July 19, 1960 — S. H. FREDERICK — 2,945,448

UNIVERSAL CENTRIFUGAL PUMP

Filed Feb. 15, 1957 — 2 Sheets-Sheet 1

Fig. 1.

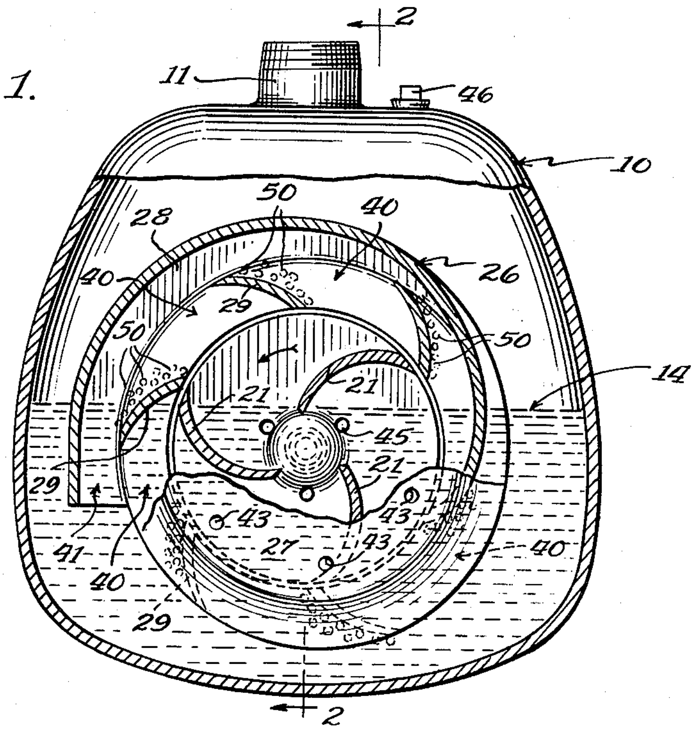
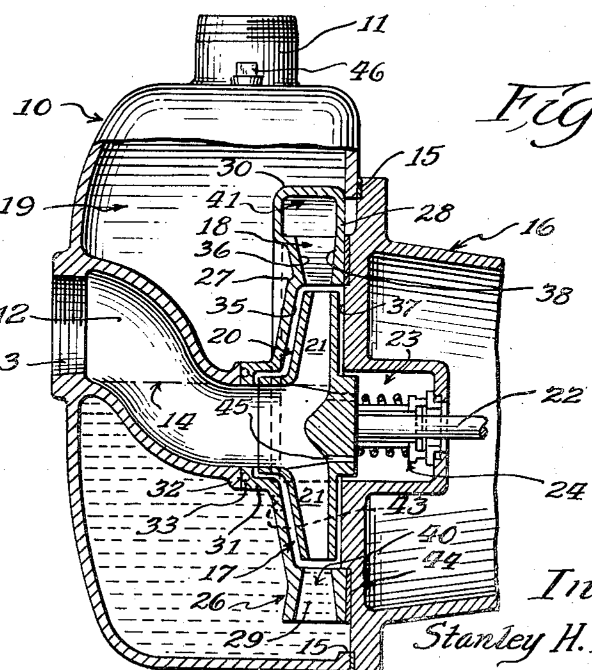


Fig. 2.



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Filed Feb. 15, 1957 2 Sheets-Sheet 2

Fig. 3.

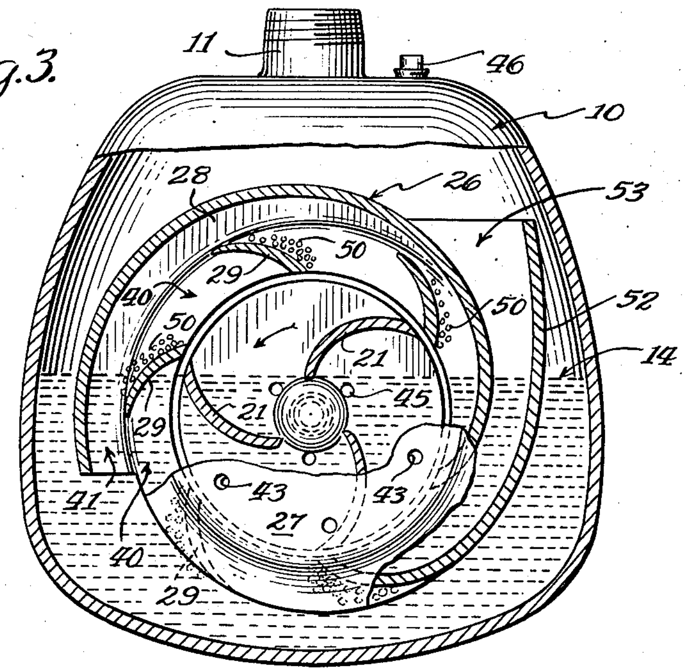
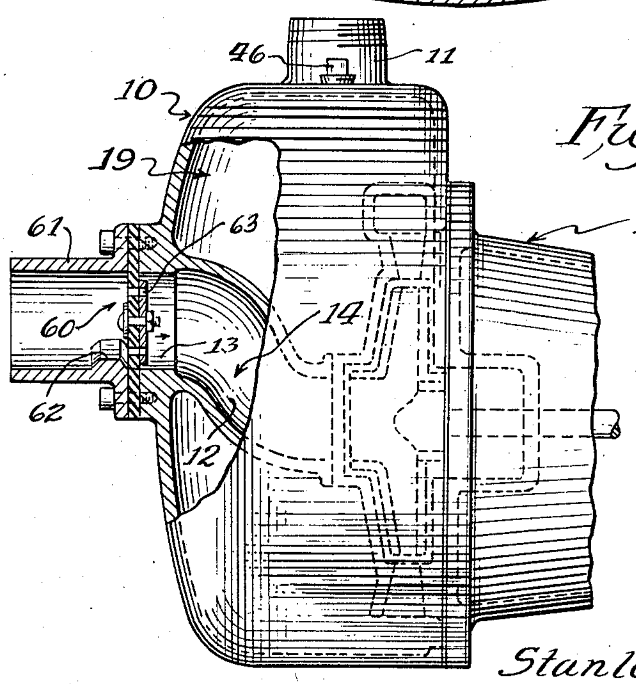


Fig. 4.



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UNIVERSAL CENTRIFUGAL PUMP

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8 Claims. (Cl. 103—113)

This invention relates to a centrifugal pump construction of universal applicability in that it exhibits, to a marked extent, all the desirable performance features for centrifugal pumps and this is achieved without compromising any known principles of effective commercial engineering design. Basically the invention is an improvement on the construction shown in Stratton Patent No. 2,281,175, which is owned by the assignee of this invention.

As is to be expected, there are many different applications for centrifugal pumps, each of which presents its own operating problems and it has not been unusual to design pumps specifically for a particular type of application. For example; some of the more general and somewhat diverse features that have been emphasized in these individualized pump designs of the prior art include: high capacity and efficiency; long effective life; ease of maintenance and repair; self-priming ability, including the ability to prime quickly and the ability to prime against positive discharge heads; the ability to handle solid laden liquids; smooth and quiet operation and uniform performance over a broad operating range; and low manufacturing costs.

As the centrifugal pump art has developed, this individualized design approach has resulted in a variety of specifically different pump constructions, each of which emphasizes certain features to the detriment of others. Thus, the versatility and hence the general usefulness of the prior art arrangements, has been seriously limited. Equally important, however, is the fact that the advantages of mass production techniques have never reached their full fruition.

Probably the most striking instance where the individualized design approach necessitates the sacrifice of certain desirable perforance features in order to emphasize a given feature arises in connection with the attempts to improve the self-priming capabilities of centrifugal pumps.

The main difficulty with prior art pumps which emphasize self-priming and particularly which emphasize the ability to prime against a positive discharge head, is associated with the fact that their ability to prime is directly related to the maintenance of extremely close clearances between the impeller blades and the point at which the foamy air-liquid mixture is peeled off for purposes of separating out the air and recirculating substantially air-free liquid to continue the priming cycle. In the first place, the use of single point, close clearance peeling results in a pump that is irritatingly noisy except for a very limited operating range. This noise condition can only be removed by increasing the clearance but this, of course, would prevent the pump from priming. Actually the wear imposed on the parts of the pump during normal operation is concentrated at the point of peeling and this wear continuuously decreases the priming ability of the pump. In certain instances pumps have been designed with an adjustable peeling tongue

in order to compensate for such wear. In addition to normal wear, however, the noise condition referred to commonly has associated with it a cavitation effect which accelerates pump wear and even more severely limits pump life.

It is the principal object of the present invention to provide a superior centrifugal pump construction that avoids the above noted disadvantages of the prior art arrangements without sacrificing any principles of effective commercial engineering design and that is capable of universal application and hence lends itself to mass production techniques.

Generally speaking the invention employs a pump construction, the parts of which are organized and arranged to complement each other in that they interact to combine a variety of diverse features without compromising one feature in favor of another. Basically this is accomplished by providing a plurality of peeling vanes spaced uniformly about the periphery of the impeller without requiring the maintenance of close clearances between these parts. Adjacent vanes partially define divergent passages that convert the high velocity turbulent flow of the foamy air-liquid mixture at the region of the impeller into a low velocity stream-like flow which is discharged into a liquid reservoir provided by a relatively quiescent plenum chamber where the air is separated out and air-free liquid is recirculated to the impeller chamber. In addition, one of the vanes is extended in the form of an arcuate wall to form an enclosed hood over the upper portion of the impeller periphery with the hood forming a collecting channel that receives the flow from the uppermost divergent passages and conducts it to the plenum chamber at a region below the liquid level of the pump.

The fact that substantial peeling clearances are permissible is significant in that the pump performance is free of noise conditions over a broad operating range. Furthermore, such wear as does occur is appreciably less and is well distributed so that the wear at any one point is minute in comparison with prior art arrangements. In addition, the clearances in the present invention are not critical and the puump performance is affected to a far less extent by such wear as does occur.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the accompanying drawings forming a part of this specification and in which like numerals are employed to designate like parts throughout the same;

Fig. 1 is a vertical sectional view through a center region of the pump casing with certain internal parts of the pump broken away and sectioned to better illustrate the arrangement;

Fig. 2 is a vertical sectional view of the pump taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is a view generally similar to Fig. 1 and illustrating a modified form of the invention; and

Fig. 4 is an end view of still another modified form of the invention with parts of the casing broken away and sectioned for purposes of illustration.

Referring now to the drawings and particularly to Figs. 1 and 2 thereof, the present pump construction includes a casing, designated generally as **10**, having a discharge outlet **11** and having a suction passage **12** terminating at a suction inlet **13**. The suction passage **12** cooperates with the inlet **13** to partially define a drain level as indicated at **14** and while the suction passage is shown curving upwardly towards the suction inlet, it will become apparent that, within limits, the arrangement of these parts may be varied considerably. The opposite end of the casing **10** is formed with an access opening that is surrounded by a sealing gasket **15** and a closure flange, designated generally as 16, cooperates with the gasket and casing to seal the access opening.

The casing carries a novel arrangement of internal surface portions that define a generally cylindrical impeller chamber 17, a flow conversion chamber 18 surrounding the periphery of the impeller chamber to convert the discharge from the impeller chamber and supply it to the plenum chamber 19 which is defined by the remainder of the casing.

A rotatable impeller is designated generally at 20 and while it may be of any desired conventional type it is illustrated herein as having a plurality of blades 21 carried between spaced plates and it is mounted in the impeller chamber 17 for counter clockwise rotation as viewed in Fig. 1, and is formed at its axis with a suction intake or eye that faces the suction passage 12. The impeller shaft 22 projects through a seal well 23 formed in the closure flange 16 and a rotatable ring assembly 24 effects a seal between the impeller and the closure flange to completely isolate the interior of the pump from the atmosphere.

Preferably the chamber-forming internal surface portions, referred to previously, are provided in part by a replaceable unitary member 26 that is disposed within the casing between the suction passage and the closure flange. This unitary member comprises a first wall 27 that surrounds the suction line; a second wall 28 spaced axially from the first wall; a plurality of circumferentially spaced vanes 29 extending between these walls; and an arcuate wall 30 extending around the upper periphery of walls 27 and 28 in the form of an integral extension of one of the vanes that is bridged across the outer edges of these walls in outwardly spaced relation to the adjacent vanes.

The vanes 29 provide multiple peeling points that do not require critically low clearances and yet they permit efficient priming even against positive discharge heads. This multiple point peeling in combination with the novel internal wall arrangements is important in providing the unusual performance characteristics of the present construction.

The first wall 27 is carried on a tubular stub 31 that abuts against the flanged inner end 32 of the suction passage wall and a sealing gasket 33 between these parts seals the suction passage from the plenum chamber.

While some or all of the walls of the unitary member could be cast integral with the casing, it is preferred that they be separate to permit of their ready replacement. Furthermore the coring operations are greatly simplified with the disclosed arrangement.

The wall 27 provides a generally annular inner surface 35 and a generally annular outer surface 36 that extends outwardly of the outer periphery of the inner surface. The inner surface 35 cooperates with a corresponding annular surface 37 provided on the closure flange 16 to define the end walls of the generally cylindrical impeller chamber 17. The wall 28 provides a generally annular surface 38 of substantially the same size and shape as annular surface 36 and these latter surfaces cooperate with the vanes 29 to provide a plurality of divergent intermediate liquid passages 40, the inlets of which terminate adjacent the periphery of the impeller chamber with their outlets extending outwardly and forwardly in the direction of impeller rotation.

As is best seen in Fig. 1, the passages 40 are arranged about the periphery of the impeller and they receive the relatively turbulent discharge of the impeller chamber and convert it into a stream-like flow. Due to their divergence these passages also cause a transition from a velocity head to a pressure head but the resulting radial forces substantially balance out about the axis of the impeller.

The arcuate wall 30 cooperates with the outer extensions of the walls 27 and 28 to form a channel that defines a passageway 41 that receives the fluid streams discharged from the outlets of the upper liquid passages and directs these streams into the relatively quiescent plenum chamber. The passageway 41, together with the intermediate liquid passages 40, forms the flow conversion chamber 18, the upper part of which is bounded by an enclosed hood that consists of the channel, the vane associated with it, and the walls 27 and 28. The hood extends beneath the liquid level and thus is sealed hydraulically.

The passageway 41 may diverge from its beginning to its end in order to handle the progressively increasing flow volume due to the incremental flows added by the successive passages 40 that communicate with the channel. By appropriately regulating the size of the channel, it is possible to maintain constant pressure and velocity conditions in the flow streams which it handles, and with this arrangement unbalanced radial forces will not be set up in this region of the flow conversion chamber.

Finally the wall 27 is provided with a plurality of priming holes or ports 43 to permit air-free liquid to recirculate from the plenum chamber to the impeller chamber during the priming cycle of the pump. In this connection, it is important to note that the ports are located beneath the liquid level and are hydraulically sealed against access of air. Furthermore they are displaced inwardly of the periphery of the impeller chamber and this location has been found to markedly improve their priming effect. While there is particular advantage in the inward location of the prime holes, the arrangement is effective even when these holes are located outside of the periphery of the impeller chamber.

Priming passages can be provided by a variety of arrangements within the scope of the invention. For instance, the ports can be at the upper region of the impeller chamber with tubing extending into the plenum chamber to a point beneath the liquid level of the pump. Alternatively the passages can be brought through the other end wall of the impeller chamber.

In the preferred form of the invention a sealing gasket 44 is provided between the wall 38 and the closure flange 16 to isolate the plenum chamber from the seal well 23. This sealing arrangement permits the use of balance holes 45 which extend axially through the impeller 20 in the region of its axis to place the eye of the impeller in communication with the seal well 23. In effect, therefore, the seal well is subjected to the pressure conditions existing at the eye of the impeller and no appreciable axial thrusts are imposed upon the impeller shaft 22 during operation of the pump. If the seal well is not isolated from the plenum chamber, the pressures in the plenum chamber act upon one face of the impeller while the opposite face is subjected to suction and a relatively severe axial thrust results.

When the pump is initially placed in service and filled through its fill plug 46, the static liquid level is determined by the lower lip of the suction intake 13. With the particular arrangement of Figs. 1 and 2, this level is more than adequate to permit the pump to prime.

In the priming cycle, the pump operation is as follows:

The rotation of the impeller 20 exhausts the liquid from the impeller chamber 17 and air is drawn into the eye of the impeller. A pressure differential then exists between the flow passages 40 and the eye of the impeller and this differential sets up a reverse flow of the liquid that had been initially exhausted. The impact of this reverse flow against the tips of the impeller vanes sets up a turbulence and splashing of liquid in the region of the impeller periphery and this permits the incoming air to be taken up to form a foamy mechanical mixture of air and liquid.

As the impeller sweeps by the foamy mixture, a hydraulic seal is established around its periphery and due to the centrifugal force of the impeller and the increased volume of the mechanical mixture, the mixture is discharged through the divergent passages **40**. These passages form the turbulent mixture into a stream-like flow and effect a velocity transition to a reduced rate of flow. The lower passages **40** discharge directly into the plenum chamber while the upper passages discharge into the passageway **41** and are jointly directed into the plenum chamber.

During this action, air bubbles, as indicated at **50**, are peeled off at the inner tips of the vanes are carried with the flow streams until they reach the relatively quiescent plenum chamber where the air separates and is vented to the compression dome of the plenum chamber for discharge through outlet **11**. To maintain an effective priming action, air-free liquid is recirculated to the impeller chamber for mixing with additional air from the suction side of the pump until all of the air is exhausted and the pump is fully primed. A certain amount of liquid returns along the air-free surfaces of the peeling vanes, but the major liquid return is provided through the ports **43** formed in wall **27**. It will be noted that these ports are located beneath the liquid level of the pump and therefore air on the discharge side of the pump can not recirculate. While the liquid recirculation paths along the uppermost vanes are physically above the liquid level of the pump, these paths are shielded against recirculation of the vented air by the sealing action of the enclosed hood which extends well beneath this liquid level.

While the prevention of recirculation of air is indispensable and is adequately achieved by the present arrangement, even though the reserve of liquid in the pump only partially fills the casing, the invention offers the important additional advantage of inherently increased priming efficiency. This results from the particular location of the priming ports relative to the impeller chamber. As best shown in Fig. 1, the priming holes are spaced inwardly of the periphery of the impeller and this location offers two important advantages over the prior art. First, priming efficiency is improved since all of the water that is recirculated through the priming ports is contacted and splashed about by the impeller blades and this results in more water in a greater state of turbulence being mechanically mixed with the air introduced at the eye of the impeller. A second advantage and one that is of particular importance from the manufacturing standpoint resides in the fact that the present construction permits greater standardization of the casing and all other parts of the pump except the impeller. With this approach a range of pumping characteristics can be achieved by utilizing smaller diameter impellers. Obviously the use of smaller diameter impellers results in increased clearances at the peeling points and necessarily reduces priming efficiency to a certain extent. However, the inward location of the priming holes, together with the fact that the present arrangement is not critically sensitive to peeling clearance changes, permits adequate priming to be achieved with these smaller diameter impellers.

Obviously the arrangement of the suction side of the pump may be variously modified to raise or lower the static drain level of the pump. All such departures are contemplated within the scope of the present invention and can readily be accommodated by maintaining the proper correlation between the positioning of the enclosed hood and the priming ports so that they will form the necessary hydraulic seal with the reserve of liquid. This correlation necessarily involves the obvious limitation that the volume of the reserve of liquid must exceed the combined liquid volume capacity of the impeller chamber and the flow conversion chamber.

These liquid level relationships defy mathematical, and to a large extent, quantitative analysis, but there are important qualitative effects that help in understanding the general requirements of the invention. In determining the actual effective level of the reserve of liquid, it is necessary to consider the dynamic conditions existing due to the motion of the impeller. For example, the level of the reserve of liquid tends to tilt under the effect of the rotating impeller, the level being lowered at the region where the blades pass downwardly through the liquid and being raised where the blades pass upwardly through the liquid. In addition, the mechanical mixture of air and liquid developed by impeller impact swells the overall volume of the liquid and produces a slight increase in the liquid level.

One of the important applications for a pump having the priming ability of the present pump is found in bulk plant operations where the pump may have a suction lift on the order of twenty feet and must pump against a positive discharge head. Each time the pump empties the storage reservoir and suction is broken on the intake side, the positive head of water drains back through the pump, there being no suction check valve, and a reserve of liquid is retained in the pump casing to permit priming. The level of this reserve of liquid is basically determined by the lower lip of the suction intake **13**. However, due to the fact that the enclosed hood and the priming ports are sealed against ingress of air from the top of the casing, a siphoning effect is developed and in severe cases continues until the level in the plenum chamber falls below the uppermost sealing point which in this case is one of the priming ports. Of course, the ultimate static liquid level is considerably above this siphon breaking point, since the enclosed hood has entrapped a head of water which is released when the siphoning action is broken and this entrapped head rebuilds the liquid level in accordance with the volume relationships in the central part of the casing.

Furthermore, the dynamic level will be still higher due to the tilting and swelling of the liquid by the impeller.

Thus, it must be understood that the term "liquid drain level," as used in the description and claims, means the level resulting from the composite effects of: the arrangement of the suction side of the pump; the dynamic effects of the impeller, and the siphon breaking provisions.

In applications involving extreme siphoning effects the alternative pump constructions shown in Figs. 3 and 4 may be employed to limit the siphoning action and prevent undue lowering of the liquid level.

The embodiment of Fig. 3 is identical with the arrangement shown in Figs. 1 and 2 except a second peeling vane carries an integral extension **52** that projects above the liquid level of the pump. This vane merges with outward extensions of the walls **27** and **28** to form a streamlined flow channel **53**. As the liquid level in the pump descends during the siphoning action that follows a suction break on the intake side of the pump, the liquid flow in this channel accelerates relative to the liquid flow in the other portions of the casing. This more rapid lowering of the liquid level in this channel results in a faster acting siphon breaking effect and maintains the ultimate liquid level substantially at the drain point of the suction side of the pump.

The embodiment of Fig. 4 is also substantially identical with the arrangement of Figs. 1 and 2 and it also limits siphoning effects though in a somewhat different manner. In Fig. 4 a conventional check valve **60** is held between the suction intake **13** and an inlet supply pipe **61** to open during forward flow and to close by engagement with an abutment **62** on the inlet pipe during reverse flow of liquid through the suction side of the pump. Suitable bleed holes **63** are provided through the check valve **60** to provide a siphon breaking action during reverse flow. This is permissible since the present pump does not require a check valve. The forward flow of liquid through the intake is substantially unaffected by the check valve **60** and reverse flow is retarded but not prevented. Since reverse flows are retarded, their tendency to siphon out the reserve of liquid in the pump is effectively neutralized.

Thus it may be seen that the objects of the invention have been accomplished in that the present pump exhibits an efficient priming action under the most rigorous operating conditions including the ability to prime against a positive discharge head. Since this priming action is achieved without requiring highly critical close clearance peeling, the pump has a long effective life, exhibits a minimum of operating wear, is unform and quiet over a broad operating range, and is even capable of pumping solid laden liquid. The parts of the pump are readily replaceable and a marked degree of standardization results in low manufacturing costs.

It should be understood that the description of the preferred form of the invention is for the purpose of complying with Section 112, Title 35 of the United States Code, and that the appended claims should be construed as broadly as the prior art will permit.

I claim:

1. In a centrifugal pump of the type including a casing having a discharge outlet and a suction passage terminating at a suction inlet with said suction passage and said suction inlet cooperating to define a liquid drain level; internal surface portions carried by said casing to form an impeller chamber communicating with the suction passage, a flow conversion chamber surrounding the periphery of the impeller chamber, and a plenum chamber occupying the remainder of said casing and communicating with said discharge outlet, said plenum chamber being located alongside the other chambers and extending therebelow, said flow conversion chamber communicating between said impeller chamber and said plenum chamber to form the relatively turbulent output of said impeller chamber into stream-like flow while decreasing the velocity head of such flow and increasing the pressure head and to direct this flow into the relatively quiescent plenum chamber for discharge through said discharge; and a centrifugal impeller rotatable in a given direction in said impeller chamber and having a suction eye around its axis with the eye facing said suction passage: the improvement wherein said internal surface portions include a first wall having an inner surface portion of generally annular shape and an outer surface portion of generally annular shape connected to the outer periphery of said inner surface portion and extending radially outwardly therefrom, said inner surface portion surrounding said suction passage and cooperating with said casing to form the end walls of a generally cylindrical impeller chamber, one of said end walls having priming passage means extending therethrough and connecting a region adjacent the periphery of said impeller chamber to a region of said plenum chamber located beneath said drain level, a third generally annular surface, of substantially the same size and shape as said outer surface portion, spaced from and facing the same, and a plurality of vanes spaced uniformly about the periphery of said impeller chamber with their inner ends cooperating with the impeller to provide a plurality of uniformly spaced peeling points, said vanes extending between said outer surface portion and said third annular surface to define therewith a plurality of divergent intermediate liquid passages that have inlets terminating adjacent the periphery of the impeller chamber and that have outlets extending outwardly and forwardly in the direction of impeller rotation, one of said vanes projecting outwardly of the periphery of the outlets of said last mentioned passages and connecting to one end of an arcuate wall portion the other end of which is free and extends from said one end in the direction of impeller rotation, said arcuate wall portion projecting above said drain level and extending around the upper portion of the periphery of said intermediate liquid passage outlets in outwardly spaced relation thereto with its opposite sides in sealing cooperation with the outer edges of said outer surface portion and said third annular surface to form a channel that collects the fluid streams discharged from the intermediate passage outlets associated therewith, and that delivers such streams into the plenum chamber at the open free end of said arcuate wall portion, said channel cooperating with said one vane to form an enclosed hood extending from a point on one side of the vertical plane of the axis of the impeller to a point on the opposite side of said vertical plane, said points being beneath said drain level, said channel and said intermediate liquid passages comprising the flow conversion chamber that supplies the output of said impeller chamber to said plenum chamber.

2. The arrangement of claim 1 and wherein said priming passage means extend through said inner surface portion and connect said region of said impeller chamber to a region of said plenum chamber located beneath said drain level.

3. The arrangement of claim 1 and wherein said inner surface portion is formed with at least one opening at a region beneath said drain level to connect said region of said impeller chamber and said plenum chamber.

4. In a centrifugal pump of the type including a casing having an access opening therein and having a discharge outlet and a suction passage terminating at a suction inlet, with said suction passage cooperating with said suction inlet to define a liquid drain level, a closure member cooperating with said casing and sealing said access opening; internal surface portions in said casing forming an impeller chamber communicating with the suction passage, a flow conversion chamber surrounding the periphery of the impeller chamber, and a plenum chamber occupying the remainder of said casing and communicating with said discharge outlet, said plenum chamber being located alongside the other chambers and extending therebelow, said flow conversion chamber communicating between said impeller chamber and said plenum chamber to form the relatively turbulent output of said impeller chamber into stream-like flow while decreasing the velocity head of such flow and increasing the pressure head and to direct this flow into the relatively quiescent plenum chamber for discharge through said discharge outlet; and a centrifugal impeller rotatable in a given direction in said impeller chamber and having a suction eye around its axis with the eye facing said suction passage; the improvement wherein a replaceable unitary member is mounted in said casing; said unitary member including a first wall having an inner surface portion of generally annular shape and an outer surface portion of generally annular shape connected to the outer periphery of said inner surface portion and extending radially outwardly therefrom, said inner surface portion surrounding said suction passage and cooperating with said closure member to form the end walls of a generally cylindrical impeller chamber, one of said end walls having priming passage means extending therethrough and connecting a region adjacent the periphery of said impeller chamber to a region of said plenum chamber located beneath said drain level, said unitary member including a third generally annular surface of substantially the same size and shape as said outer surface portion, spaced from and facing the same, and a plurality of vanes spaced uniformly about the periphery of said impeller chamber with their inner ends cooperating with the impeller to provide a plurality of uniformly spaced peeling points, the opposite sides of said vanes merging with said outer surface portion and said third annular surface to define therewith a plurality of divergent intermediate liquid passages that have inlets terminating adjacent the periphery of the impeller chamber and that have outlets extending outwardly and forwardly in the direction of impeller rotation, one of said vanes projecting outwardly of the periphery of the outlets of said last mentioned passages and integrally merging with one end of an arcuate wall portion, the other

end of which is free and extends from said one end in the direction of impeller rotation, said arcuate wall portion projecting above said drain level and extending around the upper portion of the periphery of said intermediate liquid passage outlets in outwardly spaced relationship thereto with its opposite sides merging with the outer edges of said outer surface portion and said third annular surface to form a channel that collects the fluid streams discharged from the intermediate passage outlets associated therewith, and that delivers such fluid streams into the plenum chamber at the open free end of said arcuate wall portion, said channel cooperating with one vane to form an enclosed hood extending from a point on one side of the vertical plane of the axis of the impeller to a point on the opposite side of said vertical plane, said points being beneath said drain level, said channel and said intermediate liquid passages comprising the flow conversion chamber that supplies the output of said impeller chamber to said plenum chamber.

5. A self-priming centrifugal pump comprising in combination a casing having a discharge outlet and a suction passage terminating at a suction inlet, with said suction passage cooperating with said suction inlet to define a liquid drain level; internal surface portions carried by said casing and forming an impeller chamber communicating with the suction passage, a flow conversion chamber surrounding the periphery of the impeller chamber, and a plenum chamber occupying the remainder of said casing and communicating with said discharge outlet, said plenum chamber being located alongside the other chambers and extending therebelow, said flow conversion chamber communicating between said impeller chamber and said plenum chamber to form the relatively turbulent output of said impeller chamber into stream-like flow while decreasing the velocity head of such flow and increasing the pressure head and to direct this flow into the relatively quiescent plenum chamber for discharge through said discharge outlet; a replaceable centrifugal impeller rotatable in a given direction in said impeller chamber and having a suction eye around its axis with the eye facing said suction passage; said internal surface portions including a first wall having an inner surface portion of generally annular shape and an outer surface portion of generally annular shape connected to the outer periphery of said inner surface portion and extending radially outwardly therefrom, said inner surface portion surrounding said suction passage and cooperating with said casing to form the end walls of a generally cylindrical impeller chamber, said inner surface portion having priming openings extending therethrough at a region beneath said drain level to circulate substantially air-free liquid from said plenum chamber to said impeller chamber, said priming openings being located between the periphery of said impeller chamber and the suction eye, said internal surface portions forming a plurality of diverging liquid passages spaced uniformly about the periphery of said impeller chamber and extending outwardly and forwardly in the direction of impeller rotation therefrom, with all regions of said diverging liquid passages that are above said drain level being enclosed, and vanes intermediate said diverging liquid passages with the inner ends of said vanes providing a plurality of peeling points spaced uniformly about the periphery of the impeller chamber.

6. A self-priming centrifugal pump comprising in combination a casing having an access opening therein and having a discharge outlet and a suction passage terminating at a suction inlet with said suction passage cooperating with said suction inlet to define a liquid drain level; a closure member cooperating with said casing and sealing said access opening, said closure member including a sealing chamber; internal surface portions in said casing forming an impeller chamber communicating with the suction passage, a flow conversion chamber surrounding the periphery of the impeller chamber, and a plenum chamber occupying the remainder of said casing and communicating with said discharge outlet, said plenum chamber being located alongside the other chambers and extending therebelow, said flow conversion chamber communicating between said impeller chamber and said plenum chamber to form the relatively turbulent output of said impeller chamber into stream-like flow while decreasing the velocity head of such flow and increasing the pressure head and to direct this flow into the relatively quiescent plenum chamber for discharge through said discharge outlet; a centrifugal impeller rotatable in a given direction in said impeller chamber and having a suction eye around its axis with the eye facing said suction passage, said impeller having an axial shaft projecting through said sealing chamber with said impeller being formed with axially extending pressure balancing openings providing communication between said sealing chamber and said eye; a replaceable unitary member mounted in said casing, said unitary member including a first wall having an inner surface portion of generally annular shape and an outer surface portion of generally annular shape connected to the outer periphery of said inner surface portion and extending radially outwardly therefrom, said inner surface portion surrounding said suction passage and cooperating with said closure member to form the end walls of a generally cylindrical impeller chamber, one of said end walls having priming passage means extending therethrough and connecting a region adjacent the periphery of said impeller chamber to a region of said plenum chamber located beneath said drain level, said unitary member including a third generally annular surface of substantially the same size and shape as said outer surface portion, spaced from and facing the same, and a plurality of vanes spaced uniformly about the periphery of said impeller chamber with their inner ends cooperating with the impeller to provide a plurality of uniformly spaced peeling points, the opposite sides of said vanes merging with said outer surface portion and said third annular surface to define therewith a plurality of divergent intermediate liquid passages that have inlets terminating adjacent the periphery of the impeller chamber and that have outlets extending outwardly and forwardly in the direction of impeller rotation, one of said vanes projecting outwardly of the periphery of the outlets of said last mentioned passages and integrally merging with one end of an arcuate wall portion, the other end of which is free and extends from said one end in the direction of impeller rotation, said arcuate wall portion projecting above said drain level and extending around the upper portion of the periphery of said intermediate liquid passage outlets in outwardly spaced relationship thereto with its opposite sides merging with the outer edges of said outer surface portion and said third annular surface to form a channel that collects the fluid streams discharged from the intermediate passage outlets associated therewith, and that delivers such fluid streams into the plenum chamber at the open free end of said arcuate wall portion, said channel cooperating with said one vane to form an enclosed hood extending from a point on one side of the vertical plane of the axis of the impeller to a point on the opposite side of said vertical plane, said points being beneath said drain level, said channel and said intermediate liquid passages comprising the flow conversion chamber that supplies the output of said impeller chamber to said plenum chamber; and gasket means between said second wall and said closure member to seal said plenum chamber from said sealing chamber.

7. The arrangement of claim 1 wherein the vane immediately adjacent said one vane in the direction opposite the direction of impeller rotation includes an upper extension that projects above said drain level to provide a siphon breaking action that maintains said drain level.

8. The arrangement of claim 1 and wherein said suction inlet is provided with a substantially weightless check

valve to retard reverse flow through said inlet to provide a siphon breaking action that maintains said drain level.

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679,246	Great Britain	Sept. 17, 1952
691,362	Great Britain	May 13, 1953

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,945,448 July 19, 1960

Stanley H. Frederick

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 7, line 39, after "discharge", second occurrence, insert -- outlet --; column 9, line 13, after "with" insert -- said --.

Signed and sealed this 20th day of December 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents