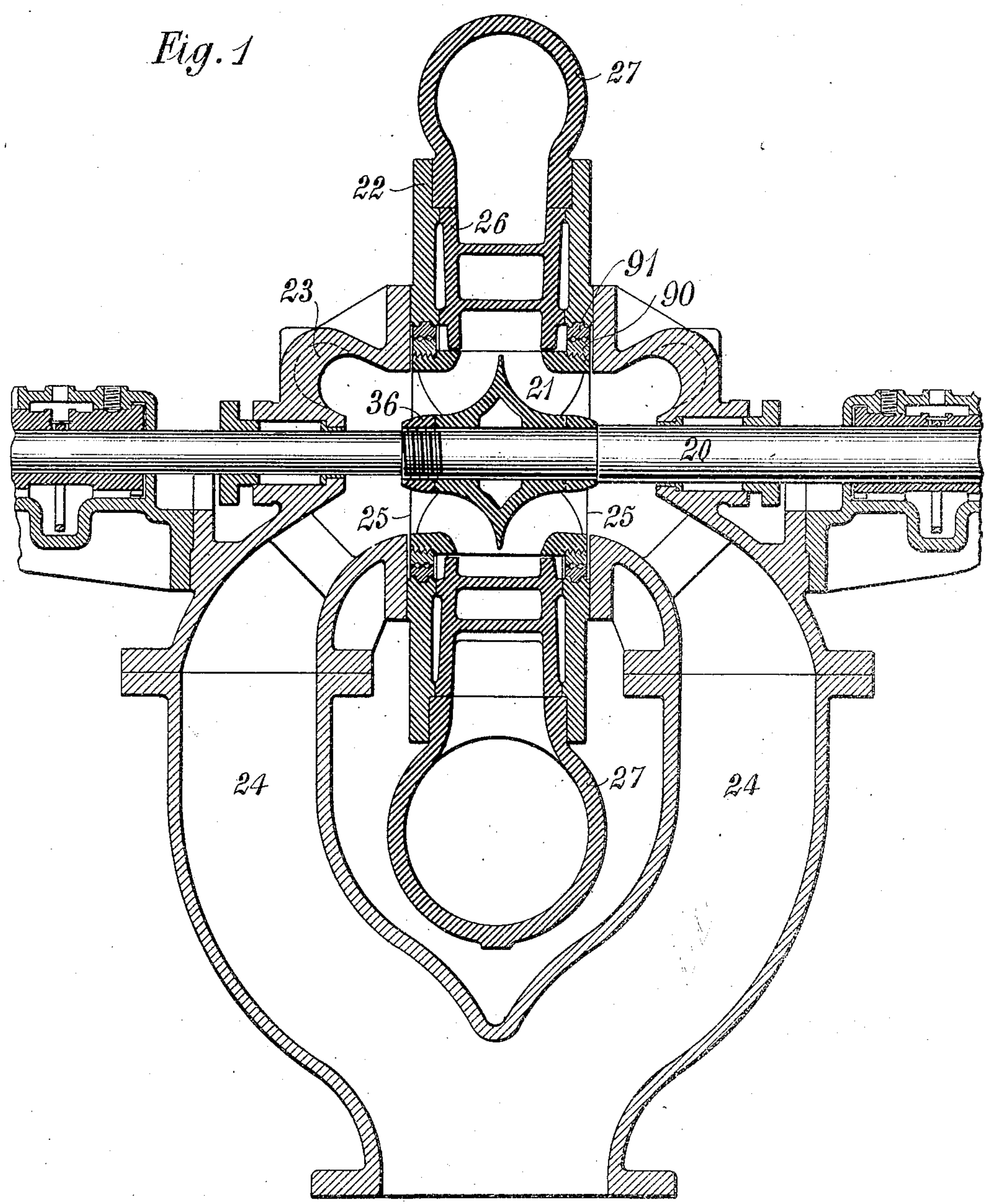
R. O. JONES.
CENTRIFUGAL PUMP.
APPLICATION FILED NOV. 25, 1908.

981,199.

Patented Jan. 10, 1911.

4 SHEETS—SHEET 1.

Fig. 1



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4 SHEETS—SHEET 2.

Fig. 2.

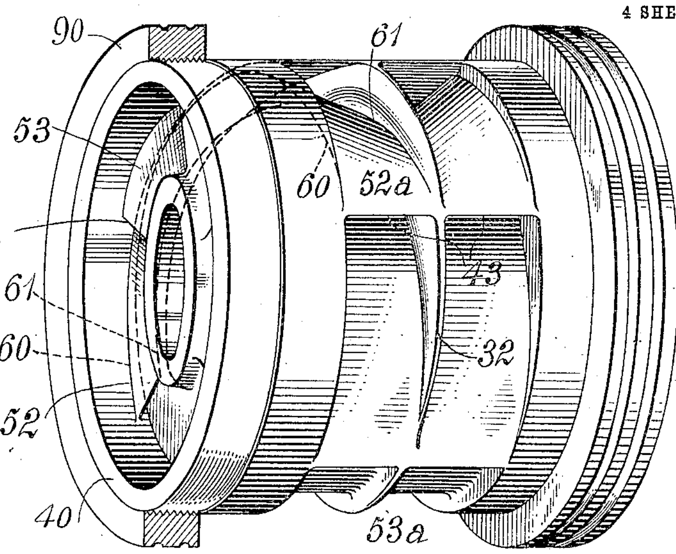
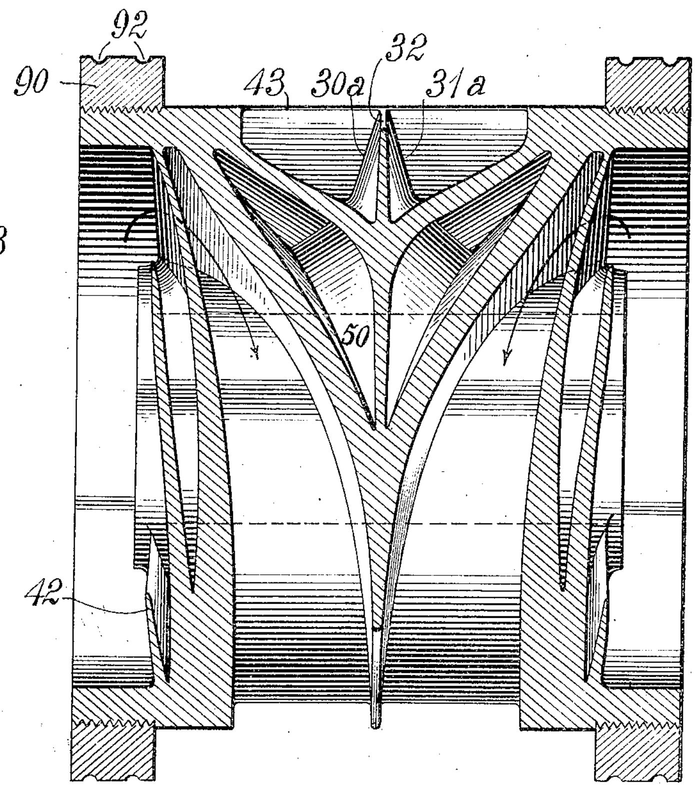


Fig. 3



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4 SHEETS—SHEET 3.

Fig. 4.

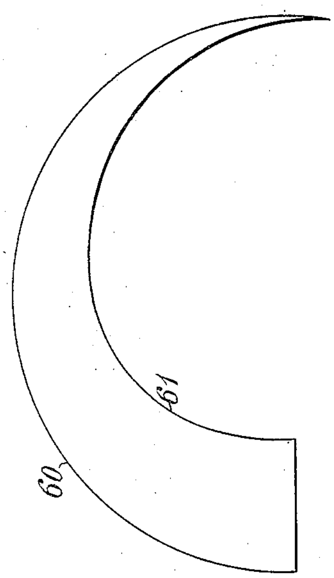
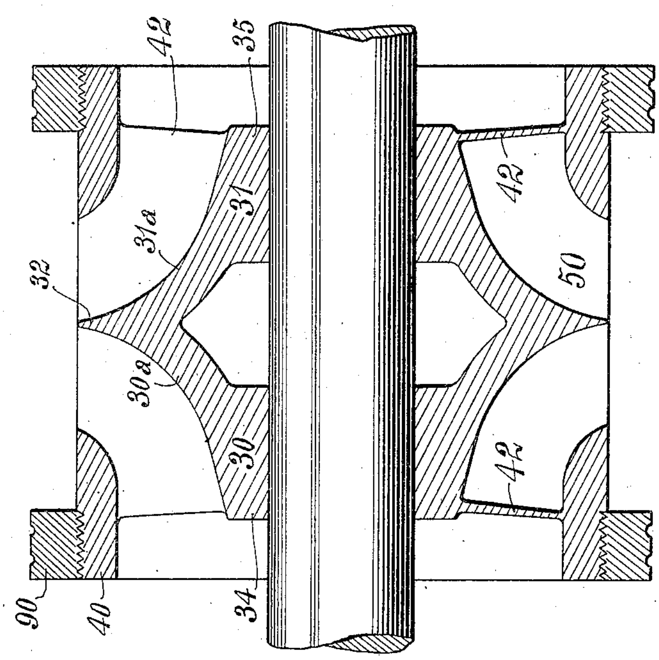


Fig. 5.



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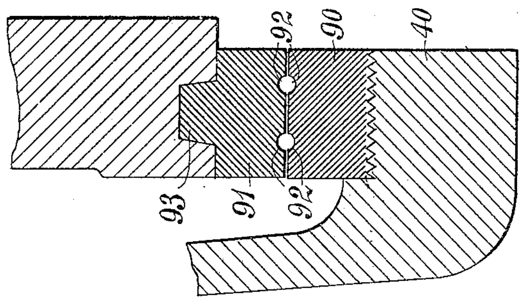
4 SHEETS—SHEET 4.

Fig. 7.



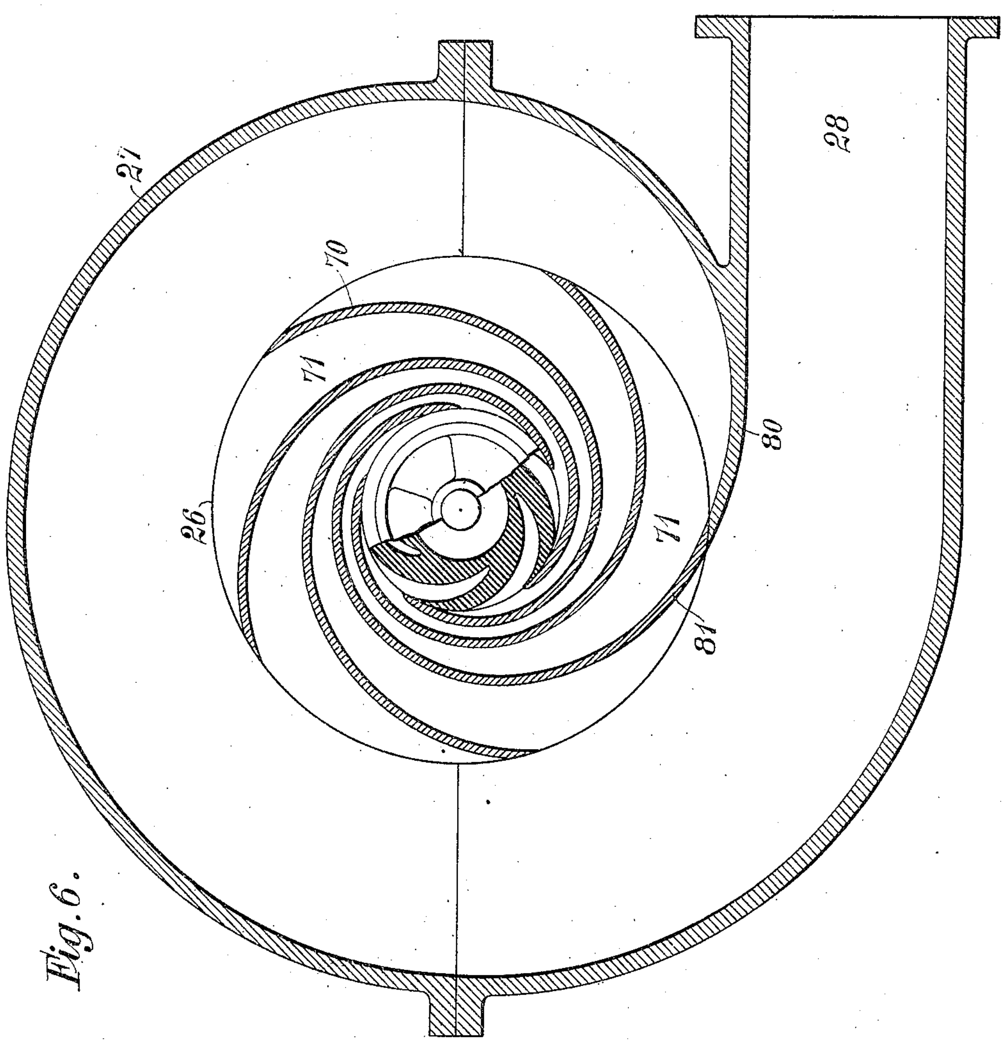


Fig. 6.

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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL PUMP.

981,199. Specification of Letters Patent. Patented Jan. 10, 1911.

Application filed November 25, 1908. Serial No. 464,356.

To all whom it may concern:

Be it known that I, RICHARD O. JONES, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Centrifugal Pumps, of which the following is a full, clear, and exact description.

This invention relates to centrifugal pumps in general, and has for its salient objects to improve the construction of such pumps both as to mode of operation and also as to structural details for the accomplishment of the purposes set forth below.

It is of course well-known that in the early development of centrifugal pumps, the structural design was such that they were limited to low heads and pressures and were of low mechanical efficiency. The progress of invention along this line has been toward attaining high heads and pressures and likewise a high degree of mechanical efficiency. Moreover, in the wide field of use of these pumps, the demands of market have emphasized the importance of simplicity, compactness, reliability and durability of construction, to withstand varieties of speed, rough usage and the various working conditions; also the importance of accessibility for repair or inspection, renewability of parts and the adaptability for a wide range of pumping requirements.

While material progress has been made in inventions designed to accomplish the above objects, yet owing to the rather intricate theory of operation of these pumps, the lack of accurate knowledge and understanding of them, and the inability of inspecting the fluid action and the various phenomena incident to the pump operation, small steps in advance in this art are difficult to effect. Nevertheless these progressive steps may become of great value commercially in attaining one or another of these various objects. And therefore variations in the structural design and in the manner of combination of the various mechanical elements, become of vital importance in inventions designed to secure the fulfilment of these purposes.

It is for the purpose of securing, to the fullest extent possible, the accomplishment of the various objects and desiderata above set forth, that I have devised the present improvements, a preferred form of which is shown in the accompanying drawings forming part of this specification.

Of said drawings, Figure 1 represents a vertical cross-section of the particular style of centrifugal pump to which these improvements are applied; Fig. 2 represents a perspective view of the double closed impeller; Fig. 3 represents a partly sectionalized view, of a diagrammatic nature, showing the water channels in the impeller; Fig. 4 represents a geometric projection to illustrate the form of spiral curve upon which the impeller vanes are constructed; Fig. 5 represents a sectionalized view of the impeller; Fig. 6 represents a partly sectionalized view showing the impeller broken away and also showing the diffusion ring and the volute casing; and Fig. 7 represents a detailed sectionalized view of the concentric bearing rings.

Referring to said drawings, the pump contains a transverse shaft 20 (see Fig. 1). Upon this shaft is mounted the revoluble impeller 21. The shaft 20 is mounted in suitable bearings at the side and is driven by any desired means, such as a steam turbine, electric motor or the like. The impeller 21, which will presently be described in detail, revolves within the cylinder which is inclosed by the cylinder heads 22 and suction heads 23. Water is drawn up through the suction pipes 24 into the intake openings 25 formed on the two opposite sides of the impeller.

Surrounding the impeller is a diffusion ring 26 (see also Fig. 6) and surrounding this diffusion ring is the volute casing 27 which is substantially circular in cross-section, but as is usual, increases from a small to a large diameter to the discharge pipe 28 (see Fig. 6). In this manner water is taken in at the intake openings from both sides of the impeller, and is conducted through the impeller by its revoluble movements and discharged through the diffusion ring 26 and then into the volute casing 27, and then into the discharge pipe 28.

The particular construction of the impeller itself will now be described.

The inner core of the impeller is in the shape of two hollow truncated conoids 30 and 31, placed base to base so that their common base forms a mid-partition to divide the impeller into two equal compartments. This common base terminates in a circular periphery 32, shown in Figs. 2, 3 and 5. These conoidal surfaces 30^a and 31^a terminate at their outer and opposite sides in axial sleeves or hubs 34 and 35, the transverse shaft 20 passing through the hubs, and the impeller being suitably keyed to the shaft to revolve therewith. As shown in Fig. 1, the impeller is further secured in place by beveled nuts or collars 36 located at either side of the axial sleeves or hubs and forming in contour a continuation of the hubs. Concentric with these axial sleeves are projecting flanges 40 which constitute the outer periphery of that portion of the impeller and form the annular intake opening 25, through which the water is conducted to the impeller vanes. These impeller vanes are curved substantially on a logarithmic spiral from the impeller axis to periphery. The plane of each vane terminates, as shown in Fig. 2, in a cutting edge 42 extending radially across the intake opening from the axial sleeve to the peripheral collar or flange. The plane of this vane is then warped or twisted a quarter turn progressively with its spiral contour, so that the plane of the vane when it terminates at the discharge or periphery opening of the impeller, as shown in Fig. 2, is parallel to the impeller axis. That is, the peripheral delivery edge 43 of the vane extends along the outer surface of the impeller in a direction parallel to the impeller axis. There are a series of these vanes in each of the two compartments of the impeller, and they are equally spaced around the impeller so as to form there between the water channels 50, through which the water is conducted from the intake or suction opening to the diffusion ring. In Fig. 2, 52 shows the end of one vane at the intake opening and 52^a shows the other end of the same vane at the delivery end. 53 shows the vane next above 52 at the intake opening, and correspondingly 53^a shows the outer end of this same vane emerging just below the outer end 52^a. If a geometric projection were taken of one of these vanes upon a plane perpendicular to the impeller axis, the curves of the two edges of the vane would be substantially as shown in Fig. 4. That is, the outer edge 60 of the vane would be substantially along the arc of a circle having a radius equal to the inside radius of the aforesaid peripheral flange 40, and the inside edge of the vane would be projected into a spiral 61 (Fig. 4). A careful inspection of the vane marked 52 and 52^a in Fig. 2 will show that the outer edge 60 thereof traces along the inner cylindrical surface of said peripheral flange 40, terminating at the periphery on the outside surface of this flange; while the other edge 61 follows along the truncated conoidal surface in a spiral direction, and at the same time longitudinally with the axis so as to terminate at the periphery at the junction of the cutting edge 43 of this vane with the periphery 32 of the mid-pa tition. The result of this is that by the formation of these vanes in this manner with one edge thereof extending along the inner cylindrical surface and the other following the contour of said conoidal surface from the axial sleeve to the outer periphery, the vane is warped through this quarter turn and is substantially of the same width from the intake to the discharge opening. And the interlacing or combining of these successive vanes forms the water channel 50 heretofore referred to, through which the water is driven upon revolving the impeller. In Fig. 3 these water channels are partially shown by the stripping of certain portions of the outer periphery or shell of the impeller, showing the truncated conoidal surface along which one side of the vane extends, and likewise showing the progressive warping of the vane as it proceeds from the discharge to the intake. This particular impeller is, as above stated, divided into two similar and equal compartments so as thereby to form a double impeller. The respective and corresponding vanes in the two opposite compartments of the impeller are similarly situated so that their respective cutting edges 42 are parallel to each other and their delivery edges 43 are brought together into the same line at the periphery, so that the plane of both these corresponding vanes at the periphery is the same and extends across between the aforesaid peripheral flanges 40. The corresponding opposite vanes are of course reversely warped for this purpose. It is believed that a reference to Figs. 2 and 3 in connection with this description will clearly show the construction of these vanes on opposite sides of the impeller, and their corresponding similarity which produces this symmetrical construction, thus balancing the action of the two sides of the impeller. It will be observed that this construction results in the delivery or peripheral end of the vanes being displaced axially from the intake end; and the curve of each vane from axis to periphery is substantially that of a logarithmic spiral, this particular construction having been found to be most desirable for the purposes in view. In the operation of this impeller, the projecting flange 40 and the axial sleeve 34 and nut 36 form an annular intake opening adjacent to the suction intake, so that the water flows into this opening and is cut by the sharp cutting edges of the impeller vanes and then forced through the water channels 50 out of the discharge openings of the impeller and then into the diffusion ring, as will be referred to later.

One of the advantageous features in the

construction heretofore described resides in its availability as a high speed pump. It is desirable to obtain an impeller which will carry medium and large quantities of water against medium and low heads at high speeds. Not only does high speed increase the efficiency of the pump itself, but if a steam turbine is used as a driving means for the pump, its efficiency is also increased for a high speed drive. It is desirable to use the smallest diameter of impeller possible for the purpose of decreasing the fluid friction between the revolving parts and the water, which is the greatest hydraulic loss. But certain working conditions sometimes arise which are difficult to meet and at the same time maintain the proper degree of efficiency. For example, in cases where there are large capacities against low heads and at high speed. Large capacities require large inlet or intake openings to the impeller in order to keep the inlet velocity down to a desirable value. Moreover, low heads require small outside diameters of the impeller, so that conditions might arise wherein, with a given fixed high speed, the calculated outside diameter of the impeller should necessarily be smaller than the inside diameter in order to get the proper capacity of intake of water and the proper delivery against low head. This would superficially appear to be impossible, but the design of impeller herein set forth solves this apparent impossibility.

A logarithmic spiral, having inlet and outlet angularity which will carry it around the impeller 180 degrees or more, is used for the working face of the impeller vane. The sharp edges 42 of these vanes cut the water as it flows in at the intake opening, and the warping and the spiral contour of the vanes changes the direction of flow of the water from parallel to the inlet opening to a direction at right angles with it, which is the direction of the discharge opening. This peculiar shape of the impeller vanes and water channels increases the working length of the vanes. Then in order to get the proper capacity of intake, the inlet area being controlled by the inlet velocity, this double form of impeller is used with two intake openings on opposite sides of the impeller. This increases the actual intake area and naturally permits the actual inside diameter of the impeller to be correspondingly smaller than would be the case where a single intake were employed on one side alone of the impeller. This inside diameter of the impeller being thereby decreased to the smallest possible value, the outside diameter is also decreased to the limit, thus giving the highest possible speed and the highest possible efficiency, because the fluid friction is reduced to a minimum. There are of course numerous other advantages which flow from the construction described, but those just set forth constitute some of the principal ones.

The diffusion ring and volute casing will now be described.

The diffusion ring 26 (see Fig. 6) is annular in form and surrounds the impeller in the usual manner, its inside periphery, beginning at the outer periphery of the impeller, and the outside diameter of the diffusion ring extending to the volute casing (see also Fig. 1). This diffusion ring, being axially of substantially the same width as the discharge openings of the impeller, has formed in it the diffusion vanes 70, which divide the diffusion ring into the water channels 71 to conduct the water from the discharge opening of the impeller into the volute. In combination with the impeller vanes formed on a logarithmic spiral, I have also utilized these diffusion vanes formed on a logarithmic spiral in order to get the maximum advantages from this style of pump for the particular purposes desired. The diffusion vanes 70, however, are not warped, but the plane of each vane extends on a logarithmic spiral from the periphery of the impeller to the periphery of the diffusion ring without any warping or twisting of the plane of the vanes, as shown both in Figs. 1 and 6.

After the water progresses through the water channels 71 of the diffusion ring it enters the volute casing 27. The discharge pipe 28 of this volute casing extends from the lower end thereof and is provided with a particular form of cut-off wall, which will now be described. This cut-off wall 80 extends from the outer wall of the volute casing to the inner wall, as shown in Fig. 6, terminating in a sharp edge brought as close as possible to the diffusion ring 26. Or, in case no diffusion ring is used but simply an impeller is used discharging directly into the volute, the cut-off wall would extend across as close as possible to the periphery of the impeller. This cut-off wall is situated at the junction of the discharge pipe and the volute where the volute is most contracted in its diameter, and the inner end of the cut-off wall extends into contact with the outer end of one of the diffusion vanes 81 so as practically to form an extension of this diffusion vane. The result of this construction is that with the usual high velocity of the water around the volute toward the discharge opening, the cut-off wall prevents the recirculation of the water back into the contracted portion of the volute. Otherwise a portion of the water might be carried by the cut-off point, and instead of being thrown through the discharge opening, would be kept traveling around the volute casing indefinitely, thereby resulting in hydraulic loss.

The interchangeable and renewable bearing rings for the impeller will now be described.

Threaded upon the previously described peripheral flanges 40 of the impeller are bearing rings 90 shown in Figs. 2, 3, 5 and 7. It will be remembered that these flanges 40 project into the suction or intake openings on each side of the impeller. In Fig. 2 only one of these bearing rings 90 is fully shown, the left hand ring being half omitted for the sake of more clearly showing the construction of the impeller proper. Seated in the cylinder casing is another bearing ring 91 which is stationary and is concentric with the impeller bearing ring. These two bearing rings are located in such proximity as to inclose a thin film of water between their confronting surfaces, the impeller ring 90 of course revolving with the impeller, and the stationary bearing ring 91 remaining fixed in the cylinder casing separated from the other ring by this water film. Grooves 92 are formed on the outer surface of the impeller ring 90 and the stationary ring 91. These grooves are matched so as to form circular water channels or grooves when the two rings are in place, as shown in Figs. 1 and 7. The stationary ring 91 has projecting from its outside diameter a beveled ring 93 which fits into a corresponding recess in the cylinder casing and holds the ring properly seated within the casing.

Inside of the cylinder casing, the point where wear is most likely to occur is between the impeller and its surrounding casing. In order to reduce slippage and consequent hydraulic loss, the impeller must run as closely as practicable to the casing. This bearing point is not made a contact, which would wear by abrasion, but the confronting surfaces of the bearing rings are held opening slightly, for example, by approximately one one-hundredth of an inch. Since all water contains more or less grit, this bearing surface will eventually be worn open by the grit and thus cause slippage. But with this construction, these bearing rings are interchangeable and renewable. The impeller ring 90, when worn, may be unscrewed from the impeller and a new ring put in its place, and by removing the upper casing of the pump and lifting the pump shaft 20 out of its bearings, the stationary bearing ring 91 may likewise be removed from its seat in the cylinder casing and slipped over the shaft and a new stationary ring put back in its place. Thus all wear due to grit is taken up by these rings, and when the wear has become great enough to cause material slippage, a new set of rings may be inserted at very slight cost, which will reduce slippage to a minimum and restore the efficiency to the original value.

Certain of the constructions shown in the present application are likewise shown and described in my co-pending application, Ser. No. 464,700, filed November 27, 1908, and are claimed in said other application.

While the form of mechanism shown and described in the present application is particularly adapted to secure the fulfilment of the object set forth, yet it is to be understood that various other forms might be used, all coming within the scope of the claims which follow.

1. In a centrifugal pump, the combination with the cylinder, of a revoluble closed impeller therein, said impeller being formed with a system of correlated vanes curved on a logarithmic spiral from the impeller axis to periphery, the plane of said vanes at the open intake face of the impeller being substantially transverse to the axis and having a cutting edge extending radially from said axis across said intake face and said plane then warped a quarter turn progressively with said spiral to bring the peripheral delivery edge of the vane parallel to the impeller axis.

2. In a centrifugal pump, the combination with the cylinder, of a double, closed, impeller therein, divided into two compartments by a mid-partition transverse to the axis and having two intake openings on opposite sides, with a system of correlated impeller vanes located symmetrically in said opposite compartments, said vanes being curved on a spiral from the impeller axis to periphery, the plane of said vanes at the open intakes being substantially transverse to the axis and having a cutting edge extending radially from said axis across its respective intake opening and the said cutting edges of the corresponding opposite vanes of the two compartments being substantially parallel to each other, and the planes of the said vanes being warped a quarter turn progressively with said spiral to bring the peripheral delivery edges of the vanes parallel to the impeller axis, the corresponding opposite vanes joining in a common plane at the periphery.

3. In a centrifugal pump, the combination with a cylinder, of a double, closed impeller therein, comprising two truncated cones having a common base forming a mid-partition to divide the impeller into two compartments and terminating at opposite sides in axial sleeves, peripheral collars concentric with said axial sleeves and forming two annular intake openings on opposite sides of the impeller, impeller vanes located symmetrically in said opposite compartments said vanes being curved on a spiral from impeller axis to periphery, the plane of said vanes at the open intakes being substantially transverse to the axis and terminating at their respective intake openings in a cuttin

edge extending radially across said opening from said axial sleeve to said peripheral collar and the said cutting edges of a pair of corresponding opposite vanes being parallel to each other, and the plane of said vanes being warped a quarter turn progressively with said spiral to bring the peripheral delivery edges of the vanes parallel to the impeller axis, corresponding opposite vanes joining in a common plane at the periphery extending across between said opposite peripheral collars.

4. In a centrifugal pump, the combination with a cylinder, of a double, closed impeller therein, comprising two truncated conoids having a common base forming a mid-partition to divide the impeller into two compartments and terminating at opposite sides in axial sleeves, projecting peripheral flanges concentric with said axial sleeves and forming therebetween two annular intake openings on opposite sides of the impeller, and a series of spiral vanes located symmetrically in said opposite compartments each vane coöperating with its adjacent vanes on either side to comprise inclosing walls and forming water-channels from their respective intakes to periphery, said vanes having cutting edges at the intake openings and having one edge of the vane extending along the inner cylindrical surface of its peripheral flange and the other edge of the vane extending along the contour of its truncated conoid from the axial sleeve to the outer periphery, whereby the plane of each of said vanes is warped a quarter turn progressively with said spiral to bring the delivery or periphery end of the vane parallel to the impeller axis and displaced axially from the intake end of the vane, the corresponding opposite vanes being reversely warped and joining in a common peripheral plane extending across between said opposite peripheral flanges.

In testimony whereof I affix my signature in the presence of two subscribing witnesses.

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