United States Patent

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[73] Assignee **General Electric Company**

[54] **COMPRESSOR-BLADE-RETAINING MEANS**
8 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** **416/215,** 416/221
[51] **Int. Cl.** **F01d 5/32**
[50] **Field of Search** 416/215, 218, 221

[56] **References Cited**

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ABSTRACT: The application describes means for retaining individual bladed members in their circumferential position on a gas turbine rotor spool. The invention comprises an elongated recess in the inner surface of a blade-root-retaining groove and a leaf spring disposed in the blind recess, which leaf spring includes a protuberance adapted to extend between the roots of two adjoining compressor blades.

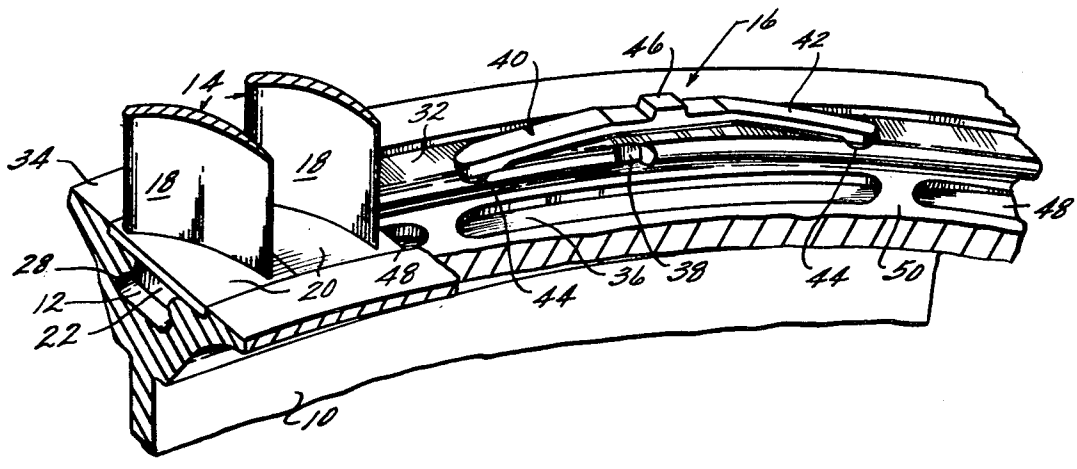


Fig 1

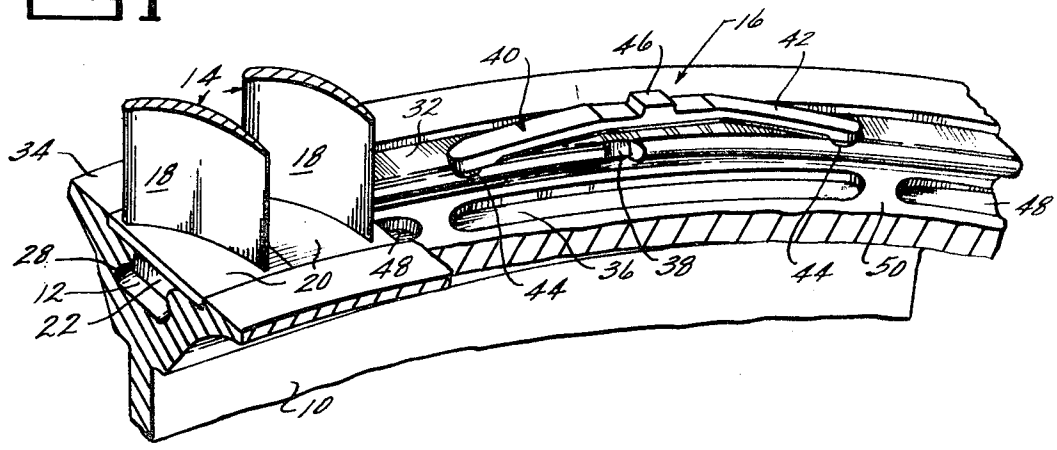


Fig 2

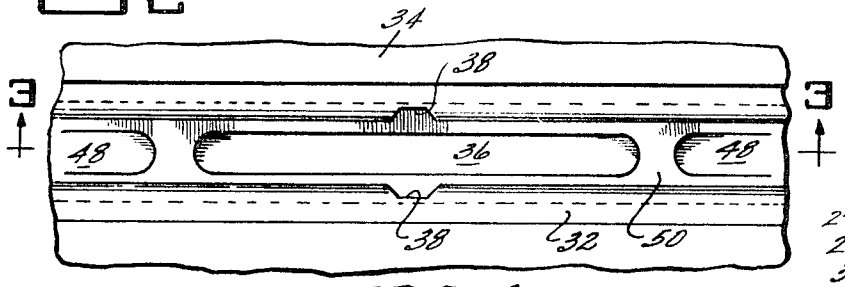


Fig 4

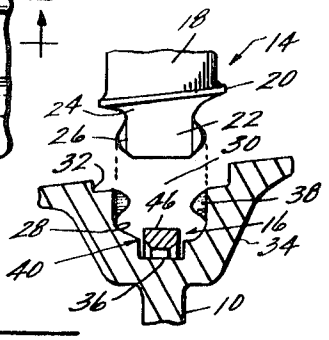


Fig 3

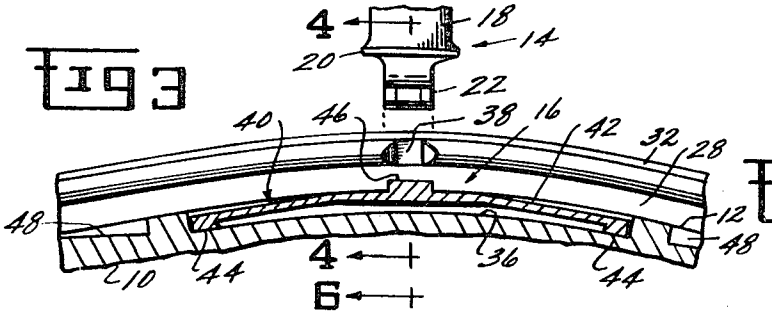


Fig 6

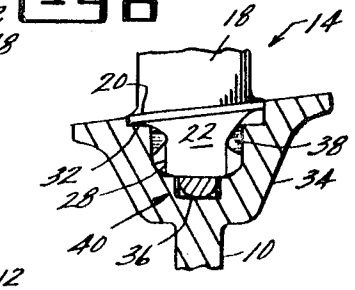


Fig 5

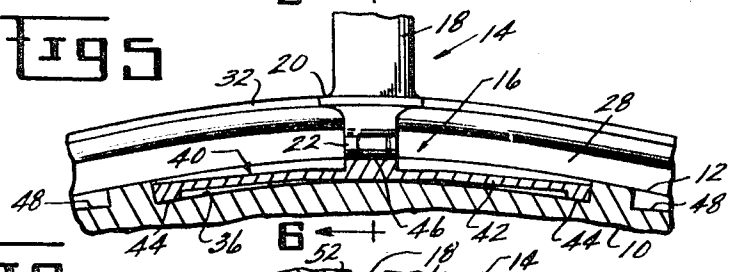
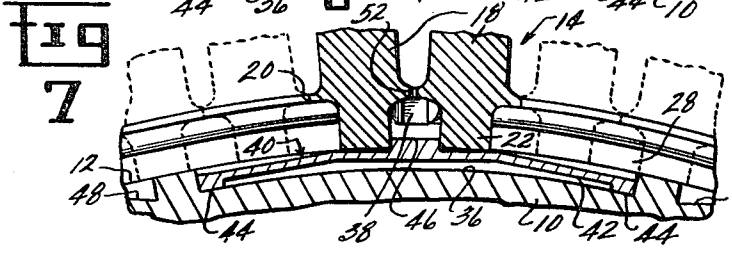


Fig 7



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COMPRESSOR-BLADE-RETAINING MEANS

BACKGROUND OF THE INVENTION

This invention relates to axial flow compressor rotor structure and more particularly to means for retaining the bladed members of such a structure in their position in a rotor spool.

A common rotor structure used in axial flow compressors for gas turbine engines comprises a drum or spool having a surface which in part defines the airflow path through the compressor, and a plurality of airfoil bladed members secured to the spool in circumferential rows. The bladed members each include a root at the base of the airfoil, which root includes a necked-in portion. The roots are secured in circumferential grooves in the rotor spool, which grooves are adapted to secure the blade roots to restrain the blades from moving radially out of the rotor. Assembly of the blade roots into the blade-retaining grooves is ordinarily accomplished by inserting a blade root through a narrow loading slot cut into the groove at one or more discreet points along the circumference of the spool and then sliding the blades in the blade-retaining groove into their respective positions. The structure described, providing freedom for movement of the bladed members circumferentially of the spool also requires a locking device which will stop such movement in each row of bladed members after all the blades in a particular row have been assembled with the rotor spool. The locking device must be capable of withstanding the circumferential component of the airfoil aerodynamic load developed during compressor operation. At the same time, the locking device must be capable of permitting assembly and disassembly of the blade members to the spool with relative ease.

Several designs have been and are being used to perform the locking function described above. These devices often take the form of setscrew arrangements or spring load devices which have reliability limitations, or are difficult to contend with during assembly and disassembly of the engine. These devices are of very small physical size and are therefore often limited in strength. Furthermore, the screws must themselves be locked in place after assembly and are therefore not easily disassembled. Other shortcomings of prior art devices include elastic stressing of such devices while in their assembled position in the rotor spool.

It is desirable, and is therefore an object of this invention, to provide a rotor-blade-locking device which permits ready assembly and disassembly of the bladed members of a compressor rotor with the rotor spool, yet provides positive locking of the blades in position during engine operation. A further object of the invention is to provide such a device which is relatively inexpensive to manufacture, which can be reused after disassembly, and which is not subject to constant elastic stress and the attendant possibility of relaxation of the elastically stressed member.

BRIEF SUMMARY OF THE INVENTION

Briefly stated, the invention is a unique retaining means in combination with a turbomachine rotor assembly of the type comprising a circumferential blade-retaining groove having a loading slot formed therein and a plurality of blade members assembled therewith. The blade-retaining means comprises a leaf spring retainer disposed in an elongated recess located in the surface of the blade-retaining groove and in fixed dimensional relationship to the loading slot and includes a span maintained in spaced relation to the outwardly facing surface of the elongated recess spring. The leaf spring includes a protuberance located for alignment with the loading slot and extending into a space between two adjacent assembled blade roots.

DESCRIPTION OF THE DRAWINGS

While the invention is distinctly claimed and particularly pointed out in the claims at the end of this application, the invention is more readily understandable by reference to the description below and the accompanying drawings in which:

FIG. 1 is a fragmented perspective view of a segment of a rotor spool having bladed members assembled therewith;

FIG. 2 is a fragmented developed planned view of the rotor spool segment shown in FIG. 1;

FIG. 3 is a fragmented section view taken along the line of 3–3 of FIG. 2;

FIG. 4 is a fragmented section view taken along the line of 4–4 of FIG. 3;

FIG. 5 is a fragmented section view taken along the line of 3–3 of FIG. 2 and additionally showing a compressor rotor blade as positioned during one step of the assembly of the blade to the rotor;

FIG. 6 is a partially fragmented section view taken along the line 6–6 of FIG. 5; and

FIG. 7 is a partially fragmented section view taken along the line 3–3 of FIG. 2 and additionally showing final assembly of the compressor rotor blades with the rotor spool and the blade-locking means.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the rotor assembly comprises a spool **10** (shown in segmented form) which includes a plurality of blade-retaining grooves **12**, a plurality of bladed members **14** assembled to the spool **10** and retained by a groove **12**, and a blade-retaining means **16** which is provided to maintain bladed members **14** in their circumferential positions on spool **10**.

Bladed members **14** each comprise an airfoil **18** extending radially from spool **10**, a platform **20** located at the base of airfoil **18**, and a root **22** in interlocking engagement with blade-retaining groove **12**. Referring to FIGS. **4** and **6**, root **22** comprises a relatively thin neck **24** adjacent the base **20** of bladed member **14**, which neck is faired outwardly to an enlargement **26**. Enlargement **26** is sized to fit snugly but slidably within the undercut **28** of blade-retaining groove **12**, and neck **24** is similarly shaped and sized to fit snugly within the narrow portion **30** of blade-retaining groove **12**. Thus, each bladed member **14** will interlock with spool **10** to restrain radial movement of members **14** with respect to spool **10**. Spool **10** additionally includes a relief **32** on each side of blade-retaining groove **12** to accept platform **20** so that platform **20** will be flush with the spool outer surface **34** and in combination therewith form a smooth surface for the passage of air over the assembled compressor rotor.

Retaining means **16** comprises an elongated recess **36**, milled or otherwise formed in the bottom surface of blade-retaining groove **12** in alignment with the loading slot **38**, and a spring retainer **40**. As shown in FIG. **2**, the elongated recess extends along the circumference of the inner surface of blade-retaining groove **12** and is centered with respect to loading slot **38**.

Spring retainer **40** is a leaf spring as shown comprising a leaf span **42** which can be slightly bowed outwardly in the unloaded state as shown and which includes a pad **44** at each of its ends to maintain leaf **42** in circumferential spaced relation and correct radial location with the bottom of recess **36** (see FIG. **3**). A locking protuberance **46** extends outwardly from span **42** and becomes aligned upon assembly of spring **40** in recess **36** with loading slot **38**. The protuberance on the leaf spring is just wide enough to space two adjacent blades correctly in the rotor with respect to the loading slot.

In some rotor designs and under certain operating conditions, the presence of spring retention groove **36** can cause undesirable stress concentrations in the rotor spool **10**. To relieve such concentrations, stress relief grooves **48** are formed in the inner surface **50** of blade-retaining groove **12**. Referring specifically to FIG. **2**, these grooves are elongated blind slots milled or otherwise formed in surface **50** and located adjacent the ends of elongated recess **36**. Each stress relief groove **48** has a depth adjacent recess **36** which is approximate that of

recess 36 and extends circumferentially along surface 50 for a relatively short distance until it fairs into surface 50.

Assembly of bladed members 14 with rotor spool 10 is illustrated by FIGS. 3—7. FIGS. 3 and 4 illustrate the first step of the assembly process wherein a bladed member 14 is positioned with its root 22 in alignment with loading slot 38. Spring retainer 40 is located in recess 36, its ends abutting the ends thereof and its span 42 maintained in spaced relation with the bottom thereof by pads 44.

FIGS. 5 and 6 illustrate the second step of the assembly procedure wherein bladed member 14 is pushed inwardly against the elastic resisting force of spring retainer 40 to a position in which the contours of root 22 are aligned with the contours of blade-retaining groove 12. Once this alignment has been accomplished, bladed member 14 is then slid circumferentially in retaining groove 12 to a position in which the inner surface of root 22 has moved off the protuberance 46, as shown in FIG. 7. As each bladed member 14 is loaded into blade-retaining groove 12 as described above, it is moved along the circumference of the rotor spool 10 to make room for the next bladed member 14 until all but the final of the said bladed members are assembled to spool 10. The last of the said bladed members is inserted in the loading slot in the manner described above and then all the bladed members 14 are moved in the groove 12 until they assume the positions indicated in FIG. 7 by solid and broken line representations. In the position shown, protuberance 46 on spring retainer 40 is interposed between adjacent root members 22 and fills the void therebetween so that the entire row of bladed members 14 is held in its circumferential position in blade-retaining groove 12. After completion of assembly spring retainer 40 assumes its undeflected shape as shown in FIG. 3, thereby removing any continuous elastic stresses 42 and precluding the possibility of relaxation of span 42 which could render spring retainer 40 ineffective. It should, of course, be recognized that it may be desirable to slightly bias spring retainer 40 so that upon completion of the assembly described a small amount of elastic stress remains to assure a tight-fitting assembly.

During operation, centrifugal force will cause the spring ends to travel outwardly and rest on the bottom of the blade roots. Locking action is maintained by means of the restraint imposed by the blade roots on the leaf spring. The depth of the elongated groove and the spring pads is chosen to prevent disengagement when the leaf spring rests on the blade root.

The bladed rotor assembly described herein can be readily disassembled by inserting a drift punch or similar tool through the hole 52 defined by adjacent blade platforms 20, pressing against protuberance 46 until it clears the inner surface of roots 22, and sliding bladed members 14 in groove 12 until a root 22 is aligned with loading slot 38, thereby permitting removal of a bladed member 14. Thereafter, successive bladed members can be removed through loading slot 38 by a pressing inwardly on spring retainer 40 to clear each successive blade root 22 and permit removal. After a sufficient number of bladed members 14 have been removed from blade-retaining groove 12, spring retainer 40 can be removed from the assembly and the remaining bladed members 14 readily removed through loading slot 38.

The bladed rotor assembly described above possesses several advantages by virtue of its unique blade locking or retaining means, including ease of assembly and disassembly as described and minimization of elastic stresses in the assembled spring retainer. Minimization of elastic stress in assembled spring retainer 40 is accomplished with no compromise in the functional integrity of the device inasmuch as during engine operation, rotation of the rotor spool 10 will give rise to centrifugal forces acting on spring retainer 40 which will maintain it in the position wherein protuberance 46 is positively engaged between adjacent roots 22 and pads 44 are circumferentially retained by the ends of retaining groove 36.

Having above described a preferred embodiment of the invention although not exhaustive of all possible equivalents thereof, what is desired to be secured by Letters Patent is specifically claimed and particularly pointed out in the claims appearing below.

What I claim is:

1. In a turbomachine rotor assembly of the type comprising a circumferential blade-retaining groove having a loading slot formed therein and a plurality of bladed members assembled therewith so that their root members are circumferentially spaced in said groove, blade-retaining means comprising,

an elongated recess in the inner surface of said groove and extending partially circumferentially thereof, said recess being located in alignment with said loading slot; and

a spring retainer disposed in said recess, said retainer comprising a leaf spring whose ends are located in said recess in juxtaposition with the ends thereof, and whose intermediate span is in spaced relation to the blind surface of said recess, said retainer including a protuberance located for alignment with said loading slot and extending into the space between two adjacent blade roots.

2. The assembly recited in claim 1 wherein said elongated recess is symmetrically located with respect to said loading slot.

3. The assembly recited in claim 2 wherein said spring retainer is relatively unstressed.

4. The assembly recited in claim 3 wherein said leaf spring includes at each of its ends a pad which maintains the said spring in spaced relation with the blind surface of said recess.

5. The assembly recited in claim 4 wherein the inner surface of the blade-retaining groove additionally includes a pair of stress relief grooves adjacent opposite ends of said elongated recess, each said stress relief groove having approximately the same depth as said elongated recess at the end adjacent thereto and fairing into the said inner surface at a point removed from said recess.

6. A turbomachine rotor assembly comprising,

a rotor spool defining a flow path surface and including at least one retaining groove therein, said retaining groove extending circumferentially of said spool and including a relatively narrow portion adjacent the said flow surface and an undercut portion radially inward from said relatively narrow portion;

a loading slot extending radially into said groove and having a dimension axially oriented with respect to the spool which substantially equals the corresponding dimension of said undercut portion;

an elongated recess in the inner surface of said groove and extending partially circumferentially thereof, said recess being located in alignment with said loading slot;

a plurality of bladed members assembled with said spool, each said bladed member comprising an airfoil and a root at the base of said airfoil, said root comprising a neck adjacent the base of said airfoil and an enlarged portion radially inward of and adjacent to said neck, said root being slidably engaged in said groove with said neck located in the relatively narrow portion of said groove and said enlarged portion located in the undercut portion of said groove;

means for circumferentially spacing said roots, said roots being circumferentially located in said groove so that a space between two adjacent roots is in alignment with said loading slot; and

a spring retainer disposed in said elongated recess, said retainer comprising a leaf spring whose ends are located in said recess in juxtaposition with the ends thereof and whose span intermediate the ends is in spaced relation to the blind surface of said recess, said retainer further including a protuberance aligned with said loading slot, which protuberance extends into and circumferentially fills the space between two adjacent blade roots.

7. The assembly recited in claim 6 wherein the means spacing said roots comprises a platform on each bladed member normal to the axis thereof, said platform being located at the base of said airfoil.

8. The assembly recited in claim 7 wherein the said platforms adjacent said loading slot cooperatively define an access hole for providing access to said protuberance.