Nov. 22, 1932. P. FABER 1,888,795

TURBINE BLADE LASHING

Filed July 18, 1930

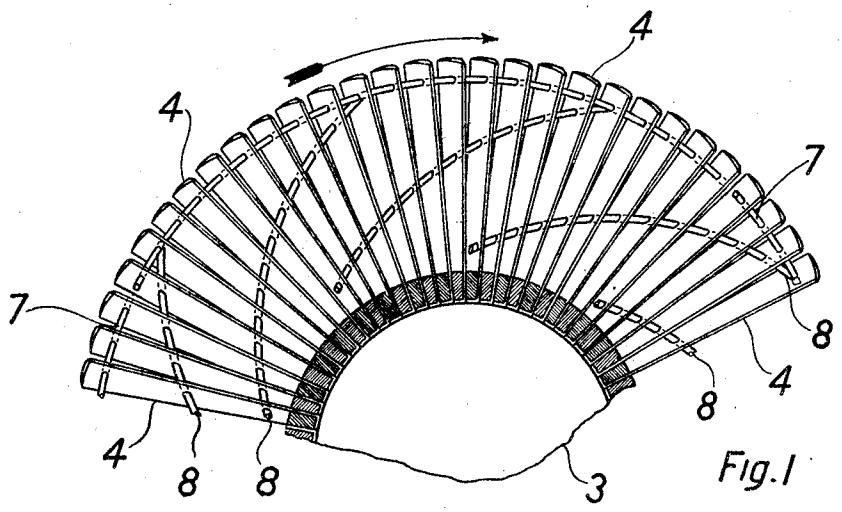


Fig. 1

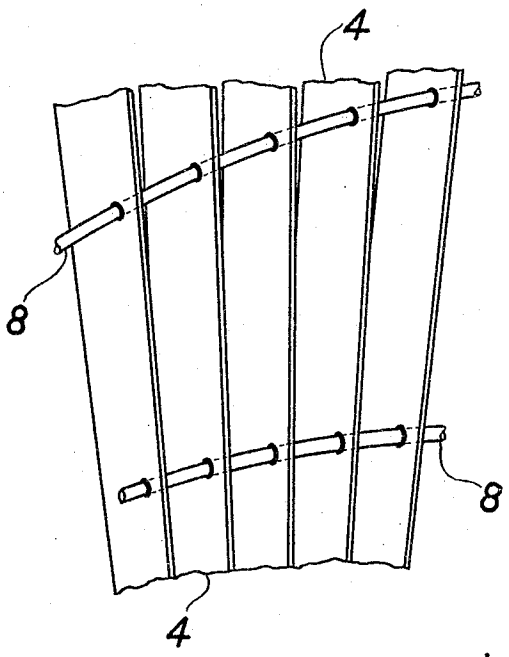


Fig. 2

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TURBINE BLADE LASHING

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This invention relates to improvements in turbine construction and particularly to a lashing arrangement for stiffening the blades of turbine rotors.

Turbine blades were heretofore generally connected by wires which extended through or along the edges of the blades in a circular direction concentric with the shaft or along diagonals from adjacent the root to substantially the tips of the blades. Such connecting or lashing wires were attached to the blade by soldering or other suitable means for the purpose of preventing oscillation, vibrations, or distortions due to operating medium impulses, irregularities in manufacture or non-uniform heat expansions in the structure. The lashing wires and other means connecting the blades must, however, be cut off at a plurality of points to allow for the different rates of expansion in the rotor structure when the temperatures change as in starting or stopping the machine. The blades are, therefore, generally divided into a plurality of connected sections which in the known structures are subject to vibrations or oscillations due to external causes so that the different sections of blades are caused to oscillate at the same frequency.

When the blades of turbine rotors are lashed as above set forth, the blades vibrate in the plane of the least moment of inertia. Such vibrations have two nodal diameters on the blade circle or circumference, which diameters remain stationary as the wheel rotates. Blades located a quarter of a wheel circumference apart will therefore swing in opposite directions so that the shroudings secured to the tips of the blades should exceed a quarter of the circumference in length and the lashing wires should be so arranged that the several sections are substantially a whole.

If the lashing is arranged in the form of a logarithmic spiral as hereinbelow described and as shown in the accompanying drawing, it will be found that deflections of the blades under load are prevented which effectually stiffens the blades against vibration in the plane of the moment of least inertia and also that sufficient flexibility is retained to permit differential expansion between the blades and the drum of the rotor structure. All components of circumferential blade deformations are avoided and, therefore, all bending at right angles to the plane of least inertia is prevented. Spiral lashings are under tension only and relieve all bending stresses at the points of attachment between the lashing and the blades due to the torque of the wheel.

It is, therefore, among the objects of the present invention to provide an improved blade lashing arrangement for turbine rotors which will prevent the occurrence of vibrations therein.

Another object of the invention is to provide a turbine rotor construction in which the blade lashing is under tension only and which avoids bending stresses at the points of attachment thereof with the blades.

Another object of the invention is to provide a turbine rotor structure in which the blade connecting or lashing arrangement is such as to avoid tangential components in the plane of the least moment of inertia of the wheel.

Another object of the invention is to provide a turbine rotor in which the blades are connected by a shrouding of more than a quarter of the circumferential length and are further connected by lashing wires extending in a logarithmic spiral from substantially the roots of the blades to the tips thereof thereby uniting the entire blade structure and forming substantially a single unit.

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

Figure 1 is a side view of a portion of one stage of a turbine rotor embodying the present invention, and

Fig. 2 is an enlarged fragmentary view of a portion of the structure shown in Fig. 1.

Referring more particularly to the drawing by characters of reference, the reference 3 designates a turbine rotor shaft or drum on which are secured a plurality of blades 4 by means of any suitable fastening or wedging means. The ends of the blades 4 on the shaft are hereinafter designated as the root

ends and the free ends are called the tip ends of the blades. The tip ends of the blades 4 are fastened together by a lashing wire 7 passing through the blades on the longitudinal axes thereof in a direction substantially concentric with the shaft 3. The wire 7 is cut at several points on its length in such manner that each section of the wire extends around more than a quarter of the circumference of the rotor stage. The blades are likewise connected into a plurality of sections by lashing wires 8 extending from points adjacent the root ends of the blade to points adjacent the lash wires 7 on a logarithmic spiral through the blades on the longitudinal axes thereof. The spirally arranged lash wires 8 are arranged to overlap each other, i. e. the wire of each section passes through a portion of the blades of the adjacent section. It will be understood that the wires 7 and 8 are suitably secured to the blades by soldering or other suitable means.

It will be seen that the tangential components of blade movement are more completely prevented, that the blades are better connected with a lower number of wires and therefore with less weakening of the blades, and that the points of support are better distributed along the blade length than was the case heretofore with lashing wires extending in a straight line diagonally across or through the blades. The logarithmic spirally-arranged lash wires extend through each blade at the same angle so that the only stresses which need to be considered are tension stresses.

Although but one embodiment of the present invention has been illustrated and described, it will be apparent that changes and modifications may be made thereof without departing from the spirit of the invention or from the scope of the appended claims.

The invention claimed is:

1. In a turbine rotor stage, blades extending radially outwardly from the axis of rotation of said stage, and lashing elements for said blades, each of said elements operating to lash a section of said blades and extending from substantially the root portion of the blade at one end of the section to substantially the tip portion of the blade at the other end of the section, said rotor stage characterized by the fact that the angles of intersection between a lashing element and the respective blades comprising a particular section are substantially equal.

2. A turbine rotor stage comprising blades extending radially outwardly from the axis of rotation of the rotor, and lashing elements for bracing said blades; said rotor stage characterized by the fact that at least one of said elements is in bracing relation with respect to a section of said blades comprising a plurality of the latter and is arcuate in shape and extends from substantially the root portion of the blade at one end of said section in both radial and circumferential directions to substantially the tip portion of the blade at the other end of said section.

3. A turbine rotor stage comprising blades extending radially outwardly from the axis of rotation of the rotor, and lashing elements for bracing said blades; said rotor stage characterized by the fact that at least one of said elements is in bracing relation with respect to a section of said blades comprising a plurality of the latter and is shaped substantially like a portion of a logarithmic curve.

4. In a turbine rotor stage, blades extending radially outwardly from the axis of rotation of said stage, a first set of lashing elements engaging the tip portions of said blades and disposed in alignment circumferentially about the axis of rotation of said stage with their respective adjacent ends disconnected and spaced from each other, and a second set of lashing elements each arcuate in shape and extending across a plurality of said blades from substantially the root portion of one to substantially the tip portion of another.

5. In a turbine rotor stage, blades extending radially outwardly from the axis of rotation of said stage, and a lashing element for a section of said blades comprising a plurality of the latter, said element extending in a generally diagonal direction with respect to said section and being disposed at substantially the same angle to the longitudinal axis of each of the blades comprising said section.

6. In a turbine rotor stage, blades extending radially outwardly from the axis of rotation of said stage, a first set of lashing elements engaging the tip portions of said blades and disposed in alignment circumferentially about the axis of rotation of said stage with their respective adjacent ends disconnected and spaced from each other, and a second set of lashing elements each arcuate in shape and arranged circumferentially about said axis to engage respectively sections of said blades, each of the elements of said second set extending from substantially the root portion of the blade at one end of the respective section to substantially the tip portion of the blade at the other end of such section and disposed at substantially the same angle to the longitudinal axes of the blades comprising such section, the adjacent ends of adjacent elements of said second set overlapping to engage the same blades of adjacent blade sections.

In testimony whereof I have hereunto subscribed my name this 9th day of July, A. D. 1930.

PAUL FABER.