April 18, 1961 L. E. RUSSELL 2,980,031

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Filed June 25, 1958 2 Sheets-Sheet 1

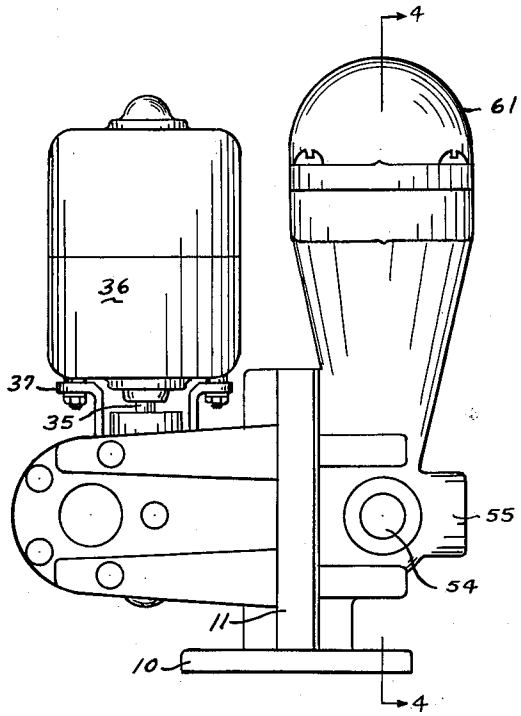
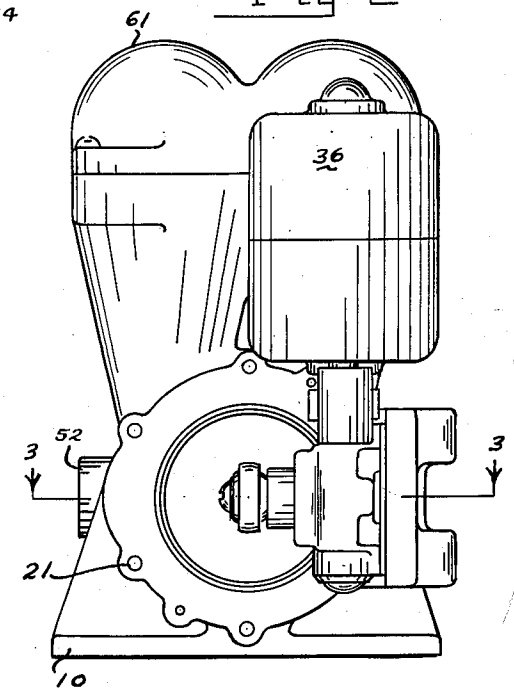


Fig-1

Fig-2



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Filed June 25, 1958 2 Sheets-Sheet 2

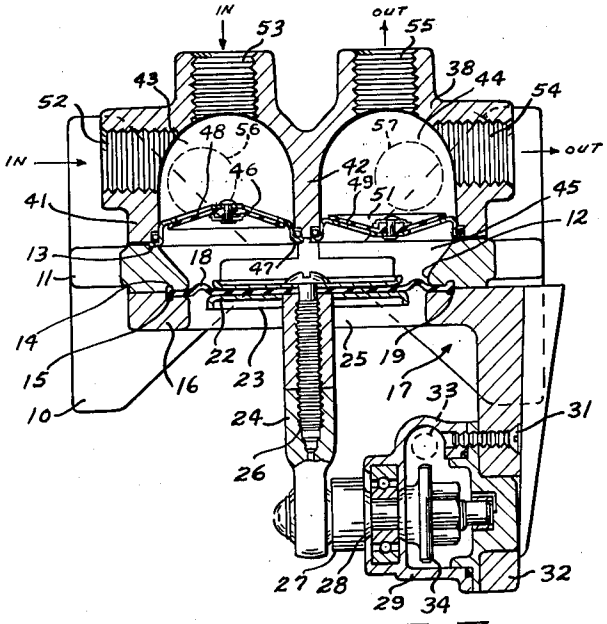

Fig-3

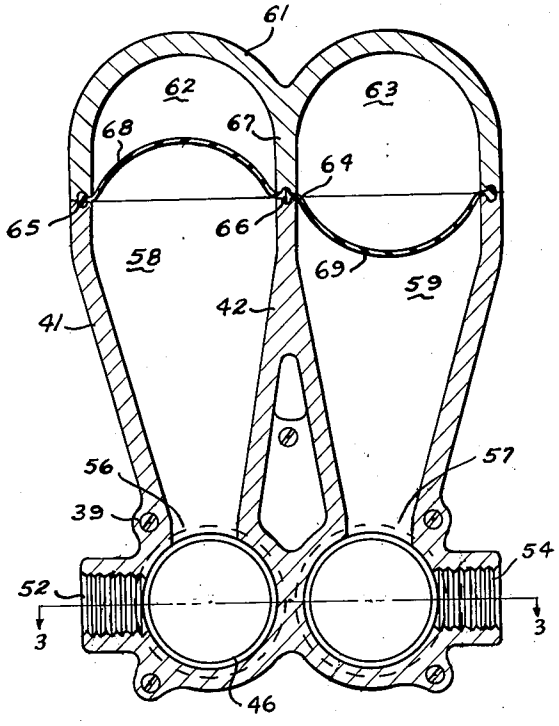

Fig-4

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8 Claims. (Cl. 103—150)

This invention relates to reciprocating pumps, and particularly to integrated diaphragm pump assemblies comprising pumping means, a motor, a transmission from the motor to the pumping means and air domes to inhibit pulsing in the fluid transfer operation, such assemblies being useful as bilge pumps but being useful also to pump gaseous fluids and liquids other than water.

The object of the invention is to simplify the construction as well as the means and mode of operation of diaphragm pumps, whereby such pumps may not only be economically manufactured, but will be more efficient and satisfactory in use, adaptable to a wide variety of applications, and be unlikely to get out of order.

A further object of the invention is to present a generally new pump assembly as described characterized by a high degree of compactness and simplicity of construction resulting in ease of assembly, adaptability of installation and dependable, trouble free operation.

Another object of the invention is to provide a pump assembly as described characterized by diaphragm pumping means installed substantially within a wall constituting a principal supporting part of the pump structure and about which the motor and transmission means, and the dome structure, are symmetrically arranged.

A further object of the invention is to present a generally new dome structure in a pump assembly as described wherein vacuum and discharge chambers of relatively large capacity are provided for leveling or smoothing out pulsations in the fluid flow.

Still another object of the invention is to obviate water logging and the like of the air domes through use of diaphragm means which according to the instant invention is common to both the vacuum chamber and the discharge chamber and has a configuration calculated to obtain a miximum efficiency in the use of the domes.

A further object of the invention is to provide pumps possessing the advantageous structural features, the inherent meritorius characteristics and the mode of operation herein mentioned.

With the above and other incidental objects in view as will more fully appear in the specification, the invention intended to be protected by Letters Patent consists of the features of construction, the parts and combinations thereof, and the mode of operation as hereinafter described or illustrated in the accompanying drawings, or their equivalents.

Referring to the accompanying drawing wherein is shown one but obviously not necessarily the only form of embodiment of the invention,

Fig. 1 is a view in front elevation of an integrated pump assembly in accordance with the instant inventive embodiment;

Fig. 2 is a view in side elevation of the assembly of Fig. 1;

Fig. 3 is a view in cross-section, taken substantially along the line 3—3 of Fig. 2; and

Fig. 4 is a view in longitudinal section taken substantially along the line 4—4 of Fig. 1.

Like parts are indicated by similar characters of reference throughout the several views.

Referring to the drawings, a pump assembly in accordance with the illustrated embodiment of the invention includes a base 10, formed integrally with which is a vertically rising wall 11. The wall 11 is centrally positioned upon the base 10, and, in accordance with a feature of the invention, provides a mounting or support for the other parts of the pump assembly which are symmetrically arranged on opposte sides of the wall for maximum compactness.

Referring to Fig. 3, the vertically rising wall 11 is formed with a through opening 12 and on one side thereof is a conically inclinging surface 13. On the opposite side of the wall 11 is a rabbet or groove 14 adapted to lie in opposing relation to a groove 15 in a plate 16 forming a part of a mounting body 17. The plate 16 and the wall 11 are adapted to clamp between their opposing surfaces the peripheral edge of a diaphragm 18 which is in effect locked in place by virtue of a flange 19 on its periphery which is received in the opposing grooves 14 and 15. The mounting body 17 is removably secured to the wall 11 by bolts 21 (Fig. 2).

The diaphragm 18 constitutes the principal pumping element of the assembly. Oppositely disposed rigid plates 22 and 23 provide a rigid connection of the diaphragm to a connecting rod 24 which extends to and reaches the diaphragm through an opening 25 in the wall 16 of the body 17. The connecting rod 24 has a tapped open interior receiving a screw or bolt 26 passed through the diaphragm and into the rod 24. The construction is such as to attach the diaphragm 18 in a relatively rigid manner to the rod 24 so that upon reciprocation of the latter the diaphragm 18 will partake thereof, moving into and out of the opening 12 in the wall 11, such motion being permitted by flexing of the diaphragm in the usual manner.

The connecting rod 24 is connected at its outer end to an eccentric 27 on a crank shaft 28 rotatable in a gear box or transmission housing 29. The latter is attached by screws 31 to a wall 32 forming a part of the mounting body 17 and extending in right angle relationship to the plate 16. Within the gear box 29, a worm 33 drives a gear 34 on the shaft 28 and is itself driven in a suitable manner from a shaft 35 (Fig. 1) extending from and actuated by an electric motor 36. The latter is mounted upon brackets 37 which in turn are mounted upon the gear box 29. The motor, and transmission mechanism, accordingly both are supported upon the body 17 to one side of the wall 11. Operation of the motor 36, which it is understood is suitably energized and controlled selectively to rotate the shaft 35, results in a rotation of the crank shaft 28 and this in turn effects a reciprocating movement of the connecting rod 24 through the eccentric 27. The motion of the rod 24, as before described, is effective to reciprocate diaphragm 18 of the pumping means.

On the opposite side of the wall 11 and mounted thereon in contacting, superposed relation, is a body 38 connected, as by bolts 39 (Fig. 4) to the wall 11 and supported thereby. The body 38 is formed with an outer wall 41 and with an intermediate generally transverse wall or rib 42 both resting upon the adjacent surface of the wall 11. The walls 41 and 42 form in the body 38 vacuum and discharge chambers 43 and 44, such chambers being in effect separated by the wall 42 but in common communication with a pumping chamber 45 defined by the adjacent faces of the wall 11 and body 38. In effect received within the vacuum chamber 43 is a perforate valve plate 46 having on its peripheral edge an out-turned portion 47 received in complementary cut outs in the contacting surfaces of the wall 41 and 11 and the

wall 42 and 11. On the underside of the plate 46 is attached a flexible flapper type valve 48 tending normally to close the perforate portions of the plate 46 but responding to a pressure in the chamber 43 which is higher than the pressure in the chamber 45 to open to permit fluid flow from the chamber 43 to the chamber 45, flow in the opposite direction being denied. Similarly mounted and received in the discharge chamber 44 of the body 38, but in an inverse position, is another valve plate 49 and a valve element 51 constructed in substantially identical manner to the plate 46 and valve 48. On account of its inverse mounting, however, the valve assembly in chamber 44 admits fluid from chamber 45 to the chamber 44 and denies flow in the opposite direction. The vacuum chamber 43 is adapted to receive liquid or another fluid by way of alternately used openings 52 and 53 extending laterally therefrom within the body 38. Fluid is discharged from chamber 44 by way of alternately used openings 54 and 55. The construction and arrangement of parts, it will be recognized, is to provide for a transfer of fluid from the chamber 43 to the chamber 44 in response to reciprocating motions of the diaphragm 18 which alternately expands and contracts the size of the pumping chamber 45. Fluid drawn from the chamber 43 into the pumping chamber 45 is replaced by other fluid brought to the pumping assembly by suitable piping and admitted thereto either through the opening 52 or the opening 53. Similarly, as fluid is forced into the discharge chamber 44 a like amount is expelled therefrom by way of the openings 54 or 55 and conducted away from the pump assembly by suitable piping connections.

The chambers 43 and 44 communicate, through respective openings 56 and 57 with expansion chambers 58 and 59. The latter are in effect continuations of the vacuum and discharge chambers and are separately identified merely for convenience of designation. They are formed by upward continuations of the walls 41 and 42 of the body 38, being separated by the internal wall 42 into distinct and separated chambers as indicated. Overlying the upper ends of the walls 41 and 42 is a complementarily formed dome structure 61 adapted to provide air chambers 62 and 63 above the expansion chambers 58 and 59. A separation between the air chambers and expansion chambers is effected by diaphragm means in the form of a molded rubber or rubber-like part 64. The part 64 has a peripheral flange portion 65 received in a groove defined by the contacting surfaces of the wall 41 of the body 38 and the mating wall of the dome structure 61. A central bead 66 in the diaphragm 64 is received in mating surfaces on the wall 42 and a central corresponding rib 67 of the dome structure. The construction and arrangement of parts is such as substantially to clamp the diaphragm between the dome 61 and body 38 while providing respective relatively free flexible portions 68 and 69. The diaphragm 64 is in its manufacture given a normal or initial configuration by which the portions 68 and 69 are reversely cupped. Further, in the installation of the diaphragm the portion 68 is placed within or between expansion chamber 58 and air chamber 62 while portion 69 is placed within or between expansion chamber 59 and air chamber 63. The arrangement is one tending to add to or to emphasize the ability of the air dome structure in reducing the effects of pulsing in the operation of the pump whereby to provide for a steady continuing flow of the fluid being handled. On a retracting stroke of the connecting rod 24, tending to expand the chamber 45, the pressure differential which results between the chamber 43 and chamber 45 causes valve 48 to open and flow from the chamber 43 and communicating chamber 58 takes place to the pumping chamber 45. The air trapped in chamber 62 is permitted, in response to this flow, to expand with the result that portion 68 of the diaphragm 64 is deformed inwardly of the expansion chamber 58. The vacuum effect produced in chamber 62 tends to smooth out the flow from the vacuum chamber 43 in a manner to obviate pulsing or impact movement into the chamber 45. In a like manner, the forcing of pressure fluid into the discharge chamber 59 is effective to deform the portion 68 of the diaphragm 64 upwardly into the chamber 63. This motion compresses the air in chamber 63 in a manner to dampen flow and again to obviate pulsing movements of the fluid.

The diaphragm 64 has especial utility in enabling effective operation of the pump in attitudes other than upright where the air cushion in chambers 62 and 63 may be lost.

The configuration of the expansion chambers is such as to give them an inverted frusto-conical shape. Thus each chamber has a maximum cross-sectional area at its upper portion and a minimum cross-sectional area at its bottom, with the two being connected by a gradually tapering wall surface. The construction, it has been determined, is one well suited to diaphragm pump operation—facilitating a smooth rapid transfer of fluid therethrough.

Similarly, the location of the expansion chambers has been found to affect the ability of the pump to achieve high performance. Thus, as indicated in Figs. 3 and 4, the inlets 56 and 57 to the expansion chambers are offset or displaced relatively to the valves 48 and 49. On the flow line, yet away from turbulence at the valves, the chambers are free to exert their steadying influence upon the pump operation. To add to the advantage obtained by such off-set arrangement spacer means may be inserted between the body 38 and the plate 11, in effect to extend the walls 41 and 42, whereby to increase the displacement of the valves relatively to the expansion chamber inlets.

From the above description it will be apparent that there is thus provided a device of the character described possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages.

While in order to comply with the statute the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise but one of several modes of putting the invention into effect, and the invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims.

Having thus described my invention, I claim:

1. A pump, including a base, a wall rising vertically from said base, a body mounted on one side of said wall and formed with vacuum and discharge chambers, said wall and said body defining between them a pumping chamber in common communication with said vacuum and discharge chambers, said body including vertically rising outer walls and an intermediate wall common to said vacuum and discharge chambers, a removable closure cap for the upper end of said body providing domes to act as continuations of said vacuum and discharge chambers and having wall portions to rest on the said outer and intermediate walls of said body, diaphragm means clamped between said closure cap and said body comprising a one-piece flexible part having an initial configuration providing reversely cupped formations respectively received in said vacuum and discharge chambers, other diaphragm means mounted in said wall to form a part of said pumping chamber, means connected to said other diaphragm means to reciprocate said other diaphragm means, and valves in said body controlling a transfer of fluid from said vacuum chamber to said dis-

charge chamber in response to reciprocation of said other diaphragm means.

2. A pump according to claim 1, characterized in that said valve means comprises perforated plates clamped between said wall and said body, and reversely arranged flexible closures or respective plates.

3. A pump according to claim 1, characterized in that the first said diaphragm means is arranged to present normally to the dome over said vacuum chamber a convex surface and to the dome over said discharge chamber a concave surface.

4. A diaphragm pump including a wall having an opening therethrough, a diaphragm to one side of the wall bridging the opening and having means connected for reciprocation thereof, a body mounted to the opposite side of said wall including a portion defining a pumping chamber with said wall and diaphragm, said portion having intake and discharge valves in planes oriented substantially parallel to the plane of said diaphragm, means defining an inlet chamber and an outlet chamber in said body respectively adjacent said intake and discharge valves for communication with said pumping chamber therethrough, and means defining expansion chambers in said body having their major axes vertical to and relatively displaced from the central axes of said valves and oriented in a direction at right angles thereto.

5. A diaphragm pump, including means defining a pumping chamber having a reciprocable diaphragm means constituting a portion of one wall and intake and discharge valve means constituting portions of an opposite wall thereof, means containing said valve means to one side of said pumping chamber providing vacuum and discharge chambers communicating with said pumping chamber through said valve means, means defining expansion chambers having openings respectively communicating with said vacuum and discharge chambers, said expansion chambers being oriented respectively in vertical relation to the central axes of said valve means and relatively offset therefrom, the construction and arrangement being such that the chambers project in directions generally parallel to the general planes of said valve means.

6. A diaphragm pump according to claim 5 characterized in that said means defining said expansion chambers include flexible diaphragm means connected to form relatively sealed air chambers therein for smoothing out pulsations in pumping fluid through said pumping chamber.

7. A diaphragm pump according to claim 6 characterized in that said flexible diaphragm means are formed to normally present to the vacuum chamber a convex surface and to the discharge chamber a concave surface.

8. A diaphragm pump including a body having means defining vacuum and discharge chambers in one end and opening laterally of said body from said vacuum and discharge chambers, generally co-planar valve means respectively bridging openings from said vacuum and discharge chambers, means to one side of said body defining a pumping chamber with an adjacent said valve means including a reciprocable diaphragm oppositely thereof for drawing fluid from the vacuum chamber and delivering it to the discharge chamber, said body having means defining expansion chambers lying vertically of said vacuum and discharge chambers with their major axes in a plane displaced from and generally parallel to the plane of said valve means.

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