July 16, 1929. K. BAUMANN 1,720,754

TURBINE BLADE SHROUDING

Filed Sept. 2, 1927

Fig. 1.



Fig. 2.

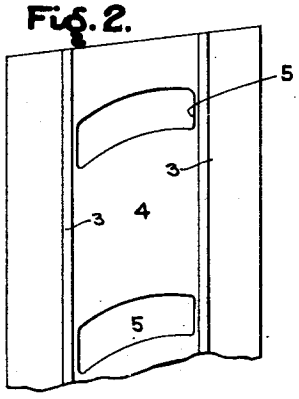


Fig. 3.



Fig. 4.

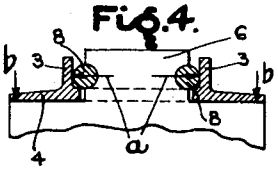


Fig. 5.

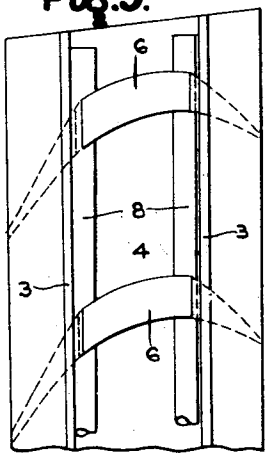


Fig. 6.

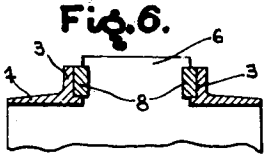


Fig. 7.

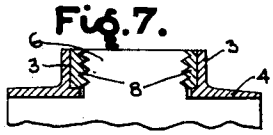


Fig. 8.

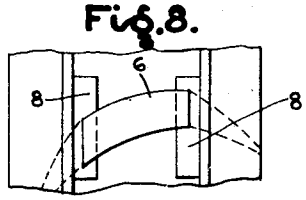


Fig. 9.

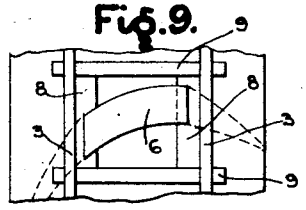


Fig. 10.

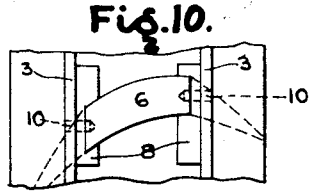


Fig. 11.

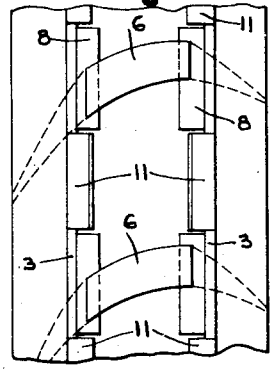


Fig. 12.

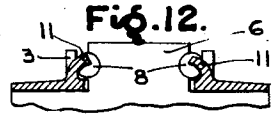


Fig. 13.

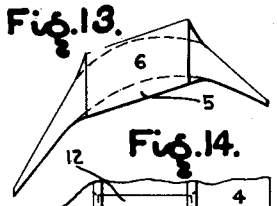


Fig. 14.

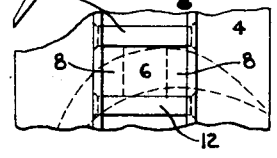


Fig. 15.

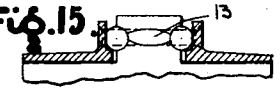
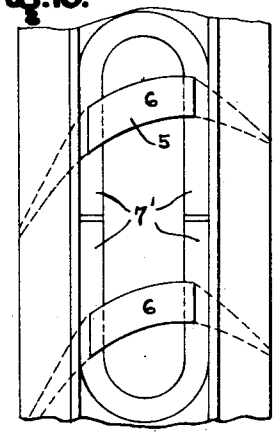


Fig. 16.



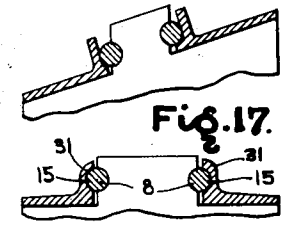


Fig. 18.

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UNITED STATES PATENT OFFICE.

KARL BAUMANN, OF URMSTON, ENGLAND, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

TURBINE-BLADE SHROUDING.

Application filed September 2, 1927, Serial No. 217,227, and in Great Britain September 9, 1926.

The invention relates to improvements in elastic fluid turbines and concerns particularly the attachment of the shrouding to the blades.

Usually shroud rings or sections are secured to turbine blades by riveting, rivets being formed on the tip of each blade and riveted over after passing said rivets through rivet holes in the shrouding. The impact on the blade in riveting the shroud thereon may damage the material of the blade and weaken it.

The present invention seeks to provide a simple means of attaching the shrouding to the blades, which does not necessitate riveting or caulking the tip of the blade, or any deformation of the material of the blade.

Accordingly the present invention provides a method of shrouding turbine blades wherein the end of a blade is passed through an aperture in the shroud and the latter is then strained by the insertion of one or more locking members so that by virtue of the elasticity of the shroud, pressure is applied between the blade, shroud and locking members. The invention also provides an improved construction of shrouding comprising a shroud member formed with projecting portions between which the ends of the blades project through apertures in the shroud and are secured by the introduction of locking members adapted to press the shroud firmly upon the ends of the blades.

In one construction, the shroud ring or section presents a double T-shaped cross-section, a reduced portion or extension of the tip of the blade being passed through an aperture in the central portion of the shroud, said reduced portion being formed on each side with a recess between which and the upstanding rib or flange of the shroud a lashing wire, locking strip or the like is inserted.

These and other features of the shrouding provided by the invention are hereinafter described with reference to the accompanying drawings wherein:

Figs. 1 and 2 show in cross section and plan, respectively, a portion of a shroud according to the invention;

Fig. 3 shows in elevation the tip of a blade employed according to the present invention;

Fig. 4 illustrates the shroud and blades according to Figs. 1, 2 and 3 assembled together;

Fig. 5 is a plan view of the assembled construction shown in Fig. 4;

Figs. 6 and 7 show modified forms of locking pieces according to the invention;

Figs. 8 to 11 are plan views showing alternative means for securing the locking members in position;

Fig. 12 is a cross section corresponding to Fig. 11;

Fig. 13 is a plan of a modified form of blade which may be employed in carrying out the invention;

Figs. 14 and 15 represent respectively a plan and cross section showing another form of blade and securing means therefor;

Fig. 16 shows a further modified form of shrouding according to the invention;

Fig. 17 shows in cross section the application of the invention to a conical type of shrouding; and,

Fig. 18 shows in cross section a further modification.

The usual type of shrouding comprises a shroud member having apertures through which rivet portions, formed integral with the tip of the blade, are passed, and riveted, or caulked and sometimes soldered to ensure a connection as rigid as possible between the blades and shrouds.

By the present invention an improved method of shrouding is proposed whereby riveting or caulking of the blade is obviated and a simple form of shrouding provided.

The shroud member according to the present invention is provided with upstanding projections which preferably take the form of ribs 3 as shown more clearly in Figs. 1 and 2, the shroud member 4 thus presenting a substantially double T-shaped cross section.

Between the upstanding ribs 3 are provided apertures 5 suitably pitched along the shroud ring or segment to receive the tips of the blades. As shown in Fig. 3 the tip of each blade is formed with a reduced portion or extension 6 in which are provided lateral recesses 7. These recesses are cut in the extension 6 without deforming the material thereof. The portion 6 of the tip of the blade corresponds in shape to the aperture 4 in the shroud and after being inserted therein as shown in Fig. 4, is secured

by locking pieces which preferably take the form of lashing wires 8 of circular cross section inserted between the upstanding ribs 3 of the shroud and the recesses 7 of the blade.

The parts are dimensioned so that upon inserting the locking pieces 8 the ribs 3 are forced slightly apart as indicated by arrows *a*, Fig. 4, pressure being thereby also exerted between the rib 3 and the extension 6 of the blade. Moreover, due to the elasticity of the shroud 4 the marginal portions thereof are also forced to press inwardly upon the end of the blade as indicated by arrows *b* in Fig. 4 while the central portions of the shroud tend to press outwardly upon the locking pieces 8. The parts comprising the shrouding, i. e., the extension 6 of the blade, the locking pieces 8 and the shroud member 4 are thereby held together under pressure and looseness and consequent wear are prevented. The centrifugal force acting on the shroud will also tend to tighten the contact between the shroud and locking pieces.

In order to obtain the above described effect it is not necessary to employ a circular lashing wire, similar effects being obtainable, for example, with lashing wires or locking pieces of rectangular or grooved form in cross section as shown by Figs. 6 and 7.

The lashing wire may be of any convenient length, for example the wires may be common to all the blades of a section of the blading, each of which sections may include a group of from five to ten blades. If desired, however, the lashing wire may be divided into shorter locking pieces which secure only one or a number of blades fewer than that comprising a section. In the constructions hereinafter described, short locking pieces, each adapted to engage with a single blade, are referred to but it will be understood that the constructions might similarly employ pieces common to a plurality of blades. Short locking pieces possess the advantage of being more readily inserted and may afford a degree of adjustment of the pressure exerted between the shrouding members by being made slightly tapered for example.

Fig. 8 illustrates one method of securing the locking pieces against movement in the circumferential direction, the locking pieces 8 being soldered, brazed or welded to the shroud at each end after being placed in position. Fig. 9 shows another method of securing the locking pieces by means of pins 9 driven through apertures formed in the ribs 3 adjacent the ends of said locking pieces, while Fig. 10 illustrates the employment of pins 10 passing through the shroud rib 3 into the locking piece 8, which latter is also soldered at the ends.

Figs. 11 and 12 show a further modified construction for securing the locking pieces against endwise movement, in this case portions 11 of the ribs 3 between the ends of adjacent locking pieces are deformed so as to prevent the removal of the locking pieces 8 after they have been inserted in position.

While the method of shrouding according to the present invention does not necessitate special thickening of the blades at the tips, it may in some cases be desirable to strengthen the blade, for example by making the extensions 6 of rectangular cross-section as shown by Fig. 13, or of circular cross-section as shown in Figs. 14 and 17. In the constructions shown in Figs. 14 and 15 rivets 12 are passed through the shroud ribs 3 so as to engage not only the locking pieces 8 but also grooves 13 (Fig. 15) formed in the extension 6 of the blade, said rivets 12 thereby serving to transmit the centrifugal force of the shrouding to the blades when the turbine is in action.

Fig. 16 illustrates a further form of locking pieces 7′ which is substantially U-shaped, the arms of the U-piece 7′ passing on opposite sides of the extension 6 of the blade and being conveniently soldered at the ends to the abutting ends of an adjacent locking piece 7′.

The above described forms of shrouding may be directly employed in conical types of shrouding as will be evident from Fig. 17. It is also possible if desired to shape the ribs 3 to any suitable form to receive the locking pieces, for example as is shown by Fig. 18 in which the ribs 3′ are curved and formed with grooves 15 engaging the locking pieces 8.

It is immaterial when carrying out the invention, whether the blades be connected to the shroud before or after mounting them on the turbine rotor, but it will be readily appreciated that in all cases the insertion of the locking members tends to exert direct compressive forces upon the blades and the shroud, and further tends to strain or deform the shroud so as to press the outer portions thereof firmly into contact with contiguous parts of the blade.

The shrouding also has the advantage that the ends of the blades are somewhat protected by the ribs against the erosive action of the steam and the windage losses are also small. For long blades it is particularly advantageous.

It will be evident that the constructions above described do not exhaust the possible forms in which the invention may be applied, but various other modifications are possible without departing from the scope of the invention.

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 method of shrouding turbine blades, which comprises inserting the end portion of a blade through an aperture in a shroud, and stressing the latter by inserting a locking member between the end portion of the blade and the shroud, so that by virtue of the elasticity of the shroud, pressure is applied between the blade, shroud and locking member.

2. Shrouding for turbine blades comprising a shroud formed with a plurality of projecting portions and apertures between the projecting portions, through which apertures the end portions of the blades project, and locking members securing the shroud to the blades and pressing the shroud firmly upon the ends of the blades.

3. Shrouding for turbine blades comprising a shroud having upstanding portions to form a substantially double T-shaped cross section and apertures in the central portion thereof between the upstanding portions, extensions on the tips of the blades adapted to be inserted through said apertures, said extensions having grooves, and locking means inserted in the grooves and between the extensions and the upstanding portions.

4. Shrouding for turbine blades according to claim 3, wherein the locking means is secured against displacement in the circumferential direction.

5. Shrouding for turbine blades according to claim 3, wherein the locking means is secured against displacement in the circumferential direction by means passing through the upstanding portions of the shroud.

6. Shrouding for turbine blades according to claim 3, wherein the upstanding portions of the shroud are formed with grooves to receive the locking means.

7. The combination with a group of blades or vanes, of shrouding therefor comprising a shroud having apertures therein, extension on the blades projecting through said apertures, means interlocking with said extensions and shroud to secure the latter to the blades, and means preventing disengagement of the interlocking means.

8. The combination with a group of blades or vanes of shrouding therefor comprising a shroud extending over the ends of a plurality of blades, said blades having portions projecting beyond the shroud and said projecting portions having inwardly-facing shoulders formed thereon without deformation of the material thereof, and locking members interposed between said shoulders and the outer side of the shroud.

9. The combination with a group of blades or vanes, of shrouding therefor comprising a shroud having apertures therein, extensions on the blades projecting through said apertures, and means interlocking with said extensions and shroud to secure the latter to the blades without deformation of material.

10. The combination with a shroud having a recess, and a blade having an end portion thereof in said recess, of means for utilizing the elasticity of the shroud for holding the blade in said recess.

11. The combination with a shroud having a recess, for receiving an end portion of a turbine blade and a blade extending into said recess, of a locking member wedged into the recess and against the end portion of the blade whereby the elasticity of the shroud may be effective to hold the blade and the shroud together.

12. Shrouding for turbine blades comprising a shroud having an abutment thereon and means cooperating with said abutment for stressing the shroud to force the same against the end of the blade near a thin edge portion thereof.

13. Shrouding for turbine blades comprising a shroud having a recess, a blade having a reduced end portion, said reduced end portion extending through the recess, a projection on the shroud, and a locking member between the projection and the reduced end portion of the blade.

14. Shrouding for turbine blades comprising a shroud having a recess, a blade having a reduced end portion, said reduced end portion extending through the recess, a projection on the shroud, means cooperating with the reduced end portion of the blade and the projection for forcing the shroud under stress against the ends of the blade adjacent the reduced end portion thereof.

15. Shrouding for turbine blades comprising a shroud having a recess, a blade having a reduced end portion, said reduced end portion extending through the recess, a projection on the shroud, and a bracing member between the projection and the reduced end portion of the blade for forcing the shroud against the end portions of the blade near the thin edge portions thereof.

16. The combination with a group of blades, of a shroud extending over the ends of a plurality of blades, and means for imposing stress on the shroud forcing it against the ends of the blades.

In testimony whereof, I have hereunto subscribed my name this 3rd day of August, 1927.

KARL BAUMANN.