Dec. 3, 1963 R. H. WELLMAN 3,112,914

TURBINE ROTOR

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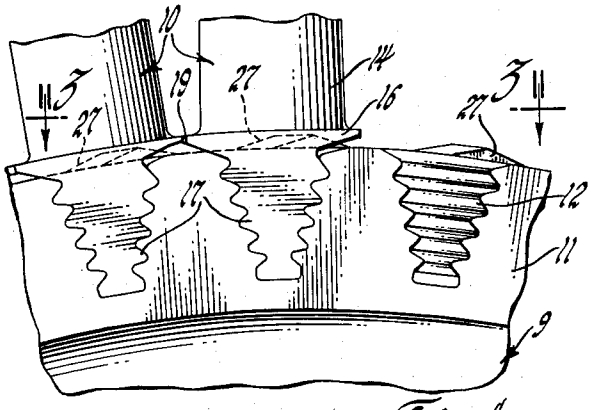


Fig. 1

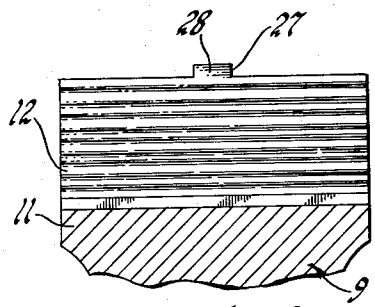


Fig. 2

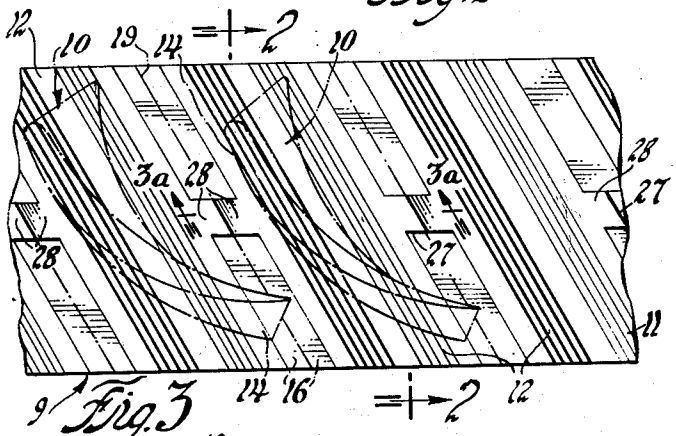


Fig. 3

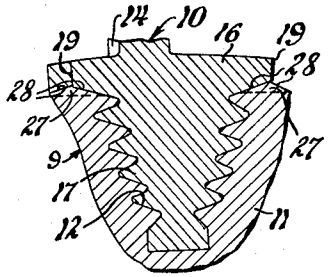


Fig. 3a

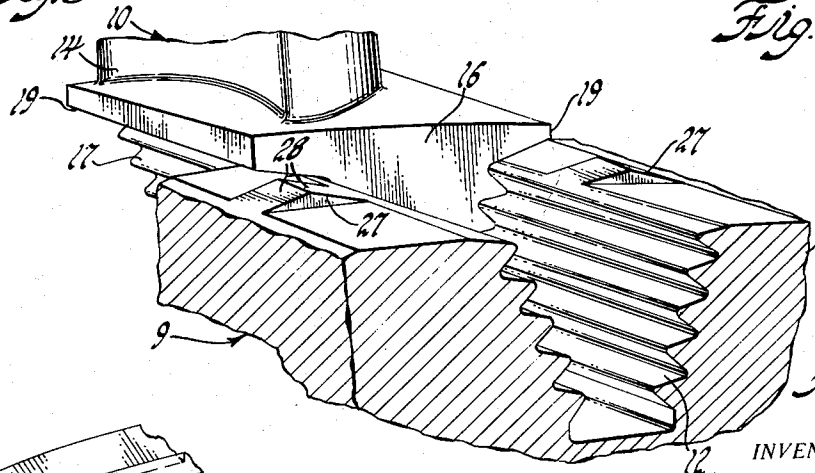


Fig. 4

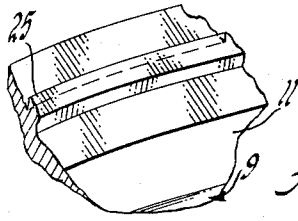


Fig. 5

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TURBINE ROTOR

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My invention is directed to improvements in rotor assemblies having removable blades. It is particularly suited for axial-flow turbine and compressor structures in which the blades are mounted in slots extending generally axially of the rotor, but skewed thereto. Other applications of the principles of the invention will, however, be apparent to those skilled in the art.

By way of introduction to the nature of the invention, it has long been common practice to mount blades of turbine or compressors in dovetail slots extending generally transversely of the rim of a compressor or turbine wheel. Especially in turbine structures, each blade ordinarily includes a platform disposed between the root and the airfoil portion of the blade. These platforms overlie the rotor and are in loose abutment at their adjacent edges so as to provide a boundary of the motive fluid path and protect the rotor wheel from direct contact with the hot motive fluid.

However, in structures of this sort of which I am aware a gas leakage path exists between the blade platforms and the periphery of the turbine wheel or rotor. Particularly where the axis of the blade slot is significantly skewed to the axis of the wheel, the clearance between the individual blade platform and the wheel varies from edge to edge of the wheel. It is not practicable to machine the wheel and blade so as to obtain close contact under the entire area of the blade platform. Also, if this is done, there is too high a rate of heat transfer from the blades to the wheel. As a result, a leakage path of varying cross section from face to face of the wheel has existed between the blade roots and below the blade platforms.

In accordance with my invention a small circumferential ridge is left on the wheel rim or periphery prior to the machining of the blade slots. When the blade slots are broached or otherwise machined, substantially all this ridge is machined away, but a small projection or dam is left extending from the outer surface of the wheel between each adjacent pair of blade slots. Since the outer surface of this dam is a continuation of the surfaces machined to provide the blade slots, it fits the similarly machined blade platforms quite accurately. Thus, the leakage path is obstructed by the dam or projection so that leakage of gas is substantially entirely prevented. The result is practically complete avoidance of the loss of energy accompanying such bypassing of the blades and a significant reduction in heating of the wheel rim which would otherwise result from the leakage flow.

The nature of the invention and the advantages thereof will be clearly apparent from the succeeding detailed description of a preferred embodiment of the invention and the accompanying drawing thereof.

FIGURE 1 is an elevation view of a portion of a turbine wheel and blade assembly taken on a plane normal to the axis of rotation thereof.

FIGURE 2 is a sectional view taken on the plane indicated by the line 2—2 in FIGURE 3.

FIGURE 3 is a plan view of a portion of the wheel rim with the blades moved, projected on the plane indicated by the line 3—3 in FIGURE 1.

FIGURE 3*a* is a fragmentary sectional view taken on the plane indicated by the line 3*a*—3*a* in FIGURE 3.

FIGURE 4 is a fragmentary axonometric view showing a blade partially inserted.

FIGURE 5 is a fragmentary view of the wheel prior to machining of the blade slots.

Referring first to FIGURE 1, the turbine structure, apart from the improvement outlined above, may be entirely conventional. As shown, it is embodied in the assembly of a turbine rotor or wheel 9 and blades 10. The wheel 9 comprises a rim 11 having therein spaced multiple dovetail blade slots 12. Each blade 10 comprises an airfoil portion 14, a platform 16, and a root 17 configured to fit within a slot 12. The blade platforms 16 are in substantial abutment along their adjacent edges, indicated at 19. As will be most readily apparent from FIGURE 3, the blade slots 12 are skewed to the axis of the wheel at an angle of approximately thirty degrees. This is customary in order to orient the blade root suitably with the airfoil portion 14 of the blade.

In the manufacture of such a turbine wheel, the blank, which may be a forging, ordinarily is turned to provide a body of revolution including a hub (not shown) and in some cases a shaft, the web or disk of the wheel 9, and the rim 11. In practicing my invention, the periphery of the wheel is not cylindrical, as is usual, but has a ridge 25 extending circumferentially thereof, preferably substantially halfway between the faces of the rim, as illustrated in FIGURE 5.

The blade slots are rectilinear, and ordinarily are provided by broaching the rim of the wheel. In this operation the ridge 25 is largely cut away, but there remains a small projection or dam 27 between each two adjacent slots 12. Each projection 27 is bounded by two plane or substantially plane faces 28 and is generally of a prismatic shape. The blade roots 17 and the undersurface of the blade platform 16 also are ordinarily machined by broaching. At at any rate, whatever the process by which the blade roots and blade slots are finished may be, they are machined with tools such as to provide accurately dimensioned surfaces for a close sliding fit between them. Dams 27 are thus readily and accurately machined to fit under the marginal portions of platforms 16 and block off gas flow through the spaces beneath the platforms.

In this connection it will be apparent upon consideration of the relation of the skewed slots and blade roots to the generally cylindrical wheel rim that the configuration of the space under the blade platform varies from one end of the platform to the other and is most symmetrical at approximately the midplane of the wheel. It will be apparent that the invention involves a negligible increase in the weight of the turbine wheel and adds substantially nothing to the machining of the wheel. However, it is very effective in eliminating flow of hot gas beneath the blade platforms.

It may be mentioned briefly that the problem of wheel heating is not so significant in compressors, but that any bypassing of the blades through any spaces which may exist under a blade platform is quite harmful to compressor efficiency. The invention therefore may be desirably included in compressors and other rotating machinery where suitable.

The detailed description of the preferred embodiment of the invention to explain the principles thereof is not to be construed as limiting or restricting the invention, as many modifications may be made by the exercise of skill in the art without departing from the invention.

I claim:

1. A turbine rotor or the like comprising, in combination, a wheel having blade mounting slots extending generally axially of the periphery thereof, blades mounted on the wheel, each blade having a root engaged in a said

slot and a platform overlying the periphery of the wheel, platforms of adjacent blades being substantially in engagement at the edges of the platforms, the wheel having a projection integral therewith between each two slots narrow relative to the width of the wheel and approximately equidistant from the faces of the wheel, the projection being bounded by surfaces fairing into the surfaces of the blade slots, and the projections being each substantially in contact with the radially inner surface of the overlying blade platforms to provide sliding clearance for movement of the platforms axially of the slots for assembly of the blades to the wheel and closing the space between the platforms and the wheel so as to substantially block flow of fluid between the platforms and the wheel.

2. A rotor as recited in claim 1 in which the blade slots are skewed to the axis of the wheel.

3. A turbine rotor or the like comprising, in combination, a wheel having a rim, the rim having dovetail blade mounting slots extending transversely thereof, blades mounted on the wheel, each blade having a root engaged in a said slot and a platform overlying the periphery of the rim, platforms of adjacent blades being substantially in engagement at the edges of the platforms, the wheel rim having a generally prismatic projection integral therewith between each two slots narrow relative to the width of the rim and approximately equidistant from the faces of the rim, the projection being bounded by surfaces fairing into the surfaces of the blade slots, and the projections being each substantially in contact with the radially inner surface of the overlying blade platforms to provide sliding clearance for movement of the platforms axially of the slots for assembly of the blades to the wheel and closing the space between the platforms and the rim so as to substantially block flow of fluid between the platforms and the rim.

4. A rotor as recited in claim 3 in which the blade slots are skewed to the axis of the wheel.

5. A turbine rotor or the like comprising, in combination, a wheel having a rim, the rim having multiple serrated blade mounting slots extending transversely thereof and skewed to the axis of the wheel, blades mounted on the wheel, each blade having a multiple serrated root engaged in a said slot and a platform overlying the periphery of the rim, platforms of adjacent blades being substantially in engagement at the edges of the platforms, the wheel rim having a generally prismatic projection integral therewith between each two slots narrow relative to the width of the rim and approximately equidistant from the faces of the rim, the projection being bounded by surfaces fairing into the surfaces of the blade slot serrations, and the projections being each substantially in contact with the radially inner surface of the overlying blade platforms to provide sliding clearance for movement of the platforms axially of the slots for assembly of the blades to the wheel and closing the space between the platforms and the rim so as to substantially block flow of fluid between the platforms and the rim.

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