July 26, 1955 L. C. SECORD ET AL 2,713,991

ROTOR BLADE LOCKING DEVICE

Filed May 5, 1951 2 Sheets-Sheet 1

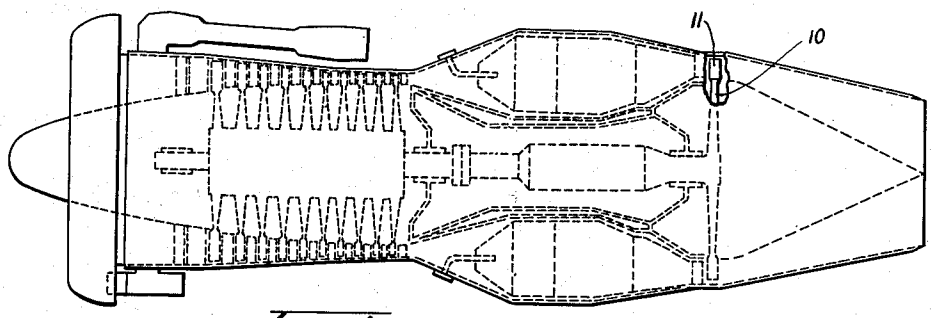


FIG 1.

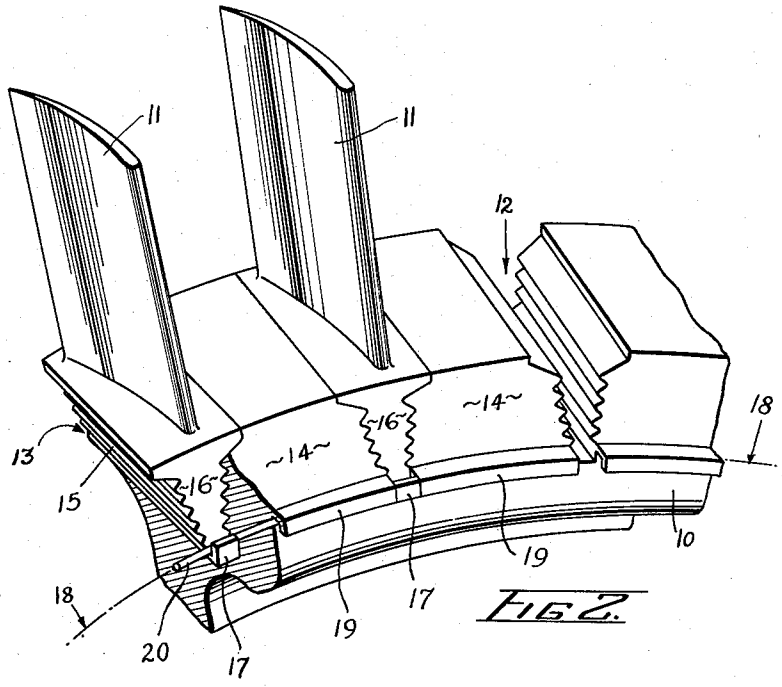


FIG 2.

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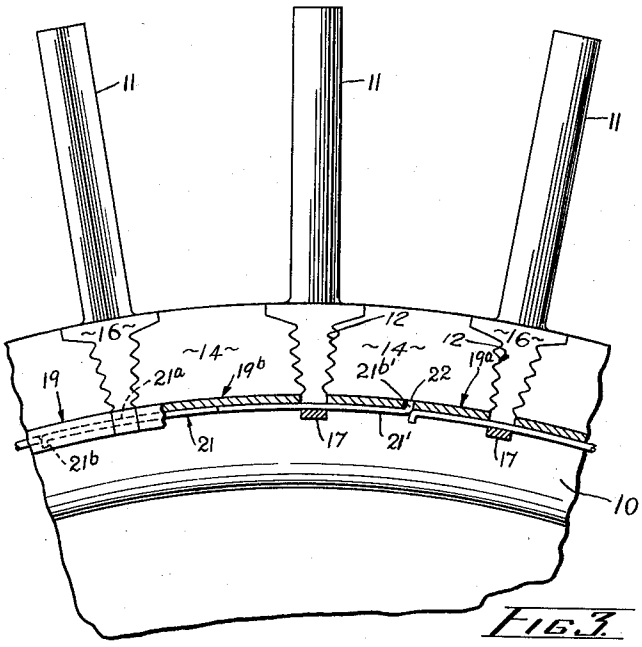


FIG 3.

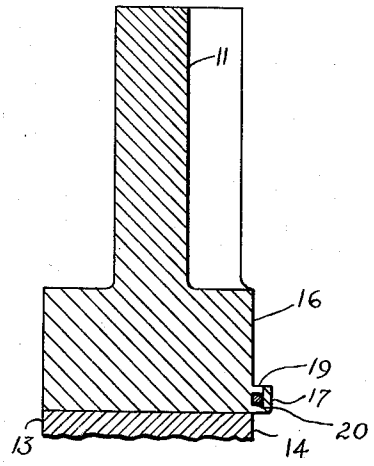


FIG 4.

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ROTOR BLADE LOCKING DEVICE

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5 Claims. (Cl. 253—77)

This invention relates to blading for rotary power conversion machines and the like and more particularly it relates to improved fastening means therefor.

Blading of this type normally requires such accuracy of form and finish that the blades have to be manufactured individually. This practice, however, introduces fresh problems in connection with the mounting of the blades in the machine, problems which are particularly critical if the blade is to be mounted on a compressor or turbine rotor which will be rotating at high speed. Not only is centrifugal loading imposed upon the blade under these conditions but there is also axial loading due to the momentum of the working fluid and although this axial loading is usually small in comparison with the centrifugal loading some provision must nevertheless be made to absorb it.

Although various locking devices have been developed for this purpose, most of these tend to reduce the tangential blade tip wobble present when the rotor assembly is cold. Since this wobble serves as a direct indication of the clearance present between the blade and its mounting slot—a clearance provided for accommodating thermal expansion—it is important that the locking device should interfere with this clearance as little as possible. Furthermore, it is sometimes desirable to provide passages between the blade root and its mounting slot in order that cooling air may flow through the mounting disc and over the blade root, and present locking devices would interfere with the flow of cooling air in such a case.

Accordingly, it is the principal object of this invention to provide improved retaining means for withstanding the axial loading on the blades that will not interfere with blade tip wobble or with the flow of cooling air over the blade root.

It is a further object of the invention to provide a retaining means which permits the operations of mounting and replacing a blade in its supporting member and locking it thereto, to be carried out from one side only of the supporting member.

The invention will be more readily understood by reference to the accompanying drawings which form a part of this specification and in which like reference characters denote like parts throughout the same. In these drawings,

Figure 1 is a side elevation of a gas turbine engine having a turbine rotor to which blades are attached,

Figure 2 is a perspective view of a portion of the turbine rotor with blades mounted thereon and locked in position in accordance with the invention, the rotor being cut away and one of the blades removed from its slot for greater clarity,

Figure 3 is an elevation, taken in an axial direction and partly broken away, of an alternative form of the locking device, and

Figure 4 is a cross sectional view on an axial plane through the alternative form of the locking device shown in Fig. 3.

Referring now to Figures 1 and 2 of the drawings, a turbine rotor **10** supports a series of radially-extending blades **11** mounted in peripheral slots **12** (which in our example are of "fir tree" cross section) extending from

the rear face **13** of the rotor to its forward face **14** in a direction substantially axial with respect to the general disposition of the rotor, which may be regarded as being in a plane normal to its axis.

The rotor blades are formed with root portions **15** of "fir tree" shape conforming to the shape of the slots **12** so that the blade roots are in interlocking relationship with the supporting rotor **10** in a radial direction, while being in slidable relationship to the rotor in the axial direction. On the forward end face **16** of each root there is an integrally formed L-shaped lip **17**, the horizontal and vertical arms of the lip cooperating with the end face **16** of the root to provide a trough adjacent the end face and open on the side remote from the axis of the rotor. The blade lips **17** are so constructed and arranged with respect to each other that when the blades are mounted in the rotor their troughs are all coincident with a hypothetical circle **18** of constant radius whose center lies on the axis of the rotor. A further series of L-shaped lips **19** is integrally formed on the forward face **14** of the rotor, the horizontal and vertical arms of these rotor lips cooperating with the forward face **14** of the rotor to provide another series of troughs open on the side adjacent the axis of the rotor and coincident with the same circle **18**. Thus the two sets of lips form, in effect, a continuous annular trough at the forward face **14** of the rotor. (For convenience, the terms "horizontal" and "vertical" are used herein in connection with the lips **17** and **19** as having direct reference to the disposition of the parts in the drawings; they actually refer to the axial and radial directions, respectively, about the axis of the rotor.)

A locking wire **20**, adapted to be passed through the annular trough on the forward face of the rotor, serves as a shear member to maintain the axial position of the blades with respect to the rotor. The diameter of the wire **20** is such that the wire fits snugly into the annular trough and has no transverse play in the direction parallel to the axis of the rotor.

To assemble the blades to the rotor, the blade roots **15** are slid into the mating slots in the rotor **10** until they take up a position with their end faces **16** flush with the forward face **14** of the rotor. This brings the blade lips **17** into alignment with the rotor lips **19** to form the continuous annular trough. The locking wire is then passed through this trough to hold all the blades against both forward and rearward movement along their slots, and its ends are trimmed to a convenient length. The ends of the wire may be left to abut each other, or nearly so, leaving a small gap for expansion; alternatively they may be joined mechanically or metallurgically, or they may be bent inwards or outwards at an appropriate spot although this last method may require additional machining of the lips in order to provide an exit slot for the wire.

One disadvantage inherent in the system just described, using a single wire to lock all the blades, is that one blade cannot be replaced without releasing all the others. In order to overcome this difficulty, an alternative form of the locking device as illustrated in Figures 3 and 4 has been developed. It comprises a series of L-shaped wire clips **21**, the long arm **21a** of each clip being equal in length to the segment of arc of the hypothetical circle **18** which extends from any hypothetical point on one blade root to a corresponding hypothetical point on an adjacent blade root. A radially directed hole **22** extends through the horizontal portion of one of the rotor lips **19a**, this hole being substantially equidistant from the slots **12** on either side of the lip. One of the clips **21** which is referred to as the key clip, and designated by the reference character **21'** is fitted to the rotor lip with its short arm **21b'** projecting into the hole **22** and its long arm extending across

the blade lip 17 to the mid point of the next rotor lip 19b. Further clips 21 may now be fitted in succession to the annular trough formed by the blade and rotor lips, the end of the long arm of each clip butting against the end of its neighbour and the short arm 21b of each clip pointing radially inwardly towards the axis of the rotor. Care must be taken to trim the ends of the clips so that each clip overlaps adjacent rotor lips equally and no cumulative error is introduced. In addition it is important that the end of the clip carrying the short arm 21b should present a flat surface for abutment of the adjacent clip, and therefore the short arm of the wire is preferably formed by cold heading or by some other process which gives a squared corner at the bend. The key clip 21', which is identical in construction to each of the other clips 21, holds these other clips against circumferential movement around the annular trough, while the opposing horizontal surfaces of the blade and rotor lips 17 and 19 hold the clips against movement in the radial direction. The short arm of each clip provides a tang by which the clip may be gripped for removal, and it will be apparent that this removal may be effected for replacement of a single blade (even when the key clip 21' is involved) without releasing the other blades.

There are many possible variations to the construction described in the foregoing, for example the direction in which the blade and rotor lips 17 and 19 open could be interchanged so that the troughs which they form open inwards and outwards respectively. It should be noted, however, that the construction described hereinbefore is preferred, since it ensures that the horizontal surfaces on the longer lips (i. e. on the rotor lips 19) are disposed to absorb the majority of the centrifugal loading imposed by rotation of the rotor.

It will be understood therefore that the forms of the invention herewith shown and described are to be taken as preferred examples of the same and that various changes may be made in the shape, size and arrangement of the parts without departing from the spirit of the invention or the scope of the subjoined claims.

What we claim as our invention is:

1. Fastening means for a blade of a rotary power conversion machine of the type having a blade supporting member and blades provided with blade root members, the said members each having an exposed end face and all the said faces being disposed generally in the same plane, the blade root members being in slidable relationship with the supporting member in a direction intersecting the said plane and in interlocking relationship with the supporting member in another direction whereby they are demountably secured to the supporting member, the said means preventing movement of the blades relative to the supporting member in the said first-mentioned direction and comprising a lip projecting from the exposed face of each of the blade root members and providing a groove having its open side facing in one sense of the said other direction, a second lip projecting from the exposed face of the supporting member and providing a groove having its open side facing in the other sense of the said other direction, the said grooves being in end-to-end registration, and a shear resistant member extending into both of said grooves.

2. Fastening means for a blade of a rotary power conversion machine of the type having a blade supporting member and blades provided with blade root members, the said members each having an exposed end face and all the said faces being disposed generally in the same plane, the blade root members being in slidable relationship with the supporting member in a direction intersecting the said plane and in interlocking relationship with the supporting member in another direction whereby they are demountably secured to the supporting member, the said means preventing movement of the blades relative to the supporting member in the said first-mentioned direction and comprising a lip projecting from the exposed face of each of the blade root members and having a flange spaced from the end face of each said blade root to form with the said exposed face a groove having its open side facing in one sense of the said other direction, a second lip projecting from the exposed face of the supporting member adjacent the blade root member and having a second flange forming with the said exposed face a groove having its open side facing in the other sense of the said other direction, the said grooves being in end-to-end registration, and a shear resistant member extending into both of said grooves.

3. Fastening means for a blade of a rotary power conversion machine of the type having a disc-shaped blade supporting member and blades provided with blade roots disposed in mutually spaced relationship around the blade supporting member, the blade roots having exposed end faces angularly spaced from each other and lying in the plane of a face of the blade supporting member, the blade roots being in slidable relationship with the supporting member in a direction intersecting the said plane and in interlocking relationship with the supporting member in the radial direction whereby they are demountably secured to the supporting member, the said means preventing movement of the blades relative to the supporting member in the said first-mentioned direction and comprising a lip projecting from the exposed face of each of the blade roots and each providing a groove having its open side facing in one sense of the said radial direction, a series of lips projecting from the supporting member between the blade roots and providing a series of grooves having their open sides facing in the other sense of the said radial direction, all the said grooves being in end-to-end registration in a circle, and a shear resistant member extending through all of the said grooves.

4. Fastening means for a blade of a rotary power conversion machine of the type having a disc-shaped blade supporting member and blades provided with blade roots disposed in mutually spaced relationship around the blade supporting member, the blade roots having exposed end faces angularly spaced from each other and lying in the plane of a face of the blade supporting member, the blade roots being in slidable relationship with the supporting member in a direction intersecting the said plane and in interlocking relationship with the blade supporting member in the radial direction whereby they are demountably secured to the supporting member, the said means preventing movement of the blades relative to the supporting member in the said first-mentioned direction and comprising a lip projecting from the exposed face of each of the blade roots and each providing a groove having its open side facing in one sense of the said radial direction, a series of lips projecting from the supporting member between the blade roots and providing a series of grooves having their open sides facing in the other sense of the said radial direction, all the grooves being in end-to-end registration in a circle, and a plurality of shear resistant members, each shear resistant member having a long arm lying in a portion of each of two adjacent grooves and having a short arm projecting at an angle to its long arm and one of the short arms being in engagement with one of the lips to locate the shear resistant member having the said one of the short arms with respect to the said one of the lips.

5. Fastening means as claimed in claim 4 in which the said one of the lips has a hole and the said short arm extends removably into the hole.

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