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FLUID CUSHION FOR HYDRAULIC TURBOMACHINERY

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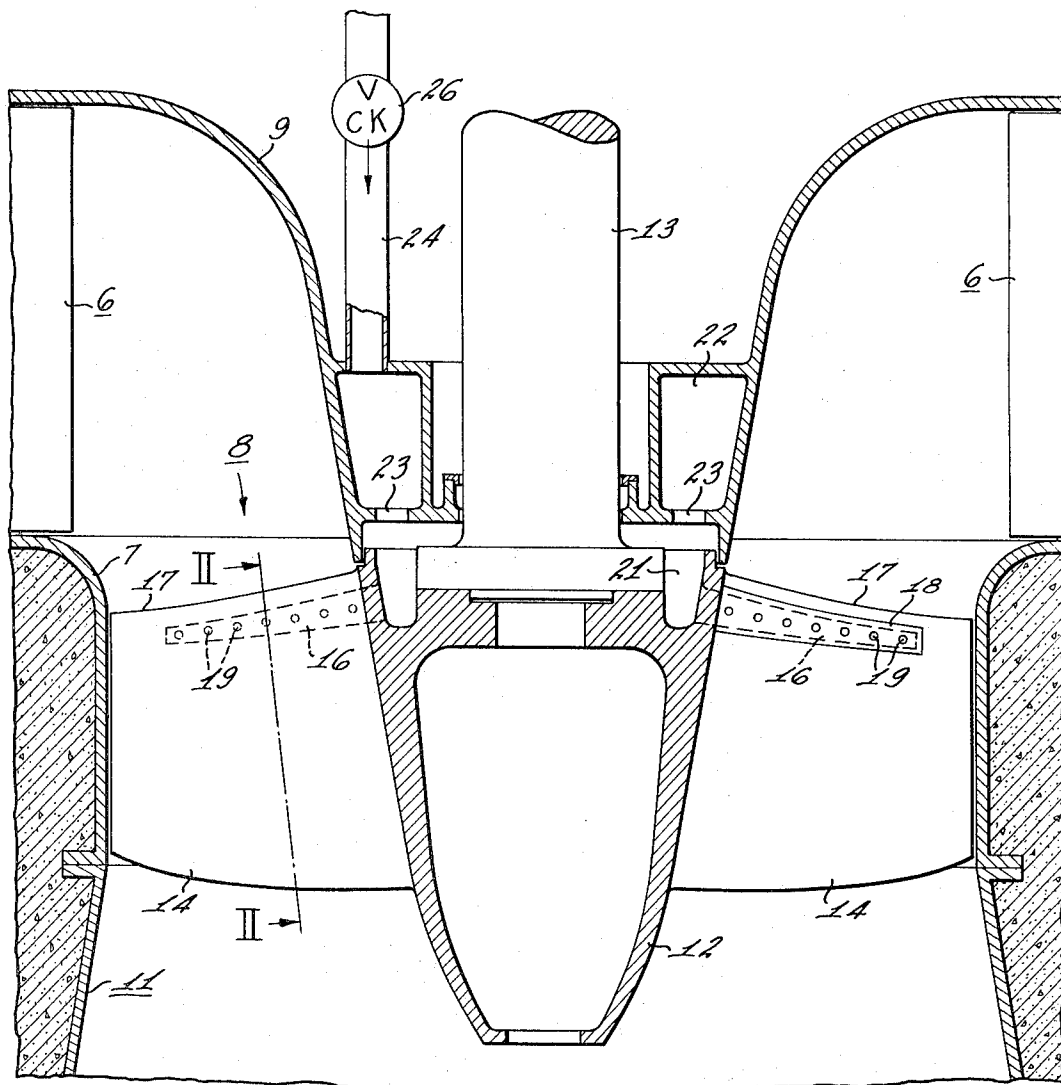


Fig. 1

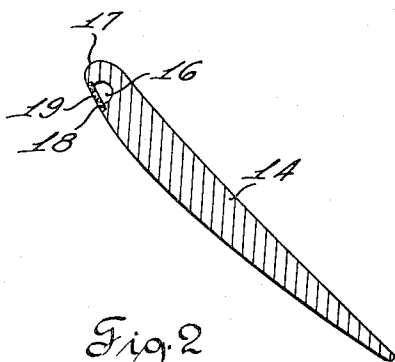


Fig. 2

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2 Claims. (Cl. 253-117)

This invention relates to hydraulic turbomachinery.

Liquid passing through hydraulic turbomachinery exhibits a particular pressure, depending on the location of the machinery relative to the free surface of the liquid at its source and delivery pools. As the liquid passes through the turbomachinery, low pressure regions are formed.

When the existing liquid pressure equals the vapor pressure at the particular liquid temperature, voids or cavities filled with vaporized liquid are formed. This phenomenon is referred to as cavitation. As the voids move with the stream of liquid to a region of higher pressure, they collapse violently. A kind of reverse explosions or "implosions" take place damaging material from which the machinery is made and also producing noise and vibrations.

One way of decreasing the harmful effects of cavitation is to fill the voids with gas to cushion the implosion which takes place when vapor voids collapse. Gas bubbles traveling with the stream of liquid are known to dissipate pressure waves in liquid and therefore they reduce very effectively all kinds of vibrations of hydraulic machinery. A thin layer of gas at the surface of the turbomachinery blade reduces liquid friction over this surface and therefore tends to increase efficiency of the machine. The desirability of gas admission at certain modes of operation of hydraulic turbomachinery being well established, the difficulty is in determining just where openings for gas admission should be located to most effectively draw gas into the liquid passage, to guide it to the region of cavitation voids formation and to disperse it in the form of a thin sheet adjacent to the surface of the runner blade. Applicants have determined that the most convenient place to release gas to the liquid passage is the underlying surface of the runner blade closely adjacent to the leading edge over which the driving liquid cascades.

It is therefore the general intention of this invention to provide a hydraulic turbomachine with structure to deliver gas to the underlying or low pressure surfaces of the runner blades immediately adjacent to the leading edge thereof.

A more specific object is to provide a hydraulic turbine with a series of longitudinally spaced air holes on the low pressure surface of the runner blades closely adjacent the leading edge thereof.

These and other objects of this invention will become more fully apparent as the following description is read in light of the attached drawing, wherein:

FIG. 1 is a partial cross sectional view of a turbine constructed in accordance with the invention; and,

FIG. 2 is a cross section of one blade of the turbine runner taken along the lines II-II of FIG. 1.

For purposes of illustration the invention is shown in connection with a hydraulic turbine. Referring to the drawing, the turbine is shown as including a plurality of circumferentially spaced gates generally designated 6. The lower ends of the gates are supported in a ring 7 forming a portion of a water passageway 8. A cover ring generally designated 9 supports the upper end of the gates 6 and provides an additional surface of the water passage-

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way 8. A draft tube generally designated 11 is connected to the lower portion of the gate ring 7 to complete the water passageway.

A runner hub 12 is rigidly connected to the turbine drive shaft 13 in any conventional manner and is centrally located within the water passageway. A plurality of circumferentially spaced runner blades 14 are connected to the hub and extend generally radially therefrom so that water flowing through the passageway will impinge thereon to cause the turbine shaft to rotate. The turbine shaft is provided with conventional bearings (not shown) as is well known in the hydraulic turbine art.

As herein shown for purposes of illustration, each blade is provided with a longitudinally extending passageway 16 located on the low pressure side of the blade and closely adjacent to the leading edge 17 of the blade. A plate 18 is rigidly connected to the low pressure side of the blades to cover the passageway 16. This plate is provided with a plurality of longitudinally spaced openings 19. It should be understood that a passageway could be provided along the interior of the blade thereby circumventing the need of the plate without departing from the spirit of the invention. Furthermore, a hollow blade could be provided with holes drilled along the leading edge of the blade on the low pressure side thereof.

Each passageway 16 is connected in fluid communication with an annular manifold 21 provided in the impeller hub 12. This manifold 21 is also in fluid communication with an annular fluid chamber 22 provided about the turbine shaft 13 by means of openings 23. Air is admitted to the chamber 22 by means of a pipe 24 which may be provided with a standard check valve 26 permitting the free flow of air in the direction of the arrow; however, blocking the flow of fluid in the reverse direction.

As water impinges on the leading surface 17 of the runner blading, it in effect "bounces off" and forms a low pressure region substantially along the lines of the holes 19 through the plate 18. This low pressure region creates a vacuum which causes air to be drawn through the holes 19 from the atmosphere or any other source. If the quantity of air supply from the atmosphere does not suffice, a pressurized air source may be provided. Any implosion of vapor bubbles downstream from the air holes 19, is cushioned by air present in the voids, thereby materially decreasing the wear on the runner surface and reducing noise and vibrations. Furthermore, it has been found that the turbine efficiency is improved because presence of air at the blade surface decreases friction.

With applicants' invention, air is admitted at the point where the low pressure voids are formed. Therefore, the voids are filled immediately on forming so there is no danger of "implosions" of the voids.

Although only one embodiment of the subject invention is shown and described herein, it will be obvious after reading the description that modifications can be effected without departing from the spirit of the invention and it is intended that all such modifications as come within a reasonable interpretation of the appended claims be covered.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In hydraulic turbomachinery including walls defining a liquid passageway the combination comprising: a hub rotatably supported in said passageway; a plurality of circumferentially spaced blades connected to said hub for rotation therewith, said blades being arranged in said

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liquid passageway to cause energy transfer between said blades and the liquid; fluid passage means including a plurality of longitudinally spaced openings on the low pressure side of the blading located closely adjacent the leading edge of the blades; and fluid connecting means connecting said fluid passage means in communication with a fluid source whereby fluid flows through said openings as the pressure in said liquid passageway about said openings decreases below the pressure of said fluid source.

2. The hydraulic turbomachinery set forth in claim 1 wherein said fluid is air and said fluid source is the atmosphere.

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