Aug. 30, 1966 G. SCHWED ETAL 3,269,325

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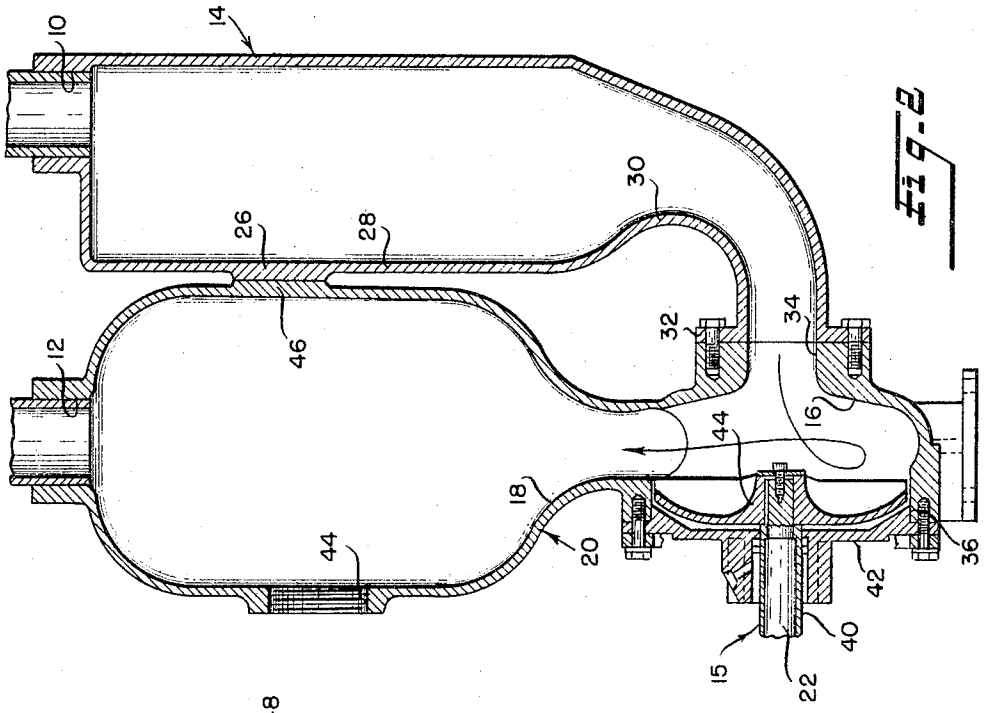


FIG. 2

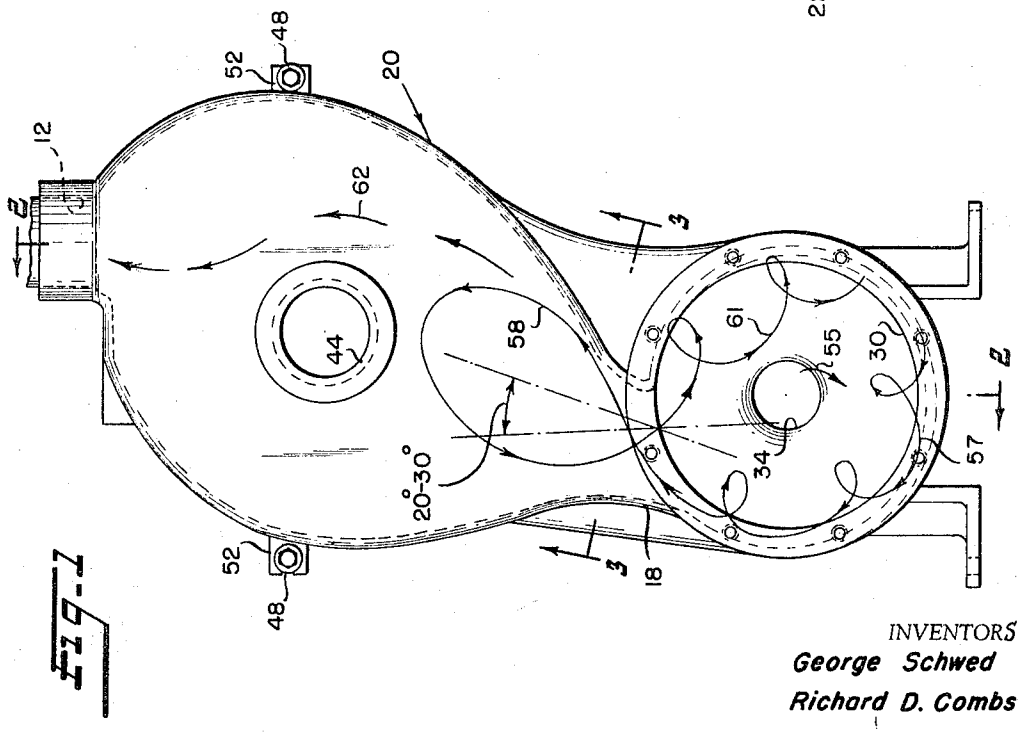


FIG. 1

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Filed July 29, 1963 2 Sheets-Sheet 2

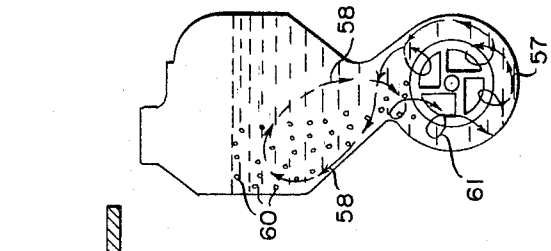


Fig. 8

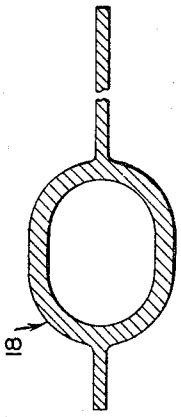


Fig. 3

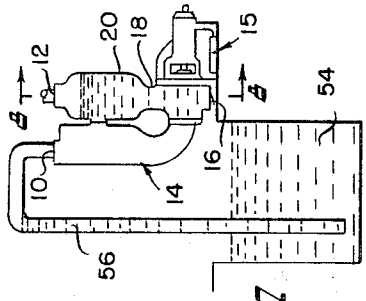


Fig. 7

Fig. 4

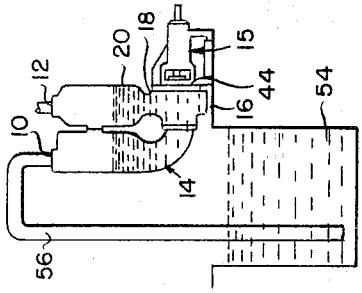


Fig. 6

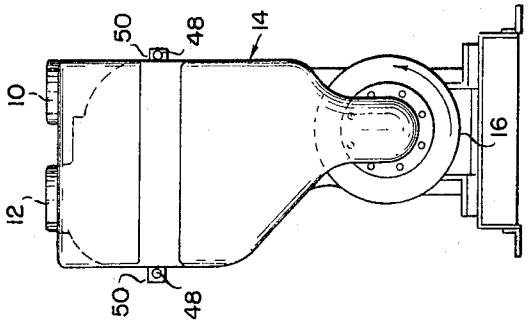


Fig. 5

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3,269,325

PUMP

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11 Claims. (Cl. 103—103)

This invention relates to improvements in a self-priming non-clogging pump. Self-priming pumps are generally described as those that will free themselves of air when they become air bound and will resume pumping action without attention.

Standard centrifugal pumps can be installed with pressure controls, vacuum pumps, float operated separating tanks and various other controls designed to keep the pumps primed, but these devices are expensive, cumbersome, complicated and not altogether reliable.

Pumps with auxiliary controls cannot properly be called "self-priming" pumps, because the pumps themselves do not do the priming.

In order to free a centrifugal pump of air and make it "self-priming" without shutting it down, it is necessary to mix liquid from some outside source with the air that is binding the pump. Here is the basic method that is used:

Liquid from a reservoir on the discharge side of the pump impeller is allowed to splash on the impeller; the liquid picks up the air in the form of bubbles and removes it from the suction side of the pump.

There are many methods now in use by which centrifugal pumps are made self-priming. However, all these methods can be reduced to two fundamental types, each employing a different principle, one of which may be called "Recirculation Priming" and the other "Diffuser Priming."

Both methods require that the pump be filled with liquid before it is first started.

Then, when the pump is started, the liquid travels through the pump, converting it temporarily into a wet-vacuum pump and exhausting the air from the suction line.

Generally, the upper part of the pump is made as a tank through which the discharge of the impeller passes to the discharge pipe, and this tank assures a reservoir of liquid ready for priming at all times.

In "Recirculation Priming," of which the structures illustrated in U.S. Patents No. 1,824,465 of September 22, 1931 to Carter and No. 2,755,743 of July 24, 1956 to H. E. Rupp are illustrative, a connection between the reservoir and the suction side of the pump provides a passageway for the priming liquid. To prevent constant recirculation when the pump is primed and working, a means of shutting off the by-passed liquid is usually provided. This control may be actuated manually, by the tank and the suction pipe.

The above kind of pump operates in this way: When air enters the suction line and the prime is lost, the by-pass control valve drops down, due to its own weight, and recirculation commences immediately. When the pump is pumping, the force of the stream is sufficient to hold the valve closed, thus cutting off recirculation.

Recirculation-type self-priming centrifugals are used both widely and successfully, but they are deficient in certain respects. If anything but clear, clean fluids are pumped, by-pass valves and ports are likely to become clogged or jammed. Furthermore, it of course takes energy to operate the priming devices, and this means a waste of power and a decrease in operating efficiency, compared to a diffuser-priming pump.

Impeller-tank recirculation pumps, illustrated by Patent 2,002,454 utilize a large rectangular-shape tank adjacent a flow-through impeller to exhaust entrapped air by recirculating liquid between the tank and the impeller without requirement of additional recirculation structure. Such tank type recirculation self-priming pumps are of only limited solids-carrying liquid displacement application since the solids entrained in the liquid cause excessive wear to the flow-through impeller, are easily clogged in the impeller vanes, and frequently tend to flocculate the solids whereby the dimensions thereof are increased resulting in an increased likelihood of discharge clogging. Furthermore, the suction lift and the discharge head characteristics of this type pump assembly render it inapplicable for many pumping uses. The tank, due to its shape and location, causes undesirable liquid flow currents which result in fluid settlement due to redundant flow and inherently produce eddy currents within the tank tending to cause the solids to flocculate often to dimensions greater than the discharge outlet dimensions so as to result in clogging. Additionally, the tank must remain substantially full of liquid during inactivity in order that self-priming may be undertaken, making check valves essential to preserve the entire volume of liquid in the tank and also necessitating frequent maintenance and cleaning.

"Diffuser priming," of which the structure shown in U.S. Patent No. 2,653,546 dated September 29, 1953 to A. S. Marlow, Jr. is illustrative, is distinguished from "recirculation priming" by the fact that the priming liquid is not returned to the suction side of the pump, but mixes with the air at the circumference of the impeller. The ability to handle air is thus inherent in the design of the casing and impeller, and the pump is not subject to any of the mechanical failures of recirculation priming mechanisms.

A highly efficient diffuser-type pump has been perfected, wherein the impeller with a diffuser ring has been submerged inside a casing sufficiently large to hold a reservoir of liquid which will assure self-priming under all conditions.

During the priming or repriming cycle in this pump, the reservoir liquid circulates or drops back through the diffuser passages to the tips of the revolving impeller. The entire circumference of the impeller is sealed by the reservoir liquid, and the liquid is repelled from returning to the suction by the revolving impeller vanes. During this repelling of the reservoir liquid by the impeller vanes, there is violent splashing at the tips of the vanes.

This action picks up air from the impeller. The air is expelled through the diffuser passageways and escapes by bubbling to the surface of the liquid. Here it is eliminated from the system, while the reservoir liquid is returned to the impeller tips through the same passageways to capture more air.

Continuously and very rapidly, this action goes on until all air is eliminated. At this time, liquid fills the suction line and pumping begins.

This invention relates to a method of combining some of the features of recirculation priming and diffuser priming to provide a means for priming vortex type swirl pumps of the type disclosed in U.S. Patent No. 2,635,548 of April 21, 1953 to C. H. Brawley and No. 2,958,293 to R. F. Pray, Jr.

The primary object of this invention is therefore to provide a non-clogging vortex type solids pump which is self-priming and a novel method of priming such pumps. Ancillary objects are provision of such a pump with a priming chamber at its outlet and siphon breaking means at its inlet which priming chamber:

(a) Is connected to the pump by a single channel through which recirculation can take place during priming and unilateral discharge can take place after priming,

(b) Has the minimum volume providing optimum water depth over the impeller for maximum suction lift,

(c) Provides an unobstructed flow path through the outlet for any solid which can enter the pump,

(d) Precludes flocculation of solids, particularly stringy solids, within the pump, and

(e) Precludes retention of sediment therein while the pump is shut down.

Other objects and novel features will become apparent by reference to the appended claims and as the description proceeds in connection with the accompanying drawings wherein:

FIGURE 1 is a side elevation to scale of one solids pump embodiment of this invention, illustrating a pump chamber and a priming chamber construction with the associated inlet and outlet ports and diagrammatically showing the fluid dynamics of flow which occur during the priming stage and during fluid displacement through the pump;

FIGURE 2 is substantially a vertical cross-sectional view to scale along line **2—2** of FIGURE 1 illustrating one construction of the present invention showing the relationship of the influent siphon breaker chamber, the pump chamber with its associated offset impeller and the priming chamber including the effluent discharge port;

FIGURE 3 is a cross-sectional view to scale along line **3—3** of FIGURE 1 illustrating the nature of the cross-section of the inclined throat intermediate the pump chamber and the priming chamber;

FIGURE 4 is an elevation view to scale showing the interrelationship between the inlet, the outlet, the siphon breaker chamber, the pump chamber, the priming chamber, the impeller and associated drive mechanism and the prime mover, in this case, an electrical motor;

FIGURE 5 is a side elevation to scale view along line **5—5** of FIGURE 4 showing the location and shape of the siphon breaker chamber;

FIGURE 6 is a diagrammatical elevation view in section corresponding to the pump arrangement of FIGURE 1 showing an inlet pipe fed by a fluid source and illustrating in particular the relationship between the optimum volume of solids-carrying liquid and air entrapped within the pump during the periods when the impeller is idle;

FIGURE 7 is a diagrammatical elevation view in section similar to FIGURE 6, further illustrating the nature of the liquid and air displacement and discharge during self priming action; and

FIGURE 8 is an elevation view in vertical section through the pumping chamber along line **8—8** of FIGURE 7, illustrating the nature of the novel recirculation flow path for exhausting the entrapped air through the unobstructed throat, priming chamber, and discharge port.

Several attempts to achieve the aforesaid primary object have been made using the conventional recirculating and diffuser-type self-priming devices integrated with the vortex-type torque-flow pump. Although it was discovered that the vortex-type torque-flow impeller could be self-primed in this manner, in actual tests and field operation, this particular combination would plug up similarly to conventional type non-clog centrifugal pumps. Various modifications were made using standard priming devices, but in every instance, some of the features of self-priming devices would turn out to be an obstacle to certain solids. The reason for the failures can be attributed to the fact that conventional self-priming devices characteristically have openings or clearances that are smaller in diameter than the size of the pipeline that feeds or discharges the pump. The vanes in the volute, no matter what their dimensions, will tend to hang up long stringy particles on the leading edges. The vanes of the volute which make possible the diffuser principle, i.e., the feature of peeling off the bubbles, appear to be necessary in a self-priming unit. Unfortunately, any type of volute vane serves as an obstacle and will eventually clog. In the experiments to develop a self-priming vortex, diffuser priming was further complicated by the fact that recirculation channels with their commensurate low velocity provide a settling point for heavy solids. Free-flowing heavy solids like sand and gravel will tend to settle out and plug up recirculation channels in diffuser-type self-priming.

In one experiment, an impeller of the type disclosed in said Pray patent was completely removed from a conventional diffuser case such as that of said Marlow patent by a separator ring to make it completely recessed and out of the main flow. This design was found to be self-priming, which proved that a fully-recessed impeller would self-prime; however, this design was not operable since the vanes of the volute employing the diffuser principle became plugged in actual field tests. A screen at the entrance to the recirculation channels was installed to prevent the solids from entering these channels. The problem here was that it became impossible to prevent the screens from building up and blinding.

The conclusion that can be drawn from the above experimental work is that all conventional methods of self-priming are not suited to the characteristics of the vortex pump principle. Any openings less than the discharge pipe diameter were not practical. Any vanes, peelers, screens, etc. all served as obstacles and tended to clog up the unit.

To design a truly non-clog vortex type pump that would be self-priming, it appeared that it would be necessary to design a self-primer with very large openings and a method of permitting the reuse of priming water during the priming cycle, and a method of quickly discharging the entrapped air; i.e., to deplete the supply of entrapped air in the suction side of the unit. Also there would be the difficult problem of providing a means to seal off the reduced pressure in the suction line which would be developed during the priming cycle from the relatively higher pressure in the discharge side.

In all centrifugal pumps of opened or enclosed or tube type so-called "non-clogging" impellers, there is a relatively close clearance or seal area that does not compare with the vortex type pump which has a sealing area or distance as great as the pipeline itself. Therefore, the problem of sealing the air across the discharge opening at first appeared to be insurmountable. A unit was then designed with the hope that the vortex cyclone or whirl effect would itself act as a discharge seal and permit the reduction of air in the suction side to be dissipated into the discharge side. In an experimental test, the Torque-Fow unit operated satisfactorily and held a differential pressure up to 11 lbs. across the sealing area of the suction and discharge. The next problem was the obstruction in the discharge of the volute, which was thought necessary to separate the return flow. This guide vane or separation vane appeared to be necessary to provide a recirculation channel. This vane was removed quite by accident to see what would happen. An unusual phenomenon took place that enabled the pump to be completely self-priming without the special recirculation channel, thereby removing the last obstacle to a truly self-priming vortex pump.

The general relationship of the component parts of an installed solids pump typical of the present invention is shown in FIGURE 4, having seriatim between inlet port **10** and outlet port **12**, siphon breaker chamber **14** secured toward its lower extremity to pump chamber and impeller housing **16**, communicating throat **18**, and priming and vortex damping chamber **20**, providing an unrestricted flow path for solids-carrying liquid since no openings in the pump have a dimension perpendicular to the direction of flow less than the minimum dimension of the inlet and outlet ports. The impeller of the arrangement of FIGURE 4 is driven by shaft **22** which in turn is rotatably driven by prime mover **24**. Prime mover **24**, depending on the circumstances, may be any one of several types of prime movers utilized to rotate the pump impeller,

for example, a direct drive electric motor or a belt driving internal combustion engine. While siphon breaker chamber **14** is the preferred mode of preserving priming fluid in the pump, under some conditions a swinging check valve may be used in place of chamber **14** as for example where available space prohibits utilization of a chamber having the dimensions of chamber **14**. However, such valves are easily unseated by solids with attendant loss of prime, a problem obviated by use of chamber **14**.

Referring to FIGURE 2, liquid displacement pumping solids-carrying liquid is drawn in at inlet **10**, transmitted through chambers **14** and **16**, throat **18**, and chamber **20** to be discharged at outlet **12**, consequential of pressure differential created by rotation of offset impeller **15** in a unique flow pattern hereinafter to be described.

Siphon breaker **14**, cantilever bolt fastened to chamber **16**, includes off-set inlet **10**, abutment **26**, tank portion **28**, effluent portion **30** and flange portion **32**. The general shape of siphon breaker **14** is such as to provide in a minimum of space sufficient tank volume capacity to break the siphon back pressure following pump shut off and thereby retain in the pump a predetermined volume of solids-carrying priming liquid, which is less than the volume of the pump. The shape of chamber **14** as viewed along the vertical plane of the axis of rotation of the impeller is shown on the right of FIGURE 2, while the rear elevation shape appears in FIGURE 5.

For manufacturing and installation convenience a portion of pump chamber **16** as well as the entirety of priming chamber **20** are integrally formed. Chamber **16** permits fluid to communicate from effluent portion **30** of chamber **14** at port **34** and bolt receives impeller mechanism **15** at port **36**. Impeller mechanism **15**, as shown in FIGURE 2, includes shaft **22**, shaft sleeve **40** surrounding shaft **22**, back plate **42** which forms a portion of the chamber **16** and lockscrew held impeller **44** which is appropriately offset and recessed out of the path of normal flow of the solids-carrying liquid being communicated through chamber **16** thereby avoiding clogging of the vanes and erosive wear of the impeller by the solids. Impeller mechanism **15** preferably includes the detailed structure and functions in a manner defined in Patent No. 2,635,548 to which reference may be made for greater detail. All passages along the liquid flow path from inlet **10** through outlet **12** are constructed so that there are no constrictions therein which are of lesser size than that of the maximum size particle which can enter the pump to thereby preclude internal clogging.

Priming and vortex damping chamber **20** uniquely includes unobstructed venturi-like throat section **18**, which as shown in FIGURE 1 along line **3—3**, is inclined preferably on the order of 20° to 30°, with respect to the vertical to avoid solids accumulation during pump inactivity and is offset with respect to the center of both chambers **16** and **20** to facilitate the unique flow pattern yet to be described. Outlet port **12** is located at the upper portion of chamber **20**, which also includes a normally closed access port **44** and abutment **46** engaging abutment **26** of chamber **14**. To increase structural integrity with respect to chambers **14** and **20**, nut and bolt assemblies **48** (FIGURE 4) secure chamber **14** to chamber **20** by means of bosses **50** and **52**.

The optimum shape of priming chamber **20**, arrived at through empirical studies, forms a major part of the present invention. The internal configuration of chamber **20** provides a maximum rate of priming fluid recirculation between the priming chamber **20** and the pump chamber **16** during priming but none after full flow is established consistent with maximum suction lift, optimum water depth over the impeller for priming a flow path for solids along the interior surface which is free of eddy current producing housing configurations and internal surfaces all sloped with respect to the horizontal preferably at an angle slightly greater than the angle of repose of the various products to be pumped, to preclude collection of solids within the priming chamber during shutdown of pumping.

Extensive tests revealed that for the requisite suction lift and discharge pressure, at least for small diameter impeller pumps, the ratio of the initial depth of priming liquid above the centerline of the impeller with respect to the impeller diameter, hereinafter called the depth-diameter ratio, has a minimum practical value on the order of 1.33, otherwise adequate priming action cannot be obtained. Maximum suction lifts were obtained when the depth-diameter ratio was in the order of 2.88. Suction lifts of 28.3 feet of water were provided by the present invention when the depth-diameter ratio was on the order of 2.2 times the impeller diameter.

Depth alone, however, is not the only influencing factor. Relative volumes, it was discovered, may be determinative with respect to the magnitude of suction lift obtainable. When the ratio of the volume of the priming water stored in the priming chamber **20** during pump inactivity with respect to the volume of the pump chamber, hereinafter called the volume ratio, was on the order of 6 maximum suction lift was obtained. Larger volume ratios were found to decrease the magnitude of the suction lift. Suction lifts in excess of 28.3 feet of water were provided when the volume ratio was substantially 2.6.

It should be noted that not only does chamber **20** gently taper away from throat **18** in diverging-converging fashion, but the center of chamber **20** is asymmetrical being horizontally off-set both with respect to the center of chamber **16** and the center of throat **18** as viewed in FIGURE 1.

As seen in FIGURE 2, however, chamber **20** is symmetrical about its vertical centerline, permitting maximum required suction lifts and maximum discharge pressure to be obtained. This shape enables entrapped air to be exhausted during the priming stage and, under all conditions, solids carried in the liquid are retained in suspension so as to obviate settlement, flocculation and clogging thereof. No close clearances are required to be maintained and solids do not have to pass through any impeller ports or passages nor through any separate recirculation channels, diffusers or other obstructions which would tend to clog the pump.

Commercially, both four inch and three inch torque flow self-priming non-clogging solids pumps of the present invention have been developed with capacities for the four inch model ranging from 50 g.p.m. to 500 g.p.m. and including shut-off head at 1800 r.p.m. of approximately 70 feet of water.

In operation, as illustrated in FIGURE 6, assuming the pump to contain ample priming liquid and to be attached to a solids-carrying liquid source **54** through inlet pipe **56**, prime mover **24** (FIGURE 4) is power actuated so as to rotate shaft **22** which in turn drives impeller **44** (FIGURE 2). The rotation of impeller **44** creates hollow vortical fluid flow in the direction of rotation of the impeller within the pump chamber **16**, driving the solids-carrying liquid rotatably along the periphery of the chamber **16**, out through a portion of throat **18** (FIGURE 3), recirculating through chamber **20** into a gentle loop flow path in a direction opposite to the rotation of the impeller **44**, and back into chamber **16** through the remaining portion of throat **18**. The particular relationship of chambers **16** and **20** and throat **18** permits rapid recirculation and countercurrent flow through throat **18** without flocculation or settlement of solids.

As the above described recirculation takes place, the water level in the priming chamber **20** immediately rises as the siphon breaker chamber is pumped dry of liquid. The swirling motion created in pump chamber **16** by recessed impeller **44** continues as liquid is suspended in priming chamber **20**, and as liquid is recirculated by pressure gradient created in throat **18** by the swirling action in chamber **18** of the impeller as above stated. Consequently, the water level in inlet tube **56**, as shown in

FIGURE 7, will rise progressively from the initial position shown in FIGURE 6 at the level of source **54** to the position shown in FIGURE 7. Before pumping can be established, the entrapped air in the siphon breaker chamber and the connecting pipe must be eliminated. This entrapped air in the inlet and chamber **14** will be drawn into the vortical flow **57** (FIGURES 1 and 8) being created in chamber **16** so as to be violently comingled with the solids-carrying liquid to pass therewith through throat **18** into chamber **20** along a portion of flow loop **58** where the air, being lighter than the liquid, is gravimetrically exhausted from the liquid through discharge **12** as seen at **60** of FIGURE 8. Whereupon, after exhausting of the air, the solids-carrying liquid without settlement of flocculation of the solids returns to the outer edge of impeller **44** in chamber **16** along flow path **61** in the direction of rotation of the impeller.

In actual operation, the exhaust of such entrapped air is characterized by a rapid pulsing motion in the priming chamber with intervals on the order of one second between pulses. The surface of the water in the priming chamber is constantly disturbed by the action of the air being released. As the partial vacuum being created at the intake of the pump increases, the pulsing action gradually becomes more frequent and violent until the pump becomes partially primed. At this point the pulsing action rapidly dies out as the pump completely exhausts the remaining air in siphon breaker chamber **14** so at full capacity flow through the priming chamber **20** is essentially laminar with only immaterial turbulence apparent at the corners of the priming chamber. In actual tests, vacuum guage readings in excess of 30.6 of water at the pump suction have been obtained. The recirculation pattern of the liquid flow during priming allows the liquid to be re-used to trap additional air during the priming cycle and thus the volume of water required to prime is constant irrespective of the length or diameter of the suction intake pipe.

Once the pump has been primed the flow path of the liquid passing through chamber **16** and **20** is indicated by flow arrows **55**, **57**, and **62** in FIGURE 1, chamber **20** being so internally contoured as to damp eddy current action at its incipiency to preserve laminar flow, prevent settlement and accumulation of solids in the chamber, and obviate flocculation of the solids which would result if vortical flow were to exist at the surfaces of chamber **20**.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

1. A self-priming, non-clogging solids pump comprising fluid guide structure defining seriatim an inlet, a siphon breaker chamber below said inlet, a pump chamber below said inlet to receive the effluent from said siphon breaker chamber, a priming chamber located above and forming an extension of said pump chamber and an outlet at the upper portion of said priming chamber; a rotatable impeller mounted on the said guide structure at said pump chamber and located substantially completely outside of the main path of fluid flow therethrough and operative when rotated to create vortical fluid flow in said pump chamber to induce fluid flow from said siphon breaker chamber through said pump chamber into said priming chamber, said chambers and the passages between said chambers being unobstructed and the passage between the pump and priming chambers forming a throat of such size and shape that any solid which may pass through said inlet can pass through said throat into said priming chamber so that passage between said inlet and outlet of solid particles entrained in fluid passing therethrough is not precluded, the internal cross-section of said priming chamber as viewed in a plane perpendicular to the axis of rotation of the impeller being essentially of diverging-converging form from the throat connecting the pump chamber and the priming chamber to the outlet and wherein the centerline through the throat is inclined substantially from the vertical and wherein the walls of said pumping chamber smoothly merge with the walls of said priming chamber through said throat.

2. The solids pump defined in claim **1** wherein said throat centerline is inclined from the vertical on the order of 20° to 30°.

3. The solids pump defined in claim **1** wherein the center of the priming chamber as viewed in cross-section perpendicular to the axis of rotation of the impeller is off-set from a vertical plane passing through the axis of the impeller in the direction of the horizontal component of fluid flow of the priming chamber influent.

4. The pump defined in claim **3** wherein said inclination of said throat with respect to the horizontal in a plane perpendicular to the axis of rotation of the impeller is anti-clockwise as viewed from the bladed side of the impeller and wherein the center of the priming chamber is similarly offset as so viewed from a vertical centerline through the impeller axis of rotation, when intended rotation of impeller is anticlockwise when so viewed.

5. A self priming non-clogging solids pump for conveying solids-carrying liquid defined in seriatim by an inlet adapted to receive said solids-carrying fluid from its source, a siphon breaking chamber attached to but below said inlet for breaking the siphon back pressure when said pump becomes inactive to permit storage of priming liquid in said pump, a vortically shaped pump chamber having an axial inlet opening and circumferential outlet opening and situated below said inlet to receive the effluent from said siphon breaking chamber, a priming chamber above said pump chamber and an outlet port at the upper portion of said priming chamber, a rotatable impeller recessedly located within said pump chamber adjacent the path of liquid flow to produce vortical flow in said pump chamber to thereby induce fluid flow in a vortical path from said inlet opening to said outlet opening without material contact of any entrained solids with said impeller, said pump chamber, said siphon breaker chamber and said priming chamber having cross-sectional dimensions all of which are at least equal to the minimum cross-sectional dimension of said inlet whereby internal clogging of said pump is precluded, the ratio of the volume of said priming chamber with respect to the volume of said pump chamber being between 2.6 and 6.0 and the ratio between the depth of priming liquid above the centerline of the impeller contained within the siphon breaker, the pump and the priming chambers during inactivity with respect to the impeller diameter is between 1.3 and 2.9 whereby self priming and maximum suction lift characteristics may be selectively obtained; the contour of said internal surfaces of the priming chamber comprising a series of curves defined such that the lines normal to tangent lines thereof intersect each other at independent positions whereby flocculation of said solids is prohibited thereby preventing increase in the dimensions of said solids, the junction between said priming chamber and said pump chamber forming an unobstructed throat inclined on the order of 20° to 30° with respect to vertical whereby during priming entrapped air is aerated through said solids-carrying liquid along one segment of said throat in one direction and the solids-carrying liquid absent the air is returned to the pump chamber in the opposite direction along the remaining portion of said throat whereby both solids settlement and flocculation is obviated, said priming chamber being substantially symmetrical as

viewed in vertical cross-section along a plane including the axis of rotation of said impeller and asymmetrical as viewed in vertical cross-section along a plane perpendicular to said last mentioned plane.

6. A self-priming non-clogging solids pump comprising:

(a) fluid guide structure defining seriatim:

(a1) an inlet;

(a2) a first chamber;

(a3) a pump chamber having axially spaced walls, an inlet throat through one of said walls and through which said pump chamber is connected to receive the effluent from said first chamber and an annular recessed impeller chamber in the other of said axially spaced walls;

(a4) a priming chamber located above said pump chamber, connected in fluid communication therewith by said pump chamber outlet throat and

(a5) an outlet at the upper portion of said priming chamber sufficiently large to permit discharge of any solid passing through said pump chamber;

(a6) said fluid guide structure being effective upon termination of pump operation and during self-priming operation to trap and maintain a sufficient volume of liquid therein to maintain a liquid seal between said pump chamber inlet throat and said outlet while said pump is inoperative and during priming;

(b) a rotary open faced impeller disposed in said impeller chamber of said pump chamber, said impeller having a plurality of blades for causing movement toward the end portion of each of said blades of the portion of fluid in said chamber adjacent said blades, said blades substantially facing the portion of said pump chamber between said walls, the portion of said impeller facing said chamber being laterally spaced from the portion of said chamber disposed opposite thereto to form a lateral clearance extending between all of said portion of said impeller and said chamber to form an unobstructed passage between said pump chamber inlet throat and the outlet throat which passage constitutes the primary path of fluid flow between said throats;

(c) said pump chamber outlet throat being disposed at the periphery of said lateral clearance and being at least substantially coextensive in width therewith, said outlet throat diverging into said priming chamber from its region of minimum cross section and beyond said region of minimum cross section being at least as large as said region of minimum cross section so that any object passing through said region of minimum cross section will pass into said priming chamber and out said outlet;

(d) whereby, during priming of said pump at least the major portion of the liquid returns into said pump chamber through said pump chamber outlet throat and enters said lateral clearance directly and flows toward the bottom of said pump chamber in a path axially offset from the path of rotation of said impeller blades to entrap air in said pump chamber for redischarge into said priming chamber when said liquid again comes under the influence of the fluid flow created by said impeller whereby said self-priming non-clogging solids pump is operative to evacuate entrapped air and thereby self prime through repetition at a progressively increasing rate until the pump becomes partially primed of the following steps:

(1) commingling the air to be exhausted with liquid in said pump chamber,

(2) discharging the air and liquid from said pump chamber into said priming chamber through said pump chamber outlet throat,

(3) gravitationally separating said air from said liquid in said priming chamber for discharge through said outlet, and

(4) returning at least the major portion of the liquid from said priming chamber into said pump chamber through said pump chamber outlet throat in a path axially offset from the portion of rotation of the blades of said impeller.

7. The solid pump defined in claim 6 wherein the volume of said priming chamber below said outlet is at least equal to the volume of liquid trapped in the bottom of said first, said priming and said pump chambers when the level thereof above the center line of the impeller is at least 1.3 times the impeller diameter while the impeller is at rest following loss of suction.

8. The solids pump defined in claim 6 wherein the ratio of the volume of the said priming chamber to the volume of said pump chamber is at least equal to 2.6.

9. The solids pump defined in claim 6 wherein the ratio of the volume of said priming chamber to the volume of said pump chamber is in the order of 6.

10. The solids pump defined in claim 6 wherein the angle of inclination from the horizonal of all upwardly facing internal surfaces of the priming chamber is sufficiently greater than the angle of repose of the solids to be pumped therethrough to prevent any material accumulation of finely divided solid particles thereon during periods which the pump is shut down.

11. The pump defined in claim 6 wherein the internal curved surfaces of said priming chamber essentially along the path of fluid flow therein are non-circular whereby vortices formed in said chamber are damped at their incipiency thus preventing flocculation of said solids.

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