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SHROUD-BLADING FOR TURBINES OR COMPRESSORS

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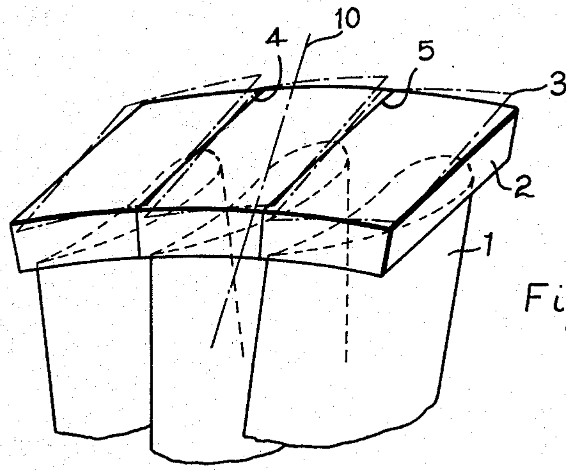

Fig. 1

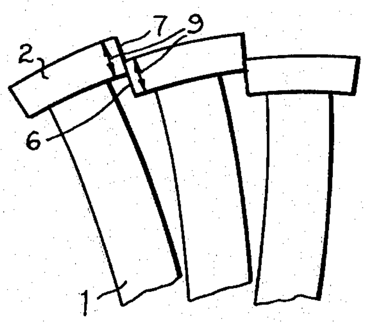

Fig. 2

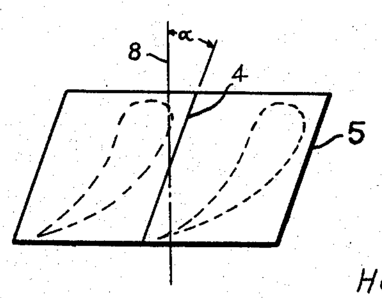

Fig. 3

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SHROUD-BLADING FOR TURBINES OR COMPRESSORS

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2 Claims. (Cl. 253—77)

The invention relates to shroud-blading for turbines or compressors with which the shroud consists of separate shroud plates, the latter not being rigidly connected to one another.

With the construction of turbines and compressors the designer must strive to form the blades so that their natural frequencies do not coincide with the exciting frequencies. This can not, however, be achieved in all cases. The attainment of this goal is made more difficult especially when additional unpredictable exciting oscillations can occur so that it can lead to resonance and thus to blade failures. To avoid this means of damping the blade oscillations are provided.

It is, for example, a known procedure to thread wires through drillings in the blades circumferentially with respect to the blading, which wires are pressed against the sides of the drillings due to the effect of the centrifugal or other forces and the oscillations thus damped by friction. Wires of this type cause additional flow losses.

The task of the invention is to provide a shroud blading for turbines or compressors with which the shroud consists of separate shroud plates, the latter not being rigidly connected with one another, the said blading guarantees sufficient damping of the blade oscillations while still avoiding the aforementioned disadvantages. For this purpose the blades are subjected, during the assembly to a torsional stressing, e.g. in an anti-clockwise direction so as to decrease the angle (α) between lines of contact of the edges of the shroud plates of adjacent blades and a line intersecting such contact lines and which extends parallel to the axis of the rotor.

After assembly, the blades and hence also their shroud plates exhibit a continuous inherent tendency to relieve the stress by untwisting, i.e. by turning back in the opposite direction, i.e. in the present case clockwise, and increase the angle α. This forces the lines of contact between the edges of the shroud plates of adjacent blades to press tightly against each other even during normal running speed of the rotor and hence the contact surfaces of adjacent shroud plates rub against one another laterally when oscillations arise, by which means a damping of the oscillations is attained in a simple manner without the employment of additional design measures being necessary.

A constructional example of the invention is described below with the aid of the drawings.

FIG. 1 is a perspective view, FIG. 2 a side view and FIG. 3 a plan view of the invention.

In FIG. 1 blades **1**, with shroud plates **2** are represented. The shroud plates have a parallelogram-shaped base section viewed in the direction of the blade longitudinal axis and form together the shroud for the blading.

As is to be seen from FIG. 1, the mutual lines of contact **4**, **5** of the shroud plates **2** include an angle with a straight line **10** running parallel to the machine axis, in the assembled and working condition. The metallic blades **1** are made from conventional blading material which is inherently elastic and hence possess an inherent property of being able to recover from stresses imposed within the elastic limit of the material upon relief of torsional stressing forces to which they are subjected. The recovery is

only partial since the blades remain under a torsional stressing even after assembly. The torsional stressing is accomplished by flexing in a torsional manner the shank portions of the blades carrying the shroud plates relative to the root portion of the blades which remain fixed, thereby to establish a continuous frictional pressure engagement between the adjoining side faces of the shroud plates brought about by the inherent tendency in the blading to recover its normal unstressed condition. In FIG. 3 a plan view of the shroud plates is represented in which view is indicated with **8**, a straight line cutting the lines of contact of adjacent shroud plates and running parallel to the turbine or compressor axis and, with α the angle included by this straight line **8** and the lines of contact of the shroud plates. If the blades are stressing torsionally so as to be twisted on their longitudinal axis—in the case of the constructional example, anticlockwise so as to decrease angle α—a gap is then formed temporarily between the shroud plates **2** which at the same time adopt the position indicated in FIG. 1 by dot-dashed line **3**. When the stressing is released, the restoring force which inherently ensues results in a twisting of the blades in a clockwise direction, which corresponds thus to an increase in angle α, causes on the other hand the separate shroud plates to lie, or resp., press against one another.

The blades **1** are so shaped that they display in the assembled static condition, as well as in the working condition with the rotor, for example, operating at normal speed, a torsional stressing which in the case of the constructional example results in a tendency for the blades to twist back in clockwise direction so that the shroud plates of adjacent blades will always be pressed against one another in the circumferential direction.

Now when bending oscillations occur at the blades as shown in FIG. 2, the shroud plates rub against one another with their surfaces **6** and **7** in direction of arrow **9** so that the oscillations are damped.

Compared with the blade design employing wires to damp the oscillation, this design has an additional advantage in that the oscillations are also damped when all the blades are oscillating in phase or when damping wires would not be sufficiently firmly pressed by the centrifugal or flow forces.

Due to the stressing it is additionally achieved that the basic torsional oscillation at least can not occur.

As there is no play in the assembled and working condition between the shroud plates, some possible means of compensating thermal expansions must be provided, as explained hereinafter.

A further development of the invention thus allows for this purpose that the value of the tangent of angle α (FIG. 3) between the mutual lines of contact **4**, **5** of the shroud plates and a straight line **8** cutting these edges of contact and running parallel to the turbine or compressor axis may be so chosen that it is greater than the coefficient of friction between the surfaces of the contacting sides **6**, **7** of the shroud plates **2**.

By giving the contacting lines **4**, **5** of the shroud plates **2** a correspondingly large inclination to a straight line cutting these edges of contact and running parallel to the turbine or compressor axis and this in the assembled condition, i.e. a correspondingly large angle α is thus provided, the blades can twist against the pre-applied torsional stressing so that angle α diminishes, on thermal expansions appearing, by this means the distance apart of the contact lines **4** and **5** of the individual shroud plates, as projected on to the blading periphery, remains constant. At the same time it is guaranteed by the measurement of angle given above, that this twisting of the blades which compensates the thermal expansions is not reduced as a result of self-restraint by friction. If necessary the surfaces of contact **6**, **7** of the shroud plates **2** can be treated by any known method, such as by chrome plating, for the reduction of friction or, resp., the easing of the compensating movements. A reduction of this type in the friction does not have a detrimental effect on the damping of the oscillations as by means of the arrangement as according to the invention the blade oscillations are not to be completely checked but correspondingly damped by friction.

The invention is not limited solely to the constructional example, it can, for example, be employed both for moving and guide blading.

What I claim is:

1. A shrouded blading assembly for rotary machines such as turbines and compressors, each blade being composed of a material having an inherent property of recovery from torsional stressing forces imposed within the elastic limit of the material, each said blade including as an integral part thereof a shroud plate constituting its appertaining portion of the complete shroud ring established by the assembly of all blades, said shroud plates having the configuration of a parallelogram and with adjoining side faces thereof lying in contact with each other at an angle which is oblique to the axis of rotation of said machine, said blades being stressed torsionally from an

unstressed condition by torsional flexure of the shank portions thereof carrying said shroud plates relative to the fixed root portions of the blades thereby to establish a continuous frictional pressure engagement between the adjoining side faces of said shroud plates brought about by the inherent tendency in the blading to recover its normal unstressed condition.

2. A shrouded blading assembly as defined in claim 1 wherein the tangent of said oblique angle is greater than the coefficient of friction existing between the adjoining side faces of said shroud plates.

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