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[21]	Appl. No.	59,045
[22]	Filed	July 29, 1970
[45]	Patented	Jan. 4, 1972
[73]	Assignee	General Electric Company

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**[54] DEVICE FOR LOCKING TURBOMACHINERY
BLADES**
5 Claims, 7 Drawing Figs.

[52]	U.S. Cl.....	416/220
[51]	Int. Cl.....	F01d 5/32
[50]	Field of Search.....	416/219, 220, 221

ABSTRACT: A unitary assembly is inserted into a space between a blade tang and the bottom of a dovetail slot. A bolt is rotated relative to the spacer so that its head overlies the side of the rotor and the blade tang. A nut threaded on the opposite end of the bolt is tightened to clamp a plate against the other side of the rotor and the blade tang.

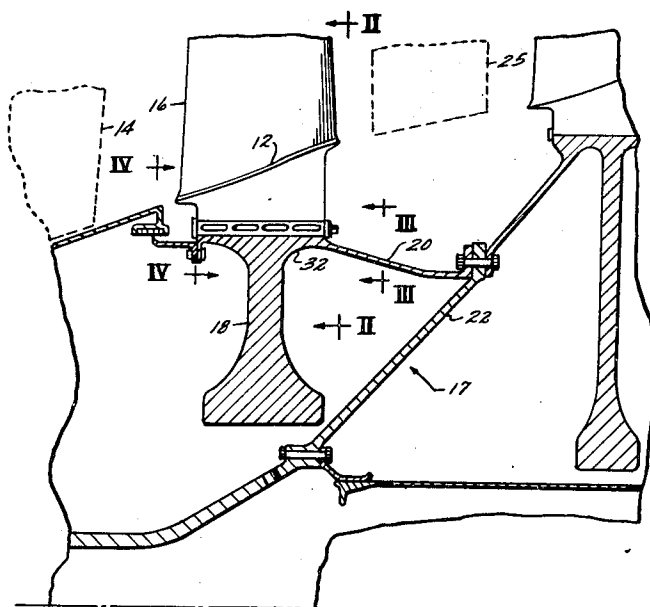


Fig 1

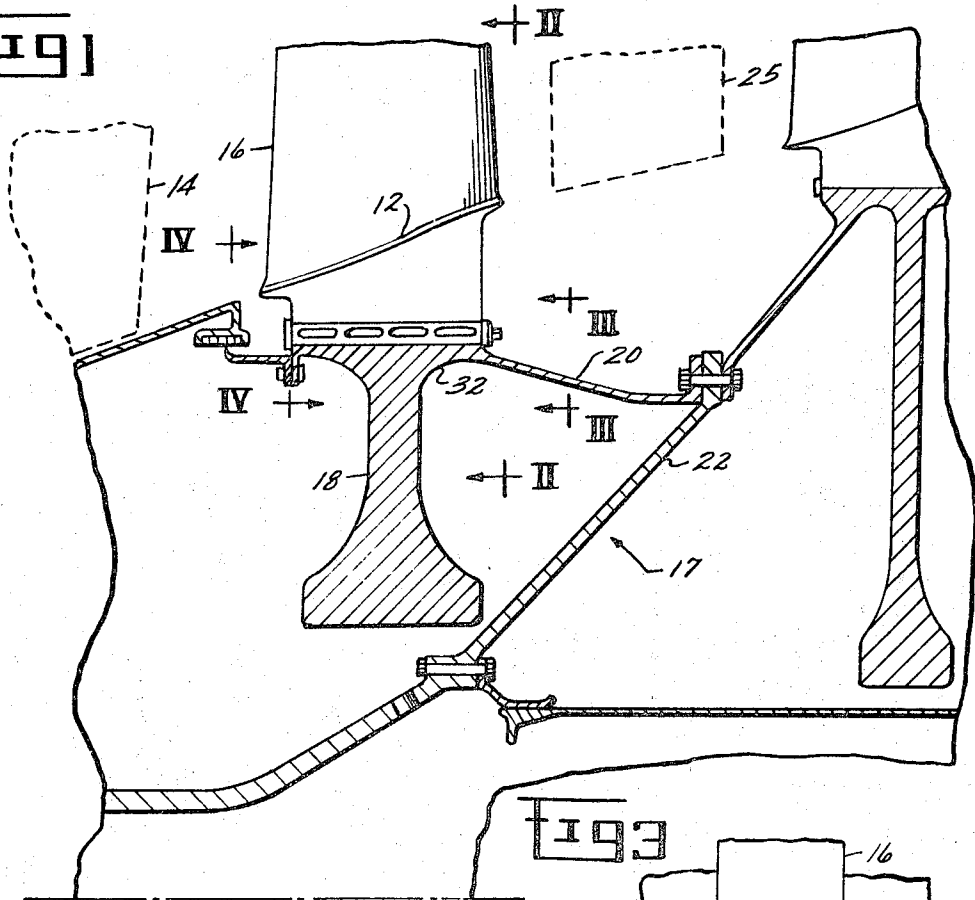


Fig 3

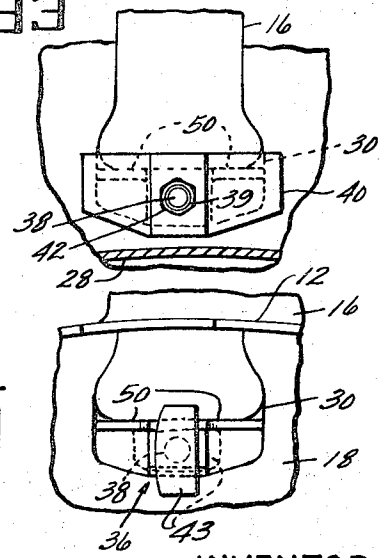


Fig 4

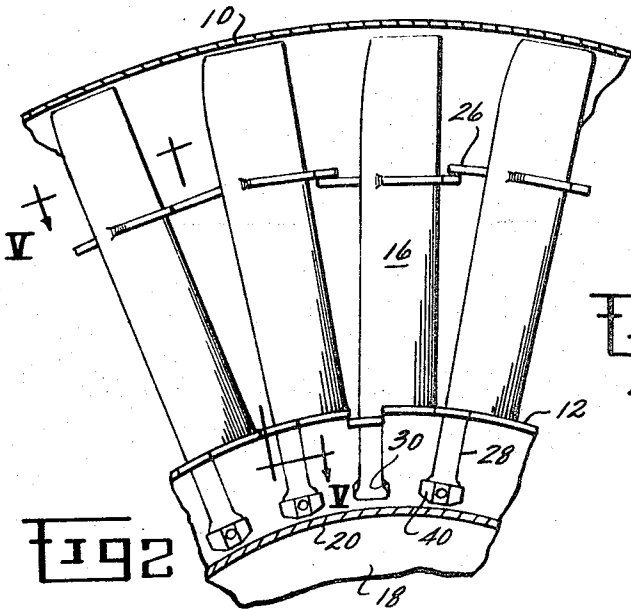
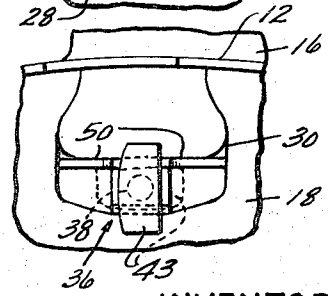


Fig 2

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Fig 5

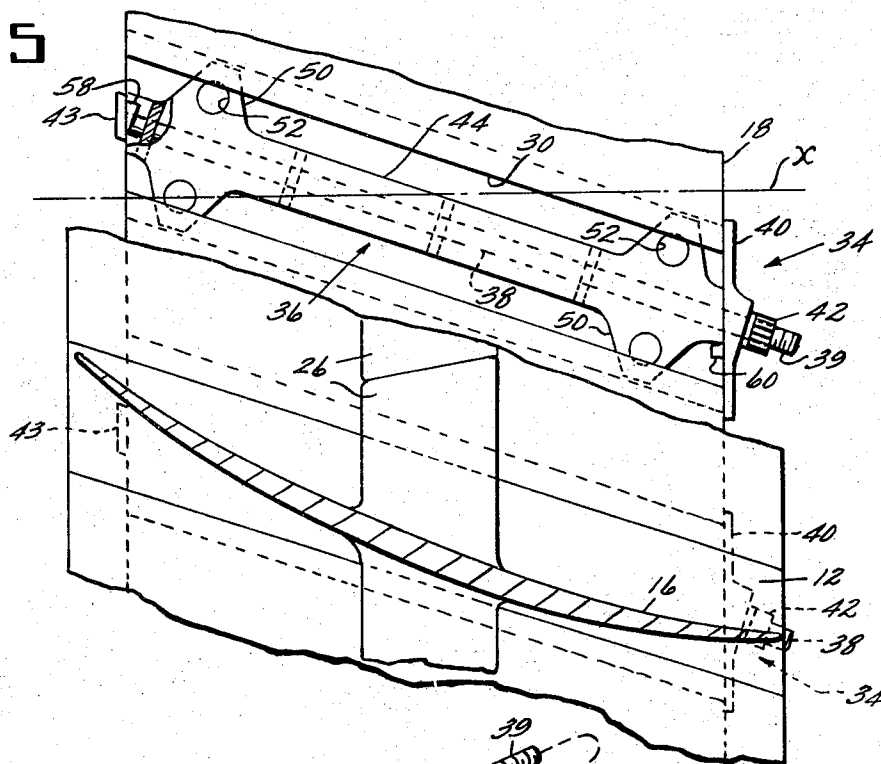


Fig 6

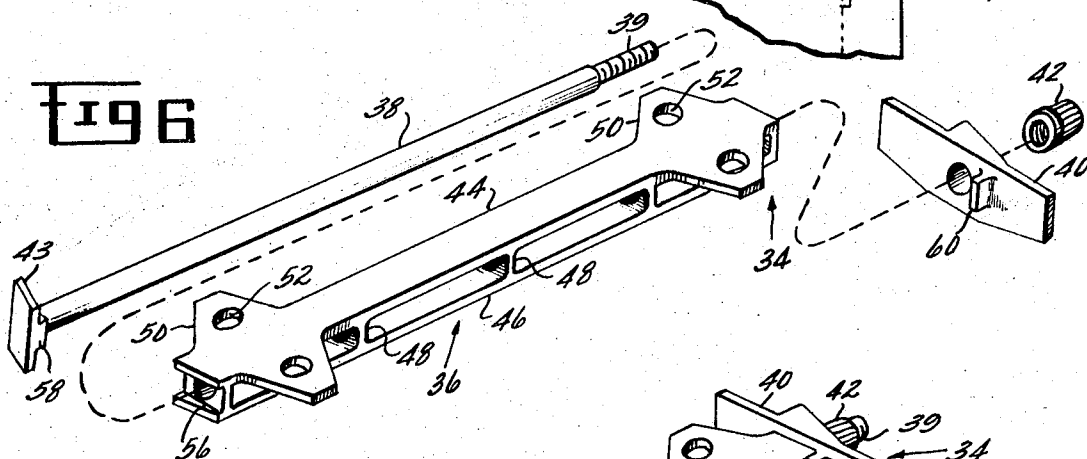
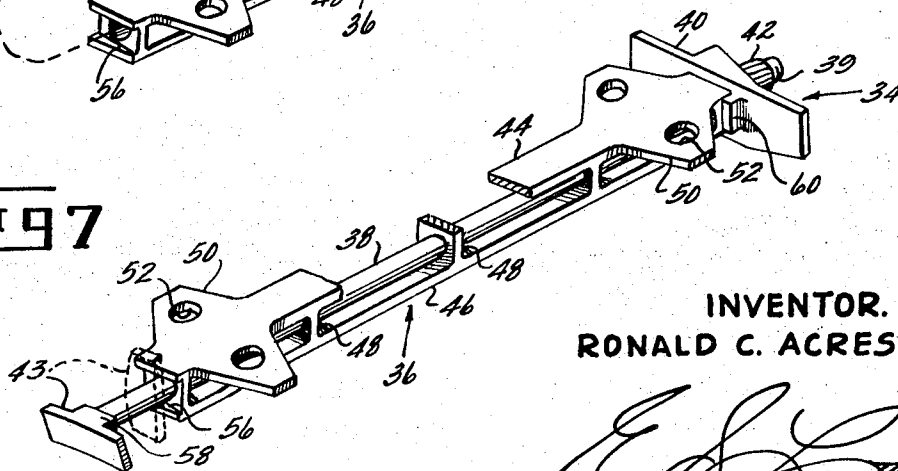


Fig 7



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DEVICE FOR LOCKING TURBOMACHINERY BLADES

The invention described and claimed in the U.S. patent application herein resulted from work done under U.S. Government contract FA-SS-67-7. The U.S. 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 device 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 dovetail 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 overlies 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 suited for locking blades having shrouds either intermediate their length or at 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 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 maintenance or the like where it is desired to remove one or more blades.

There have been many blade locking devices proposed to solve the problems discussed above. U.S. Pat. No. 3,395,891 discloses a blade-locking device which, in fact, does provide a positive lock for the blade without relying on bending of any of its component parts and which is capable of insertion and removal where access is available to only one side of the rotor. That locking device, however, has the disadvantage that it is comprised of three separate component parts which must be separately manipulated during each removal and insertion. The result is that the insertion and removal process is relatively lengthy and there is a chance of one or more of the parts being misplaced.

The object of the present invention is to provide an improved blade lock which is particularly suited for shrouded blades which must be shifted radially relative to the rotor for removal and insertion and which comprises a unitary assembly to reduce the time required for insertion and removal as well as to minimize loss or misplacement of its component parts.

Briefly, these ends are attained by a unitary assembly comprising a spacer, a headed bolt extending through the length of the spacer, a plate telescoped over a threaded end of the bolt and a nut threaded onto this threaded end. In one position of the bolt, the bolt head is aligned with the spacer and the assembly may be inserted into the spacing between blade tang and the bottom of the rotor groove which receives the tang. The bolt is then rotated so that its head overlies the side of the rotor and the blade tang. The nut is then tightened to clamp the plate against the other side of the rotor and the blade tang. Additional features prevent relative rotation and the bolt, spacer and plate to insure proper positioning of these parts when the blade is locked in place.

The above and other 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:

FIG. 1 is a generally longitudinal section of a portion of an axial flow compressor taken in part along the centerline of a blade-retaining groove;

FIG. 2 is a section, on a reduced scale, taken on line II—II in FIG. 1 and showing a larger portion of the compressor;

FIG. 3 is a section, on an enlarged scale, taken on line III—III in FIG. 1;

FIG. 4 is a view on an enlarged scale, taken on line IV—IV in FIG. 1; view,

FIG. 5 is a section, on an enlarged scale, taken on line V—V in FIG. 2 with one of the blades removed;

FIG. 6 is an exploded view, in perspective, of the blade-locking device of the present invention; and

FIG. 7 is a perspective view of the blade lock unitary assembly with portions broken away.

FIGS. 1 and 2 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 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 vanes 25 which are mounted on the compressor casing 10. The outer portions of the blades 16 are of a cambered airfoil shape and, due to their length, are provided with midspan shrouds 26 which extend from opposite sides of the airfoil into abutting relation with corresponding shroud portions on adjacent blades. Such shrouds are known means for minimizing blade vibration.

The inner ends of the blades 16 are provided with dovetail tangs 28 which are received by correspondingly shaped slots 30 formed in a circumferential rim 32 of the disc 18. The slots 30 are formed at an angle to the axis of the rotor which is indicated by the line X in FIG. 5. This angled relationship corresponds to the angled relationship of the airfoil portion of the blade and minimizes stress loadings into the tang resulting from centrifugal force on the blade during rotation. Each blade is locked in place by a locking device 34 which will be described in detail with reference to FIGS. 5-7.

The locking device 34 comprises four elements: a spacer 36, a bolt 38, a plate 40 and a nut 42. The spacer 36 preferably comprises upper and lower strips 44, 46 which are connected and spaced apart by integral, vertical ribs 48. Wings 50 project from the upper strip 44 and apertured at 52 to reduce weight. The bolt 38 passes through aligned holes 54 in the ribs 48. The blade 40 passes over the threaded end portion 39 of the bolt 38 and the nut 42 is then turned onto the threaded end of the bolt 38 to provide a unitary assembly as illustrated in FIG. 7. The bolt 38 has a flathead 43 at its opposite end.

Other features to be noted with respect to the locking device 34 are found in the provision of a horizontal slot 56, defined by the strips 44, 46, in one end of the spacer 36 which receives a lug 58 formed beneath the bolt head 43. The bolt 38 when assembled as shown in FIG. 7, has a length greater than that of the spacer so that its headed end may be projected beyond as indicated in that figure. It will also be seen that the plate 40 has a lug 60 for preventing relative rotation between the spacer and the plate 40 when they are in their assembled relation.

Use of this locking device will now be described for replacement of one of the blades 16. In such maintenance actions, the compressor casing or a half thereof will be removed from the

engine and with it the row of vanes 25 seen in FIG. 1. This provides access to the rear side of the first-stage rotor disc 18. Assuming that one of the blades has been removed and now is to be placed, as for example, the blade without a locking device in FIG. 2. This blade would be displaced radially outwardly providing a spacing between the blade tang and the bottom of the groove 30. The bolt 38 of the assembly 34 is rotated to the position illustrated in FIG. 7 with the lug 58 extending beyond the end of the spacer. The bolthead 43 has a height which is equal to or less than the height of this spacing while the height of the spacer 36 closely approximates this spacing. This is further illustrated by the broken line position of bolthead 43 in FIG. 4. Thus, the locking device may be simply inserted beneath the blade tang from the downstream side of the rotor disc 18.

After being inserted in place essentially as illustrated in FIG. 5, the bolt 38 is rotated to bring the bolthead 43 to the position illustrated by the broken lines in FIG. 7 and the solid lines in FIG. 4. The width of the bolthead 43 is greater than the height of the spacing between the tang and the bottom of the slot and less than the width of the slot so that it may be inserted as described and then rotated to overlie one side of the rotor disc and one end of the tang. The bolt 38 is rotated in the proper direction so that the angled inner face of the head 43 is aligned with the side face of the disc and the end face of the tang 28, thus taking into account the angled relation of the slot. The bolt 38 is then drawn in a downstream direction so that the lug 58 will be received by the slot 56. Thereafter, the nut 42 is fully tightened on the bolt 38 securely clamping the locking device 34 in place as illustrated in FIGS. 3, 4 and 5. It will also be noted that the wings 50 position the locking device 34 centrally in the slot 30 and that the length of the spacer is slightly greater than the length of the slot 30 to avoid excessive stresses in the bolthead 43. Further, it will be noted that the plate 40 is angled to align with the side of the rotor disc. The outer surface of the plate 40 is formed on a plane normal to the bolt to provide a firm seat for the nut 42. Also, the plate 40 has an outline greater than that between the tang and the bottom of the groove to block flow of pressurized air from the downstream side of the rotor to the upstream side.

Removal of the locking device to facilitate removal or replacement of a blade 16 is the reverse of the procedure described above. Again, it is capable of being carried out where there is access only to the downstream surface of the rotor disc 18.

Various modifications of the preferred embodiment described herein will occur to those skilled in the art within the spirit and scope of the present inventive concepts which are therefore to be derived solely from the appended 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. A blade-locking device for locking radially projecting blades on a rotor where each blade has a dovetail tang at its inner end and the rotor has dovetail slots extending across its peripheral from one side to the other thereof, each blade being received in a slot with a spacing between the tang and the bottom of the groove,

said blade-locking device comprising

a spacer having a height approximating the spacing between the blade tang and the bottom of the rotor slot,

a bolt having a length greater than that of the spacer and a head at one end and a threaded portion at the other end, said bolthead having a height no more than the height of said spacer and a width greater than the height of said spacer and less than the maximum width of the rotor slot,

said spacer having a passageway along its length through which the bolt extends and within which the bolt is rotatable,

a plate telescoped over the threaded portion of said bolt, and

a nut threaded onto said threaded portion to form a unitary assembly which may be slipped into the spacing between the tang and the bottom of the groove, the bolt rotated to register its head with both the tang and one side of the rotor and the nut tightened to clamp the latter against tang and the other side of the rotor.

2. A blade-locking device as in claim 1 further including means, acting between said spacer and bolt, for locking the bolt against rotation relative to the spacer when the bolthead is in a selected position to engage the blade tang and the one side of the rotor and when the bolthead is drawn into close proximity to the spacer.

3. A blade-locking device as in claim 1 wherein the spacer is noncircular in cross section, the plate has an outline greater than that of the space between the blade tangs and rotor slots, and means acting between said bolt and plate, are provided for locking said plate in overlying position relative to said spacing when the nut is fully threaded on the threaded portion of the bolt.

4. A clamping device as in claim 1 wherein the spacer comprises upper and lower, relatively thin strips having a length approximating that of the rotor slots and spaced apart by integral, vertical, transverse ribs, said spacer further having wings projecting laterally from one of said strips, which are engageable with the sides of said slot to position the spacer centrally thereof, said ribs have aligned holes therethrough forming the passageway for said bolt,

a short lug is formed on the bolt underneath said head, said lug being receivable between the ends of the spacer strips when the bolthead is rotated to a selected position to engage the blade tang and the one side of the rotor and when the bolthead is drawn into close proximity to the spacer,

the plate has an outline greater than that of the space between the blade tangs and the bottom of the rotor slot, and has a lug engageable with the spacer for positioning said plate in overlying relation to said spacing when said bolt is fully threaded on the threaded portion of said bolt.

5. A locking device as in claim 4 for a locking blade in a slot which is angled relative to the axis of the rotor and angled from a square relation relative to the sides of the rotor, wherein

the inner surfaces of the bolthead and the plate have the same angular relationship for flush engagement with the sides of the rotor disc and the blade tangs, and

the portion of the outer surface of the plate surrounding the bolt is normal to the bolt for effective clamping action when the nut is threaded thereagainst.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,632,228 Dated January 4, 1972

Inventor(s) Ronald C. Acres

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 56, after "peripheral" should read
-- face --. Column 4, line 32, "clocking" should read
-- locking --.

Signed and sealed this 24th day of October 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents