Aug. 11, 1942. P. S. MORGAN 2,292,896

FLUID PUMPING APPARATUS

Filed Nov. 18, 1940 4 Sheets-Sheet 1

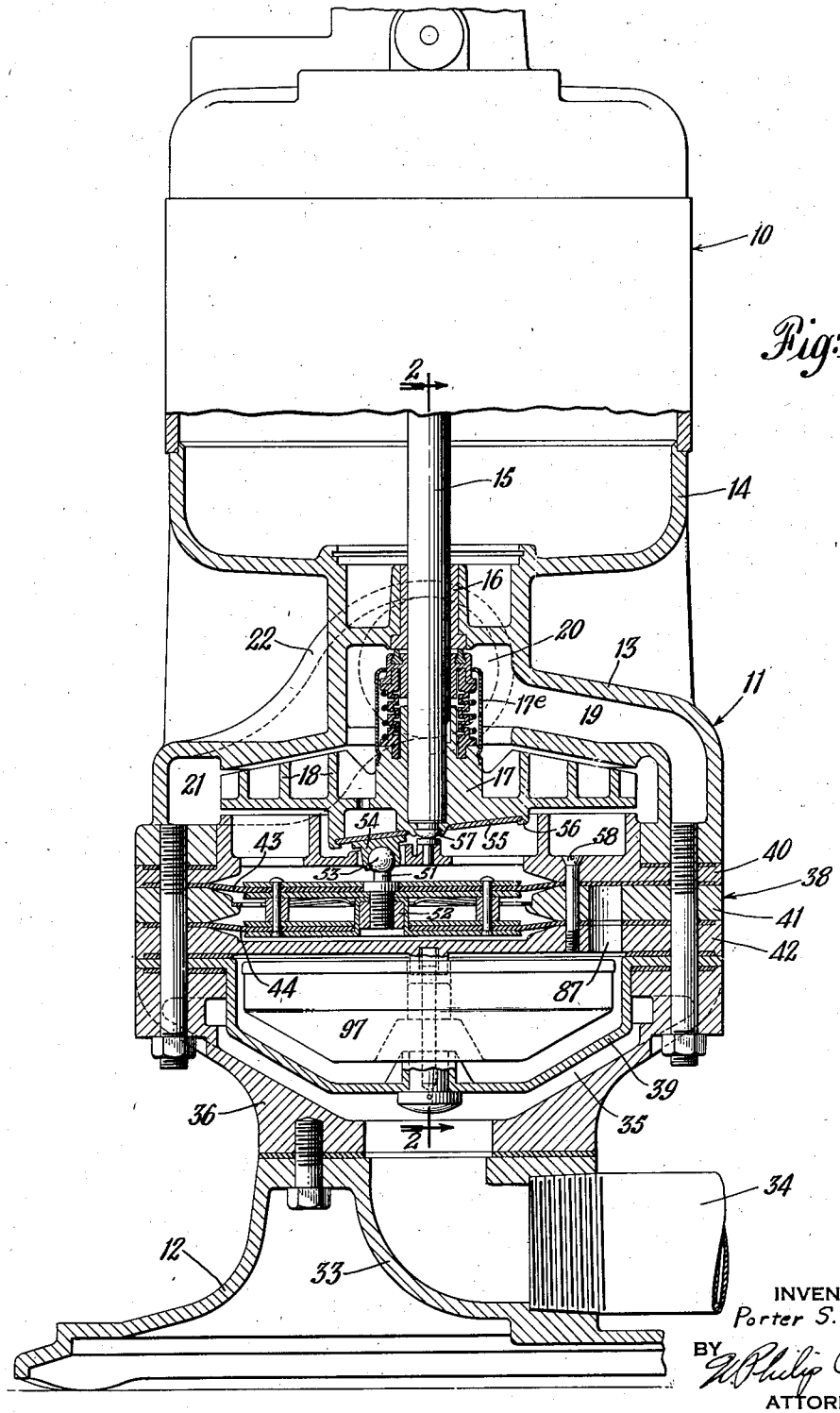


Fig. 1.

INVENTOR
Porter S. Morgan
BY
Philip Churchill
ATTORNEY

Aug. 11, 1942. P. S. MORGAN 2,292,896

FLUID PUMPING APPARATUS

Filed Nov. 18, 1940 4 Sheets-Sheet 2

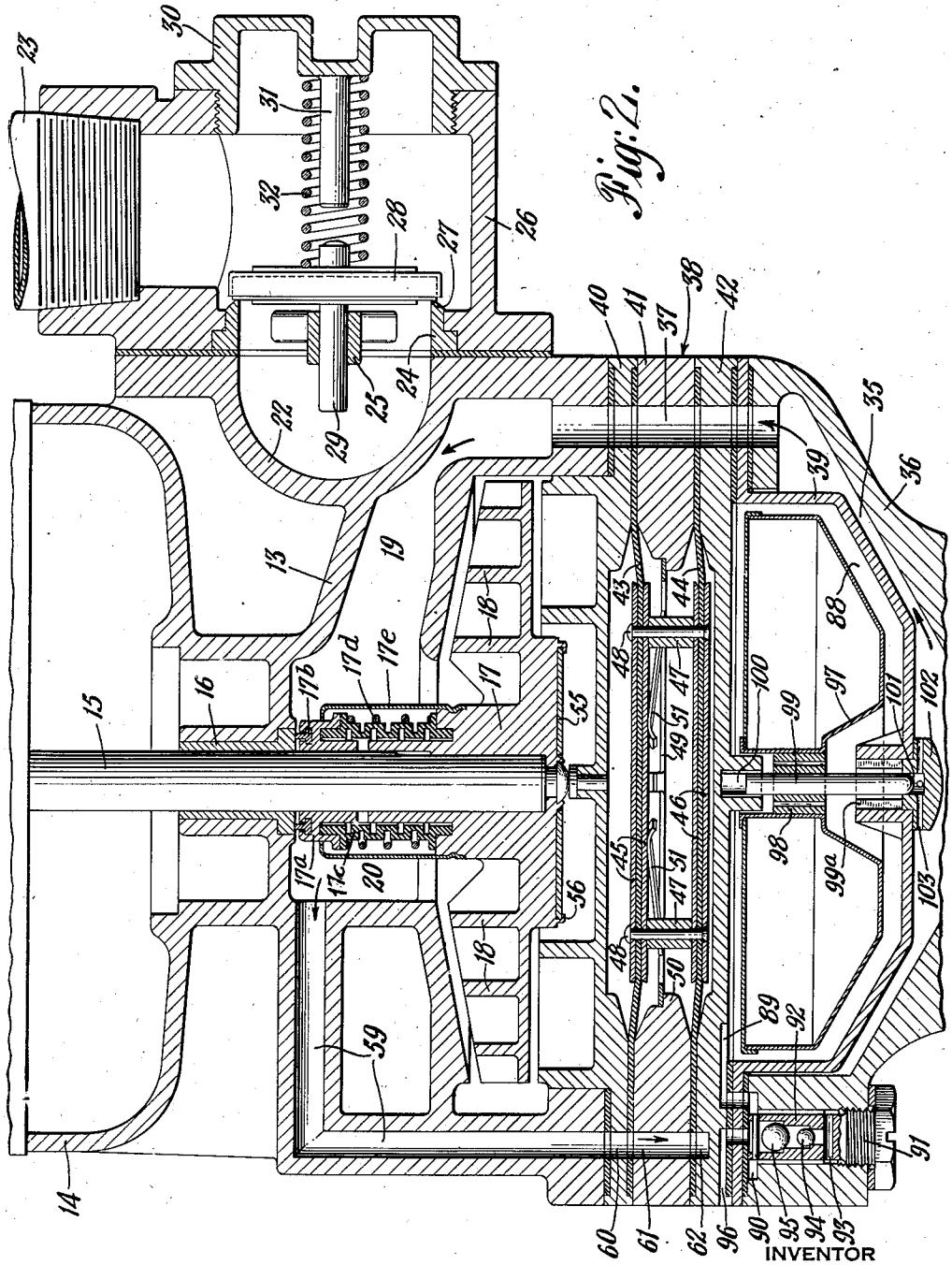


Fig. 2.

INVENTOR
Porter S. Morgan
BY
H. Philip Churchill
ATTORNEY

Aug. 11, 1942. P. S. MORGAN 2,292,896

FLUID PUMPING APPARATUS

Filed Nov. 18, 1940 4 Sheets-Sheet 3

Fig: 3.

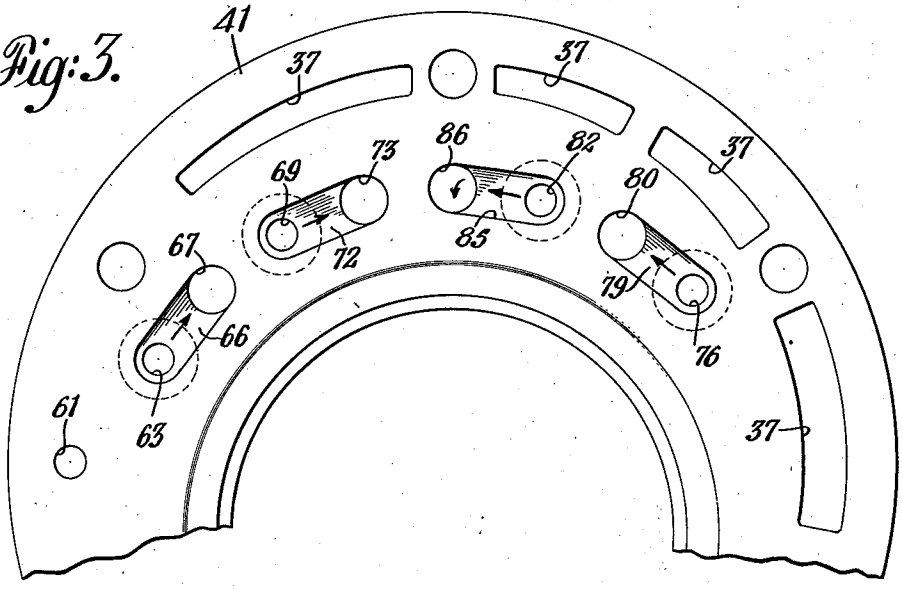
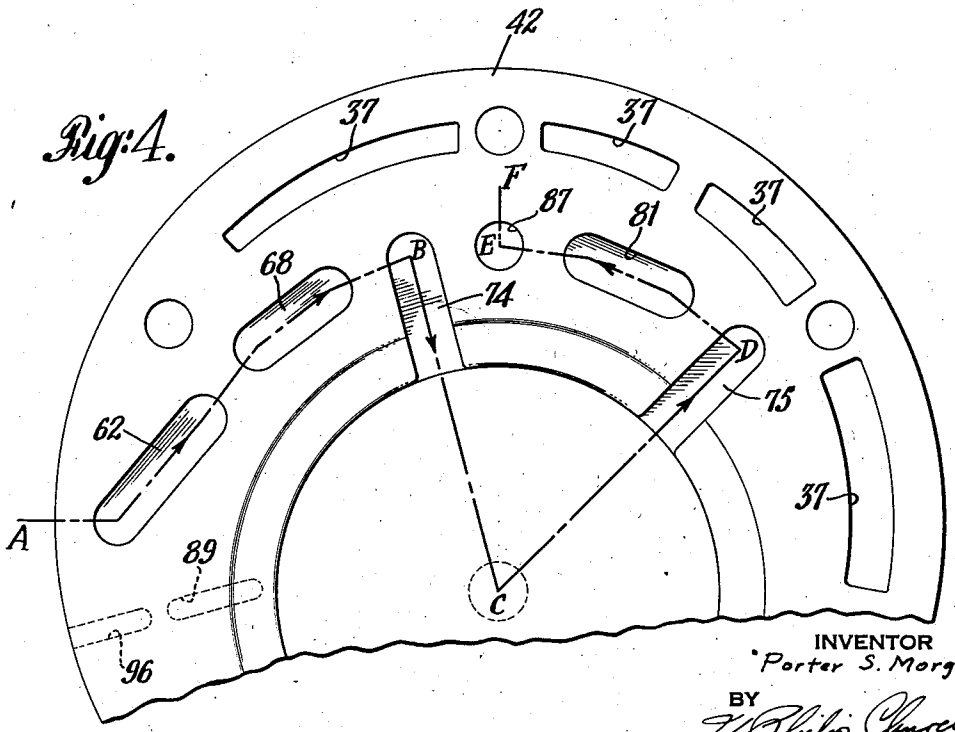


Fig: 4.



INVENTOR
Porter S. Morgan
BY
W. Philip Churchill
ATTORNEY

Aug. 11, 1942. P. S. MORGAN 2,292,896

FLUID PUMPING APPARATUS

Filed Nov. 18, 1940 4 Sheets-Sheet 4

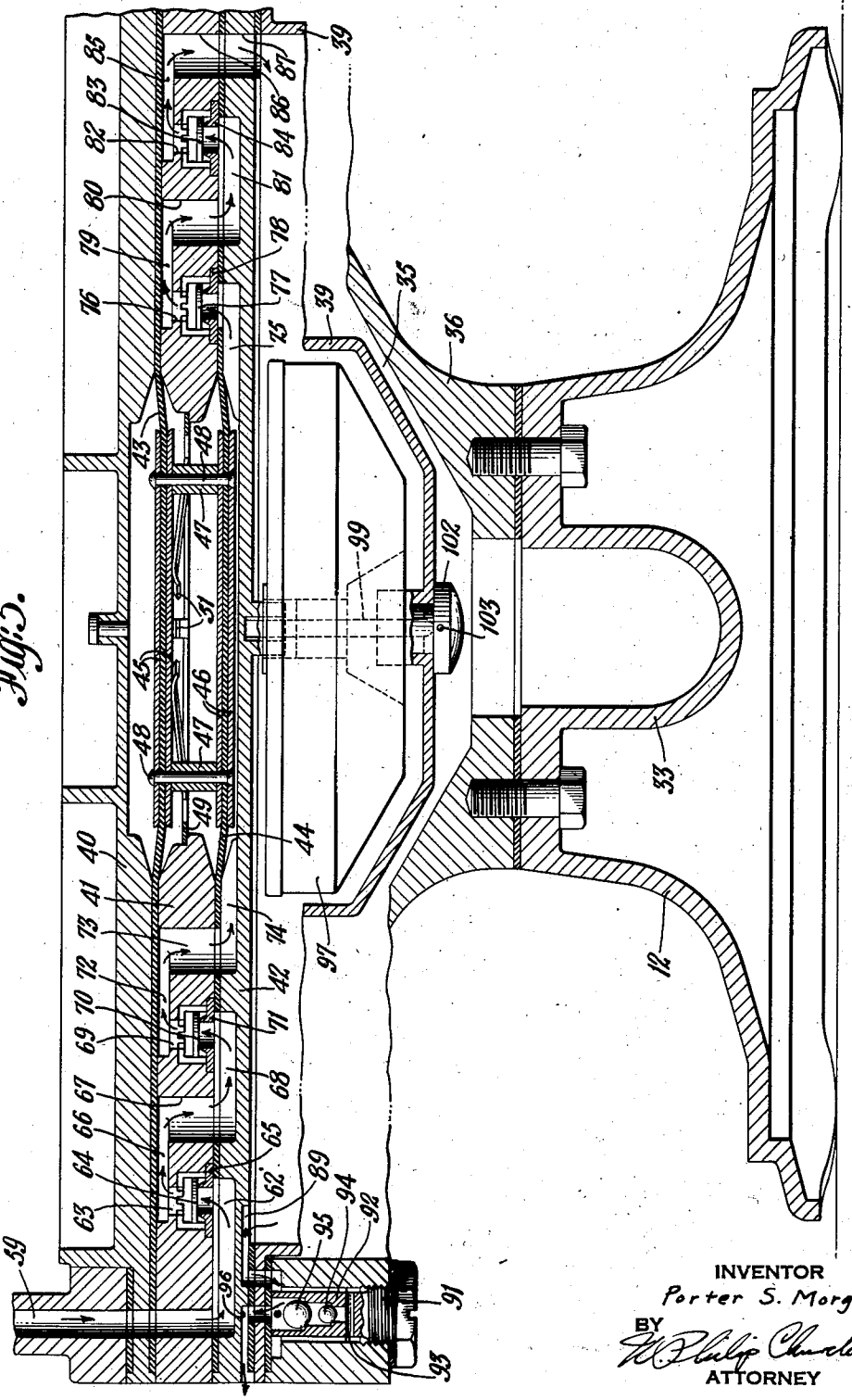


Fig. 5.

INVENTOR
Porter S. Morgan
BY
Philip Churchill
ATTORNEY

Patented Aug. 11, 1942 2,292,896

UNITED STATES PATENT OFFICE

2,292,896

FLUID PUMPING APPARATUS

Porter S. Morgan, Weston, Conn., assignor to The Capewell Manufacturing Company, a corporation of Connecticut

Application November 18, 1940, Serial No. 366,083

10 Claims. (Cl. 103—113)

This invention relates to pumping apparatus capable of pumping either a liquid or a gas. More particularly, the invention concerns a self-priming centrifugal type of pump.

Various combinations of pumps and priming devices therefor are known or have been proposed heretofore, but such devices have not been automatic in their operation, or have been complicated and cumbersome to a point where they cannot readily be transported. At the same time, there has been an obvious need for a self-priming centrifugal type of pump that is fully automatic, compact, economical to manufacture and efficient in its operation.

One object of my invention is to provide a fluid pump capable of pumping either a liquid or a gas.

A further object of the invention is to provide pumping apparatus in which a gas pumping priming means is incorporated as an integrated part of the pump and automatically ceases to operate as soon as the pump begins to handle liquid.

Other objects and advantages of the invention will be explained in connection with and will be apparent from the description of a preferred embodiment thereof illustrated in the drawings, in which

Figure 1 is a vertical sectional view through approximately the center of the pumping apparatus.

Figure 2 is a vertical sectional view through the principal portion of the pumping apparatus in a plane approximately at right angles to the plane of the section in Figure 1, taken on the line 2—2 of Figure 1.

Figure 3 is a top plan view of a portion of the housing plate between the two flexible diaphragms.

Figure 4 is a top plan view of a portion of another housing plate just below the plate illustrated in Figure 3.

Figure 5 is a developed view to show the passages for gas in the apparatus, following approximately the irregular line ABCDEF of Figure 4.

The apparatus illustrated comprises a motor 10 connected directly to a pump housing indicated generally at 11, both the motor and pump housing being supported by a suitable base 12. The pump housing may consist of a casting 13 having a section 14 forming one end of the motor housing. The shaft 15 of the motor projects through a suitable bearing 16 pressed into an opening in the housing casting 13, and an impeller 17 is fixed on the end of this shaft by means of a key, set screw or the like. The impeller 17 may be of any conventional or other construction, such for example, as the impeller illustrated with the spiral vanes 18 extending toward the motor.

To prevent the escape of liquid through bearing 16 around the shaft 15, a seal may be provided consisting of a ring 17*a* around the shaft 15 carrying a shoe 17*b* that bears against the side of bearing 16. A flexible bellows-like sleeve 17*c* of rubber or other flexible liquid proof material may surround the shaft between the ring 17*a* and the hub of the impeller with a coil spring 17*d* around this sleeve to hold the shoe 17*b* tightly against bearing 16. This seal may be covered, if desired, by a sheet metal casing 17*e* crimped or spun into place in such a manner as to permit some axial movement of the ring 17*a* along shaft 15.

The pump housing casting 13 is preferably formed with an inlet passage 19 leading to the space 20 surrounding the hub of impeller 17, and with an opening to receive the impeller 17 that is enlarged as at 21 around the periphery of the impeller and communicates with the outlet passage 22.

The outlet passage 22 of the pump housing casting 13 may be connected to a suitable delivery pipe 23 with a check valve interposed therebetween. Such a check valve may consist of the spider 24 having a central bearing 25 held in place by a valve housing 26 bolted or otherwise secured to the pump housing casting 13. The delivery pipe 23 may be fixed in any suitable way to one side of the valve housing 26. Spider 24 is preferably provided with a sharp annular valve seat 27 to receive the valve 28 carried on the stem 29. The stem 29 of the valve 28 is arranged to slide through the opening in the bearing 25 in spider 24.

Threaded into an opening in the valve housing 26 is a nut 30 carrying an inwardly projecting guide stem 31, and a suitable coil spring 32 may be interposed between the valve 28 and the nut 30 surrounding one end of stem 29 and the stem 31. Pressure on the valve 28 from within the pump housing casting 13, of course, forces the valve 28 to the right, as viewed in Figure 2, until the end of the stem 29 strikes the end of the stem 31. As soon as this pressure is released, the valve, of course, is returned to the closed position by the spring 32.

The inlet passage 19 of the pump housing may communicate with the inlet opening 33 and the inlet pipe 34 in the base 12 by means of the passage 35 in the base housing casting 36 and a number of arcuate passages 37 (see Figs. 2, 3 and 4)

in the plates of the diaphragm pump assembly indicated generally at 38.

The diaphragm pump assembly 38, which may be made up as a unit prior to assembly of the entire apparatus, the reservoir housing 39 and the base housing casting 36 may all be bolted, as illustrated in Figure 1, directly to the pump housing casting 13. The diaphragm pump assembly 38 is composed of three housing plates 40, 41 and 42. Between the plates 40 and 41 there may be clamped a flexible diaphragm 43, and a second flexible diaphragm 44 may be clamped between the plates 41 and 42. These flexible diaphragms may be made of suitable material such as sheets of soft rubber, and are re-inforced throughout their central portions by the pairs of metal plates 45, 45 and 46, 46 respectively. The central portions of the diaphragms and reinforcing plates may be spaced from each other by means of the tubular rods 47 through which the rivets 48 are passed to hold the diaphragms together as an integral unit.

A flat annular member 49, inserted between the two diaphragms and adapted to rest on the shoulder 50 around the central opening of plate 41, carries a number of leaf springs 51 projecting radially inward from its rim that serve to lift the diaphragms 43 and 44.

As will be apparent from Figure 1, the central portions of the diaphragms just described are disposed within openings in the housing plates 40, 41 and 42 that are offset eccentrically with respect to the pump and motor shaft 15. A ball rod 51 formed with a ball 53 on its end is threaded into a block 52 of the diaphragm assembly 38. This ball 53 projects through an opening in the plate 40 and has a shoe with a ball socket 54 mounted thereon for universal movement. Shoe 54 is adapted to bear against the inclined plate 55, which is preferably made of a special wear resistant material such as a case hardened steel, and is supported on the lower side of the impeller 17 in a plane inclined to a plane at right angles to shaft 15.

This plate 55 may be set into an opening in the under surface of impeller 17 and the flange 56 surrounding this opening then peaned over to hold the plate 55 in place. The impeller may have a suitable round headed rivet 57 located in its center to bear upon a central portion of the plate 41 and act as a thrust bearing for one end of the shaft 15.

The diaphragm assembly 38 may be assembled as a unit with the plates 40, 41 and 42, the diaphragms 43 and 44, and the ball pin 53 and shoe 54 held together by means of two or more of the bolts 58.

The shoe and ball held by block 52 move the diaphragms 43 and 44 down against the resistance of the springs 51 as the impeller 17 is rotated for one half of a revolution. Continued rotation of the impeller allows the diaphragms 43 and 44 to move up again since the springs 51 hold the shoe 54 constantly in contact with the inclined plate 55 as it is rotated.

The space 20 in the pump housing around the hub of the impeller communicates through a passageway 59 in the casting 13 with an opening 60 in the plate 40, an opening 61 in the plate 41 and an elongated groove 62 cut into the top surface of the plate 42. The plate 41 has an opening 63 communicating with one end of groove 62 in which the disc valve 64, normally resting on the valve seat 65, is guided for vertical movement by the fluted side walls of the opening 63. The upper end of opening 63 in plate 41 communicates with a groove 66 cut into the upper surface of the plate 41. This groove 66 communicates by means of an opening 67 in the plate 41 with one end of the groove 68 in the upper surface of the plate 42. The other end of groove 68 communicates with a second opening 69 in the plate 41 containing a disc valve 70 carried on the valve seat 71, and this opening communicates at its top with the groove 72 cut on the upper surface of plate 41. The other end of groove 72 is connected to opening 73 in the plate 41 which communicates with the radial groove 74 in the upper surface of plate 42 leading into the central space below the diaphragm 44.

A short distance around this central space is another radial groove 75 cut into the upper surface of the plate 42 and communicating at its outer end with the opening 76 containing the disc valve 77 on valve seat 78 in the plate 41. The upper end of opening 76 is connected to groove 79 in the upper surface of plate 41, and through the opening 80 in plate 41 communicates with the groove 81 in the upper surface of plate 42. The other end of groove 81 leads to another opening 82 in plate 41 carrying another disc valve 83 on the valve seat 84. The upper end of opening 82 communicates through the groove 85 in the upper surface of plate 41, with the aligned openings 86 and 87 in the plates 41 and 42, respectively, leading into the reservoir chamber 88 inside the reservoir housing 39.

Each of the valves containing the discs 64, 70, 77 and 83 is substantially the same in construction and includes the discs guided for vertical movement by fluted walls and normally resting on the sharp annular edges of the valve seats. Suitable stops may, of course, be provided above the discs to allow free passage of fluid when the discs are raised off these seats.

This reservoir chamber 88 has a gas outlet at one side provided by a radial groove 89 in the lower surface of the plate 42 leading to an opening 90 in an enlarged portion at one side of the base housing casting 36. The opening 90 is partially filled by the plug 91, having its upper portion 92 formed to provide a double ball valve chamber. The outer surface of the portion 92 is milled or fluted to provide vertical passages for gas to the transverse opening 93 in the plug. This transverse opening 93 leads to the interior of the plug where the balls 94 and 95 are seated and held in place by a small pin or other suitable means. The central opening in the upper end of the plug communicates with another radial groove 96 in the lower surface of plate 42 that leads to the atmosphere.

The reservoir 88 is designed to trap any liquid passing through the disc valve train operated by the diaphragms 43 and 44, and means is provided to allow this liquid to be drained out of the reservoir. This means comprises the float valve 97 fixed by the block 98 to a pin 99. The upper end of pin 99 is guided by the opening 100 drilled into the lower surface of the plate 42. The lower end of pin 99 is guided by fluted walls of the opening 99a in the reservoir housing 39 and is adapted to be seated, in the lowermost position of the float valve 97, in an opening 101 in the plug 102. Opening 101 communicates with the lateral openings 103 in the head of plug 102 which lead to the inlet space 35 in the base housing casting 36.

The operation of the pump is as follows:

When the motor of the pump is started, shaft

15, impeller 17 and the inclined plate 55 are rapidly rotated. Assuming that there is no liquid in the pump housing 13 at this time, the force of the spring 32 will be sufficient to hold the check valve 28 firmly against the seat 27 at the outlet side of the pump. The springs 51 will hold the shoe 54 in contact with the rotating plate 55, and by reason of the inclination of this plate, the diaphragms 43 and 44 will be caused to reciprocate rapidly.

With each upward movement of the diaphragms, air or other gas in the pump housing will be drawn through the passage 59, the openings 60, 61, 62, opening 63, groove 66, opening 67, groove 68, opening 69, groove 72, opening 73 and groove 74 into the space between the diaphragm 44 and the central portion of the plate 42. The valve discs 77 and 83 will, of course, remain closed during this movement of the diaphragms, and the valve discs 64 and 70 will be raised to permit passage of the gas.

Now, as the diaphragms make each downward movement, the valves 64 and 70 will be forced to close and the air or other gas will be forced out of the space between plate 42 and diaphragm 44 through the groove 75, opening 76, groove 79, opening 80, groove 81, opening 82, groove 85, and openings 86 and 87 into the reservoir 88. During this operation, of course, the pressure of gas will raise the valve discs 77 and 83.

If the reservoir 88 does not contain any liquid, the float 97 will remain in its lowermost position, with the lower end of pin 99 closing the opening 101 in plug 102. Gas thus pumped into the reservoir 88 will be forced out of the reservoir through the groove 89, opening 90, and the transverse opening 93 to a point underneath the balls 94 and 95. The pressure of gas will raise these balls and allow the air or other gas to escape through the groove 96 to the atmosphere.

This pumping of gas from the pump housing 13, because the valve 28 remains closed, will cause a flow of gas or liquid through the inlet pipe 34 and inlet opening 33 into the pump housing. If the inlet pipe 34 is in communication with liquid to be pumped, this liquid will be drawn up into the pump housing through the inlet 33, the passage 34, the arcuate openings 37 in the housing plates 40, 41 and 42 and the passage 19 in the housing 13. As the liquid flows up into the space 20 around the hub of the impeller 17, this liquid will be thrown radially outward by the spiral vanes 18 of the rotating impeller.

The force of this liquid will be applied through central openings in plate 40 against the upper surface of diaphragms 43. At the same time, additional suction will be created around the hub of the impeller 17 in the space 20 due to the action of the impeller vanes 18 on the liquid. This suction will be transmitted through the passage 59 and the openings described above for the passage of gas to hold the valve discs 64 and 70 against their seats 65 and 71 in the closed position.

The pressure of liquid on the upper surface of diaphragm 43 will force it down against the force of springs 51 until the shoe 54 remains just out of contact with the rotating plate 55.

As soon as this liquid pressure differential in the pump housing becomes effective, therefore, the diaphragms 43 and 44 will cease to reciprocate and no more air or liquid will be drawn through the passage 59 into the reservoir 88. The pump will continue to operate as a simple centrifugal pump, the impeller 17 forcing the liquid through the outlet passage 22 against the check valve 28. The pressure of this liquid will open the check valve 28 against the action of spring 32 and the liquid will be allowed to flow out through the outlet pipe 23 as long as the pump retains its prime.

Should the pump lose its prime for any reason, the pressure on check valve 28 will be relieved allowing it to be returned to its seat 27 by spring 32, and the pressure of liquid against the top of diaphragm 43 will be relieved so that the shoe 54 will again be held against the plate 55 by the springs 51. The diaphragms 43 and 44 will then start to reciprocate again, pumping air or other gas out of the housing 13 so long as the motor is running, or until liquid again flows into the pump housing.

In the event that any liquid gets into the reservoir 88, it is desirable that this liquid should be trapped and not expelled through the gas outlet from the reservoir. Therefore, the float 97, which will be raised by any liquid in the reservoir 88, is provided to allow this liquid to flow out of the reservoir through the opening 101 and the lateral openings 103 into the inlet passage 35. As soon as this liquid is drained out, of course, the float 97 drops down again, and the pin 99 closes the opening 101.

Pumping apparatus utilizing the principles of my invention is compact, economical to manufacture and easily carried from place to place. It can be used for pumping any type of fluid either liquid or gas. For example, the pump may be operated as a vacuum pump with the inlet pipe 34 connected to a chamber to be evacuated, or, if the inlet pipe extends into a fluid, the diphragms will serve to prime the pump and the liquid thereafter will be pumped by the impeller 17, as described above.

Various modifications of the preferred embodiment of my invention may also be employed since other gas pumping mechanisms can be built into the pump or other arrangements of diaphragm pumping devices may be used. In the valve train in the lower part of the apparatus, double valves are employed in each instance to ensure positive action, but it should be understood that single valves may be employed, if desired. Also the reservoir 88 and parts associated therewith are not essential to the operation of the device although their provision avoids the possibility of liquid being ejected directly from the pump housing by the diaphragm assembly.

The terms and expressions which I have employed are used as terms of description and not of limitation, and I have no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed.

I claim:

1. A self-priming pump comprising a pump housing, a centrifugal pump within said housing, and diaphragm operated gas pumping means within said housing for creating a partial vacuum within said housing to prime said pump.

2. Pumping apparatus comprising a pump housing having an inlet and an outlet, a check valve in said outlet, a centrifugal pump within said housing, and gas pumping means within said housing to prime said pump, said means being rendered temporarily inoperative by liquid pressure when said pump is primed.

3. A centrifugal pump comprising a housing having an inlet and outlet, an impeller therein, check valve means associated with said outlet, gas pumping means in said housing for evacuating the space around said impeller, and a passageway communicating with said space for the transmission of liquid pressure to render said pumping means temporarily inoperative while said impeller is pumping liquid.

4. A centrifugal pump comprising a housing, a shaft, an impeller mounted on said shaft within said housing, reciprocating gas pumping priming means within said housing, and inclined means rotated with said impeller and shaft for actuating said priming means.

5. A centrifugal pump comprising a housing having an inlet and an outlet, a check valve in said outlet, a shaft, an impeller mounted on said shaft within said housing, and means including a reciprocating diaphragm within said housing for evacuating the space around said impeller, said diaphragm being exposed to the pressure of liquid within said housing for holding said diaphragm in a relatively fixed position during pumping of liquid by said impeller.

6. A centrifugal pump comprising a housing, a shaft, an impeller mounted on said shaft within said housing, means including a reciprocating diaphragm within the housing for evacuating the space around said impeller, and means connected to said diaphragm actuated by rotation of said shaft and impeller for reciprocating the diaphragm.

7. A centrifugal pump comprising a housing, a shaft, an impeller mounted on said shaft within said housing, means including a reciprocating diaphragm within the housing for evacuating the space around said impeller, and means connected to said diaphragm actuated by rotation of said shaft and impeller for reciprocating the diaphragm, said reciprocating means being disengaged to stop said reciprocation by the pressure of liquid being pumped by said impeller.

8. Pumping apparatus comprising a housing capable of holding a partial vacuum, a shaft carrying a rotary liquid pump inside said housing, a diaphragm having one side exposed to the pressure of liquid flowing through said housing, a gas exhaust passageway communicating with the interior of said housing, check valve means in said passageway operated by reciprocation of said diaphragm for evacuating said housing, and means operated by rotation of said shaft and pump for reciprocating said diaphragm.

9. Pumping apparatus comprising a housing capable of holding a partial vacuum, a shaft carrying a rotary liquid pump inside said housing, a diaphragm having one side exposed to the pressure of liquid flowing through said housing, a gas exhaust passageway communicating with the interior of said housing, check valve means in said passageway operated by reciprocation of said diaphragm for evacuating said housing, and means operated by rotation of said shaft and pump for reciprocating said diaphragm, said reciprocating means being temporarily disengaged by pressure of liquid in said housing against said diaphragm.

10. Pumping apparatus comprising a housing capable of holding a partial vacuum, a shaft carrying a rotary liquid pump inside said housing, a diaphragm having one side exposed to the pressure of liquid flowing through said housing, a gas exhaust passageway communicating with the interior of said housing, check valve means in said passageway operated by reciprocation of said diaphragm for evacuating said housing, a shoe member connected to said diaphragm, a member rotated by said shaft and pump having an inclined surface for engaging said shoe to reciprocate the shoe and diaphragm, and spring means for urging said shoe into contact with said inclined surface.

PORTER S. MORGAN.