July 26, 1949. A. V. MUELLER 2,477,079

PUMP

Filed May 18, 1946 6 Sheets-Sheet 1

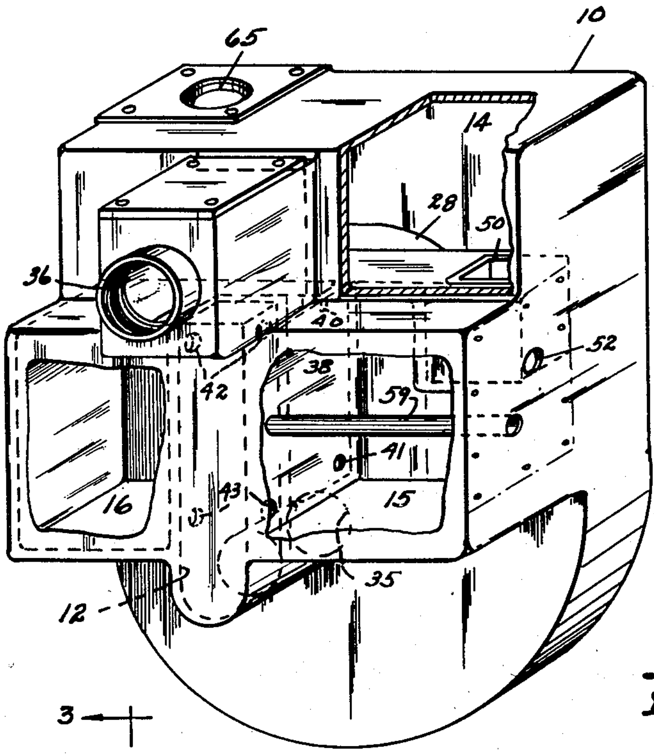

FIG. 1

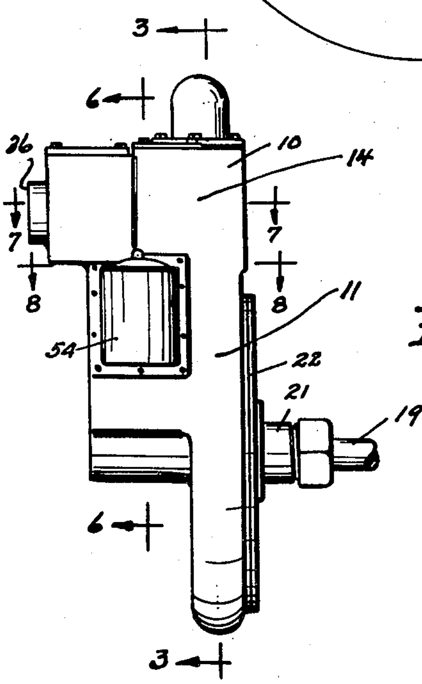

FIG. 2

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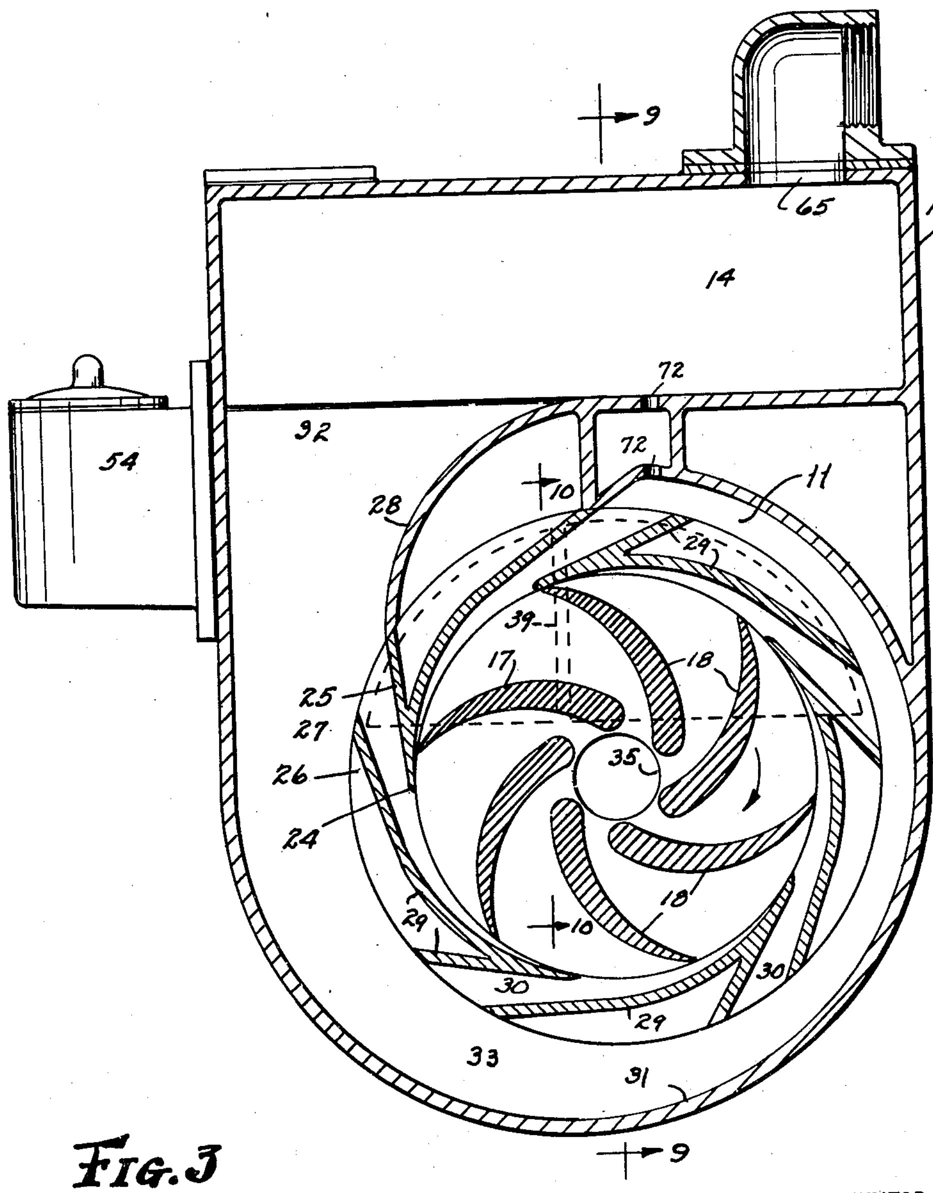

FIG. 3

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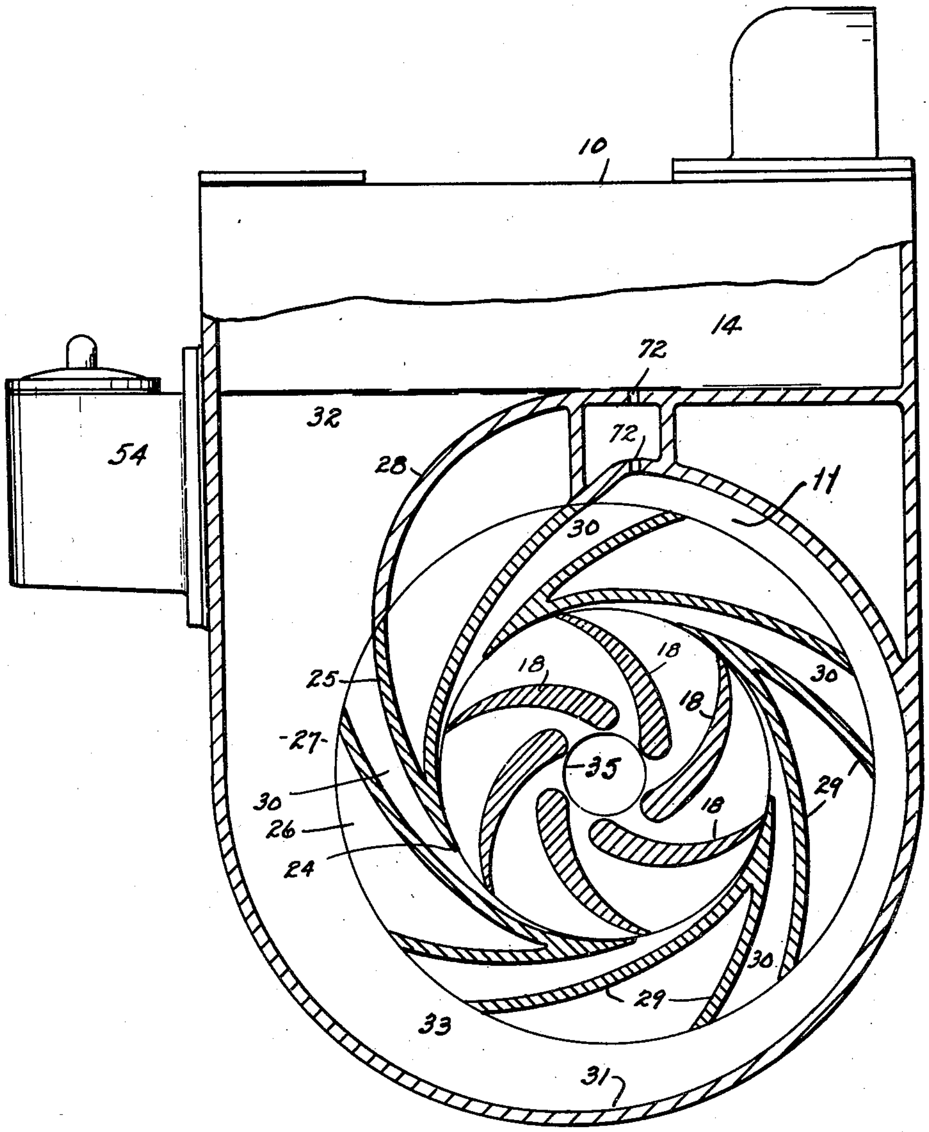

FIG. 4

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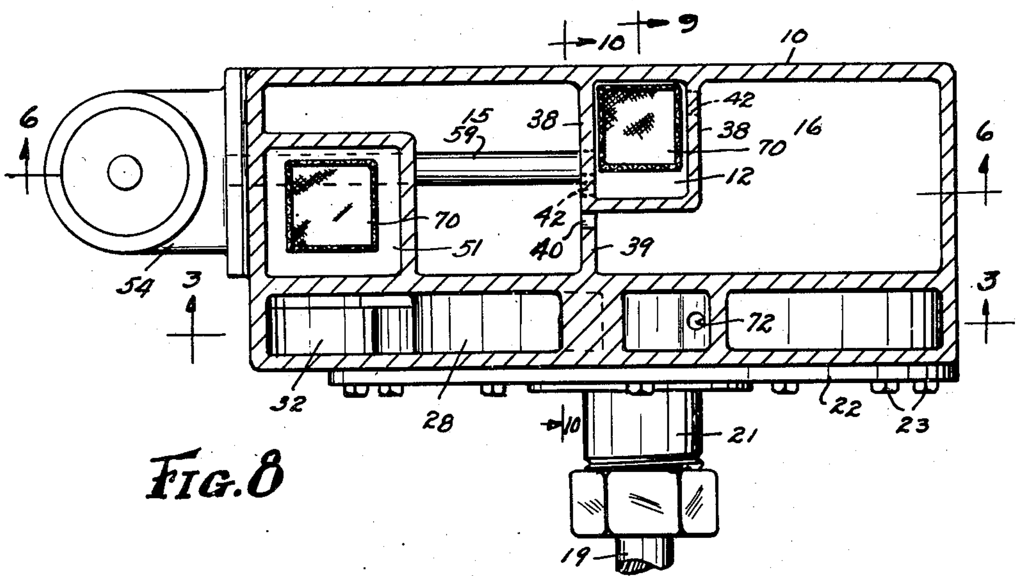

FIG. 8

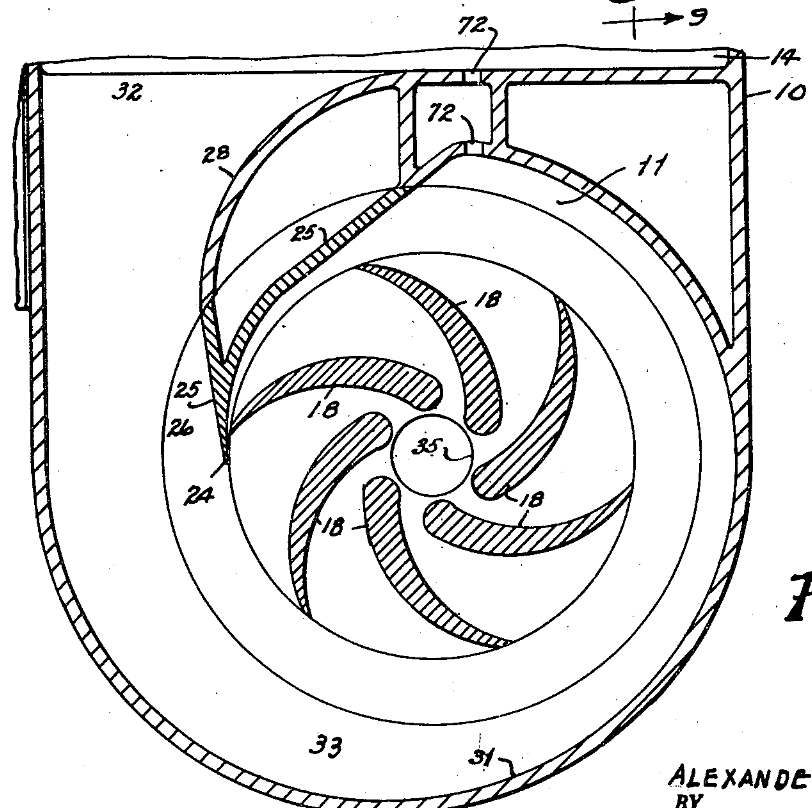

FIG. 5

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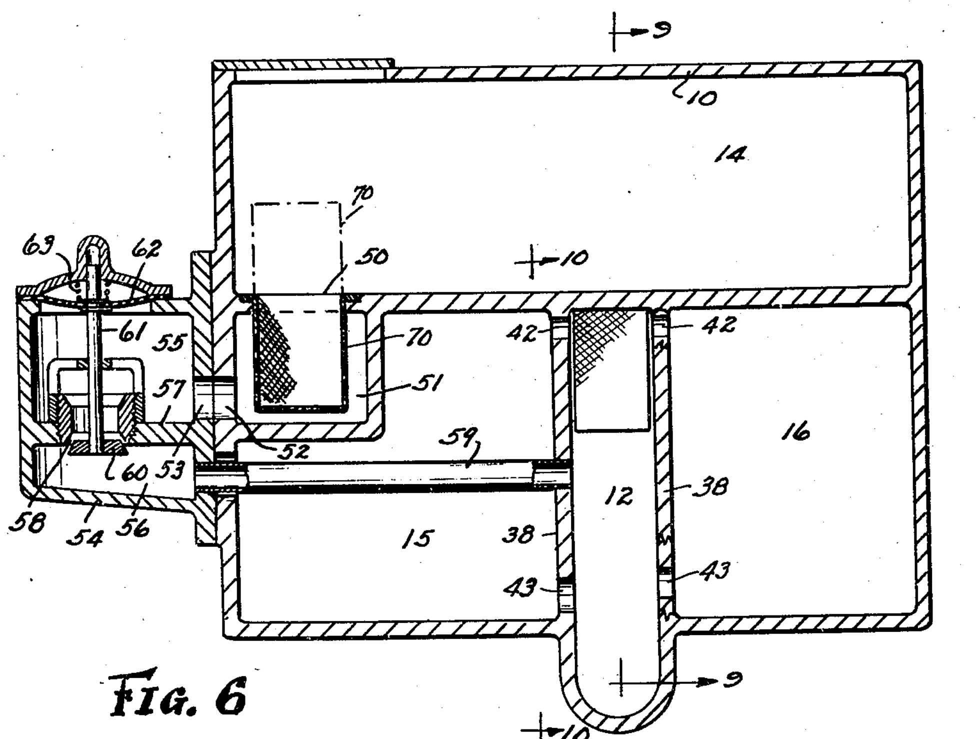

FIG. 6

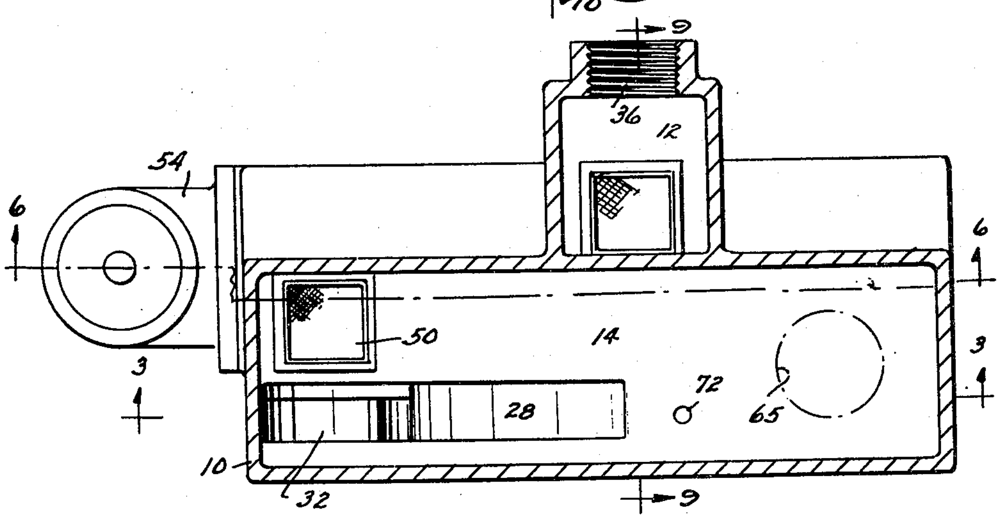

FIG. 7

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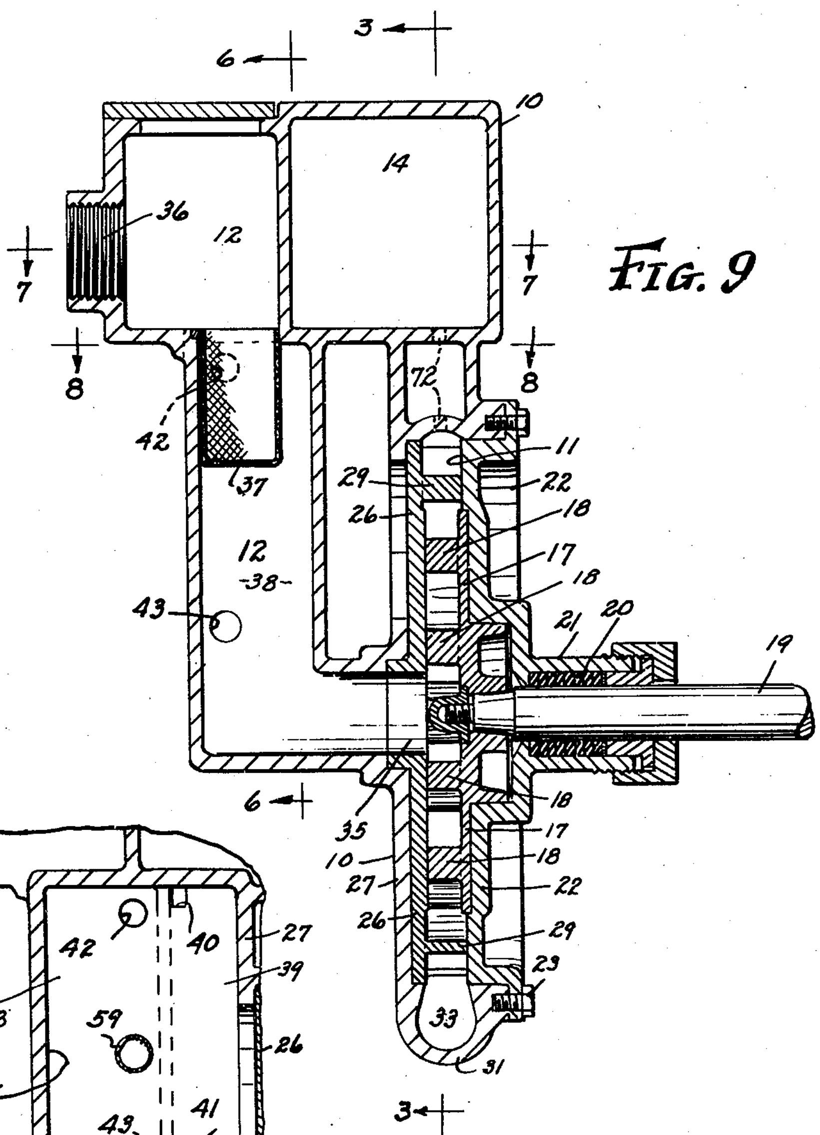

FIG. 9

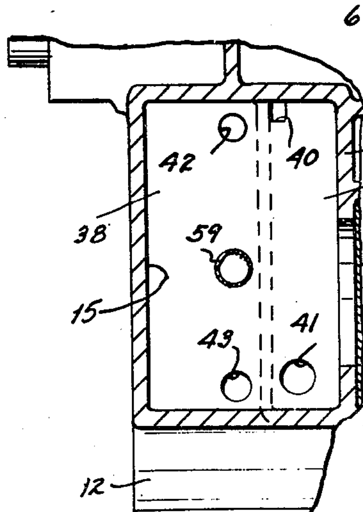

FIG. 10

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2,477,079

UNITED STATES PATENT OFFICE

2,477,079

PUMP

Alexander V. Mueller, Salem, Ohio, assignor to The Deming Company, Salem, Ohio, a corporation of Ohio

Application May 18, 1946, Serial No. 670,657

18 Claims. (Cl. 103—113)

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This invention relates to improvements in self-priming pumps, and particularly to a self-priming rotary pump which, after the pump is initially primed, will reprime itself automatically. These, therefore, are the general objects of this invention.

Repeated attempts have been made to provide a self-priming pump which, when either the source of power or the supply of liquid at the pump intake is for any reason interrupted, will reprime itself automatically, consequent upon the correction of such interruption. One of the difficulties encountered has been the siphoning of all of the liquid, including the priming liquid from the pump through the suction line when an interruption in the functioning of the pump occurs. At the present time, pumps which are designated as self-priming, generally rely upon a check valve at the foot of the suction line and/or in the pump itself to prevent this siphoning action. In some instances special air inlet or snuffle valves have been arranged to admit air to the suction line of the pump to thereby prevent the withdrawal or siphoning of the priming liquid from the pump when the supply of liquid to the suction line becomes exhausted.

This use of check valves and the like to facilitate the priming of the pump is far from satisfactory. Such valves are generally subject to failures particularly seepage and therefore are generally, if at all, effective only for interruptions of relatively short periods of time. Further, when pumps are used to pump materials containing solids, foreign matter and the like, such as when pumping from sumps, as in mines, excavations, and the like where sand and other foreign matter is encountered, check valves frequently are held open by particles of non-fluid matter. Further, such valves are generally inaccessible and difficult to repair or replace without dismantling the entire pumping system. The equipment of the foot of the suction line with screens sufficiently fine to prevent particles of foreign matter from reaching the check or foot valves results in premature clogging of the screen and consequent failure of the pump.

The use of snuffle valves to open the suction line to atmosphere is also disadvantageous as they, likewise, are subject to failure due to the presence of foreign particles. The failure of either a check valve or a snuffle valve causes a complete failure of the functioning of the pump. The failure of a check valve causes the failure of the pump after an interruption of either the power or the fluid supply, while the failure of a

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snuffle valve causes the failure of the pump immediately.

It is an object of the present invention to provide a pump, and particularly a valveless pump such as a rotary or centrifugal pump, which pump will overcome the disadvantages above mentioned and, when once primed and interrupted, will reprime itself automatically consequent upon the elimination of the cause of interruption.

A further object of the present invention is to provide a pump of the valveless type which reprimes itself automatically, and without the aid of foot valves, check valves, and the like.

Another object of this invention is to provide an improved centrifugal pump having a minimum number of moving parts, and which may be readily and economically manufactured and assembled.

A more specific object of the invention is to provide a pump which may be used to pump liquids containing foreign matter such as weeds, solid particles, and the like, and which pump will reprime itself despite the presence of such foreign matter in the pumping system.

A further object is to provide a pump which may be readily converted for various types of uses and capacities.

Other objects and advantages of this invention will become more apparent from the following description, reference being had to a preferred embodiment thereof illustrated in the accompanying drawings. The essential features of the invention will be summarized in the claims.

In the drawings, Fig. 1 is a perspective view of one form of the improved pump, certain portions thereof being broken away to more clearly illustrate the internal construction; Fig. 2 is a side elevation of the pump on a scale somewhat smaller than that of Fig. 1 and looking at the right-hand side of such figure; Fig. 3 is a vertical section taken in substantially the plane indicated by the lines 3—3 on Figs. 2, 7, 8 and 9; Figs. 4 and 5 are sectional views similar to Fig. 3 but illustrating the arrangement of the pump for different uses and capacities; Fig. 6 is a vertical section through the pump casing and is indicated by the lines 6—6 on Figs. 2, 7, 8 and 9; Figs. 7 and 8 are substantially horizontal sections as indicated by the correspondingly numbered lines on Figs. 2 and 9; Fig. 9 is a vertical section taken thorugh the axis of the pump, the plane of the section being indicated by the lines 9—9 on Figs. 7 and 8; and Fig. 10 is a fragmentary vertical section, the plane of the section being indicated by the lines 10—10 on Fig. 6.

Referring now to the drawings and particularly to Figs. 1, 2 and 9, it will be seen that my improved pump has a housing 10 provided with a pump chamber 11, a suction passageway 12, a stilling chamber 14, and a pair of supplemental suction or priming chambers 15 and 16. As illustrated, the pump is of the centrifugal or impeller type having an open type impeller 17 provided with vanes 18. The impeller is mounted on and driven by a horizontally extending shaft 19 which extends through a stuffing box 20 formed in a boss-like formation 21 on a plate 22. This plate is secured to the open face of the housing 10 by bolts 23, thereby closing the pump chamber. Any suitable bearing structure for the shaft 19 may be carried by the plate 22 and a driving connection may be established with the shaft 19 in the usual manner.

The pump chamber 11 is provided with the customary cut-off tongue 24. As shown in Figs. 3, 4 and 5 this cut-off is formed by a wall or web 25 formed on a plate 26. This plate forms the inner wall of the pump chamber, being clamped against a wall 27 of the housing 10 by the closure plate 22. The cut-off tongue 24 is preferably located in one side of the impeller, that is, disposed in a horizontal plane substantially passing through the axis of rotation of the impeller. The wall 25 forms a continuation of a wall 28 formed by the pump housing. As shown in Figs. 3 and 4, the plate 26 is provided with a plurality of webs 29 which extend across the pump chamber and which form diffuser passageways 30.

The diffuser passageways 30 increase in cross sectional area as they recede from the periphery of the impeller, and extend to a point spaced from the circumferential wall 31 of the pump chamber 11. The wall 31 is formed in the nature of a volute and is eccentric relative to the pump axis so that the space 33 between the periphery of the diffuser member and the wall increases in cross sectional area in the direction of rotation of the impeller indicated by the arrow in Fig. 3. The wall 28 of the housing, heretofore mentioned, is shaped so that the discharge passageway 32 of the pump leading from the volute passage 33 upwardly into the stilling chamber 14 also increases in cross sectional area as it passes from the pump chamber 11 to the stilling chamber 14. The diffuser passageways 30 together with the volute chamber 33 and the discharge passageway 32 act to transform the kinetic energy imparted to the fluid by the impeller 17 into fluid pressure efficiently.

The stilling chamber 14, as shown in Figs. 2, 3 and 9, is positioned above the pump chamber 11. The chamber 14 is of at least a sufficient size to contain a quantity of fluid which will insure priming of the pump, that is, a quantity of liquid more than sufficient to maintain the level of the liquid above a horizontal line passing through the pump above the pump inlet opening or eye 35.

Fluid is drawn into the pump through the suction passageway 12 which extends from the eye 35 of the impeller axially, thence upwardly to a point above the impeller eye 35 where a suitable flange or threaded opening 36 is provided to facilitate the connection on a suction conduit (not shown) to the housing 10. Generally the suction conduit extends downward a considerable distance from the pump to a wall or sump. A screen 37 is shown in the passageway 12. However, the screen may be eliminated as heretofore mentioned.

The supplemental suction or priming chambers 15 and 16, are, as shown in Figs. 1 and 6, positioned above the pump eye 35 and below the stilling chamber 14. As illustrated, these chambers lie back of the pump chamber 11. The combined area of the chambers 15 and 16 is such that they may contain a quantity of liquid sufficient to prime the pump, that is, to submerge the impeller to such an extent as to completely separate the suction passageway 12 from the pump outlet 32, and the stilling chamber 14 is of sufficient size to retain such quantity of liquid.

The priming chambers 15 and 16, as illustrated in Figs. 6 and 8, are separated from each other by the walls 38 of the suction passageway 12 and by a wall 39 which extends from one of the walls 38 to the wall of the pump chamber 11. Communication is provided between the two chambers 15 and 16 by ports 40 and 41 (Fig. 10) in the wall 39, the port 40 being located adjacent the top of the chambers and the port 41 adjacent the bottom thereof. The cross sectional area of the ports 40 and 41 may be comparatively small so that only a restricted communication may be established between the two chambers.

The priming chambers 15 and 16 communicate with the suction passageway 12. As shown in Fig. 6, the walls 38 of the suction passageway are each provided with a port 42 and a port 43 located adjacent the top and bottom respectively of the chambers 15 and 16. The ports 42 and 43 provide restricted and independent passageways between each priming chamber and the suction passageway 12. Thus, the only communication with the chambers 15 and 16 is via the ports 40 and 41 which afford intercommunication between the chambers, and the ports 42 and 43 which afford a restricted and independent communication between each chamber and the suction passageway 12. The priming chambers 15 and 16 serve, as will hereinafter be more fully described, to store priming liquid in the pump despite siphoning actions.

The automatic repriming of the pump utilizes a recirculation of liquid from the stilling chamber 14 to the suction passageway 12. As shown in the drawings, and particularly in Fig. 6, the stilling chamber 14 has a port 50 communicating with a small chamber 51 formed in the housing 10. The chamber 51 is provided with a port 52 which forms a passageway through the external wall of the pump housing. This passageway communicates with a port 53 in a recirculating valve housing 54 which is secured to the exterior of the pump housing 10. The housing 54 is provided with upper and lower chambers 55 and 56 separated by a partition 57. Liquid enters the upper valve chamber 55 through the port 53 and passes into the lower chamber through a valve port 58 formed in a partition 57. A conduit 59 extends from the chamber 56 through the priming chamber 15 and discharges into the suction passageway 12 as indicated in Fig. 6. Thus, so long as the valve port 58 remains open a portion of the liquid being pumped to the stilling chamber 14 will recirculate to the pump intake.

The flow of the recirculating liquid through the port 58 is controlled by a valve 60 mounted on a valve stem 61 which is carried by a spring pressed diaphragm 62. This diaphragm is exposed to the pressure in the upper portion of the valve housing which is at all times substantially equal to that in the stilling chamber. The spring

63, which may, if desired, be adjustable, preloads the diaphragm 62 such that the valve 60 will be held open until the desired discharge pressure is reached in the chamber 14 whereupon the action of this pressure against the diaphragm 62 will raise the valve 60 closing the port 58 and stopping the recirculation of the liquid. The use of the conduit 59 is preferable; however, recirculation may be effected by omitting this conduit whereupon the recirculating fluid will pass to the passageway 12 through the chamber 15. The use of the conduit 59 adds to the efficiency of the pump.

As heretofore mentioned, when the pump is initially placed in operation, a quantity of liquid, sufficient to prime the pump, is placed in the stilling chamber 14. Generally speaking, the amount of liquid required is an amount sufficient to maintain liquid at the pump eye, and to enable recirculation of liquid from the stilling chamber through the recirculating valve to the pump eye.

After the pump has been initially primed and placed in operation it will evacute the suction passageway and the suction line of air, pumping the air and some liquid into the stilling chamber where the air separates from the liquid. The liquid passes through the recirculating valve and back through the conduit 59 into the suction passageway 12 to maintain the pump primed. The air passes outward from the chamber through the discharge opening 65 thereof. As soon as the suction line and passageway 12 have been pumped free from air, liquid flows into the pump and, due to the restricted nature of the discharge opening 65 relative to the stilling chamber 14, a pressure is built up in the stilling chamber whereupon this pressure acts on the diaphragm 62 to close the recirculating valve 60 and stop the recirculation of the liquid, thereby preventing loss of efficiency of the pump. When the flow of liquid from the suction line fills the suction passageway 12 it likewise fills the priming chambers 15 and 16. Such chambers are subjected to the substantially same degree of vacuum or suction as the passageway 12. Accordingly they quickly fill with liquid.

As heretofore mentioned, neither the pump nor the discharge conduit is provided with a check valve to prevent the flow of fluid in the reverse direction through the pump housing and the discharge conduit, should for any reason the pump impeller cease its rotation or materially slow down. Accordingly, any interruption of the rotation of the impeller 17, whether intentional or unintentional, will result in a siphoning action.

In the normal operation of the pump the stilling chamber 14 is substantially filled with liquid under discharge pressure while the suction passageway 12 and the priming chambers 15 and 16, which are under the influence of a partial vacuum also, are also substantially filled with liquid and the recirculating valve is held closed by the discharge pressure in the chamber 14. When the impeller 17 ceases to rotate or has its speed of rotation materially decreased, the pressure in the stilling chamber immediately drops, and the spring 63 opens the recirculating valve 60. Simultaneously a siphoning action takes place in the suction line and the liquid normally flowing from the suction line through the suction passageway 12 and the eye of the pump into the pump chamber 11, immediately reverses its direction of flow, so that it flows from the pump chamber through the suction passageway 12 into the suction line which, ordinarily, is located some distance below the pump level. This reversal of liquid flow through the pump is almost instantaneous and is accompanied by an almost instantaneous change in pressure. When the pump impeller 17 is stopped, the pressure in the suction passageway 12 immediately rises to atmospheric pressure and then quickly drops below atmospheric pressure. The amount of this drop depends somewhat upon the height of the pump above the liquid level from which it was pumping.

The pressure in the priming chambers 15 and 16 during the normal pumping operation is below atmospheric pressure and changes with the change of pressure in the suction passageway. However, during this change in pressure, the passageway 12 is filled with liquid. Accordingly no liquid flows from the chambers 15 and 16. Indeed as the chambers 15 and 16 are under a subatmospheric pressure or vacuum during the normal pumping and as they have no communication except with each other and with the suction passageway 12, liquid tends to enter these chambers during the reversal of the direction of flow in the passageway 12. As the reversal of direction of flow of liquid in the passageway 12 is almost instantaneous, and as the chambers 15 and 16 are out of the path of liquid flowing through the passageway 12, the liquid content of such chambers remains substantially unchanged while there is liquid in the passageway 12, regardless of the direction of flow of such liquid.

During the siphoning action liquid flows from the stilling chamber 14 and the pump chamber 11 through the suction passageway 12 and the suction conduit into the well or sump. As soon as the liquid is exhausted from the stilling chamber 14 and the pump chamber 11, air reaches the suction passageway 12 and immediately breaks the siphoning action. The pressure in the passageway 12 accordingly falls to atmospheric pressure whereupon the liquid from the chambers 15 and 16 drains through the openings 43 into the passageway 12 and thence to the eye of the impeller. The chambers 15 and 16 contain sufficient liquid to prime the pump in the manner heretofore described. Therefore, consequent upon the restoration of the power the rotor or impeller will cause the pump to prime as heretofore explained and as soon as liquid flows from the suction line into the suction passageway 12, the chambers 15 and 16 will refill with liquid, and the pressure will be restored in the stilling chamber 14, causing the recirculation valve to automatically close.

Should for any reason the liquid in the sump or well drop below the bottom of the suction conduit the pump ceases to function. However, upon the restoration of the liquid supply, the pump of the present invention will reprime itself automatically.

When no more liquid is available, either from the suction line, the passageway 12 or the chambers 15 and 16, the continued rotation of the impeller 17 acts as a fan and retains liquid in the stilling chamber 14 above the pump chamber 11. Inasmuch as the impeller is air bound it can generate no liquid pressure. Accordingly, there is no liquid flow from the pump and no pressure in the chamber 14. Consequently, the recirculating valve 55 automatically opens, causing the liquid to recirculate from the chamber 14 into the suction passageway 12. Thus the pump in effect draws some air from the suction conduit through the passageway and discharges it with liquid into the chamber 14 which acts as a stilling chamber. The air passes out of the pump and the liquid returns through the recirculation valve to the pump intake. Thus, as long as the liquid in the sump or well is below the level of the bottom of the suction line, the pump merely recirculates liquid through the pump itself.

When the liquid in the sump or well rises to again cover the bottom of the suction conduit, the recirculating liquid automatically reprimes the pump, and as soon as liquid again reaches the passageway 12 it fills the chambers 15 and 16. Accordingly, it will be seen that the improved pump reprimes itself even when, for any reason, the pump rotor ceases its rotation or when the supply of liquid pumped becomes exhausted, and the pump will immediately and automatically re-prime itself consequent upon the restoration of the power or the restoration of the source of liquid being pumped.

While I have described the use of two priming chambers, namely the chambers 15 and 16, the pump will operate with one chamber. Under some conditions, the use of a plurality of chambers, each independently connected with the suction passageway 12, is an advantage. To facilitate illustration, only two such chambers have been described. The passageways which connect these chambers (15 and 16) with the suction passageway 12 are restricted in cross sectional area so as to insure retention of liquid therein during the siphoning action. During the siphoning each chamber acts quite independent of the other, so far as the relation of their liquid contents and the effect of the siphoning fluid thereon are concerned. However, the size of the openings into the chambers remains constant whether one or a plurality of chambers are used.

While I have utilized a valve in the recirculating passageway, a failure of this valve to close, unlike the failure of check valves to close, does not materially affect the operation of the pump. Should the valve 60 for any reason fail to close, the pump will operate to reprime itself equally as well as though this valve had closed. Therefore, seepage through the valve 60 is immaterial so far as the repriming operation is concerned. Indeed as the sole purpose of this valve is to increase the efficiency of the pump during normal operations it may be eliminated.

A strainer 70 is disposed in the passageway in the chamber 51 leading from the stilling chamber 14 to the recirculating valve to protect this valve against the flow of foreign particles. While this strainer is shown as being positioned in the chamber 51 it may be inverted and positioned in the chamber 14, as indicated by the dot and dash lines in Fig. 6, and when in the latter position the flow of liquid in the stilling chamber will prevent clogging of the strainer.

Inasmuch as fluid cut-off 24 is positioned substantially upon a horizontal axis, I may provide the pump chamber 11 with a vent 72. This vent permits the filling of the pump chamber with liquid to a point above the eye of the pump by permitting the escape of trapped air. This vent is normally sealed by the liquid in the chamber 14 and is comparatively small so that it has practically no effect upon the efficiency of operation of the pump.

The pump is arranged so that it may be readily adapted for different capacities. This is ordinarily accomplished in pump structures by reducing the size or diameter of the pump impeller and generally requires an entire new pump casing for each size of impeller. However, in the present structure a different sized impeller may be substituted for the one in use by merely removing the diffuser plate and replacing it with another having diffusing passageways of a somewhat greater length to thereby compensate for the difference in size or diameter of the impeller. This feature forms the subject matter of my divisional application, Ser. No. 1,729, filed January 12, 1948. Herein, it is best illustrated in Figs. 3 and 4 where it is evident than the impeller in Fig. 4 is considerably smaller in diameter than in Fig. 3, and the width of the annulus of the diffuser vanes has been enlarged to compensate for the decrease in the diameter of the impeller.

The pump may also be used as a contractor's pump where it is desired to pump from sumps or excavations where foreign material, such as weeds and the like, are apt to exist. Under these conditions the diffuser plate is removed and a plate substituted therefor which has merely the cut-off member 24. Such a construction is shown in Fig. 5.

From the above description it will be seen that I have provided a pump which will reprime itself automatically and which does not rely on check valves and the like to prevent siphoning, and which pump is readily adapted for different capacities and uses. Thus the pump may be used at one time for one purpose and for one capacity, and it may be readily changed for use either at another capacity or for another purpose without necessitating the replacement of the entire pump structure.

I claim:

1. A centrifugal pump, a pump chamber having an inlet and an outlet, rotary impeller means in said chamber, a substantially enclosed stilling chamber positioned above the pump communicating with the outlet of the pump and having a discharge opening whereby pressure may be built in said chamber by said pump, a suction passageway communicating with the pump inlet and having a suction inlet positioned above the pump inlet whereby liquid may be trapped in the pump, a liquid storage chamber out of the path of fluid flowing through the suction passageway and out of communication with the stilling chamber, a restricted passageway between the storage chamber and the suction passageway, a recirculating conduit between the stilling chamber and the suction passageway, said chambers being arranged to permit the flow of liquid from the stilling chamber through the recirculating passageway to the suction passageway and from the storage chamber to the suction passageway under the influence of gravity.

2. A rotary pump, a pump chamber, a rotary impeller therein, said pump chamber having an inlet opening and an outlet opening, a stilling chamber communicating with the outlet of the pump and having a discharge opening, a storage chamber positioned below the outlet opening of the pump and above the inlet thereof, a suction passageway for said pump communicating with the pump inlet and having a suction inlet positioned above the pump inlet, a restricted passageway between the storage chamber and the suction passageway, a liquid recirculating passageway between the stilling chamber and said suction passageway, said recirculating passageway connecting with the suction passageway at a point below the top of the storage chamber.

3. A centrifugal pump having a pump chamber having an inlet and an outlet, a rotary impeller in said chamber, a stilling chamber communicating with said pump outlet and provided

with a discharge opening, a suction passageway communicating with said pump inlet, an inlet for the suction passageway positioned above the pump inlet, a plurality of fluid storage chambers positioned out of the line of flow through said suction passageway, an independent restricted passageway between each of said storage chambers and said suction passageway, a fluid recirculating conduit between said stilling chamber and said suction passageway, said chambers being arranged to permit the flow of liquid from the stilling chamber to the suction passageway and from the storage chambers to the suction passageway solely under the influence of gravity.

4. A centrifugal pump having a pump chamber provided with an inlet and an outlet, a rotary impeller in said chamber, a stilling chamber communicating with said pump outlet and having a discharge opening, a suction passageway communicating with said pump inlet, an inlet port for the suction passageway positioned above the pump inlet, a plurality of fluid storage chambers positioned out of the line of flow of fluid through said suction passageway, an independent restricted passageway between the top of each of said storage chambers and said suction passageway, an independent passageway between the bottom of each of said storage chambers and said suction passageway, a restricted passageway between said storage chambers, a liquid recirculating conduit between said stilling chamber and said suction passageway, said chambers being arranged to permit the flow of liquid from the stilling chamber to the suction passageway and from the storage chambers to the suction passageway solely under the influence of gravity.

5. In a pump, a housing, a pump chamber formed in said housing, a rotary pump member in said pump chamber, a stilling chamber formed in said housing and provided with a discharge opening, said stilling chamber positioned above said pump chamber and directly connected therewith, a fluid inlet passageway formed in said housing and terminating at the inlet of the pump chamber and having a fluid inlet port positioned above the pump inlet, a storage chamber formed in said housing and positioned above the inlet to the pump chamber, a restricted passageway between the top of the storage chamber and the suction passageway, a restricted passageway between the bottom of the storage chamber and the suction passageway, and a recirculating conduit extending between the stilling chamber and the suction passageway.

6. In a pump, a housing, a pump chamber formed in said housing, a rotary pump member in said pump chamber, a stilling chamber formed in said housing and provided with a discharge and inlet openings, said stilling chamber being positioned above said pump chamber and directly connected therewith, an inlet passageway terminating at the inlet to the pump chamber and having a fluid inlet at a point above the bottom of the stilling chamber, a pair of storage chambers formed in said housing and positioned intermediate the bottom of the stilling chamber and the inlet to the pump chamber, an independent passageway between the top of each of the storage chambers and the suction passageway, an independent restricted passageway between the bottom of each of the storage chambers and the suction passageway, and a recirculating conduit extending between the stilling chamber and the suction passageway, a valve in said recirculating passageway, and means responsive to fluid pressure in the stilling chamber to control the operation of said valve.

7. A centrifugal pump having a pump chamber provided with an inlet port and a discharge passageway, a rotary impeller in said chamber, a stilling chamber positioned above and communicating with said passageway, said discharge passageway increasing in cross-sectional area as it approaches said stilling chamber, said stilling chamber having a discharge opening adjacent its upper end, a suction passageway communicating with said pump inlet, a fluid inlet opening into the suction passageway and positioned above the pump inlet, a fluid storage chamber positioned out of the line of flow of fluid through said passageway, a restricted passageway between the said storage chamber and said suction passageway, a recirculating conduit between said stilling chamber and said suction passageway, said chambers being arranged to permit the flow of liquid from the stilling chamber to the suction passageway and from the storage chamber to the suction passageway solely under the influence of gravity.

8. A centrifugal pump having a pump chamber provided with an inlet and an outlet, rotary impeller means in said chamber, a substantially enclosed stilling chamber positioned above the pump and in communication with the outlet thereof, said chamber having a restricted discharge opening whereby pressure may be built in said chamber by said pump, a suction passageway communicating with the pump inlet and having a fluid inlet positioned above the pump inlet whereby liquid may be trapped in the pump, a pair of storage chambers positioned on opposite sides of said suction passageway, a restricted passageway between each of the storage chambers and the suction passageway, a recirculating conduit between the stilling chamber and the suction passageway, said chambers being arranged to permit the flow of fluid from the stilling chamber through the recirculating passageway to the suction passageway and from the storage chambers to the suction passageway under the influence of gravity.

9. In a pump a housing having a pump chamber arranged to receive a rotary impeller mounted with its axis in a horizontal plane, said housing having a stilling chamber above said pump chamber and directly connecting with the discharge thereof, said stilling chamber being provided with a discharge opening, an inlet opening into said pump chamber substantially along the axis of rotation of the impeller, a suction passageway formed in said housing and having one end in communication with the inlet opening to the impeller, a suction inlet for said passageway positioned above the bottom of said stilling chamber, a storage chamber positioned at one side of said suction passageway having its bottom positioned above the top of the pump inlet and its top below the stilling chamber, a restricted opening between the top of said storage chamber and said suction passageway, a restricted opening between the bottom of said storage chamber and said passageway.

10. In a pump, a unitary housing, a pump chamber formed in said housing, a rotary impeller mounted in said pump chamber with its axis in a horizontal plane, a stilling chamber formed in said housing immediately above said pump chamber, the walls of the pump chamber forming a passageway which discharges upwardly directly into said stilling chamber, a dis-

charge port adjacent the top of said stilling chamber, an inlet port for said pump chamber positioned substantially along the axis of rotation of the impeller, a suction passageway formed in said housing and leading from the inlet port of the pump chamber upwardly to a plane above the pump chamber inlet port, a suction inlet into said passageway positioned above said inlet port, a storage chamber formed in said housing and positioned at either side of said suction passageway and having a portion thereof extending from substantially the inlet port substantially to the bottom wall of the stilling chamber, a restricted opening between the top of said storage chamber and said suction passageway, a restricted opening between the bottom of said storage chamber and said suction passageway, a recirculating passageway extending between said stilling chamber and said suction passageway, a valve in said recirculating passageway to control the flow of fluid therethrough, and means responsive to pressure in said stilling chamber to control the operation of said valve.

11. In a pump, a unitary housing, a pump chamber formed in said housing, a rotary impeller mounted in said pump chamber with its axis in a horizontal plane, a stilling chamber formed in said housing immediately above said pump chamber, the walls of the pump chamber forming a volute which discharges upwardly directly into said stilling chamber, a discharge port adjacent the top of said stilling chamber, an inlet port for said pump chamber positioned substantially along the axis of rotation of the impeller, a suction passageway formed in said housing and leading from the inlet port of the pump chamber upwardly to a plane above said inlet port, a suction inlet into said passageway positioned above said inlet port, a pair of storage chambers formed in said housing and positioned at either side of said suction passageway and having their top walls below said stilling chamber, a restricted opening between the top of each of said storage chambers and said suction passageway, a restricted opening between the bottom of each of said storage chambers and said suction passageway, a restricted passageway between the tops of said storage chambers, a restricted passageway between the bottoms of said storage chambers, a recirculating passageway extending between said stilling chamber and said suction passageway.

12. In a pump, a unitary housing, a pump chamber formed in said housing, a rotary impeller mounted in said pump chamber with its axis in a horizontal plane, a stilling chamber formed in said housing immediately above said pump chamber, the walls of the pump chamber forming a passageway which discharges upwardly directly into said stilling chamber, a discharge port adjacent the top of said stilling chamber, an inlet port for said pump chamber positioned substantially along the axis of rotation of the impeller, a suction passageway formed in said housing and leading from the inlet port of the pump chamber upwardly to a plane above the bottom of said stilling chamber, a suction inlet into said passageway positioned above the bottom wall of said stilling chamber, a pair of storage chambers formed in said housing and positioned at either side of said suction passageway and extending at least from the region of the inlet port to that of the stilling chamber, a pair of restricted vertically spaced openings between each of said storage chambers and said suction passageway, a pair of restricted vertically spaced passageways between said storage chambers, a recirculating passageway extending between said stilling chamber and said suction passageway, a valve in said recirculating passageway to control the flow of fluid therethrough, and means responsive to pressure in said stilling chamber to control the operation of said valve.

13. In a pump, a unitary housing, a pump chamber formed in said housing, a rotary impeller mounted in said pump chamber with its axis in a horizontal plane, a stilling chamber formed in said housing immediately above said pump chamber, the walls of the pump chamber forming a volute which discharges upwardly directly into said stilling chamber, a discharge port adjacent the top of said stilling chamber, an inlet port for said pump chamber positioned substantially along the axis of rotation of the impeller, a suction passageway formed in said housing and leading from the inlet port of the pump chamber upwardly to a plane above the bottom of said stilling chamber, a suction inlet into said passageway positioned above the bottom wall of said stilling chamber, a pair of storage chambers formed in said housing and positioned at either side of said suction passageway and having their bottom walls above the top of the inlet port of the pump chamber and their top walls below said stilling chamber, a restricted opening between the top of each of said storage chambers and said suction passageway, a restricted opening between the bottom of each of said storage chambers and said suction passageway, a restricted passageway between the tops of said storage chambers, a restricted passageway between the bottoms of said storage chambers, a recirculating passageway extending between said stilling chamber and said suction passageway, a valve in said recirculating passageway to control the flow of fluid therethrough, and means responsive to pressure in said stilling chamber to control the operation of said valve.

14. A centrifugal pump having a pump chamber provided with inlet and outlet ports, rotary impeller means in said chamber, passageway for recirculating a portion of the liquid discharged from said pump back to the pump, a suction chamber connected with the pump inlet port and extending upward therefrom and having a fluid inlet port positioned above the pump inlet, a fluid storage chamber at least a portion of which is disposed above the pump inlet and below the suction chamber inlet, a passageway between the upper portions of said storage chamber and said suction chamber, a passage extending from the lower portion of said storage chamber and communicating with said suction chamber at a point below the point of communication of the first named passageway, said passageways being small in comparison to the suction chamber and pump inlets.

15. A centrifugal pump having a pump chamber provided with inlet and outlet ports, rotary impeller means in said chamber, a passageway for recirculating a portion of the liquid discharged from said pump back to the pump, a suction chamber connected with the pump inlet port and extending upward therefrom and having a fluid inlet port positioned above the pump inlet, a fluid storage chamber at least a portion of which is above the pump inlet and below the suction chamber inlet, a passageway between the upper portions of said storage chamber and said suction chamber, a passage extending from the lower portion of said storage chamber and com-

municating with said suction chamber at a point below the point of communication of the first named passageway, said passageways being small in comparison to the inlets to suction chamber and pump and providing the only fluid communicating passageways into or out of said storage chamber.

16. A centrifugal pump having a pump chamber provided with inlet and outlet ports, rotary impeller means in said chamber, a passageway for recirculating a portion of the liquid discharged from said pump back to the pump, a suction chamber connected with the pump inlet port and extending upward therefrom and having a fluid inlet port positioned above the pump inlet, a fluid storage chamber positioned between a horizontal plane extending through the pump inlet and a horizontal plane extending through the suction chamber inlet, a passageway between the upper portions of said storage chamber and said suction chamber, restricted passages extending from said storage chamber and communicating with said suction chamber, said passageways being small in comparison to the inlets to suction chamber and pump, said storage chamber being in communication with said suction chamber only and being out of the normal path of fluid flowing through said suction chamber.

17. A centrifugal pump having a pump chamber provided with inlet and outlet ports, rotary impeller means in said chamber, a passageway for recirculating a portion of the liquid discharged from said pump back to the pump, a suction chamber connected with the pump inlet port and extending upward therefrom and having a fluid inlet port positioned above the pump inlet, a fluid storage chamber positioned between horizontal planes passing through the pump inlet and the suction chamber inlet respectively, a passageway between the upper portion of said storage chamber and said suction chamber, a passage extending from the lower portion of said storage chamber and communicating with said suction chamber at a point below the point of communication of the first named passageway, said passageways being small in comparison to the inlets to suction chamber and pump and providing the only fluid communicating passageways into or out of said storage chamber, said storage chamber being out of the path of recirculating fluid.

18. A centrifugal pump having a pump chamber provided with inlet and outlet ports, rotary impeller means in said chamber, a stilling chamber into which said impeller discharges, a passageway between said stilling chamber and the inlet of said pump chamber for recirculating a portion of the liquid discharged, a suction chamber connected with the pump inlet port and extending upward therefrom and having a fluid inlet port positioned above the pump inlet, a fluid storage chamber positioned above the pump chamber inlet port and below both the stilling chamber and the suction chamber inlet port, a passageway between the upper portions of said storage chamber and said suction chamber, a passage extending from the lower portion of said storage chamber and communicating with said suction chamber at a point below the point of communication of the first named passageway, said passageways being small in comparison to the inlets to suction chamber and pump, said passageway providing the only fluid communicating passageways into or out of said storage chamber, said storage chamber being in communication with said suction chamber only and out of the normal path of fluid flowing through said suction chamber from the suction chamber inlet to the pump chamber inlet and out of the path of recirculating fluid.

ALEXANDER V. MUELLER.

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