March 23, 1926. 1,578,236

H. E. LA BOUR

CENTRIFUGAL PUMP

Filed March 4, 1922 2 Sheets-Sheet 1

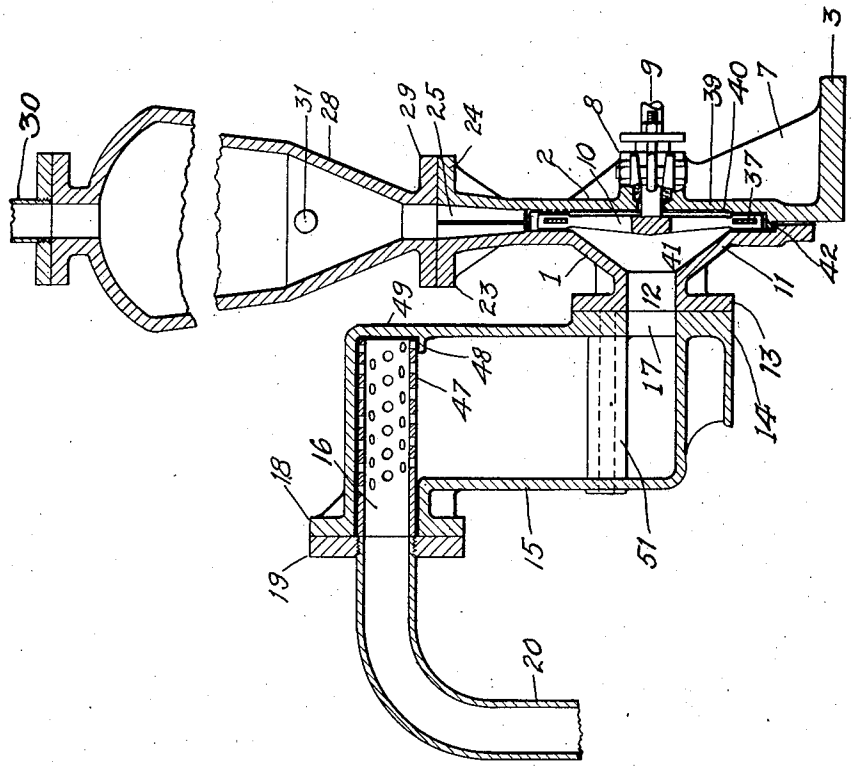


Fig. 2

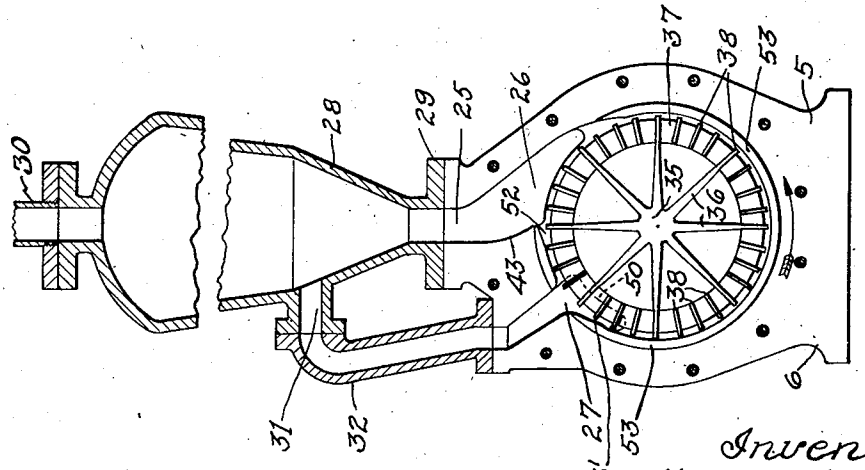


Fig. 1

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1,578,236

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2 Sheets-Sheet 2

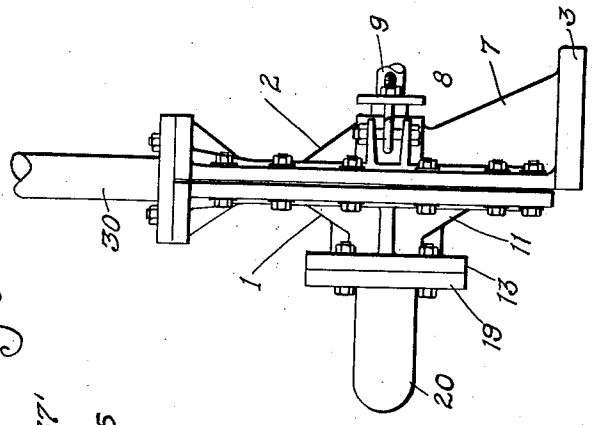
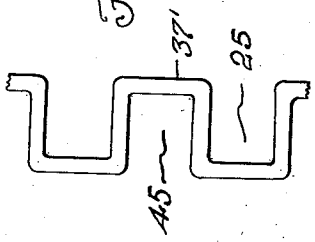


Fig. 4

Fig. 5



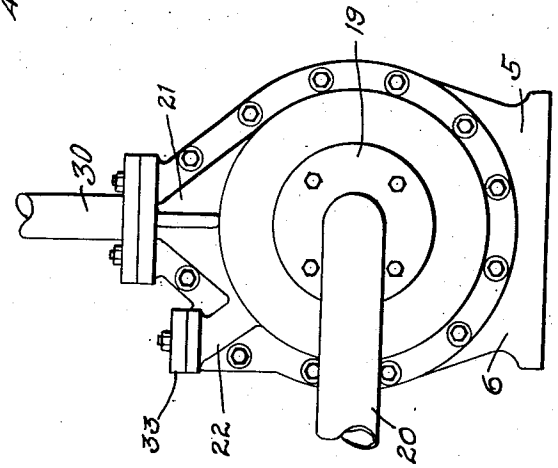


Fig. 3

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Patented Mar. 23, 1926. 1,578,236

UNITED STATES PATENT OFFICE.

HARRY E. LA BOUR, OF CHICAGO, ILLINOIS.

CENTRIFUGAL PUMP.

Application filed March 4, 1922. Serial No. 541,030.

To all whom it may concern:

Be it known that I, HARRY L. LE BOUR, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Centrifugal Pumps, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to centrifugal pumps. The pump which I shall describe in connection with the following specification as being the preferred embodiment of my invention has a novel characteristic in that it operates both by injection and momentum to discharge a greater quantity of liquid than would appear to be possible when considering merely the capacity of the pocket and the speed of rotation of the impeller.

My explanation of this feature is, that the pump operates not only on the principle of the well known centrifugal pump by throwing fluid outwardly by centrifugal action, but also that it operates on the injection principle. It is well known that while a column of liquid is moving, it has a very considerable inertia and sudden stoppage or change of direction often causes a liquid to evidence the inertia that it has to a very considerable degree. In the present case I provide an open pump runner having an open spider with a ring upon its outer periphery, this ring having transverse blades or impellers which project radially and laterally from the sides of the ring to form U-shaped pockets, both legs of the U being open and the bottom of the U being closed by the normal inner periphery of the pump casing. The casing provides a channel or race-way fitting quite closely about these pins or blades. At the point where the discharge is to occur, the bottom of the channel is removed to provide a discharge or outlet opening which may be and preferably is substantially tangential. At this point the bottom of each U-shaped slug of water is permitted to move radially and the arms of the U follow it. Since the inner ends of the arms of the U open into the liquid upon the interior of the ring the movement of the U tends to draw liquid in and elongate the arms of the U so that more actual liquid than that which fills the U-shaped pocket actually does pass out the discharge giving the pump a greater displacement than would be caused by mere emptying of the pocket.

Another feature of my invention relates to the means for making this pump self-priming so that it may operate as a suction pump to lift liquids a very considerable distance within suction limits. I provide a separating chamber upon the discharge side of the pump for separating liquid from gas and near the lower part of this separating chamber I provide a connection which delivers liquid to the pump through an auxiliary inlet, this inlet entering the pump near the outer portion of the impeller, and preferably substantially radially of the impeller at a point adjacent the outlet, but posterior thereto with regard to the direction of rotation of the runner or impeller. Upon the intake side of the pump I provide a trap for trapping a certain amount of liquid sufficient to start the operation of the pump as a suction pump, this amount of liquid being only great enough to fill the pump chamber, the bottom of the separator and the auxiliary intake, to maintain the runner substantially full of liquid. A further feature of novelty comprises the provision of a removable and self-cleaning strainer of relatively large size in the suction pipe.

The impeller is of a self-balancing type, that is, having no or substantially no end thrust so that no additional bearing is required for this purpose.

In order to acquaint those skilled in the art with the manner of constructing and using a pump according to my invention, I shall now describe in connection with the accompanying drawings one embodiment of the invention;

Figure 1 is a vertical cross-sectional view of a pump of the self-priming type embodying my invention;

Fig. 2 is a vertical cross-sectional view taken at right angles to the section of Fig. 1 of the same;

Fig. 3 is a front elevation;

Fig. 4 is a side elevation of a pump embodying my invention omitting the self-priming feature; and

Fig. 5 is a fragmentary view of a modified form of impeller.

As shown in Fig. 2 the pump casing com-

prises the front half 1 and the rear half 2, these parts being bolted together by suitable flanges thru which bolts are passed for clamping the halves of the casing together. The rear half 2 has a foot plate 3 for supporting the pump. This foot plate is joined to the rest of its casing portion by the integral webs 5 and 6, as shown in Fig. 1, and the stiffening web 7 on the back, this stiffening web merging into the stuffing box 8 thru which passes the shaft 9 for the impeller 10. The front half 1 comprises a flaring inlet portion 11 which has a flanged inlet opening 12, the flanges 13 of which are adapted to be joined to the cooperating flanges 14 of the trap member 15. This trap member 15 extends upwardly and has an inlet opening at 16 sufficiently above its outlet opening 17 as to trap a body of liquid suitable for priming the pump. The flanges 18 at the inlet opening of the trap member 15 are adapted to be connected by suitable flanges 19 to the suction or inlet pipe 20.

It is to be noted that the inlet opening through the flange 18 is made slightly larger than the outlet from pipe 20. This is done to provide room for the screen 47 which comprises a suitable short length of pipe provided with perforations to form a screen. The inner end of the screen rests upon a ledge 48. The inner end of the screen is closed off by the wall 49 of the trap 15. The outer end of the screen is held in the opening through the flange 18 by the pipe 20 and cooperating flange 19. As will be pointed out later, when the pump is stopped, the liquid in the discharge pipe tends to force its way back through the pump and through the suction pipe until air passes over. This back flow tends to clean the screen 47. This screen is accessible by releasing the flange 19. Thus the screen may be cleaned without disturbing the trap or losing the priming charge of liquid. The total area of the holes through the side walls of the screen is considerably in excess of the cross sectional area of the pipe out of which it is formed, so that little or no restriction is formed by said screen. Any foreign substance large enough to damage the impeller 10 will be stopped by the screen 47.

The trap 15 is bolted to the flange 13 by suitable bolts, the upper ones of which pass thru bosses 51, extending thru the trap 15. If desired a separate support may be provided for the trap 15 since it is quite heavy.

The two halves of the casing are generally circular, the upper part being provided with two bosses 21 for forming the discharge, and 22 for forming the auxiliary inlet nozzle. The discharge 25 has flanges 23 and 24 formed on the corresponding halves of the casing so as to form a complete circular flange about the discharge port 25 of the pump. The discharge port is flared upwardly as is apparent from Fig. 2, and it is flared out peripherally of the impeller 10 to form a fairly wide discharge opening 26, as is shown in Fig. 1. This discharge port 26 is widened immediately beyond the ends of the impeller blades to permit the fluid to expand laterally as soon as it leaves the impeller. This reduces the friction of flow at this point. In a similar manner the boss 22 provides the auxiliary port 27 which leads in substantially radially towards the impeller 10. This port is also flared to form pockets in the sides of the casing, which extend down to a point below the ends of the impeller blades, maintaining, however, a seal along the sides of the impeller as indicated at 50. The boss 22 is similarly provided with bolting flanges formed on the corresponding halves of the casing. A fitting 28 which I term the gas separating chamber, is connected by means of a suitable bolting flange 29 to the flanges 23—24, surrounding the discharge port 25. This fitting constitutes an enlargement in the discharge pipe 30 of which it forms a part. An opening or port 31 is formed in the wall of the fitting 28 and this is connected by a suitable flanged pipe 32 to the auxiliary inlet 27.

Where the pump is to be employed without the self-priming feature, the separating chamber 28, the connection 32 and the inlet trap fixture 15 are omitted, as is shown in Figures 3 and 4. In that event, the auxiliary inlet passageway 27 is closed by a plate 33 which is bolted to the flanges on the boss 22. The discharge pipe 30 without any enlargement is then clamped directly to the flanges 23, 24 on the discharge nozzle 25, and the intake pipe 20 with its flange 19 is connected directly to the intake opening 12 of the front half of the pump casing. The impeller or runner 10 forms, in connection with the cooperating casing, a novel structure having a very highly advantageous operating characteristic. The runner 10 comprises a central hub member 35 from which radiates a plurality of arms 36, in the present instance 8 in number. Integral with the ends of the arms 36 I have formed a flat ring 37 which appears in side elevation in Fig. 1 and in section in Fig. 2. A series of vanes or impellers 38 are formed on the ring 37 preferably cast integral therewith, these blades or vanes extending out laterally from both sides of the ring 37 and extending out radially in a similar manner to form pockets which are U-shaped with the legs of the U communicating freely with the liquid in the central part of the casing. To permit this, the flared inlet connection 11 communicates freely with the adjacent open ends of the U-shaped pockets and the casing is so formed that the rear wall 39 of the back half of the

casing provides a free space 40 which communicates with the other leg of the U-shaped pocket. The space 40 communicates with the space 41 in the flared portion 11 through the open spider of the impeller 10. The impeller may be constructed in any other manner which will secure the same result. A closed runner or impeller may be employed. I find the one illustrated preferable but do not intend to limit the invention thereto.

The two halves of the casing provide an interior peripheral channel 42 which fits closely about the blades or vanes 38 with only the necessary operating clearance between the casing and the blades of the impeller. The peripheral channel 42 is unbroken except at the discharge port 26 and the auxiliary inlet port 27. It will be noted from Fig. 1 that the advance or anterior edge of the discharge port 26 is substantially tangent to the channel 42 across the full width thereof. This opening extends preferably across the full width of the channel 42. The posterior or trailing edge has less inclination and it has a wall curved gently at 43 for merging into the vertical discharge nozzle 25. The change of direction of the fluid is thereby effected with a minimum loss of head. There is also a clearance 52 at the trailing corner of the discharge port 26 to prevent eddy currents at this point.

The leading or anterior edge of the port 27 is substantially radial to the impeller 10 while the trailing or posterior edge is rounded off as shown at 53′ to diminish the friction to the flow of liquid at this point. The port 27 opens into said channel 42 preferably across the full width of the same and has in addition the lateral pockets adjacent 50. The rear half 2 of the casing has a forming flange 53 which extends parallel to the axis of shaft 9 to bring the joint between halves over to one side of the channel 42. This flange assists in centering the halves 1 and 2.

The operation of the device shown in Figs. 1 and 2 is as follows:

Assuming that the inlet trap 15 is filled with liquid to the level of the bottom of the intake port 16 and that the liquid stands at an equal height in the pump and the discharge connections, the pump may be caused to evacuate the gas such as air or the like in the suction pipe 20 by rotation of the impeller 10, counter-clockwise in Fig. 1, as indicated by the arrow. Rotary movement of the impeller 10 tends to throw the water in each of the pockets formed between the vanes or impeller blades to the bottom of the channel 42. The slug of water contained in each of these pockets is substantially U-shaped, the bottom of the U resting against the bottom of the channel 42 and the sides of the U being restrained between the sides of the channel and the ring 37 with the top of the U in communication with the liquid in the body of the pump. As each successive pocket comes into register with the discharge port 26, the U-shaped slug of liquid is thrown out into the discharge port 26. The movement of this slug of water in each case creates back of each leg a region of reduced pressure, or what may be termed "suction," with the result that a continued refilling of the legs of the U results until the pocket passes under the trailing edge of the port 26. If insufficient liquid is present in the body of the pump, the gas itself will tend to follow each slug with the result that between the slugs of water discharged through the discharge port 26 there are expelled small bodies of gas, which together with the water are expelled through the nozzle 25 into the gas separating chamber 28, the gas rising above the water and the water tending to drop down and pass through the port 31, fitting 32, into the auxiliary admission port at 27 where unmixed liquid is fed back into the channel to fill the pockets of the impeller as they pass. It is to be noted that if the upper part of the pump contains air, then the pockets as they pass the discharge port 26 are completely emptied and they cannot, therefore, create any material pressure against the incoming of liquid at the auxiliary inlet port or passageway 27. The result is that the liquid freely reenters through the passageway to keep the pockets primed between the auxiliary inlet port 27 and the discharge port 26 in the direction of rotation. If, however, the gas has been exhausted from the suction pipe 20 and from the casing of the pump so that liquid fills the casing of the pump, the pressure developed by the liquid in the pockets after they pass the trailing edge of the discharge port 26 rises to a pressure substantially equal to the pressure prevailing in the inlet 27 whereby there is substantially no interchange of liquid between them. In fact, by suitable proportioning, the pressure developed by the impeller may rise to a value high enough to cause a discharge of liquid from the pockets into the auxiliary inlet 27 during normal operation.

This is a novel feature and new mode of operation not attained in any pump with which I am familiar, namely, that I have an auxiliary inlet port which operates during the priming period as a means for permitting the liquid to reenter the pump to maintain the same primed, but which becomes substantially ineffective as an inlet port and in fact may serve as an outlet port when the pump is operating upon liquid in normal operation. It is thereby possible to secure a maximum priming action when necessary, but a minimum loss when the pump is operating under normal conditions.

The injector action which this pump secures is not limited to the particular shape of impeller, although I have found that the particular impeller which I have illustrated is preferable. It is not necessary that the pocket form a U-shaped slug, since the ring 37 may be extended out to the bottom of the channel 42 and be given a zig-zag form, as I have shown at 37' in Fig. 5. Here pockets 45 are formed alternately upon opposite sides of the ring 37', this ring being mounted directly upon the ends of the spider arms 36. It is necessary that the pockets be open at the rear or at the end which faces towards the center when the outer end of the pockets register with the discharge port 26, so that the outward throw of the slug of water contained in the pocket may induce a flow through the pocket while the same is in register with said port 26. The impeller which I have shown gives a balanced effect since liquid is drawn equally from each side of the ring so that no end thrust in the impeller is developed. It is desirable that the blades or vanes extend closely adjacent to the bottom of the channel 42 in order to secure maximum effect. It is not desirable so far as I have found to have a radial flow of liquid through the pockets as is customary in the ordinary volute pump, except during that period when the pockets register with the discharge opening.

The pump is highly effective whether used with the self-priming feature or not. Where the self-priming feature is not required, the auxiliary inlet may be closed by a plate as indicated in Figures 3 and 4, and the inlet and discharge are then directly connected to the pump casing without the inlet trap and the gas separator. That the injector action does occur as stated is evidenced by the fact that the discharge of a pump of this character is very greatly in excess of the quantity which would be discharged by mere emptying of the pockets at a given speed. Thus, for instance, I find that for a one-inch size pump operating at 1800 R. P. M. the displacement capacity of the pockets alone would be approximately 15 gallons per minute. I have found that it is possible to discharge liquid greatly in excess of 15 gallons per minute. For instance, I find that it is possible to deliver 50 gallons per minute with this pump against a pressure of 14 pounds head.

I do not intend to be limited to the precise construction shown and described, since considerable modification is possible without departing from my invention.

There are several features to which I wish to call attention in this connection. First, that it is highly desirable that the discharge port 26 be at substantially the highest point in the pump casing so that the air which separates from the liquid by gravity will be readily and completely withdrawn.

Another feature to which I wish to call attention is the auxiliary inlet port 27. The advanced edge of the auxiliary inlet port 27 is substantially radial, while the trailing edge is rounded. The result is that a slug of liquid finds difficulty in moving out of the pocket into this auxiliary inlet port when the pump is full of liquid. The auxiliary inlet passageway is shaped however, to promote the introduction of liquid into the impeller when the top of the impeller is otherwise occupied by air or gas.

It is not essential that the liquid for the auxiliary inlet 27 be introduced from the discharge pipe, it may be introduced from any convenient source. It is, furthermore, not essential that the auxiliary inlet port open at the top of the pump although this is more desirable to secure greater efficiency and better balance.

I claim:

1. The method of operating a centrifugal pump which comprises rotating the impeller and simultaneously introducing liquid peripherally into the runner independently of the main source of liquid.

2. The method of exhausting gas from a centrifugal pump which comprises rotating the impeller and simultaneously introducing liquid into the impeller at a point remote from the normal inlet of the pump.

3. The method of priming a centrifugal pump containing gas, which comprises rotating the impeller and simultaneously introducing liquid peripherally into the impeller at a point posterior to the normal discharge opening.

4. A pump comprising a casing having an internal peripheral channel, a discharge port opening from said channel at substantially the highest point thereof, an inlet opening laterally into the casing, a peripheral inlet port opening into said channel at a point adjacent but posterior to the discharge port, and a pump runner for throwing successive slugs out of the discharge port, said pump runner having pockets communicating at their interior with the contents of the casing.

5. A pump comprising a casing having a central inlet, a peripheral outlet and a constantly opened auxiliary inlet connected to said outlet, an impeller having blades in said casing, said inlet being subject to the centrifugal force of the liquid in the pump to render it less effective when the pump is filled with liquid than when it is only partly filled with liquid, most of the area inside said blades being axially open.

6. A pump comprising a casing having a central suction inlet for liquid, a runner lying in a vertical plane, a peripheral outlet at

substantially the highest point in the casing, and means for introducing liquid peripherally into the casing when the pump is only partly filled with liquid.

7. A pump comprising a casing having an interior peripheral circular channel and having a tangential outlet opening into said channel, an impeller having a peripheral member closely fitting within said channel, said peripheral member defining pockets opened at both ends radially with respect to the axis of the impeller.

8. A pump comprising a circular interior channel having a tangential discharge port, an impeller having a peripheral member closely fitting within said channel, said peripheral member comprising a ring having pockets at each side thereof, defined, in part, by the side of the channel, said pockets being open radially at both ends.

9. In a centrifugal pump, a closed casing having an inlet, a peripheral outlet and an auxiliary inlet opening peripherally into the casing, said auxiliary inlet being constantly open and subjected to the internal pressure of the casing.

10. In a centrifugal pump, a closed casing having an inlet, a peripheral outlet and an auxiliary inlet opening peripherally into the casing, said auxiliary inlet being connected with the outlet.

11. In a centrifugal pump, having a closed casing, a horizontal impeller shaft in the casing, an intake, a peripheral discharge opening arranged near the top of the casing and a constantly open auxiliary connection entering the casing near the discharge opening and on the posterior side of the same with relation to the direction of rotation of the impeller shaft.

12. In a centrifugal pump, having a casing, an impeller lying in a vertical plane in the casing, an intake, a tangential discharge opening and an auxiliary inlet connection opening substantially radially into said casing.

13. As an article of manufacture, a pump runner including a centrally disposed spider, said spider having a plurality of radial arms, a circular element mounted on the arms of the spider, and a plurality of blades formed on said element and projecting radially beyond the element, most of the area inside said element being axially open.

14. As an article of manufacture, a pump runner including an open and centrally disposed spider, said spider comprising a central hub and a plurality of arms projecting radially therefrom, a shaft adapted to be associated with one side of the said hub, a ring mounted on the ends of the arms of the spider, and transversely disposed blades formed on the said ring, said blades projecting from a side of the ring and projecting radially beyond the ring, most of the area inside of the said ring being axially opened.

15. In combination, a pump runner including a spider, said spider having a plurality of radial arms, a ring mounted on the arms of the said spider, transversely disposed blades on the said ring projecting laterally on both sides and radially from the ring, and a casing closely fitting said blades, said casing having a generally central inlet and a peripheral outlet, most of the area inside said ring being axially opened.

16. In combination, a pump runner having a series of transverse vanes or blades forming pockets at the periphery thereof, spider arms supporting said blades and leaving an axially continuous open central space, a casing closely fitting said blades or vanes, and having a flared central inlet communicating freely with the pockets formed by the blades or vanes.

17. A pump casing, comprising two halves divided along a vertical plane, one half having an opening for permitting the entry of an impeller shaft, the other half having an opening in the central portion thereof serving as an inlet for liquid, a cylindrical channel or race-way within the casing, a runner or impeller mounted in said race-way or channel, a discharge connection at the top of the casing, said casing having a substantially tangential outlet connection formed partly in each half, an auxiliary inlet connection formed partly in each half of the pump casing, said inlet connection opening substantially radially into said channel, at a point adjacent the discharge or outlet connection, posterior to said discharge or outlet connection.

18. A pump casing, comprising two halves divided along a vertical plane, one half having an opening for permitting the entry of an impeller shaft, the other half having an opening in the central portion thereof, serving as an inlet for liquid, a cylindrical channel or race-way within the casing, a runner or impeller mounted in said race-way or channel, a discharge connection at the top of the casing, said casing having a substantially tangential outlet connection formed partly in each half, an auxiliary inlet connection formed partly in each half of the pump casing, said inlet connection formed partly in each half of the pump casing, said inlet connection opening substantially radially into said channel, at a point adjacent the discharge or outlet connection, posterior to said discharge or outlet connection and a discharge connection having an enlargement extending upwardly above the the pump, said outlet connection having communication with the auxiliary inlet connection.

19. A pump casing, comprising two halves

divided along a vertical plane, one half having an opening for permitting the entry of an impeller shaft, the other half having a central opening, serving as an inlet for liquid, a cylindrical channel or race-way within the casing, a runner or impeller mounted in said race-way or channel, a discharge connection at the top of the casing, said casing having a substantially tangential outlet connection formed partly in each half, an auxiliary inlet connection formed partly in each half of the pump casing, said inlet connection opening substantially radially into said channel, at a point adjacent the discharge or outlet connection, posterior to said discharge or outlet connection, and a trap in the main inlet connection for the pump, said trap having a portion extending above the said main inlet connection.

20. In a pump of the class described, a casing having an internal peripheral channel, a tangential outlet communicating with said channel, a runner in said channel, said runner having transverse fins extending laterally and radially, said fins fitting closely within said channel, and forming therewith U-shaped pockets, and an inlet connection at its central portion communicating freely with both legs of the U of each U-shaped pocket.

21. The method of pumping a compressible fluid which consists in mixing it with a liquid in an impeller chamber, throwing the mixture forcibly outward, permitting the fluid and liquid to separate from each other, and guiding the liquid back peripherally into the impeller chamber.

22. The method of pumping a compressible fluid which consists in mixing it with a liquid in an impeller chamber, throwing it with a velocity into a separating chamber, generating pressure in said chamber by the arrest of the velocity of injection, and utilizing both the force of gravity and the excess of the separating chamber pressure over intake pressure to return the separated liquid peripherally into the impeller chamber.

23. In combination, an impeller and housing therefor shaped to agitate and mix liquid and gas, a separating chamber above said housing, a delivery conduit to deliver mixed liquid and gas at high velocity into said chamber, and a return conduit connected to the periphery of the housing to return liquid separated in said chamber directly to the housing under the combined forces of gravity and the pressure developed in said chamber.

24. The method of pumping a compressible fluid which consists in mixing it with the liquid in an impeller chamber throwing the mixture with velocity into a separating chamber, separating the compressible fluid by change in direction of the flow of the mixture, and returning the separated liquid peripherally into the impeller chamber by the difference in pressure between said separating chamber and the impeller chamber.

25. The method of compressing a gas which consists in mixing it with a liquid in an impeller chamber and simultaneously throwing the mixture into a separating chamber, permitting the gas and liquid to separate, and returning the liquid from the separating chamber peripherally into the impeller chamber.

26. In a centrifugal pump, a closed pump casing having a suction inlet, a peripheral outlet, and a constantly open auxiliary inlet leading peripherally into said casing, said inlet being externally connected to the discharge outlet.

27. In a centrifugal pump, a closed casing having a suction inlet, a peripheral discharge passageway, an axial inlet passageway, and an auxiliary passageway opening peripherally into the casing, said auxiliary passageway being supplied with liquid externally of the pump casing, and subjected at its inner end to the pressure prevailing in the peripheral part of the pump casing posterior to the aforesaid discharge passageway.

28. In a centrifugal pump, an impeller, a closed casing having a suction inlet, a pair of peripheral outlet passageways through which liquid is discharged in normal operation, one posterior to the other with respect to the rotation of the impeller, a separator, said outlets being connected to said separator externally of the casing, the posterior outlet serving as an auxiliary inlet when the liquid driven by the impeller is insufficient to fill both outlets.

29. As an article of manufacture, a priming chamber for a self priming pump comprising a casing having an inlet in the lower part thereof with means about the inlet for connecting said casing directly to the pump body, an outlet from the top of the casing adapted to be connected to the liquid discharge pipe, and an auxiliary outlet passageway from the interior of the casing adapted to return liquid from the casing to the periphery of the pump, said inlet and said auxiliary outlet being separated and so disposed in the lower part of the chamber as to permit gases to separate out of the liquid entering the chamber and liquid to discharge from said auxiliary outlet.

30. As an article of manufacture, a separating chamber for a self priming pump comprising a flanged inlet in the lower part of the chamber, a flanged outlet in the top of the chamber adapted to discharge gas and liquid, an auxiliary outlet in the lower part of the chamber for discharging liquid only, the inlet and auxiliary outlet being spaced from each other.

31. The method of operating a centrif-

ugal pump having a casing and an impeller to cause it to evacuate its suction pipe, which comprises trapping a body of water in the casing in contact with the impeller, whirling the impeller to mix the liquid with the air in the casing, drawing the mixture out of the casing of the pump into a closed separating chamber, developing pressure in said chamber, separating the liquid from the air in said chamber, returning the liquid peripherally into the casing, and stopping the flow of liquid from the separating chamber when the air is substantially exhausted, by the increasing peripheral pressure of the solid liquid.

32. The method of operating a pump of the class described having a casing and an impeller to cause it to pick up its own liquid load, which comprises rotating the impeller, mixing liquid with the air in the casing of the pump by rotation of the impeller, moving the mixture along the periphery of the casing, throwing out a stream of the mixture by centrifugal force at a suitable discharge point, separating the liquid and gas under discharge pressure, returning a part of the liquid into the periphery of the casing posterior to the point of discharge and stopping the re-entry of said liquid into the casing by the increased centrifugal force developed by liquid free of gas.

33. In a pump of the class described, the combination of a casing comprising a peripheral channel, an impeller having pockets for air and water running in said channel, said casing being adapted to retain a priming charge of liquid, a peripheral port for liquid and air having a throat adapted to be substantially filled by the discharge from the impeller while the pump is operating to draw air, and an additional peripheral port adapted to conduct liquid from the separator back into the channel during the pumping of air, and to serve as a discharge port for liquid when the pump is pumping liquid.

34. In combination, in a pump, a casing having a lateral inlet and a peripheral discharge outlet, a channel in said casing, an impeller having buckets running in said channel, said buckets opening radially at both ends, said peripheral discharge outlet being restricted in size to be substantially filled with the discharge of air and liquid from the buckets when the pump is pumping air only, and a peripheral passageway forming a secondary discharge outlet for liquid when the pump is pumping liquid.

35. A pump comprising in combination, a casing adapted to contain liquid, said casing having a lateral inlet and a peripheral discharge outlet, an annular channel in said casing, an impeller having buckets running in said channel, said buckets opening radially at both ends, said peripheral discharge outlet being restricted in size to be substantially filled with the discharge of air and liquid from the buckets when the pump is pumping air only, said casing having a peripheral passageway forming a secondary discharge outlet for liquid when the pump is pumping liquid, and a separating chamber connecting the outer ends of both of said discharge passageways.

36. In combination, a pump casing having a lateral inlet for air and liquid, an annular channel, an impeller having vanes running in said channel, said casing having two passageways communicating with the channel, one of said passageways being restricted to a size to be substantially filled with the discharge of air and liquid when the pump is drawing air, and a separating chamber joining the outer ends of both passageways.

37. In combination, a pump casing having a channel, a suction inlet for liquid, a pump impeller having vanes running in said channel, a plurality of passageways leading peripherally out from said channel and impeller, and a separator having means for causing the liquid to pass out from the one passageway and describe a return circuit and pass into the channel through the other passageway when the pump is drawing air.

38. In combination, a pump comprising a casing having an annular channel, a suction inlet for liquid, an impeller having vanes running in said channel, a pair of passageways extending from the channel, one of said passageways comprising a discharge passageway and the other comprising a return passageway, a separator extending above the impeller, said separator having means for directing the liquid and air discharged out of the discharge passageway to describe a loop within the separator for freeing air therein, the return passageway being of a cross section smaller than the discharge passageway to insure the return of solid liquid to the impeller.

39. The method of priming a centrifugal pump which comprises taking out through a discharge orifice a mixture of gas and liquid substantially filling said orifice, checking the velocity of the mixture so discharged and separating the gas from the liquid, returning the liquid to said impeller substantially free of the gas, to be again entrained with gas within the pump for discharge out of said discharge orifice.

40. The method of operating a centrifugal pump to cause it to evacuate the air from its suction pipe and draw liquid, which comprises throwing a mixture of air and liquid out of the discharge orifice, checking the velocity of the mixture, separating the gas from the liquid, and returning the liquid to the impeller to be mixed with gas within the pump and discharged out of the discharge orifice until the suction pipe is evacuated.

41. The method of operating a centrifugal

pump to cause it to evaporate the air from its suction pipe and draw liquid, which comprises throwing a mixture of air and liquid out of the discharge orifice, checking the velocity of the mixture, separating the gas form the liquid, and returning the liquid to the impeller to be mixed with gas in the pump and discharged out of the discharge orifice until the suction pipe is evacuated, and then throwing the excess of liquid which is carried by the impeller out of the passage which previously served as the return passage for liquid.

In witness whereof, I hereunto subscribe my name this 2nd day of March, 1922.

HARRY E. LA BOUR.