Nov. 3, 1936. A. PFAU 2,059,650

HYDRAULIC TURBINE

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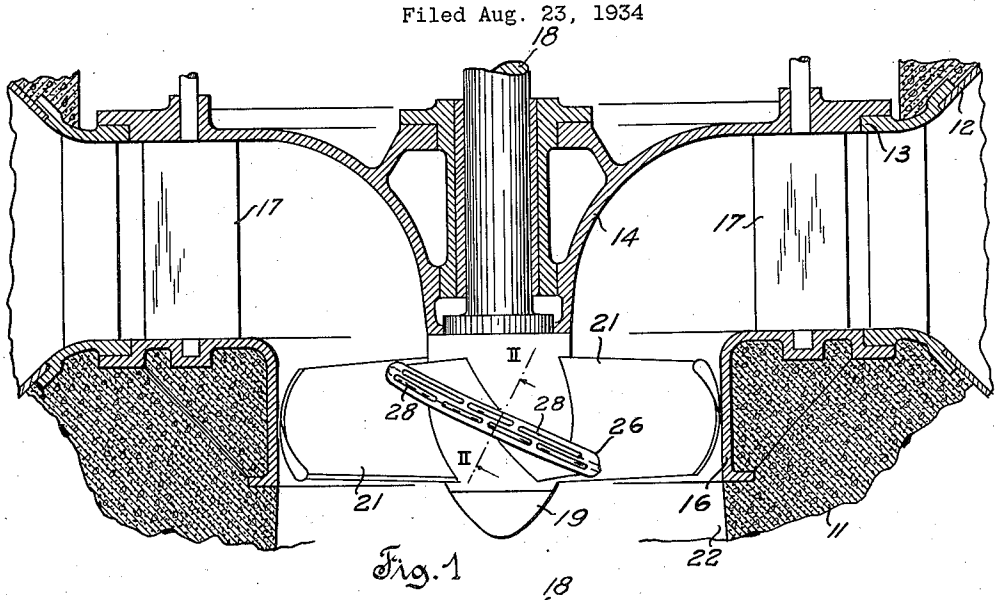


Fig. 1

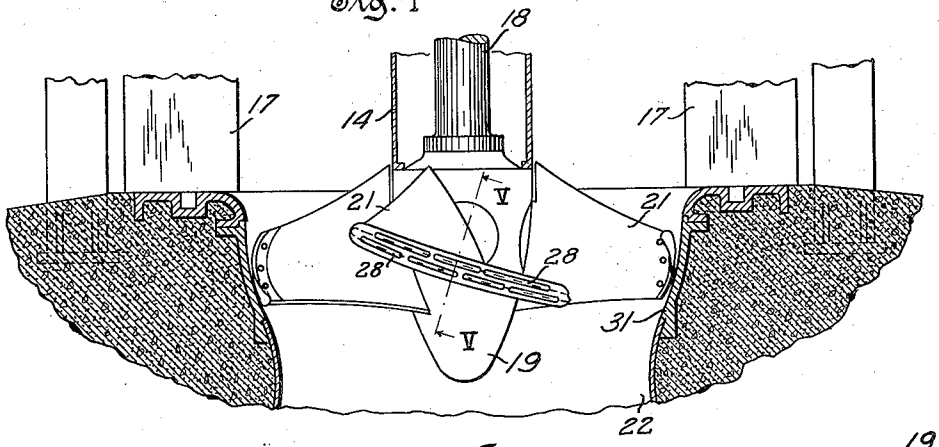


Fig. 4

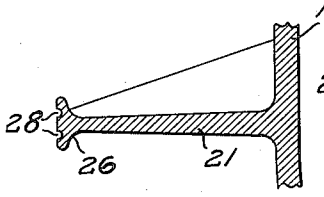


Fig. 2

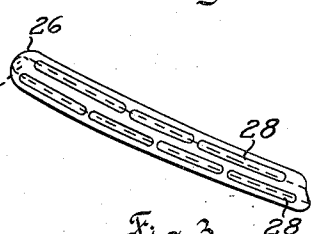


Fig. 3

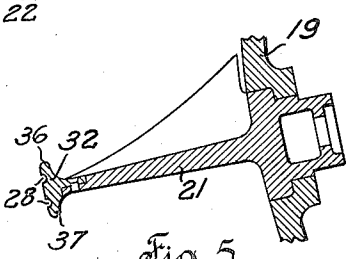


Fig. 5

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HYDRAULIC TURBINE

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9 Claims. (Cl. 253—117)

This invention relates to improvements in devices operated by or operating upon a fluid and particularly to devices in which the fluid operated or fluid handling element is formed as a propeller.

Hydraulic devices such as pumps or turbines of the type in which the fluid driving element or fluid driven element is formed from a plurality of blades or vanes mounted in either fixed or movable relation on a shaft are well known. Such vanes must, however, rotate with, at least, some slight clearance between them and the adjacent portion of the casing to guarantee the avoidance of engagement between the rotating and stationary portions of the structure. Even when such clearance is reduced to a practical minimum it has been found that a large quantity of fluid leaks through the space remaining between the ends of the vanes and the casing without being acted upon or without acting upon such vanes. Such leakage materially reduces the efficiency of the device whether used as a pump or as a turbine and contributes to greater wear of the parts. Numerous methods of preventing such leakage have been proposed, such as fitting rubber tips to the vanes, etc., but none of such methods has been found to be entirely successful in practice. A second and equally important disadvantage of the present constructions which allows leakage about the outer face of the vane is the fact that such leakage produces whirls and eddies in the hydraulic flow which cause cavitation of the end and of the surfaces of the vanes particularly and hence diminish the efficiency and reduce the life of such vane.

It is therefore among the objects of the present invention to provide means for sealing the ends of the rotor vanes of a hydraulic device of the propeller type into the casing thereof to prevent leakage of fluid about the ends of such vane.

Another object of the invention is to provide fluid pressure sealing means for the ends of the vanes of a propeller type hydraulic device without eliminating the clearance desired between the ends of the vane and the casing.

Another object of the invention is to provide fluid pressure sealing means for sealing the space required between the ends of the vane of a propeller type hydraulic device and the casing thereof in which the sealing means will be equally effective regardless of the angle of the vane to the axis of the moving column of fluid passing through such vanes.

Objects and advantages other than those above set forth will be apparent from the following description when read in connection with the accompanying drawing, in which:

Fig. 1 is a partial vertical sectional view of a hydraulic turbine of the propeller type, it being assumed that the vanes are fixedly mounted on the shaft and that the portion of the casing in which such vanes rotate is made with a substantially cylindrical configuration;

Fig. 2 is a sectional view of one of the vanes illustrated in Fig. 1 and is taken on the plane II—II of Fig. 1;

Fig. 3 is an enlarged end view of one of the vanes to illustrate the construction of the sealing means in detail;

Fig. 4 is a partial vertical sectional view of a hydraulic turbine of the propeller type in which the vanes are rotatably mounted on the shaft and rotate in a portion of the casing having a somewhat spherical configuration, and illustrating the position of the vanes in the casing portion when the vanes are given a low tilt or are in a substantially horizontal position; and

Fig. 5 is a vertical sectional view of one of the vanes illustrated in Fig. 4 and is taken on the plane V—V of Fig. 4.

Referring more particularly to the drawing by characters of reference, reference numeral 11 designates concrete or other suitable setting for a hydraulic turbine construction which includes a spiral casing 12 to which water is supplied to a turbine chamber formed by a speed ring 13 connected with the spiral casing and a cover plate 14 and discharge rings 16 extending from the speed ring. The quantity of water supplied to the spiral casing is controlled by a wicket gate formed from a plurality of movable vanes 17 operable in any manner known to the art. A shaft 18 extends through the cover plate 14 and is provided at the lower end thereof with a hub 19 in which are mounted a plurality of vanes 21 to which the column of water moving through the turbine chamber transmits its energy to rotate the shaft. After passing through the vanes the water is discharged through a draft tube 22 into a suitable tailrace (not shown). As shown in Fig. 1, the discharge ring 16 is made substantially cylindrical and the vanes 21 are fixedly mounted in the hub 19. To accomplish the purpose of the present invention, the ends of the vanes, to be specifically described, are formed to rotate at a predetermined close radial clearance with the discharge ring.

Each of the vanes illustrated in Fig. 1 is formed with a substantially T-shaped portion 26. Each of the end portions 26 extends both above and

below the operative surfaces of the vanes thus providing an end surface of much greater width than the thickness of the vane. Such surface is shaped to conform with the interior surface of the discharge ring 16 in order that the vanes may rotate within the discharge ring at as close a clearance as is practical. The end portions 26 are provided with several series of grooves 28 which will be specifically described.

Fig. 3 illustrates the arrangement of grooves 28 as a plurality of series of grooves arranged substantially parallel with the opposite surfaces of the vanes and as being interrupted and formed in overlapping relation.

The embodiment illustrated in Fig. 4 differs from that previously described in that the vanes 21 are movably mounted in the hub 19 and are rotatable therein in any manner known to the art to permit variation of the angle of tilt of the vanes as is well known. The vanes are rotatable within a chamber of somewhat spherical configuration which is formed by the discharge ring 31. The ends of the vanes 21 are provided with separable T-shaped members 32 having extensions or flanges 36 and 37 projecting above and below the operating surfaces of the vanes respectively as is shown in Fig. 5. The member 32 provides a surface which is also preferably provided with grooves 28 as was previously mentioned. Such members 32 are preferably somewhat curved to conform with the inner surface of the discharge ring 31 which is somewhat spherical and are therefore substantially on radii of the sphere containing the inner surfaces of the discharge ring.

When water is passing through the turbine, the water impinging on the upper or pressure surfaces of the known forms of vanes leaks around the peripheral ends of the vane to the lower or suction surfaces thereof. Such flow about the ends of the vanes is pure waste for the reason that the leakage water does not transmit its energy to the vane. In addition to the waste of power, such leakage also produces conditions about the ends of the vanes and at the portions of the turbine construction which operate at close clearances and particularly on the suction side of the vanes, which produce cavitation and hence materially reduces the life of the vane. Such cavitation may even take place on the discharge ring and may lead to such high degree corrosion as to increase the leakage to the point at which such leakage materially affects the hydraulic efficiency of the machine. With vanes provided with end members extending both upwardly and downwardly from the surfaces of the vanes, the length of the passageway between the ends of the vanes and the discharge rings is greatly extended, a pressure therefore builds up in the passageway and greatly retards the flow of water therethrough. The presence of grooves aids in building up such pressure and increases the sealing in the same manner as is obtained with the usual elaborate sealing gland. The extent and degree of leakage is reduced by sealing thus substantially eliminating any whirl or eddying on the suction side of the vane which causes cavitation. Elimination of such whirls or rather the removal of such whirls to such distance away from the vane as to be without effect thereon is caused by the extension of the end member downwardly. Any whirl which may be formed by the water leaking through the joint between the ends of the vanes and the discharge ring is accordingly forced to occur at such distance from any of the operating portions of the structure as will not cause cavitation thereof.

Although but two embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. A hydraulic machine comprising a casing, a shaft extending into said casing, and a plurality of propeller vanes mounted on said shaft and forming a screw rotatable therewith, the peripheral ends of said vanes being formed to extend from both sides thereof to provide a surface of materially greater width than the thickness of said vanes, such surface being provided with grooves.

2. A hydraulic machine comprising a casing, a shaft extending into said casing, and a plurality of propeller vanes mounted on said shaft and forming a screw rotatable therewith, the peripheral ends of said vanes being formed to extend from both sides thereof to provide a surface of materially greater width than the thickness of said vanes, the surface being provided with interrupted grooves extending substantialy parallel with the surfaces of said vanes.

3. A hydraulic machine comprising a casing, said casing having a substantially spherical portion, a shaft extending into said casing, and a plurality of propeller vanes mounted on said shaft and forming a screw rotatable therewith, the peripheral ends of said vanes being curved to conform with the spherical surface of said casing and having extensions from both sides of said vanes to seal the joints between said casing and the ends of said vanes.

4. A hydraulic machine of the screw propeller type and comprising a casing, said casing having a substantially spherical portion, a shaft extending into said casing, and a plurality of propeller vanes mounted on said shaft and rotatable therewith, the axis of each of said vanes being substantially on a radius of the spherical portion of said casing and being curved to conform with the curvature of said casing portion, the peripheral ends of said vanes having extensions from both sides thereof to seal the joints between said casing and the ends of said vanes.

5. A hydraulic machine of the screw propeller type and comprising a casing, said casing having a substantially spherical portion, a shaft extending into said casing, and a plurality of propeller vanes mounted on said shaft and rotatable therewith, the axis of each of said vanes being substantially on a radius of the spherical portion of said casing and being curved to conform with the curvature of said casing portion, the peripheral ends of said vanes having extensions from both sides thereof and being provided with grooves substantially forming a labyrinth gland to seal the joints between said casing and the ends of said vanes.

6. A hydraulic machine comprising a casing, said casing having a substantially spherical portion, a shaft extending into said casing, and a plurality of propeller vanes adjustably mounted on said shaft and forming a screw rotatable therewith, the peripheral ends of the vanes having extensions from both sides thereof and being curved to conform with the surface of the spherical portion of said casing to maintain the same spacings

between the ends of said vanes and said casing regardless of the adjustment of said vanes.

7. A hydraulic machine comprising a casing, said casing having a substantially spherical portion, a shaft extending into said casing, and a plurality of propeller vanes adjustably mounted on said shaft and forming a screw rotatable therewith, the ends of the vanes having extensions from both sides thereof and being curved to conform with the surface of the spherical portion of said casing to maintain the same spacings between the ends of said vanes and said casing regardless of the adjustment of said vanes, the surface formed by the extensions from the ends of said vanes being provided with grooves to seal the space between the ends of said vanes and said casing.

8. A hydraulic machine comprising a casing, said casing having a substantially spherical portion, a shaft extending into said casing, and a plurality of propeller vanes adjustably mounted on said shaft and forming a screw rotatable therewith, the ends of the vanes having extensions from both sides thereof and being curved to conform with the surface of the spherical portion of said casing to maintain the same spacings between the ends of said vanes and said casing regardless of the adjustment of said vanes, the surface formed by the extensions from the ends of said vanes being provided with interrupted grooves extending substantially parallel with the surfaces of said vanes and arranged in overlapping relation to seal the space between the ends of said vanes and said casing.

9. A hydraulic machine of the screw propeller type and comprising a casing, a shaft extending into said casing, a plurality of propeller vanes mounted on said shaft and rotatable therewith, and a member removably mounted on the end of each of said vanes and extending from both sides thereof and forming a surface of materially greater width than the thickness of said vanes, said surface being provided with a plurality of series of grooves extending substantially parallel with the surfaces of said vanes to seal the joints between the casing and said vanes.

ARNOLD PFAU.