Nov. 28, 1939. H. E. RUPP ET AL 2,181,792

CENTRIFUGAL SELF-PRIMING PUMP

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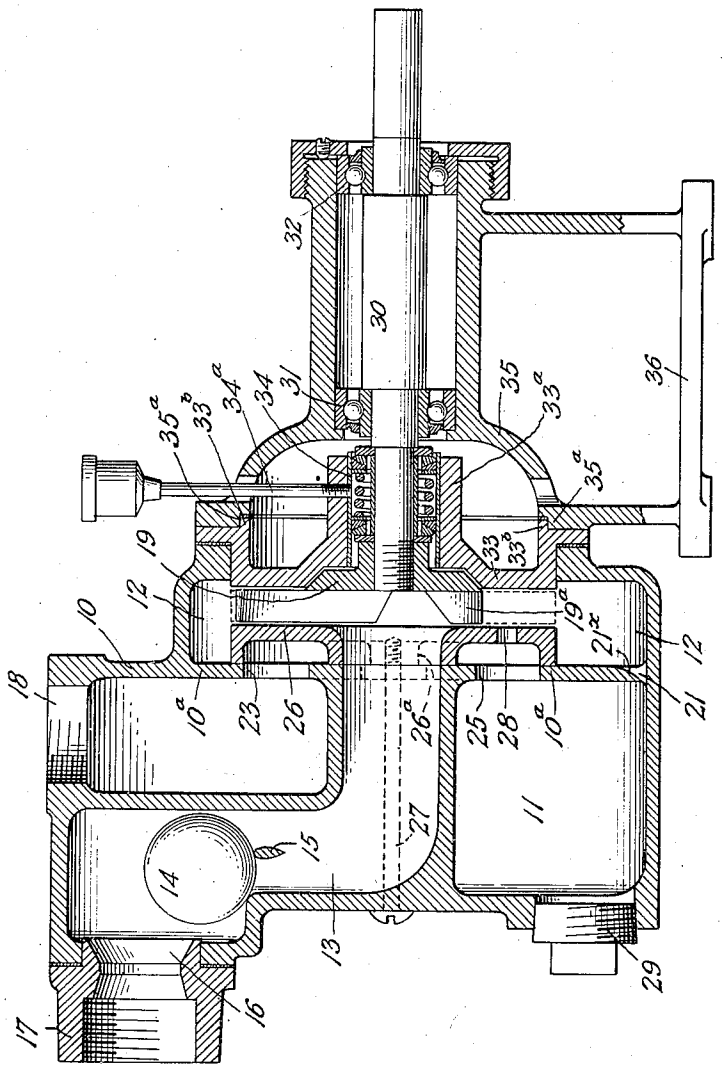

Fig. 1.

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Fig. 2.

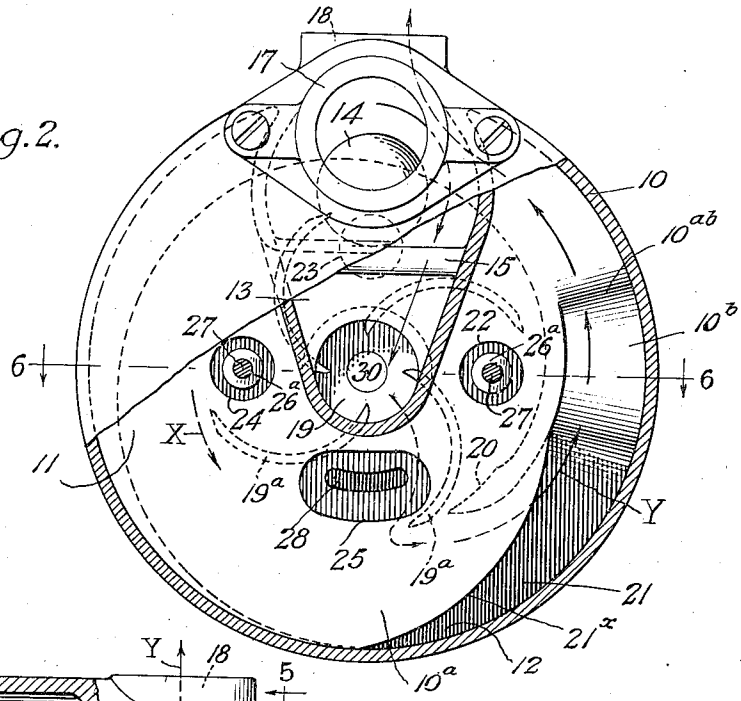

Fig. 3.

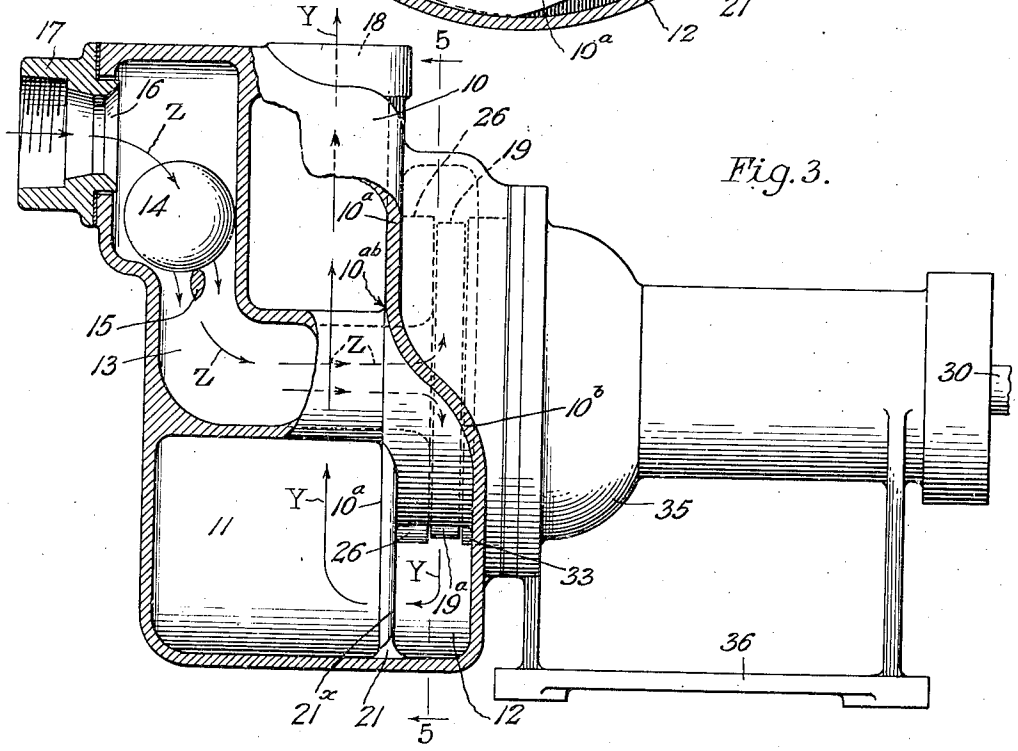

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Fig. 4.

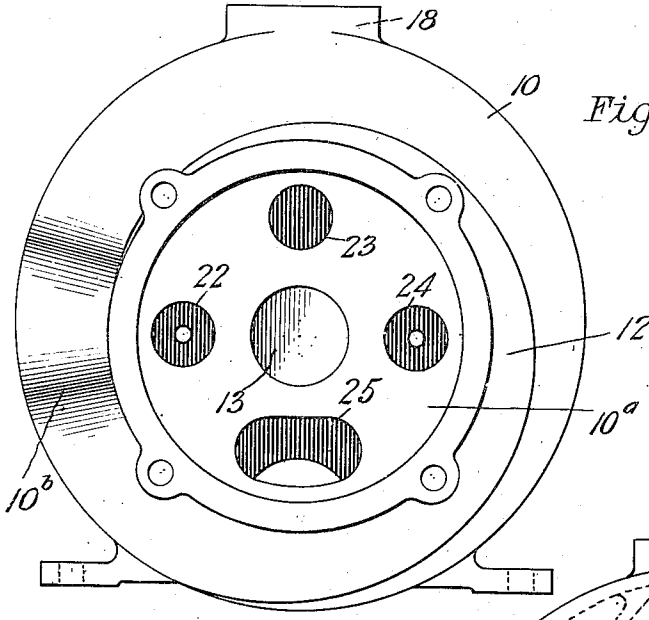


Fig. 5.

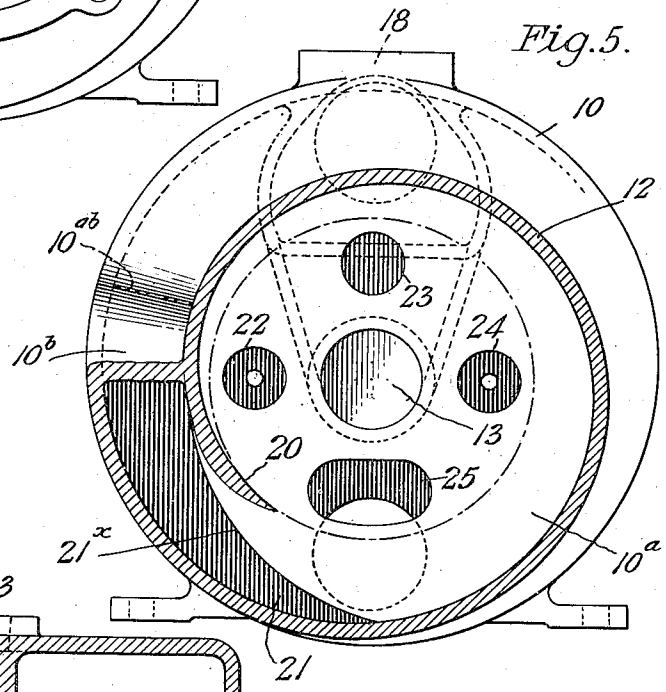
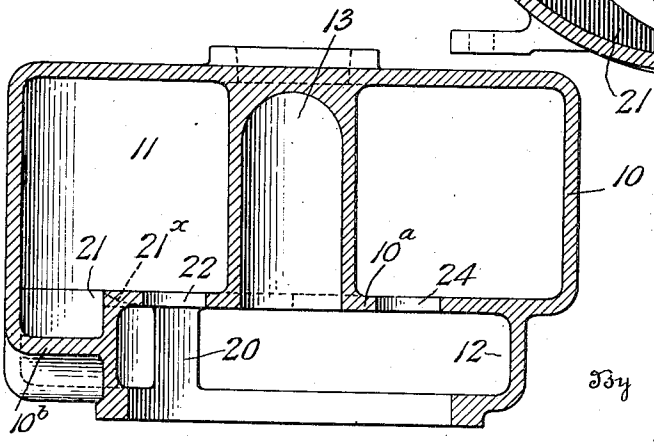


Fig. 6.



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CENTRIFUGAL SELF-PRIMING PUMP

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Application March 7, 1938, Serial No. 194,496

4 Claims. (Cl. 103—113)

This invention relates to self-priming centrifugal pumps, with reference more particularly to suction-lift pumps and those of the type in which the inlet is in the axis of the pump rotor or impeller, and it aims to provide an improved self-priming pump of said general character.

A particular object of the invention is to provide a pump embodying an improved method or action of self-priming which is inoperative when the pump is primed or pumping liquid, i. e. a pump in which the method or action of self and automatic priming is operable or effective only when the pump is first started or loses its prime and becomes unoperating or ineffective when the pump is primed and pumping liquid.

Another particular object is to provide a highly efficient pump of the greatest possible capacity, suitable for various uses and purposes but adapted especially to heavy duty service or to any other use wherein a high pressure lift or force is required.

The aforesaid objects contemplate also an improved construction or organization in a pump of otherwise common type known to be best suited for the work for which it is primarily intended and simplicity and compactness, together with accessibility and a replaceability of parts, are further objects sought in this connection.

As the particular concept and other purposes, in addition to the advantages of the invention, will be best understood from further specification with illustration of the same, it will be described and explained hereinafter with reference to the attached drawings illustrating in different views one practical embodiment of the invention as constructed in an actual working model.

In said drawings:

Fig. 1 is a vertical side or longitudinal section view of the pump;

Fig. 2 is an end view, partly in elevation and partly in broken away section, showing the volute discharge;

Fig. 3 is a side view, partly in broken away section on two different planes or depths and partly in elevation, showing the discharge from the volute to the adjacent liquid chamber;

Fig. 4 is an end elevation view of the pump body on the impeller side;

Fig. 5 is a vertical section view of said end of the body taken on the line 5—5 of Fig. 3; and

Fig. 6 is a horizontal plan or transverse section view taken on the line 6—6 of Fig. 2.

Referring to these several views generally, 10 is the pump body, formed in one part in this instance, as by an aluminum or other metal casting. A larger portion of this body, constituting the front or forward end in the illustrative embodiment, forms a liquid chamber 11, serving also as an air separating chamber, and a smaller portion of said body constituting the back or rearward end, forms an impeller chamber or volute 12 into which liquid is drawn, the two chambers being separated by a wall 10^a of the pump body or casting.

Through said liquid or separating chamber an inlet passage 13 extends from its top downwardly into the side of the impeller chamber or volute, opening through said separating wall substantially centrally or in line with the axis of the pump impeller. Said passage in this instance is L-shaped as viewed from the side (see Fig. 1) and V-shaped as viewed from the front (see Fig. 2) and accordingly gives to the generally circular chamber an interior formation roughly corresponding to that of a ring. Within the upper L or V portion of this inlet passage, a ball 14, serving as a check valve, is housed and below this ball a transverse bar 15 formed as part of the pump body or casting, and streamlined to the liquid flow, is provided to prevent the ball from moving into and becoming wedged in the lower portion of the passage. Said ball is adapted to seat upon a seat 16 in the upper end or entrance of the passage, provided in this instance in a fitting or nipple 17 applied to the entrance on the top side of the pump body for connection or coupling of a suction pipe or hose (not shown). At the top of the chamber, a discharge opening 18 is provided for connection of a discharge pipe or hose (also not shown).

It will be observed that the admission of liquid is not directly to the liquid chamber, but is direct through said inlet passage to the impeller chamber or volute. In its admission, the liquid passes around or at the sides of the ball 14 which, by reason of the cross-bar 15, is unable to enter the lower portion of the entrance passage sufficiently to obstruct the liquid flow therethrough.

In said impeller chamber or volute a rotary impeller 19 operates axially opposite the opening of the inlet passage thereto. This chamber consists essentially of a volute channel or wall surrounding the impeller, starting from a point or surface 20 near the bottom providing what may be termed the "cut-off" edge and gradually enlarging or expanding therefrom all the way around the periphery of the impeller back to and under said "cut-off" edge (see Figs. 4 and 5). Below said "cut-off" the volute discharges into the liquid or separating chamber through an opening 21 provided in the separating wall 10^a, and by deflection of another wall 10^b of the pump body extending upwardly from the side across the outer periphery of the volute into merger with the aforesaid separating wall (see Fig. 3). This last-named opening is formed by blocking out or cutting away a portion of said separat-

ing wall from the outer circular wall of the pump body at the side of the volute terminus, in this instance on an arcuate line of edge 21x (see Fig. 2) giving it a curved wedge or V-shape as viewed from the front, and said edge is advantageously beveled from the inner side of the volute (see Fig. 3) to smooth the flow therefrom into the liquid chamber. Of course said opening extends upward to the point of the deflecting wall's merger into the separating wall, or, with reference to Fig. 2, to approximately the point 10ab.

Between the two described chambers a series of communicating holes are provided in the separating wall 10a, there being four such holes in this instance, denoted respectively by 22, 23, 24 and 25 (see Figs 1 and 2) and the same being disposed in circular spacing around the impeller axis within the horizontal plane of its rotation orbit, or within the circle described by its tips as viewed from the front (see Fig. 2). These holes are covered over by a dish-shaped plate 26, serving as a wear plate, inverted against said separating wall on the impeller chamber or volute side thereof and held in place by bolts 27 extending through the holes from the front face or side of the pump body into bosses 26a formed in the plate. This dish-shaped wear plate is provided with a slightly arcuated slot or opening 28 opposite the lowermost of the aforesaid series of holes in the separating wall and said lowermost hole, being that denoted as 25 in this instance, is enlarged to elliptical form overextending said slot. Viewed from the front (see Fig. 2) the said slot is visible through said lowermost hole 25. Opposite this hole, a hand-hole with closure plug 29 is provided at the bottom of the liquid or separating chamber on the front of the pump body through which the hole and said slot therebehind may be reached or viewed, and through which the pump may be drained.

The aforementioned impeller 19 rotatable in the impeller chamber or volute comprises a series of rearwardly curved blades 19a, there being four in number in this instance, overlapping each other and sweeping close to the aforementioned "cut-off" edge 20 so that liquid operated upon will not pass with or under their tips above or across said edge. Said impeller operates with its front side next to or close against the aforementioned dish-shaped wear plate and is mounted or carried on a driven shaft 30, which is journaled in bearings 31 and 32. Its back side, and the back side also of its chamber or volute, is closed over by a gasketed plate 33, having a boss 33a through which the shaft extends and in which there is fitted or provided proper sealing means sealing the parts against leakage, generally indicated by 34—including the lubricant feed 34a—and preferably constituting or corresponding to that which is described in detail in our prior Patent No. 2,104,355 dated January 4, 1938. The said closing plate 33 is centrally located with respect to the driving shaft by an extended lip 33b, which fits into the bell part 35a of a bearing housing 35. This bearing housing is formed or made integral wtih a pedestal portion 36 for the purpose of mounting the pump in any fixed position. In the latter connection it will be noted that the pump body itself may be turned to any desired position or angulation with respect to the pedestal portion.

It will be understood that the impeller shaft is driven by connection with any suitable power source, such as a motor or gas engine. Said connection (not shown) may be of any desired form, either direct as by a clutch coupling, or indirect as by a belt pulley attachment. However, an ordinary direct clutch coupling will be generally preferred, both for power conservation and compactness in unit assembly. The power or driving source employed will also preferably be one of high-speed generation, i. e. a source capable of imparting rotation up to 1800 or more R. P. M., as the best results are obtained when the impeller is rotated at this or an approximate speed ranging from 1200 R. P. M. upward.

The operation of the pump is as follows: The liquid chamber 11, and hence the entire pump body, having been first filled, or assuming it to be already filled from prior operation, with liquid of the kind to be pumped, the impeller 19 is set into rotation—in this instance in counter-clockwise direction as viewed and as indicated by the arrow X in Fig. 2. This member impelled from rest quickly acquires great speed under drive of the power source. As it actuates with increasing velocity, it initially expels the liquid from between its blades by centrifugal force outwardly within the impeller chamber or volute 12, setting the same into rotation with discharge from the volute into the separating chamber. Simultaneously, it draws thereinto the liquid standing in the inlet passage 13, which it likewise expels or throws off into the volute by centrifugal force, bringing the liquid into an increasingly rapid rotation around its orbit within the volute scroll. During this interval the liquid driven out of its center or orbit and from the inlet passage causes the liquid in the liquid chamber 11 to rise in the discharge pipe or hose (not shown) connected with its outlet opening 18, or in other words to be displaced to a higher level.

Then, having drawn and expelled off all liquid in said inlet passage 13, the impeller begins to draw air from the said passage and from the suction pipe or hose connected therewith through its nipple connection 17. This air it similarly expels outwardly by centrifugal force toward the liquid surrounding its orbit within the volute or impeller chamber. Pockets or swirls created in said liquid by the blade action and agitation caused by the vigorous rotation receive the air and envelope or engulf it in the liquid in the form of bubbles. The air is thus literally "driven" into the liquid surrounding the impeller and is carried off with the liquid by the volute discharge into the liquid chamber through the opening 21.

Meanwhile, liquid from the liquid chamber 11 flows into the side or rotational field of the impeller through the elongate slot 28 in the wear plate 26, finding its way thereto of course through the communicating holes 22, 23, 24 and 25 in the separating wall 10a and principally through the lowermost larger one 25 of said holes opposite the said slot. This liquid flowing back into the impeller side is in turn expelled off by centrifugal force into the rotating liquid surrounding the impeller orbit and in so doing picks up or entraps the air being drawn from the inlet passage and aids or promotes the evacuative drive of the air into said liquid around the impeller orbit. Thus the liquid is continually recirculated from the volute to the liquid or separating chamber and back from the latter chamber into the volute, discharging peripherally through the volute mouth and reentering on a line parallel with but below the impeller axis.

This action and recirculation continues until

all of the air has been exhausted from the inlet passage 13 and the suction line connected therewith, the air contained in the liquid in the form of bubbles being impelled or carried around therewith from the volute through its discharge and up through the body of liquid in the liquid chamber substantially on the line of the arrows Y shown in Fig. 3. By virtue both of the force of impeller action and its own lighter gaseous character the air naturally rises through the liquid chamber and expels off into the discharge connection with the outlet opening 18 in the top of said chamber. The liquid chamber accordingly serves as a separating chamber in which the air is separated and expelled off from the liquid until all of it has been drawn or evacuated from the inlet passage and its connection so as to thereby establish suction in said inlet passage. It will be noted that none of the liquid, or at least very little of the same, is carried with or under the impeller blade tips above or across the cut-off edge 20 and that the action of the impeller in its volute or continuous scroll from said edge around to the discharge opening 21 is such that liquid therein is kept in a continuous state of rotation next to the impeller and so removes all air from the volute or impeller chamber. This it does at a very rapid rate, there being no point in the volute scroll where air can become entrapped so as to prevent the efficient performance of the pump in its priming action or subsequently. Any air present in the volute passage is quickly expelled by being carried off with and by the liquid.

After the inlet passage and connection has been evacuated and all air expelled from the impeller chamber, thereby establishing a suction, so as to draw up liquid thereinto through said intake, this denser fluid entering axially into the impeller and thrown off peripherally thereby into the volute channel in rapid movement past the slot 28, cuts off or arrests the flow through said slot from the liquid to the volute or impeller chamber and so suspends the recirculation. In other words, the rapid movement of the indrawn liquid past said slot, in the peripheral discharge by the impeller, stops the flow therethrough from the liquid to the impeller chamber, or vice versa, so that the pump thereafter operates or pumps in the manner of an ordinary standard centrifugal pump, to which it is fully comparable in pumping efficiency, the liquid being discharged along the line of the aforesaid arrows Y.

So long as suction or liquid pumping is continued, the recirculation or flow from the liquid to the impeller chamber is suspended. But when the pump has ceased operation, or loses its prime, the recirculation is restored or brought into function again until the pump has reprimed itself. The repriming of course is performed in the manner described and when the pump has taken in, or become charged with, only a small amount of air, with or during interrupted operation, it will naturally take a lesser time to reprime than when it has admitted or become charged with a large quantity of air. So long as its water content and connections exclude or remain sealed against air, it maintains its prime and operates with pumping effect the instant its impeller is started up.

When the pump is stopped, or its pumping effect is interrupted, the liquid body in the liquid chamber will drop or tend to reverse the flow and thereby possibly siphon the liquid out of the liquid or separating chamber, especially if the pumping source of liquid or supply of the liquid is at a lower level than the pump. This siphoning and loss of liquid is prevented by the ball 14, which will be carried by the falling or reverse liquid flow against its seat 16 and thereby prevent continued flow or escape of liquid back down the inlet connection. To facilitate the closing of this valve with reverse liquid flow, the said ball 14 is made of a material having a specific gravity less than the liquid being pumped, so that it has a tendency to rise or float and will be immediately pressed against its aforementioned seat. Of course it will be understood that the ball would function even though its specific gravity might be equal to or somewhat heavier than the liquid. However the ideal condition is to make it lighter than liquid, so that it has a natural buoyancy. During the intake in pumping action said ball is of course carried with the liquid flow against the cross-bar 15, so that the indrawn or incoming liquid passes thereabout at either side into and through the inlet passage on a line of flow indicated by the arrows Z in Figs. 2 and 3.

From the foregoing it will be appreciated that the pump has essentially four novel features. First, it is a self-priming centrifugal pump. It is also a heavy duty or high suction lift pump, which with respect to its relatively small size renders it especially efficient and suitable for use where larger pumps would otherwise be required. Second, after it is once primed and pumping liquid, it pumps the same as an ordinary centrifugal pump. That is, it ceases or cuts off the circulation of liquid in the way it circulates the same in the priming operation. In other words, the self-priming action and function is suspended or rendered inoperative when the pump is primed and pumping liquid, and is restored into operation only when the pump is priming or repriming itself. Third, the parts adjacent to the impeller, which are subject to the most wear, are readily renewable without necessity for replacing the entire pump casing, and may be reached for inspection, adjustment or repair with easy facility, simply by removing the pump body from the mounting pedestal. Ready inspection of the wear plate and elongate opening therein may be had by simply removing the plug 29 at the front of the pump. Therefore, the upkeep of the pump is very economical. Fourth, the pump is exceedingly simple and compact in construction and organization or arrangement of its parts, the pump body in this instance being formed in a single part or casting. In this connection, the aforementioned communicating holes 22, 23, 24 and 25 serve expediently in the making or casting of the pump body in that they aid in the aligning and spacing of the cores forming the forward and rearward chamber parts and said cores may be held in proper relation to each other through said holes. Thus the pump is inexpensive to make and may be very light in construction, in addition to being compact and exceedingly simple in construction with a minimum number of movable parts.

The several advantages of the invention will be appreciated from its nature and what has been stated. One of the factors of principal advantage is that there is no place where air can become trapped so as to render the pump "air-bound", i. e. there is no place in the volute where air can congregate above the impeller. The impeller makes a clean cutting sweep across the cut-off edge or surface 20 and maintains the liquid in a swirling whirl around its orbit, with the liquid closest to its blade tips rotating exceedingly rapidly and tending to similarly rotate the entire body of liquid present in the volute channel.

Hence there is no place for air to concentrate or become trapped and any air present in the pump is quickly forced out by the action of the impeller in its volute.

It will be understood that certain changes in the general organization and arrangement of the pump may be made without departing from the spirit and scope of the invention. Certain of such changes may be suggested or required in pumps of differing size, there being no limitation of course upon the size in which the pump may be constructed so as to fulfill the requirements of any specified or particular work to be performed. Therefore, it is not intended by the appended claims to limit the invention to the specific construction and arrangement herein shown and described.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. A liquid pump, comprising a pump body having a forward liquid chamber and a rearward impeller chamber adjacently arranged with a separating partition wall therebetween, an inlet passage extending through the liquid chamber from its top downwardly into the side of the impeller chamber upon the line of the impeller axis and giving to said liquid chamber an internal formation corresponding roughly to that of a ring, a discharge passage in the top of said liquid chamber, a rotatable impeller in the impeller chamber, a discharge from said impeller chamber into the liquid chamber at the bottom of the two formed by an opening in the separating partition wall between the two and by a wall portion extending from the outer side of the impeller chamber across the outer periphery thereof into merger with said separating wall, and means for admitting a return flow of liquid from the liquid chamber into the side of the impeller chamber at a point between the inlet to said impeller chamber and the said discharge therefrom and also anterior to said discharge with reference to the direction of impeller rotation.

2. A self-priming centrifugal pump, comprising a pump body having a forward liquid chamber and a rearward impeller chamber of volute form separated by a wall therebetween, an inlet passage extending through the liquid chamber from its top downwardly into the side of the impeller chamber upon the line of the impeller axis and giving to said liquid chamber an internal formation corresponding roughly to that of a ring, a discharge passage in the top of said liquid chamber, a rotatable impeller in the impeller chamber, a discharge opening from the volute of the impeller chamber into the liquid chamber formed by an opening in the wall between the two and by a wall portion extending from the outer side of the pump chamber laterally across the outer portion of the volute into merger with said separating wall between the two chambers, and means for admitting a return flow of liquid from the liquid chamber into the side of the impeller chamber at a point between the normal said inlet thereto and the outer periphery edge of the impeller therein and anterior with reference to the impeller rotation to said discharge opening between the two chambers.

3. A self-priming centrifugal pump, comprising a pump body having a forward liquid and air separating chamber and a rearward impeller chamber of volute form adjacently arranged with a separating wall therebetween, an inlet passage extending through said liquid and air separating chamber to the side of said impeller chamber opening thereinto in line with the axis of the impeller housed within the same and giving to said liquid and air separating chamber an internal formation corresponding roughly to that of a ring, an outlet passage at the top of said liquid and air separating chamber into which the same opens upwardly directly and which forms the sole outlet therefrom, a rotatable sloping-blade impeller in the impeller chamber, a discharge opening from the volute of the impeller chamber into the liquid and air separating chamber at the bottom of the two formed by an opening in the separating wall between the said two chambers and by a wall portion extending from the outer side of the impeller chamber laterally across the outer portion of the volute into merger with said separating wall, and means for admitting a limited return flow of liquid from the liquid and air separating chamber into the side of the impeller chamber at a point between the normal said inlet to the latter and the outer peripheral edge of the impeller therein, but anterior with reference to the impeller rotation to said discharge opening between the two chambers; the beginning of the volute formation of the impeller chamber, preceded by a cut-off edge swept by the tips of the impeller blades, being located above the said discharge opening and terminus of the volute and at a point posterior to the said means for admitting a return flow of liquid into the impeller chamber.

4. A self-priming centrifugal pump, comprising a pump body having a forward liquid chamber and a rearward impeller chamber of volute form separated by a wall therebetween, an inlet passage extending through the liquid chamber from its top downwardly into the side of the impeller chamber upon the line of the impeller axis and giving to said liquid chamber an internal formation corresponding roughly to that of a ring, a ball valve in said inlet passage admitting liquid thereinto but closing to prevent the outflow of liquid therefrom by lift of the liquid itself, a discharge passage in the top of said liquid chamber, a rotatable impeller in the impeller chamber comprising rearwardly curved blades overlapping each other, a discharge from the volute of the impeller chamber into the liquid chamber formed by an opening in the separating wall between the two by a wall portion of the pump body extending upwardly from the outer side of the pump chamber laterally across the outer portion of the volute into merger with said separating wall, a series of communicating passages in the wall between the liquid and impeller chambers in circular arrangement around the inlet passage opening into the latter, a wear plate adjacent to the impeller closing over said communicating passages on the impeller side thereof, and a single opening through said plate allowing a limited return flow of liquid from the liquid chamber to the impeller chamber on a line substantially parallel with but at a different level from the inlet to said impeller chamber.

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