Aug. 6, 1968 J. C. BURGE ET AL 3,395,891

LOCK FOR TURBOMACHINERY BLADES

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Fig 1

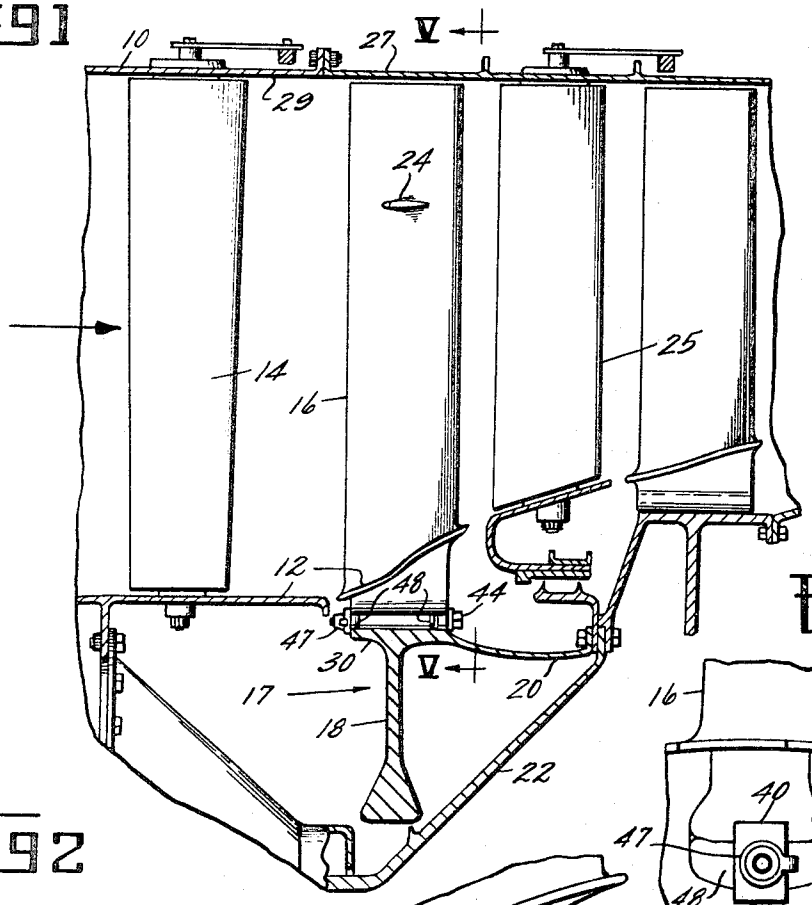


Fig 3

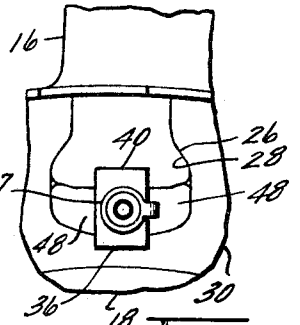


Fig 2

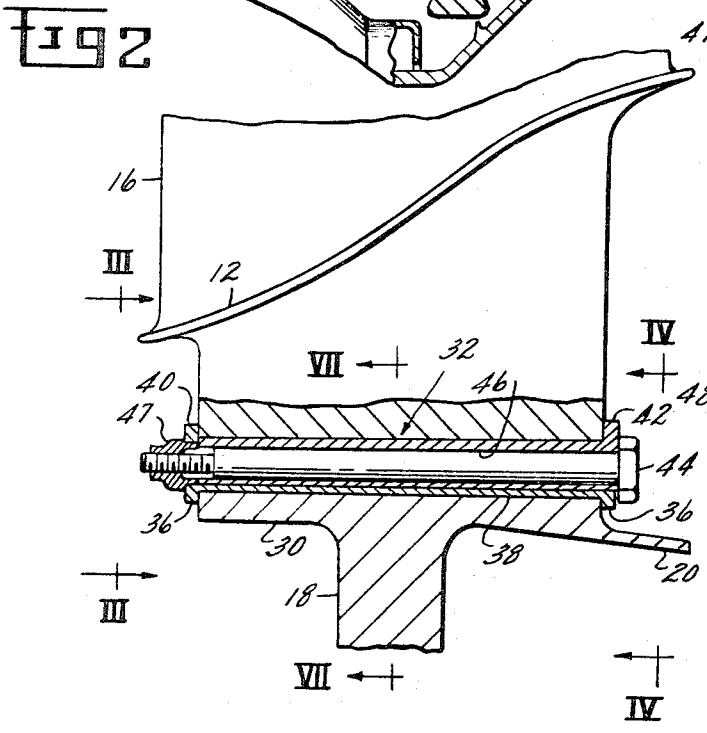
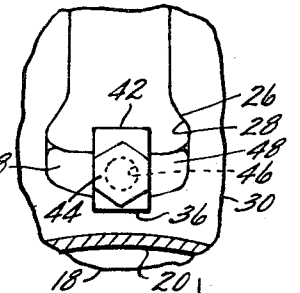


Fig 4



Inventor
JOSEPH C. BURGE
RICHARD BEAL

ATTORNEY—

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Fig 5

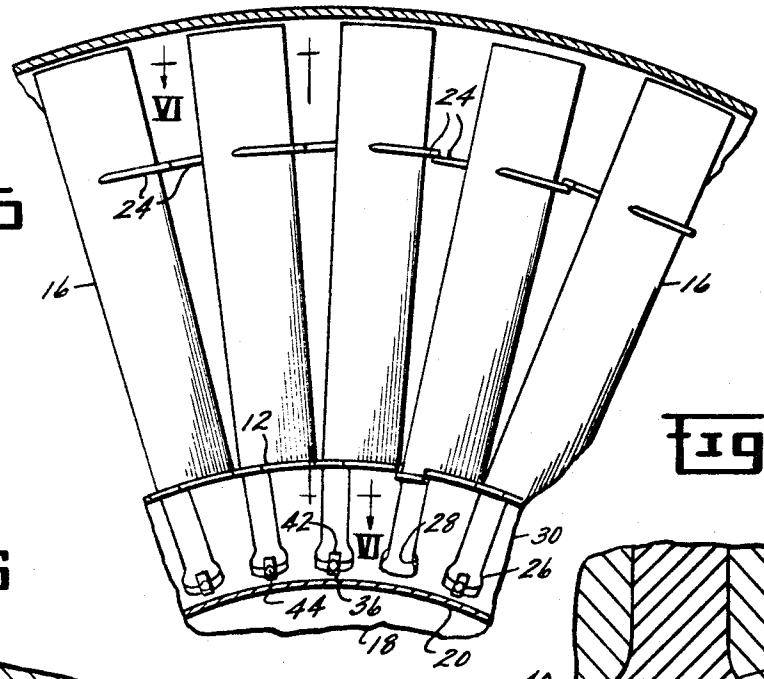


Fig 7

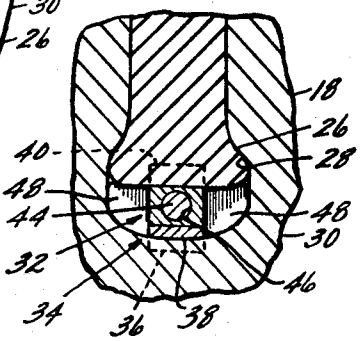


Fig 6

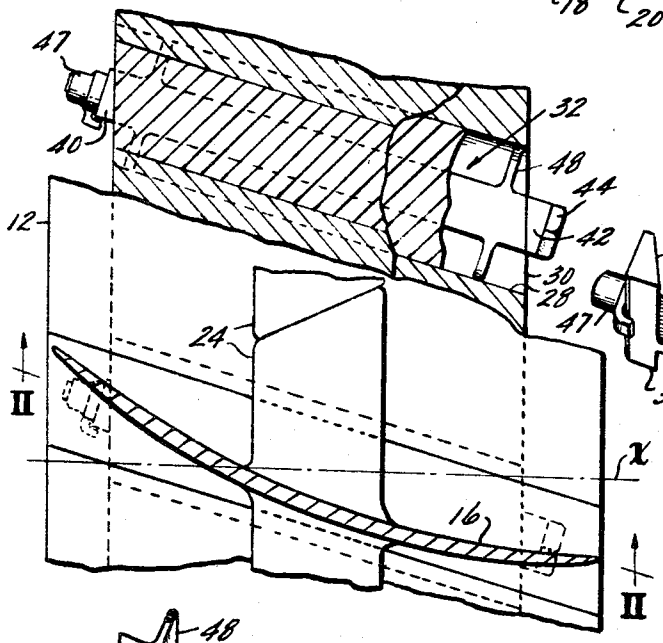


Fig 8

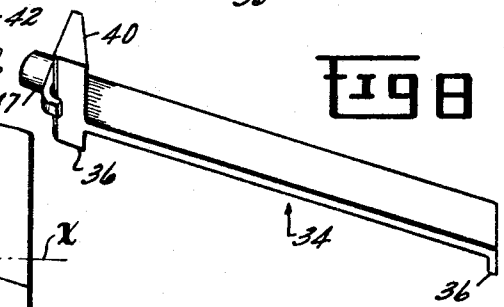
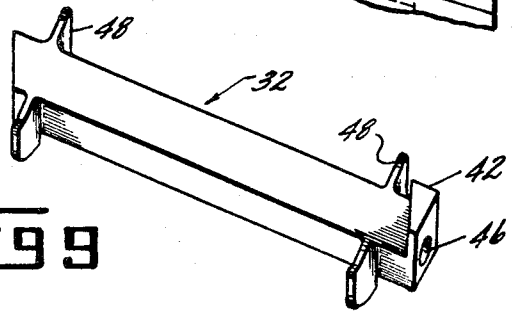


Fig 9



Inventor
JOSEPH C. BURGE
RICHARD BEAL

ATTORNEY

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LOCK FOR TURBOMACHINERY BLADES

Joseph C. Burge, Cincinnati, and Richard Beal, Loveland, Ohio, assignors to General Electric Company, a corporation of New York

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4 Claims. (Cl. 253—77)

ABSTRACT OF THE DISCLOSURE

This disclosure illustrates a fragmentary portion of a compressor rotor rim having tanged blades which are locked thereon by locking devices lying between the bottoms of the tangs and slots in the rim. The locking devices comprise a retainer having legs embracing the opposite sides of the rim and one leg engaging one end of the tang. A spacer maintains the blade in an elevated position and has a leg which engages the opposite end of the tang. The retainer and spacer are held together by a bolt. Upon removal of the bolt and the spacer, the blade may be dropped radially inwardly to clear a midspan shroud between adjacent blades and thus enable the blade to be removed from the slot. The bolt is threaded into a captured nut on the inner member so that assembly and disassembly can be had from one side of the rotor.

The invention described and claimed in the United States patent application herein resulted from work done under United States Government contract FA–SS–66–6. The United States Government has an irrevocable, nonexclusive license under said application to practice and have practiced the invention claimed herein, including the unlimited right to sublicense others to practice and have practiced the claimed invention for any purpose whatsoever.

The present invention relates to improvements in turbomachinery rotors and more specifically to an improved mechanism for locking blades in place on such rotors.

In the manufacture of bladed turbomachinery rotors, it is common practice to mount the blades on the rotors through the use of tangs formed at the base of the blades which are received by corresponding slots formed across the peripheral face of the rotor. It has been a commonly accepted practice also, particularly in gas turbine engines for the propulsion of aircraft, to lock the blades in the rotor slots by the use of metal strips which are slipped through the rotor slots and their ends bent so that they overlie both the tang and adjacent portions of the side of the rotor. This is a simple arrangement which enables individual blades to be replaced if desired.

It has the disadvantage, however, that any relative movement between the blade and the rotor, in an axial sense, will be taken by a portion of the retainer which has been bent after assembly. While such a retainer can be designed to function satisfactorily, if an attempt is made to reuse it or if it is not designed exactly as specified or used exactly as specified, reliability problems can arise. A further problem is that the bent metal tab retainers are not particularly suitable for locking blades having shrouds either intermediate their length or their outer ends. Shrouded blades require that the blade be shifted radially inwardly before it can be removed from the slot. Yet another drawback of the conventional blade locking devices is that they generally require access to both sides of the blade slot for insertion and removal. In some instances other design requirements make it impractical or inconvenient to provide such access during routine mainteance or the like, where it would be desired to remove one or more blades.

In a broad sense, these various problems have been recognized in the past, and, generally speaking, there have

been proposals which purport to solve such problems. However, such proposals have been either complicated, expensive, or not fully adaptable for all operating conditions, as for example, where it is desired that the blade slots be angled relative to the axis of the rotor.

The object of the invention is therefore to provide an improved lock for a blade mounted on a rotor and in doing so to overcome the several problems identified above.

To this end, a turbomachinery rotor is employed with the usual circumferential rim having slots thereacross. Blades are mounted in these slots by means of tangs at their inner ends. A clearance is provided between the slot and the lower surface of the tang. Blade locks are disposed in these clearances, each comprising a retainer having legs embracing either the opposite ends of the tang or the opposite sides of the rotor rim, and a third leg extending in an opposite direction to engage either one side of the rotor rim or one end of the tang. A spacer lies against the retainer to maintain the blade in is radially outward position and is provided with a leg which engages the other side of the rotor rim or the other end of the slot. The retainer and spacer are held in locking position by a bolt which is preferably threaded into a threaded element on the retainer. Upon disassembly of the bolt, the spacer can be removed, permitting the blade to be shifted radially inwardly to clear shroud portions thereon for removal of the blade from the slot, and, in reverse fashion, the blade may be assembled on the rotor.

The above and other related objects and features of the invention will be apparent from a reading of the following description of the disclosure found in the accompanying drawings and the novelty thereof pointed out in the appended claims.

In the drawings:

FIGURE 1 is a longitudinal section of a portion of an axial flow compressor;

FIGURE 2 is a longitudinal section, on an enlarged scale, through the tanged root of a blade seen in FIGURE 1 and taken on line II—II in FIGURE 6;

FIGURE 3 is a view taken on line III—III in FIGURE 2;

FIGURE 4 is a section taken on line IV—IV in FIGURE 2;

FIGURE 5 is a section taken on line V—V in FIGURE 1;

FIGURE 6 is a section, on an enlarged scale, taken generally on line VI—VI in FIGURE 5;

FIGURE 7 is a section taken on line VII—VII in FIGURE 2;

FIGURE 8 is a perspective view of one of the locking elements employed herein; and

FIGURE 9 is a perspective view of another of the locking elements employed herein.

FIGURES 1 and 5 illustrate the first stage of an axial flow compressor of the type employed in gas turbine engines. From the engine inlet, air passes through an annular flow passageway, defined at its outer bounds by the compressor casing **10** and at its inner bounds by platform elements **12**, some of which are stationary and some of which are integral with the compressor rotor.

Air first passes through a circumferential row of inlet guide vanes **14** and then past a circumferential row of blades **16** which are mounted on the compressor rotor **17**. The compressor rotor comprises a first stage disc **18**, which is connected by a web **20** to a conical torque shaft **22**, which comprises a part of the compositely formed rotor structure. Downstream of the blades **16** is a row of stator blades **25** which are mounted on the compressor casing **27**. The compressor casing comprises two semicylindrical shells secured to a frame member **29** which encompasses the inlet guide vanes **14**.

The outer portions of the blade **16** are of an airfoil

shape and, due to their length, are provided with midspan shrouds **24** (FIGURES 5 and 6) which extend from opposite sides of the airfoil into abutting relation with corresponding shroud portions **24** on adjacent blades. Such midspan shrouds are a known means for minimizing blade vibration.

The inner ends of the blades **16** are provided with tangs **26** which are received by corresponding slots **28**, formed in a circumferential rim **30** peripherally of the disc **18**. The slots **28** are formed at an angle to the axis of the rotor which is illustrated by line *x* in FIGURE 6. This angled relationship corresponds to the angled relationship of the airfoil portion of the blade and minimizes stress loadings resulting from centrifugal force on the blades during rotation.

Each blade is locked by a spacer **32**, a retainer **34**, and a bolt **44** which are disposed between the clearance between the lower end of the tang **26** and the bottom of the slot **28**. The retainer **34** has inwardly extending legs **36** at opposite ends of a bridge portion **38**. The legs **36** are angled relative to the bridge **38** corresponding to the angled relationship of the slot **28**. The bridge **38** thus fits snugly against the bottom of the slot **28** with the legs **36** embracing opposite radial faces of the rim **30**. The retainer **34** also has an outwardly extending leg **40** which is angled to engage the forward end face of the tang **26**. The spacer **32** overlies the bridge **38** and has an outwardly extending leg **42** which engages the rearward end of the tang **26**. A bolt **44** passes through a hole **46** in the spacer **32** and is threaded into a self-locking nut **47** captured on the forward end of the retainer **34**. The described lock thus provides by means of the legs **36** a positive clamping relative to the rim **30** and by means of the legs **40**, **42** a positive clamping to the opposite end faces of the tang **26**, and, at the same time, functions to positively maintain the blade **16** in a radially outwardly shifted position.

When it is desired to remove a given blade **16**, one or both of the compressor casing shells and the stator blades **25** mounted thereon are removed to provide access to the rear of the rotor rim. The appropriate bolt **44** is removed, thus permitting removal of the spacer **32**. The blade **16** may then be shifted radially inwardly, clearing its midspan shroud elements **24** of the midspan shroud elements of adjacent blades. The blade **16** can then be slid rearwardly, bringing its tang **26** clear of the slot **28** for removal of the blade.

Similarly, the blade would be mounted by first placing a retainer **34** in an empty slot, next inserting the blade in the slot and shifting it outwardly. The spacer **32** would then be inserted beneath the blade as pictured in the drawings, and the bolt **44** threaded into the nut **47** to secure the locking device for operation. It will be noted that both installation and removal of blades can be accomplished once the compressor casing is removed from the rear side of the disc without requiring removal of the platform element **12** in advance thereof, which is for other design reasons not readily accessible for removal.

It will also be noted that the spacer **32** is provided with wings **48** which block air flow through the clearance between the bottom of the slot and the bottom of the blade tang. These wings also prevent the retainer and spacer from shifting in this clearance under the influence of the high centrifugal forces encountered during rotation of the rotor.

It will be apparent that the described locking device could be essentially turned upside down where access may be had to both sides of the rotor rim. Further, while the present invention has been described as a lock for compressor blades, it could also be used on other turbomachinery blades to advantage. These and other modifications of the disclosure will occur to those skilled in the art within applicants inventive concepts which are to be limited solely by the language of the following claims.

Having thus described the invention, what is claimed as novel and desired to be secured by Letters Patent of the United States is:

1. In a turbomachinery rotor comprising a circumferential rim with slots thereacross and blades having tangs received by said slots wherein there is a clearance from one end to the other of the tang between the slot and the lower surface of the tang,

a blade lock, for each blade, comprising,

a retainer having a bridge disposed in said clearance and having a pair of legs, at opposite ends thereof, extending in one radial direction and a third leg, at one end thereof, extending in an opposite radial direction,

a spacer also disposed in said clearance and having a leg extending in the same radial direction of said third leg, and

means retaining said spacer and with said legs engaging the opposite faces of said rim and opposite ends of said tang.

2. A combination as in claim **1** wherein,

said pair of legs extend radially inwardly of the retainer bridge to engage opposite faces of said rim and retainer in assembled relation

said third retainer leg and said spacer leg extend radially outwardly to engage opposite ends of said tang.

3. A combination as in claim **2** wherein,

the retaining means comprise a bolt, threadably connected with said retainer with its head clamped against the end of the spacer having the leg extending therefrom,

whereby the blade lock may be assembled and removed from one side of the turbomachinery rotor.

4. A combination as in claim **3** wherein,

the bolt extends through said clearance,

a lock nut is attached to the end of the retainer having legs extending in opposite directions,

the spacer comprises a relatively narrow body portion through which the bolt extends and laterally extending wings, conforming to the remainder of the said clearance not filled by the body portion of the spacer or by the retainer,

whereby air leakage through the clearance is prevented.

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EVERETTE A. POWELL, JR., *Primary Examiner.*