United States Patent [19]

Hartley

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[45] **Nov. 19, 1974**

[54] **PUMP**

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[52] **U.S. Cl.** **417/203**, 417/536

[51] **Int. Cl.** **F04b 1/00**

[58] **Field of Search** ..... 417/201, 203, 205, 534, 417/536, 273, 566, 465, 413, 470, 471, 472, 479, 566 C, 273 O, 273 R; 92/98, 99, 100; 74/18.2

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Primary Examiner—William L. Freeh
Assistant Examiner—Gregory Paul LaPointe
Attorney, Agent, or Firm—Gordon L. Peterson

[57] **ABSTRACT**

A pump including a variable volume chamber having an inlet and an outlet, a cam mounted for rotation in communication with the inlet, and a shuttle block driven by the cam for alternately increasing and reducing the volume of the chamber. The cam has a surface which selectively blocks and unblocks flow through the inlet to thereby provide valving for the inlet. The cam may be configured so as to form an impeller for supplying fluids under pressure to the variable volume chamber, in which event the cam serves not only as a cam but also as an inlet valve and an impeller.

6 Claims, 6 Drawing Figures

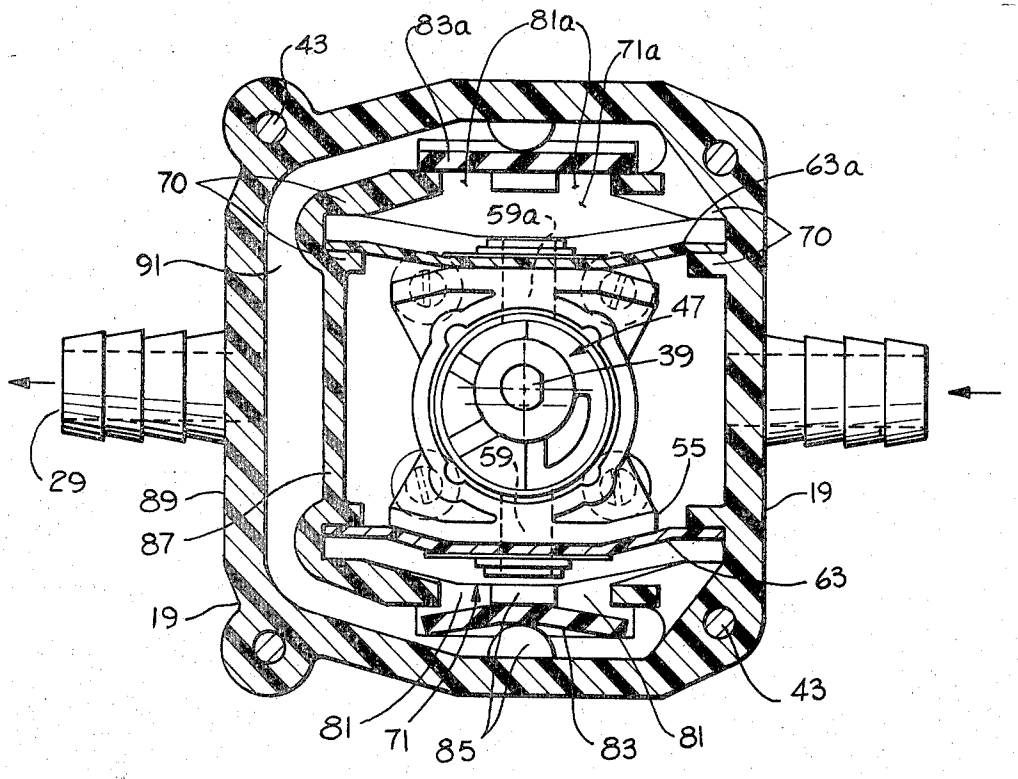


Fig. 1

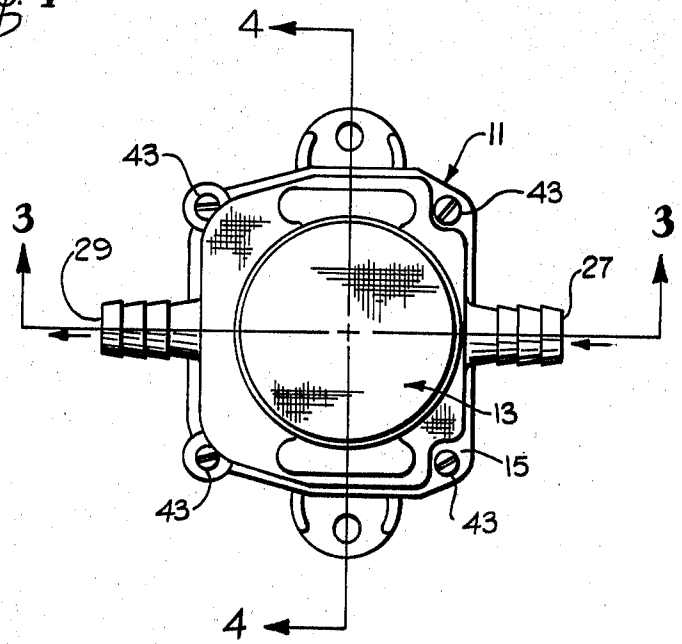


Fig. 2

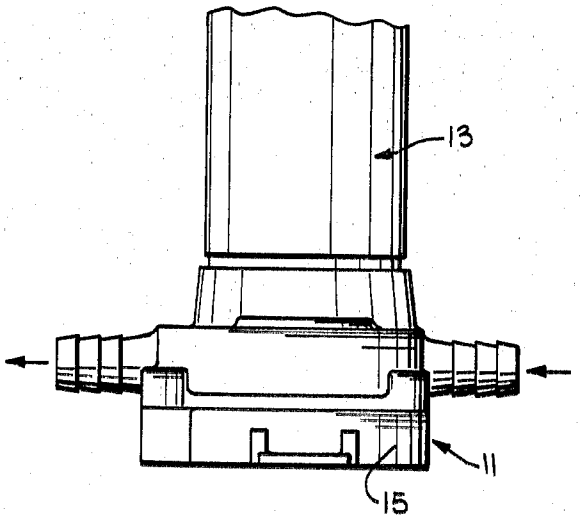


Fig. 3

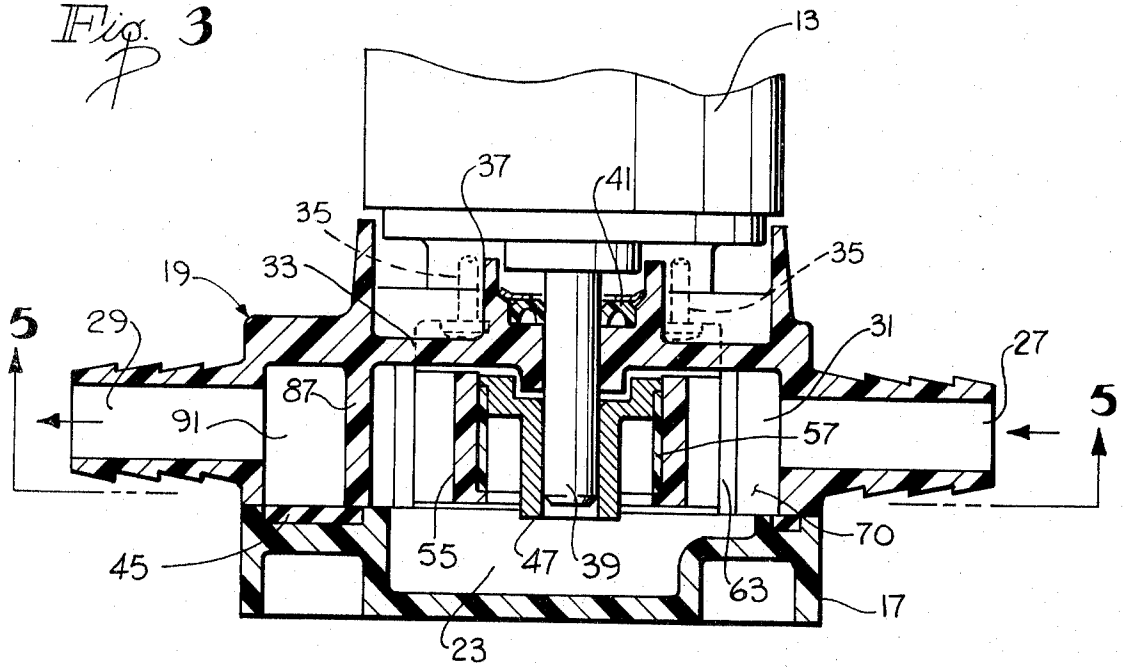

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Fig. 4

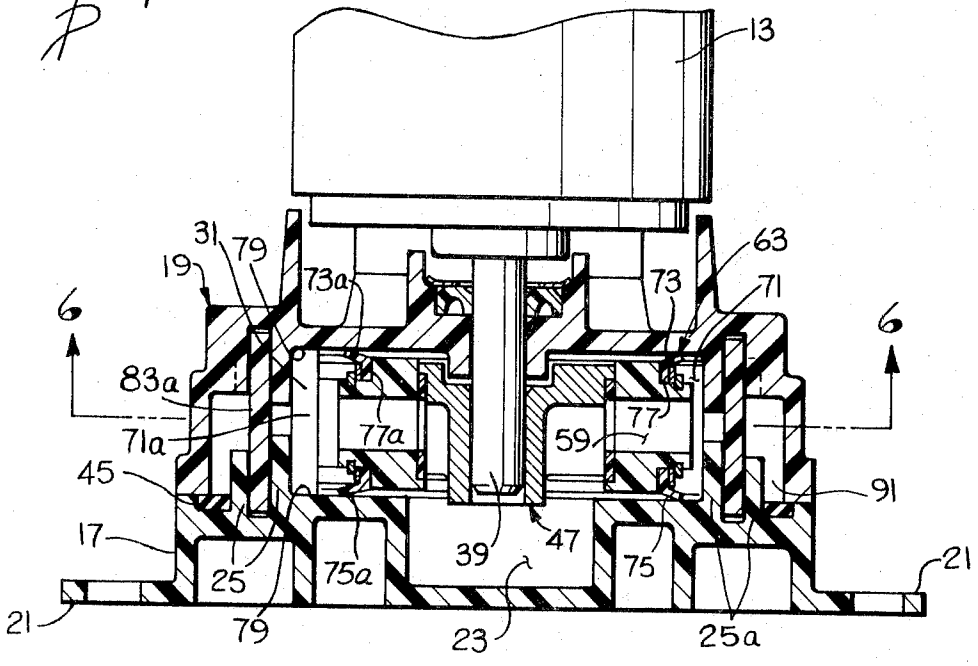

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31
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73a
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71a
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25a

Fig. 5

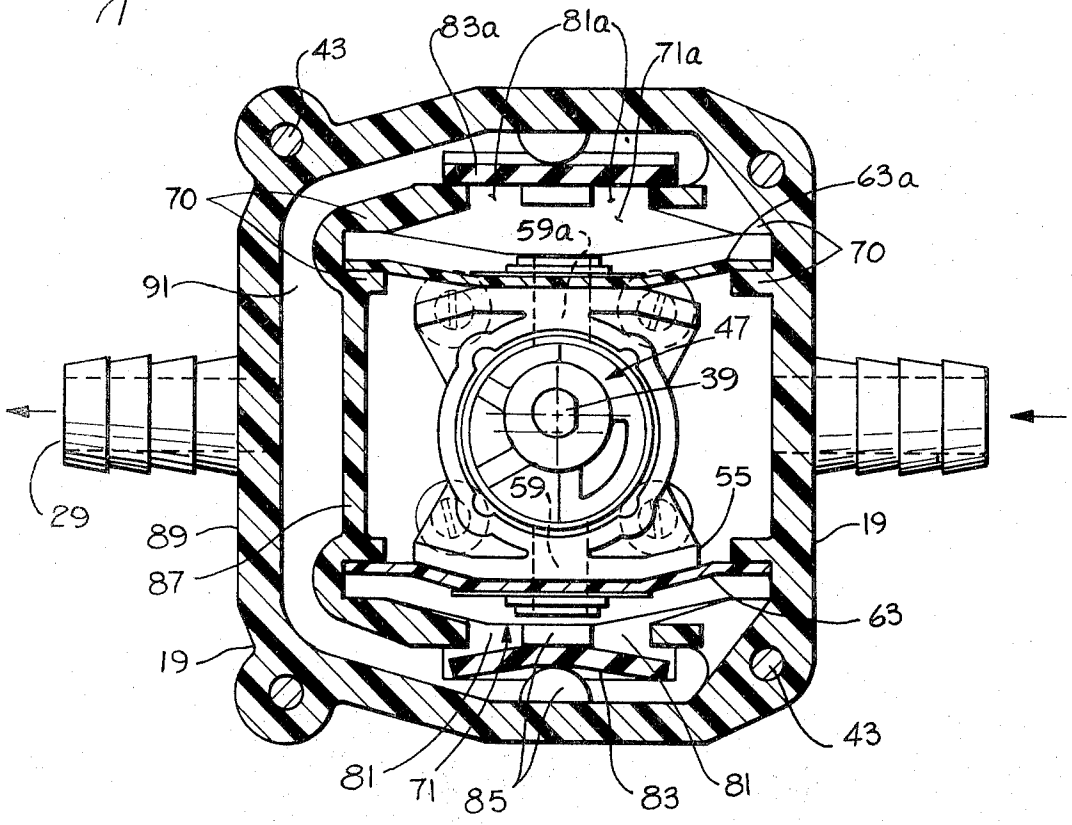
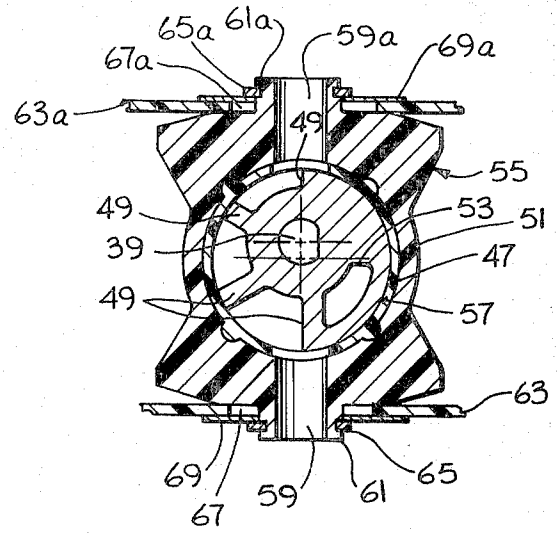

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83a
81a
71a
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63a
59a
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43
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Fig. 6


65a
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59a
69a
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PUMP

BACKGROUND OF THE INVENTION

Both positive displacement pumps and centrifugal pumps possess certain advantages and disadvantages. For example, a positive displacement pump produces relatively high discharge pressure and is self priming. On the other hand, a positive displacement pump is usually noisy and relatively expensive, cannot accommodate dirt, and requires relatively close tolerances. Centrifugal pumps are not generally subject to these disadvantages, but they are difficult or impossible to prime and do not produce high discharge pressures.

SUMMARY OF THE INVENTION

The present invention provides a novel pump which generally possesses the advantages of both positive displacement pumps and centrifugal pumps without the attendant disadvantages. This pump combines a positive displacement pumping action with loose tolerances and quiet operation. The pump of this invention is relatively inexpensive, is self-priming, and can accommodate reasonable amounts of dirt and practiculate matter.

The features of this invention can advantageously be embodied in a pump of the type which includes one or more chambers of variable volume. The chamber has an inlet through which fluid can flow into the chamber and an outlet through which fluid can be expelled from the chamber. The variable volume chamber has a movable wall for varying the volume of the chamber. On the suction stroke, the movable wall is moved to increase chamber volume, and on the discharge stroke the movable wall is moved to reduce chamber volume.

One feature of this invention is to employ a cam or eccentric to drive the movable wall and to use a surface of the cam to provide a valving action. To accomplish this the cam can advantageously be mounted for rotation and be drivingly connected to the movable wall so that rotation of the cam imparts a reciprocatory movement to the movable wall. For example, a shuttle block may partially circumscribe the cam and serve as at least one of the members drivingly connecting the cam to the movable wall. A passage in the shuttle block provides communication between the cam and the inlet. The cam surface is appropriately configured so that it also provides an inlet valve function for the chamber by selectively blocking and unblocking the flow through the passage of the shuttle block to the inlet to the chamber.

Another advantage of this invention is that the shuttle block may fit loosely on the cam and no close tolerances are required. The reason is that when the cam surface is forcibly engaging the shuttle block to drive the latter to cause a decrease in chamber volume, the inlet to the chamber must be closed. During this time, there is inherently tight sliding engagement between the cam surface and the shuttle block to thereby provide tight closure of the passage in the shuttle block which leads to the inlet.

Another feature of the invention is to provide an impeller as part of the pump for providing fluid under a positive pressure to the chamber. The impeller serves, in effect, as a supercharger to supply fluid at some positive pressure to the chamber. This provides for more

complete filling of the chamber and therefore a greater pumping volume.

The impeller can be combined with either or both of the cam or the inlet valve. To combine the impeller with the cam, the cam is partially cut away to provide impeller vanes around a preselected portion of the cam. Thus, a single element may serve as a cam, an inlet valve for the variable volume chamber, and an impeller, or any combination of these three.

The pump can be constructed at relatively low cost. To this end, the pump contains very few parts and many of the parts are molded plastic parts. Another feature contributing to the low cost is the outlet valve for the chamber. The outlet valve may advantageously include a strip of resilient flexible material held between two projections on the pump housing. When pressure in the chamber reaches a predetermined magnitude, the resilience of the strip is overcome and the outlet is opened. The strip need not be attached with any of the usual fasteners, but it can be simply inserted into position between the two projections thereby facilitating assembly.

The pump may include any suitable number of variable volume chambers. If more than one variable chamber is provided, the shuttle block is appropriately configured to provide the desired number of inlet passages to the several chambers.

To facilitate construction and to provide a watertight chamber, the movable wall can advantageously take the form of a flexure member having a pair of flanges joined by a web to define a cup-shaped cross section which opens toward the interior of the chamber. In this manner, pressure within the chamber forces the flanges against the walls of the chamber to provide a tight seal as the flexure member reciprocates.

The invention can best be understood by reference to the following description taken in connection with the accompanying illustrative drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of a pump constructed in accordance with the teachings of this invention.

FIG. 2 is a front elevational view of the pump.

FIG. 3 is a fragmentary sectional view taken along line 3—3 of FIG. 1.

FIG. 4 is a fragmentary sectional view taken along line 4—4 of FIG. 1.

FIG. 5 is a sectional view taken generally along line 5—5 of FIG. 3 with the shuttle block and impeller being shown in bottom plan.

FIG. 6 is a fragmentary sectional view taken along line 6—6 of FIG. 4 and rotated 90° clockwise.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1 and 2 show a pump 11 constructed in accordance with the teachings of this invention. The pump is driven by a motor 13 of any suitable construction.

The pump 11 includes a housing 15. The housing 15, in turn, includes a lower housing section 17 and an upper housing section 19 (FIGS. 3 and 4). Each of the housing sections 17 and 19 in the embodiment illustrated is of intricate shape and molded of a suitable plastic material. Generally the lower housing section 17 includes a pair of flanges 21 for attaching the pump to a support (not shown). The lower housing section 17 defines an elongated generally rectangular well 23 and

has two pair of integral, spaced, upstanding projections 25 and 25a.

The upper housing section 19 includes a housing inlet 27 and a housing outlet 29 each of which is defined by a short conduit adapted for connecting the pump to external conduits (not shown). The upper housing section 19 defines a cavity 31 which communicates with the well 23. The housing section 19 has a transverse upper wall 33 on which the motor 13 is mounted in any suitable manner such as a plurality of screws 35. The upper wall 33 (FIG. 3) has an upstanding boss 37, and the motor 13 has a shaft 39 extending through the boss and sealed thereto in any suitable manner such as with a seal 41.

The housing sections 17 and 19 are interconnected in any suitable manner such as by screws 43 (FIG. 1). The housing sections are sealed against leakage by a resilient gasket 45 (FIG. 3).

An impeller 47 is suitably affixed to the shaft 39 of the motor 13 for rotation with the shaft. As best shown in FIGS. 5 and 6 the impeller includes a plurality of circumferentially spaced, radially extending, vanes 49 which define pockets therebetween. The impeller 47 is eccentrically mounted, and its periphery defines a cam surface 51. The vanes 49 extend around about one half of the circumferential periphery of the impeller 47 and the other one half of the periphery defines the cam surface 51. As viewed in FIG. 6, the vanes 49 are of progressively decreasing length in the clockwise direction from the 6 o'clock position to the 12 o'clock position. In the embodiment illustrated, the cam surface 51 is cylindrical; however, this contour can be varied depending upon the results desired. The impeller 47 also has a cutout region 53.

Circumscribing the impeller 47 is a shuttle block 55 which can be integrally molded from plastic material. The impeller 47 and the shuttle block 55 are radially spaced by an annular bearing 57, which is affixed to the shuttle block 55. The bearing 57 may be constructed of a suitable low friction plastic material such as Teflon. Passages 59 and 59a extend through the shuttle block 55 and the bearing 57 in the opposite radial directions.

The shuttle block 55 has integral flanged projections 61 and 61a extending in opposite directions therefrom. Central regions of flexer members 63 and 63a are connected to the projections 61 and 61a by C-shaped retainers 65 and 65a, respectively. Specifically, the flexer members 63 have centrally located slots 67 and 67a, respectively, which receive the flanged projections 61 and 61a to thereby allow relative lateral movement between the shuttle block 55 and the flexer members. To prevent the retainers 65 and 65a from falling into the slots 67 and 67a, thin retainer plates 69 and 69a are provided intermediate each of the flexer plates and retainers.

The opposite ends of the flexer members 61 and 61a are retained by pairs of spaced projections 70 (FIG. 5) molded integrally with the housing 15. The flexer member 63 cooperates with portions of the upper housing section 19 to define a variable volume chamber 71. Similarly, the flexer member 63a cooperates with portions of the upper housing section 19 to define a second variable volume chamber 71a. The variable volume chambers 71 and 71a are identical and, accordingly, corresponding parts of the variable volume chambers 71a are designated by corresponding reference numerals followed by the letter a. As shown in FIG. 4, the flexer member 63 has flanges 73 and 75 interconnected by web 77 which slidably engage opposed side walls 79 of the variable volume chamber 71. Thus, the flexer member 63 has a cup-shaped cross section which opens toward the interior of the chamber 71. As fluid pressure is developed within the chamber 71, it urges the flanges 73 and 75 outwardly against the wall 79 to form a tight seal.

The flexer member 63 is constructed of a resilient deformable material such as Teflon and forms a movable wall of the variable volume chamber 71. The passage 59 communicates with the chamber 71 and forms an inlet therefor. A pair of openings 81 define an outlet for the chamber 71. An outlet valve 83 which is normally in a closed position controls the flow of fluid out of the chamber 71. The outlet valve 83 in the embodiment illustrated is in the form of a resilient deformable strip retained between the projections 25 (FIG. 4) and between similar projections 85 formed in the upper housing section 19 (FIG. 5). When pressure within the chamber 71 increases to a predetermined level, it forces the valve 83 off of its seat to open the outlet 81 as shown in FIG. 5.

The upper housing section 19 has an interior wall 87. The interior wall 87 and a portion of the peripheral wall 89 of the upper housing section cooperate to define a discharge passage 91 which leads from the outlets 81 and 81a to the outlet 29.

In operation, the inlet 27 is connected to a source of fluid (not shown) and the outlet 29 can be connected to appropriate fluid components for receiving the fluid under pressure from the pump 11. The motor 13 is energized to rotate the shaft 39 and hence the impeller 47. Rotation of the impeller 47 causes three important functions to occur. First, the impeller 47, and in particular the cam surface 51 thereof, functions as a cam to move the shuttle block 55 along a path which defines a loop. The shuttle block 55 is moved both vertically and horizontally by the cam surface 51 and more particularly in an orbital motion. The vertical component of motion of the shuttle block 55 causes a central region of the flexer members 63 and 63a to reciprocate. The horizontal component of motion of the shuttle block 55 is accommodated by the slots 67 and 67a of the flexer members 63 and 63a and, accordingly, the shuttle block moves horizontally relative to the flexer members. The reciprocatory motion of the flexer members 63 and 63a cuases these members to cooperate with their chambers 71 and 71a to provide a positive displacement pumping action somewhat analogous to a diaphram pump. Specifically, the chambers 71 and 71a are alternately increased and reduced in volume with the chamber filling as its volume is increased and with fluid being discharged during the time the chamber volume is being decreased. The cam surface 51 causes one of the chambers 71 and 71a to be filling while the other is discharging. In FIG. 5 the chamber 71a is at the end of the suction stroke, and the chamber 71 is at the end of the discharge stroke.

A second important function of the impeller 47 is an inlet valve function. This function is performed by the cam surface 51 in that this surface alternately opens and closes the passages 59 and 59a leading to the chambers 71 and 71a, respectively. Specifically, the passage 59 is open when the chamber 71 is increasing in volume (suction stroke) in that the vanes 49 and the

spaces therebetween confront the passage 59 during this period. The passage 59 is confronted by and closed by the cam surface 51 when the chamber is being decreased in volume (discharge stroke). There can be loose tolerances between the cam surface 51 and the bearing 57 in that the cam surface tightly bears against the bearing at the region adjacent to passage 59 during the discharge stroke for the chamber 71. That is, as the cam surface 51 is advancing the shuttle block 55 during the discharge stroke for the chamber 71, the cam surface 51 tightly engages and prevents leakage through the passage 59 during this time.

Third, the impeller 47 serves as an impeller to provide centrifugal pumping action. As shown in FIGS. 3 and 4, the cavities between the vanes 49 of the impeller 47 are open to the well 23 and to the cavity 31 so that water can enter the cavities between the vanes 49. As the liquid is exposed to the rotating vanes 49, the vanes serve to provide centrifugal pumping action which delivers the water to the chambers 71 and 73 at some positive pressure. This assures that the chambers 71 and 71a will be completely filled and, accordingly, the pumping volume of the pump 11 is correspondingly increased. During the discharge stroke for the chamber 71, the pressure of the water in the chamber forces the valve 83 off its seat as shown in FIG. 5 to open the outlet 81 whereupon the liquid flows through the outlet 81 and the discharge passage 91 to the outlet 29. Identical action occurs with respect to the valve 83a during the discharge stroke for the chamber 71a.

Although an exemplary embodiment of the invention has been shown and described, many changes, modifications and substitutions may be made by one having ordinary skill in the art without necessarily departing from the spirit and scope of this invention.

I claim:

1. A pump comprising:
a housing;
means for defining a variable volume chamber in said housing, said variable volume chamber including a movable wall for varying the volume of said chamber, said chamber having an inlet through which fluid can flow into the chamber and an outlet through which fluid can be expelled from the chamber;
said movable wall including a flexible diaphragm;
an eccentric;
means for mounting said eccentric for rotation in said housing;
a shuttle block substantially circumscribing said eccentric and being driven thereby as the eccentric rotates;
said shuttle block having a driven surface which confronts said eccentric and which is constructed and arranged to allow said eccentric to drive said shuttle block along a path which forms a loop;
means for interconnecting said diaphragm and said shuttle block whereby at least a portion of the diaphragm is moved by said shuttle block;
said diaphragm having means to accommodate the loop-like motion of the shuttle block without damaging the diaphragm;
first valve means for controlling fluid flow through said inlet; and
second valve means for controlling fluid flow through said outlet whereby said variable volume chamber can take in fluid through said inlet and discharge the fluid under pressure through said outlet.

2. A pump comprising:
a housing;
means for defining a variable volume chamber in said housing, said variable volume chamber including a movable wall for varying the volume of said chamber, said chamber having an inlet through which fluid can flow into the chamber and an outlet through which fluid can be expelled from the chamber;
said movable wall including a flexible diaphragm;
an eccentric;
means for mounting said eccentric for rotation in said housing;
a shuttle block substantially circumscribing said eccentric and being driven thereby as the eccentric rotates;
means for interconnecting said diaphragm and said shuttle block whereby at least a portion of the diaphragm is moved by said shuttle block;
said eccentric having a plurality of vanes and defining an impeller;
means for introducing fluid to said vanes;
passage means for receiving fluid discharged by said impeller, said passage means being defined at least in part by said shuttle block, said passage means leading to said inlet;
the outer periphery of said eccentric opening and closing said passage means as the eccentric rotates whereby the vanes provide a centrifugal pumping action for supplying fluid under pressure to said variable volume chamber and said variable volume chamber provides diaphragm pumping action for further increasing the pressure of the fluid supplied thereto; and
said shuttle block having a driven surface which confronts said eccentric and which is constructed and arranged to allow said eccentric to drive said shuttle block along a path which forms a loop, said diaphragm having means for accommodating the loop-like motion of the shuttle block without damaging the diaphragm.

3. A pump comprising:
a housing;
means for defining a variable volume chamber in said housing, said variable volume chamber including a movable wall for varying the volume of said chamber, said chamber having an inlet through which fluid can flow into the chamber and an outlet through which fluid can be expelled from the chamber;
said movable wall including a flexible diaphragm;
an eccentric;
means for mounting said eccentric for rotation in said housing;
a shuttle block substantially circumscribing said eccentric and being driven thereby as the eccentric rotates;
means for interconnecting said diaphragm and said shuttle block whereby at least a portion of the diaphragm is moved by said shuttle block;
said eccentric having a plurality of vanes and defining an impeller;
means for introducing fluid to said vanes;
passage means for receiving fluid discharged by said impeller, said passage means being defined at least

in part by said shuttle block, said passage means leading to said inlet;

the outer periphery of said eccentric opening and closing said passage means as the eccentric rotates whereby the vanes provide a centrifugal pumping action for supplying fluid under pressure to said variable volume chamber and said variable volume chamber provides diaphragm pumping action for further increasing the pressure of the fluid supplied thereto;

said housing defining a well adapted to receive fluid, the space between said vanes opening in the axial direction into said well and adapted to receive fluid therefrom, said shuttle block being integrally molded from plastic material and including a projection extending through said diaphragm into said chamber, said passage means extending through said projection of said shuttle block; and

said eccentric driving said shuttle block along a path which forms a loop, said diaphragm having means for accommodating the loop-like motion of the shuttle block without damaging the diaphragm.

4. A pump comprising:

a housing;

means for defining a variable volume chamber in said housing, said variable volume chamber including a movable wall for varying the volume of said chamber, said chamber having an inlet through which fluid can flow into the chamber and an outlet through which fluid can be expelled from the chamber;

said movable wall including a flexible diaphragm;

an eccentric;

means for mounting said eccentric for rotation in said housing;

a shuttle block substantially circumscribing said eccentric and being driven thereby as the eccentric rotates;

means for interconnecting said diaphragm and said shuttle block whereby at least a portion of the diaphragm is moved by said shuttle block;

said eccentric having a plurality of vanes and defining an impeller;

means for introducing fluid to said vanes;

passage means for receiving fluid discharged by said impeller, said passage means being defined at least in part by said shuttle block, said passage means leading to said inlet;

the outer periphery of said eccentric opening and closing said passage means as the eccentric rotates whereby the vanes provide a centrifugal pumping action for supplying fluid under pressure to said variable volume chamber and said variable volume chamber provides diaphragm pumping action for further increasing the pressure of the fluid supplied thereto; and

said means for interconnecting including a projection on said shuttle block projecting through said diaphragm and into said chamber, said passage means extending through said projection.

5. A pump as defined in claim **4** wherein said shuttle block is integrally molded from plastic material and completely surrounds said eccentric.

6. A pump as defined in claim **4** wherein said housing includes a pair of spaced projections, a resilient flexible member positioned between the projections and retained thereby, said resilient flexible member controlling the discharge of fluid from said outlet.

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