Oct. 29, 1935. H. E. LA BOUR 2,019,143

CENTRIFUGAL PUMP

Original Filed Nov. 21, 1924 2 Sheets-Sheet 1

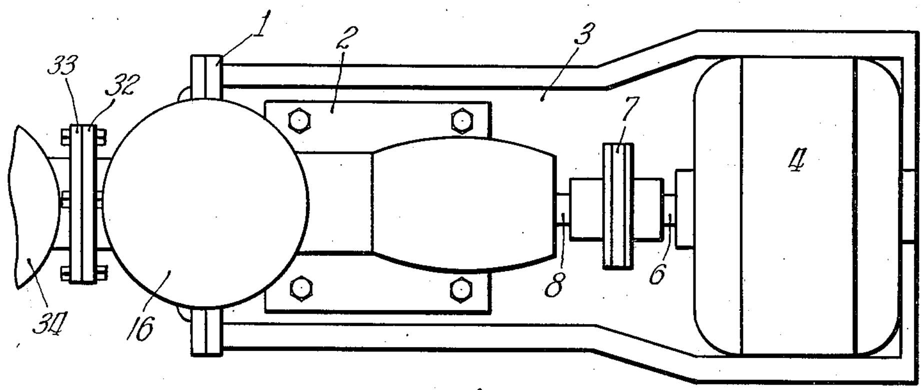

Fig. 1.

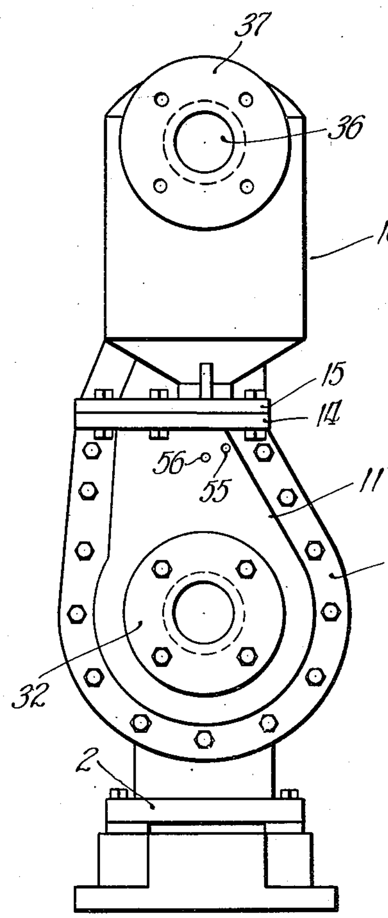

Fig. 2.

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Fig. 3.

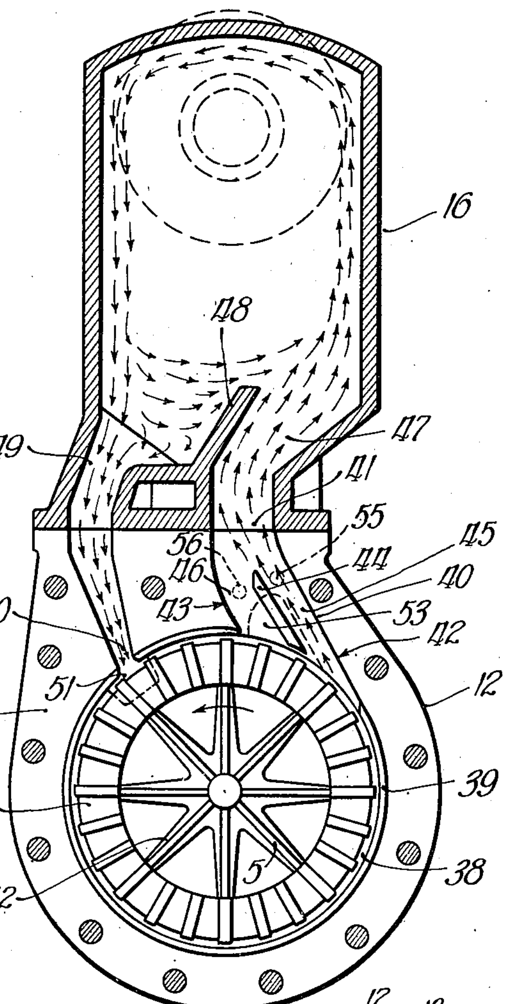
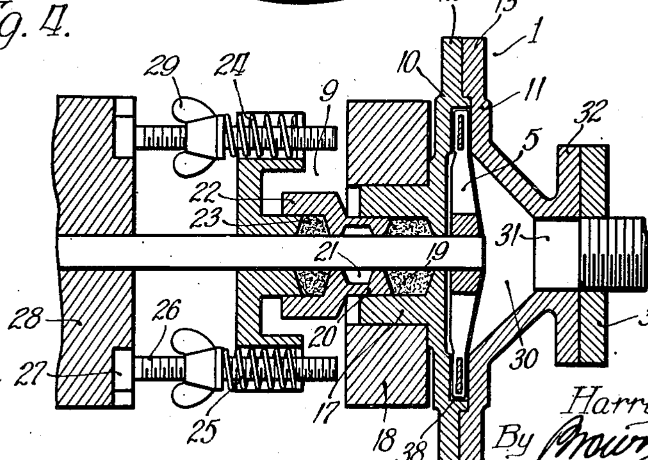


Fig. 4.



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UNITED STATES PATENT OFFICE

2,019,143

CENTRIFUGAL PUMP

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Original applications February 23, 1924, Serial No. 694,526, and November 21, 1924, Serial No. 751,210. Divided and this application February 3, 1928, Serial No. 251,489

17 Claims. (Cl. 103—113)

My invention relates to pumps, and more particularly to self priming centrifugal pumps of the type disclosed in my prior Patent No. 1,578,236, of March 23, 1926. The present application is divisional of my co-pending Patent No. 1,674,115 of June 19, 1928 and co-pending application No. 751,210 filed November 21, 1924.

In the operation of pumps constructed specifically as shown in said prior patent, I have observed that during the priming stage and upon a relatively high vacuum, there is a tendency for the mixture of gas and liquid in the throat to set up a surging action which delays the evacuation of the suction line and in some cases limits the rate of gas pumping or limits the degree of suction obtainable to a value below what I conceive should be proper for the pump.

I have inserted a glass window at the discharge passageway of the pump and studied the action of the pump. During the priming stage the runner does not receive a full charge of liquid as the flow thereinto is restricted by the size of the return passageway from the separator. The impeller throws a stream of liquid at high velocity substantially tangential of the impeller out through the mouth of the discharge passageway. This stream does not fill the mouth of the discharge passageway but permits air or air-charged liquid to pass up on the side of the discharge passageway which is posterior in the direction of rotation of the impeller. As observed through the glass window there appears to be a standing cone shaped pocket converging upwardly towards the throat or restricting part of the passageway. This pocket appears to be relatively unstable and from my observation I conceive that the following action takes place.

The outgoing stream of solid liquid on the anterior side of the mouth is traveling at high velocity substantially tangential of the wheel. As its velocity is high, it lacks pressure at right angles to its line of travel. The pocket of air tends to move over into the side of the stream of liquid and tends to interfere with the flow. As the pocket moves over an eddy appears to be set up back of the pocket and liquid re-enters the impeller on the posterior side of the mouth of the passageway. Then sometimes the air pocket sufficiently interferes with the stream of solid liquid to cause the same to lose its impact pressure in the throat and a surge of liquid or air and liquid slumps back toward the impeller.

The present invention stabilizes the action of the pump during the priming stage and prevents such surging. As a result the pump has greater air pumping capacity both in point of volume of free air discharge and also in point of increase in vacuum without interfering with the ability of the pump to handle liquids efficiently on the succeeding stage of pumping straight liquid.

The means by which I have accomplished this result and the principles upon which the same operates will now be described by reference to the specific embodiment herein illustrated and described in the following specification which will teach those skilled in the art how to construct and practice my invention.

In the drawings:

Fig. 1 is a plan view of a pump and driving motor embodying my invention;

Fig. 2 is an end view of the pump with the inlet trap and discharge pipe removed;

Fig. 3 is a vertical section transverse to the axis of the driving shaft and

Fig. 4 is a horizontal cross section taken on the plane of the driving shaft, illustrating the packing gland for the pump.

As shown in Figs. 1 and 2, the pump 1 is mounted by a pedestal bracket 2 on a base 3 which base also supports the motor 4 which is direct connected to the impeller 5 of the pump 1. The motor shaft 6 is connected through a suitable coupling 7 to the impeller shaft 8, which impeller shaft 8 extends through a packing gland 9 into the casing of the pump.

The casing of the pump is made in two parts, a back section 10 and a front or cover section 11 held together by the clamping flanges 12 and 13 and these sections 10 and 11 bear at their upper ends portions of a clamping flange 14 cooperating with a companion flange 15 formed on the lower part of the separator 16.

The rear or main section 10 has a rearwardly extending boss 17, which is mounted in a collar 18 forming a part of a bracket 2. Said boss 17 on the rear section 10 of the pump contains an axial recess for receiving fibrous or other packing 19 held in place by a gland member 20 said gland member having a hollow central portion 21 for receiving a lubricant and having an enlarged and recessed portion 22 which in turn receives a fibrous or other packing 23 and is held in place by a gland follower 24 having a pair of cross arms, the outer ends of which are slotted to receive the compression springs 25 on the gland bolts 26. The gland bolts 26 have non-circular heads 27 disposed in recesses in a part of the bracket frame 2 shown at 28 in Fig. 4. Suitable thumb nuts 29 on the threaded bolts 26 are provided for compressing the springs 25.

The cover or front portion of the pump casing has a conical inlet 30 provided with an inlet opening 31 about which is formed a clamping flange 32 to receive a companion clamping flange 33 for connecting to the intake trap and screen indicated at 34 in Fig. 1.

Such inlet trap and screen are fully disclosed in my prior patent and need not be explained in detail here. The separator 16 has a discharge passageway 36 surrounded by clamping flange 37 for connection to the discharge pipe.

The casing of the pump 1 has a peripheral channel in which the impeller 5 runs quite closely. Said channel 38 embraces the buckets formed on the rim of the impeller 5. The outer periphery and one side of the channel are formed in the main casing portion 10 and the other side is formed by the cover or front portion 11. A piloting flange 39 is formed on the main portion 10 to facilitate the application of the cover and to hold the parts in predetermined relation.

The upper part of the casing is extended to provide certain passageways hereinafter mentioned to form communication with the separator 16 and to provide a suitable frame for mounting of said separator 16.

When the pump casing and the separator casing are connected the passageways in the pump casing and the passageways in the separator are connected together to form continuous passageways as will now be described. Referring to Fig. 3, the impeller 5 is rotated in the direction of the arrow located thereupon, namely in a counter clockwise direction. A discharge passageway having its narrowest or throat portion 40 disposed a short distance above its mouth, considering the mouth as the opening of discharge passageway into the channel in the casing of the pump. Said discharge passageway has a relatively large mouth, the anterior wall of the mouth as considered in respect to the direction of rotation of the impeller being substantially tangential to the impeller 5. The posterior wall 43 of the mouth is sloped in the direction of rotation and its lower end might be tangential but the wall curves up to the throat 41 as will be observed in Fig. 3.

Within the mouth of the discharge passageway 40, I provide a vane 44 which is disposed approximately parallel to the wall 42 on the anterior side of the mouth of the discharge passageway 40. This vane 44 reaches down substantially through the channel 38. The vane 44 may be suitably shaped to cause stream line flow although the form I have shown is satisfactory for the purpose. This vane divides the mouth portion of the discharge passageway into two parts, namely, the anterior part 45 and the posterior part 46.

These two parts merge into the throat portion 41 from whence the passageway continues up into the separator 16 and widens out as shown at 47 in said separator to permit decrease of velocity and increase in pressure of the discharged liquid at this point.

A transverse web or vane 48 is provided in the lower portion of the separator 16 to define in part the discharge passageway and to direct the flow of liquid upwardly along the wall of the chamber 16 in such a manner that the air which is entrained in the throat 41 may become disentrained and liquid be returned on the opposite side of the web or wall 48 to pass back through the return passageway 49 which leads back into the channel of the pump casing and into the periphery of the runner 5. This return passageway 49 leads liquid back for the purpose of maintaining a continuous discharge of liquid through the discharge passageway during the priming stage. The lower part of the discharge passageway 49 is restricted as indicated at 50 to limit the return flow, the most restricted part of the passageway being substantially at the periphery of the impeller 5 in order to minimize eddy currents during operation of the pump on straight liquids.

The lateral recess is provided preferably on each side of the impeller as indicated at 51 in dotted lines for the purpose of assisting in introducing liquid returning by way of the return passageway 49 into the buckets of the impeller 5.

The impeller 5 comprises a central spider portion comprising a plurality of separate arms and a continuous ring portion 53 which has U-shaped buckets formed therein along the sides and the periphery of the ring portion 53, that is to say, the buckets are formed on the sides of a relatively thin continuous ring by webs which extend along the sides and periphery of said ring. It will be seen, therefore, that these buckets are open at their inner end so that liquid or gas can discharge through the bucket.

As explained in my aforesaid co-pending application, Pitot tubes facing toward the impeller or counter to the normal flow may be disposed in the two portions of the discharge passageway on opposite sides of the vane 44.

I am aware that it is old in centrifugal pump to provide one or more vanes for stratifying the flow of liquid but such pumps of the prior art have always operated solely on liquid and have not been intended to operate nor capable of operating as self priming pump.

Furthermore, I wish to call attention to the fact that the liquid which passes through the anterior portion of the discharge passageway, that is on the right hand side of the vane 44, as viewed in Fig. 3, passes completely across the throat of the discharge passageway so as to fill the same completely and the bend which is formed in the discharge passageway sponsors this action. This construction forms, in effect, an ejector. The stream of liquid and gas on the right-hand side of the vane 44 effectively acts upon and entrains gas from the passage 53 on the left-hand side of the vane 44.

The operation of the device is as follows:

As previously explained, I have found that when the pump is operated without the vane 44, there is a tendency for an air pocket to form as indicated within the dotted boundry 53 of Fig. 3. I place the vane 44 in such a position that the air pocket is prevented from engaging the sides of the out flowing stream of solid liquid along the tangential wall 42 of the discharge passageway. The vane 44 also extends to a point above the uppermost tip of the cone 53 and this vane directs the flow of solid liquid in the branch passageway 45 over against the opposite wall of the passageway at and above the bottom of the throat portion 41 so as to diminish the tendency to form an eddy or swirl which would cause the re-entry of liquid on the posterior side of the passageway and also to assist the entraining or wiping action of the flow of liquid upon the air which may be contained in the posterior branch 46.

The space immediately above the vane 44 forms an ejector chamber with the high velocity inlet

45, the eduction passageway 46, and the outlet passageway 47. The high velocity stream of mixture of liquid and entrained gas under pressure which flows through passageway 45 during the priming operation is peculiarly effective in an ejector. The release of the pressure on the entrained air causes it to expand and break up the liquid, whereby the stream of mixture is expanded to the full cross section of the outlet of the ejector chamber. The eductive and ejecting action is thereby greatly enhanced. The expansive force of the entrained gas with the inertia of the liquid particles which are separated by the expansion of the gas produces a far greater effect than either gas or liquid alone.

When the pump is started sufficient liquid is maintained in the intake trap and in the pump casing and, if desired, in a part of the separator 16, to form the working charge for evacuating the suction line.

As soon as the impeller 5 is brought to speed, liquid is discharged through the discharge passageway and into the separator and the return flow through the return passageway 49 occurs at a predetermined rate to partially fill the buckets or pockets on the impeller 5. The rate of return flow is not sufficient to completely fill these buckets with solid liquid. Said liquid, however, is churned up with air in the pump casing and the liquid with entrained air is thrown out along the substantially tangent wall 42 in the anterior branch 45 tending substantially to fill said passageway 45, the return flow being so proportioned that this result will be secured. The liquid with entrained air is discharged from the chamber in the region where its energy content is a maximum. That is to say, the discharge throat 45 is disposed at such a point as to realize discharge at maximum velocity or pressure of the liquid by the action of the runner thereupon. This main discharge of liquid flows through the ejector chamber and educts fluid, i. e., air by way of the passageway 46. The liquid then takes the course shown in the light arrows, passing across the throat 41 and filling the same and then engaging the web or deflector 48 and passing on up into the separator 16.

The liquid may then be caused to travel up along the walls of the separator 16, as shown in the short arrows, or it may be merely thrown up against the top wall and splashed back, but at all events sufficient opportunity and drop in velocity is provided within the capacity of the separator 16 to let the air become disentrained and to escape out the discharge opening 36. Liquid fills the lower part of the separator 16 and then flows back as indicated through the return passageway 49, the throat 50, into the pocket 51 and into the buckets of the impeller 5 where the operation is again repeated.

Where the liquid is driven in the peripheral swirl along the inner walls of the separating chamber, as indicated by the short arrows in Figure 3, there is a centrifugal stratifying or separating action which assists in the rapid separation of air from the liquid, the air escaping by way of the discharge outlet 36.

It will be observed that the posterior branch 46, of the discharge passageway is substantially clear of liquid, since there is not sufficient liquid in addition to that discharged through the anterior branch 45 to fill the posterior branch 46. As a result, the stream of liquid in the anterior branch 45, moving with high velocity and at a relatively small angle to the wall 43 of the discharge throat 41, tends to entrain air and carry the same up into the separator up to a point where the velocity of the liquid is transformed into pressure and the return of air and liquid is prevented.

When the evacuation has been carried to a point where the suction line is filled with solid liquid, a greater amount of liquid will be discharged by the impeller through the mouth of the discharge passageway and then the two branches 45 and 46 provide the necessary capacity for handling the discharge of the pump. It will be observed then that the high velocity branch 45 instead of entraining air assists merely in the discharge of liquid along the branch 46.

Also the pressure of liquid thrown outwardly by the impeller 5, is sufficient at the reentry pocket 51 and throat 50 to prevent the return of liquid into the impeller from the separator 16. The degree of pressure obtainable on the throat 50 is determined by a number of factors, some of which are the remoteness of said return passageway opening from the discharge passageway; the angularity of the return passageway opening with respect to the periphery of the impeller, the diameter of the impeller and the like.

As explained in the earlier of said co-pending application, Pitot tubes 55 and 56 may be disposed in the two branches 45 and 46 facing toward the impeller where it is desired to have means to ascertain the gas ratio upon which the pump is operating. As explained in said prior application, the admission of air or liquid or both into the pump may be controlled by means responsive to the pressure discovered by said Pitot tubes.

I do not intend to be limited to the precise details shown or described herein.

I claim:—

1. A self priming pump having a casing, an impeller therein, a separator, two adjacent substantially tangent discharge passageways extending from the interior of the casing and merging into a discharge throat communicating with the separator, a vane separating said passageways and directing the flow of one of them across the throat to fill the cross-section of the same.

2. A self priming pump having a casing, a runner therein, a curved discharge passageway, having one wall substantially tangent to the runner and a vane substantially parallel to said one wall for directing liquid from the periphery of the impeller across the full cross-section of the discharge passageway.

3. A self priming pump having a casing, a runner therein, a gas and liquid separator, a return passage from the separator to the casing, a discharge connection between the separator and the periphery of the casing and having a relatively large mouth opening into the periphery of the casing, a vane in said mouth defining an anterior substantially tangent branch and a posterior branch, said discharge passageway having a throat beyond said vane and the passageway being curved beyond the throat, the liquid in the anterior branch being directed across the throat of the passageway.

4. A pump for pumping gas and liquid comprising a casing, an impeller therein, a discharge passageway lying substantially in the plane of the impeller, said passageway having a relatively enlarged portion opening into the periphery of the casing, a constricted throat portion beyond said enlarged portion, the anterior wall of

the enlarged portion below the throat being substantially tangent to the impeller and being disposed at an acute angle to said throat, and a vane in the enlarged portion substantially parallel to said tangent wall.

5. A pump for pumping gas and liquid comprising a casing having a channel, a runner in said channel, a separator for separating gas and liquid, a return passageway for liquid from the separator into the casing, a substantially tangential liquid discharge passageway and an adjacent gas discharge passageway leading into said liquid discharge passageway at an acute angle, said passageways both leading from the periphery of the channel and the gas passageway being posterior in the direction of rotation of the impeller with respect to the liquid discharge passageway.

6. A pump for pumping gas and liquid comprising a casing having a channel, a runner in said channel, said runner having radially extending buckets, a substantially tangential liquid discharge passageway and an adjacent gas discharge passageway leading into said liquid discharge passageway at an acute angle, said passageways both leading from the periphery of the channel and the gas passageway being posterior in respect to the direction of rotation of the impeller to the liquid discharge passageway.

7. An air ejecting centrifugal pump comprising a casing having a peripheral channel, a runner in said channel, said runner having buckets open at both ends radially, a tangential liquid discharge passageway and a gas discharge passageway intersecting each other and merging at a small angle, said passageways opening into said channel at their inner ends.

8. In a self priming centrifugal pump, the combination of a pump casing, a runner mounted therein and adapted to be rotated about a horizontal axis, a throat leading upward tangentially of said casing, said throat carrying the mixture of gas and liquid discharged by said runner during the priming period of the pump, a separator, means connecting said throat tangentially into said separator, said separator bending the stream of mixture in an arcuate path about an axis parallel to the axis of the runner to stratify it and bring a stratum of solid liquid above a stratum of mixture, a lateral port through which the gas in said mixture stratum is permitted to escape, and a return passage leading from said separator into said casing substantially radially of said runner.

9. In a self priming centrifugal pump, the combination of a pump casing, a runner mounted therein and adapted to be rotated about a horizontal axis, a throat leading upward tangentially of said casing, said throat carrying the mixture of gas and liquid discharged by said runner during the priming period of the pump, a separator communicating with said throat, said separator having means for bending the stream of mixture in an arcuate path about an axis parallel to the axis of the runner to stratify it and bring a stratum of solid liquid above a stratum of mixture, there being a lateral port leading out of the side of said separator through which the gas in said mixture stratum is permitted to escape, and a return passage leading substantially tangentially from said separator into said casing substantially radially of said runner.

10. In a self-priming pump, a casing, a runner in the casing, a substantially tangential discharge passageway leading from the casing, a separator connected to said discharge passageway for separating gas from liqoid during priming, a return passageway for liquid from the separator to the runner, the discharge passageway adjacent the runner being divided into two parts which operate during priming in functionally different manners, said two branches of the passageway merging into a throat portion which operates as an ejector one branch constituting the main outlet throat of the pump and carrying gas charged liquid thrown outwardly by the runner and the other branch carrying gas educted by the gas charged liquid.

11. A self-priming pump comprising a casing, a runner in the casing, a main discharge passageway for the discharge of liquid with entrained gas from the casing, a separator connected to said passageway for separating gas from the liquid, a gas eduction passageway connecting with the inside of the pump casing at its inner end and forming a junction with the main discharge passageway at its outer end, said junction constituting an ejector for causing the liquid discharged by the impeller to entrain and remove gas through said eduction passageway, and a priming passageway for liquid leading from the separator back to the impeller.

12. In a self-priming pump, a casing, a runner therein, a separator chamber having an outlet of smaller cross sectional area than that of the chamber, a tangential passageway leading from the casing to the separator and forming the main discharge passageway for liquid at all times, an ejector formed in said passageway, said ejector comprising a passageway leading from the interior of the casing for the eduction of fluid by the liquid discharged through the main discharge passageway, and a priming passageway from the separator to the interior of the pump casing.

13. In a pump, a casing, a runner therein, the casing having a tangential outlet forming the main discharge throat of the pump, an ejector chamber into which said throat directs the main discharge of the pump, an eduction passageway leading from the interior of the chamber to said ejector chamber, a separator chamber, a discharge passageway leading from the ejector chamber into the separator, and a priming passageway between the separator and the inside of the casing.

14. The method of evacuating gas from the casing of a self-priming pump having an impeller and a main outlet, which comprises mixing gas and liquid by action of the impeller, imparting energy to the mixture, driving the mixture through the main outlet in a high velocity stream, allowing the mixture stream to expand, conducting gas from the casing into contact with said expanding stream of mixture and ejecting said gas by said expanding stream of mixture, separating the gas from the liquid and returning the liquid through an independent path to the inside of the casing where the pressure is substantially less than the pressure of the main outlet.

15. The method of evacuating gas from the casing of a self-priming pump having an impeller and a main outlet, which comprises mixing liquid with gas in the casing by action of the impeller, imparting energy to the mixture to drive it in a stream from the casing with substantially maximum energy content, and causing said discharge stream to entrain gas and withdraw the same from the casing, separating the gas from

the liquid and returning the liquid through an independent path to the inside of the casing where the pressure is substantially less than the pressure of the discharging stream.

16. The method of evacuating the casing of a self-priming pump, which comprises driving a body of liquid in a closed circuit through the casing of the pump, at one point in said circuit charging the liquid with gas in the casing, driving the liquid with contained gas at maximum velocity out of the casing, contacting the mixture while flowing at high velocity with gas from the inside of the casing, causing the contacted gas to be educted from the casing at another point in the circuit, separating the gas from the liquid and through another part of the circuit returning the gas freed liquid into the casing.

17. In a self-priming centrifugal pump, a casing, a main discharge throat leading from the casing, a runner in the casing, a separator, a return passageway from the separator to the casing, an ejector having its inlet connected to the discharge throat, its outlet connected to the separator, and an eduction passageway from the inside of the pump casing to the ejector.

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