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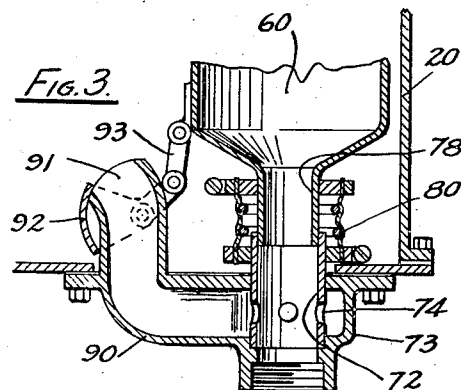
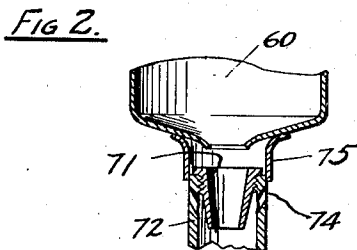
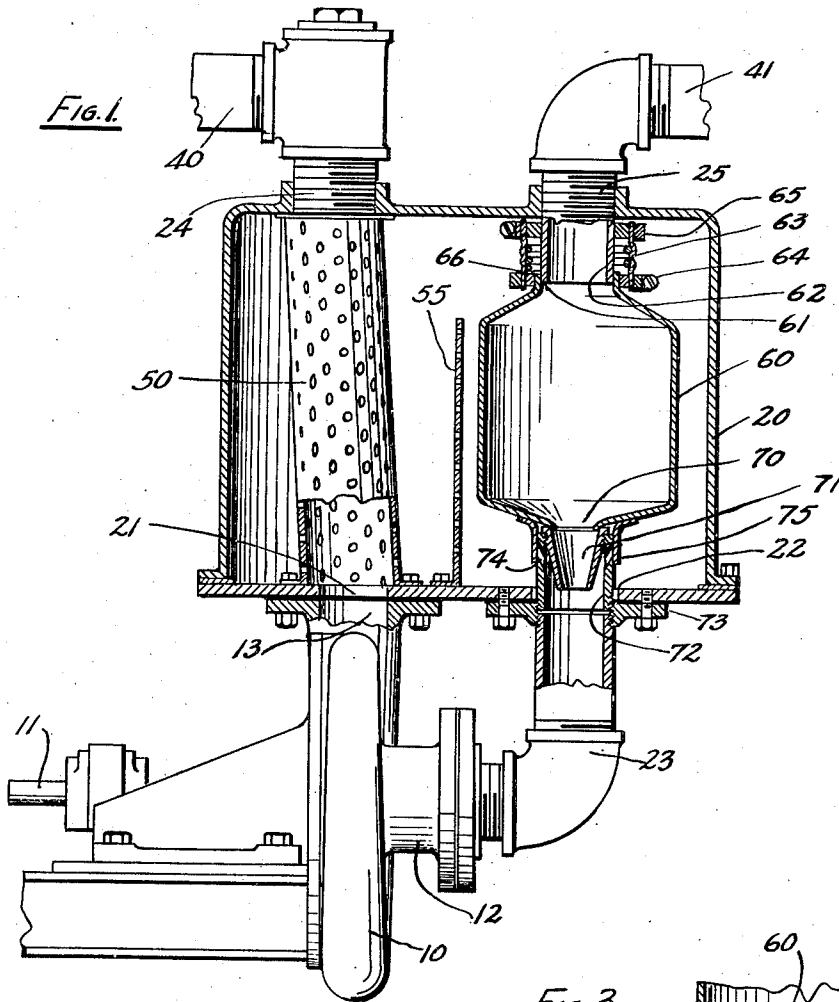
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SELF PRIMING IMPELLER PUMP

Filed June 7, 1935

3 Sheets-Sheet 1



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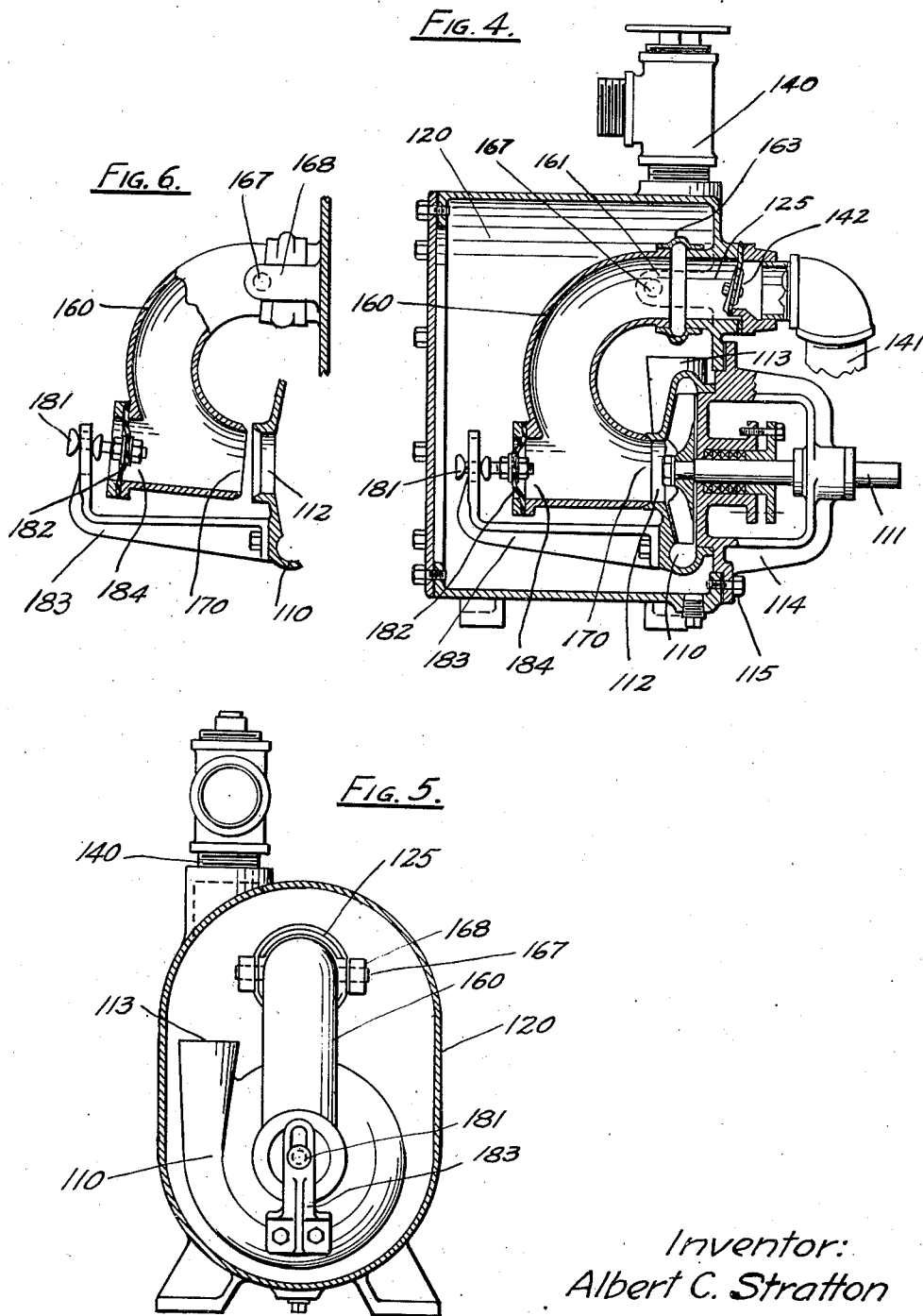
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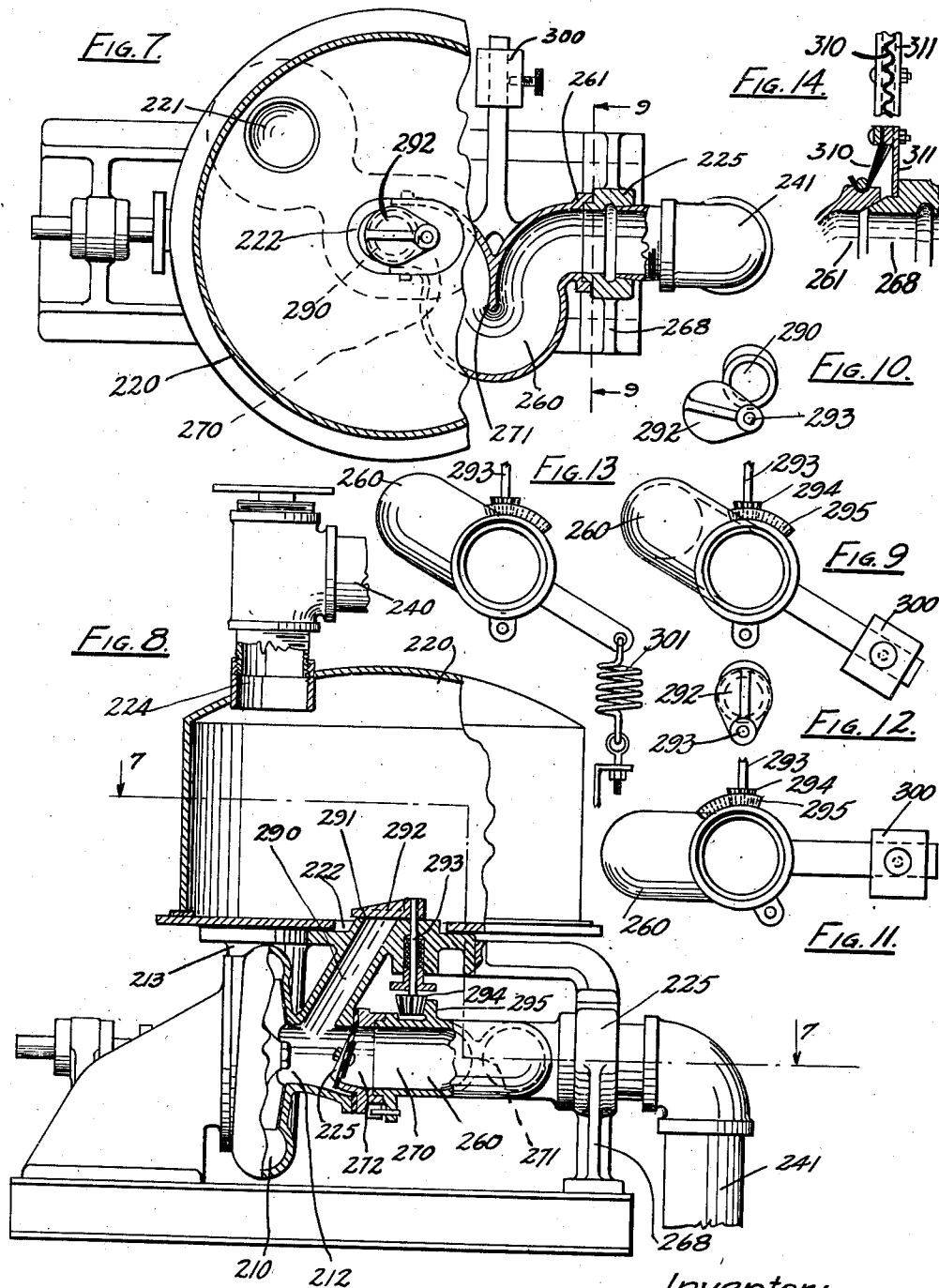
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UNITED STATES PATENT OFFICE

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SELF-PRIMING IMPELLER PUMP

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Application June 7, 1935, Serial No. 25,394

18 Claims. (Cl. 103—113)

This invention relates to impeller pumps and more particularly to priming arrangements for pumps of this type.

It is an object of the invention to provide a pumping system of this type which is capable of developing a high vacuum for sucking liquid or gas or mixtures of liquid and gas in different proportions or in varying proportions.

It is a further object to provide a priming arrangement for a centrifugal pump which is capable of maintaining the prime continuously under greatly and rapidly varying load conditions.

It is a further object of the invention to provide a pumping system such as just characterized which is capable of continuously maintaining a high vacuum even when the proportions of liquid and gas taken in vary suddenly and over the full range, as from all liquid to all gas and vice versa.

It is a further object to provide an automatic priming arrangement the functioning of which is substantially independent of any head pressure on the discharge side of the pump.

It is a still further object of the invention to provide a pumping system of this type which will be simple, as by having few moving parts; will be rugged, as by having no delicate valve parts; and will be certain in operation, as by offering little or no chance for clogging by debris or fine particles.

It is well known that the centrifugal pump has found many different uses, and that a certain type has come to be known as a contractor's outfit. In this last capacity it is subject to greatly varying operating conditions, such as different suction lifts and different discharge heads, as well as different load conditions; thus, when operating on excavation jobs the pump may be taking water in to its full capacity or the water supply may suddenly fall and then the pump may be required to automatically remove small quantities of water, as they collect in the intake sump; leaky suction lines are also frequently met with, which supply the outfit with a mixture of air and water, usually detrimental to the continued operation of a centrifugal pump.

Various schemes have been provided in which a reserve supply of water is arranged to renew the prime of a centrifugal pump when it has been broken by a sudden failure of the main water supply to keep the suction line filled. These arrangements have operated during repriming in a manner closely resembling a reciprocating pump in that the pump will reprime and develop a vacuum for a short time, then lose its prime due

to entrance of air and then again reprime, repeating this until water fills the pump.

It is evident that such action often makes the pump too slow in handling a sudden rush of water. It is furthermore obvious that a leaking suction line would seriously and continuously reduce the capacity of a pump operating in this manner.

Whereas the invention may be applied with advantage to centrifugal pumping outfits of the type just referred to, it finds its most advantageous application in pumping systems in which the prime is continuously maintained against wide variations in the load condition, that is systems which on account of the steadily maintained prime continuously develop a high vacuum in the suction system, so that the pump at any time will be capable of handling such load as may be presented to it.

As will be apparent from the disclosure in my application for Letters Patent, Serial No. 538,129, filed May 18, 1931 relating to improvements in Self-priming impeller pumps, an essential feature of a prime-maintaining centrifugal pumping system resides in the control of the flow of priming liquid to the pump in response to the rate of main flow in the suction connection, or in other words in response to the amount of air contained by the main flow, since only thereby it is possible to supply priming fluid to the pump in anticipation of a break in the prime and thus prevent the break from occurring. Other essential features are provisions for thorough mixing of the priming water with the air in the suction line and for this mixing to take place close in front of the pump or even inside the suction opening, so that no large bodies of air will have time to form and break the seal.

The above-mentioned objects and features are attained in accordance with the invention by passing the main suction flow to the pump through a movable chamber, the position of which will change in accordance with the ratio of air to water in the flow passing through the chamber at any moment. The changing position of the chamber is utilized to operate the shutter or valve which controls the flow of priming water into the pump.

By such an arrangement a large force is made available for quick and certain operation of the priming valve.

The reactive force on the chamber may be obtained in different ways. Thus in accordance with one specific embodiment of the invention

the chamber may be placed within the priming tank to be submerged in the priming water, in which case the buoyancy of the tank will increase and decrease with the rate of air flow taken in by the pump. In accordance with another embodiment of the invention the chamber is mounted in bearings and has an unsymmetrical overhang which is forced downward by the weight of the main water flow at any instant and is counterbalanced by a weight or a spring; when certain limiting conditions arise, the chamber is caused to take different positions as the ratio of air to water in the flow through the chamber changes.

It is evident that whether the control chamber is submerged in the reserve water tank or is mounted outside the tank and counterweighted its operation will not be affected by any head pressure on the discharge side of the pump.

The operation of the priming valve by the moving chamber may be accomplished in different ways. This and other features of the invention will be apparent from the following detailed description of different embodiments of the invention.

It should be understood that these embodiments illustrate specific ways in which the invention may be carried out and are merely typical examples. The invention is adaptable for various modifications as will be apparent to those skilled in the art. Thus it is possible to place the movable chamber in the discharge connection to be moved by the discharge flow from the pump to control the priming valve on the suction side of the pump in accordance with the amount of air contained in the discharge flow.

The invention will now be described more in detail as applied to different characteristic embodiments shown in the accompanying drawings, in which:

Fig. 1 shows a pumping outfit equipped with a submerged tank for control of the reserve water valve.

Fig. 2 is a view of the reserve water valve in Fig. 1, showing the valve in open position.

Fig. 3 is a fractional view of an outfit similar to that shown in Fig. 1 with an alternative arrangement for control of the reserve water valve by the submerged tank.

Figs. 4 and 5 show a pumping outfit in which the pump is submerged in the reserve water tank, and shows a submerged control tank and valve of a simplified design.

Fig. 6 is a fractional view of the outfit in Fig. 4, showing the valve in open position.

Figs. 7 and 8 show a pumping outfit in which the reserve water valve is controlled by a counter-weighted hinged portion of the intake pipe.

Figs. 9 to 12 show different positions of the valve in Fig. 7 and the operating mechanism therefor.

Fig. 13 shows an alternate arrangement for counter-balancing the hinged portion of the intake pipe in Fig. 7.

Figs. 14 and 15 are detail views, showing an arrangement for a water tight junction between the stationary and the movable parts of the intake pipe in Fig. 7.

Referring now more particularly to Figs. 1 and 2, the centrifugal pump 10 may be of any conventional or special design; it may be driven through its shaft 11 by means of a motor or other source of power. The pump has an intake or suction opening 12 and an output or discharge opening 13.

A reserve water tank 20, preferably of sufficient

capacity to supply the pump for its initial priming, is placed directly above the pump and has in the bottom one opening 21 connected directly to the discharge opening 13 of the pump, and another opening 22 connected by a passage 23 to the suction opening 12. The passage 23 may be of piping, as shown in the drawings or may be a casting integral with or connected to the volute of the pump 10. The tank further has an opening 24 at the top for discharge of water either simply by overflow or through any convenient discharge system 40, and an opening 25 for intake of water through a suction line 41 from a main supply.

A tubular section 50 is placed within the tank 20 to lead the water from the pump to the discharge 40. The tube 50 has numerous perforations for admitting discharge water to the tank without passing debris of appreciable dimensions, which otherwise would interfere with the automatic prime-maintaining operations. The tube 50 is preferably placed at a small angle from the vertical in a manner to impart a circulatory movement to the water within the tank; by this means air which may have entered the tank with the discharge water will segregate in the center of the tank, rise and escape through the uppermost perforations and the opening 24 and will thus be prevented from reentering the pump and reduce the certainty of the priming action.

A submerged tank 60 is placed within the tank 20 and forms part of the intake circuit.

The tank 60 has an opening at the top, the rim 61 of which is guided for vertical movement by the tube 62 which connects the interior of the tank 60 with the suction line 41 and which is fitted watertight in the opening 25 of tank 20. An airtight flexible seal is formed about the sliding junction 61, 62 by means of a short section of flexible corrugated rubber tube 63, or the like, which is clamped by means of rings 64 and 65 to the rim 61 and guide 62 respectively; the tube 63 is prevented from collapsing under the discharge pressure by means of metal rings 66 placed inside the tube, or any other convenient reinforcement.

The tank 60 also has an opening 70 at the bottom which leads into a spout or nozzle 71 fastened in a tube 72 which in turn leads through the opening 22 of the main tank and is fastened to the bottom of the main tank in any convenient manner; thus as shown in the drawings a flange 73 may serve to hold both the tube 72 and the pipe connection 23 and to fasten them watertight to the bottom of the main tank 20. The tube 72 has one or more ports 74 for admitting water from the reserve tank 20 to the pipe connection 23 and to the pump; and the tank 60 has fastened to its bottom a collar 75 which cooperates with the outer surface of tube 72 to guide the vertical movement of the tank 60, and which also serves as a shutter for the ports 74 as the tank 60 moves up and down. Before the outfit is first started the tanks 20 and 60 will usually both be filled, and upon starting the tank 60 will immediately be emptied by the pump, whereas the tank 20 always will remain filled. With the reserve tank 20 filled with water and with the submerged tank 60 empty, the latter will obviously move to its uppermost position, thereby opening the ports 74, as shown in Fig. 2 and admitting reserve water to the pump for priming.

With the pump running there will be a circulation of reserve water between the reserve tank 20 and the pump, which however, will be limited by the size of the ports to be only sufficient to safely

maintain the priming seal about the impeller blades in the pump. Under these conditions a vacuum will be set up in the suction line and the pump will take in air from the line 41 together with water from the reserve tank 20. By the arrangement of the ports 74 about the nozzle 71 the air and water will be thoroughly mixed when the flow enters the pump and there will be little danger of the prime breaking due to the continued intake of air. The pump thus will develop a continuous suction which is not appreciably impaired by the limited intake of reserve water.

When, upon continued operation, water enters the submerged tank 60 from the suction line 41, this tank will lose its buoyancy to a degree which depends on the amount of air taken in together with the main water flow. The tank 60 consequently will sink to more or less close the ports 74 and shut off the reserve water. The adjustment should preferably be such that, when enough water is being taken in from the suction line to safely maintain the priming seal about the propeller blades in the pump, the reserve water from tank 20 would be completely shut off.

This construction is simple and rugged and affords little chance for clogging by such litter and particles as are usually met with on contractor's jobs.

The outfit shown in Fig. 1 may be modified as shown in Fig. 3. In this embodiment the submerged tank 60 has a tubular guide portion 78 at its bottom which fits into the tube 72. The ports 74 communicate with the reserve water tank 20 through a passage 90 which has a mouth 91 opening directly into the tank 20. A pivoted shutter 92 is connected, as by a link 93, to the tank 60 to open and close the mouth 91 as the tank 60 is moved up and down, respectively, by the presence of varying amounts of water in its interior, thus controlling the flow of reserve water through the ports to the pump. A watertight seal 80, similar to the seal 63 at the top of tank 60, may be placed about the sliding junction 72, 78. On advantage of this embodiment is that grit is almost entirely prevented from entering the sliding junctions both at top and bottom of tank 60 and thus from interfering with the free movement of tank 60.

The embodiment shown in Figs. 4, 5 and 6 is arranged with the pump 110 submerged in the reserve water within the reserve tank 120, the discharge opening 113 of the pump opening directly into the reserve tank at a point immediately below the discharge connection 140, and the volute being fastened to the side of the reserve tank by means of the bearing structure 114 for the pump shaft 111 and screws 115.

The control tank 160 is formed into a tubular 180° elbow having the ends 161 and 170 arranged substantially in a common plane. The end 161 is pivoted at 167 in lugs 168 formed on the inside of the tank 120 and is in juxtaposition to the intake opening 125 through the tank wall; a flexible tubing 163 of waterproof material interconnects the tank 160 and the intake tube 125, the latter in turn connecting through the check valve 142 to the suction line 141.

The lower end 170 of the elbow 160 is in juxtaposition to the suction opening 112 of the pump and is adapted to seat against the rim of the suction opening for shutting off reserve water from the pump, when the elbow is filled with water during the operation of the pump. When the elbow carries little or no water its buoyancy will act to swing it about the pivot 167 and away from

the rim of the pump to admit reserve water through the annular opening thus formed, as shown in Fig. 6.

For the purpose of facilitating the operation of the elbow tube 160 a diaphragm 182 of flexible material, such as rubber reenforced with thread or fabric, is clamped across an opening 184 in the back of the elbow substantially opposite the suction opening 112. The diaphragm and its clamping are substantially airtight. A double shouldered pin 181 is clamped airtight to the center of the diaphragm, and a stationary bracket 183, mounted on the pump housing or in any other convenient manner, has its slotted end extending up between the shoulders of the pin 181 to practically prevent the pin from moving in a lengthwise direction, yet permitting a slight transverse movement of the pin when the tank 160 swings about the pivoting point 167 as shown in Fig. 6.

The object of the arrangement just described is to substantially neutralize the forces acting on the elbow 160 which are due to the suction within the elbow, so that the movements of the elbow will be due solely to the gravitational and buoyancy forces arising from the presence and absence, respectively, of water within the elbow. The consequences are that the angular movements of the elbow will bear a definite relation to the rate of water flow in the suction connection and that reserve water will be admitted in desired proportions to the air flow in the suction connection.

The explanation of this equalizing effect of the diaphragm may be found in the fact that the two lower openings 170 and 184 in the elbow are of the same size and face in opposite directions. Thus the suction forces acting on these two areas will always be equal and opposed. It is evident that the tendency of the suction forces is to reduce the volume of the elbow interior, for which reason the force acting at the suction opening will tend to swing the elbow toward the stationary pump, whereas the force acting at the diaphragm will tend to swing the elbow toward the stationary pin; these tendencies being practically equal in degree and opposed in direction, they will substantially neutralize each other.

An additional advantage of the present arrangement lies in the fact that when the elbow tube is contacting with the edge about the suction opening 112 and the main flow is decreasing any tendency of the elbow to stick to the edge on account of the high vacuum, will be counteracted by the tension in the diaphragm 182 which under this condition will be stretched as shown in Fig. 4. It is furthermore evident that by changing the size of the clamping rings for the diaphragm, or by choosing diaphragms of different rigidity it is possible to readily establish various operating properties of the outfit as desired.

In the two embodiments described above in connection with Figs. 1 and 4 the movable tank or chamber which controls the reserve flow is operated in one direction by the weight of the suction flow through the chamber and in the other direction by the buoyancy of the chamber in the surrounding reserve water.

The embodiment of the invention shown in Figs. 7 and 8 together with the auxiliary views in Figs. 9 to 12 is an example of a gravity counter-balanced movable chamber, which consequently is mounted outside the reserve water tank.

The pump 210 has its discharge side 213 connected through the opening 221 in the bottom of

the reserve water tank 220, from which the discharge water continues through the opening 224 in the top of the tank and out into a suitable discharge system 240.

5 The reserve water from tank 220 flows through the passage 290, which extends through the opening 222 in the bottom of the tank, and directly into the suction opening 212 of the pump.

10 The control tank or chamber 260 is inserted between the suction line 241 and the pump. The rim 261 at the intake opening of the chamber is formed to fit on the rim of the stationary intake annulus 225 formed in the standard 262; the rim of the output opening 270 of the chamber forms 15 a similar annular fit onto the suction opening attachment 272 on the suction opening of the pump. The two circular rims are aligned with each other and thus form bearings about which the tank 260 can swing.

20 The tank is shaped to be unsymmetrical with respect to its bearings, but forms a smooth, continuous path for the flow from the suction line into the pump; it has, however, preferably a baffle plate or obstruction 271 extending transversely of the straight path of the suction flow, between the openings within the bearings, thereby forcing the flow outward from said straight path. The overhanging portion of the tank 260 25 extends in a horizontal or nearly horizontal direction from its bearings, so that the weight of the liquid flowing in the suction line will tend to swing the overhanging portion downward. An adjustable counter-weight 300 is attached to the chamber 260 for swinging it in the upward direction when little or no water flows in the suction line and the chamber.

It should, of course, be understood that this arrangement may be modified by providing a 30 straight path for the greater part of the main suction flow between the openings 261 and 270 and for the chamber 260 to form a smaller by path for a proportion of the main flow.

35 This automatic action of the main suction flow through chamber 260 is utilized to control the reserve water flow through the passage 290, by causing it to control the position of the shutter or vane 292 to shut or open for the passage 290. The vane 292 is operated by a rod 293 which is 40 turned by a pinion 294 meshing with a toothed sector 295 fastened to or integral with the elbow chamber 260. The small angular movement of the chamber 260, shown in Figures 9 and 11, which is due to the absence or presence of water in the chamber, respectively, thus suffices to turn 45 the shutter 292 from the open to the closed positions shown in Figs. 10 and 12, respectively, thereby admitting reserve water to the pump or shutting it off therefrom.

50 The check valve 225 serves to prevent loss of reserve water, especially when the pump is not operating.

55 It is of course possible to use a large spring instead of the counter-weight for swinging the chamber 260 upward as shown in Fig. 13 by attaching one end of the spring 301 to the chamber and the other to a stationary part of the outfit.

60 In Figs. 14 and 15 is shown a suitable arrangement whereby the junction between the swinging tank 260 and the stationary parts may be made water-tight and air-tight. For this purpose an annular collar or ring 310, of waterproof, flexible material, such as rubber, is tightly clamped along one edge to the movable member, such as the rim 65 261 of the elbow 260, and along its other edge

to a flange 311 integral with the stationary member, such as the bearing standard 268 or fastened thereto in a manner to preclude passing of air 5 between these parts. The clamp on flange 311 is preferably corrugated to flute the flexible ring 310 and thus give it a freedom of movement in its own plane which a flat ring would not possess.

What is claimed is:

1. A centrifugal pump for pumping liquids, a priming flow system, valving means for controlling the flow of priming liquid from said system to said pump, a main flow system connected to said pump, and a movable chamber inserted in said main flow system and connected to open said 10 valving means as the rate of the main flow through said chamber decreases and to close said valving means as said rate of flow increases. 15

2. A pumping system for pumping gas and liquid comprising a centrifugal pump, a source of priming liquid, a passage for the flow from said source into said pump, and a main flow connection for said pump having a portion thereof movable in accordance with the rate of the main liquid flow to control the flow in said passage. 20

3. A pumping system for pumping gas and liquid comprising a centrifugal pump, a priming flow connection to said pump, valving means for control of the flow through said priming flow connection into said pump, and a main flow connection for said pump having a short section thereof movable by the flow therethrough to operate said valving means in accordance with the rate of liquid flow through said section. 25

4. A pumping system in accordance with claim 3 in which said section is movable in a direction parallel with the direction of the flow therethrough. 30

5. A pumping system in accordance with claim 3 in which said section is movable in a direction at right angles to the direction of the flow therethrough. 35

6. A pumping system for pumping gas and liquid comprising a centrifugal pump, a priming flow connection to the suction side of said pump, 40 valving means for control of the flow through said connection, a main flow connection to the suction side of said pump and a movable chamber connected to said main flow connection to carry at least a portion of the flow in said main flow connection and to be moved in accordance with the rate of liquid flow in said chamber to operate said valving means accordingly. 45

7. A centrifugal pump, a priming tank above said pump, valve means for control of reserve 50 flow from said tank into said pump, a suction connection from said pump to a main flow supply, a movable chamber serially connected into said suction connection and counterbalanced to operate said valve means in accordance with the weight of the flow at any moment passing through said chamber. 55

8. An impeller pump, a priming tank above said pump, a passage for a reserve flow from said tank into said pump, a suction connection from said pump to a main flow supply, said connection having a U-shaped movable section and said section being hinged and counterbalanced and connected to vary said passage in accordance with the weight of the flow at any moment passing 60 through said section. 65

9. An impeller pump, a tank for reserve water above said pump, valving means for control of reserve water flow from said tank into said pump, a suction connection from said pump to a main 70

water supply, an overhanging U-shaped portion of said suction connection, bearings for both ends of said portion, means for counterbalancing said overhanging portion and mechanical means for control of said valving means by the movements of said U-shaped portion in accordance with the weight of water present at any moment in said portion.

10. In combination an impeller pump for air and water, a main circuit for said pump, a tank containing reserve water for said pump, a movable chamber submerged in said tank and connected in said main circuit for varying its position in accordance with the ratio of air to water passing through said main circuit, and valving means connected to said chamber for control of the flow of reserve water from said tank for priming of said pump in accordance with the varying positions of said chamber.

11. In combination, a centrifugal pump for gas and liquid, a tank for reserve liquid, a main circuit including said pump, a movable chamber forming a part of said circuit, a passage from said tank to said main circuit, valving means connected to said chamber and included in said passage for the control of reserve water flow to said pump, said chamber being subject to internal pressure resulting from the proportion of gas to water within said chamber for movement in one direction and to an external pressure from the liquid in said tank for movement in the opposite direction for the operation of said valving means.

12. In a self-priming pumping outfit for pumping of air and water, an impeller pump having a main circuit including intake and discharge openings and connections therefor, a tank for storage of reserve water having connecting passages to said openings, a movable chamber within said tank connected into said intake connection and adapted to be moved in one direction by the water in said chamber and to be moved in the opposite direction by the water in said tank when said chamber contains air and valve means mechanically connected to said chamber for control of the flow of reserve water from said tank through said pump in accordance with the positions of said chamber.

13. An impeller pump for air and water, an intake circuit and a discharge circuit for said pump, a tank containing reserve water for said pump, a passage between said tank and said intake circuit, a floating container connected into said intake circuit and placed within said tank to be subject to opposing pressures by the water in said tank and the intake water within said container in accordance with the proportion of air in the intake water, movable connections between said container and said intake circuit, valving means for said passage controlled by the movements of said container under said opposing pressures to admit reserve water to said in-

take circuit in accordance with the proportion of air in the intake water.

14. An impeller pump for air and water, an intake circuit and a discharge circuit for said pump, a tank containing reserve water for said pump, a passage between said tank and said intake circuit, a floating container connected into said intake circuit, and placed within said tank to be subject to opposing pressures by the water in said tank and the intake water within said container in accordance with the proportion of air in the intake water, a flexible connection from the intake side of said container and a sliding connection from the output side of said container to said intake circuit, said sliding connection comprising a stationary element forming part of said intake circuit and a moving element forming part of said container, a port for passage of reserve water in one of said elements to be opened and closed by the relative movements of said elements for admission of reserve water to said pump in accordance with the proportions of air in the intake water.

15. An impeller pump for air and water, an intake circuit for said pump, a tank containing reserve water for said pump, a passage between said tank and said intake circuit, a container connected into said intake circuit and submerged in the reserve water in said tank, said container being mounted for movement relative to said tank and connected to open and close said passage in accordance with the ratio of air to water in the flow from said intake circuit.

16. An impeller pump for air and water, an intake circuit for said pump, a container for reserve water for said pump, a passage between said container and said intake circuit, said intake circuit passing through said container and having a movable portion submerged in said container and subject to a buoyant force from air passing through said section to open said passage for admitting reserve water to said pump.

17. An impeller pump for air and water having an intake opening, a container of reserve water, an intake circuit for said pump from a main supply having a section submerged in said container, said section being hinged at one end and being formed at the other end to alternately seat against said intake opening and to separate from said intake opening when the main flow through said section is all water and all air, respectively, to control the flow of reserve water from said container to said pump through said intake opening.

18. A pumping system in accordance with claim 17 in which said submerged section has an airtight piston-like insert in one wall and mounting means are provided for holding said insert substantially stationary relative to the movements of said section to compensate for the suction effect at the seated end of said section.

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