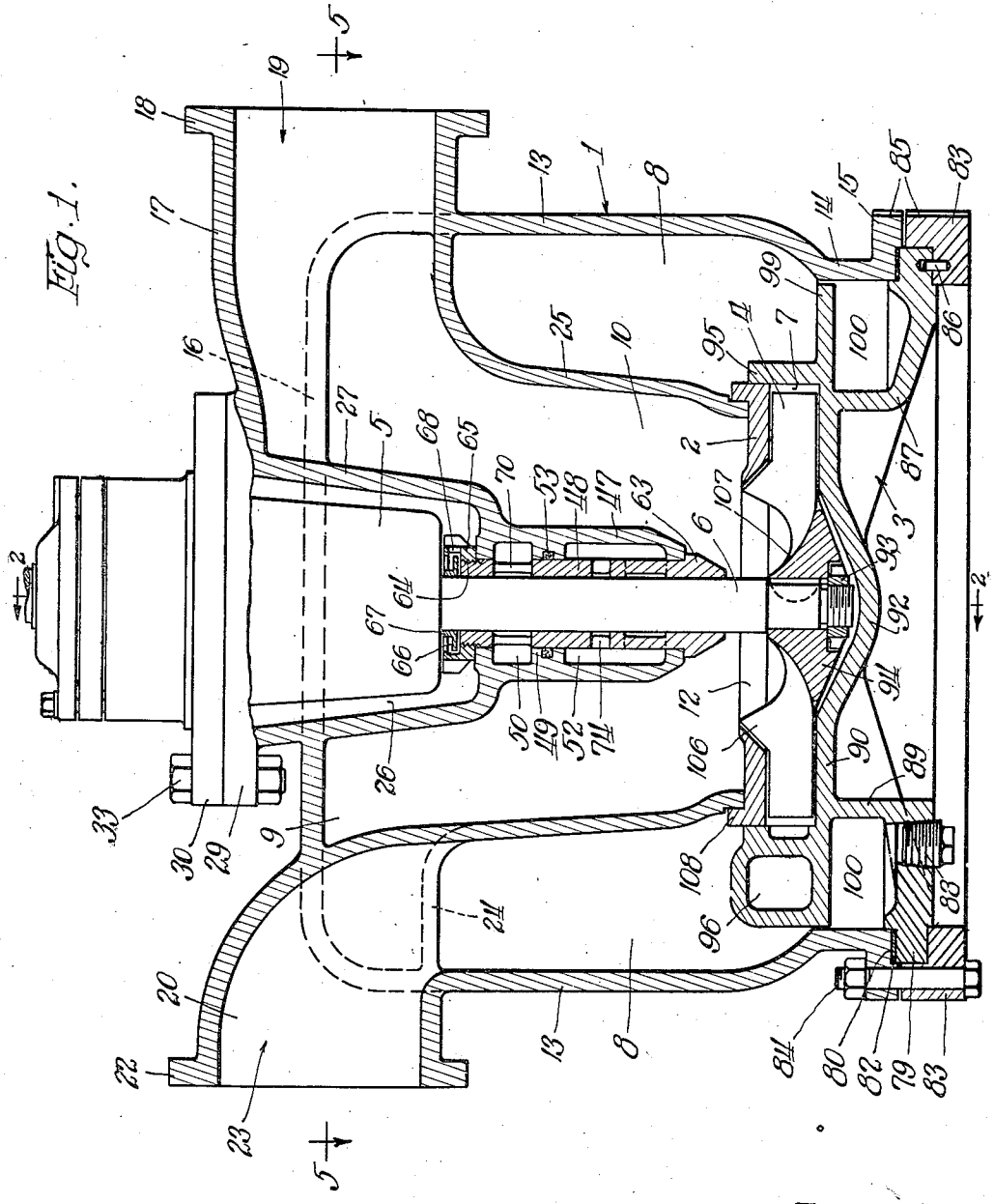
Sept. 29, 1942. H. E. LA BOUR 2,297,001

SELF-PRIMING CENTRIFUGAL PUMP

Filed March 17, 1939 4 Sheets-Sheet 1

Fig. 1.



Inventor:
Harry E. LaBour.

By Brownjackson Boettcher & Dienner

Attys.

Sept. 29, 1942. H. E. LA BOUR 2,297,001

SELF-PRIMING CENTRIFUGAL PUMP

Filed March 17, 1939 4 Sheets-Sheet 2

Fig. 3.

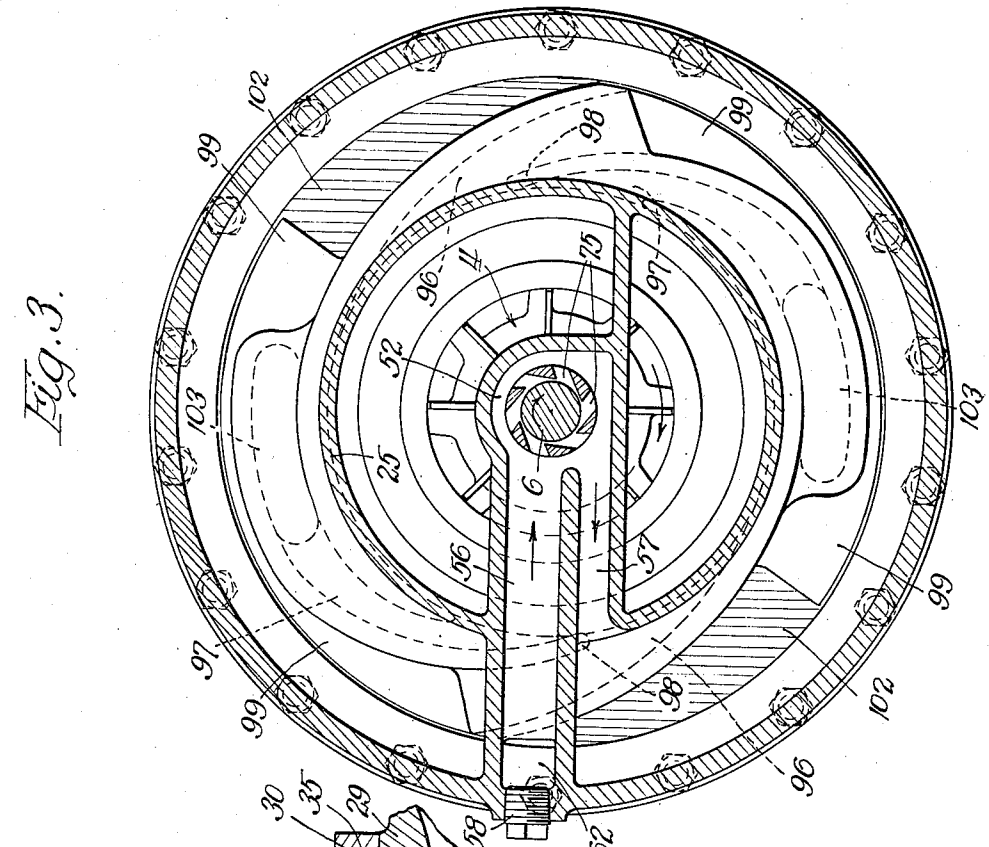
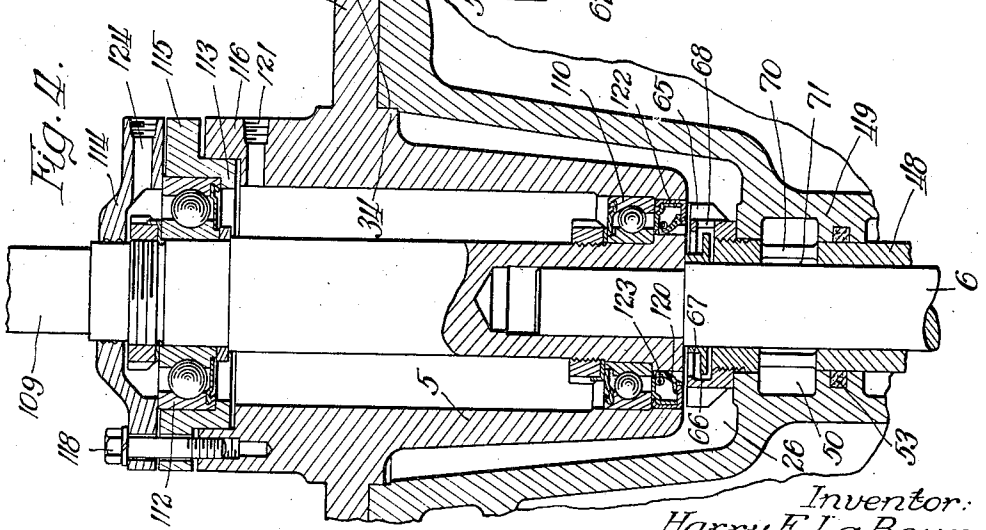


Fig. 4.



Inventor:
Harry E. La Bour.

By Brown Jackson Boettcher Dennes
Attys.

Sept. 29, 1942. H. E. LA BOUR 2,297,001

SELF-PRIMING CENTRIFUGAL PUMP

Filed March 17, 1939 4 Sheets-Sheet 3

Fig. 5.

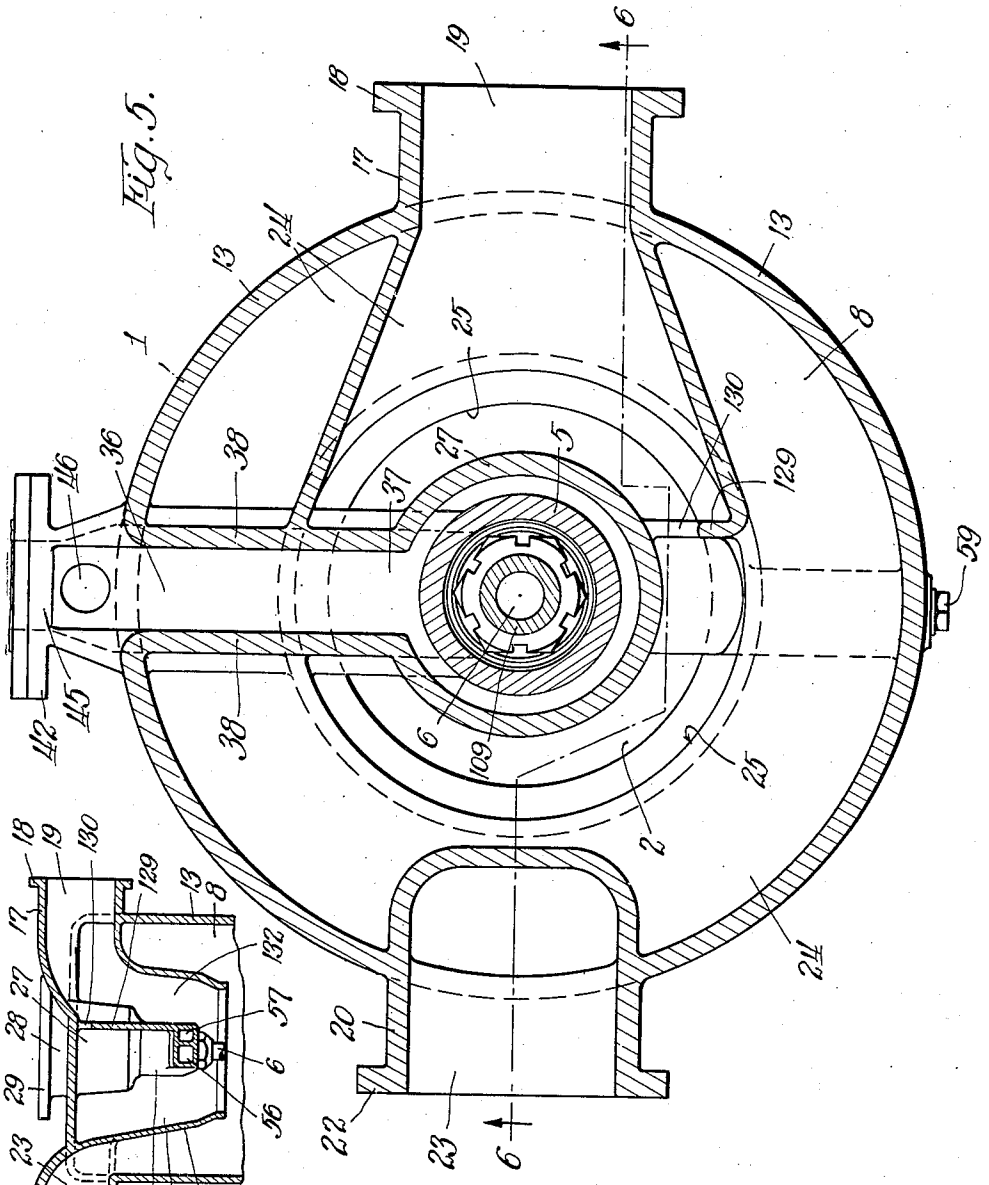


Fig. 6.

Inventor:
Harry E. LaBour.
By Brownjacobson Bortlett & Klemm
Attys.

Sept. 29, 1942. H. E. LA BOUR 2,297,001

SELF-PRIMING CENTRIFUGAL PUMP

Filed March 17, 1939 4 Sheets-Sheet 4

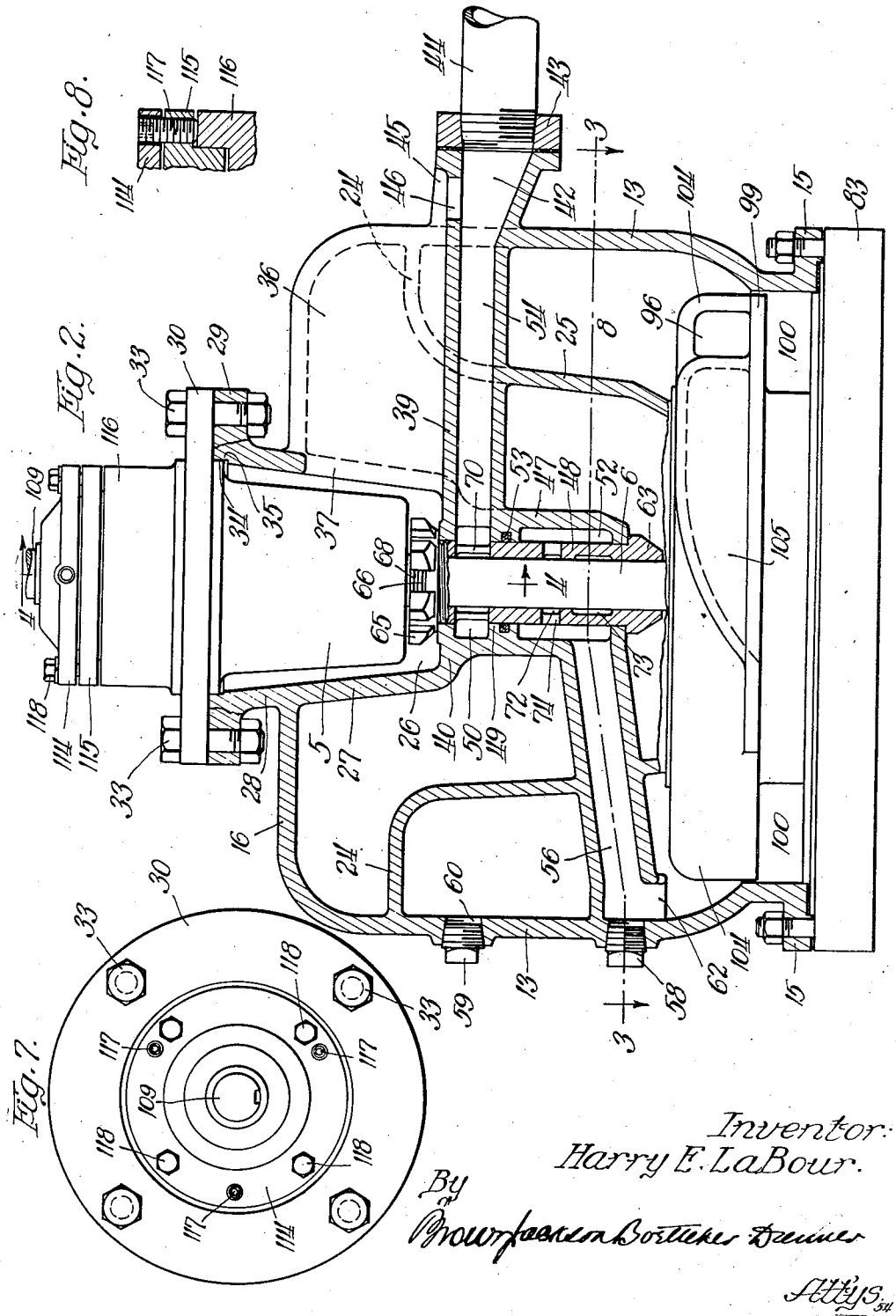


Fig. 8.

Fig. 2.

Fig. 7.

Inventor:
Harry E. LaBour.

By
Brownscombe Bottcher & Brenner
Attys.

Patented Sept. 29, 1942 2,297,001

UNITED STATES PATENT OFFICE

2,297,001

SELF-PRIMING CENTRIFUGAL PUMP

Harry E. La Bour, Elkhart, Ind.

Application March 17, 1939, Serial No. 262,339

22 Claims. (Cl. 103—113)

My invention relates to centrifugal pumps. While the invention primarily and mainly relates to centrifugal pumps of the self-priming type, certain features of the invention, as will later appear, have a wider application than this particular type. Further, while I have shown herein a self-priming centrifugal pump of the type wherein recirculation is inherently controlled by the pressures developed by the fluid mixture at or near the periphery of the impeller during priming, according to the principle disclosed in my Patent No. 1,578,236, it is to be understood that certain features, as will later appear, are applicable to self-priming pumps of other types. Also, it is to be observed that while I have shown a specific form of impeller housing employing two pairs of throats, this feature may be varied, as certain advantages of my invention may appear in pumps employing one or more pairs of throats or single throats in lieu of pairs.

The present invention constitutes in some respects an improvement upon my copending application, Serial No. 174,522, filed November 15, 1937.

One of the difficulties of a vertical pump is the extended vertical dimension which that type of structure tends to require. If the driving motor or driving means be based upon the top of the pump, the difficulty of adequately supporting the shaft arises. Also, with the usual packing glands, space is required for servicing, and this makes a direct mounting of the pump upon the motor difficult and cumbersome. While any suitable means for mounting the driving means or motor fixedly relative to the pump may be employed, a highly desirable and advantageous form of mounting is disclosed and claimed in my copending application Serial No. 273,718, filed May 15, 1939.

In my copending application, Serial No. 174,522, above referred to, I have disclosed a novel means of packing the impeller shaft with the liquid being pumped or employed for priming. Sealing of the shaft with liquid requires a certain and continuous supply of liquid to the gap between the shaft and the surrounding sleeve or casing. The liquid tends to be thrown away from the shaft by centrifugal force, thereby reducing the effectiveness of the seal. Also, the problem of providing suitable space within which the seal may be effected, presents a serious difficulty in the construction of a compact vertical pump.

According to the present invention, I have provided a novel method of compelling the liquid to hug the shaft, so that the tendency for the liquid to be thrown away from the shaft by the centrifugal force of the spinning shaft is satisfactorily overcome. The pump herein illustrated and described is suitable for and is intended to be operated at speeds of the order of 2400 to 3600 R. P. M., and can be operated at higher speeds if necessary. Under such speeds, the problem of centrifugal force and diminishing of the pressure of the sealing liquid at the surface of the shaft becomes acute. Also the problem of adequate bearings and accurate alignment is thereby accentuated. The invention is not to be limited to pumps of high shaft speed, as the advantages appear at all practicable speeds. This liquid shaft seal is the subject of divisional application Serial No. 425,836, filed January 7, 1942.

Along with the means for compelling the sealing liquid to hug the shaft, there is provided herein means for insuring an adequate and constant supply of sealing liquid to the seal.

A further problem which I have encountered in the development of the liquid type of shaft seal is the necessity for certainty of disposal of the necessary outflow or wastage of sealing liquid. In my prior pump, I extended a tubular passage from the upper end of the sealing sleeve to the exterior of the pump, and a surface runoff on the top wall of the pump. In the present construction, I have extended the bearings for the shaft down below the top wall of the body. Absolute assurance that the overflow of liquid cannot, under any circumstances, rise into the bearings must be had, and to this end an open gutter extending off from the upper end of the sealing sleeve is provided.

Another problem which is acute in the vertical form of pump is the provision of adequate means for maintaining sufficient liquid in the pump to insure an adequate supply of priming liquid to perform the operation of priming. This is a particularly pressing problem in a compact high speed high capacity pump such as herein disclosed.

The present pump provides a compact body, desirable for obvious reasons, with the intake trap at the center and the separator surrounding the same. The circular type of separator is particularly desirable for the multi-throat design because it permits separation by centrifugal force or vortex action, herein designated as dynamic separation, but where the impeller chamber lies at the bottom of the separator and has

multiple throats, it tends too easily to empty itself of the liquid necessary to be retained for priming upon stopping the operation of the pump.

The limited space at the center of the body for the intake trap space presents a serious problem of how to keep the intake trap from being emptied by collapse of suction in the suction pipe, particularly where the latter is of considerable volume. The present pump will quickly draw a high vacuum, and this intensifies the difficulty.

According to one phase of the present invention, the top of the trap is extended above the shaft seal and above the separator to provide the added capacity. To insure that liquid escaping from the shaft seal will not enter the bearing which extends below the top of the trap, an open channel extends out of the pocket so formed. To insure that the trap of such relatively limited capacity and of such short vertical height is not emptied by the collapse of suction in the suction pipe, or rapid return flow upon stopping of pumping, the trap is divided into two portions, one of which, being preferably of less capacity than the other, may be emptied by the outrush of return liquid and the suction broken without depleting the supply of liquid retained in the other or main portion of the trap. This main or retaining portion is provided with a restricted communication at its upper end, to the intake duct to facilitate filling of this portion while retarding emptying. A free communication of the two portions with each other exists at their lower ends.

In brief, the vertical design of self-priming pump presents problems of shaft sealing, retention of priming liquid mounting of the shaft and motor, and compact arrangement of the parts, which are wholly new and not solved in the horizontal design of pumps, and not solved anywhere in the prior art.

The present form of pump is particularly applicable to chemical service. Such a pump must be adapted to be constructed of high chrome alloys. Such alloys are difficult to cast and to machine. All parts subject to corrosion are made replaceable individually at minimum expense and inconvenience.

The basic structure of the present pump is such that a variety of impeller casings and impellers may optionally and interchangeably be employed. Thus various throatings and impeller shapes and designs may optionally be provided with a minimum stock of parts. While the present construction shows an open impeller, a closed impeller with appropriate housing and throating may be substituted.

The present pump is particularly intended for use above the level of liquid to be pumped, and under that circumstance the liquid packing is preferably employed. It is to be understood, however, that the other features of the present pump may be employed when the pump is located below the level of liquid to be pumped, and a conventional or preferred form of solid packing employed.

Also, while I have shown the impeller shaft as supported in a driving shaft having bearings borne directly upon the body of the pump, it will be understood that this feature may be varied under certain circumstances without varying the fundamental character of the pump.

The chief object of the present invention is to provide a compact, efficient vertical pump capable of satisfactorily meeting the above stated and other problems.

Another object is to improve certain details of pump construction applicable to the solution of the above stated problems and useful in other forms of pump.

A particular improvement is herein disclosed relative to the mounting of the impeller. The impeller at its hub is so formed and related to the casing wall as to avoid cavitation pockets and better guide the water from the eye of the impeller into the blades.

A further specific improvement resides in the means for supplying the liquid seal. The supply duct is so constructed as to be self-cleaning and normally non-clogging. Access to the interior thereof is provided through an opening which may serve as a core support during casting.

A further specific improvement is the provision of a simple effective way of forming and mounting the top plate of the impeller housing upon the lower end of the annular trap wall by a shrink fit.

Further objects and improvements will be apparent from the following specification.

In the accompanying drawings, which form a part of the present specification, and in which like reference numerals refer to like parts,

Figure 1 is a vertical axial section through a form of pump embodying my invention;

Figure 2 is a section taken at right angles to the view shown in Figure 1 on the line 2—2 of Figure 1;

Figure 3 is a horizontal cross section taken on the line 3—3 of Figure 2;

Figure 4 is a vertical longitudinal section through the shaft bearing, taken on the line 4—4 of Figure 2;

Figure 5 is a horizontal cross-section taken on the line 5—5 of Figure 1;

Figure 6 is a vertical section, on a reduced scale, taken on the line 6—6 of Figure 5;

Figure 7 is a top plan view of the bearing structure as viewed from the top of Figure 2; and

Figure 8 is a cross-sectional view of a detail.

The main parts of the pump are a main body casting 1, an impeller housing plate 2, a closure plate 3 which forms not only a closure for the main body casting 1 but also completes the impeller housing for the impeller 4, a bearing bracket 5 for supporting the impeller shaft 6 being mounted in the upper part of the main body casting 1. The parts 1, 2, 3, 4 and 5 are preferably all castings. With the main body casting 1, a wide variety of impellers 4 and cooperating housing and closure plates 3 may be employed to provide different forms of impellers and throatings as may be desired.

The above described parts define three main coaxial chambers, namely, the impeller chamber 7, the discharge chamber 8, and the inlet chamber 9. It will be observed that the discharge chamber 8, which serves also as a gas and liquid separator during priming and as a trap to retain liquid when the pump stops, surrounds the impeller chamber 7, extending both above and below it and communicating with it through throatings later to be described. The intake chamber, which serves as a liquid trap for retaining liquid when the pump is stopped, is coaxial with the other chambers, and extends above the discharge chamber 8 and has a central tubular portion extending down to and communicating with the eye or inlet opening 12 which is

formed in the housing plate 2. Thus a large part of the capacity of the trap or inlet chamber is disposed above the tubular portion 10 and above the discharge chamber, as will be apparent from Figures 1 and 2. The main body portion 1 is a casting comprising the outer peripheral wall 13, preferably in the form of a cylinder, although this is optional as the wall might be in the form of a square or polygon if desired. The lower end of the wall 13 is preferably constricted slightly, as at 14, and terminates in a clamping flange 15 which preferably also, but not necessarily, is circular. The wall 13 extends upwardly to a horizontal top wall 16, to which it is joined, preferably by a suitable fillet, that is, a rounded corner, for appearance and facility in casting. A short tubular inlet neck 17, provided preferably with a flange 18, provides an inlet passageway 19 through the wall 13 and into the inlet chamber or trap 9. Similarly, a short tubular neck 20, preferably provided with a flange 22, provides a discharge passageway 23 which communicates with the separator space 8. An annular horizonal wall 24, more clearly seen in Figure 2, at its outer periphery joins integrally the outer wall 13 and it, in turn, is connected through a suitable fillet or curved annular wall to the tubular depending neck 25 which defines the lower part of the intake trap as designated by the reference numeral 10. The top wall 16 of the main body 1 has a pocket or depression 26 which is formed by a conical annular wall 27 which is joined integrally to the top wall 16 and has a portion 28 terminating in a bolting flange 29 extending above the said top wall 16. The top of the inlet neck 17 is joined directly to the extension or neck 28 at one side, as a matter of convenience in construction. The shaft bearing bracket 5 has a radially extending flange 30 which matches with the mounting flange 29. Suitable clamping bolts 33 hold the bearing bracket 5 to the main body casting 1. The bracket 5 is piloted, as at 34 in Figure 4, into a short cylindrical piloting bore 35 in the top of the cup or depression 26, to hold these parts together securely in alignment. The pump may be supported by a bracket clamped to the top of flange 30 or it may be supported in any other suitable manner.

The bottom of the pocket 26 communicates with the outside of the main body casting 1 through an open cut or channel, as will be seen more readily from Figures 2 and 5. This open cut or channel 36, which provides free and open communication with the inside of the pocket 26 to atmosphere, is provided for the purpose of insuring free overflow for any liquid coming up along the impeller shaft 6, as will be described more in detail later. There is an opening 37, as shown in Figures 2 and 5, in the side walls 27 of the pocket 26, and the vertical or substantially vertical walls 38 which, at their upper ends, join the top wall 16, at their outer ends join the side wall 13, and at their lower ends join the bottom wall 39 which forms, in effect, an extension of the bottom wall 40 of the pocket 26. The bottom wall 39 of the channel extends outwardly to the outside of the body 13, where it forms part of a flanged pipe connection 42. The flanged pipe connection 42 is joined by a companion flange to an overflow or drain pipe 44. The end of the bottom wall 39 of the cut or groove 36 is provided with a short or low flange 45 surrounding an opening 46 by which any liquid running out along the bottom of the groove 36 that is on the wall 39 may, by gravity, run through the opening 46 into the pipe connection 42.

There is an integral tubular extension 47 which provides a barrel for housing a liquid seal sleeve 48 surrounding the shaft 6. This barrel 47 is divided by an inwardly extending flange wall 49 into two functionally separate chambers, namely, the upper or drain chamber 50 and the lower or liquid supply chamber 52. A suitable packing 53, disposed in an annular pocket or recess in flange 49, tends to maintain a substantially tight joint with the sleeve 48 so as to seal off the two chambers 52 and 50 from each other.

There is a discharge or overflow passageway 54 from the overflow chamber 50 to the flanged neck or pipe connection 42. This passageway 54 is defined by an integral tubular cored passageway the upper wall of which is the same as the bottom wall 39 of the draining groove 36. This passageway 54 is substantially oblong in cross section. The form thereof is optional. However, it provides free communication between the discharge or overflow pocket 50 and the discharge or overflow pipe 44 extending through the walls 25 and 13, to which it is joined integrally during casting. Obviously, this overflow connection may be made by other specific mechanical expedients, but the above described arrangement permits of convenient integral construction by casting.

The lower chamber 52, which is a liquid supply chamber, is provided with two integral ducts 56 and 57 (see Figure 3), also preferably formed integral with the main body casting as cored passageways. The walls of the tubular inlet passageway 56 extend out to the outer peripheral wall 13, where an opening is provided, which opening may be utilized during casting to support the core. The opening is normally closed by the screw plug 58 which permits inspection and cleaning. A similar opening through the wall 13, shown in Figure 2 above the pipe plug 58, is closed by a pipe plug 59. This opening 60, which is closed by the pipe plug 59, is a filling opening and it defines the level at which liquid will stand when the pump is initially filled for operation. This level, it will be observed, is substantially at or slightly below the drain or overflow duct 54, whereby a filling of the pump to the level of the bottom of the opening 60 does not tend to escape by gravity through the shaft seal and out the overflow or waste duct 54. The supply passageway 56 opens downwardly at the opening 62 (see Figures 2 and 3), so that the duct may be supplied with liquid even at a minimum of liquid level in the separator space 8. The opening 62 is substantially non-clogging and it opens at the point where the liquid is densest and, during priming, has the maximum swirl. The passageway 57 is a liquid overflow or return passageway from the liquid supply chamber surrounding the sleeve 48. The liquid sealing sleeve is provided with an annular shoulder 63 at its lower end, and this flange is drawn against the bottom wall of the tubular extension 47 to form a tight connection by means of the threads at the upper end of the sleeve 48, these threads 64 being engaged by the nut 65, which nut has engagement with the bottom wall of the pocket 26 to hold the sleeve 48 in place. The nut 65 is internally channeled, as shown at 66 in Figure 4, to cooperate with the slinger ring 67 which is slipped onto the upper end of the shaft 6. The nut 65 has openings 68 by which any liquid

thrown off by the slinger ring may drain into the bottom of the pocket 26 and flow out along the wall 39 to the opening 46 and be conducted off through the drain pipe 44.

The sleeve 48 forms a tight joint with the lower wall of the tubular extension 47 as by means of a flanged head 63, and it forms a substantially tight connection with the flange 49 by virtue of the packing 53 above described, so that the liquid supply chamber 52, which is put under discharge pressure when the pump operates to pump liquid, will be substantially liquid tight. Obviously, the details of securing the parts together and of securing the tight relationship above referred to may, optionally, be varied.

The sleeve 48 is bored to fit the shaft 6 without gripping it. That is to say, there is a small clearance between the bore of the sleeve 48 and the shaft 6. This clearance is a small annular gap which is made so small as to constitute a material restriction to liquid flow but which would not exclude entry of gas or air if no sealing liquid were supplied. A few thousandths of an inch clearance may be provided, depending upon the character of the liquid to be pumped, the entrained solids, etc. Near its upper end, and registering with the discharge or overflow pocket 50, there are in the sleeve 48 a series of slots or windows 70 and the inside of the bore is relieved at these windows 70. Any liquid coming along the shaft 6 and entering the relief pocket at the windows 70 is free to flow outward radially into the chamber or pocket 50 in the tubular extension 47 and to escape to waste through the pipe 44. Liquid tending to creep upwardly along the shaft 6 past the relief pocket and windows 70 must pass, first, the restricted gap in the upper end of the sleeve and then it will encounter the slinger ring 67, where it will be thrown off within the surrounding slinger groove 66 in the nut 65.

Within the supply pocket 52 the sleeve 48 has a relief groove 72 communicating with the window 74. A shallow relief groove 73 may be cut in register with the inlet passageway 75. This groove is optional. The lower relief groove 73 communicates through a series of tangential inlet passageways 75 (see Figure 3) which permit liquid to come into contact with the shaft, moving substantially tangentially in the direction of rotation of the shaft 6. The liquid contacting the shaft adheres thereto and is dragged, by rotation of the shaft, into a narrowing space provided by the inclined walls of the passageways 75 which lead the liquid against the surface of the shaft. In effect, the shaft tends to wrap itself up in liquid by dragging the liquid into wedging engagement with itself along the inclined walls of the duct or passageway 75. The result is that there is maintained a very definite pressure of liquid against the shaft. In fact, the shaft and the cooperating inclined passageways constitute, in effect, a small multiple pump, forcing liquid inwardly into engagement with the cylindrical surface of the shaft and providing an excess of pressure at the surface of the shaft which forms a very effective seal. The plenum of liquid pressure along the surface of the shaft produced by this arrangement makes is possible to provide a relatively short liquid seal of great effectiveness. Heretofore, attempts to seal with liquid have encountered the marked difficulty of maintaining the liquid in firm contact with the surface of the shaft all the way around it because of the centrifugal effect of the shaft in throwing the liquid away from itself. The higher the speed, the greater has been the tendency to discharge the liquid away from the shaft, and suction would tend to strike down along the shaft even though liquid were supplied in abundance.

This can be seen particularly if the shaft is slightly eccentric with respect to the surrounding sleeve with which a liquid seal is to be maintained, for there would be a crescent-shaped lacuna or passageway left open between the shaft and the rotating liquid in the sleeve if there were any lack of concentricity between the two.

In the arrangement which I have shown (see particularly Figure 3), the higher the speed of the shaft the greater the velocity effect which occurs in driving the liquid into the narrowing space between the wedge-shaped part of the sleeve and the surface of the shaft.

The wedging action of liquid at each of the inclined vanes produces a longitudinally extending area of positive liquid pressure. This pressure tends to act in all directions and since it is restrained circumferentially of the shaft it tends to force liquid endwise into the gap. These ports and their inclined spaces are close enough to each other and have an effect sufficiently far in a circumferential direction to produce the effect of a complete circumferential ring of pressure at both the upper and the lower ends of the ports 75. That is to say, in effect there is a pump forcing liquid into the gap between the shaft 6 and the sleeve 48, both in an upwardly and in a downwardly direction from the region of the ports 75.

Since this pumping effect produces a plenum of pressure at the surface of the shaft, there is a tendency for liquid to be discharged longitudinally along the shaft through the clearance. In order to avoid an excess of discharge along the shaft in the upward direction, where it would be wasted, I have provided, at a point slightly above this liquid wedging arrangement, the relief windows 74 which permit excess pressure at the surface of the shaft to be relieved and to flow back into the liquid supply pocket 52. Obviously this latter is an expedient which, while advantageous, is not essential to securing the wedging action against the surface of the shaft for sealing purposes.

The arrangement above described may obviously be varied in detail, but the wedging of the liquid against the shaft around the same has proven highly effective, and maximum suction which the pump may attain by virtue of its pumping and self-priming action is unable to produce any gas leakage along the shaft. I therefore consider the above novel arrangement of forcing liquid against the surface of the shaft to provide a liquid seal to be of importance, and a marked advance in the art.

It will be observed that I have disposed the liquid sealing sleeve at as low a point as possible along the shaft length 6. It is desirable to have the liquid flow by gravity into the supply chamber 52 so that the sealing effect may be initiated the moment the shaft begins to rotate. Also, in order to bring the bearing support sleeve 5 as far down the shaft as possible, the sealing sleeve must be made as short as possible in order to produce the minimum overhang or outboard length of the shaft 6.

The liquid seal sleeve 48, and particularly the ports 75 and the sealing portion of the sleeve below said ports 75 is disposed below the normal

trapped level of liquid in the pump when the pump stops. It is to be observed that as soon as the impeller is rotated the liquid is withdrawn from the trap and discharged into the separator. This raises the level in the separator and produce a swirling of liquid in the separator, producing dynamic separation of gas from the liquid and insuring that the level will be above the bottom of the ports **75**, so that a liquid seal may be maintained on the lower end of the sleeve. For best results the liquid should be at a high enough head to insure filling the ports **75** and then the pumping effect of the shaft **6** and said ports **75** is insured. In earlier forms of this pump I have faced the inlet opening **62** for the inlet passageway against the direction of rotation or swirl of liquid in the separator, so as to cause an impacting of the moving liquid upon said opening. It then acts as a Pitot tube to transmit liquid pressure to the chamber **52**. That construction has a greater tendency to conduct entrained solids into the chamber **52**.

Now I shall describe more in detail the pump housing and its throating.

The closure plate **3**, to which reference has been made above, provides, in a single casting, a closure for the lower end of the main body walls **13** as by means of the sealing flange **79** which cooperates with a gasket seat **80** on the bottom flange **15** to clamp a suitable sealing gasket **82** between the adjacent surfaces. The clamping ring **83**, which may be of inexpensive metal as compared with the expensive corrosion-resisting metals of which the above described parts of the pump may be constructed, cooperates with the flange **15** and the clamping bolt **84** to hold the plate **3** in place. The clamping ring **83** and the flange **15** may be registered by means of the registering groove **85** (see Figure 1). Then, by means of a locating pin **86**, registration of the plate **3** with the body **1** may be secured without interfering with the seal at the gasket **82**. The annular wall **87** which joins the sealing flange **79** is sloped to substantially a low point at the drain plug **88**. This annular wall **87** may be substantially horizontal or it may be tapered upwardly. In the present case there is a cylindrical circular wall **89** by which the annular wall **87** joins the bottom housing plate **90**. The plate **90** forms a part of the main impeller housing, constituting, in this case, the bottom wall, since the impeller is disposed in a horizontal plane. The central part of the wall **90** is bulged downwardly at **92** to provide a pocket for the hub of the impeller **4** to house both the fastening nut **93** and the adjacent end of the shaft and also the projecting hub portion **94** of the impeller, in order to provide a shape of hub which will permit of easy entrance of the liquid at the eye of the impeller and at the same time prevent any cavitation pockets around the hub which would produce noise and some loss of efficiency.

There is formed, as an integral part of the closure plate **3**, a vertical annular flange **95** which forms the peripheral part of the impeller housing and which contains the throating and to which tubular discharge connections for the throating are integrally connected as by being formed in the process of casting. The flange **95** telescopes with the outer cylindrical surface of the upper plate **2**. This is a sliding fit. It need not be liquid-tight, for during operation there is a plenum of pressure on the inside of the flange **95** except that during the priming operation there is a low pressure in the region of the auxiliary throats. But since the pressure difference is never more than atmospheric during priming, a slight leakage at this sliding fit is of no moment.

It is to be observed that by removing the cover plate **3** the impeller is completely separated from the bottom and peripheral parts of the housing and the impeller may be readily removed and replaced or renewed, or, in the process of manufacture, any suitable form of impeller may be substituted for the particular form herein shown. Likewise, since the cover plate and impeller housing with throatings are formed integral, the particular form of housing and throating may be replaced by any desired or known form of housing and throating without alteration of the other parts of the pump. Hence, a combination of various impellers and throatings may be made with a minimum of parts carried in stock.

The impeller housing and throating will now be explained more in detail with reference to Figures 1, 2 and 3.

In the specific housing and throating herein disclosed and illustrated there are two pairs of throats. As viewed in Figure 3, the impeller shaft **6** rotates in a clockwise direction and the throats are tangential discharge throats opening out also in a clockwise direction. The main throats **96** of each pair are anterior to the auxiliary or priming throats **97** of each pair. These throats are closely adjacent to each other, being separated only by the nose of the wall **98**, in each case, between them. A horizontal flange or wall **99** lies substantially at the level of the bottom wall **90**, as may be seen in Figures 1 and 2, and this divides the space in the separator into the main space above the flange **99** and a channel **100**, which amounts to a manifold connecting the auxiliary throats **97**. The main throats **96** communicate freely with the space in the separator **8** above the flange **99** and they tend to discharge liquid during priming, which liquid has air admixed therewith, for the removal of air from the intake trap **10** and the connected suction pipe. This mixture of air and liquid has an opportunity to separate, both by the gravity effect and by the centrifugal or dynamic effect inside the chamber **8**, and the denser liquid tends to gravitate downwardly. This horizontal plate or flange **99** is interrupted at the slots **102** and **102** which provide relatively free communication between the space in the separator **8** above the flange **99** and the channel or manifold **100** below the flange **99**. The auxiliary or priming throats **97** open downwardly to the channel or manifold **100** through openings which are indicated in dotted lines at **103**, **103** in Figure 3. The main throats **96**, which open through the peripheral housing or flange **95**, communicate through passageways of increased cross-section defined by integral conduit walls **104**, as shown in Figure 2, for the main throats, and **105** as shown for the auxiliary priming throats. The main throats and passageways **96** thus discharge tangentially substantially in a horizontal plane, whereas the auxiliary priming throats **97**, while they open in a horizontal plane, discharge liquid during liquid pumping helically or downward below the flange or horizontal baffle **99** into communication with the channel or manifold **100**. During priming the openings for the main throats **96** discharge their mixture into the separator **8** above the baffle **99** and the mixture has an opportunity to segregate into gas and liquid, the more solid or gas-free liquid dropping down through the openings **102** into the channel **100** beneath the flange **99** and there reentering

the periphery of the impeller chamber through the ducts and throats 97 to be again brought into cooperation with the rotating blade tips to form a further mixture or gaseous fluid which is discharged out at the main throats 96. At low suction the initial mixture of liquid and gas, while more dense than gas, is much less dense than liquid alone. As the suction increases, the return flow through the priming ducts and throats 97 increases in amount so that a denser medium is formed to produce the necessary discharge pressure to overcome the suction on the inside of the pumping chamber, that is, toward the center of the impeller, and as the suction builds up the medium becomes denser, to the degree required to produce the necessary discharge pressure, air being meanwhile discharged in the mixture, separated, and evacuated through the discharge connection 20. When liquid is drawn over in the suction pipe, the density and volume of liquid in the impeller pockets, that is to say, in the blades, is great enough not only to fill the throats 96 but also the throats 97 to provide the necessary or desired discharge of liquid.

It will be apparent to those skilled in the art that the number of throats may obviously be varied either as to the number of pairs thus cooperating with the impeller or, instead of a pair of throats, a single opening large enough to provide for both the outflow of mixture and the return of priming liquid, may be provided without departing from the present invention. Thus, where a single large throat is employed, the discharge passageways, which are volute-shaped like the extensions of the throats 96 in the present case, may be provided with lateral openings, particularly at the bottom sides of the same as for a vertical pump, as in the co-pending application, Serial No. 175,187. In that event, the lateral opening in the volute extension opens preferably downwardly only into the channel 100 to give substantially the same effect as the downward discharge of the auxiliary throats 97 here disclosed. The shape of the volute in that case is such as to cooperate with a suitable curved blade impeller or any other form of impeller desired.

The impeller herein illustrated has substantially straight blades with backwardly curved tips and with the upstanding wings 106 conforming to the flared opening 12 in the top plate 2 of the impeller housing. In the present construction, the hub 94 of the impeller 4 is disposed mainly on the bottom side of the median plane of the impeller itself so that an easy curvature of the hub surface at 107 leads the liquid from the eye of the plate 2 into the blades without cavitation pockets around the hub. The shaft 6 is keyed to the impeller as shown and the impeller is readily removable from the shaft. The shaft is preferably made of a corrosion resisting metal, the same as the other parts of the pump where the pump is to handle corrosive liquids. While the pump is mainly designed for the handling of corrosive liquids, it obviously need not be confined to that service.

The top plate 2 of the impeller housing is secured to the annular wall 25 by means of a flange 108 which is machined to fit with a shrink fit upon a machined annular surface of the bottom rim or margin of the tubular wall 25. To apply the plate 2 to the tubular wall 25 the same is heated to expand the flange 108 and is thereupon placed in position and shrunk upon the rim of the tubular connection 25. To remove the plate 108 it may be heated with a blow torch or other suitable means, whereupon it is readily removable, and replaceable. Thus all parts of the pump subject to wear or corrosion are readily serviced or replaced.

The upper end of the impeller shaft 6 is telescopically forced into the lower tubular end of the driving shaft section 109. This shaft section is supported in two ball bearings 110 and 112. The bearing 110 provides radial support and the bearing 112 provides both radial and axial support. The bearing 110 is fastened to the lower end of the driving shaft section 109 and floats in a seat in the sleeve or barrel 5. The upper bearing 112 has its inner ring fastened to the shaft 109 and its outer race or ring is supported upon a supporting flange 113 to sustain the downward load and is clamped by the cover member 114. The flange 113 is carried in a supporting ring 115 and this ring is adjustable vertically with respect to the upper end 116 of the bracket 5, as by means of the three concealed screws 117 (see Figures 7 and 8). These screws are threaded into the supporting member 115 and bear against the top portion 116 of the bracket 5. The clamping studs or cap screws 118 hold the parts 114 and 115 firmly together and to the bracket 5. Thus by means of the screws 117 and the clamping cap screws 118, the vertical adjustment of the driving shaft 109 and the attached impeller shaft 6 may be made as desired. The lower bearing 110 is preferably provided with a Neoprene ring which acts somewhat like a cup leather, the outer margins of the Neoprene ring 120 being bonded to a sheet metal fitting 122 and the inner end of the Neoprene ring 120 being held against the shaft by a garter spring 123. Lubricant is preferably supplied through a duct 124 in the cap 114 and this supplies the upper bearing 112. The lower bearing 110 is preferably packed with lubricant and additional lubricant may be supplied through the duct 121.

The operation of the pump and the constituent parts thereof will be apparent from the foregoing detail description, but I shall recapitulate briefly the operation of the pump as a whole.

The pump is preferably disposed above the source of liquid, a suction pipe is connected to the suction or inlet fitting or neck 17 so that liquid is required to be raised from the source by suction. If it is intended to place the pump below the level of the liquid supply, then a conventional shaft seal is to be employed instead of the liquid shaft seal herein described. The structure of the seal may be altered accordingly. The pump is filled to the level of the filling plug opening 60, the drain pipe 44 leads back to the source of supply, and any liquid which is wasted by the liquid seal of the shaft is therefore returned to the source by gravity. Liquid stands in the supply pocket 52 surrounding the shaft 6. As soon as the shaft is rotated the impeller 7 drives liquid out through all of the throats, emptying the impeller housing and inlet chamber, driving the liquid from the inlet chamber over into the discharge chamber. As soon as this has occurred, or substantially simultaneously with the dropping of the discharge pressure as the liquid on the intake side of the blades is exhausted, liquid begins to return through the auxiliary throats 97 to form a working fluid the density of which varies with the difference in pressure existing upon the discharge and suction sides of the impeller. As the gas or air is gradually evacuated from the suction line and the intake chamber 9,

10, liquid will be raised in the suction pipe until is is drawn over, whereupon the pump operates upon liquid, discharging liquid at both the main and auxiliary throats.

During priming the mixture is discharged by the main throats 96 and their tangential volute-like extension above the plate 99 and the gas and liquid separates in the upper part of the separator, the gas escaping at the discharge connection 23. The denser liquid drops into the channel 100 through the openings 102 in the plate 99 and returns to the periphery of the impeller through the ducts or throats 97. Thus a continuous circulation is carried on so long as priming is required, or so long as the pump does not receive liquid on the intake side. Air is constantly being carried out from the intake side and discharged into the discharge side by the mixing of gas and liquid to form a working fluid, and is discharged into the separator. During this priming operation, liquid is drawn or flows through the inlet duct 56 into the sealing chamber 52, where the liquid entering the passageways 75 into contact with the shaft 6 is caused to be pressed against the shaft at the various inclined vane-like surfaces so as to create, completely around the shaft 6, a plenum of liquid pressure which is exerted both downwardly and upwardly along the shaft. The escape of liquid upwardly along the shaft is relieved at the windows or relief ports 74 and flows back into the liquid supply chamber 52. Such liquid as flows up along the shaft above the relief ports or windows 74 is free to be discharged at the upper relief windows 70 and there to flow out through the duct 54 to waste back to the source of liquid by way of the drain pipe 44. Any liquid carried along the surface of the shaft beyond such point and past the constriction between the shaft and the sleeve 48 is thrown clear by the slinger 67 into the slinger pocket 66, from which it drains on the outside through the open channel 36 and opening 46 to the return or drain pipe 44 as the case may be.

The swirling of liquid in the separator 8 tends to keep the entry port 62 clear. It will be observed that the return or discharge port 57 from the pocket 52 opens radially inwardly further toward the shaft than does the opening 62 in the supply duct 56. Obviously, if desired, the direction of supply and discharge of liquid through the pocket 52 may be altered and, if desired, the impingement of the swirling liquid upon the supply duct inlet opening may be employed for assisting in the circulation of liquid in and out of the liquid supply pocket 52. In case of stoppage of the pump, particularly before the liquid has been drawn over in the suction pipe, there is a tendency to collapse the vacuum in the suction pipe by very rapid counterflow of liquid out of the pump back into the empty space in the suction pipe. This collapse of the suction tends to pull the liquid very rapidly out of the intake trap of the pump because liquid is peculiarly free to be discharged from the separator 8 through all of the throats 97 and 98 in multiple, and through the large open passageways including the eye 12, the tubular connection 19, and the intake passageway 19. Such an occurrence, therefore, tends to clean the pump of liquid in a few seconds in case of a suction pipe of relatively large capacity and at fairly high suction. The rapidity of counterflow is not so great in the case of a suction pipe filled with liquid, but even so, it tends to be very rapid. One of the difficulties has been to keep the priming charge of liquid in this pump. I have made a special provision to insure the retention of a priming charge when such collapse of the suction occurs on the suction side of the pump.

It will be observed from Figure 1 that the inlet or suction connection 19 communicates, by way of the tubular portion of the trap 25, with the eye 12. The separator space 8 communicates with the interior of the impeller chamber through the volute ducts 96 of the main discharge throats above the flange or baffle 99 and communicates by way of the auxiliary or priming throats 97 from below the baffle 99. In the present construction, these four throats give a relatively large and free discharge of liquid from the separator back through the impeller housing, upwardly through the eye thereof, through the tubular portion of the trap 25 and out the inlet connection 19 in case of suction on the inlet pipe being allowed, through cessation of operation of the impeller, to pull liquid from the separator through the impeller housing, through the trap and down toward the source. As above explained, if the impeller should be stopped at a time when the pump has drawn a relatively high suction and in a fairly large volume of the suction pipe, the collapse of suction in the suction pipe operates with great rapidity to pull the liquid out of the trap through the impeller housing and back toward the source. The problem of keeping sufficient liquid in the inlet trap that it may be retained as a priming charge is unusually severe because of the disposition and arrangement of these parts.

In order to insure the retention of a priming charge I have disposed a large part of the trap space at the upper end of the trap and then have divided the trap into two functionally separate parts by means of a baffle or wall which is more clearly shown in Figures 5 and 6. This baffle wall 129 defines a downward extension of the inlet connection 19. This downward extension 132 provides a normal course of inflow for liquid during operation of the pump on liquid and serves as a discharge passageway for liquid when the pump is stopped and reflow or reflux occurs. At the upper end of the baffle or wall 129 I provide one or more small openings such as 130 shown in Figures 5 and 6, to provide a restricted communication between the top of the storage space 133 at the left of the baffle or wall 129 (Figure 6), and the upper end of the inlet or suction conduit 19—132. At their lower ends the passageway 132 and the storage compartment 133 of the trap space communicate freely with each other and with the eye of the impeller housing and with the impeller. Thus, normally, in pumping liquid, the suction pipe will be put under suction and liquid will flow in through the tubular neck 17 defining the inlet passageway 19, down through the passageway 132 and into the eye of the impeller of the pump. Also, liquid will flow over into the storage space 133 and fill the same with liquid. If now, upon stoppage of rotation of the impeller, discharge pressure of the impeller upon the throats of the pump drops to less than the suction tending to pull the liquid back, the liquid will begin to flow from the trap back through the throats 96, 97 into the impeller housing, through the eye of the housing, and up through the passageway 132—19.

This backflow does not appreciably deplete the liquid in the storage space 133, since the opening or openings 130 constitute a very material

restriction to the flow of liquid, although presenting no great restriction to the flow of air. As soon as liquid has been pulled out of the pump sufficiently to let air follow to break the vacuum, air will enter the passageway 132 and pass out through the connected passageway 19 to the suction pipe, allowing the liquid to drop down to the source. As soon as the pressure of this air upon the port or ports 130 rises to the value which will allow the liquid in the storage space 133 to drop, the said stored liquid in the space 133 will drop down into the impeller housing and some of it pass over into the separator space 8 and thereby supply the charge of priming liquid for the next start of the pump. Thus the storage space 133, with the major part of its capacity disposed above the restricted communication, cannot be rapidly emptied and tends to retain sufficient liquid for subsequent operations. If the suction in a partially empty suction pipe at high vacuum is allowed to collapse without filling the pump, there is a tendency to remove a part of the priming charge. In that event, the collapse of the suction tends to pull some of the liquid out through the passageway 132 and to pull some of it up into the storage space 133 through the flow of air or other gas through the opening or openings 130. Sufficient liquid is thereby diverted into the storage space during the breaking of the seal through the pump that upon dropping of this liquid back into the impeller housing and separator a sufficient charge for repriming is present.

It will be observed that the inlet connection 132 to the eye 12 of the impeller housing is offset, so that a rapid discharge of liquid through the eye 12 will tend, at least as to the major part, to be directed into the storage space 133.

It is to be understood that this particular feature of liquid retention may be employed or omitted independently of other features of the present pump. Also it is to be understood that other means for preventing the outrush of liquid known in the art may be employed without affecting certain other features of the present invention.

I do not intend to be limited to the details of construction herein shown or described except as they are recited as substantial features in the following claims.

I claim:

1. A vertical self-priming centrifugal pump comprising a hollow body, a central vertical shaft carrying at its lower end an impeller, said body comprising a central intake chamber forming a trap, an impeller housing having an opening facing upwardly into the bottom of the trap, and having a peripheral portion provided with throating opening radially outside the intake trap, said body containing an annular discharge chamber surrounding the impeller housing and forming a separator, suction and discharge connections opening into the tops of the aforesaid chambers, respectively, said intake trap having an enlarged portion at its upper end to provide a substantial space for trapping priming liquid, and means for preventing emptying of the trap upon violent flow of liquid out of the suction connection, said means comprising a wall dividing the trap into two chambers, both chambers opening at their lower ends into the intake of the impeller housing.

2. In a vertical self-priming centrifugal pump, a vertical impeller shaft, an impeller at the lower end of the shaft, an impeller housing provided with throating and a discharge connection including a separator, said housing having an eye facing upwardly, an intake trap having its lower end opening into said eye, and having a suction connection at its upper end, and means for preventing emptying of the trap upon violent flow of liquid out of the suction connection, said means comprising a wall dividing said intake trap into two functionally separate parts both opening freely into the eye of the impeller and having a restricted communication with each other at their upper ends.

3. A pump body for a vertical pump comprising a hollow casting closed at the top and sides and open at the bottom, there being a top wall with a central depression for a shaft bearing and an aperture for an impeller shaft, said casting comprising an outer wall and an inner wall concentric with the shaft opening, walls defining an open gutter leading laterally from said depression for the escape of liquid from the bottom of said depression, the inner wall terminating in an annular rim, and the outer wall terminating at a lower level in an outer annular rim parallel with said inner annular rim.

4. A pump body comprising a hollow casting having a closed top wall with a central opening for a shaft in the said top wall, said casting comprising an outer and an inner wall concentric with the central opening, the inner wall terminating in an annular rim, the outer wall terminating in an annular gasket surface lying below the said rim, said inner wall defining a trap and the space between the inner and outer walls defining a separator, tubular inlet and discharge connections providing external communication with the trap and separator, respectively, a sealing barrel depending from the top wall and having a bore in line with said opening, said barrel being divided into upper and lower chambers, an integral liquid inlet duct extending from the separator through the inner wall to the lower chamber in the barrel, and a liquid drain duct leading from said upper chamber through said inner and outer walls for draining off escaping liquid from said seal.

5. A pump body comprising a hollow casting closed at the top and sides and open at the bottom, there being a top wall with a central depression for a shaft bearing and an aperture for an impeller shaft, said casting comprising an outer substantially cylindrical wall and an inner substantially cylindrical wall concentric with the shaft opening and separated by an annular separating space, the inner wall terminating in a free annular rim and the outer wall terminating at a lower level in an outer annular rim parallel with said inner annular rim, and a mounting flange integral with said casting at the upper end of the central depression for supporting a bearing in said depression.

6. The combination of the pump body of claim 3 having a depending liquid seal barrel extending below the depression and having a bore in line with said opening, an integral duct extending from the lower end of the bore to the space between said concentric walls and an integral duct extending from the upper end of the said bore to the outside of the pump body, said last named duct lying below said open gutter and having an opening communication with said gutter at its outer end, and a common drain for draining liquid from the gutter and the adjacent duct.

7. In a vertical pump, a shaft bearing and sealing structure comprising a cup-shaped depression

in the top wall of a pump body, said depression having a clamping flange about its upper margin, a bearing sleeve piloted into the upper end of said depression and having a clamping flange to clamp the sleeve in position with respect to the first clamping flange, a shaft section disposed in the sleeve, bearings for radial and for thrust load disposed between the shaft section and the bearing sleeve, an impeller shaft joined to the shaft section, a liquid sealing barrel depending from the walls of the cup-shaped depression, a liquid sealing sleeve embracing the shaft and disposed in the sealing barrel, a drain externally for the cup-shaped depression, and a drain duct leading from the inside of the upper end of the sealing sleeve to the outside of the pump the inner end of the sealing sleeve being exposed to the suction side of the impeller.

8. A pump housing for a vertical self-priming pump, comprising a top plate having a central inlet opening and a circular periphery and a main body portion comprising a bottom plate and a vertically extending peripheral flange telescopically embracing the periphery of the top plate, said peripheral flange having hollow tangential extensions defining pairs of throats and substantially horizontally extending baffles disposed between the outlets of the throats of each pair, and an extension of the bottom plate serving to define an annular passageway below said baffle, said annular passageway constituting in effect a manifold connected to one of the throats of each pair.

9. A pump body comprising a hollow casting having a closed top wall with a central opening for a shaft in the said top wall, said casting comprising an outer and an inner wall concentric with the central opening, the inner wall terminating in an annular rim, the outer wall terminating in an annular gasket surface lying below the said rim, said inner wall defining a trap and the space between the inner and outer walls defining a separator, tubular inlet and discharge connections providing external communication with the trap and separator, respectively, and a substantially vertical partition in said trap for constituting the space within the trap as two separate portions, the smaller portion forming a continuation of the inlet connection, and the larger portion forming a liquid storage space, said portions communicating with each other through a restricted opening in the top of said dividing wall and communicating freely with each other below the bottom of said wall.

10. In a pump, the combination of a tubular member defining an inlet passage, said member terminating in an annular rim, and an impeller housing part comprising a centrally apertured side plate member lying against the end of said rim and having a short circular flange thermally shrunk upon and tightly embracing the periphery of said rim for supporting said housing part upon said rim.

11. A main body for a vertical self-priming centrifugal pump consisting of a hollow integral casting closed at the top and open at the bottom comprising two substantially cylindrical walls having substantially a common vertical axis and terminating as free annular rims in spaced horizontal planes with the outer wall extending a substantial distance below the inner wall, a top wall having an open central depression surrounded by a bearing mounting flange, and an integral shaft seal sleeve disposed within the inner wall and extending to a point adjacent the lower end of said inner wall.

12. An integral pump body for a vertical self-priming pump comprising a series of coaxial substantially vertical annular walls comprising a central sleeve for sealing a vertical shaft, the upper end of the sleeve being enlarged to define a bearing pocket, an intake trap wall surrounding the sleeve and having an intake connection opening into the top of the trap, a separator wall surrounding the intake trap wall and defining an annular separator chamber, a discharge connection opening into the top of the separator chamber, and joining walls between the sleeve and the upper ends of the trap and separator walls.

13. In a vertical self-priming pump, a hollow body casting comprising a top wall, a vertical annular separator wall joined to the top wall and open at the bottom and having a clamping flange about the margin of the open end, a central wall defining a sealing sleeve open at both ends, said sleeve being connected to the top wall, a liquid supply tube within the hollow body leading from a point adjacent the separator wall to the inside of the lower end of the sleeve, and a liquid drain tube leading from the upper end of the sleeve and extending through the separator wall and opening outside of said separator wall.

14. In a vertical self-priming pump, a hollow body casting comprising a top wall with a central opening, a vertical annular separator wall joined to the top wall and open at the bottom and having a clamping flange about the margin of the open end, an annular pocket defining wall joined to the margins about the opening in the top wall and extending above the top wall, and having a bearing supporting flange at its upper end, a sealing sleeve open at both ends joined at its upper end to the lower end of said pocket defining wall, an intermediate annular wall surrounding the sleeve and defining a trap, a supply tube within the body extending from a point adjacent the separator wall through the intermediate wall and opening into the lower end of the sleeve, a drain tube extending from the upper end of the sleeve through the intermediate wall and through the separator wall and carrying a pipe connection outside the body.

15. The pump body of claim 14 wherein a depressed groove is formed in the top wall, separator wall and intermediate wall, and disposed over said drain tube to provide an open drain from the bottom of the pocket, and a drain conduit communicating with said open drain and with said drain tube.

16. In a pump the combination with an intake conduit having a tubular portion with an external peripheral seat at its end, and an annular impeller housing plate having an aperture at its center and provided with a flange adapted to embrace said peripheral seat, said plate having its flange thermally shrunk upon and gripping said peripheral seat, and means for keeping said joint submerged in liquid.

17. In combination in an acid resisting pump, a tubular conduit of cast acid resisting metal terminating in a plane substantially at right angles to the longitudinal axis of the conduit and having a circular external peripheral seat and a cast acid resisting metal plate provided with a short integral flange embracing said seat and gripping the same by thermal contraction.

18. In a self-priming centrifugal pump, an integral hollow pump body comprising a top wall having a central depression forming a bearing

pocket and a sealing sleeve extending down from the bottom of the pocket, an outer substantially cylindrical wall joined to the top wall and terminating at its lower end in a clamping flange, an inner substantially cylindrical wall substantially concentric with said outer wall and terminating at its lower end a substantial distance above the clamping flange, the upper end of the inner wall flaring out and joining the outer wall at a level a substantial distance below the junction of the top wall and the outer wall, and a depression in the top and side walls forming an open drain groove extending from the bottom of the pocket.

19. In a self-priming centrifugal pump, an integral hollow pump body comprising a top wall having a central depression forming a bearing pocket and a sealing sleeve extending down from the bottom of the pocket, an outer substantially cylindrical wall joined to the top wall and terminating at its lower end in a clamping flange, an inner substantially cylindrical wall substantially concentric with said outer wall and terminating at its lower end a substantial distance above the clamping flange, the upper end of the inner wall flaring out and joining the outer wall at a level a substantial distance below the junction of the top wall and the outer wall, and a depression in the top and side walls forming an open drain groove extending from the bottom of the pocket, said sleeve having a liquid supply pocket adjacent its lower end and a liquid drain pocket adjacent its junction with the bottom of said bearing pocket, a liquid supply duct extending from a point between the lower ends of said cylindrical walls to said supply pocket, and a liquid drain duct extending from said drain pocket to the outside of the body, said drain duct lying immediately beneath said groove and having a wall common with the bottom of the groove.

20. A vertical self-priming centrifugal pump comprising a hollow body casting having a top wall, a substantially cylindrical outer wall joined to the top wall and terminating at its lower end in a clamping flange, said top wall having a central depression, an open seal sleeve forming an extension of the lower end of the walls of said pocket, the walls of the pocket terminating above the top wall in a clamping flange, a bearing barrel extending down into said pocket and projecting above the top of the pocket, a mounting flange intermediate the ends of the bearing barrel, said mounting flange being removably clamped to the clamping flange, a vertical shaft extending through said bearing barrel and sealing sleeve and carrying an impeller at its lower end, said impeller being removable through the open bottom of said body, and bearings in said bearing sleeve for supporting the vertical shaft axially and radially.

21. In a vertical self-priming pump the combination of a main hollow body closed at the top and open at the bottom comprising a top wall, a depending outer cylindrical wall and an inner cylindrical wall terminating above the lower end of the outer wall, a two part impeller chamber of the concentric type comprising an apertured top plate mounted on the lower end of the inner wall, a cooperating housing portion having an extending flange seating against the lower end of the outer wall to provide a closure for the body, said housing portion having peripheral throating comprising pairs of throats and an interrupted horizontal annular flange separating the throats of each pair from each other and defining a common annular communicating passageway in the bottom of the pump body for corresponding throats of each pair.

22. In a pump body, an outer substantially cylindrical separator wall, an inner substantially cylindrical trap wall substantially coaxial with the outer wall and terminating inside the separator wall, the end of the trap wall having a peripheral sealing face, an impeller housing side plate comprising a disc-like body with a central opening and having a flat annular wall and a short integral cylindrical wall forming an annular flange about the periphery of the flat annular wall, said flange being thermally shrunk upon said peripheral sealing face and being releasable by heat applied to said flat annular wall.

HARRY E. LA BOUR.