April 6, 1943. W. H. LLOYD ET AL 2,315,631

TURBINE BLADE LOCKING APPARATUS

Filed Feb. 14, 1942

FIG. 1.

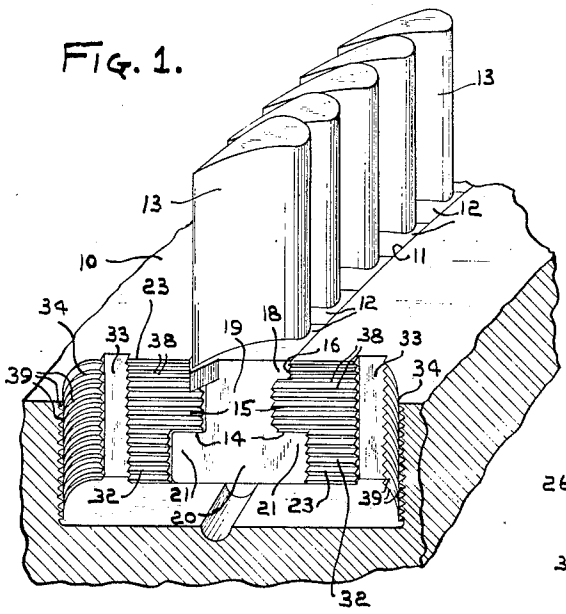
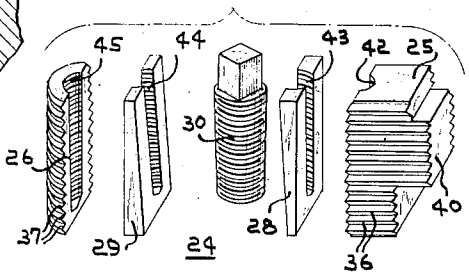


FIG. 2.



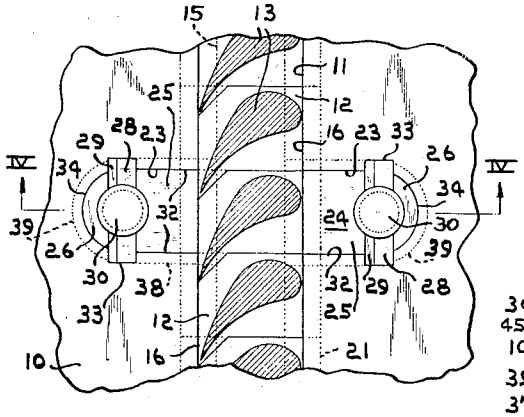
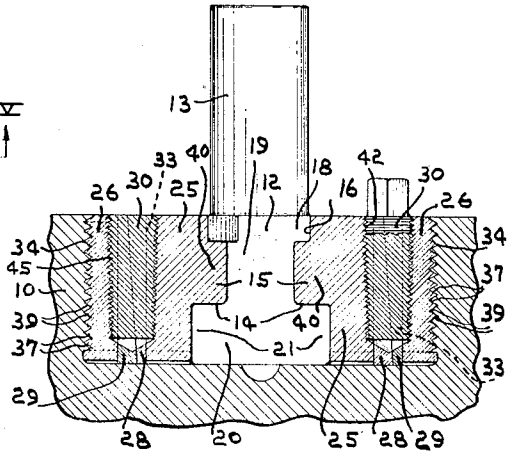


FIG. 3.

FIG. 4.



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TURBINE BLADE LOCKING APPARATUS

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2 Claims. (Cl. 253—77)

The invention relates to a turbine rotor carrying a row of blades and it has for an object to provide structure of increased strength for connecting the last-inserted blade to the rotor.

In the patent to Ray 1,687,891, October 16, 1928, there is shown a rotor having an undercut groove for blade roots. The short grooves extending transversely of the blade groove provide for widening of the latter so that a row of blades may be inserted in the undercut groove, the last-inserted blade having its root disposed in the widened portion or entrance space. Each transverse groove has parallel walls joined by a circularly-curved end wall and the walls have serrations extending parallel to the groove bottom. Locking pieces are disposed in the transverse grooves, have serrations fitting serrated walls of the latter, and have inner ends shaped to conform to the blade groove side walls so that when they are in their inner positions, they serve to hold the last blade in place. Filler pieces substantially of semi-circular section fit the semi-circular end walls of the transverse grooves and have serrations engaging the serrations of such end walls. With the locking pieces spread apart to the extent permitted by the filler pieces, there is sufficient room for the insertion of blade roots incident to assembly of a blade row. After the blades are inserted with the last blade disposed with its root in the entrance opening, the locking pieces are moved inward to engage the root of the last-inserted blade and compound wedges are driven in between each locking piece and its associated filler piece, after which the locking and filler pieces and the intervening wedges are bored and tapped for a locking screw.

A more particular object of the present invention is to provide for increased strength of the locking pieces of the type disclosed in said patent, this result being accomplished by increasing the locking piece dimension in the direction of length of the transverse groove without increasing the length of the latter; and, to this end, the arcuate or segmental extent of each filler piece is less than a semi-circle and opposed slots are provided at the sides of each transverse groove so as to intersect the circularly-curved back wall. These features provide for increased extent of length of the groove available for locking piece movement and it is, therefore, possible to increase the locking piece dimension in the direction of groove length with the result that the strength of the locking piece and its connecion to the rotor are increased.

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

Fig. 1 is a fragmentary isometric view of a blade row and its rotor with the rotor shown partly in section;

Fig. 2 is an exploded view of structure for filling the blade entrance opening and for locking the blade in place;

Fig. 3 is a fragmentary plan view showing the improved entrance opening filling and blade locking device; and

Fig. 4 is a sectional view taken along the line IV—IV of Fig. 3.

Referring to the drawing more in detail, there is shown a turbine rotor 10 provided with a blade groove 11 within which are disposed the roots 12 of a row of blades 13.

The blades are held in place with respect to the rotor by any suitable interlocking means provided at the sides of the blade groove 11 and at the sides of the roots 12. For example, as shown, the blade groove 11 is undercut at 14 at each side and at the bottom thereof to provide overhanging flanges 15. Also, instead of having the flanges 15 extend to the peripheral surface of the rotor, the blade groove may have a counter-grooved portion 16 extending from the peripheral surface to the flanges 15.

Each of the blades has its root 12 formed to suit the groove section, that is, the roots 12 are formed with an upper portion 18 fitting the counter-grooved portion 16 and joined by a neck portion 19 to a bottom portion 20 having laterally-projecting portions 21 overlapped by the flanges 15.

With the arrangement described, it is necessary that the blade groove shall have an entrance opening through which the blade roots may be inserted for assembly or removal of blades. Accordingly, as shown, the blade groove is widened by the provision of grooves 23 extending transversely to the blade groove, and structure, at 24, is employed to fill each groove 23 and to lock the last-inserted blade in place.

Each structure, at 24, includes a locking piece 25, a filler piece 26, wedge means comprised, for example, by compound wedge elements 28, 29 and a screw 30.

Each groove 23 has parallel side walls 32 separated by opposed slots 33 from a circular back wall 34, the slots 33 extending depthwise of the groove. The slots are so located as to intersect the circular back wall.

The locking and filler pieces 25 and 26 are

provided with serrations 36 and 37 for engagement, respectively, with serrations 38 and 39 formed at the groove side and back walls. Also, the filler pieces have flange portions 40 adapted to align with the flanges 15.

With the locking and filler pieces 25 and 26 inserted in each groove 23, the locking pieces may be moved apart until they contact with the filler pieces at which time the distance between the flange portions 40 is great enough to permit of the bottom portion 20 of each blade root being inserted into the blade groove.

Assuming that the blades of a row are assembled with blades disposed adjacent to the sides of the entrance opening, then the last blade is brought into position with its root disposed within the circumferential zone of the entrance opening, whereupon the locking pieces 25 are caused to approach, the flange portions 40 thereof being brought into alignment with the flanges 15 so as to constitute in effect parts completing the latter circumferentially and overhanging the projecting portions 21 of the root of the last-inserted blade.

With the locking pieces moved inward to overhang the lateral extensions of the blade root of the last blade, the wedge devices, each comprised by the compound wedge elements 28 and 29, are inserted in the opposed pairs of slots 33 and driven tight so as to react against the filler piece and exert pressure on the locking piece for firmly locking the last blade in place.

After tightening of the wedges, each pair of the latter, the filler piece and the locking piece are bored and tapped to provide a threaded opening formed jointly by threaded portions 42, 43, 44, and 45 formed on the locking piece 36, the wedge 28, the wedge 29, and the filler piece 37, respectively, and a screw 30 is inserted in each threaded opening to hold the filling structure tightly in place.

As the section of each filler piece 26 is defined by the circular curved surface and a chordal surface whose chordal dimension is substantially less than that of a diameter whose radius is the radius of curvature of the curved surface, it will be apparent that the extent of length of the transverse groove occupied by the locking piece will depend upon how much less the chordal dimension is than the diameter. Therefore, so far as the filler piece is concerned, the cooperating locking piece has a greater extent of movement than in the patent aforesaid; however, to provide for such increased extent of movement, it is necessary to avoid interference of the locking piece with the curved back wall of the groove, and this result is achieved by the provision of opposed slots for the wedges, the slots being located so as to intersect the circularly-curved back wall, thereby affording an increased extent of groove length for locking piece movement.

While the invention has been shown 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 it is desired, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What is claimed is:

1. In an elastic-fluid turbine, rotor having a blade groove; a groove extending in a direction which is transverse to the blade groove and providing an entrance opening for blade roots; a row of blades having their roots in the groove and including a blade whose root is disposed within the entrance opening; interlocking means at groove and blade root sides; said transverse groove having parallel side walls and a curved back wall separated from the side walls by opposed slots extending depthwise of the groove and intersecting the curved back wall; a locking piece in the transverse groove, engaging the side walls thereof, and having interlocking means for cooperation with the blade root in the entrance opening; a filler piece in the transverse groove and having a curved face engaging the back wall thereof; the arcuate extent of the curved face of a filler piece being less than a semi-circle so that the chordal distance between the side edges of the filler piece may be less than a diameter whose radius is the radius or curvature of the curved face; interlocking means for connecting the filler and locking pieces in place with respect to the walls of the transverse groove and providing for movement of the locking piece in a direction toward or away from the blade root; wedge means disposed between the filler and locking pieces and including structure insertable in and removable from between the locking and filler pieces by movement along said opposed slots; said filler and locking pieces and said structure being formed to provide jointly a threaded opening; and a screw cooperating with a threaded opening to hold the filler and locking pieces tightly engaged with the locking piece engaging the blade root in the entrance opening.

2. In an elastic-fluid turbine, a rotor having a blade groove whose sides are undercut to provide opposed overhanging flanges; grooves opening into the blade groove through opposite sides of the latter, extending transversely with respect to blade groove, and providing an entrance opening for blade roots; a row of blades having their roots formed to fit the undercut groove, disposed in the latter, and including a blade whose root is located in the entrance opening; each of said transverse grooves having parallel side walls and a circularly curved back wall separated from the side walls by opposed slots extending depthwise of the groove and intersecting the curved wall; the radius of the back wall being equal to one-half of the width of the transverse groove; said side and back wall having serrations parallel to the groove bottom; locking and filler pieces in each transverse groove and having serrations engaging the serrations of the side walls and of the back wall, respectively; wedge means insertable in and removable from between the filler and locking pieces of each opposed pair of slots, and, when inserted, having surfaces thereof arranged for abutment with adjoining surfaces of the filler and locking pieces; said filler and locking pieces and said wedge means being formed to provide jointly a threaded opening; and a screw engaging the threaded opening for holding the filler and locking pieces and the wedge means in place with the locking pieces engaging the root of the blade located in the entrance opening.

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