Dec. 6, 1960 H. L. McCORMICK 2,963,271

TURBINE BLADE LOCKING

Filed July 19, 1956

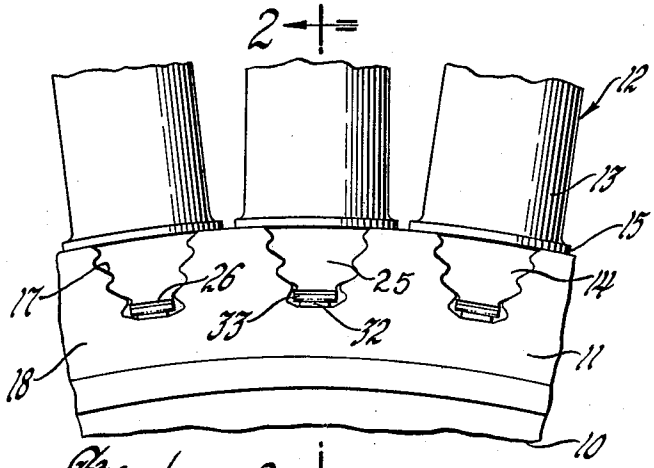


Fig. 1

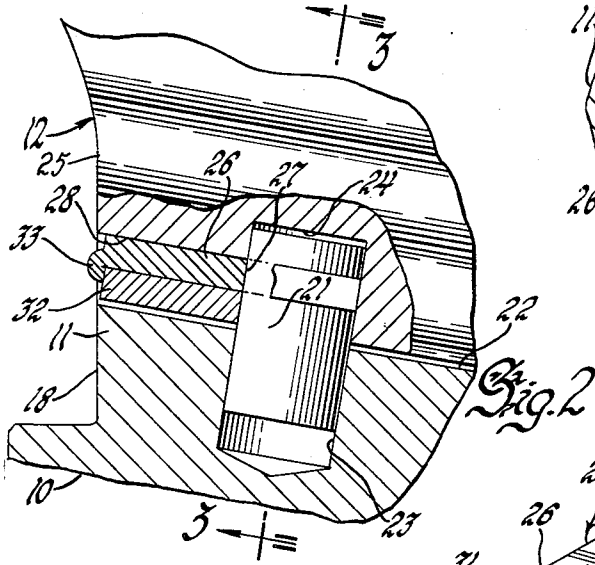


Fig. 2

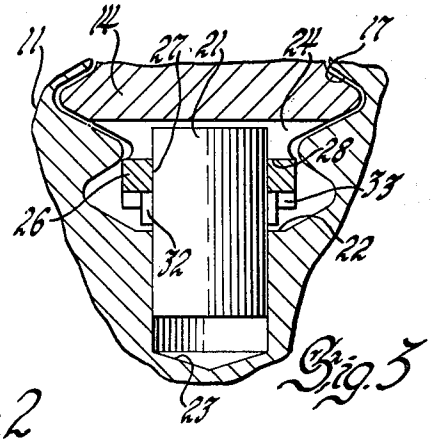


Fig. 3

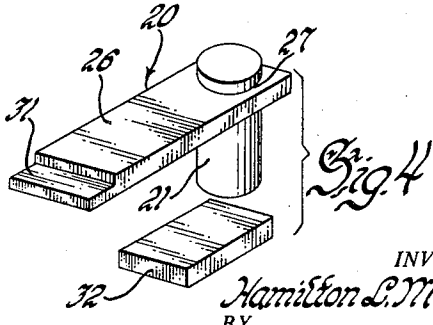


Fig. 4

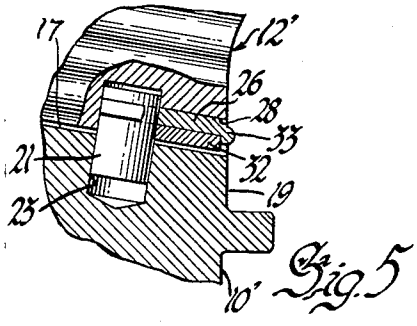


Fig. 5

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2,963,271

Patented Dec. 6, 1960

2,963,271

TURBINE BLADE LOCKING

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Filed July 19, 1956, Ser. No. 598,883

3 Claims. (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.

The blade locking structure of the present invention, while it is disposed at the base of the blade slot, is characterized by a minimum of reduction of strength of the rim of the wheel and of the strength of the dovetail connection between the wheel and the blade. It is also characterized by ease of assembly and disassembly, and simplicity and economy of structure. By virtue of the invention, no enlargement of the blade slot is required and only a shallow socket is required in the wheel rim for the blade retainer.

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 interferes less with the strength of the wheel than previously proposed locking means; and to provide a simple, convenient locking means.

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 elevation 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 slot as indicated by line 3—3 in Fig. 2;

Fig. 4 is a perspective view of the blade retaining device; and

Fig. 5 is a reduced scale view similar to Fig. 2 of an alternative installation.

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 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**.

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. This is immaterial to the invention. 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 fit 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 locking means of the present invention comprises a pin **21** extending generally radially of the wheel, preferably at right angles to the base **22** of the blade slot **17**. This pin is an easy sliding fit in a socket **23** defined by a drilled hole extending into the wheel rim from the base of the blade slot. The radially outer end of pin **21** engages in a socket **24** in the blade root defined by a notch extending transversely of the root or circumferentially of the wheel. The sockets **23** and **24** are preferably adjacent one face of the wheel as, in this case, the face **18**, but may be any desired distance from the face of the wheel. A rectangular plate **26** integral with the pin **21** extends at right angles to the pin longitudinally of the blade slot approximately to the face of the wheel. The plate **26** and pin **21** are a unitary part, identified as **20**, which may be formed by inserting the pin in a hole **27** in the plate and then brazing the parts together. The radially inner part of the blade root **17** is cut away as indicated at **28** between the socket **24** and the face of the blade root to provide a space for the plate **26**. It will be understood, however, that the notch **24** extends into the blade radially outwardly of the cut-away portion **28**. The end of plate **26** remote from pin **24** defines a tab or lip **31** of thinner section than the remainder of the plate. To support the pin **21** in the socket **24** after the parts have been assembled, a support **32** in the form of a small rectangular plate is disposed between the radially inner surface of plate **26** and the base **22** of the blade slot. One end of plate **32** engages pin **21** and the other end is held in place after the assembly is completed by a head **33** formed by peening or bending over the tab **31** of plate **26**.

To assemble each blade in its slot, the retainer **20** is put in place with the radially inner end of pin **21** in socket **23**. Plate **32** is not in place at this time so that plate **26** may rest against the bottom **22** of the blade slot. The blade is then inserted by sliding the blade root from right to left as shown in Fig. 2 into the slot, the cut-away portion **28** of the blade root being able to slide over the outer end of pin **21** with the pin more or less bottomed in the socket **23**. When the blade has been slid into place aligning sockets **23** and **24**, the retainer **20** may be moved radially outwardly by pressing upwardly as shown in Fig. 2 on the plate **26**. The support **32** is then slid under the plate **26**, holding the outer end of pin **21** in the blade root socket **24**. The tab **31** is then bent over to form the head **33** on the blade engaging the support and holding it in position between the head and pin **21**. With the support thus locked in place, the pin cannot move radially inwardly into the wheel and the blade is positively locked against movement transversely of the rim of the wheel.

In order to remove the blade, the head **33** may be cut off with a chisel and the support **32** is pulled out, permitting the pin **21** to drop further into the socket **23** so that the blade will have clearance for removal over the outer end of the pin.

As will be apparent, with this structure, only a rather small shallow socket need be provided in the wheel rim as distinguished from the previous pin hole extending entirely through the rim. The locking means is very simple and cheap and easy to install and remove, and, because of its cheapness, may be discarded whenever it is necessary to remove the blade. The support **32** need not be discarded.

Figure 5 shows, to a reduced scale, a modified installation in which the pin **21** is located adjacent the rear face **19** of the wheel. Because of the relocation of notch **24**, cut-away portion **28**, and socket **23**, the blade is identified as **12'** and the wheel as **10'**. The locking parts are the same as previously, and are so identified.

The structure of Fig. 5 has the advantage over that of Fig. 2 that centrifugal force urges part **32** into the slot, so that it would not fly out in operation of the turbine in the event of any casualty to head **33**. On the other hand, there is a considerable bending moment on pin **21** in this form, whereas the pin is subject almost exclusively to a shear load in the form of Fig. 2.

The structure shown may obviously be reversed to provide the additional clearance in socket **24** instead of socket **23** and install support **32** between plate **26** and the blade root, if desired.

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:

1. A turbine wheel assembly comprising, in combination, a wheel having opposite side faces and including a rim having dovetail slots extending axially of the rim between the faces; turbine blades including blade roots with dovetail engagement with the rim slots; means for retaining said blades against displacement axially of said slots; said means comprising sockets opening into said slots; said sockets being defined by walls forming shoulders extending generally radially inwardly from said slots; a retainer for each blade comprising a pin extending generally radially of the wheel and engaged in one of said sockets and extending therefrom; and a plate secured intermediate the ends of the pin and extending axially therefrom toward one of the side faces of said wheel; each blade root having a walled socket therein for receiving the radially outer end of said pin; the radial length of the socket in said wheel combined with the radial length of the corresponding socket in said blade root being greater than the radial length of said pin; a support for said plate in overlapping relation therewith for retaining the pin in engagement with the corresponding pair of sockets, and means to prevent substantial relative movement of said support from its overlapping position with said plate.

2. An assembly as recited in claim 1 in which the last-recited means is means on the plate engaging the support.

3. An assembly as recited in claim 1 in which the last-mentioned means is deformable means on the plate bent over the end of the support.

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