ARTICULATED SLEEVE FOR TURBINE BUCKET LASHING

Filed April 23, 1971

FIG.1

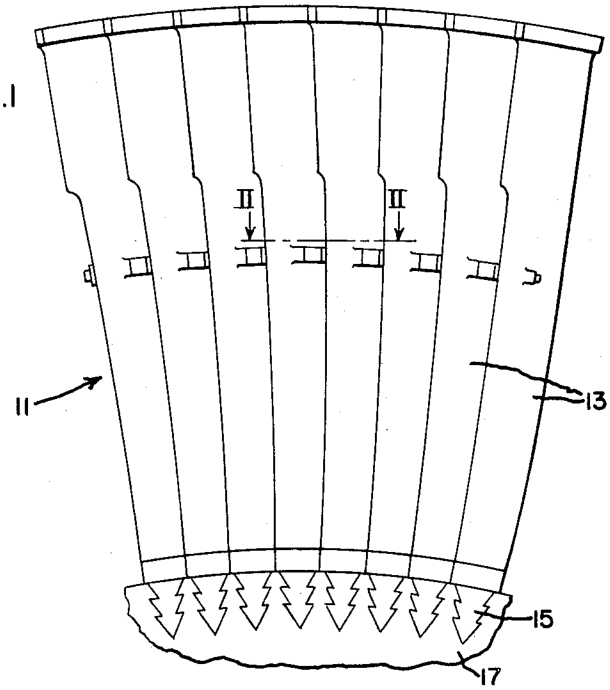


FIG.2

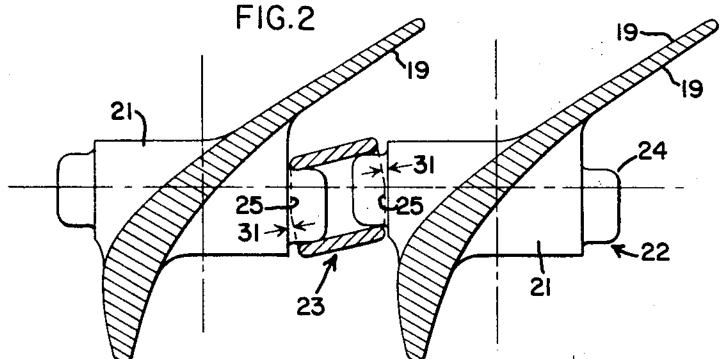


FIG.3

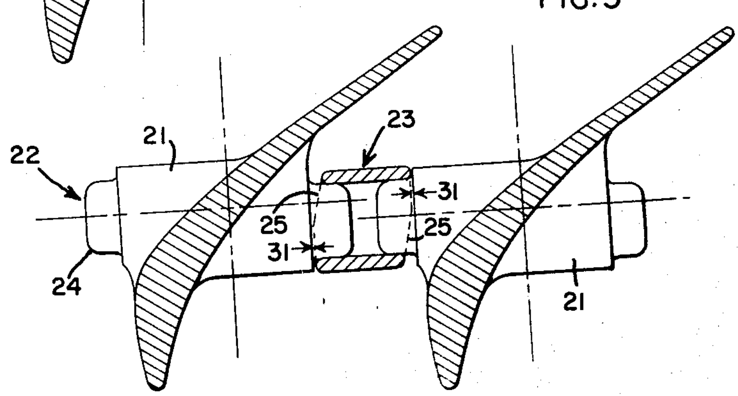
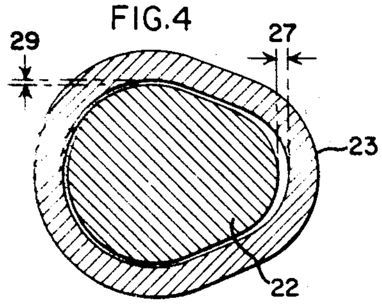


FIG.4



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ARTICULATED SLEEVE FOR TURBINE BUCKET LASHING

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ABSTRACT OF THE DISCLOSURE

A blade lashing device for a turbine wheel having closely adjacent blades formed with a lug on each blade face. A sleeve is interposed between lugs on opposing blade faces to connect turbines blades. The sleeve is formed with clearances so that it will form an articulated joint between interconnected turbine blades.

BACKGROUND OF THE INVENTION

This invention generally pertains to the design of turbomachinery such as steam turbines, was turbines, axial and centrifugal flow compressors and propellers. In particular, this invention relates to bucket or blade lashings in a turbo-machine.

Turbo-machinery may be generally divided into two types. One type of turbo-machine is motivated by a flowing fluid which passes through a blade path, causing the turbine blades to rotate and which also rotates the turbine shaft. In the other type of turbo-machinery, the shaft rotates, causing the blades to rotate which causes movement of fluid through the turbo-machine. In either type of machine, motive forces are transferred from the shaft to the fluid and vice versa through the turbine blades.

Turbine blades are sometimes long, thin members which are greatly influenced by various forces acting within the turbo-machine environment. These forces, cause stresses in the turbine blades and may be characterized as thermal stresses, centrifugal stresses, bending stresses and torsional stresses. Physical factors which may cause these stresses may be the high speed rotation of a turbine shaft to which the blades are attached, and also the reaction forces upon the blades as high speed fluid contacts the blades, or as the blades are required to motivate a fluid to high speed. These stresses, acting together or in part, may cause severe blade vibration, blade bending, misalignment, or even failure. The end result of these difficulties is a loss of efficiency, turbine breakdown and even damage to associated turbine parts.

One known method of decreasing turbine blade vibration is to lash all the blades of a turbine wheel together by means of a single hoop or wire. This is sometimes ineffective because the blades tend to vibrate radially and transversely with respect to one another, causing distortion or fracture of the hoop. Another method of decreasing turbine blade vibration is to lash each turbine blade to its adjacent turbine blades by means of a rigid connector. This type of lashing often fails because of high stress concentrations at the point of connection with the turbine blade.

The two aforesaid lashings are also unsatisfactory because even if they should remain intact, there are high torsional stresses introduced into the blade connectors because of blade twisting and untwisting. Also, the use of a lashing wire requires a hole in the blade which may be in a high stress region.

In other prior art designs, it has been known to provide non-rigid connections between blades, but they prevented bucket twisting and untwisting. Consequently, in a transverse plane, these non-rigid connections may have

just as well been rigid because of the bending moment stresses induced in the connections.

Finally, at least one prior art connector sought to allow for blade twist and untwist but the construction was relatively complex, requiring the use of pivotal pins and pivot members.

OBJECTS OF THE INVENTION

Accordingly, it is an object of this invention to provide an improved turbine blade lashing device which under ordinary operating conditions will be free of transverse loadings.

It is another object of this invention to provide a turbine blade lashing device which will freely allow normal twisting and untwisting of turbine blades.

It is another object of this invention to provide a turbine blade lashing device which will prevent extreme and extraordinary differential blade movement.

It is another object of this invention to provide a blade lashing device which requires a minimal cross-sectional area for interconnecting turbine blades and is relatively simple in construction.

Other objects, advantages and features of the present invention will become apparent from the following description of the preferred embodiment thereof when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevation view of a portion of a turbine wheel showing the present invention applied thereto.

FIG. 2 is a plan view taken at Section II—II of a pair of interconnected turbine blades with the present invention applied thereto and the turbine wheel at standstill.

FIG. 3 is a plan view taken at Section II—II of a pair of interconnected turbine blades with the present invention applied thereto and the turbine wheel at running speed.

FIG. 4 is a cross section view of the sleeve and lug interconnected.

SUMMARY OF THE INVENTION

According to the present invention, a turbine blade lashing is provided for a turbine wheel having a plurality of radially extending blades. A lug is formed on each blade face and opposing lugs are hingedly interconnected by a sleeve. This sleeve is provided with clearances and relief cuts to allow limited untwisting of blades without causing transverse loads to be applied to the sleeve and lugs.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, a turbine wheel, shown generally at **11**, is formed with a plurality of radially extending blades **13** attached by means of dovetail connection **15** to a turbo machine rotor **17**. The manner in which the blades are attached to the rotor is merely illustrative and any known method of attachment may be used in this invention.

Each blade face **19** is formed with a boss **21** and a lug **22** as is shown best in FIGS. 2 and 3. The boss and the lug may be fabricated by any known method and preferably are located at a point from one-half to two-thirds radially outward on the turbine blade. A sleeve **23** is movably mounted between opposing lugs, thereby interconnecting turbine blades. The lugs are generally machined from a portion of the boss which is forged or otherwise attached to the blade face. There is a radius **24** formed on the lug to help promote articulation of the sleeve as will later be described.

As is shown in FIG. 4, the lug and the sleeve member are somewhat similar in cross section. Preferably, the cross sections of the sleeve and the lug are streamlined to provide a more efficient fluid flow path. A non-circular cross section prevents rotation of the sleeve about the lug which may occur under certain fluid flow conditions causing premature wear of the device.

The sleeve is fabricated with two side cuts **25**, one cut at each end of the sleeve member, one cut being diagonally opposite and parallel to the other cut when viewed from a plan view as shown in FIGS. 2 and 3. The cuts each extend from either side of the sleeve to a point approximately midway between the sides of the sleeve. These cuts in the sleeve permit the blades to twist and untwist for a limited amount without developing transverse loads on the lugs and sleeve which ordinarily can be very significant.

As viewed in FIG. 4, the lug and the interior circumference of the sleeve have clearances **27** and **29** provided therebetween. The clearance **27** acting in concert with the radius on the lug allows articulation in the transverse direction as blades twist and untwist. The clearance **29** is more pronounced when the machine is up to speed since this throws by the sleeve radially outwardly and this permits articulation in the radial direction between adjacent blades. Finally, clearances **31** between each end of the sleeve and the boss on the blade face further allow for blade articulation.

While the drawings sequentially show the blades in a twisted position at standstill, this being the preferred construction, allowing the blades to untwist when the machine is up to speed, it is also possible that the blades could be aligned in an untwisted mode at standstill so that they would twist at speed.

The device operates as follows. As a turbo machine rotates to speed, the blades attached to the rotor will have a tendency to either tiwst or untwist, depending upon the fabrication of the blades to the rotor. As is shown in a sequential viewing of FIGS. 2 and 3, the cuts on the sleeve, the clearances between the sleeve and the boss on each blade face, the radius on the lug and the associated interior clearances all allow the blades to move relative to one another a permissible amount without transversely loading the lugs and sleeve. In effect, this invention allows an articulating relation to exist within the blade lashing rather than introducing transverse stresses into the lashing.

Since the sleeve is supported on the lugs, there is a frictional damping effect between adjacent blades which reduces vibratory stresses while the machine is running.

While there is shown what is considered at present to be the preferred embodiment of the invention, it is of course understood that various other modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A blade lashing device for a turbo machine including a plurality of radially extending rotor blades mounted circumferentially about the turbine rotor, each rotor blade mounted adjacent another rotor blade to provide closely adjacent opposing blade faces; each opposing blade face formed with a boss having a lug extending therefrom; said blade lashing device including:

- a sleeve interposed between each pair of opposing blade faces and mounted on each pair of opposing lugs;
- a cut formed at each end of the sleeve, one cut diagonally opposite the other cut; and,
- a clearance provided in the radial direction, with respect to the rotor axis, between each boss and the sleeve ends.

2. The blade lashing device as described in claim **1**, wherein each cut extends form either side of the sleeve approximately midway between the sides of the sleeve.

3. The blade lashing device as described in claim **1**, wherein each lug is formed with a radius.

4. The blade lashing device as described in claim **1** wherein there are clearances formed between the lug and the interior circumference of the sleeve.

5. The blade lashing device as described in claim **1** wherein the lug and the sleeve are non-circular in cross section.

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