June 28, 1960 J. R. HAYES 2,942,842

TURBINE BLADE LOCK

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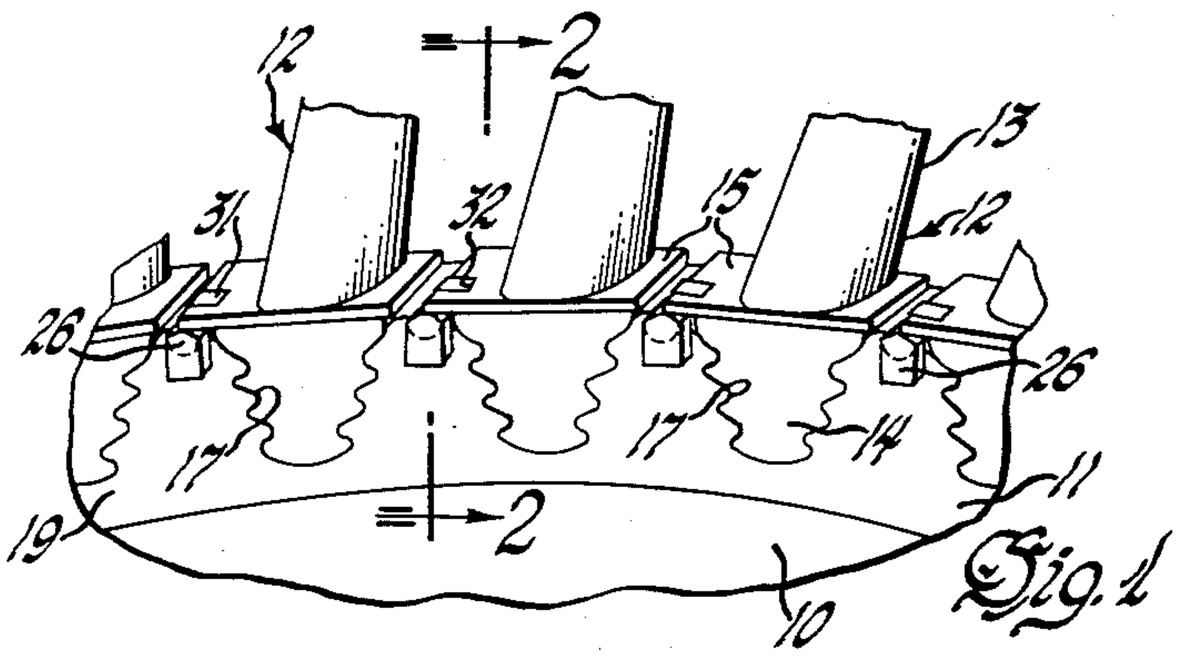

Fig. 1

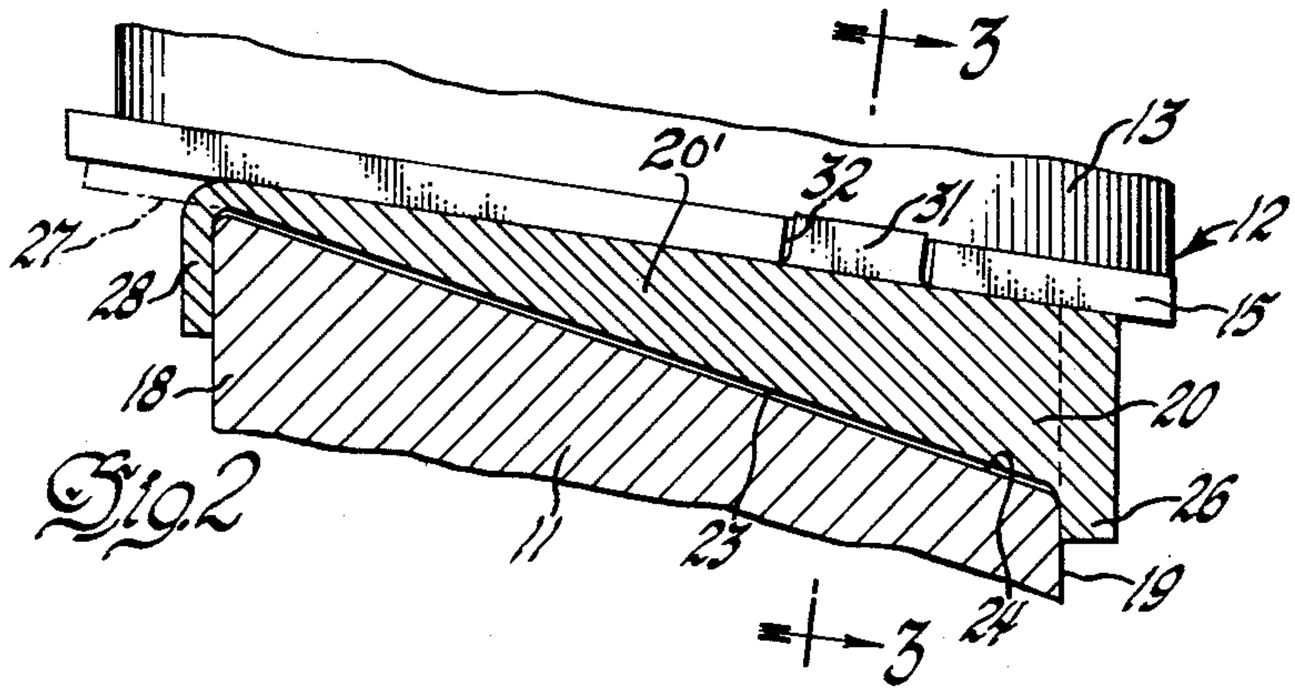

Fig. 2

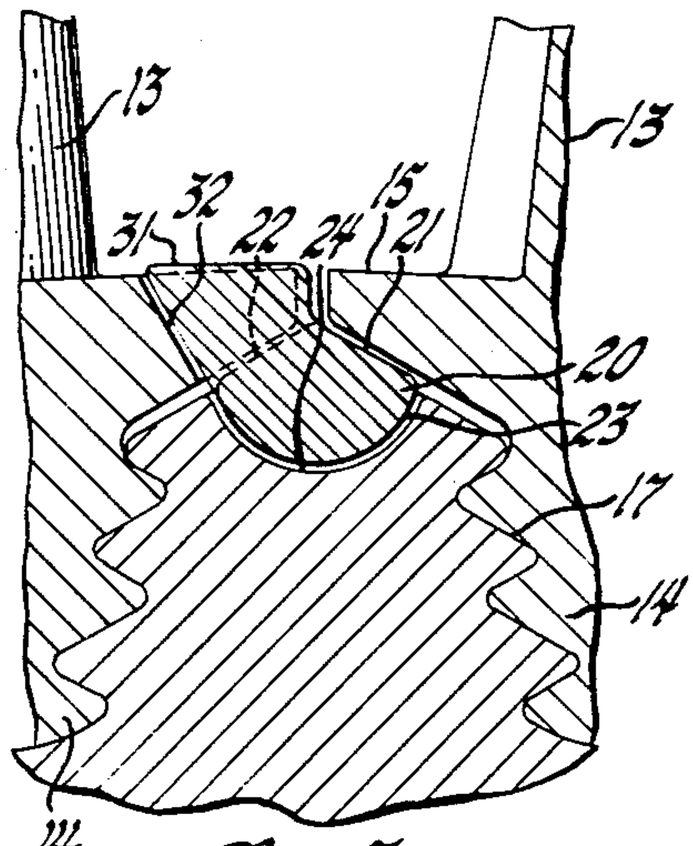

Fig. 3

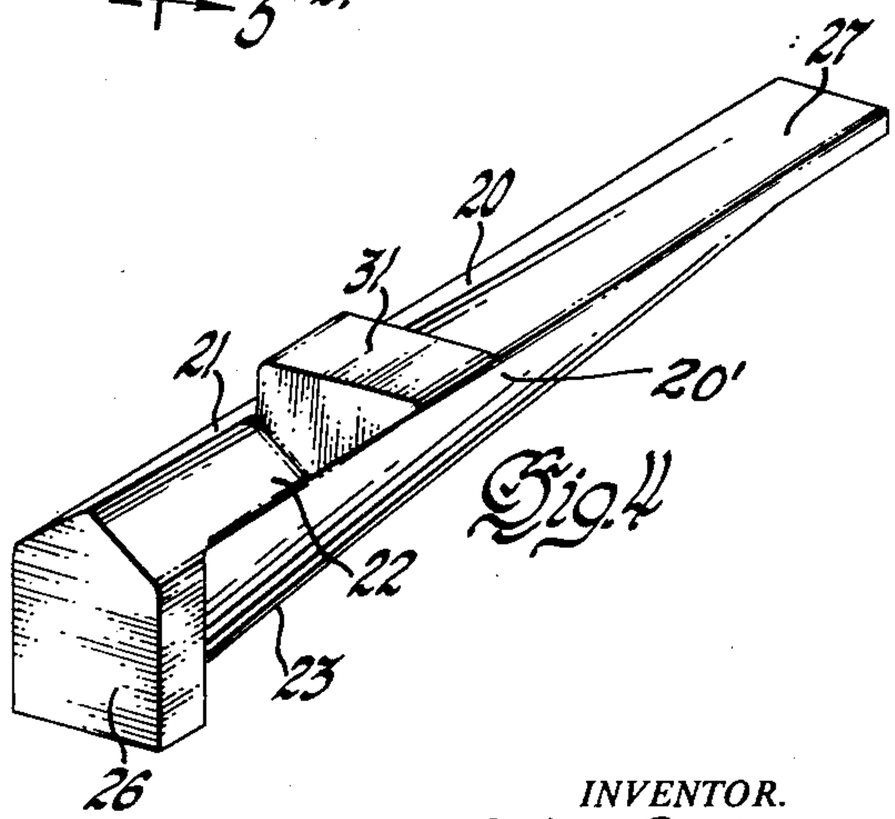

Fig. 4

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TURBINE BLADE LOCK

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1 Claim. (Cl. 253—77)

My invention relates to wheel and blade assemblies such as are used in axial flow compressors and turbines and is particularly directed to providing an improved means of retention of blades on wheels.

By way of background, it may be pointed out that axial flow compressors and turbines commonly are made up of one or more wheels, each of which has a number of blades mounted around the rim of the wheel. Commonly, the wheel has slots cut across the rim into which the blades are inserted, there being some form of dovetail engagement between the root of the blade and the walls of the slot. Usually, the blades are retained from sliding out of the slots by some structure which keys or pins the blades to the wheel. Perhaps the most common mode of retention involves the use of a pin which extends more or less radially through the wheel rim into the base of the blade. Other structures which have been proposed (see, for example, U.S. Patents 2,434,935 and 2,686,656) involve keys which lie under the base of the blade at the bottom of the blade slot and are fixed in some way to the wheel and blade. While such structures may provide adequate blade retention, they have the disadvantage that they weaken the wheel at a point of very high stress at the blade root, with the result that the entire wheel must be made heavier than would otherwise be necessary.

In distinction to these prior proposals, the blade locking structure of the present invention involves structure disposed at the rim of the wheel between the blade slots in a region of low stress, with the result that the weight of the wheel and, consequently, of the other parts of the engine, need not be increased to compensate for stress inducing conditions presented by blade locking means located at the bottom of the blade slot.

The principal objects of the invention are to provide an improved turbine wheel assembly; to decrease the weight and increase the strength of such assemblies; to provide a turbine wheel and blade assembly with locking means which is readily applied and removed and does not weaken the wheel; and to provide a simple, effective, and convenient blade locking means for such installations.

The nature of the invention and the advantages thereof will be clearly apparent to those skilled in the art from the succeeding detailed description of the preferred embodiment of the invention and the accompanying drawings in which:

Fig. 1 is a fragmentary perspective view of a wheel and blade assembly according to the invention;

Fig. 2 is a sectional view of the same taken on a plane containing the axis of the turbine wheel, as indicated by the line 2—2 in Fig. 1;

Fig. 3 is a sectional view taken on a plane at right angles to the blade slots, as indicated by the line 3—3 in Fig. 2; and

Fig. 4 is a perspective view of the blade retaining key.

The invention is shown and described herein as applied to a typical turbine structure and the structure hereinafter will be referred to as a turbine, but the term is not intended as one of limitation, since the invention is readily applicable to various machines of similar configuration.

Referring to Fig. 1, there is illustrated a fragmentary portion of a turbine wheel 10 including the rim 11, the central portion of the wheel not being illustrated, since it may follow any suitable known configuration and the invention is not concerned with the disk or hub of the wheel. Blades 12 are mounted in the wheel, each blade comprising an airfoil or blade portion 13, a root 14, and a blade platform 15, projecting circumferentially of the wheel immediately adjacent the rim thereof, between the blade portion and root portion of the blade. As illustrated, the blade roots are of the common multiple dovetail form and are mounted in the multiple serrated slots 17 in the rim of the wheel. It will be understood that the particular slot and root form is immaterial. These slots extend across the rim from the forward face 18 of the wheel to the rearward face 19 thereof.

The wheel illustrated is one in which the periphery of the wheel is conical or tapered, in which case the serrations on the wheel and blade root are likewise at an angle to the axis of the wheel, which axis may be considered as horizontal in Fig. 2. The invention is particularly desirable in connection with a coned wheel, but is not limited thereto. Ordinarily, the blade roots are a slightly loose fit in the slots in the turbine wheel. The blades are mounted by sliding them axially of the wheel into the grooves.

It will be understood that the structure so far described is old and well known. In connection with prior structures, however, it has been customary to extend a pin through the rim 11 of the wheel into the blade root 14 or to dispose retainers in the bottom of the groove 17. Structures of both these types weaken the wheel at the base of the groove, which is a point of high stress.

The blade retaining or locking means of the present invention comprises keys 20 which, as will be most clearly apparent from Figs. 3 and 4, are tapered longitudinally or from end to end with the thin end of the key adjacent the larger diameter face 18 of the wheel, which is the forward face in this example. The major portion of the tapered body 20' of the key is approximately of the form of a 120° sector of a circle in cross section, as shown most clearly in Fig. 3. The upper face of the body is defined by two surfaces 21 and 22 which lie beneath and substantially parallel to the under surfaces of the blade platforms 15, which incline outwardly from the blade root. The generally cylindrical under surface 23 of the key lies in a complementary groove 24 in the rim of the wheel, the groove being disposed in the projecting part of the wheel rim between the blade slots. The key is a single integral piece including a generally rectangular head 26 at the thicker end of the body, the head 26 extending inwardly and circumferentially from the body and being adapted to abut the face 19 of the wheel. The other end 27 of the key, which is flat and relatively thin, defines a deformable portion which may be bent inwardly from its original form, illustrated in Fig. 4 and by the broken lines in Fig. 2, to provide a head 28 abutting the face 18 of the wheel. The key is thus retained against displacement axially of the turbine or transversely of the wheel rim by the heads 26 and 28.

The blade is interlocked with the key to hold the blade against axial displacement by the interengagement of abutments defined by a lug or projection 31 extending radially outwardly from the body of the key and a notch 32 in one of the adjacent blade platforms receiving the lug. As will be apparent, the key is retained against moving radially out of the assembly by the fact that it is lodged under the blade platforms.

With a tapered wheel, there is a very substantial force urging the blade to the left as shown in Fig. 2 because

of the action of centrifugal force on the blade when the wheel rotates. This, of course, is resisted by the substantial head **26**, the heavier portion of the body **20'**, and the lug **21** which positively keys with or engages the notch in the blade platform. The relatively light bent-over head **28** need serve only to retain the blade against relatively light forces which might tend to displace it when the turbine is stationary or turning at a low speed during starting and stopping.

The blade locking key, as will be apparent, is a simple and easily manufactured piece and the provision of the tapered groove **24** and the notch **32** in the blade platform requires no difficult machining.

In the assembly of the wheel, the blade lock is engaged in the notch in the blade and the two are slid together into the wheel rim, whereupon the head **28** is bent over as illustrated in Fig. 2. If it should be desirable to remove a blade, the head **28** may easily be cut off to permit removal, and a new blade lock is provided upon reassembly. The key is of substantially the same weight as the material cut away from the wheel and blade to provide for installation, so that there is no increase in the weight at the turbine rim, and, since the key is mounted in the relatively unstressed portion of the rim between the blade grooves, the strength of the wheel remains at the maximum value.

It will be apparent to those skilled in the art from the foregoing detailed description of the preferred embodiment of the invention that it is well adapted to realize the objects and secure the advantages described above.

The detailed description of the invention for the purposes of explaining the principles thereof is not to be regarded as limiting or restricting the invention, as many modifications may be made by exercise of skill in the art within the scope of the invention.

I claim:

A turbine wheel assembly comprising, in combination, a wheel having faces and including a rim and having dovetail blade mounting slots both the rim and slots being inclined to the wheel axis and extending transversely of the rim between the faces; turbine blades including dovetail blade roots mounted in the slots and blade platforms projecting circumferentially of the wheel rim from the blade roots adjacent the wheel rim; and means for retaining each blade against displacement longitudinally of the slots, the retaining means comprising means on the wheel defining axially tapered grooves of arcuate cross-section extending transversely of the rim intermediate the slots; an axially tapered key mounted in each groove and shaped to conform to the groove, each key including a head at the thicker end of the key engaging one face of the wheel and a deformable portion at the other end of the key engaging the other face of the wheel, the key lying between the wheel and the blade platforms of the blades adjacent the key, one of the adjacent blade platforms having a notch therein and the key having a projection thereon nearer to the thicker end of the key than to the other end thereof received in the notch, the dovetail engagement between the blade root and wheel being defined by slots inclined radially to the axis of the wheel, and the thicker end of the key being at the end of the slots nearer to the axis of the wheel.

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