Feb. 24, 1931. B. V. DENSMORE 1,793,468

TURBINE BLADE

Filed May 28, 1929

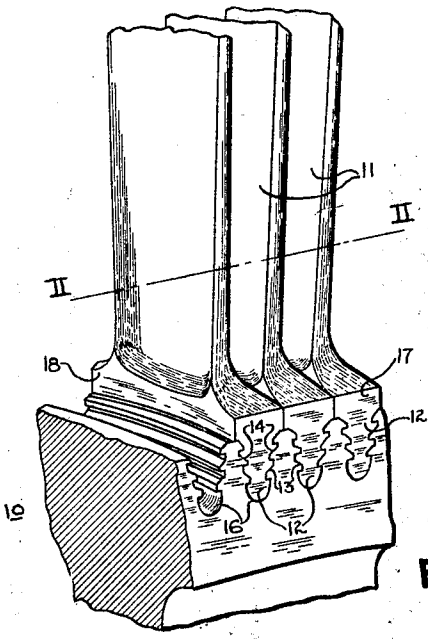


FIG. 1.

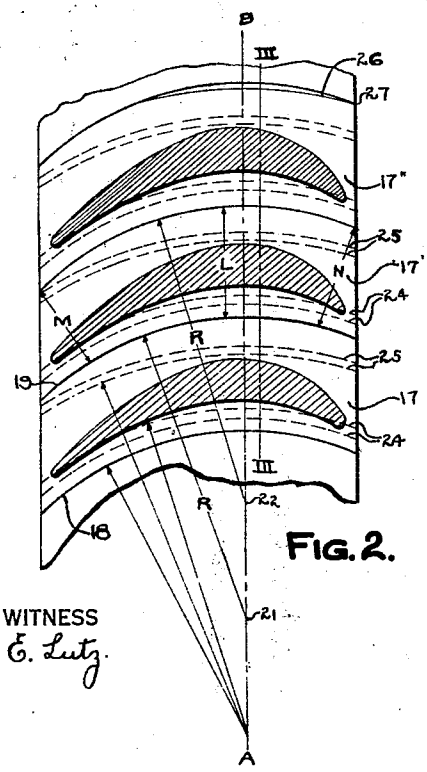


FIG. 2.

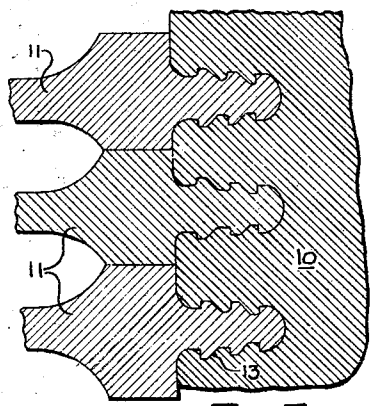


FIG. 3.

WITNESS
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UNITED STATES PATENT OFFICE

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TURBINE BLADE

Application filed May 28, 1929. Serial No. 366,618.

My invention relates to an elastic fluid turbine, more particularly to the blading thereof, and it has for an object to provide an improved construction of blading.

More particularly, my invention relates to turbine blades of the side entry type in which the root portions are curved to conform in a general way to the curvature of the blade, for the purpose of providing increased strength with minimum space requirements, as fully set forth in the copending application of Goldie Back, Serial No. 219,485, filed September 14, 1927, patented July 2, 1929, No. 1,719,415, and assigned to the Westinghouse Electric & Manufacturing Company.

In the construction described in the above mentioned application, the rotor is formed like a disc with transverse, serrated retaining grooves or slots of curved form and the roots of the blades are properly shaped to fit into these curved retaining grooves. The blades are secured against radial movement by the interfitting serrations in the side walls of the grooves and the roots, respectively.

A particular object of my invention is to provide means for bracing the blades against each other adjacent the root portions, and thus to provide a more rugged type of blading construction.

A further object is to provide means for locking the blades in their retaining grooves against axial movement, that is, movement lengthwise of the groove.

In accordance with my invention, the base portions of the respective blades are provided with buttress-like enlargements having arcuate side walls, the side walls of each enlargement being adapted to abut the side walls of the next adjacent enlargement in such a manner as to brace the blades against movement lengthwise of their retaining grooves. The side walls of the enlargements are so formed that with one blade mounted in place, the next adjacent blade can be inserted without interference of the adjacent side grooves, this being preferably accomplished by forming the said adjacent side walls of the enlargements and the sides of the root portion of said next adjacent blade about a common center. These enlargements thus serve the dual purpose of strengthening the blades and of locking them in the rotor.

The above 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:

Fig. 1 is a perspective view of a portion of a turbine rotor, showing some of the blades in place;

Fig. 2 is a section on the line II—II of Fig. 1; and,

Fig. 3 is a section on the line III—III of Fig. 2.

In the drawing, I show a turbine rotor in the form of a disc, indicated generally, at 10, in Fig. 1, and fitted with a number of blades 11 arranged in a row about the periphery of the rotor. The blades 11 are provided with root portions 12, which are curved transversely, or in the direction of fluid flow, to conform in a general way to the curvature of the blades, and which are provided with serrations 13 adapted to interlock with serrations 14 formed in the side walls of the transverse retaining grooves 16. These retaining grooves are, of course, curved similarly to the root portions. The serrations 13 and 14, therefore, serve to restrain the blades from moving radially in their respective grooves.

In this type of construction, the curved root portion follows approximately the curvature of the blade section so that the blade is directly over its anchoring projection, or root portion and hence, the bending stresses are greatly reduced and a relatively strong and compact anchorage is provided.

In order to provide for bracing and strengthening such blades at their base portions and to provide for locking the respective blades against movement lengthwise of the respective retaining grooves, I have provided buttress-like enlargements 17 on the base portions of the respective blades, and these enlargements have arcuate side walls, the curvature of which is similar to that of the retaining grooves. Each enlargement has a concave side wall 18 and a convex side wall 19, the concave side wall of each enlargement being adapted to abut the convex

side wall of the enlargement of the next adjacent blade, and, due to the curvature of the respective side walls, to lock the blades against axial movement.

This will be more apparent from a consideration of Fig. 2, wherein the convex side wall 19 of the enlargement 17, is shown as an arc described about the center 21 and having a radius R. As shown in this figure, the center 21 falls upon the line AB which is parallel to the side of the rotor disc 10, and intermediate the axial extent of the enlargements.

For convenience, the enlargements shown in Fig. 2 have been designated as 17, 17′ and 17″ respectively. The convex side wall 19 of the enlargements 17 obviously must have the same curvature as the juxtaposed, concave side wall 18 of the adjacent enlargement 17′, for otherwise, it would not be possible to slide the enlargement 17′ past the enlargement 17 in inserting the blades into their respective slots in the rotor. Spaced from the center 21, along the line AB a distance equal to the maximum thickness of the enlargement 17′ is the center 22 about which the convex side wall 19 of the enlargement 17′ is formed as an arc having the same radius R. Likewise, the concave side wall of the next enlargement 17″ is formed in a similar manner with the same radius about the same center.

Considering the enlargement 17′, it will be seen that as the opposite side walls of this enlargement are formed as arcs having the same radius of curvature, but having different centers, this enlargement must have its maximum thickness circumferentially of the rotor on the line AB as designated by the dimension L. Since, if the arc forming the convex side wall 19 of the enlargement 17′ be completed to a circle, then this circle must necessarily intersect a circle formed in the same manner by extending the concave side wall of the same enlargement. Since these circles intersect each other, it follows that the adjacent arcs of these circles must approach each other. Hence, these enlargements have a greater thickness in their central portions than at the sides thereof, and the dimension L will always be greater than either the dimension M, or the dimension N, which indicate the respective thicknesses of the enlargements at the end portions thereof. Furthermore, as the curvature of the adjacent side walls of the respective enlargements is the same in each case, it will be apparent that the blades may be slid into their respective grooves, one at a time, and that each blade will be locked in place between the enlargements of the adjacent blades.

As will be observed from a consideration of the above, the curvature of the root portions and the grooves must be so related to curvature of the enlargement as to permit each blade to be inserted after one of the adjacent blades has been inserted without interfering therewith. A preferred manner of accomplishing this is to form the sides of the root portion and the groove and one side of the enlargement of each blade about a common center; the other side of the enlargement being formed to contact with the enlargement adjacent thereto, that is, about the center of curvature of the adjacent root portion and groove, which is spaced a distance equal to the pitch of the blades at the enlarged portions.

This will be apparent from Fig. 2, wherein the dotted lines 24 and 25, are meant to indicate that the sides of the root portion and the groove associated with the enlargement 17′ are formed about the center 21, which is the center of curvature of the concave side wall 18 of the enlargement 17′. It will thus be apparent that the blade having the enlargement 17′ may be inserted after the blade having the enlargement 17 is in place, and that the concave side wall 18 of the former will slide along the convex side wall 19 of the latter.

Any suitable provision may be made for the insertion of the last blade. For example, if the blade 17″ is the last to be inserted, the convex side wall 19 thereof may be relieved along a curved surface whose center is the center 22, as indicated by the line 26, to provide a maximum thickness equal to the dimension N. This permits the convex side of the enlargement 17″ to pass the corner 27 of the adjacent enlargement. The enlargement 17″ and its associated root portion may then be secured against movement transversely of the rotor in any suitable manner, as by caulking or peening the root portion.

From the above description, it will be seen that I have provided interlocking enlargements for blades of the character set forth, which lock the blades in the grooves and which brace the blades against each other, at the same time forming the enlargements to permit successive insertion of the root portions.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various 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 of a rotor disc having blade-holding grooves disposed transversely of its periphery, and blades having root portions secured in the grooves and provided with enlargements abutting each other along curved surfaces.

2. The combination of a rotor having a row of curved blade-holding grooves, the grooves extending transversely of the row, and blades having curved root portions secured in the grooves and provided with enlargements abutting each other along curved surfaces.

3. In a turbine, the combination of a rotor, a row of blades, means providing for the attachment and detachment of the blades by lateral movement thereof relative to the rotor, and interfitting enlargements carried by the blades, each enlargement having contact surfaces which are convex and concave in a direction transverse of the rotor and the convex and concave surfaces of each enlargement having spaced centers of curvature.

4. In a fluid motor, a rotor and a row of blades mounted thereon, said blades having root portions and enlarged portions intermediate the blades and the root portions, the opposite sides of each enlarged portion being formed along arcuate surfaces whose centers are spaced, circumferentially of the rotor, a distance equal to the pitch of the blades at the enlarged portions, and said root portions being secured in grooves in the rotor extending transversely of the row.

5. In a turbine, the combination of a rotor having curved grooves, each groove having concentric sides, and blades having curved root portions fitting the grooves and having abutments provided with contacting curved surfaces, the root of each blade and one abutment surface of that blade and the contacting abutment surface of the next adjacent blade being all concentric.

6. The combination of a rotor having a row of blade-holding grooves, the grooves extending transversely of the row, and blades having root portions secured in the grooves and provided with abutting enlargements, the sides of the root portion and grooves and one side of the enlargement of each blade being formed along arcuate surfaces having a common center disposed intermediate the axial extent of the grooves.

7. In a fluid machine, a rotor having an annular row of blade-holding grooves extending transversely of the row, and blades having root portions inserted in said grooves and abutting enlarged portions, the sides of each groove and the root portion therein being formed along arcs having a common center, one side of an enlarged portion being formed along an arcuate surface whose center coincides with said common center of the associated root portion and the opposite side being formed conjugate to the adjacent side of the enlarged portion abutting therewith.

8. In a fluid machine, a rotor having an annular row of blade-holding grooves extending transversely of the row, and blades having root portions inserted in said grooves and abutting enlarged portions, the sides of each groove and the root portion therein being formed along arcs having a common center disposed intermediate the axial extent of the grooves, one side of an enlarged portion being formed along an arcuate surface whose center coincides with said common center of the associated root portion and the opposite side being formed conjugate to the adjacent side of the enlarged portion abutting therewith.

9. In a fluid machine, a rotor having an annular row of blade-holding grooves having concave and convex sides and extending transversely of the row, and blades having root portions formed with concave and convex sides inserted in the grooves and having abutting enlarged portions, the concave and convex sides of the grooves and root portions being formed to permit insertion of the root portions in the grooves laterally of the row from one side thereof, means extending laterally of the concave and convex sides of the root portions for anchoring the same in the grooves, one side of the enlarged portion of a blade and the adjacent or abutting side of the enlarged portion of the adjacent blade being formed to permit insertion of the root portion of the first blade while the second blade is in place, and the other side of the enlarged portion of the first blade being formed similarly to the first-mentioned side thereof but spaced therefrom a distance equal to the pitch of the blades at the enlarged portions.

10. In a fluid machine, a rotor having an annular row of blade-holding grooves having concave and convex sides and extending transversely of the row, and blades having root portions formed with concave and convex sides inserted in the grooves and having enlarged portions contacting with each other along contacting surfaces, the concave and convex sides of the slots and root portions being formed to permit insertion of the root portions in the grooves laterally of the row from one side thereof, means extending laterally of the concave and convex sides of the root portions for anchoring the same in the grooves, one side of the enlarged portion of a blade and the adjacent or contacting side of the enlarged portion of the adjacent blade being formed to permit insertion of the root portion of the first blade while the second blade is in place, and the other side of the enlarged portion of the first blade being formed similarly to the first-mentioned side thereof but spaced therefrom a distance equal to the pitch of the blades at the enlarged portions.

11. In a fluid machine, the combination of a rotor having an annular row of blade-holding grooves having curved sides and extending transversely of the row, and blades having blade portions, root portions secured in

the grooves, and abutting enlarged portions intermediate the blade and root portions, said root and enlarged portions having curved sides, one side of the enlarged portion of a blade being concentric with the corresponding side of the root portion of the blade and the opposite side of the enlarged portion being conjugate to the abutting side of the adjacent enlarged portion.

12. In a fluid machine, the combination of a rotor having an annular row of blade-holding grooves having curved sides and extending transversely of the row, and blades having blade portions, root portions secured in the grooves, and abutting enlarged portions intermediate the blade and root portions, said root and enlarged portions having curved sides, one side of the enlarged portions and the corresponding side of the root portion of a blade being formed along arcs having a common center disposed intermediate the axial extent of the grooves, and the opposite side of the enlarged portion being conjugate to the abutting side of the adjacent enlarged portion.

13. In a fluid machine, a rotor having an annular row of blade-holding grooves extending transversely of the row, and blades having root portions inserted in the grooves and having abutting enlarged portions, the side walls of the grooves and the sides of the root portions being formed with interengaging parts retaining the root portions in the grooves but permitting insertion of the root portions in the grooves laterally of the row from one side thereof, the sides of the grooves and the root portions and the abutting surfaces of the enlarged portions being so formed and arranged relatively to each other that when one blade is in place, the root portion of a next adjacent blade may be inserted and when inserted, the enlarged portion thereof contacts the enlarged portion of said one blade and locks the same against movement laterally of the row.

In testimony whereof, I have hereunto subscribed my name this 27th day of May, 1929.

BENJAMIN V. DENSMORE.