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3,045,603

SELF-PRIMING CENTRIFUGAL PUMP

Filed Oct. 26, 1959

3 Sheets-Sheet 1

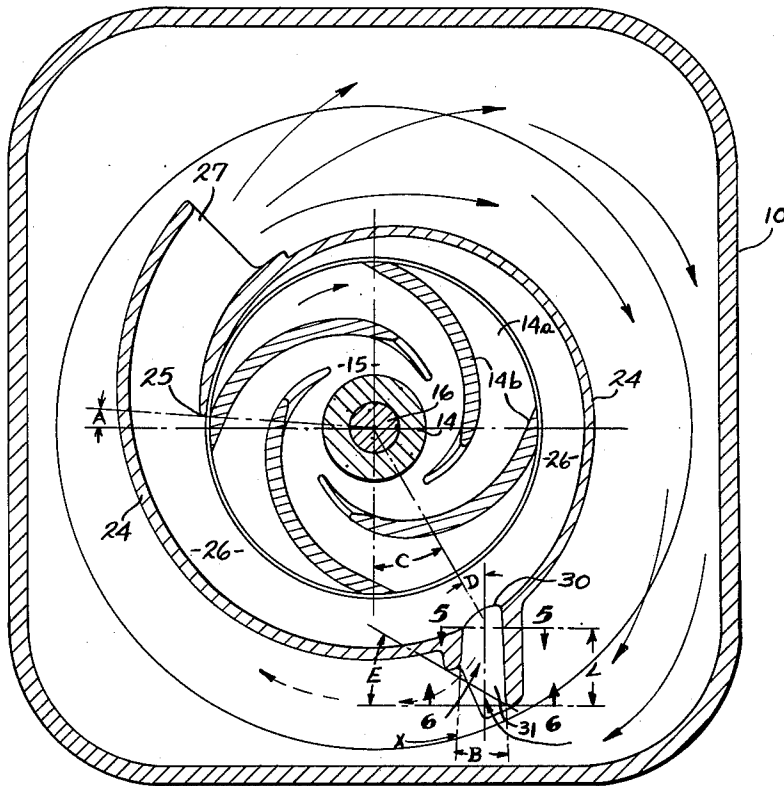


Fig. 2

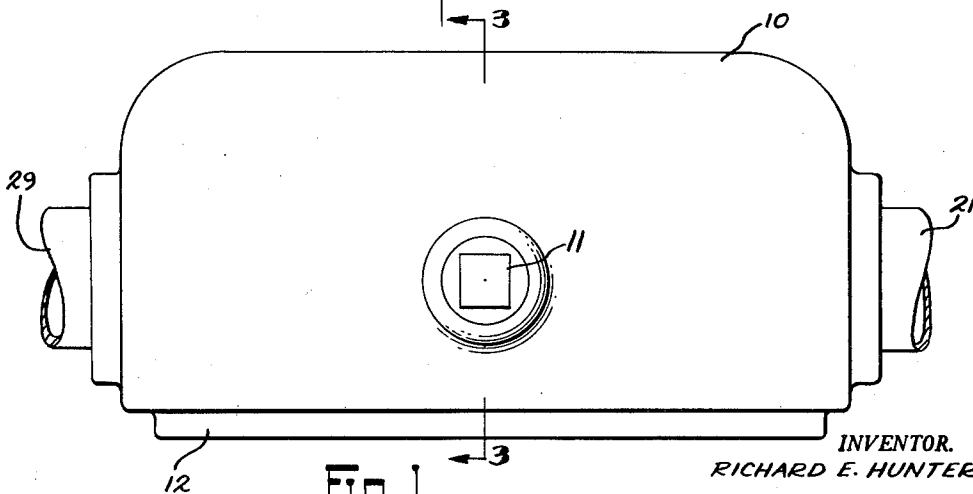


Fig. 1

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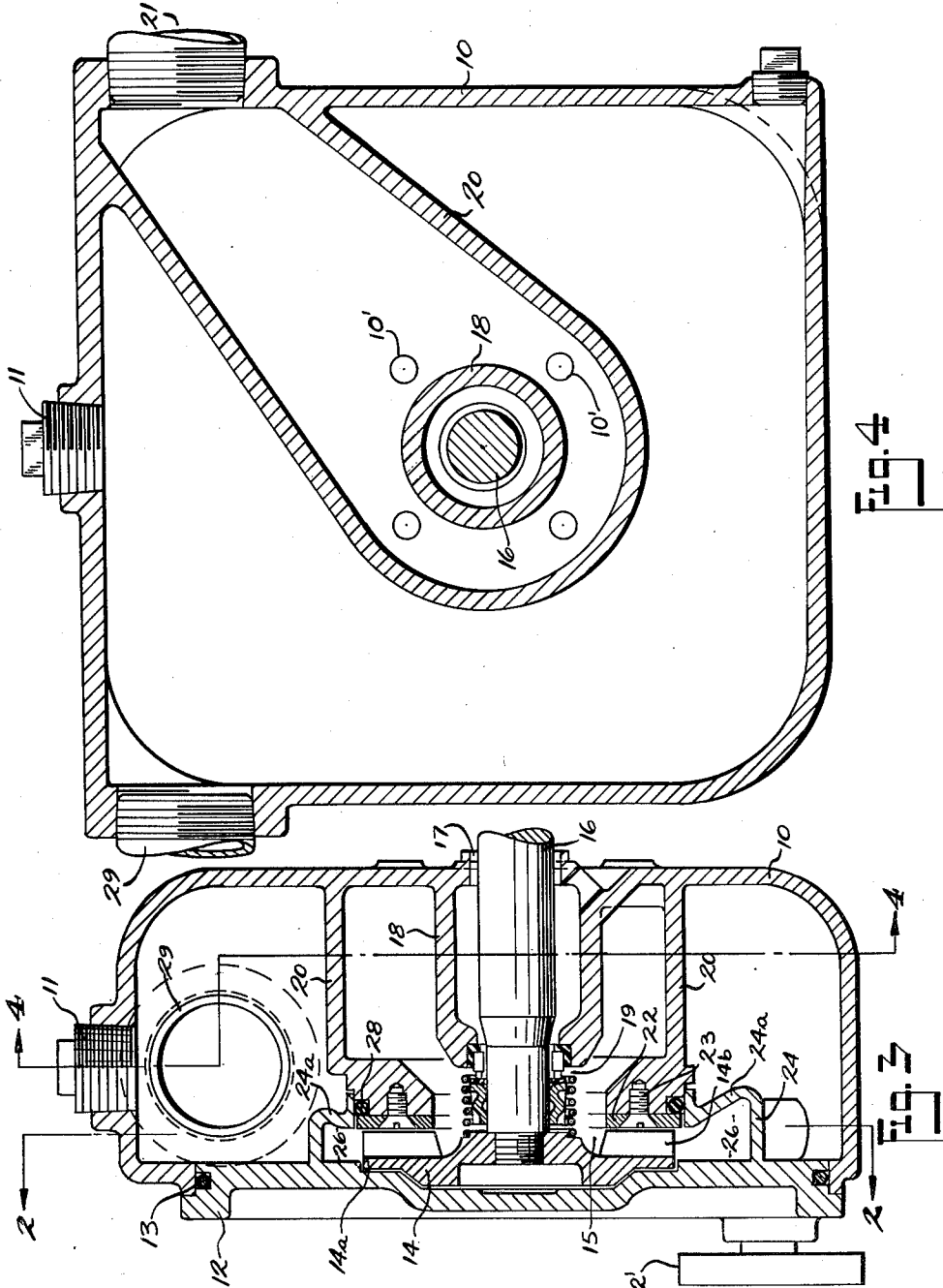
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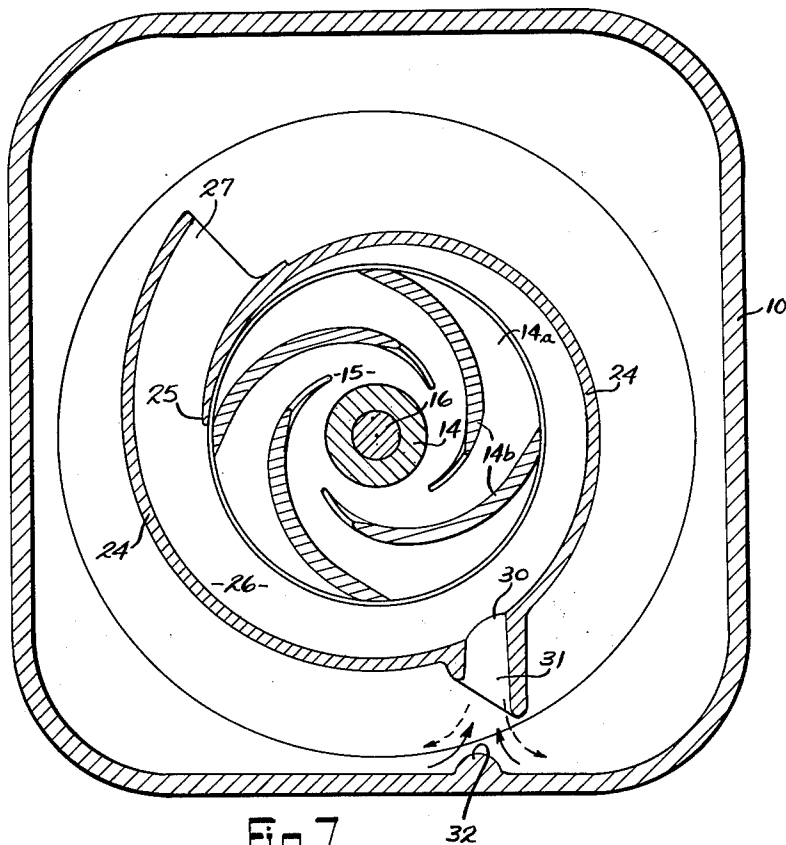


Fig. 7

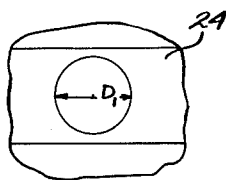


Fig. 5

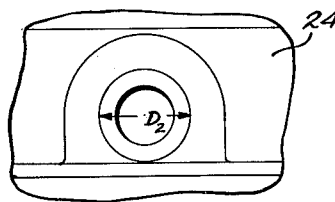


Fig. 6

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SELF-PRIMING CENTRIFUGAL PUMP

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2 Claims. (Cl. 103-113)

This invention relates to improvements in a self-priming centrifugal pump.

One of the objects of the present invention is to provide a self-priming centrifugal pump designed and constructed to give positive priming action without the use of an auxiliary vacuum pump, check valves, reeds, double volutes, siphon breakers and other auxiliary equipment which have heretofore been used to produce priming action in such a pump. At the same time, the improved pump herein disclosed gives optimum efficiency for centrifugal pumps of this nature after the completion of the priming cycle, which efficiency is decreased to a very slight degree, if at all, because of the structure provided for the self-priming function.

The invention also provides a pump of the type described comprising a casing with an impeller chamber within the casing and a bladed impeller rotatably mounted in the chamber, with the walls of the chamber closely associated with the opposite faces of the impeller, there being a cutwater at one side of the chamber having substantially a running fit with the impeller, the impeller chamber also having a partition wall which together with the side walls of the chamber provide a volute passageway outside of the periphery of the impeller and extending more than 360 degrees from the cutwater, this volute passageway progressively increasing in cross sectional area from the cutwater in the direction of impeller rotation at an uninterrupted rate at every point along its length save for a priming passageway of small area communicating directly between the lower part of the casing and the volute passageway at a point in the latter passageway outside of the orbit of the impeller and more than 180 degrees from the cutwater in the direction of impeller rotation, this priming passageway being quite short and of venturi construction so that after the pump is primed, the priming passageway converts some of the velocity head of the pump liquid into pressure head giving good pumping discharge in the reverse direction through the priming passageway.

The invention further provides a low cost, simple construction in a pump of this type.

Other objects and advantages of the invention will be apparent from the accompanying drawings and description and the essential features thereof will be set forth in the appended claims.

In the drawings,

FIG. 1 is a top plan view of a pump embodying this invention;

FIG. 2 is a sectional view of the same taken through the pump impeller and volute passageway along the line 2-2 of FIG. 3;

FIG. 3 is a central transverse sectional view of the pump of FIGS. 1 and 2 taken along the line 3-3 of FIG. 1;

FIG. 4 is a sectional view taken along the line 4-4 of FIG. 3;

FIGS. 5 and 6 are fragmental sectional views taken along similarly numbered lines in FIG. 2; while

Fig. 7 is a view similar to FIG. 2 and showing a modification.

In the pump shown in FIGS. 1 through 6, there is provided an outer casing 10 provided at the top with a filling plug 11 which is threaded into a suitable opening. It should be understood that the sectional configuration of

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the casing 10 as seen in FIGS. 2 and 4 may be generally square as there shown or generally circular, or arcuate at the bottom, or any other suitable shape so long as the principles of my invention are carried out as herein-after set forth. The casing 10 is generally cup-shape and open at one side as clearly seen in FIG. 3, which open side is closed by a face plate 12 which is connected to the casing 10 in a leak-proof manner as for instance by means of the O-ring seal 13. A threaded handle screw 12' is utilized to hold the face plate to the casing 10 in the position shown in FIGS. 1 and 3. The openings 10' in FIG. 4 are for self-sealing screws for holding the casing 10 rigid with a power source.

A conventional impeller 14 is mounted in the casing for rotation on a horizontal axis although other arrangements will occur to those skilled in this art. The impeller comprises a back plate 14a having on one face thereof upstanding blades 14b which are conventional backward curved vanes describing a tangential discharge angle of less than 90 degrees. The blades stop short of the center of the impeller and there provide an intake eye 15. The impeller is rigid with and driven by a shaft 16 which extends out of the casing and is driven by a power source not shown. It should be understood that the bearings on the shaft 16 hold it in position both radially and endwise and additional bearings might be provided at the point 17 if desired or required. An annular flange 18 integral with the casing 10 extends from the rear wall of the casing toward the impeller and supports a seal 19 which prevents any leakage along the shaft 16.

Means is provided for leading liquid to be pumped to the intake eye 15. This might take any one of various forms but is here shown as comprising a manifold 20 which is formed integrally with the casing 10 and which surrounds an area axially opposite the eye 15 and leads therefrom upwardly and toward the right as shown in FIG. 4 to an inlet conduit 21.

Means is provided defining an impeller chamber inside of the casing 10. This might be formed entirely supported by the casing 10 but in the present instance is supported partially by the face plate 12 and partially by the casing 10 as best seen in FIG. 3. This impeller casing has one side wall where the impeller back plate 14a has a running fit against the cover plate 12. The other side wall is formed by a wear plate 22 of annular shape secured to the manifold 20 by a plurality of screws 23 as clearly shown in FIG. 3. With a fully shrouded or closed impeller, wear plate 22 is eliminated and the shroud has a close running fit at this point and a wearing ring fit at the impeller eye area. The radially outermost portion of the impeller chamber is completed by a partition wall 24 which in the present instance is integral with the face plate 12 but could be provided as an extension of the member 20 as will be understood by those skilled in this art. This partition wall closely approaches the orbit of the impeller at the point 25 to one side of the impeller chamber to provide a cutwater there which is substantially a running fit with the impeller. This partition wall 24 together with the side walls of the impeller chamber previously described together provide a volute passageway 26 which starts with an almost zero area at the point 25 and extends more than 360 degrees therefrom in the direction of impeller rotation finally terminating in a discharge opening 27. The area of this volute passageway progressively increases in cross sectional area from the cutwater in the direction of impeller rotation at an uninterrupted rate at every point along its length save for an entrance opening for a priming passageway to be later described. Such a true volute passageway greatly increases pumping efficiency after priming has been accomplished and I believe this pump to be a great advance over prior pumps

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which utilized two generally parallel passageways of which the outer one acted as a priming passageway with flow in one direction and later as a discharge passageway with pumping in the opposite direction. At the point of junction of these two passageways in prior known pumps, there was a sudden increase in the area of the volute passageway diminishing pumping efficiency. It will be understood by those skilled in this art that the length of the volute passageway 26 from the cutwater point 25 to the discharge 27 is determined by well known laws and is of sufficient length to change a portion of the velocity head into pressure head to give good pumping action. The partition wall 24 has a radially inwardly extending flange 24a integral therewith and of different radial extent depending on the area of the volute passageway at the particular point. This flange 24a closely surrounds that portion of the manifold 20 which supports the wear plate 22 and is sealed against leakage at the meeting joint by means of an O-ring seal 28 as clearly shown in FIG. 3.

A connection is provided in the upper portion of the casing 10 as indicated at 29 for the discharge of pumped liquid.

The pump as above described is designed for maximum pumping efficiency and I will now describe the arrangement made so that the pump is self-priming without interfering except perhaps in a very slight degree with such pumping efficiency.

Referring to FIG. 2, there is a priming opening provided at 30 directly in the partition wall 24 and radially outside the orbit of the impeller 14. I am aware that others have introduced priming liquid within the orbit of the rotating impeller but this causes undesirable turbulence and reduces pumping efficiency. I find that the efficiency is well maintained if the cross sectional area at the level as shown in FIG. 5 is approximately equal to a circle whose diameter equals the width of the impeller blades 14b when the dimension is measured between the side walls of the impeller chamber. The location of the opening 30 may be between 180 degrees and 270 degrees from the cutwater 25 in the direction of impeller rotation. However, the preferred location of the opening 30 is shown in FIG. 2 as having its center at that point intersected by a line passing through the axis of the impeller and at an angle C of approximately 30 degrees counterclockwise from a vertical plane through the axis of the impeller. From the opening 30 a priming passageway 31 extends outwardly from the impeller chamber. The direction of this passageway may vary somewhat from the position shown in FIG. 2 but the best results are obtained when the axis of the priming passageway is substantially vertical in that type of pump where the axis of rotation of the impeller is horizontal. I have shown such a center line of the priming passageway in FIG. 2 wherein the angle D is 30 degrees, thus making the center line of the priming passageway parallel to a vertical plane through the axis of the impeller.

The preferred form for the shape of the priming passageway is that of a venturi with its throat adjacent the opening 30 and with the length of the priming passageway being sufficient to convert enough velocity head to pressure head to give good discharge through the opening 30 during the pumping periods after the pump is primed. A preferred form for the walls of the priming passageway is that of a truncated cone although my invention is not limited to such a shape. Referring to FIGS. 2, 5 and 6, if the cross section of the passageway at the level indicated by the line 5—5 is a circle diameter D1 and the area at the level of the line 6—6 is that of a circle having the diameter D2, then the included angle B between the two sides of the truncated cone is preferred to be between 6 and 8 degrees. Note that the circle of FIG. 2 designated by the diameter D2 extends to the dot-dash line X of FIG. 2 which is a prolongation of the shorter side or lefthand side as seen there of

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the walls of the priming passageway. The length of the passageway, designated L in FIG. 2, is such that the area at the diameter D2 is approximately 1.49 times the area at the diameter D1 when the divergent angle B is 6 degrees, and the area at diameter D2 is approximately 1.63 times the area at diameter D1 when the divergent angle B is 8 degrees.

The pump priming passageway would operate effectively even if the wall thereof seen at the left side in FIG. 2 were as long as the wall seen at the right-hand side. However, I prefer to cut the left-hand wall back approximately at an angle E of 30 degrees as shown in FIG. 2 so as to provide an elliptical shape and a larger area at this opening which allows a faster entrance of the priming liquid as well as giving a better guidance to this liquid.

It will be understood by those skilled in this art that the location of the cutwater 25 is arrived at by means well known in the pump design industry. The angle A in FIG. 2 is equal to the angle formed between the impeller peripheral velocity and the absolute velocity on the impeller discharge velocity diagram. Then, as shown in FIG. 2, the preferred location of the axis of the opening 30 is 240 degrees minus angle A in a clockwise direction (the direction of impeller rotation) from the cutwater 25.

The operation of this form of my invention should now be apparent. The pump casing 10 is initially filled with liquid through the opening 11 at least sufficiently to give an initial pumping action. This would mean preferably filled to at least the axis of the impeller and in any case so as to cover the lower ends of the impeller blades. When the impeller starts to rotate by means of its drive shaft 16 and in clockwise direction as seen in FIG. 2, the impeller vanes 14b start discharging liquid through the impeller chamber and through the discharge passageway 26, 27 and into the separation and discharge chamber which is at the upper portion of the casing 10. There any lighter air or gas is separated from the heavier water or liquid and discharged through the outlet conduit 29. While this action is taking place, the heavier, substantially gas free, liquid is returned to the lower region of the pump casing 10 where it travels up through the priming passageway 31 to join the lighter gas laden liquid in the impeller or volute chamber 26. This cycle is repeated with a partial vacuum action taking place in the impeller eye 15 which is there immediately filled with gas or air from the suction manifold 20 and the inlet conduit 21 until the suction system is completely purged of gas or air. Once the pump is primed, as above described, the venturi shaped passageway 31 acts as a discharge passageway along with the normal volute discharge passageway 26, since the venturi section at passageway 31 is so designed as to convert part of the velocity energy in the impeller chamber to pressure energy at the passageway 31. This action prevents any re-circulation with the resultant hydraulic efficiency loss. The design of my pump is such that during the pumping period approximately 75 percent of the discharge occurs through passageway 26, 27 and approximately 25 percent through passageway 31.

The pump described is so designed as to allow for a sufficient volume of liquid to be retained in the lower region of the casing 10 and in the suction passageway to insure repeated priming even when high static discharge heads produce siphoning when the pump is shut down.

In the pump as modified in FIG. 7, all parts are identical except that about to be described and have, therefore, been given identical reference characters. The difference between FIG. 7 and FIG. 2 resides in a baffle 32 provided at the bottom of the casing 10 and substantially in line with the passageway 31. The design of this baffle 32 is such that it will direct priming liquid in the direction of the full line arrows of FIG. 7 up into the priming

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passageway during the priming cycle of the pump. At the same time, the baffle preferably also serves to smooth stream line flow of liquid out of the passageway 31 during the pumping cycle of the pump in the direction of the dotted line arrows. This refinement may be added if desired but the pump works very well without it.

I have thus provided an improved centrifugal volute type pump which is completely self-priming in nature after the pump case has been initially charged with liquid to be pumped. This improved pump does not require the presence of any auxiliary priming devices. My improved pump incorporates only a single volute passageway with the cross sectional interior area of this passageway, outside of the impeller, becoming progressively larger in size from the tip or cutwater around to the exit thereof, not requiring a second or secondary cutwater tip which heretofore has resulted in an area differentiation or an interruption in the smooth progression of the volute passageway cross sectional area from cutwater to discharge. My improved pump gives fast, efficient priming action even at the highest suction lifts, and with no sacrifice in pumping efficiency due to recirculation of the liquid within the pump itself after the priming has been completed. My improved pump, when once primed, becomes practically free of any plugging or fouling due to the presence of foreign matter in the liquid to be pumped. Furthermore, this improved pump is inexpensive to build since only simple pattern and core work are required.

What is claimed is:

1. A self-priming centrifugal pump comprising a casing, means defining an impeller chamber in said casing, a bladed impeller rotatably mounted in said chamber and having an intake eye at its axis, a cutwater at one side of said chamber and having substantially a running fit with said impeller, said impeller chamber defining means having side walls closely associated with opposite faces of said impeller, said chamber defining means also having a partition wall joined to said side walls and said walls providing a volute passageway outside of the periphery of said impeller and extending more than 360 degrees from said cutwater, said volute passageway progressively increasing in cross sectional area from

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said cutwater in the direction of impeller rotation at an uninterrupted rate at every point along its length, the discharge end of said volute passageway located in the upper part of said casing and opening toward the top of said casing, there being a priming passageway communicating directly between the lower part of said casing and said volute passageway at a point in said volute passageway outside of the periphery of said impeller and more than 180 degrees from said cutwater in the direction of impeller rotation, said priming passageway being of Venturi shape with its throat adjacent said volute passageway, said priming passageway having a flow area adjacent said volute passageway approximately equal to a circle whose diameter equals the width of said impeller blades between said side walls, means for liquid inlet to said impeller eye, and outlet means for discharging liquid from the upper part of said casing, whereby substantially gas-free liquid enters said priming passageway during priming periods and liquid is discharged at high efficiency from both said passageways during pumping periods, said priming passageway being delimited by walls approximately the shape of a truncated cone having a central axis substantially vertical, and said delimiting walls diverging outwardly into the lower part of said casing at an angle between approximately 6 to 8 degrees.

2. A pump as defined in claim 1 wherein said truncated cone has an outer end adjacent the bottom of said casing and an inner end adjacent said impeller and wherein the area at its outer end is between approximately 1.49 and 1.63 times its area at its inner end.

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