Feb. 5, 1957 W. J. HOENECKE 2,780,177

PNEUMATICALLY OPERATED DIAPHRAGM PUMP

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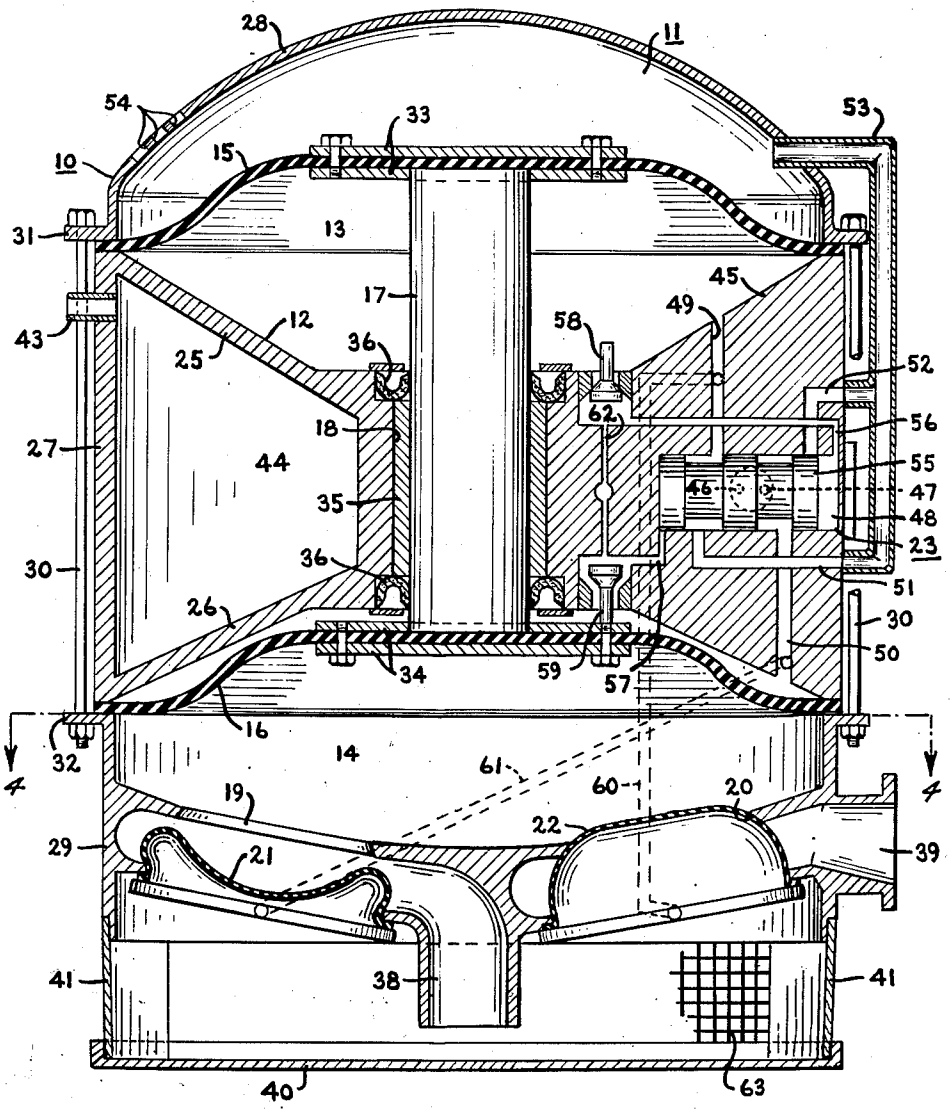


FIG. 1

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FIG. 2.

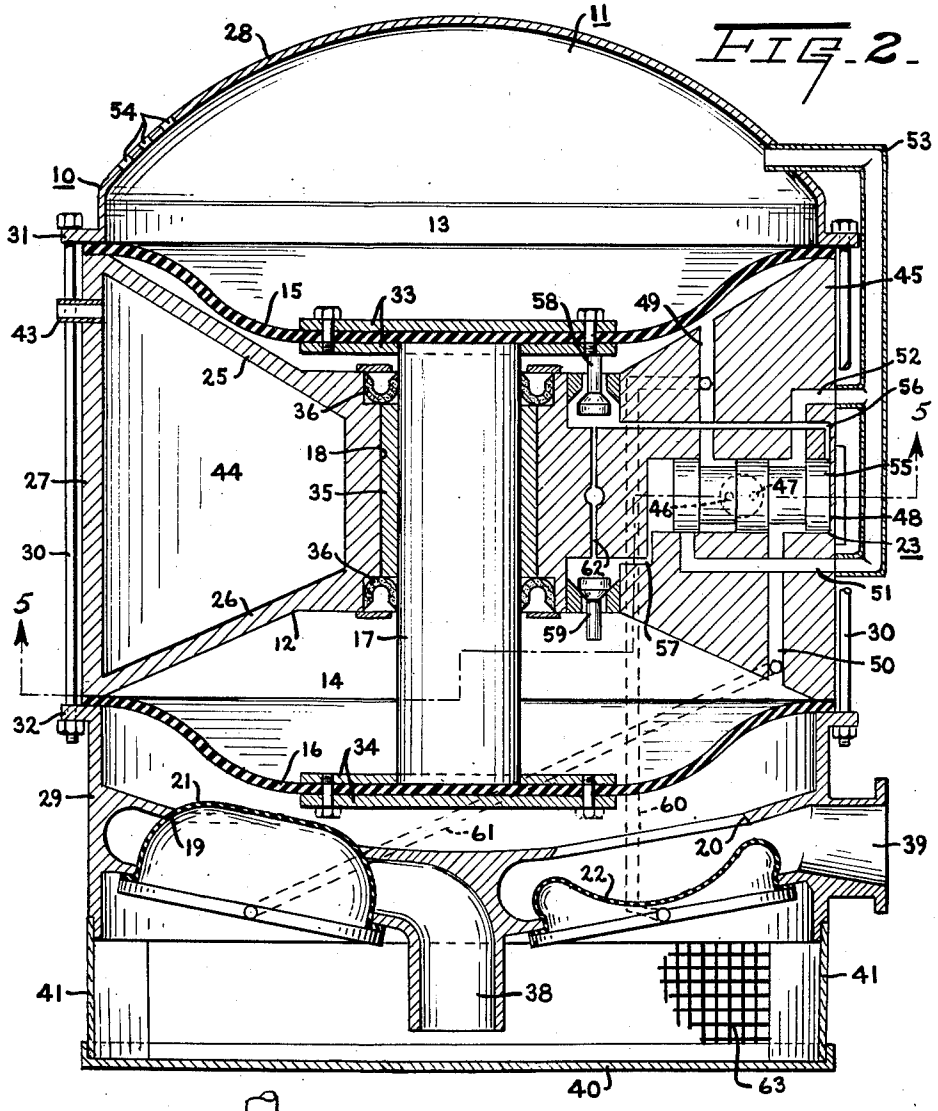
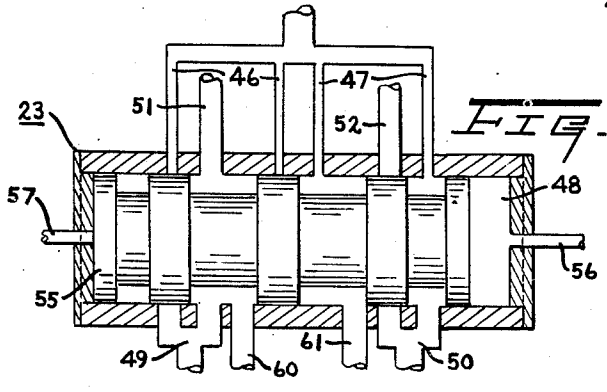


FIG. 3.



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FIG. 4.

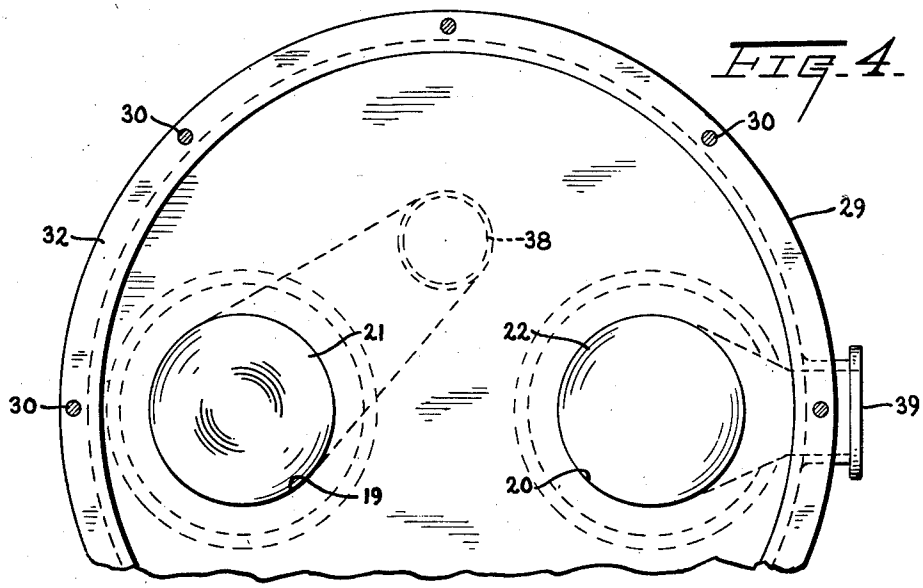
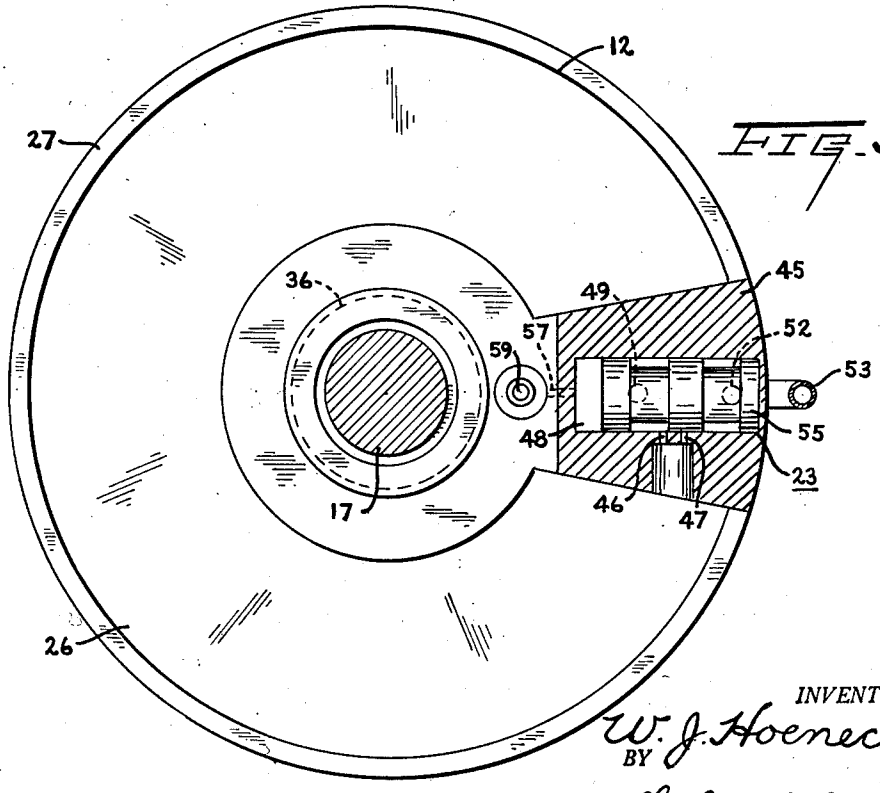


FIG. 5.



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United States Patent Office 2,780,177 Patented Feb. 5, 1957

2,780,177

PNEUMATICALLY OPERATED DIAPHRAGM PUMP

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Application September 29, 1952, Serial No. 312,062

2 Claims. (Cl. 103—150)

My present invention relates generally to improvements in the art of pumping liquids, and relates more particularly to improvements in pneumatically operable diaphragm pumps.

A primary object of this invention is to provide an improved diaphragm pump for liquids which is exceedingly compact, light in weight, unitary in construction, and which is moreover highly efficient and entirely safe in operation under all conditions.

Many different types of pumps for transferring liquids have, of course, heretofore been proposed, and these prior pumps have met with varying degrees of success dependent upon the intended application thereof. For instance, various conventional pumps are normally adapted to handle relatively large volumes of liquid in a rather effective manner, but due to the fact that they are driven by gas engine or the like, they are restricted to work above ground and in localities in which the hazards of fire and emission of dangerous gases are not eminent, thereby resulting in the frequent necessity for long and highly inefficient suction lifts and other difficulties. With respect to electrically powered pumping units, there is always the danger of shock or fire due to short-circuits and the like, and in addition, both the electrically driven and the gas engine driven units are objectionably heavy and cumbersome and therefore not well adapted for certain applications such as in the dewatering of trenches, shafts or other excavations. While certain air operated jet type sump pumps possessing desirable safety and head capacity features are also available, such pumps are also highly undesirable in certain respects such as in the limited use thereof insofar as suction lift is concerned, undesirably high air consumption necessary for operation, and wear and tear on working parts due to the exposure of the operating mechanisms to the muddy and gritty fluids being pumped. Likewise, while relatively efficient reciprocable piston type pumps are quite satisfactory for some applications, they have not proven satisfactory or successful in the handling of gritty solutions due to the high cost of maintenance; and the same is true of air motor driven centrifugal pumps in which the necessarily high rotative speeds of operation cause rapid destruction of packings and rotor vanes when it is attempted to handle abrasive fluids, the air consumption of such units also being undesirably high. It has also been heretofore proposed to utilize diaphragm type pumps to transfer liquids in certain instances as in excavations and the like wherein comparatively small amounts of water must be constantly removed, but the use of such prior diaphragm type pumps has likewise been undesirably restricted because of the cumbersome weight and bulk of such units numerous moving parts, dangerous power application for operation thereof, uneven and excessive wear on the diaphragms, and extremely limited discharge height capacity thereof.

It is therefore a more specific object of the present invention to provide an improved pneumatically operated diaphragm pump which obviates all of the above-mentioned objections and disadvantages heretofore attendant prior liquid pumping devices.

Another specific object of this invention is to provide an improved diaphragm pump which may be effectively operated by a novice with the aid of compressed air in a most reliable manner and with utmost safety.

Another specific object of the invention is to provide an improved pump of the diaphragm type which is highly portable and which may be safely operated directly in or exceptionally near to the source of liquid to be pumped.

Another specific object of my invention is to provide an improved pneumatically operated pumping unit comprised of a minimum number of parts, all of which are readily accessible for inspection or repair, and which is moreover extremely rugged and durable in construction as well as reliable in operation and capable of handling large volumes of gritty and dirty liquids with minimum upkeep and attention.

Still another specific object of my present invention is to provide an improved pneumatically operated diaphragm pump which is entirely devoid of external moving parts and wherein the diaphragms are subjected to evenly distributed pressure and wear.

A further specific object of the present invention is to provide an improved diaphragm pump which is especially adaptable to subsurface operations and which possesses high discharge head capacity, and which may nevertheless be manufactured, sold and operated at relatively low cost.

An additional specific object of the present invention is to provide an improved pump comprising, means forming a chamber having segregated pressure compartments, a flexible diaphragm spanning each of the compartments, means connecting the diaphragms for simultaneous movement thereof, liquid inlet and discharge ports communicating with one of the compartments, a valve for each of the ports, and means for interchangeably introducing air under pressure to the compartments to cause the diaphragms to flex and alternately open and close the inlet and discharge valves.

These and other specific objects and advantages of the present invention will be apparent from the following detailed description.

A clear conception of the various features constituting my present improvements and of the mode of constructing and of utilizing diaphragm pumps constructed in accordance with my invention may be had by referring to the drawings accompanying and forming a part of this specification, wherein like reference characters designate the same or similar parts in the several views.

Fig. 1 is a more-or-less diagrammatic vertical section through a typical pneumatically operated diaphragm pump embodying the invention, the diaphragms being shown at the extreme top of the suction stroke thereof and the pressure control valves being shown at the very moment of the start of the return or discharge stroke;

Fig. 2 is a similar section through the pump but with the diaphragms being shown at the extreme lower end of their stroke and with the pressure control valves being shown at the instant of the start of the suction stroke;

Fig. 3 is a somewhat enlarged schematic sectional view of the differential spool type pressure control valve showing the same in the position illustrated in Fig. 1;

Fig. 4 is a fragmentary transverse section through the pump taken along the line 4—4 of Fig. 1; and

Fig. 5 is another transverse section through the pump taken along the irregular line 5—5 of Fig. 2.

While the invention has been shown and described herein as being specifically embodied in a pump having a particular type of inlet and discharge valves and housed in an annular casing and especially adapted for use as a sump pump for operating on water having a high per-

centage of materials in supension, it is not desired or intended to unnecessarily restrict or limit the scope or utility of the improvement by virtue of such specific embodiment; and it is also contemplated that certain specific descriptive terms used herein shall be given the broadest possible interpretation consistent with the disclosure.

Referring to the drawings, the improved pump assemblage comprises, in general, a main outer casing 10 forming a chamber 11 centrally spanned by a hollow partition 12 to provide segregated upper and lower compartments 13, 14 respectively; flexible diaphragms 15, 16 spanning the respective upper and lower compartments 13, 14, the diaphragms 15, 16 being centrally interconnected for simultaneous movement by a connecting rod 17 reciprocable through a central opening 18 in the partition 12; a liquid inlet port 19 and a liquid discharge port 20 in the lower casing wall, both of the ports 19, 20 communicating with the lower compartment 14; valves 21, 22 for the inlet and discharge ports 19, 20 respectively; and means such as a reciprocable differential spool type valve 23 communicating with a suitable source of compressed air supply for interchangeably introducing air under pressure to the respective compartments 13, 14 to cause the diaphragms 15, 16 to simultaneously flex and alternately open and close the respective inlet and discharge valves 21, 22.

The hollow partition member 12 may conveniently consist of an annular member having outwardly flaring upper and lower walls 25, 26 respectively connected at their outer ends by an annular wall 27 forming the intermediate wall of the main casing 10, the casing 10 being completed by an upper dome shaped hood 28 and a lower dished end wall 29 interconnected by an annular series of connecting rods 30 coacting with the flanges 31, 32 respectively of the hood 28 and lower wall 29. The diaphragms 15, 16 respectively may readily be conveniently peripherally clamped between the annular flange 31 and wall 27 and the flange 32 and wall 27, and each of the diaphragms may be suitably clamped to the respective ends of the rod 17 in any convenient manner as by means of cooperating sets of clamping disks or plates 33, 34 respectively. To prevent leakage of air between the compartments 13, 14, a packing 35 is interposed between the rod 17 and opening 18 of the partition 12 and suitable sealing rings 36 or the like may be additionally provided.

The inlet port 19 communicates directly with the lower compartment 14 below the diaphragm 16 and past the valve 21 with an inlet or suction conduit 38, and the discharge or outlet port 20 likewise communicates directly with the lower compartment 14 below the diaphragm 16 and past the valve 22 with an outlet or discharge conduit 39 to which a flexible hose, not shown, may be coupled for conducting the liquid pumped to any desired locality. The valves 21, 22 may be of any suitable type, but as shown, they are of the flexible diaphragm type and communicate with the compressed air source through the control valve 23 as will hereinafter more fully appear. To provide a suitable standard for the unit, a flat base 40 may be provided which is connected to the casing 10 in spaced relation in any suitable manner as by a series of spacers or legs 41, thereby enabling placement of the pump directly in or immediately adjacent to the source of liquid to be pumped.

With particular reference to the air control and operating means, it will be noted that the compressed air supply may conveniently communicate directly through a supply line 43 with the hollow interior 44 of the partition 12, with the valve 23 being housed in a segmental body portion 45 of the partition which is provided with air inlet ports 46, 47 communicating directly with the space 44 and with the valve chamber 48. In turn, the valve chamber 48 communicates with the upper compartment 13 below the diaphragm 15 through a passageway 49 and with the lower compartment 14 above the diaphragm 16 through a passageway 50, the valve chamber 48 also being vented to the atmosphere through passageways 51, 52 and then through an exhaust tube 53 leading to the space immediately below the hood 28 which is vented at 54 to provide, in effect, an exhaust muffler. As shown more particularly in Fig. 3, the valve spool 55 is provided with a series of flow control flanges or enlargements adapted to control the flow of air through the various ports and passageways depending upon the position of the spool 55 as it reciprocates within its chamber 48. In addition, the opposite ends of the valve chamber 48 are in communication with the upper and lower compartments 13, 14 respectively through passageways or air ducts 56, 57 respectively past upper and lower pilot valves 58, 59 respectively which are adapted for actuation by the respective diaphragms 15, 16 as will hereinafter be more fully described; and the respective air conducting passageways 49, 50 furthermore communicate with the diaphragm type discharge and inlet valves 22, 21 respectively through auxiliary ducts or passageways 60, 61 respectively.

In operation, air under pressure is constantly admitted to the space 44 by way of the supply line 43 from any suitable source of compressed air supply; and referring now to Fig. 1, the diaphragms 15, 16 have just been raised to their uppermost positions to thereby raise the pilot valve 59 from its seat as shown, thus venting the inner end of the valve chamber 48 to atmosphere through ducts 57, 50, 52 and permitting the valve spool 55 to reciprocate to the extreme left position shown by reason of air under pressure accumulated in the passageway 56 and acting on the valve 55 at the opposite end of the chamber 48. In such position, the compartment 13 below the diaphragm 15 is vented to the atmosphere through the passageways 49, 51 as shown and the pilot valve 58 is seated by the compressed air admitted through the passageway 62. On the other hand, compressed air from the space 44 is being admitted through the port 47 to the chamber 14 above the diaphragm 16 by way of the duct 59 and air is also able to be admitted to the lower side of the diaphragm valve 21 through the passageway 61. As the valve 21 is closed by air under pressure, the compressed air entering the chamber 14 above the diaphragm 16 also acts on the upper side of this diaphragm to cause the diaphragms 15, 16 to simultaneously move downwardly, the air from within the chamber 13 and that below the diaphragm valve 22 being exhausted through the ports 49, 60, 51 and the tube 53, thereby causing collapse or retraction of the valve 22 and forcing the liquid from within the chamber 14 below the diaphragm 16 outwardly through the discharge outlet 39. As the diapragms 15, 16 reach the lowermost end of their stroke, the upper diaphragm 15 depresses the pilot valve 58 as shown in Fig. 2 venting the extreme right end of the valve chamber 48 to the atmosphere through the ducts 56, 49, 51 to thereby unbalance the pressures within the chamber 48 and cause the valve spool 55 to reciprocate to the right as shown in Fig. 2. Immediately thereafter, the air pressure builds up through the port 46 within the passageways 49, 60, causing the discharge valve 22 to expand and seat itself to seal the discharge port 20. Simultaneously, the inlet valve 21 and the up side of the diaphragm 16 are vented to the atmosphere through the respective passageways 61, 50, 52 and exhaust tube 53, and the pressure also continues to build up below the diaphragm 15 within the compartment 13 to positively seat the pilot valve 59 and also cause upward flexing of the diaphragms 15, 16. Such action continues automatically as long as air is supplied to the space 44, the air pressure being interchangeably introduced to the compartments 13, 14 thereby causing the diaphragms to flex in alternate directions and alternately opening and closing the inlet and discharge valves for sucking liquid into the compartment 14 below the diaphragm 16 and thereafter discharging the same from the compartment 14.

From the foregoing detailed description it is apparent that the present invention contemplates provision of an improved unitary pneumatically operated diaphragm valve which is exceptionally compact and portable as well as relatively simple and inexpensive in construction. Obviously, the improved unit comprises relatively few parts, all of which are readily accessible but which are nevertheless effectively housed and protected from grit and the like. The three piece main casing **10** may be readily dismantled by removal of the tie rods **30** in an obvious manner whereupon access may be obtained to all parts. The compressed air source for operating the improved pump may of course be located at a remote point and may be connected in a well known manner by means of a flexible tube to the space **44**. The action of the spool type valve **23** is completely automatic, with the valve being entirely segregated and effectively housed so as not to contact the liquid being pumped. The upper and lower diaphragms **15**, **16** respectively are inter-connected in a novel manner so as to insure against angular distortion which would naturally hasten the destruction of the diaphragms, and while both of the elements **15**, **16** have been shown and described herein as being flexible diaphragms of rubber or the like, the upper diaphragm **15** may be replaced by a suitable piston operating within a chamber communicating with the passageways **49**, **56** and **62** as hereinabove described. Obviously, the improved units may be placed either directly in the source of liquid to be pumped or directly adjacent thereto without danger of shock or explosion due to electrical supply or exhaust gas fumes; and when the unit is used as a sump pump operating on liquids containing a considerable amount of grit and dirt or the like in suspension, it is highly preferable to surround the inlet **38** with a suitable screen or the like, a fragment of which is shown at **63**, to filter the liquid being pumped. It is also highly desirable to form the space **44** as large as possible so that this space likewise serves as a sediment chamber, permitting any materials conducted thereto with the compressed air to settle within the space **44** before the air is conducted through the valve **23**.

It should be understood that it is not desired or intended to limit this invention to the exact details of construction or to the precise mode of use herein shown and described, since various modifications within the scope of the appended claims may occur to persons skilled in the art, to which this invention pertains.

I claim:

1. A pump comprising, a casing having therein a partition dividing its interior into two separate chambers, a flexible diaphragm spanning and dividing each chamber into segregated inner and outer spaces the former of which adjoin while the latter are located remote from said partition, means interconnecting said diaphragms to cause simultaneous flexing thereof in like directions, liquid inlet and discharge ports communicating with one of said outer spaces and each being provided with a liquid flow control valve, a valve chamber formed in said partition, a compressed air supply conduit communicating with said valve chamber and having branches extending from said chamber and communicable with each of said inner spaces, a spent air exhaust conduit also communicable with each inner space through said valve chamber and said supply conduit branches, a control valve having actuating faces and being reciprocable within said valve chamber for admitting compressed air through one of said branches to one of said inner spaces while simultaneously connecting the exhaust conduit of the other inner space with the ambient atmosphere, and pilot valves alternately directly operable by the flexing of said diaphragms in opposite directions to vent said valve chamber on alternately opposite sides of the valve actuating faces to atmosphere and thereby effect operation of said control valve.

2. A pump comprising, a casing having therein a partition dividing its interior into two separate chambers, a flexible diaphragm spanning and dividing each chamber into segregated inner and outer spaces the former of which adjoin while the latter are located remote from said partition, means interconnecting said diaphragms to cause simultaneous flexing thereof in like directions, liquid inlet and discharge ports communicating with one of said outer spaces and each being provided with a liquid flow control valve, a valve chamber formed in said partition, a compressed air supply conduit communicating with said valve chamber and having branches extending from said chamber and communicable with each of said inner spaces, a spent air exhaust conduit also communicable with each inner space through said valve chamber and said supply conduit branches, a control valve having opposed faces and being reciprocable within said valve chamber for admitting compressed air through one of said branches to one of said inner spaces while simultaneously connecting the exhaust conduit of the other inner space with the ambient atmosphere, means forming a passage communicable with each of said inner spaces and with opposite faces of said control valve, and a pair of pilot valves in said passage, said pilot valves each having an actuating portion extending into one of said inner spaces and being alternately directly operable by the flexing of said diaphragms to vent said valve chamber on alternately opposite sides of the control valve faces to atmosphere and thereby effect reciprocation of said control valve.

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