

July 8, 1941.

O. JACOBSEN

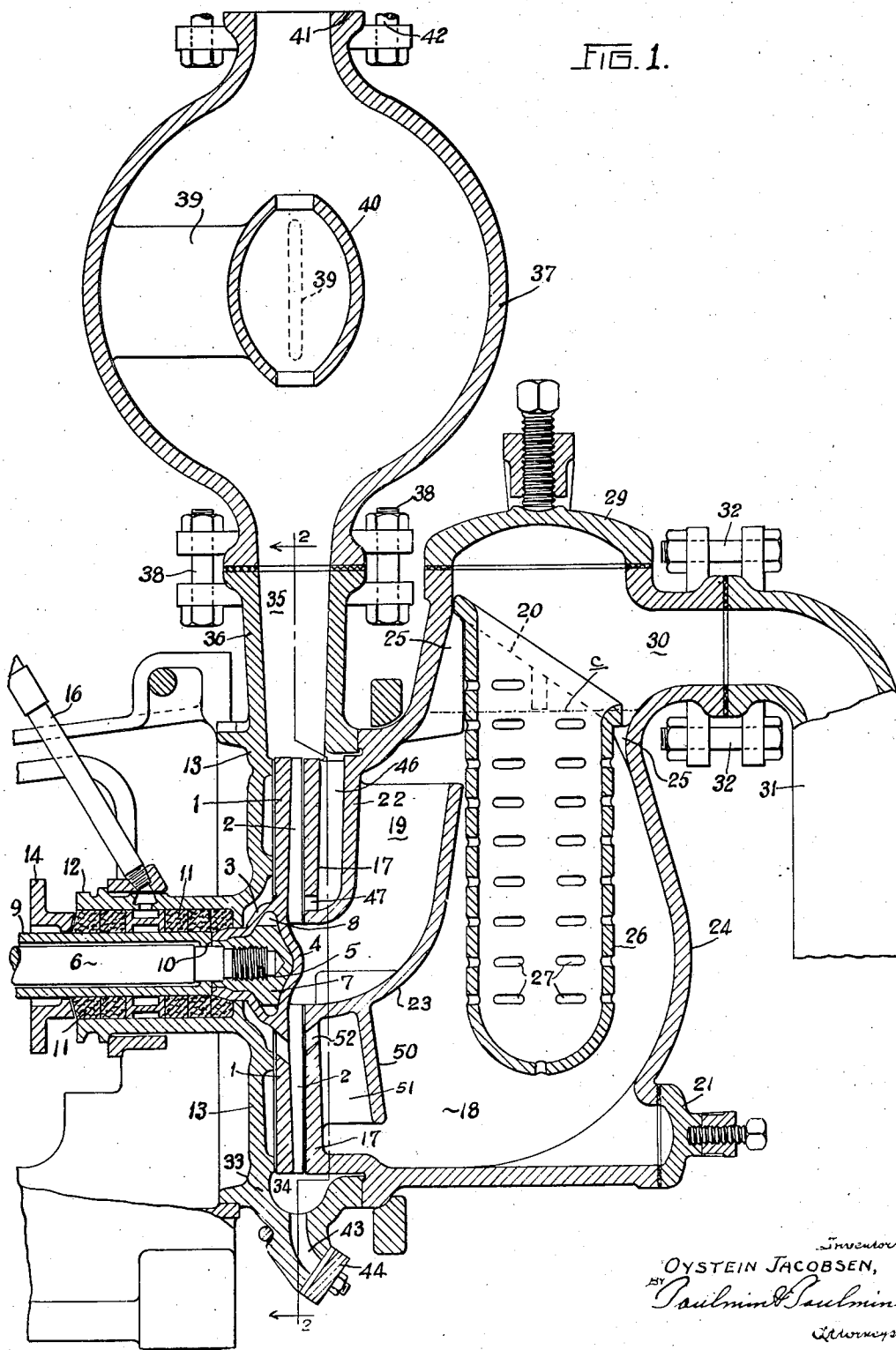
2,248,174

SELF-PRIMING CENTRIFUGAL PUMP

Filed Feb. 23, 1939

2 Sheets-Sheet 1

FIG. 1.



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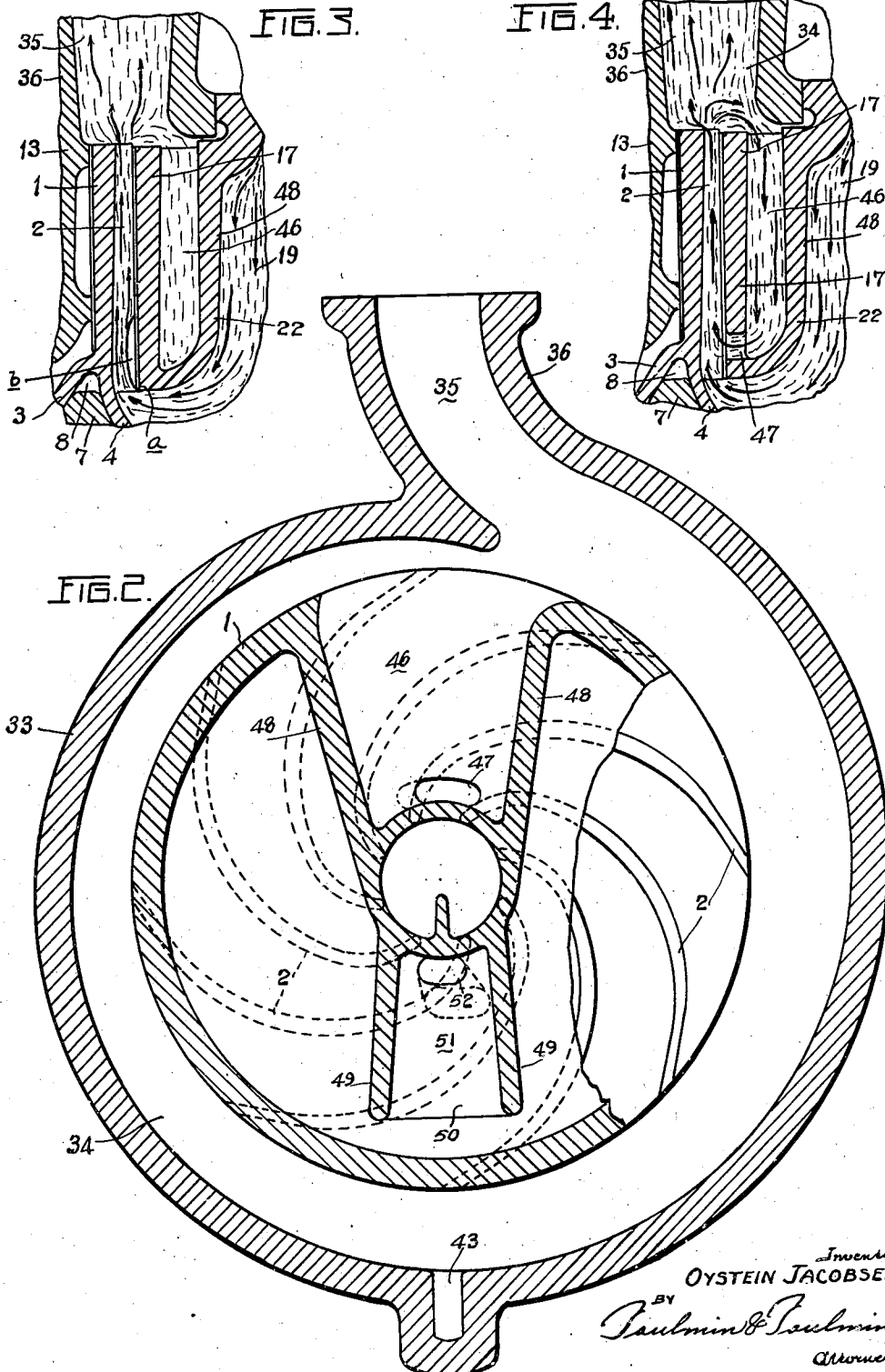
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SELF-PRIMING CENTRIFUGAL PUMP

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5 Claims. (Cl. 103-113)

The present invention relates to self-priming centrifugal pumps and more especially to pumps designed to operate at considerable velocities and adapted to handle acids or water containing acids.

It is somewhat different to prime pumps of the centrifugal type and thus their operation is considerably interfered with in case the head of water is accidentally lost or reduced below a predetermined level, as when leaks occur in the system. Moreover, the fluid passing through the pump travels at an extremely high velocity and, since the direction of the fluid necessarily changes in passing through the pump, zones of contraction appear, which reduces the cross sectional area of the passing fluid which causes a reduction in the output and efficiency of the pump.

The primary object of the invention is to provide a centrifugal pump which operates at a higher efficiency than the pumps of this type on the market.

Another object is to provide a pump of this character in which the degree of self-priming is considerably enhanced.

Still further objects are to provide a centrifugal pump, in which the pumping action is maintained even when leaks appear anywhere in the system; to provide a centrifugal pump having a suction elbow, and in which the fluid is withdrawn from the lower part of the elbow as well as from the upper part thereof. The present day pumps withdraw the water only from the upper part of the elbow.

These objects are attained, in brief, by providing a repeated circulation of the priming liquid in a circuit including the separation chamber to withdraw air from the suction elbow, and introducing this liquid into the impeller at a position where a zone of contraction would normally occur. Thus, this zone is being continually filled with liquid and the cross sectional area of liquid flowing between the vanes of the impeller is correspondingly increased. The object last mentioned above is carried out, in brief, by providing an opening in the impeller casing and causing the fluid to pass over the lower portion of the suction elbow through the opening into the impeller.

The invention will be better understood when reference is made to the following description and the accompanying drawings in which—

Figure 1 shows a view in cross section, except for a few minor parts of the improved pump.

Figure 2 is an enlarged view, taken along line

2-2 in Figure 1 and looking in the direction of the arrows.

Figures 3 and 4 are enlarged cross sectional views of the upper part of the impeller and immediately adjacent parts, useful in explaining the manner in which certain improvements provided by this invention serve to increase the efficiency of the pump. Figure 3 shows the effect obtained without the improvement, while Figure 4 illustrates the enhanced result obtained by the improvement described hereinafter.

Referring to the drawings in detail, numeral 1 designates a heavy disk or plate of an acid-resisting metal such as silicon iron, to which is secured, in any suitable manner, a number of arcuate vanes 2, as seen more clearly in Figure 2. The plate 1 is provided at the center with a cored out hub 3 and a nose portion 4 which form a compartment for receiving the end 5 of the driving shaft 6. The end 5 of the shaft is threaded into a cap 7 of any suitable metal such as bronze, which is machinable and which metal is cast in place. The cored compartment is provided with ribs 8 which extend radially inwardly and the metal 7 is cast about these ribs so as to form a positive lock. The improved locking device is described and claimed in my copending application Ser. No. 257,978, filed February 23, 1939, and entitled "Pump runner assembly."

The shaft 6 is contained within a sleeve 9 which abuts the hub portion 3 and bears against a shoulder on the shaft at 10. A packing 11 is provided about the sleeve 9 and is contained within a housing 12 forming part of the back plate 13 of the pump casing. Longitudinal pressure may be applied to the packing in any suitable manner, for example, by means of a cap member 14 adapted to move longitudinally with respect to the housing 12. The packing is kept saturated with grease from a pipe 16 which leads to an adjustable grease cup (not shown).

Adjacent the free edge of the vanes 2, there is a casting 17 which constitutes the front plate of the pump housing. This casting forms part of a large irregularly shaped casing which provides a number of compartments including the suction elbow indicated at 18, an inlet passage indicated at 19 and a throat indicated at 20. The suction elbow takes the shape of a goose neck and has secured thereto at the bottom a removable cover 21 for cleaning purposes. The inlet passage 19 is formed of a pair of spaced portions 22, 23, respectively and extends from the casing 17, first, axially and then in an upward direction, bearing slightly to the right into the com-

partment formed by the suction elbow. The wall 22 is extended upwardly beyond the wall 23 and then curves to the right so as to form together with the goose neck portion 24 a throat 20, at which position there are provided a pair of lugs 25. These lugs support a heavy metal screen or filter 26 which projects downwardly and in a re-entrant manner into the suction elbow, as can be readily seen in Figure 1. This screen is provided with a number of openings 27 and its purpose is to separate the solid materials from the fluid entering the throat of the suction elbow.

Above the throat 20, the casting terminates in a seat for a gasketed and removable cover 29, the purpose of which will be explained. Beyond this point, the casting draws down to a portion of smaller diameter indicated at 30, to which the inlet pipe 31 can be bolted as at 32 or otherwise secured.

As shown more clearly in Figure 2, the front and back portions 2, 13 of the pump casing terminate at their periphery in a volute shaped casing 33 which contains a chamber 34 of similar shape. This chamber communicates with an outlet passageway or opening 35 formed in an extension of the volute casing and indicated at 36. A gasket seat is provided on the top of the extension 36 to receive an air or separation chamber 37 by means of the bolts 38. This chamber is preferably of spherical configuration and is provided at the center, by means of lugs 39, with the circular partition 40 which serves to cause the fluid to take divided paths through the chamber. A seat 41 is provided at the upper end of the chamber 36 to receive the outgoing pipe which may be secured by the bolts 42.

It will be noted that the lowermost side of the volute chamber 34 communicates with a drain 43 closed by a plug 44.

For operating the pump, the shaft 6 is rotated, which causes the impeller 1 to draw the fluid which collects in the suction elbow 18 through the inlet passage 19, into the eyelet of the pump indicated at 4, the fluid being then forced out centrifugally by the blades 2 into the volute chamber 34 and from thence through the outlet opening 35 into the air chamber 37.

This fluid, of course, travels at an extremely high velocity and changes its direction from the axial to the transverse direction in passing from the lower end of the inlet passage 19 into the passageways between the revolving blades or vanes 2. In passing around the corner indicated at *a* in Figure 3, particularly when traveling at such a high velocity, a zone of contraction shown at *b* in Figure 3 is formed. As the velocity of fluid becomes greater, the length and width of this zone are increased in corresponding degree. Moreover, as can be seen from Figure 1, the lower portion of inlet passageway 19 is of considerably greater size than the small narrow passageways between the vanes 2 of the impeller. It is well known in hydraulics that, when a fluid passes from a pipe of large size to a smaller pipe, zones of contraction occur due to the crowding of the stream directions. These zones represent a space where the air carried by the fluid has collected, the pressure of the air pocket being substantially the same as the pressure of the surrounding fluid. The net result of these zones of contraction is to reduce the cross section of the stream passing by this point and thus greatly to restrict the output of the pump.

In accordance with one of the features of my invention, I propose to eliminate the fluid vol-

ume-reducing effect of the zone of contraction so that the spaces between the vanes 2 are kept full of water at the point where the zone of contraction would normally occur.

As seen more clearly in Figure 4, the improved construction takes the form of an additional conduit or passageway by which fluid which has been pumped into the volute chamber 34 and which might normally flow back along the vanes is caused to be introduced into the passageways between vanes at the zone of contraction and thus to be recirculated through the pump. This backflow of fluid is a well-known effect and it occurs more especially at the top portion of the impeller and is due to gravitational effects on the fluid. These effects, of course, become less as the speed of the pump becomes greater, but in general there is always a certain amount of back-flow which cannot be avoided. The recirculating fluid is introduced to the impeller preferably at the zone of contraction, although proportionally good results may be obtained by introducing the fluid as close as possible to the zone.

For conducting the recirculating fluid to the impeller, I provide a conduit or passageway indicated at 46 (Figure 4), which communicates at the upper end with the volute chamber 34, and thus also the outlet passageway and at its lower end terminates in one or more openings 47 drilled through the casing 17, preferably at the zone of contraction. The passageway 46 is of restricted width and is contained between a pair of walls 48, which are integrally joined at the top to the inner wall of the volute casing 33. The opening 47 is preferably of elongate configuration and extends through the casing 17 in a diagonal direction, depending on the direction of rotation of the vanes 2. Thus, as the vanes are rotated counterclockwise, as seen in Figure 2, the opening extends to the left, as indicated by the dotted lines. As stated hereinbefore, the opening 47 may be positioned anywhere along the depth of the casing 17, as seen in Figure 4, but its preferred position is immediately opposite the zone of contraction indicated at *b* in Figure 3.

A comparison of Figures 3 and 4 will show that whereas, in the absence of an opening in the casing 17, a zone of contraction occurs at the center of the impeller, by providing the opening, fluid is caused to recirculate from the periphery of the impeller through the passageway 46 and the opening 47 to fill the zone of contraction with fluid. This water which is recirculated is usually of no greater amount than normally flows back into the impeller due to gravitational effects. The back-flow of water is thus impelled a second time by the vanes without impeding the flow of fluid which has reached the impeller for the first time.

It will be understood that this back-flow fluid tends to move downwardly through the passageways of those vanes which are in the vertical position for the moment, the velocity of flow and the position attained by this downwardly moving fluid being dependent on the speed of the impeller. The greater the impeller speed the less does the fluid flow backwardly. As the fluid moves downwardly through the vane passageways, and assuming a structure similar to that shown in Figure 3, the fluid will be impeded by the zone of contraction *b*, that is to say, this fluid will flow around the zone *b*, causing greater restriction of the space through which the upwardly flowing water has to move. Thus this back-flow fluid curtails the upward flow of use-

ful fluid at the zone of contraction and to that extent reduces the efficiency of the pump. On the other hand, by providing the opening 47 at the zone of contraction, and by providing a ready path 46 for the back-flow fluid, the latter is directed against the zone of contraction 3, filling this zone and thus taking up no more space at the position of the zone of contraction than if there were no back-flow fluid. In other words, the zone of contraction 3 (Figure 3) is made to accommodate the back-flow fluid by providing the opening 47, and this fluid no longer impedes the upwardly flowing fluid by adding to the zone of contraction. The vane passageways, positioned upwardly from the zone of contraction, are of sufficient area to accommodate the upwardly moving useful stream of water combined with the back-flow water which has been injected into the vane passageways at the opening or openings 47.

Consequently, the capacity and, therefore, the efficiency of the pump is enhanced by the amount of back-flow fluid which can be accommodated at the zone of contraction and which eventually reaches the outlet passageway. To give a concrete example, the zone of contraction in a given pump might easily be such as to represent a 20% impediment to flow. When the zone is completely filled with fluid, which would normally constitute a back-flow, the efficiency of the pump is enhanced approximately by the same amount.

Another important aspect of the fluid which leaves the volute chamber and is recirculated through the pump is the enhancement of the priming ability of the pump. The average level of the fluid in the suction chamber 13 is indicated by the dot-dash line c. Under these conditions, a centrifugal pump of any type will continue to draw water and air from the chamber 13 and thus create a suction by which to draw fluid up through the pipe 31. However, due to leaks anywhere in the system, more especially in the pipe 31 and perhaps at the packing 11, the level of the fluid might abruptly drop from the level c, and in fact to such an extent that the elbow 18 may be entirely devoid of fluid. In such a case, the centrifugal pump of an unimproved design would be unable to create the necessary suction in the elbow. However, the pump disclosed herein would still continue to provide the necessary suction, because the fluid which had already collected in the chamber 37 would not only tend to fill up the suction elbow 18, but in addition would cause a circulating flow of fluid through the passageway 46 and the opening 47 to the impeller 1 and this circulating fluid would be sufficient to induce a heavy suction at the elbow 18, which would, in turn, cause a sufficient drawing effect on the fluid in pipe 31, notwithstanding leaks throughout the system.

Thus, the passageway 46 and opening 47 serve a two-fold purpose, namely, they render the pump self-priming in providing an additional circulatory flow of fluid from the volute and air chambers to the center of the impeller and also in eliminating the flow-impeding effects of the zones of contraction found near the center of the impeller. This elimination being brought about by filling these zones or regions with fluid diverted from the volute chamber or other outlet passageways.

While I have explained the zone of contraction as being a region where there is a scarcity of fluid due to a change in flow and direction, or

change in the size of the flow passageways, it will be understood that this terminology is intended to include a contraction in the size of the stream due to any cause whatsoever, for example, due to local eddies or other turbulences which prevent free flow of the fluid.

In accordance with the second aspect of my invention, I propose to provide a construction including the pump and its suction elbow accessory by which the pump obtains fluid not only from the upper part of the elbow, but from the lower part thereof. Thus, the elbow is being continually scoured by the moving fluid and no part of the latter is permitted to remain stationary in the elbow. For carrying out this feature, I provide in the lower portion of the wall 23 of the inlet passage 19 a pair of partitions 49 indicated on Figure 2, to which is secured a wall portion 50, shown in Figure 1. The fourth side of the passageway 51 is constituted by the lower portion of the casing 17. The members 49 and 50 extend downward from the wall 23, leaving only a small opening between their lower edge and the bottom of the elbow 18. An opening 52 is provided in the casing 17 at the upper end of the passageway 51. As seen more clearly in Figure 2, this opening is directed preferably in a downward direction toward the impeller and is also flared to a larger size as the impeller is approached.

It is apparent that, as the impeller is rotated and assuming that the level of the water is at c, the entrance to the inlet passageway 19 draws fluid from the upper portion of the elbow, whereas the fluid at the lower portion of the elbow finds its way to the impeller through the passageway 51 and the opening 52. This last-mentioned portion of the fluid is that which ordinarily would remain at the bottom of the elbow and little or no movement would be accorded thereto by pumps of unimproved type. It is also apparent that, by providing the opening 52 and the passageway 51 which extends to a position near the bottom of the suction elbow, the pump is capable of drawing water, at least for a limited time, even when the level of the water in the elbow falls below that indicated at c.

When the pump is installed for the first time so that the suction elbow 18 is empty, as is also the air chamber 37, the pump may be conveniently primed by removing the cover 29 and filling the elbow with fluid to the necessary height. However, it will be understood that, after the pump has been initially primed in this manner, no further priming is necessary for the reasons stated hereinbefore.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims and the invention.

Having thus fully described my invention what I claim as new and desire to secure by Letters Patent is:

1. A self-priming fluid pump of the centrifugal type comprising an impeller, vanes secured thereto, said impeller and vanes being adapted to rotate within a casing, an inlet passageway communicating with the inner ends of the passageways between the vanes and extending angularly thereto to leave a relatively sharp edge at the junction between the inlet and vane passageways whereby a zone of contraction is produced in the region of the sharp edge, an outlet passageway leading from the periphery of the impeller through said casing to the exterior of the pump,

and a passageway for priming fluid leading from the periphery of the impeller through the casing adjacent said sharp edge and leading to said zone of contraction.

2. A self-priming fluid pump of the centrifugal type comprising an impeller, radially extending vanes secured thereto, said impeller and vanes being adapted to rotate within a casing, an inlet passageway communicating with the inner ends of the passageways between the vanes and extending angularly thereto, said inlet passageway having a relatively sharp edge where it meets the inner ends of said vanes, an outlet passageway leading from the periphery of the impeller through said casing to the exterior of the pump, and a passageway for priming fluid leading from the periphery of the impeller through said casing to a position closely adjacent the inner ends of the vanes.

3. A self-priming fluid pump of the centrifugal type comprising an impeller, vanes secured thereto, said impeller and vanes being adapted to rotate within a casing, an inlet passageway communicating with the inner ends of the passageways between the vanes and extending angularly thereto whereby a relatively sharp edge appears between the inlet and vane passageways, an outlet passageway leading from the periphery of the impeller through said casing to the exterior of the pump, and a passageway for priming fluid leading from the periphery of the impeller through said casing to a position in one of the vane passageways closely adjacent said sharp edge of the casing.

4. A fluid pump of the centrifugal type having

a casing and comprising an impeller, vanes secured thereto to form passageways, an inlet passageway leading to the center of the impeller, a suction elbow forming part of the inlet passageway and having a portion positioned below the center of the impeller, a passageway extending partially across said suction elbow to leave an opening between the edge of the passageway and the lowermost portion of the elbow, and means including a drainage aperture communicating with the space in the region of the center of the impeller and said passageway for draining fluid from the lowermost portion of the elbow.

5. A fluid pump of the centrifugal type having a casing and comprising an impeller, vanes secured thereto to form passageways, an inlet passageway leading to the center of the impeller, a suction elbow forming part of the inlet passageway and having a wall portion which extends from the casing wall into the elbow intermediate the upper and lower surfaces thereof, a partition extending downwardly from said wall portion to a position short of the lowermost surface of the elbow whereby an opening is left between the edge of the partition and the lower surface of the elbow, said partition extending substantially parallel to the direction of the impeller and forming with the casing wall adjacent said vane passageways a compartment which opens into the suction elbow, and an aperture leading from the space at the center of the impeller to said compartment, said aperture being positioned above the lower surface of said elbow.

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