R. A. McKEE.

STEAM TURBINE.

APPLICATION FILED MAR. 3, 1906.

937,006.

Patented Oct. 12, 1909.

Fig. 1.

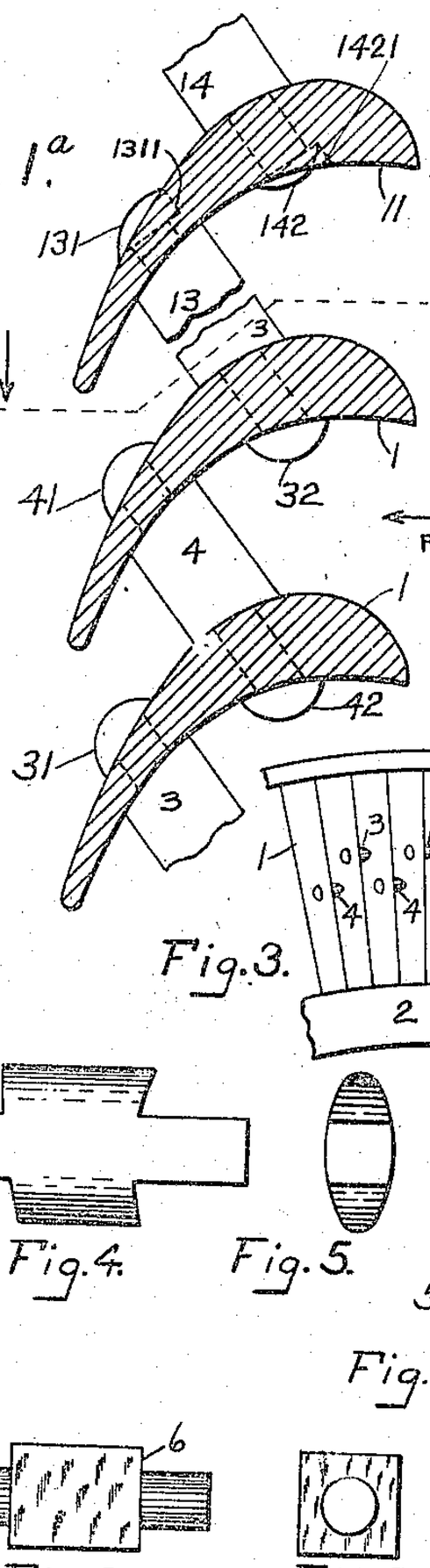


Fig. 1a.

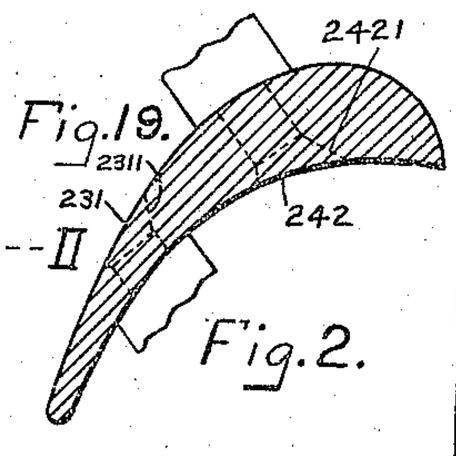
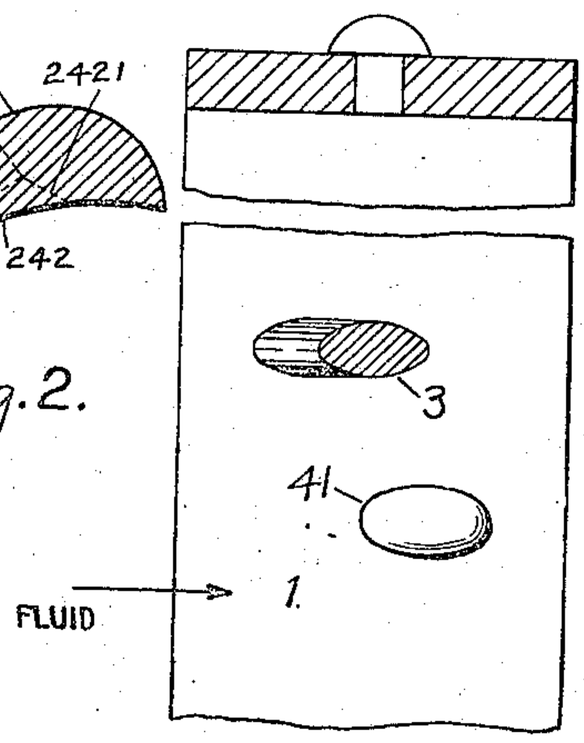


Fig. 19.

Fig. 2.



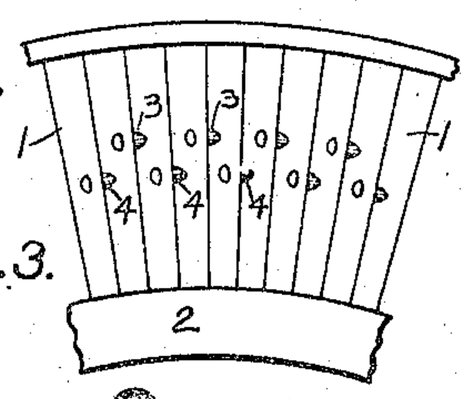


Fig. 3.

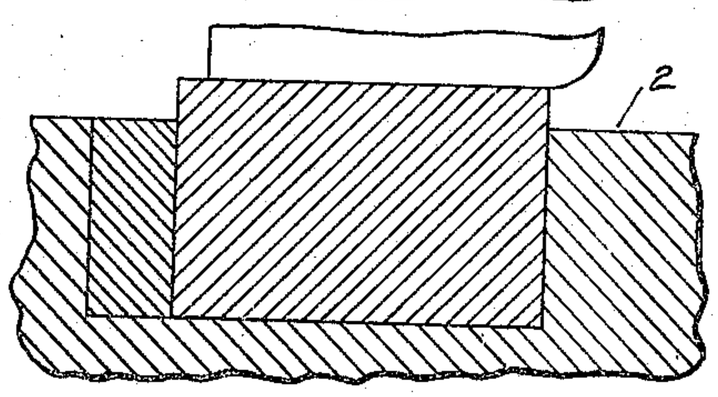


Fig. 4.

Fig. 5.

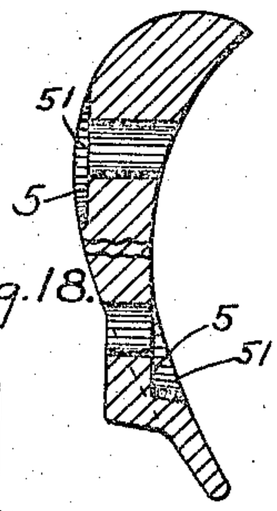


Fig. 18.

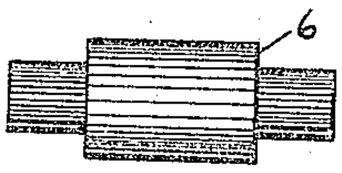


Fig. 12.

Fig. 13.

Fig. 6.

Fig. 7

Fig. 14.

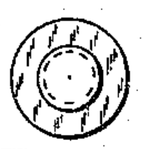


Fig. 15.

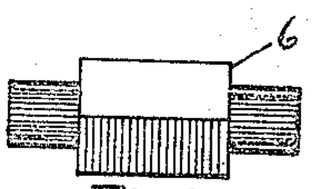


Fig. 8.

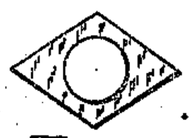


Fig. 9.

Fig. 10.

Fig. 11.

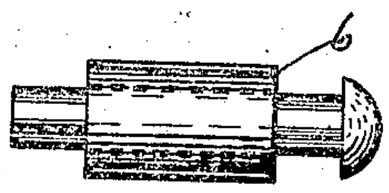


Fig. 16.

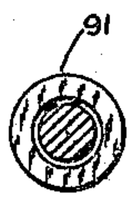


Fig. 17.

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UNITED STATES PATENT OFFICE.

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STEAM-TURBINE.

937,006. Specification of Letters Patent. Patented Oct. 12, 1909.

Application filed March 3, 1906. Serial No. 303,975.

To all whom it may concern:

Be it known that I, ROBERT A. McKEE, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Steam-Turbines, of which the following is a specification.

This invention relates to blowers or turbines generally, either parallel or radial flow, and more specifically to steam turbines in which the rings of blades are alternately attached to a rotor and a stator. When a fluid medium is passed through the turbine, end pressure is directed by the stator blades onto the rotor blades, causing the rotor to rotate. In turbines in which the fluid used is a gas or steam, the blades become of greater length as the fluid expands, or as the velocity is reduced. The question then arises as to how to properly support and stiffen the rings of blades.

This invention is intended to provide means for stiffening or staying the longer blades at any point or points along their length. This means may be embodied into a great variety of modifications, some of which are illustrated and described in the accompanying drawing, in which,

Figure 1 is a sectional view of a portion of the blading looking endwise of the blades. Fig. 1ª is a similar view of a preferred form of the invention. Fig. 2 is a sectional view in the direction of the arrow, on the line II—II, Fig. 1, through a ring of blades, the base being also shown and being broken away. Fig. 3 is a broken view in elevation of a portion of a ring of blades on a reduced scale. Figs. 4 and 5 are elevation and end view respectively of a preferred form of stiffener. Figs. 6 and 7, Figs. 8 and 9, Figs. 12 and 13, Figs. 14 and 15, Figs. 16 and 17, are similar views respectively of various modifications of the stiffening or staying means. Figs. 10 and 11 show a modification somewhat similar to a preferred form, shown in Figs. 4 and 5. Fig. 18 is a cross section of a blade showing how the same may be shaped for the attachment of one form of stiffener. Fig. 19 is a sectional end of a blade and stiffener of a preferred form of the invention.

Referring to the drawings, blades 1 are mounted by any convenient means in a base 2, either a rotor or a stator, one of such means being shown in United States Patent 784,670. Any means is sufficient for the purpose of this invention. The blades shown in the drawing are the longer ones used and ordinarily are at the low pressure end of the turbine, and in certain sizes of turbines may be as much as thirty or forty inches long. In order to make the structure more rigid and also to more certainly space the blades and prevent vibration, stiffeners are provided for the blades at their middle portion. As clearly shown in Fig. 3, these stiffeners connect the blades together in consecutive pairs by riveting together two consecutive blades. This riveting is shown in Fig. 3 as the outer series of riveted stiffeners 3. The pairs are then united by another series of stiffeners 4. This arrangement being a staggered one, causes additional rigidity of the ring of blades. By staggered arrangement is meant the placing of the rivets on each side of a median line alternately. The median line is a circle passing between the inner and outer series of rivets as referred to the base. This arrangement is clearly shown in Fig. 3. A staggered arrangement need not necessarily be used. Instead of being connected in pairs, the blades may be connected together into groups of more than two blades to a group by setting the stiffener at the proper angle to the blades. Such a group or plurality of blades may be connected together by the means shown in Figs. 10 or 16 by using a longer rivet 8 and more than one spacing block 9, 91, instead of one block as hereinafter described in connecting a pair of blades. Adjacent groups of blades thus stiffened may be connected together by another stiffener coacting with one or more of the blades of a group. The stiffeners can be placed at different distances from the base.

From a study of Fig. 1 it will be seen that the stiffeners 3, 4, are so located that they lie parallel to one another and that they are placed at such an angle to the blades in spanning across from one blade to the adjacent blade, that they are endwise accessible from either the pressure or the exhaust side of the series of blades. The function of this positioning is to permit of easy access of the riveting tool in placing the stiffeners, also to bring the stiffeners as nearly as possible normal to the blades. This location of the stiffeners also allows of access to the body

of the stiffener by a tool which may grip the stiffener when the same is attached by screwing, as in the modification shown in Figs. 14 and 15.

Particular attention is directed to the isolation of the point of connection between the stiffeners and the blade. That is, taking any one blade as shown, it is found that there are formed therein two holes for the attachment of the stiffeners, and these holes are at different distances from the base. These two holes are also at different portions of the thickness of the blades as clearly shown at Fig. 1. Such a distribution of the points of attachment between the stiffeners and the blades is conducive to rigidity of the stayed structure.

In an ordinary practice of the invention the form of the stiffeners, see Figs. 4 and 5, is oval in section and the tenoned ends are approximately of square section. The ends of the body of the stiffener are formed to fit the respective blade surfaces. The purpose of the oval shape is to prevent as much as possible the retardation of the steam in passing between the blades and the forming of eddies, the stiffeners being placed with the major axis of the oval section in the direction of the flow of fluid. The tenoned ends of the stiffeners being substantially square in section, will prevent the stiffener from turning after it is in position. The blades are of course in this case formed with substantially square holes to correspond to the shape of the tenons. The protruding ends of the tenons are riveted down to securely hold the blades in place. This riveting may take place either before the blade is otherwise worked, as in Fig. 1, or after the blade is formed with recesses, as in Fig. 1ª. In the former case the riveted heads 42, 32, on the pressure side of the series of blades and those 41, 31, on the exhaust side of the series of blades, project into the fluid space. In the means shown in Fig. 1ª, the blades are first further formed with recesses 1421, 1311, adjacent the tenon ends. These then are riveted into heads 142, 131, which occupy the recesses and project very slightly into the fluid space. The recesses 2421, 2311, see Fig. 19, may be so formed as to be filled by the heads 242, 231, which may be made flush with the curved surface of the blades.

A modification of stiffener is shown in Figs. 10 and 11, which differs from that shown in Fig. 1ª in comprising two parts, a spacing block 9 and a rivet 8 longitudinally centrally therethrough. In applying this form of stiffener, the blades are recessed, as shown in Fig. 1ª. A bolt or screw may be used instead of a rivet if desired.

In all the other modifications of stiffener shown on the drawing, the body of the stiffener is cut square across at its end 6. This shape will necessitate adapting the blades to conform to this square cut end 6 of the body of the stiffener. In other words, the blade must be shaped as shown in Fig. 18, with a plane portion 5 at the bottom of the recess 51, surrounding the holes in the blade, the plane being at right angles to the axis of the hole. In assembling the stiffeners in these modifications, it will be found that the end 6 of the stiffener body will fit snugly against the plane portion 5 at the bottom of the recess 51 formed in the blade.

In the modification shown in Figs. 6 and 7, the body is square in section with round tenoned ends.

In the modification of Figs. 8 and 9, the stiffener body is diamond shaped with round tenoned ends. The acute edge of stiffener is turned toward the flow of steam to prevent eddies.

In the modification shown in Figs. 12 and 13, the stiffener has both its body and tenoned ends circular in cross section.

The modification of Figs. 14 and 15 differs from the last preceding in providing the tenons with right and left screw threads. In attaching this stiffener, the blades are pried apart, the stiffener is inserted between them and is then screwed in place in screw threaded bores in the blades. After the stiffener is screwed tightly in place, the projecting ends may be riveted over, thus firmly uniting the parts.

The modification shown in Figs. 16 and 17 is similar to that of Figs. 10 and 11, in being in two parts. The spacing piece 91 is a short plain tube and is annular in cross section and cut square off at its ends. The blade is recessed, as shown in Fig. 18, for the application of the stiffener.

It will be seen that by this invention a means is provided for rigidly stiffening or staying series of blades. By so stiffening the blade, excessive bending is prevented, accurate spacing assured, and vibration reduced to a minimum.

In accordance with the provisions of the patent statutes, the principle of operation of the invention has been described, together with the means which is now considered to represent the best embodiment thereof; but it is desired to be understood that the means shown is merely illustrative and that the invention can be carried out by other means.

What is claimed and is desired to be secured by Letters Patent is,—

1. A series of end supported, pressure subjected blades and a plurality of means for staying the blades at their middle portions, the axes of the means being severally free from intersection with adjacent blades.

2. A series of end supported, pressure subjected blades and discontinuous means for staying the blades at their middle portions.

3. A series of blades, and means extending through the blades and riveted thereto

and extending obliquely to the series for connecting the blades in groups.

4. A series of blades and discontinuous means extending through the blades and riveted thereto and out of the plane of the series for staying the blades at their middle portions.

5. A base, blades attached to the base, means spaced from the base for connecting the blades in pairs, and means spaced from the base at a different distance than that of the first means, for connecting the pairs of blades, both said connecting means extending through the blades and being riveted thereto.

6. A plurality of spaced blades, and means for connecting the blades in pairs, said means extending through said blades and being riveted thereto and the ends thereof being flush with the outer surfaces of said pairs of blades.

7. In combination, a turbine rotor, a ring of buckets carried thereby, and stay-bolts for strengthening and supporting said buckets, each of which passes through a plurality of adjoining buckets forming part of the ring intermediate the ends of said buckets.

8. In combination, a turbine rotor, a ring of buckets carried thereby, the buckets of said ring being arranged in groups, each group comprising a plurality of individual buckets, and means intermediate the ends of the buckets forming the group for securing them together in spaced relation.

9. In combination, a turbine rotor, a ring of buckets mounted thereon, the buckets of said ring being arranged in groups, each group comprising a plurality of individual buckets, and a stay-bolt located intermediate the ends of the buckets for securing them together in spaced relation.

10. In combination, a turbine rotor, a ring of buckets mounted thereon, the buckets of said ring being arranged in groups, each group comprising a plurality of individual buckets, and devices for securing the buckets forming the group together in spaced relation, comprising a bolt passing through the buckets intermediate their ends, and means carried by the bolt which engages the buckets and spaces them apart.

11. In combination, a turbine rotor, a ring of buckets carried thereby, the buckets in said ring being arranged in groups, each group comprising a plurality of individual buckets provided with a cover attached to their outer ends, means for fastening the inner ends of the buckets to the rotor, a stay-bolt passing through the buckets intermediate their ends, and means carried by said stay-bolt that engages the buckets and spaces them apart.

12. In combination, a turbine rotor, a ring of buckets carried thereby, the buckets in said ring being arranged in groups of two, and means for strengthening and supporting the buckets of each group comprising a stay-bolt having a shouldered portion engaging the adjacent faces of the two buckets and end portions which pass through said buckets and are secured thereto.

13. In combination, a turbine member, a row of buckets mounted thereon, and a plurality of means for uniting the buckets, the said means being located between the ends of and acting to divide the buckets into groups, each of said means being independent of the other means.

In testimony whereof I affix my signature in presence of two witnesses.

ROBERT A. McKEE.

Witnesses:
G. F. De Wein,
Max Rotter.