Fig. 3.

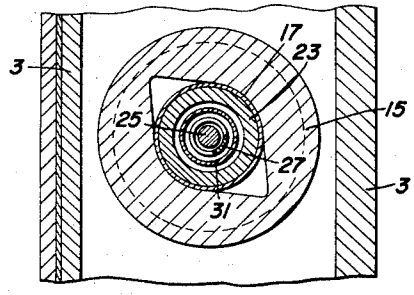


Fig. 4.

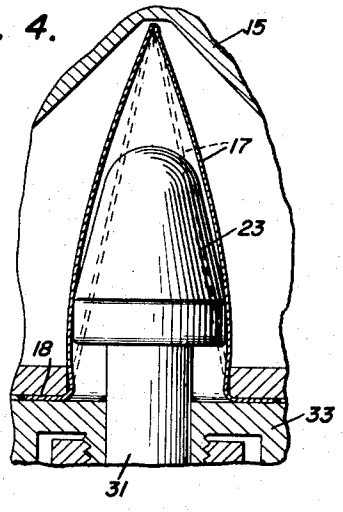


Fig. 6.

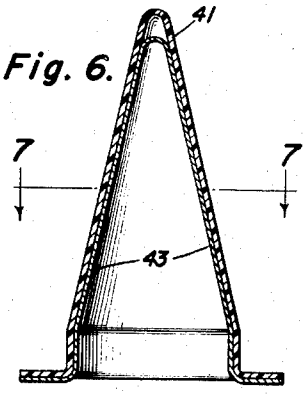


Fig. 5.

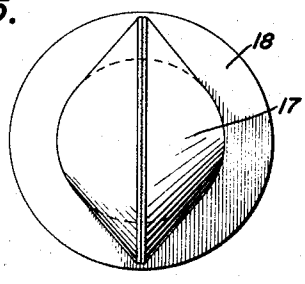
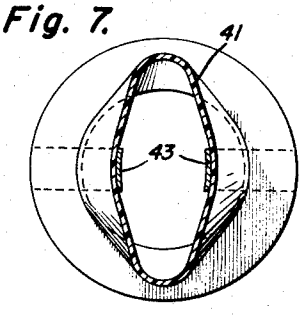


Fig. 7.



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PUMP FOR CORROSIVE AGENTS

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7 Claims. (Cl. 103—148)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment to me of any royalty thereon.

This invention relates to pumps and in particular to a plunger-diaphragm pump especially suitable for use with corrosive agents.

Leakage is a common problem encountered in pumping. Where the agent is a corrosive one this problem is greatly enhanced. Diaphragm type pumps have been used successfully to prevent leakage when pumping highly penetrative agents. Elastic type diaphragms have been used which are stretched by a plunger thereby changing the volume within the pumping chamber and resulting in a pumping action. However, the constant expansion and contraction of the diaphragm by stretching results in fatigue of the material and thereby diaphragm deterioration.

It is an object of this invention to provide a diaphragm pump which can be used to pump any fluid and in particular fluids of a corrosive nature.

It is also an object of this invention to provide a pump with a flexible diaphragm which will not deteriorate excessively and which can employ diaphragms made of any one of numerous flexible materials.

It is a further object to provide a pump in which the cylinder units can be quickly and easily replaced and the capacity easily varied.

Another object of this invention is to prevent or minimize leakage problems in a pump especially when handling corrosive agents.

Further objects and advantages of the invention will be apparent from the following description.

Fig. 1 is a sectional elevational view of a pump along line 1—1 of Fig. 2.

Fig. 2 is a sectional plan view of the pump taken along line 2—2 of Fig. 1.

Fig. 3 is a partial sectional view along line 3—3 of Fig. 2.

Fig. 4 is a partial sectional view of the plunger and diaphragm.

Fig. 5 is a plan view of the diaphragm shown in Fig. 4.

Fig. 6 is a sectional view showing a modification of the diaphragm.

Fig. 7 is a sectional view of the modification taken along line 7—7 of Fig. 6.

Referring to Figs. 1 and 2, the pump, generally designated as 1, comprises a body member 3 which supports cylinder units generally designated as 5. The body member 3 is shown as having in internal portion 7 and external portion 9, each portion being provided with bores 11 and 13 respectively for reception of the cylinder units 5. The external portion 9 of the body provides added support for the cylinder units and can be dispensed with where such support is not required.

A cylinder unit 5 consists of an outer shell 15 and a flexible diaphragm 17, having a flange 18, welded or otherwise secured together to form a closed cavity between them. Fig. 4 best shows a preferred manner in which these members are joined. Suction and discharge valves 19 are located at one end of shell 15. Such valves are a common type and will not be described. The opposite end of shell 15 is threaded internally and exteriorly. The exterior threads serve to hold the cylinder unit in the body 3 by engaging a threaded portion of bore 11. The remainder of the cylinder unit consists of a plunger assembly generally designated as 21.

The diaphragm 17 is circular at the plunger entrance end and flat at the other end, forming a tube similar in shape to a "toothpaste" tube, whose cross section is elliptical in shape at an intermediate section. The periphery of the diaphragm is substantially the same from end to end. The shape of the diaphragm is predicated on the fact that a perimeter of a certain length encloses the greatest area when that perimeter is the circumference of a circle. Any other area of another shape such as an ellipse enclosed by a perimeter of the same length is smaller. The importance of this shape will be seen further in the description.

The plunger assembly 21 consists of a plunger head 23 fastened to push rod 25. A spring 27 encloses push rod 25 and extends into an opening 29 in the plunger head. A spring housing 31 encloses the spring and push rod and also extends into the plunger head. Retainer nut 33 is welded or otherwise secured to the spring housing 31. The outer surface of the retainer nut is threaded so as to engage the inner threads of shell 15. Cap 35 contains a bore through which one end of the push rod extends. The cap is threaded internally to engage a central threaded portion of retainer 33 thereby holding the plunger assembly in place.

Pressure on the free end of push rod 25 forces the plunger into the diaphragm 17 causing its cross section to change from elliptical to circular, thus reducing the volume in the housing cavity since the diaphragm increases its volume by having a circular cross section, which, as seen previously, has a greater area for a given perimeter than any other area with the same perimeter. As the pressure is relieved on the push rod, the spring 27 returns the plunger head 23 to its original position and the diaphragm 17 returns to its original elliptical shape thereby again enlarging the housing cavity. This breathing action of the diaphragm 17 causes the suction and discharge valve to operate producing a flow of gas or liquid through the cylinder.

Figs. 1 and 2 show the pump assembly with a plurality of cylinder units operated in sequence by a smooth return cam 37 mounted on drive shaft 39. As the cam 37 rotates the cylinders operate consecutively causing a constant and continuous flow through the pump when the suction and discharge valves are connected to conventional suction and discharge manifolds (not shown).

The diaphragm shown in Figs. 1, 2, 4, and 5 may be made of a corrosion resistant flexible metal or of a flexible metal, as spring steel, coated with a corrosion resistant synthetic resin.

In the modification shown in Figs. 6 and 7 the diaphragm consists of a corrosion resistant bag 41 with a flat U-shaped spring 43 inside to cause it to recover its ellipitical cross section when the plunger is withdrawn. This spring would also provide a wearing surface for the plunger head 23. The bag may be made of any one of numerous materials, such as flexible plastic, coated cloth, etc. This makes available a large number of materials, making it possible to handle a wide variety of fluids.

Since the outer shell 15 and the diaphragm 17 are welded together leakage cannot occur at this point or is at least kept to a minimum. However, a gasket is generally held against the flange 18 of the diaphragm 17 by retainer nut 33 in the event slight leakage occurs, as might result

from a defective weld. With the modification shown in Figs. 6 and 7 a gasket is used since the corrosition resistant bag cannot be welded to the shell.

A complete cylinder consisting of the outer shell 15, inlet and outlet valves 19, diaphragm 17, and plunger assembly 21, forms an integral unit. Interruption of pumping operations are thereby held to a minimum by replacing a defective cylinder unit with another unit while the defective one is being repaired. This can be done simply by shutting off the suction and discharge valves from their respective manifolds, breaking connections and removing the entire cylinder unit by disengaging the threaded shell from the threaded bore of the pump body. Then a new cylinder unit can be replaced and the connections restored without affecting operation of the other cylinder units. Thus operation continues with only a slight decrease in capacity.

Capacity of the pump can be changed by varying the size of the cylinders or by varying the number of cylinder units in operation on one pump body. It can also be varied by replacing the cam. By employing cams of different configurations the plungers may be given strokes of different lengths.

Capacity can also be increased by having a series of the pump units 1 driven by a common drive shaft.

I claim:

1. A pump cylinder unit comprising an outer shell; a flexible member of substantially uniform periphery throughout its length within said shell and forming a closed cavity with the walls of said shell, said flexible member being closed flat at one end, open at the other end and having a circular cross section at said open end, and continuously changing shape from said open end to said closed end; inlet and outlet means attached to said outer shell and communicating with said cavity; a plunger having a leading edge and a trailing edge within said flexible member, said plunger tapering from said trailing edge to said leading edge and having a circular cross section at said trailing edge, and means to reciprocate said plunger within said flexible member.

2. A pump cylinder unit as defined in claim 1 in which said flexible member is metallic.

3. A pump cylinder unit as defined in claim 1 in which said flexible member is a corrosion resistant metal.

4. A pump diaphragm comprising a flexible member of substantially uniform periphery throughout its length, closed flat at one end, open at the other end and having a circular cross section at said open end, and continuously changing shape from said open end to said closed end.

5. A pump diaphragm as defined in claim 4 in which said flexible member is a corrosion resistant metallic cylinder flattened at said closed end.

6. A pump diaphragm as defined in claim 4 in which said flexible member is a metallic cylinder flattened at said closed end and coated with a corrosion resistant synthetic resin.

7. A pump diaphragm comprising a corrosion resistant bag of substantially uniform periphery throughout its length, open at one end and having a circular cross section at said open end, closed flat at the other end and continuously changing shape from said open end to said closed end thereby having an elliptical shape at its midpoint, and a flat U-shaped spring within said bag to retain the shape of said bag.

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