May 10, 1932. G. B. WARREN 1,858,067

ELASTIC FLUID TURBINE

Filed Oct. 21, 1930

Fig. 1.

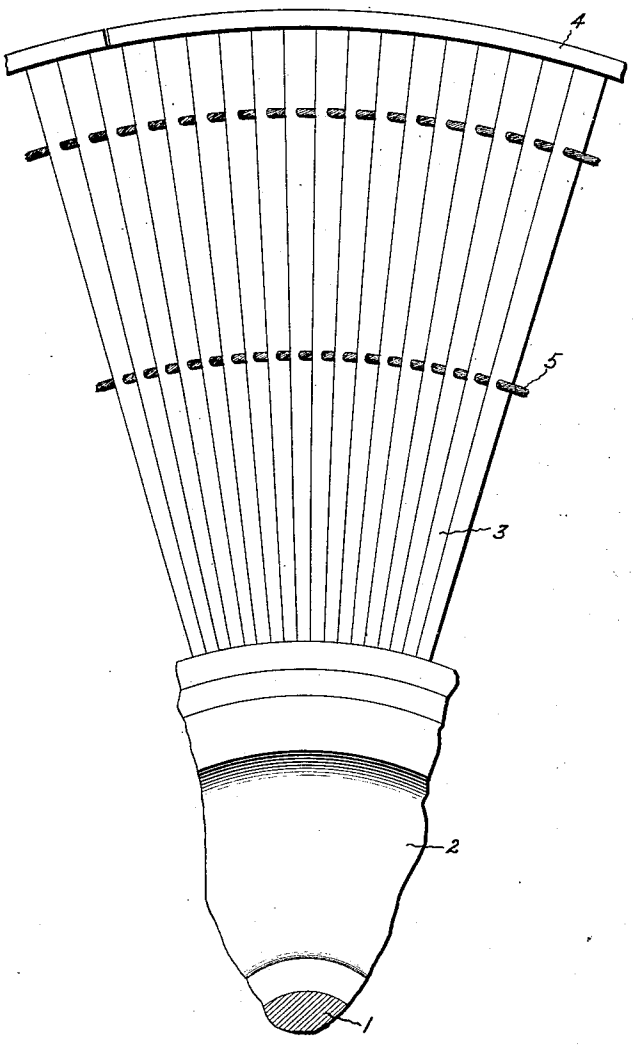


Fig. 2.

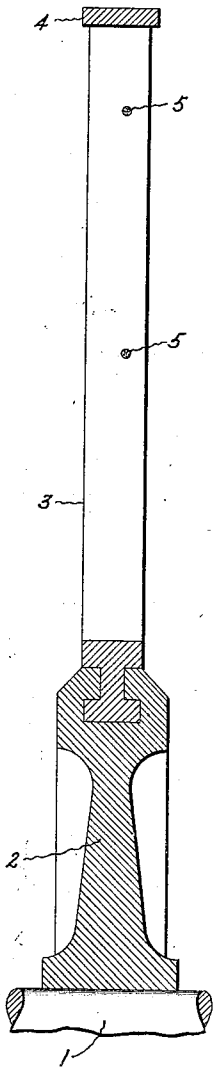
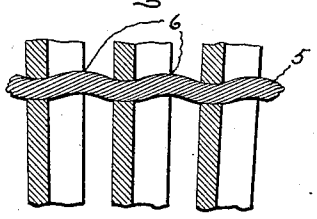


Fig. 3.



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UNITED STATES PATENT OFFICE

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ELASTIC FLUID TURBINE

Application filed October 21, 1930. Serial No. 490,232.

The present invention relates to elastic fluid turbines, and especially to rotors for such turbines.

At the low pressure end of a turbine rotor for a large machine the buckets become quite long and it is known in connection with bucket rows having buckets of considerable length to provide circumferentially extending tie wires between the inner and outer ends of the buckets to strengthen the buckets and increase their stiffness.

My invention relates especially to tie wires for turbine buckets, and has for its object to provide an improved tie wire construction and arrangement.

For a consideration of what I consider to be novel and my invention, attention is directed to the following specification and the claims appended thereto.

In the drawings, Fig. 1 is a side view of a portion of a turbine rotor, the buckets of which are provided with tie wires embodying my invention; Fig. 2 is a radial sectional view, and Fig. 3 is a detail view on a larger scale illustrating in somewhat exaggerated form the operation of the tie wire.

Referring to the drawings, 1 indicates a turbine shaft, 2 a rotor thereon, 3 a row of buckets carried by the rotor, and 4 a sectional bucket cover for the buckets. Intermediate between their ends the buckets are provided with tie wires 5.

According to my invention, I form the tie wire 5 from a wire cable comprising a plurality of strands, the tie wire being threaded through openings in the buckets and being preferably continuous, that is, in one continuous piece suitably fastened together at its ends. The openings in the buckets are of a size such that the tie wire makes a reasonably close fit therein and the tie wire is of a length such that when its ends are joined together it is not tight but on the contrary is somewhat loose. In operation, a turbine wheel expands due to centrifugal force and the tie wire is made loose enough that such expansion of the wheel will not be sufficient to take up all the looseness. As a result, the parts of the tie wire will be supported by the buckets, and thus the stresses will be low. At the same time, however, due to centrifugal force acting on the tie wire, the tie wire will be held tight between adjacent buckets, the tie wire sections between adjacent buckets bowing outwardly as is illustrated in exaggerated form at 6 in Fig. 3. By my invention, therefore, I obtain the advantages of a continuous tie wire but at the same time avoid the disadvantages heretofore met with. The tie wire comprises preferably a twisted stranded cable formed of a multiplicity of wires or strands, and it is not fastened to the buckets except by the frictional fit in the openings through which it extends.

My improved tie wire construction has the further advantage that if the buckets tend to vibrate tangentially out of phase one with the other, they will have to work and bend the segments of the tie wire in between the different buckets or else slip on the tie wire, and in either case this will absorb the energy to such an extent that resonant vibration cannot be set up. Furthermore, the tendency of the tie wire will be to damp out nodal axial vibration inasmuch as it will be necessary for a wave to travel along the cable for it to conform the cable to the wave formation. Such bending of the cable will absorb energy and inasmuch as this axial vibration is also a resonant condition the amplitude will be greatly reduced. It will be readily understood that bending of the tie wire causes frictional resistance between the plurality of strands of which the wire is composed. This frictional resistance and also the frictional resistance set up between the tie wire and the blades abstracts oscillatory energy from the wheel.

In accordance with the provision of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. The combination with a turbine rotor having a row of buckets, of a continuous tie

wire for the buckets comprising a plurality of strands extending through passages in the buckets, said strands being loose enough that they do not become tight when the wheel expands due to centrifugal force.

2. The combination with a turbine rotor having a row of buckets, of a continuous tie wire for the buckets comprising a plurality of strands twisted together and extending through passages in the buckets and having a friction fit in such passages for absorbing oscillatory energy of the buckets.

3. The combination with a rotor comprising a disk, a row of blades secured to the disk, the blades having transverse holes in circular relation to the rotor, of a continuous tie wire comprising a plurality of strands twisted together and extending through the holes in said blades and being in frictional engagement with the blade walls defining said holes, said tie wire being loosely arranged between adjacent blades whereby dangerous stresses of the tie wire during operation of the rotor are prevented and circumferential and axial nodal vibrations are dampened due to frictional resistance set up between the individual strands and between the cable and the walls of the blades.

In witness whereof, I have hereunto set my hand this 20th day of October, 1930.

GLENN B. WARREN.