

Aug. 13, 1946.

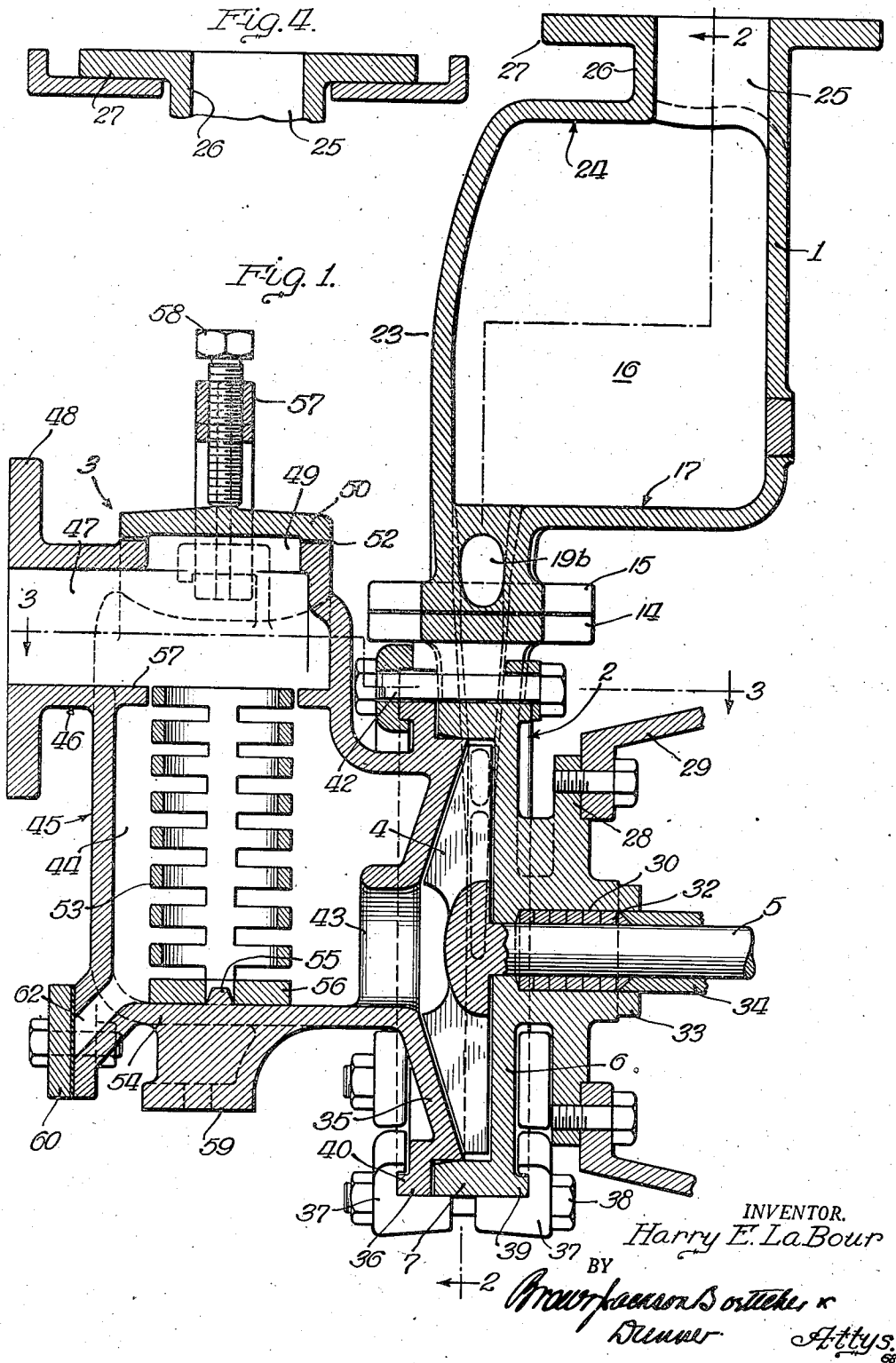
H. E. LA BOUR

2,405,836

SELF-PRIMING PUMP

Filed March 8, 1944

3 Sheets-Sheet 1



Aug. 13, 1946.

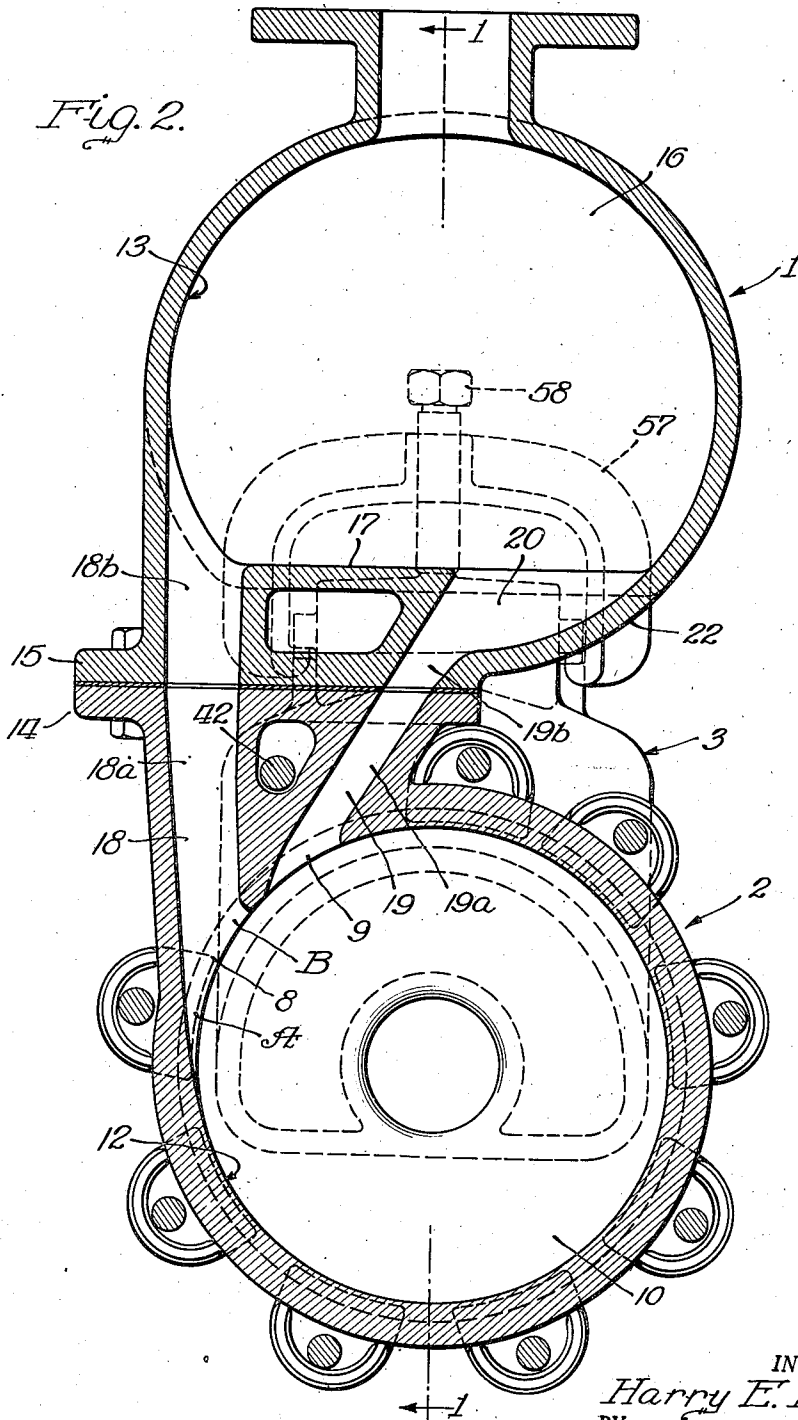
H. E. LA BOUR

2,405,836

SELF-PRIMING PUMP

Filed March 8, 1944

3 Sheets-Sheet 2



INVENTOR.

Harry E. La Bour

BY

Wm. J. Mason & Son, Inc. - Denver

Attys

Aug. 13, 1946.

H. E. LA BOUR

2,405,836

SELF-PRIMING PUMP

Filed March 8, 1944

3 Sheets-Sheet 3

Fig. 3.

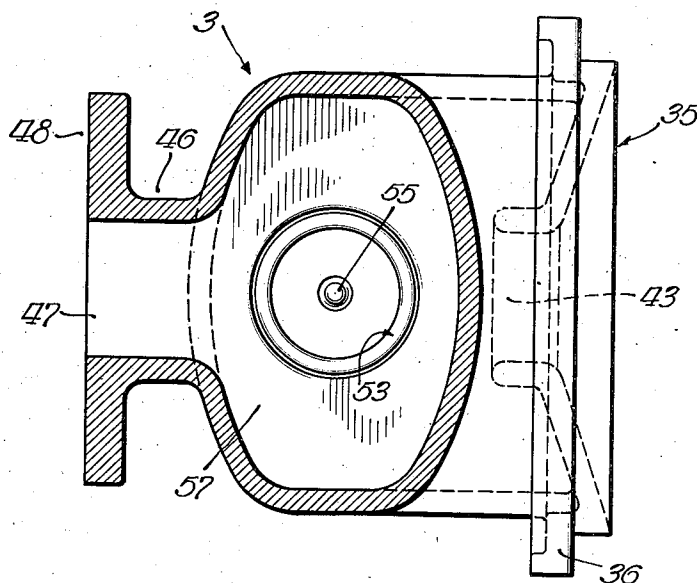


Fig. 5.

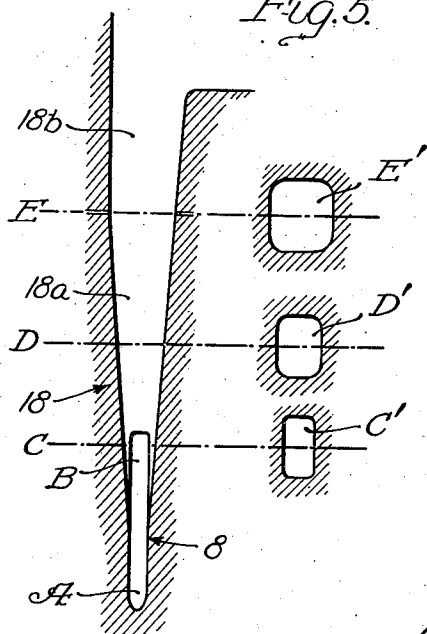
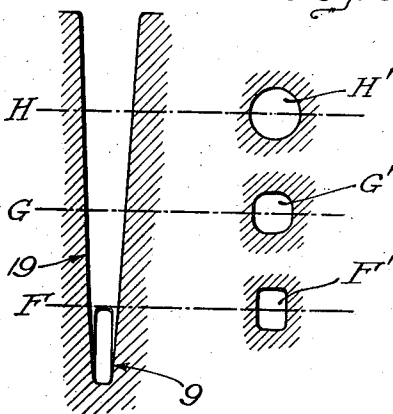


Fig. 6.



INVENTOR.

Harry E. La Bour

BY

Brewer Jackson Bottcher, Denver

Attys

UNITED STATES PATENT OFFICE

2,405,836

SELF-PRIMING PUMP

Harry E. La Bour, Elkhart, Ind.

Application March 8, 1944, Serial No. 525,530

7 Claims. (Cl. 103—113)

1

2

The present invention relates to self-priming pumps. A primary object is to provide a novel arrangement and relation of throats which attains greater efficiency on liquid pumping, and which also provides better gas pumping characteristics when the pump is priming.

Another primary object is to provide a novel structural arrangement of the necessary parts of a self-priming pump to secure certain advantages in manufacture, in operating characteristics and in repairing and servicing, as will be more fully hereinafter disclosed.

Other objects will be apparent from the following specification, drawings and claims.

A pump exhibiting the preferred embodiment of my present invention is of the type of my basic expired patent, No. 1,578,236, and employs the improved throating of the type disclosed in my prior patent, No. 2,291,478.

A self-priming pump encounters the conflicting requirements of efficiently pumping gas during priming and efficiently pumping liquid during liquid pumping. The density of air as compared with water is in about the ratio of one to eight hundred. Hence the same impeller and casing applied to air or other gas and to water or other liquid gives at the same R. P. M. vastly different results. As is known to those skilled in the art, the self-priming pump of the hydraulic balance type of my prior Patent No. 1,578,236, removes the air by forming a mixture of liquid and air in the pumping chamber, discharging the same into a separator where the air is disentrained, and returning the liquid freed of air into the impeller chamber peripherally to be again mixed with air and discharged in a continuous operation.

The present pump herein illustrated employs a main throat and an auxiliary or priming throat with a suitable expanding passageway for each between the impeller chamber and the separator chamber of the character disclosed in the aforesaid patent, No. 2,291,478. In the priming of a pump of this character, the priming charge of liquid is initially thrown out of the impeller chamber upon starting rotation of the impeller. The medium which remains in the impeller chamber is substantially only air received from the suction pipe. Since the air is of so low a density that no adequate delivery pressure can be developed, liquid must be admitted in order to make a dense enough fluid medium to start an orderly discharge from the impeller chamber to the separator, and a return of liquid from the separator into the impeller chamber. In

other words, there must be a continuous supply of working medium, that is, a flow of liquid to carry out the air. Since immediately after initial starting of the impeller there is substantially no liquid in the impeller chamber, and there is only a small head of liquid in the separator available to initiate the return flow, the tendency of the rapidly revolving blades is to check the return flow. This is due both to the blocking effect of the impeller blade, which in the case of curved blades is very substantial, and also due to the centrifugal force of the very light medium in the impeller chamber choking return flow at both throats. Since the force which tends to establish the return flow of liquid, namely, the gravity head of liquid in the separator, is small, the elastic fluid pressure developed by the impeller upon the thin gaseous medium in the impeller chamber tends merely to block any substantial return of priming liquid, at the same time failing to expel any substantial amount of air. The pump thereupon exhibits at this initial stage a disinclination to initiate the orderly circulation, which is termed "priming stall."

Opening up the priming throat to overcome this initial priming stall entails the undesirable consequence of too free return of the liquid when the pressure difference between the impeller chamber and atmosphere becomes relatively great, as when the pump attains a substantial vacuum.

In the older form of throat, such as was employed prior to Patent No. 2,291,478, the most restricted part of the main throat and of the priming throat was at a substantial distance away from the opening of the passageway into the impeller chamber. This provided a pre-throat enlargement or pocket, and apparently in that form of throat there was a burble or eddy in each pre-throat pocket. The same fluid (mostly air) that left the tips of the impeller eddied and regurgitated in the pre-throat pockets of each passageway, with the result that no substantial quantity of air was discharged. Hence, priming stall was at its worst.

Heretofore, in order to overcome the priming stall in pumps of the peripheral reentry type, the priming throat has been made relatively large, so that there would be greater freedom for the reentry of water to break up the priming stall. This, however, entailed the disadvantage that as the vacuum increased, the amount of liquid returned to the pumping channel increased, and the entrainment and carrying out of air was ineffective to let the pump evacuate

liquid to carry the operation to a satisfactory high dry vacuum.

With the slot type of throats of my Patent No. 2,291,478, the maximum restriction of the passageway is substantially at the junction of the passageway and the impeller chamber. I conceived that this form of throating might be employed in a novel ratio of throat sizes as between main and bypass throats, which would accomplish two highly desired purposes which heretofore have been antagonistic to each other, that is, shorten the slot length, that is, the cross-sectional area of the priming throat, whereby at high vacuum the amount of liquid returned would be controlled, and at the same time lengthen the slot of the main throat, whereby a more rapid initial evacuation of air would be secured, and thereby the priming stall would be reduced or eliminated.

The total outlet area for a given velocity of liquid traveled through the throating to give a predetermined delivery by a pump of given dimensions and speed may readily be determined by dividing the total delivery flow by the selected rate of flow through the throating. The novel arrangement of a shorter slot for the priming throat and a longer slot for the main throat is to be made while maintaining the total throat area at the predetermined or optimum value.

In a pump having a main throat and a priming throat, where both throats operate upon maximum delivery, the total throating area is distributed between the main and the priming throats in the present novel ratio.

I discovered that by reducing the length of slot of the bypass throats, and substantially increasing the length of slot of the main throat, it was possible to simultaneously overcome, or at least greatly ameliorate the difficulties of the two conflicting requirements, namely, of overcoming rapidly the priming stall and of preventing excessive return flow of priming liquid on high vacuums. And this is attainable without substantially impairing the efficiency of liquid pumping.

For best results, I find that the length of slot of the priming throat should be substantially 50% of the length of the main throat. This ratio may be varied due to differences in length and configurations of the passageways, so that the length of slot of the priming throat may be more or less than 50% for the best efficiency, most rapid priming and high dry vacuum, but the mean, I find by experiment, is where the length of priming throat slot is approximately half that of the main throat, and the two throats and passageways are of similar configuration. It is to be understood that when I speak of slotlike throats, I refer to a width of throat opening axially of the impeller which is at least one-eighth inch less than the width of the blade tip co-operating therewith.

In tests which I have run on this type of throating, I find that the time of the priming stall may be cut in half, that is, it will take only one half the time that it previously did to start the orderly circulation and rapid air evacuation. The efficiency has run as high as 65% on a 200-gallon per minute pump, operating at 1750 R. P. M., and a delivery pressure of 102 feet head, whereas, in older forms of the same size pump, the head was as much as 10 feet less, and the efficiency as much as ten points lower, the priming stall twice as long, and the over-all time of

reaching maximum dry vacuum at least twice as long.

The form of pump illustrated and described in this application involves a compact pump which is arranged for maximum ease in servicing and replacement of the wearing parts, and for facility in providing access to the inside of the pump, as for example, to clean out the strainer.

While the present pump is shown as a general utility pump, the design is suitable for acid service by the employment of a metal or material which is not attacked by the liquids which the pump may be called upon to pump.

Referring now to the accompanying drawings in which I have illustrated the preferred embodiment of the present invention:

Figure 1 is a vertical, longitudinal section through a pump embodying the present invention;

Figure 2 is a vertical cross section taken on the line 2, 2 of Figure 1;

Figure 3 is a horizontal section taken on the line 3, 3, of Figure 1 looking in the direction of the arrow;

Figure 4 is a fragmentary sectional view of a clamping flange;

Figure 5 is a diagrammatic development of the main throat and discharge passageway, with sections showing the cross sectional area at various stages or locations; and

Figure 6 is a diagram, similar to Figure 5, showing a like development of the priming throat and passageway, with the cross sections at various stages indicated.

The pump comprises three main stationary parts, namely, the separator 1, the impeller chamber body 2, and the combined trap and front plate 3, which parts are all bolted together, as will be described in detail. The moving part is the open impeller 4 with its integral impeller shaft 5.

The main impeller chamber member 2 comprises a backplate portion 6 which has a peripheral flange 7 interrupted by the main throat 8 and the priming throat 9, as will appear from Figure 2.

The main throat 8 is disposed in the fourth quarter of the circumference of the impeller chamber 10, so that the main discharge passageway 18 extends in substantially a vertical direction, substantially tangent at its lower end to the inside wall 12 of the impeller chamber 10, and substantially tangent to the circumferential walls of the separator 1. The passageway 18, which is the main discharge passageway, expands in cross section, as will be understood by reference to Figure 5 from the throat 8 to the upper end of the main pump body 2 which terminates in the bolting flange 14. The portion of the main passageway 18 in the separator chamber body 1 is designated as 18b. It lies above the clamping flange 15, and opens tangentially to the inner circumferential wall 13 of the separator.

The priming throat 9 opens into the passageway 19, the major part of which 19a lies within the pump body 2, and the minor part of the same, 19b, lies above the clamping flange 15 in the separator body 1. The separator 1 contains a separator chamber defined by generally cylindrical walls, the axis of the cylinder being substantially parallel to the axis of the impeller shaft 5, but the bottom part of the space 16 has a flat bottom wall throughout the major part of its length. A pocket 20 is formed by continu-

5

ation 22 of the cylindrical wall adjacent the upper end of the passageway 19b, so as to form a sealing body of liquid to seal the return passageway 19 against the drawing of air therethrough, particularly when the pump is operating under high vacuum. The front head or front wall 23 of the separator lies next to the outlet of the main discharge throat 18, and its upper part extends diagonally upwardly and toward the plane of the passageways 18—19, with the result that the issuing stream of mixture tends to be crowded endwise of the surface of revolution, that is, along the cylindrical wall, to which the passageway 18 is substantially tangent.

This may be understood by reference to Figure 1, wherein it may be seen that the two passageways, 18 and 19, lie substantially in the same vertical plane at right angles to the impeller shaft. The issuing stream of mixture is forced or crowded to the right as viewed in Figure 1 to describe an arcuate somewhat helical path engaging in an upwardly arched path along the cylindrical wall indicated at 24, and then following on down and striking the floor 17, which tends to check the rotary or whirling movement. This action of the arching flat stream of mixture is highly efficient in disentraining air. The delivery passageway 25 from the separator is offset with respect to the plane of the discharge throat and passageway 18, so that the issuing stream of mixture is not thrown out of the discharge opening 25 while priming occurs. The discharge opening 25 has a suitable neck 26 provided with a clamping flange 27, which may be integral, or which may be a split clamping flange indicated at 27 in Figure 4.

The impeller 4 has open blades. The blades preferably have curvature particularly in the larger sizes of impellers. For smaller sizes the blades may be substantially straight. The efficiency in the larger sizes is better with an impeller having some curvature. The blades are tapered in the axial direction towards their tips. In one form of the invention, an eight-bladed impeller is employed, although the number of blades is optional. Where the blades are curved, preferably a smaller number is employed. The main impeller casting 2 has a mounting flange 28 which is adapted to be connected to a suitable supporting bell housing 29 for direct mounting on the end of a driving motor, or it may be connected to a suitable mounting bracket where the pump is not supported on the driving motor. A gland pocket 30 to receive packing 32 is provided in the gland boss 33 formed on the backplate of the impeller body 2. Any suitable form of seal for the shaft 5 may be provided. In the present case, a fibrous packing 32 and a follower 34 serve this function.

The front of the impeller casing member 2 provides a cylindrical recess in which the impeller 4 operates, a suitable front plate member 35 fitting into the said cylindrical recess, and having a flange 36, which is clamped against the flange 7.

Separable C clamps 37, 37 connected by a clamping bolt 38 are spaced at suitable intervals around the periphery of the impeller chamber to hold the parts together. These clamps engage over suitable annular flanges 39, 40 to keep the clamps from slipping off the edge of the parts clamped together. It will be noted that the bolt 42 is disposed in an opening through the casting 2 between the passageways 18 and 19.

The front plate 35 is formed as an integral part

6

of the trap and front plate member 3. There is a central inlet opening 43 from the trap chamber 44 into the recess formed at the central part of the impeller 4. The main body of the trap is formed as a vertical flattened bottle-like body with a neck with the walls 45 merging laterally with an inlet connection or neck 46 for the inlet or suction passageway 47. A suitable clamping flange 48 terminates the neck 46 to adapt the pump to be connected to a suction pipe. A circular opening 49 is formed in the upper end of the neck of the trap body 3, this opening being closed by a round disk-like cover plate 50 which seats on a suitable gasketed seat 52 on the body member 3. The opening 49 is large enough to pass the cylindrical screen member 53 which rests on the bottom wall 54 of the intake trap member 3. The piloting stud 55 is formed integral with the bottom wall 54 and opens into a hole in the plate 56 which closes the lower end of the screen 53. The screen 53 is held down by gravity, and held against lateral displacement by the pin or stud 55 which projects into a hole in the bottom wall of the screen. A suitable diaphragm or annular flange 57 provides an opening which allows the screen 53 to pass therethrough, and be seated therein. The closure plate 50 is clamped in place by a yoke 57 and bolt 58, the ends of the yoke hooking over lugs formed on the sides of the neck of the said inlet trap member 3. By reference to Figure 3 it will be seen that the cross section of the main body of the trap below the flange 57 is oblong so as to provide a fairly large volume without increasing the fore and aft dimension of the pump. When it is desired to clean out the strainer 53, the clamp 57, 58 is released; the cover 50 is removed, and by inserting a hook on the inside of the strainer basket 53 the same may be withdrawn through the opening 49.

The intake trap member has a supporting foot 59 below the same for carrying a part of the weight of the pump. A releasable cover 60 for a drain opening 62 permits the liquid to be drained down to the bottom of the intake opening 43.

In operation, the pump is provided with a suitable priming charge, which is sufficient to serve as a working medium for the removal of air by entrainment. The charge of priming liquid may stand anywhere from the bottom of the inlet opening 47 to approximately the top of the opening 43 in the front plate 35, the amount of charge required depending upon the ability to maintain a complete sealed circulation during priming. In ordinary operation, sufficient liquid is trapped after each operation of the pump to perform this function.

Assume that the inlet connection 47 is connected to a suction hose which is sealed by the liquid to be pumped. As soon as the power shaft 5 is operated at suitable speed, the liquid will be pulled out of the inlet trap and discharged out of the impeller chamber into the separator 1. With the present improved arrangement of main and priming throats, the pump will promptly start up an orderly evacuation of air. It appears that with the relatively light medium, consisting of air and a small spattering of liquid, whatever slight amount of mixture is thus formed has its highest velocity and tendency to discharge at the region A, that is, the beginning of the main throat. Since the maximum constriction is substantially at the very opening 8, and a slowing down and expansion can occur immediately therebeyond, there is a tendency for any slight amount of mixture which is discharged in the initial part

of the opening A to rise and tend to gravitate up in the throat 18 towards the separator chamber 16. This tends to induce a downward travel of an amount of liquid purely by displacement, and I conceive that some liquid substantially free of air tends to enter at the region B and is immediately mixed with air. Some of it may be discharged initially into the throat 9, either with sufficient velocity to cause a slight upward current or perhaps merely sufficient to block reentry at the throat 9. At all events, I have found that with a pump constructed with the throat arrangement herein disclosed, the priming time for that part which has heretofore been designated as the "priming stall" has been cut as much as 50%. Compared with the best previous arrangement of throating, the priming time including the priming stall has been cut, for example, from 120 seconds to 60 seconds, and even less.

I am not able to state with certainty that the above flow does actually occur as I have indicated, but it is my belief that it does. However, I do not wish to predicate the invention upon a theory, but predicate the invention upon the practical results which flow from this arrangement of throats. The throats, it will be observed, are always at least $\frac{1}{8}$ inch narrower than the blade tips which serve them. As shown in Figures 5 and 6, the main passageway expands from the throat 8 through the stages indicated at C, D and E according to the sections indicated at C', D', E', opposite the positions that they occupy relative to the length of the passageway. In like manner, at the stages F, G and H, in the auxiliary passageway 19, the cross sections indicated at F', G', and H' illustrate the expansion which is permitted to the flow of liquid in the priming passageway. The priming throat and passageway being reduced to substantially one half of the like dimensions of the main throat, with approximately the same rate of expansion, the efficiency of outflow of these two throats on liquid pumping is quite comparable, and increase of delivery to include flow through the throat 19 does not impair the efficiency of the pump. However, the relatively small size of the priming passageway cuts down the return flow of priming liquid on high vacuum to a value which permits mixture to be formed and effectively discharged through the main throat during those stages of priming characterized by high dry vacuum. In other words, the throat 9 and its passageway 19 allows the return of no more liquid than will effectively operate to carry out gas until a high upper limit of suction is reached. Hence, the present arrangement of throat provides rapid overcoming of the priming stall, prevents excessive return flow on high vacuums whereby the pump can evacuate gas rapidly to the limit of its suction, and the pump shows a remarkably high pumping efficiency when operating upon liquid alone.

The ratio of the length of the priming throat to that of the main throat, assuming the same width of opening of each, gives best results at a value where the length of the priming throat is about 50% of that of the main throat, but the relation is capable of attaining the desired results with a reasonable variation, for example 10% on each side of the mean ratio of 50%.

I do not intend to be limited to the details specifically referred to, except as they are made essential by the appended claims.

I claim:

1. A pump of the class described, comprising an

open bladed rotatable impeller and a stationary pump body, the body comprising an impeller housing and backplate member having a circular recess in which the impeller is disposed for rotation concentrically in the recess, said body providing a separator chamber communicating with the inside of the impeller recess through two ducts substantially tangent to the inside peripheral wall of the recess, said ducts opening into the impeller chamber through narrow slotlike throat openings of less width than the width of the blade tips of the impeller, the main throat opening being in advance of the priming throat opening and being of approximately double the area of opening of that of the priming throat opening, said ducts each having an expanding cross section from the throat to the separator, a closure plate for the open side of the impeller recess having a central inlet opening and an inlet trap communicating with said latter opening.

2. A pump of the class described comprising a rotatable open impeller and a stationary body, the body comprising an impeller housing and backplate member having a circular recess in which the impeller is disposed for rotation, said member having a neck, a separator chamber at the upper end of the neck, there being two passageways substantially tangentially to the inside of said impeller recess extending upwardly through the neck of the separator, said passageways opening adjacent each other on one side of the center of said recess into said recess through narrow slotlike throat openings of less width than the width of the blade tips of the impeller, the main throat opening being in advance of the priming throat and being of approximately double the area of opening of that of the priming throat, a front plate closing the impeller recess and having a central inlet opening and an inlet trap communicating with said latter opening.

3. In a pump of the class described comprising the combination of a main body member, a trap and front plate body member, a separator body member and a rotatable impeller provided with a shaft; said main body member having a circular recess for receiving the impeller concentrically thereof and having a stuffing box for receiving the shaft of the impeller, said main body member having an integral neck disposed mainly at one side of the body, there being a substantially vertical main duct substantially tangential to the impeller recess at the side thereof, and an inclined substantially tangential priming duct at one side and near the top of the impeller recess, said ducts opening into the said recess adjacent each other and extending through said neck, the neck terminating in a flat clamping surface around which there is a clamping flange; the second member comprising a circular front plate for closing said impeller recess to constitute the same an impeller chamber, said front plate having a central inlet opening, there being a vertically extending hollow trap body portion of substantially oblong cross section, the upper end of which hollow trap body has an opening, a cover plate and clamp for closing said opening, there being a lateral inlet connection at the upper end of said trap body portion, an internal circular flange in the trap portion below said inlet connection, a basketlike strainer embraced by said flange and being removable through the upper opening in said trap body, the third member comprising a substantially cylindrical hollow separator body having a boss with clamping flanges for cooperating with the clamping flanges of said neck, said boss being dis-

posed mainly at one side of the said separator body whereby the separator is substantially directly in vertical alinement with but disposed mainly back of said first body member, said boss having a main duct substantially internally tangent to the circular wall of the separator body and matching with the main duct in the first body member, and having a priming duct leading from substantially the lowest portion of the hollow separator body and matching with the priming duct in the first body member, said separator body having an end wall disposed closely adjacent the plane of said ducts and overhanging the ducts to cause the discharge of mixture from the main duct during priming to be forced endwise out of register with the priming duct in its travel around the inner wall of the separator, there being a discharge connection at the upper end of the separator remote from said boss.

4. A self-priming pump having a horizontal impeller shaft with an open impeller, a body portion comprising a concentric impeller chamber for said impeller having a central inlet and substantially tangential main and priming ducts disposed in substantially the plane of the impeller, a hollow separator body having its front end disposed above the impeller chamber and its major portion disposed to the rear of the impeller chamber, the front wall of the separator intersecting the line of flow of fluid from the main discharge duct to crowd the same to the rear, and an inlet trap communicating with the inlet to the impeller chamber and being disposed in front of said impeller chamber, said impeller chamber being flattened fore and aft of the direction of the impeller shaft and having a lateral inlet connection at its upper end, there being a circular opening in the top of the trap for insertion and removal of a strainer basket, a cover for the opening, a yoke clamp for the cover, a cylindrical strainer basket disposed in the trap below the inlet connection and a transverse internal wall at the bottom of the lateral inlet connection having an opening through which the strainer basket extends.

5. An inlet trap and front plate member com-

prising a disk-like front plate portion of conical shape with a peripheral clamping flange and a central inlet opening, a hollow body portion extending vertically from substantially the bottom of said inlet opening to a point substantially above the top of the clamping flange and having a circular opening at its top through which to insert and remove a cylindrical strainer basket, a lateral inlet connection neck below said opening, and a transverse wall at the bottom of said inlet connection having an aperture in line with and of approximately the same size as said first opening, and a cylindrical strainer basket disposed in said latter opening and having a substantially closed bottom wall resting by gravity upon the bottom wall of the trap, said hollow body portion being oblong in cross section with its major dimension in a direction parallel to the plane of said front plate portion.

6. The inlet trap and front plate member of claim 5 having an upwardly extending stud on the bottom wall of said hollow body, and said basket having an opening in the bottom fitting loosely over said stud for holding the lower end of the basket against lateral displacement.

7. For use in a self-priming pump, a hollow separator body of substantially cylindrical form with its axis horizontal and having end walls forming heads, a discharge connection neck at the top of the rear end of said body and a boss at the bottom of the front end and at one side of the center, a substantially vertical main duct tangential to the inner cylindrical wall of the body, a priming duct disposed diagonally in said boss and opening into the bottom of the body at the side of the center opposite that into which the main duct enters, said ducts lying in substantially the same plane normal to the horizontal axis of the body, the bottom of said cylindrical wall being flattened to the rear of said ducts for the purpose of damping the swirling of liquid in the separator, the end wall at the front being disposed in the path of the discharge stream from the main duct to crowd it toward the rear of the body.

HARRY E. LA BOUR.