

July 10, 1928.

1,676,946

C. J. FECHHEIMER

CENTRIFUGAL PUMP

Filed Dec. 31, 1926

2 Sheets-Sheet 1

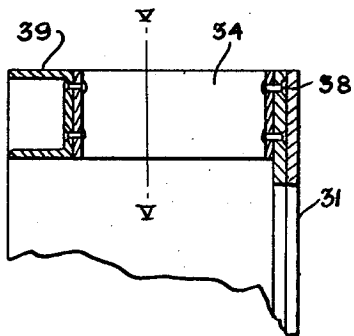


Fig. 6.

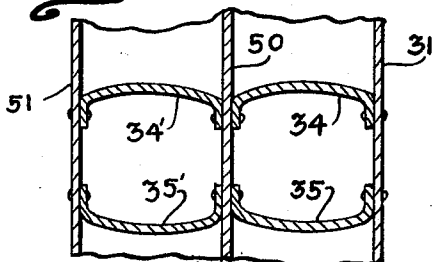


Fig. 9.

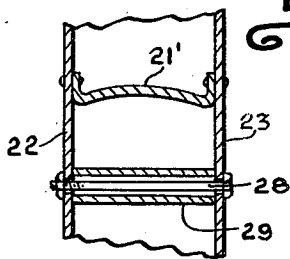


Fig. 7.

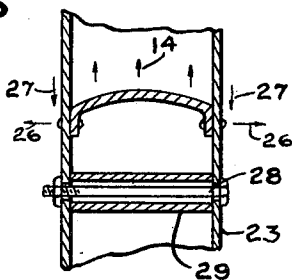


Fig. 3.

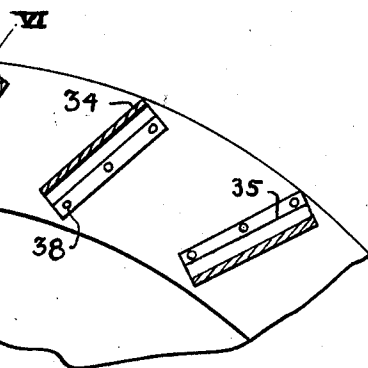


Fig. 5.

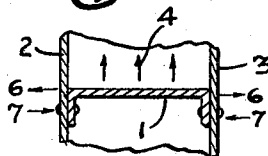


Fig. 1.

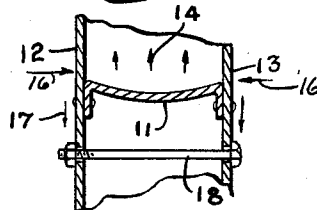


Fig. 2.

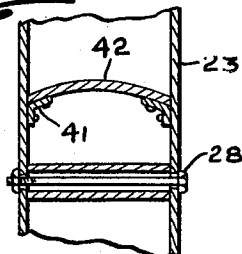


Fig. 8.

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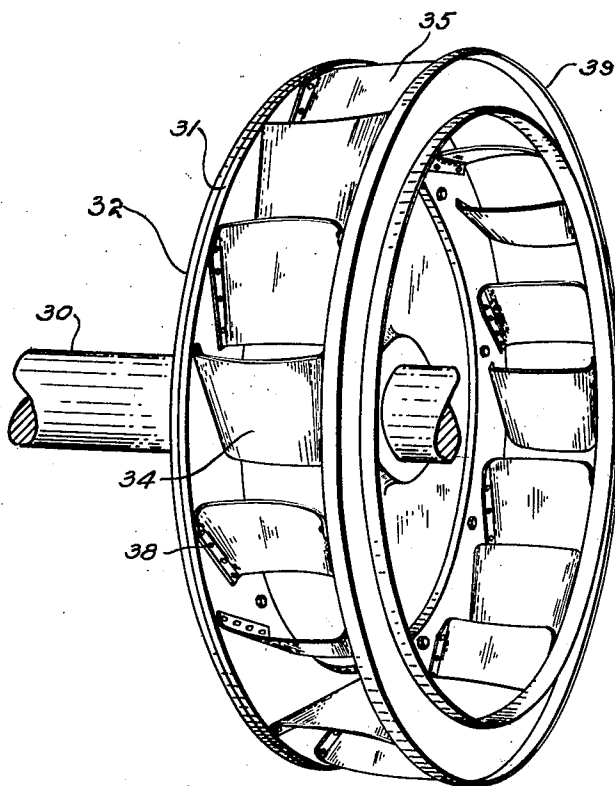
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2 Sheets-Sheet 2

Fig. 4.



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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL PUMP.

Application filed December 31, 1926. Serial No. 158,223.

My invention relates, in general, to centrifugal pumps or fans and has particular relation to pumps or fans designed for supplying relatively large volumes of fluid at relatively low pressure while operating at high angular velocities.

This application relates especially to pumps or fans of the type described in my prior Patent No. 1,519,245, dated December 16, 1924, and assigned to the Westinghouse Electric & Manufacturing Company, and has for its object the prevention of bending stresses in the members supporting the blades.

This and other objects of my invention will be apparent from the following detailed description, when read in connection with the accompanying drawing, wherein:

Figs. 1, 2 and 3 are diagrammatic sectional views illustrating the stresses on blades of various forms; Fig. 1 illustrating the form in use prior to my invention and Figs. 2 and 3 illustrating blades constructed according to my invention;

Fig. 4 is a perspective view of the rotor of a pump constructed in accordance with my invention;

Fig. 5 is a sectional view of the rotor taken on the line V—V of Fig. 6;

Fig. 6 is a section on line VI—VI of Fig. 5;

Figs. 7 and 8 are sectional views illustrating other methods of attaching the blades to the support; and,

Fig. 9 is a sectional view showing the use of a plurality of blade carrying rings.

Throughout the further description of my invention I have employed the word "fluid" in its broad sense, that is, to include both gases and liquids; and the term "pump" is employed in its broad sense, since I do not desire to limit my invention to pumps for use in connection with non-compressible fluids.

In the prior art it has been the practice to make the blades of centrifugal pumps such that the section cut by a plane normal to the axis of the impeller is a curve and in my prior patent I described a pump having flat blades; but I now propose to make the blades of such shape that they are curved with respect to respective planes passing through the longitudinal axis.

The blade I show in Fig. 1 is such as is known in the prior art. The blade is held between supports 2 and 3. The centrifugal forces acting in the direction of the arrows 4 cause a bending moment in the blades. It is therefore the purpose of this invention to very materially reduce this bending moment. I accomplish the reduction by providing a blade which is curved with respect to a plane passing through the longitudinal axis of the pump. Various curves may be used. The parabola or catenary will give more nearly perfect results but because of simplicity in manufacture, arcs of circles may be used. The divergence between the results of employing a circular arc rather than a parabola or a catenary is not enough to cause appreciable stress and for small arcs is not apparent except by most exact measurement.

In Figs. 2 and 3 I show such curved blades, the blade 11 in Fig. 2 being curved inwardly, the forces due to the components of the centrifugal forces normal to the blades being represented by the arrows 14; and the blade 21 of Fig. 3 being curved outwardly.

In Fig. 2 if the blades are so shaped that the blade is in compression only, the bending moment being eliminated, the forces needed to balance these forces at the supporting members 12 and 13 to balance the centrifugal forces 14, may be indicated by vectors 16—16, and by vectors 17—17. If the blade curve is not properly taken there will be a slight bending moment but it may be made as small as desired. To oppose the force normal to the support, I may provide tension members 18.

In Fig. 3 the stress in the blades is tensile to balance which at the supports 22 and 23 forces 26 are needed. The forces necessary to overcome the components 14 of the centrifugal forces normal to the blades is represented by 27. To take up the force normal to the plane of the supports, I may provide a compression member 29 supported by a bolt 28.

In the preferred form of my invention, shown in Figs. 4, 5 and 6, I make the blades alternately concave and convex. In this case the forces of the two blades normal to the support counterbalance each other. The

pump runner comprises a shaft 30 carrying a disc 32 which, in turn, carries an annular member 31 on which are mounted a plurality of blades 34—35. As illustrated, the blades 34 are convex and the blades 35 are concave. The blades are secured to the annular member by bolts or rivets 38. The other ends of the blades are secured to a ring 39 by similar bolts or rivets. In my preferred form, I make this ring of channel cross section to secure stiffness without excessive weight. As the result of the opposed curvature of alternate blades there is no tendency for the ring 39 to move with respect to the disc 32 or the attached annular member 31.

In Figs. 7 and 8 I show alternative methods of attaching the blades to the support. In Fig. 7 the supporting portion of the blade 21' is turned so as to be in compression instead of tension. In Fig. 8 a separate support 41 is provided for the blade 42.

In case it is desired to make the pump so wide that there would be a tendency for the supports to buckle I may make the blades in sections as shown in Fig. 9, rings being provided between the blades. In this figure the disc 32 carries the blades 34 and 35 which are attached to a ring 50. Blades 34' and 35' are secured to the ring 50 opposite the blades 34 and 35 respectively and the opposite edges of these blades are secured to a circular member 51 corresponding to the channel member 39.

While I have shown my invention as applied to blades which have a straight cross section in a plane normal to the axis of the impeller, it is evident that the invention is applicable to blades which are curved in this plane, the resulting blades being concave in one plane and either convex or concave in a plane passing through the longitudinal axis of the pump. Moreover, I do not wish to limit myself to a structure in which the bending moment is entirely eliminated as it may be desirable to bend the blades a lesser or a greater amount.

With the action of centrifugal force, the compression blade deflection decreases and the tension blade deflection increases, thereby destroying the exact balance of the two. To counteract this effect, the initial bulge of the compression blade may be made slightly more or the tension blade slightly less, or both. Actually, there are slight bending moments introduced in the blades when a perfect balance of the tension and compression does not exist, and these bending moments, in combination with the other forces, maintain the equilibrium.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications, without departing from the

spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:—

1. A centrifugal impeller for impelling fluids embodying a plurality of backwardly directed blades, the blades being curved with respect to planes which pass through the longitudinal axis.

2. A centrifugal impeller for impelling fluids embodying a plurality of backwardly directed blades, the sections of alternate blades in planes passing through the longitudinal axis being curved similarly.

3. A centrifugal impeller for impelling fluids embodying a plurality of backwardly directed blades, the sections of adjacent blades in planes passing through the longitudinal axis being curved oppositely.

4. A centrifugal impeller for impelling fluids embodying a rotor comprising spaced supporting members and backwardly directed blades extending between the supporting members, said blades being so curved that the stresses transmitted to a supporting member by a blade will be substantially in a plane tangent to said blades at its connection to said supporting members.

5. A device as claimed in claim 4 wherein adjacent blades are curved in opposite directions.

6. A centrifugal impeller for impelling fluids embodying a rotor comprising spaced supporting members and backwardly directed blades extending between the supporting members, said blades being so curved that the bending moment within the blades is nearly eliminated.

7. A centrifugal impeller for impelling fluids comprising a plurality of backwardly directed blades, the section of the blades in planes radial to the longitudinal axis being substantially circular.

8. A device as claimed in claim 4 wherein the supporting members consist of a disc and a circular member having a channel cross section.

9. A centrifugal impeller for impelling fluids embodying a rotor comprising two or more circular supporting members and blades extending between adjacent supporting members, the blades being so curved that the bending moment within the blades is nearly eliminated.

10. A device as claimed in claim 9 wherein adjacent blades between the same pair of supporting members are curved in opposite directions.

11. A centrifugal impeller for impelling fluids comprising a plurality of backwardly directed blades, the section of circumferentially adjacent blades being curved oppositely with respect to planes passing through

the longitudinal axis, the initial deflection of circumferentially adjacent blades being unequal.

12. In a centrifugal impeller a row of relatively wide blades considered transversely of fluid flow thereover and curved in the direction of force exerted by the fluid being acted upon.

13. A centrifugal fluid impeller embodying blades inclined with respect to planes including the longitudinal axis, sections of said blades with respect to planes parallel to the longitudinal axis and intersecting said first-mentioned planes on radii of said impeller being substantially catenaries.

14. A centrifugal fluid impeller embodying blades inclined with respect to planes passing through blades and the longitudinal axis said blades being curved with respect to planes parallel to the longitudinal axis and intersecting said first-mentioned planes.

15. In a centrifugal impeller a row of blades characterized by that the blades of the row are curved transversely of the direction of fluid flow thereover.

16. In a centrifugal impeller a row of blades characterized by that the blades of the row are curved transversely of the direction of fluid flow thereover and alternate blades are curved in opposite directions with respect to the direction of rotation.

17. In a centrifugal impeller for impelling fluids, a rotor, a plurality of rows of relatively wide blades considered transversely of fluid flow thereover and curved in the direction of force exerted by the fluid being acted upon.

18. In a centrifugal impeller for impelling fluids, a rotor, a plurality of rows of equal radii, of relatively wide blades considered transversely of fluid flow thereover and curved in the direction of force exerted by the fluid being acted upon.

19. In a centrifugal impeller for impelling fluids, a row of relatively wide blades considered transversely of fluid flow thereover and wherein sections on planes normal

to the respective surfaces of alternate blades are substantially catenaries and sections similarly taken in the remaining blades are substantially catenaries of opposite sign.

20. In a centrifugal impeller for impelling fluids, a row of relatively wide, backwardly directed, blades considered transversely of fluid flow thereover and wherein sections on planes normal to the respective surfaces of alternate blades are substantially catenaries and sections similarly taken on the remaining blades substantially catenaries of opposite sign.

21. In a centrifugal impeller for impelling fluids, a row of relatively wide blades considered transversely of fluid flow thereover and wherein the blades are curved in the direction of force exerted by the fluid being acted upon and adjacent blades are curved in opposite directions with respect to the direction of rotation.

22. In a centrifugal impeller, a row of relatively wide blades considered transversely of fluid flow thereover and curved in the direction of force exerted by the fluid being acted upon and straight in the direction of fluid flow thereover.

23. A centrifugal impeller for impelling fluids embodying a row of blades curved transversely with respect to the direction of fluid flow thereover and oppositely with respect to each other and wherein one half of the total number of blades act in compression and the other half in tension when impelling a fluid.

24. A centrifugal impeller for impelling fluids embodying a row of blades in which alternate blades act in compression and the remaining blades in tension when impelling a fluid whereby the circumferential components of the forces exerted by the impelled fluid tend to react against each other.

In testimony whereof, I have hereunto subscribed my name this 16th day of July, 1926.

CARL J. FECHHEIMER.