July 16, 1929. H. J. HANZLIK 1,720,729

BLADE FASTENING

Filed March 29, 1928

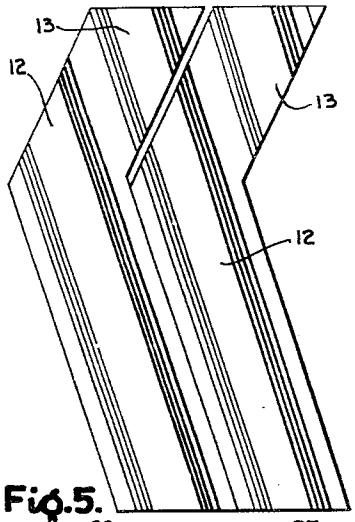


Fig.5.

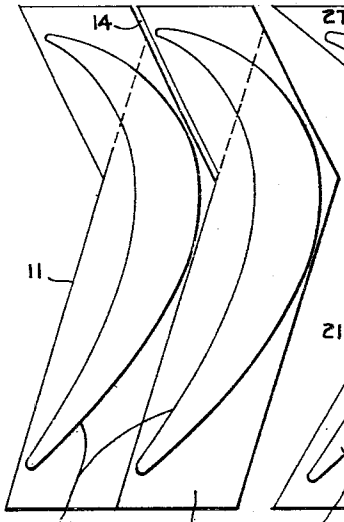


Fig.1.

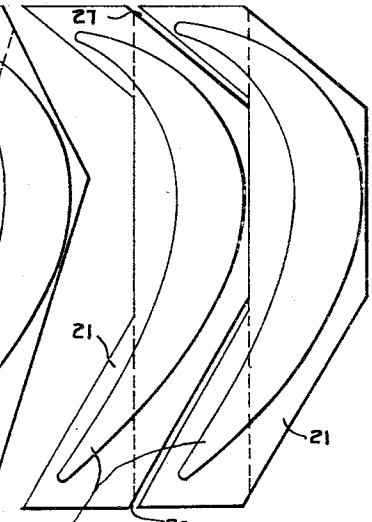


Fig.2.

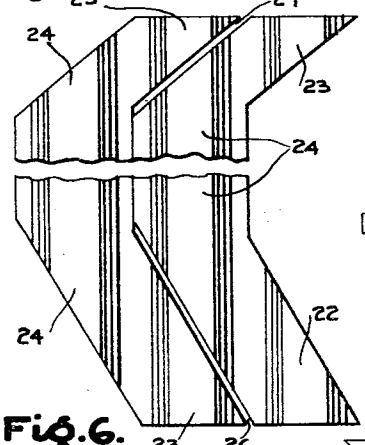


Fig.6.

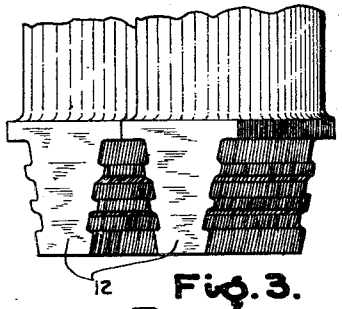


Fig.3.

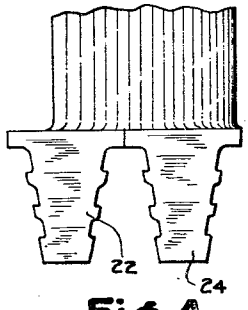


Fig.4.

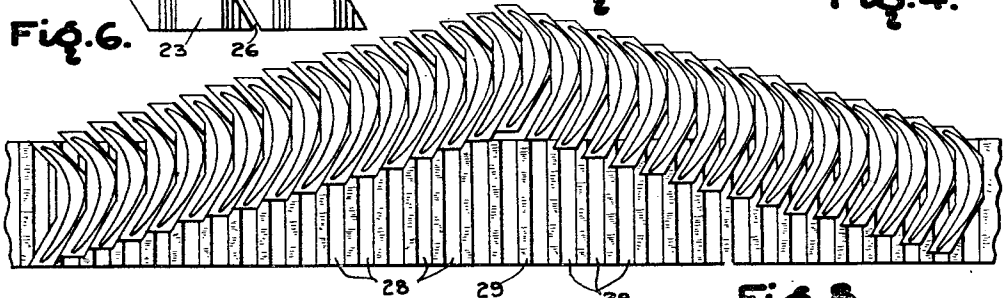


Fig.8.

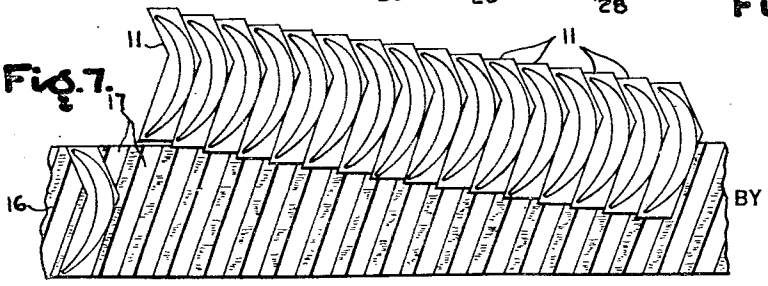


Fig.7.

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UNITED STATES PATENT OFFICE.

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BLADE FASTENING.

Application filed March 29, 1928. Serial No. 265,611.

My invention relates to elastic fluid turbines, and more particularly to the blading for such turbines, and it has for an object, to improve the construction of apparatus of this character.

From a manufacturing and assembling point of view, it is advantageous to have blades provided with root portions which may be anchored in straight slots, as this type of construction is relatively inexpensive to manufacture and is easily assembled. While this type of construction possesses these advantages from a manufacturing standpoint, there are certain conditions, dependent upon the design of the blades and upon the operating speeds, which have considerably limited its field of application. For example, it often occurs that the curvature and the spacing of the blades is such that, if provided with a root adapted to be fitted into a straight slot, the inlet and outlet edge portions of a blade would overhang its root and hence, upon operation, objectionable bending moments would be created due to the centrifugal force acting through the centers of gravity of these overhanging edge portions of the blade. These bending moments tend to flex a blade about its anchoring means.

In order to give a blade sufficient strength to enable it to withstand the stresses due to these bending moments, it has been considered necessary to make the entire blade relatively heavy. This increases the weight, not only of the blading, but of various component parts of the entire turbine, since if the blades are made heavier, the spindle must be made heavier to withstand the stresses due to the increased weight of the blading, and likewise, the supporting means for the spindle must be made stronger.

For any given speed of rotation, the stresses set up in a rotor due to centrifugal force are a function of the weight of the rotor, as well as of its speed of rotation. Hence, the permissible stress for the material of which the rotor is composed may prove to be a limiting factor which determines the maximum diameter and speed of rotation of the machine. If the weight of a rotor could be, comparatively, decreased, then the diameter of the rotor, or its speed or rotation, or both could be increased without exceeding the permissible stress. It will be clear, therefore, that if the blading can be improved so as to permit the use of a lighter rotor, then machines of this class can be made in larger sizes and designed to operate at higher speeds than has heretofore been possible.

Furthermore, the sectional area of a blade is often abruptly changed where the base of the blade proper joins the root portion. Where blades of the larger sizes are arranged to be secured in straight slots, a considerable reduction in sectional area at the juncture of the blade proper and the root is often necessary. As is well known, these abrupt changes in sectional area are undesirable, as they result in an abnormal concentration of stresses in the outer fibers where the smaller section joins the larger and hence, render a blade more susceptible to elongation, or fracture at such points.

More particularly, therefore, an object of my invention is to provide turbine blading with anchoring projections which shall be adapted to be secured in substantially straight slots in a rotor, and which shall be so constructed and arranged as to have a relatively gradual change in sectional area from the anchoring portions to the blade portion thereof, and to so improve the construction and the arrangement of the anchoring means that the weight of a turbine may be appreciably reduced.

This and other objects are effected by my invention, as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Figs. 1 and 2 are plan views of turbine blading;

Figs. 3 and 4 are elevations of the root portions of the blading shown in Figs. 1, and 2 respectively;

Figs. 5 and 6 are bottom views of the blading shown in Figs. 1 and 2, respectively;

Fig. 7 is an assembly view showing the manner of assembling the blading shown in Fig. 1, and

Fig. 8 is a view similar to Fig. 7, but showing the manner of assembling the blading shown in Fig. 2.

In accordance with my invention, the central portion, as well as the edge portions of a blade are provided with independent anchoring projections which are adapted to be inserted in substantially straight slots in the rotor. The anchoring projections are, pref-

erably, also arranged so as to have their sectional area gradually reduced from the blade section. In this way the stresses due to the moments produced by centrifugal force acting on the various portions of the blade are so materially reduced as to be practically negligible and hence, a much lighter rotor construction is made possible. Further, due to the relatively gradual reduction in sectional area from the blade section to the root section, a more rigid construction is obtained.

In Fig. 1 of the drawing, I show the blades 10 spaced fairly close together, and it will be obvious to those skilled in this art that, if these blades were arranged to be mounted in straight slots in a rotor in the usual manner, there would be a considerable portion of each blade in the vicinity of its inlet and outlet edges which would extend to one side of the anchoring slot in the rotor and, in all probability, a portion of the back of the blade would extend beyond the anchoring slot in the opposite direction. The action of centrifugal force on these offset, or extending portions would create bending moments and, consequently, the blade would have to be relatively heavy.

In order to overcome these objections, I form an enlarged portion 11, about the base of the blade, and, preferably, integral therewith. This enlargement may take any suitable form, being preferably arranged to have any convenient number of side walls and, by arranging the adjacent side walls in angular relation with respect to one another and the opposite side walls substantially parallel, it will be obvious, from Figs. 1 and 5, that these enlargements 11 may be fitted contiguous to one another, the walls of one side of one enlargement being complementary with respect to the opposed side walls of the enlargement 11 formed on the next adjacent blade.

In Figs. 3 and 5 I show the manner in which the anchoring projections, or roots 12 and 13 depend from the enlargement 11. While these anchoring projections have serrated side walls to interlock with complementary serrations in the walls of the retaining slots in the rotor, and are, in general, in a form well known in this art, it will be observed that these anchoring projections are offset with respect to each other so that each projection fits into a different slot.

By providing a plurality of anchoring projections for each blade in this manner, it is possible to obtain a very gradual change in sectional area between the blade and its root portion and thus, to avoid any objectionable concentration of stresses in the outer fibers of the root portion. It is also possible to do away with the bending moments, which have heretofore presented a serious obstacle, for with this type of construction it will be observed that the blade does not extend to either side of its root portion and the retaining slots therefor and hence, the possibility of bending moments due to centrifugal force is practically eliminated.

In order to provide for readily assembling blading of this type the enlarged portion 11 of each blade may be so arranged that when the blades are assembled, as shown in Fig. 1, there will be a small clearance space between two opposed side walls of the enlargements of adjacent blades, as for example, the space 14 shown between the upper opposed side walls in Fig. 1.

In Fig. 7 I show a simple and expedient method of assembling the blades shown in Fig. 1. The rotor 16 is provided with straight slots 17 for receiving the roots 12 and 13. The uppermost blade in this figure is just outside of the rotor and the next blade on the right has been moved downwardly, or toward the rotor a sufficient distance to take up the clearance 14 shown in Fig. 1, and this process has been repeated progressively down the row until, it will be observed that the last blade on the right is well started into its proper anchoring slots, only, of course, it will be obvious that this process is begun with the blade on the extreme right in this figure. By repeating this process a few times the blades may be gradually advanced into their proper positions.

In Fig. 2, I show blades 20 having even greater curvature than the blades 10 shown in Fig. 1, and these blades 20 are also provided with enlargements 21, which have their sides so arranged that those of one enlargement will be complementary with respect to those of the next adjacent enlargement. It will also be observed that the opposite side walls of each enlargement are substantially parallel and that those portions of each enlargement 21 which extend beneath the inlet and outlet edges of the blade have their side walls inclined away from the central portion in order to follow the general direction of the curvature of the blade.

With this type of blading, I provide three anchoring projections, or roots 22, 23 and 24, as shown in Fig. 6, the projections 22 and 23 being beneath the respective inlet and outlet edge portions of the blade and being preferably arranged to fit into the same slot in the rotor, while the projection 24 beneath the central portion of the blade is preferably arranged to fit into the next adjacent slot.

To provide for readily assembling blading of this type, the enlargements 21 are arranged so that when fitted together as shown in Fig. 2, there will be two clearance spaces 26 and 27, respectively, between the opposed side walls of the outer end portions of the respective enlargements 21. The blades are assembled in the straight slots 28 in the rotor 29 in the manner shown in Fig. 8. From this figure, it will be apparent that by arranging a number of blades, to be assembled, in a row

in proper alignment with the slots in the rotor and then advancing the blades on the extreme ends of the row toward their respective slots a sufficient amount to take up the clearances 27 as shown on the right in Fig. 8 and to take up the clearances 26, as shown on the left in this figure, the process may be started. This procedure is then repeated with the blades next to those on the extreme ends and so on, advancing from both ends of the group toward the central blade and, when this blade is reached, beginning again in the same manner with blades on the ends of the group, and repeating the process until all the blades of the group are in proper position.

It will readily be seen that I have provided a simple and yet rigid and efficient type of construction suitable for blades of any curvature, or size. By providing a plurality of anchoring projections, or roots in offset, or staggered relation on each blade, a rigid connection is assured and the blades have no portions which extend laterally of their roots to create bending moments. Moreover, this type of construction provides for a gradual reduction in section from the blade proper to its root portions and thus assures good stress distribution.

Furthermore, a double root blade, of the type described, locks the individual projections of the wheel rim together. Such a condition does not exist with a single root blade, for with the latter type, if the blade and disk rim expand by centrifugal force, there is a tendency for the blade roots to loosen as the circumference of the rim is enlarged.

These advantages are gained, not only without in any way increasing the cost of the rotor, for it will be remembered that the blades are secured in straight slots which may be readily formed, but, by practically eliminating the bending moments due to centrifugal force, it becomes possible to make the blades of much lighter construction and consequently the rotor may also be made of lighter construction and hence, a considerable saving effected.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. The combination with a turbine rotor having longitudinally extending slots therein for anchoring the blading, of blades, a plurality of independent anchoring projections on each blade, one projection of each of adjacent blades being adapted to be secured in the same slot.

2. The combination with a turbine rotor having longitudinally extending slots therein for anchoring the blading, of blades, a plurality of anchoring projections arranged in staggered relation on each blade, whereby alternate projections of adjacent blades may be secured in the same slot.

3. The combination with a turbine rotor having longitudinally extending slots for anchoring the blading, of a plurality of independent anchoring projections on each blade, one anchoring projection being connected to an edge portion and another anchoring projection being connected to the central portion of the blade, said one and said another anchoring projections of each blade being arranged to fit different slots.

4. The combination with a turbine rotor having longitudinally extending slots for anchoring the blading, of a plurality of independent anchoring projections on each blade, one anchoring projection being connected to an edge portion and another anchoring projection being connected to the central portion of the blade, said one anchoring projection of one blade and said another anchoring projection of another blade being arranged to fit the same slot.

5. The combination with a turbine rotor having longitudinally extending slots therein for anchoring the blading, of blades, a plurality of anchoring projections on each blade, some projections on each blade being aligned, another projection on each blade being offset from said aligned projections, said aligned projections of one blade and said offset projection of another blade being adapted to be secured in the same slot.

6. The combination with a turbine rotor having longitudinally extending slots therein for anchoring the turbine blading, of blades, a plurality of anchoring projections on each blade, some of the projections of each blade being spaced apart and aligned, another projection on each blade being offset with respect to the aligned projections on that blade and adapted to fit between the aligned projections of an adjacent blade and in aligned relation therewith.

7. A turbine blade having an enlarged portion about the base thereof, a plurality of anchoring projections depending from the enlarged portion and spaced to fit adjacent ones of substantially longitudinally extending slots in a rotor.

8. In an elastic fluid turbine, a row of blades, an enlargement about the base of each blade, and anchoring projections depending from the enlargements, each enlargment having side walls disposed to approximately follow and to include the curvature of its blade and the respective side walls of each enlargement being complementary with respect to the side walls of the enlargement of the next adjacent blade.

9. In an elastic fluid turbine, a row of

blades, an enlargement about the base of each blade, and anchoring projections depending from the enlargements, each enlargement having two or more substantially straight side walls angularly disposed with respect to each other to substantially follow and to substantially include the curvature of a face of the blade, the side walls of one enlargement being complementary with respect to the side walls of the next adjacent enlargement.

10. In an elastic fluid turbine, a row of blades, an enlargement about the base of each blade, and anchoring projections depending from the enlargements, the sides of each enlargement being composed of two or more substantially straight side walls angularly disposed with respect to each other to substantially follow and include the curvature of the respective front and back faces of the blades, the side walls of one enlargement being substantially complementary with respect to the side walls of the next adjacent enlargement, a pair of the opposed side walls of adjacent enlargements being juxtaposed in substantially co-planar relation and another pair of opposed side walls of adjacent enlargements being spaced apart a relatively small distance to provide a clearance space for assembling the blade.

In testimony whereof, I have hereunto subscribed my name this 23rd day of March, 1928.

HENRY J. HANZLIK.