United States Patent [19]

Sauer

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[45] **Sept. 2, 1975**

[54] **BLADE LOCK**

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[73] Assignee: **General Motors Corporation,** Detroit, Mich.

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[52] **U.S. Cl.** **416/215;** 416/221

[51] **Int. Cl.²** **F01D 5/32**

[58] **Field of Search** 416/215, 218, 221

[56] **References Cited**

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3,120,277	2/1964	Brown et al.	416/215
3,383,094	5/1968	Diggs	416/215
3,597,112	8/1971	Garten	416/215
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FOREIGN PATENTS OR APPLICATIONS

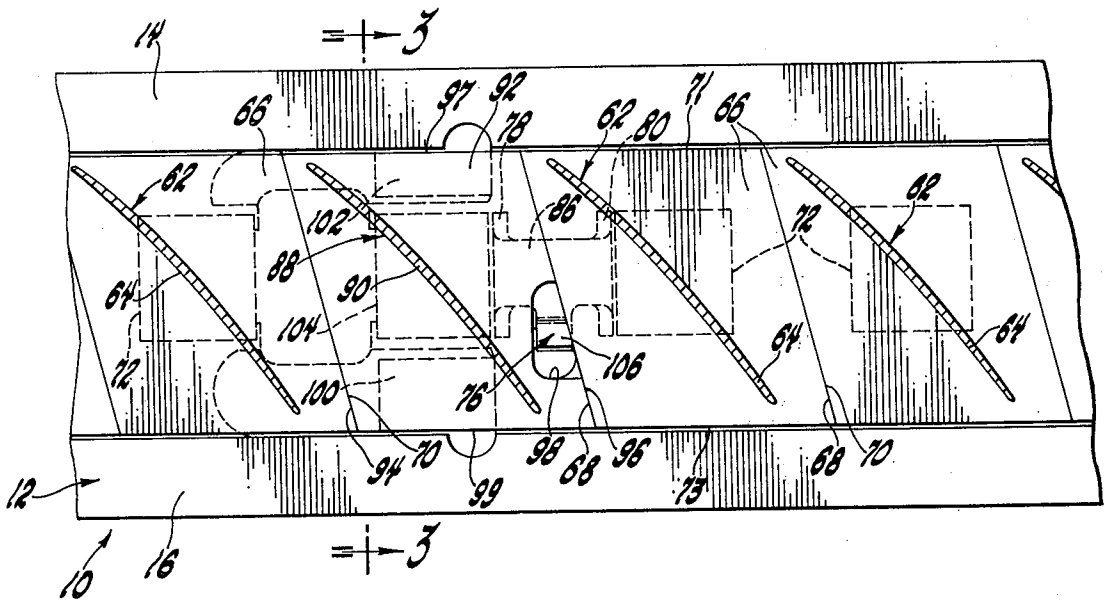
554,119	7/1932	Germany	416/215
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Primary Examiner—Everette A. Powell, Jr.
Attorney, Agent, or Firm—J. C. Evans

[57] **ABSTRACT**

A rotor stage has a circumferential groove in the wheel rim including a loading slot therein to receive the root portions of a plurality of individual aerodynamic blades in interlocked relationship therewith and including a locking blade having a configuration that is indexed on the wheel rim to align a sheet metal spacer and lock element with respect to a lock notch on the wheel rim so that loads on the airfoil will act to force lugs on the locking blade into abutment with the wheel rim to insure that all aerodynamic loads are transferred from the airfoils to the rotor wheel without subjecting the sheet metal spacer and lock element to excessive stress conditions.

2 Claims, 6 Drawing Figures



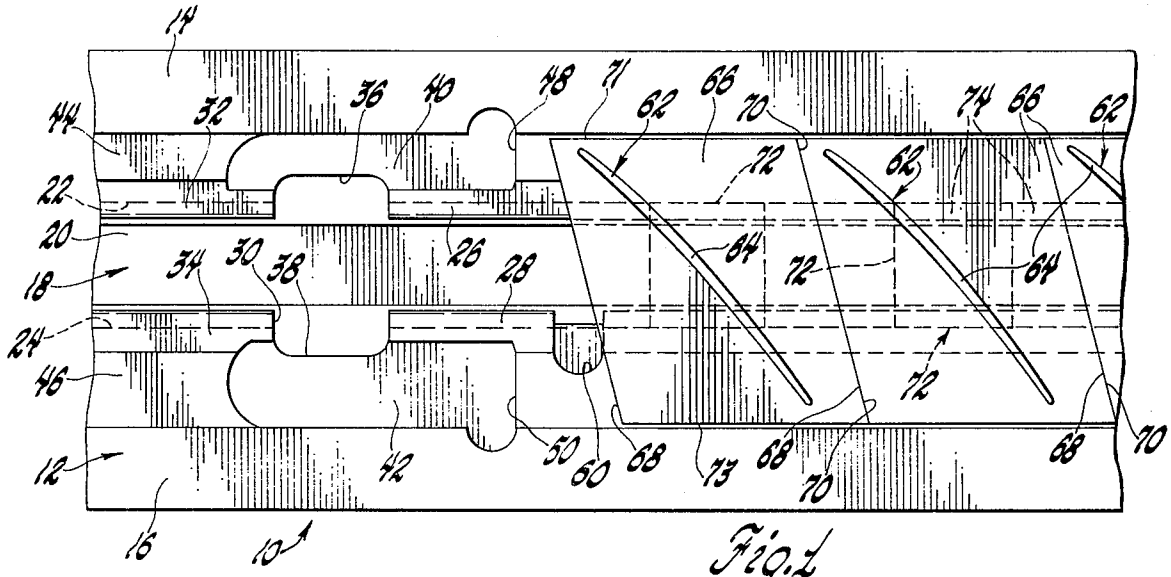


Fig. 1

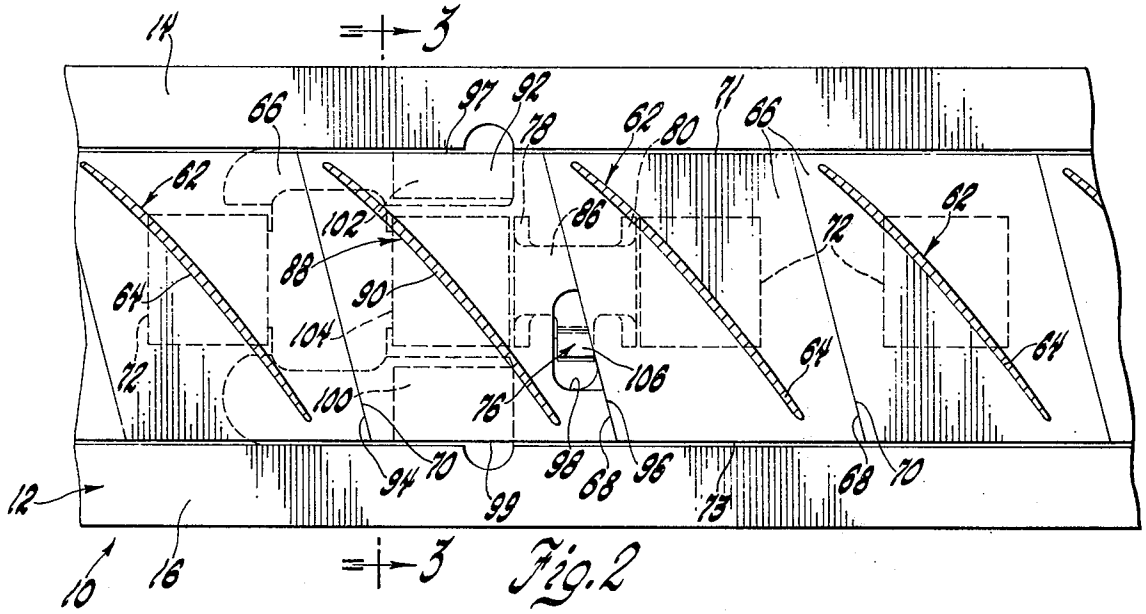


Fig. 2

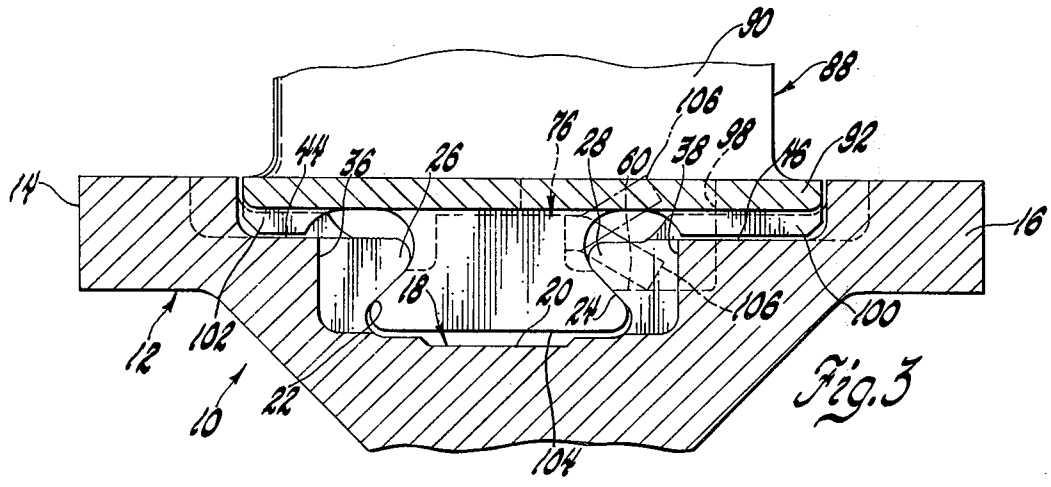


Fig. 3

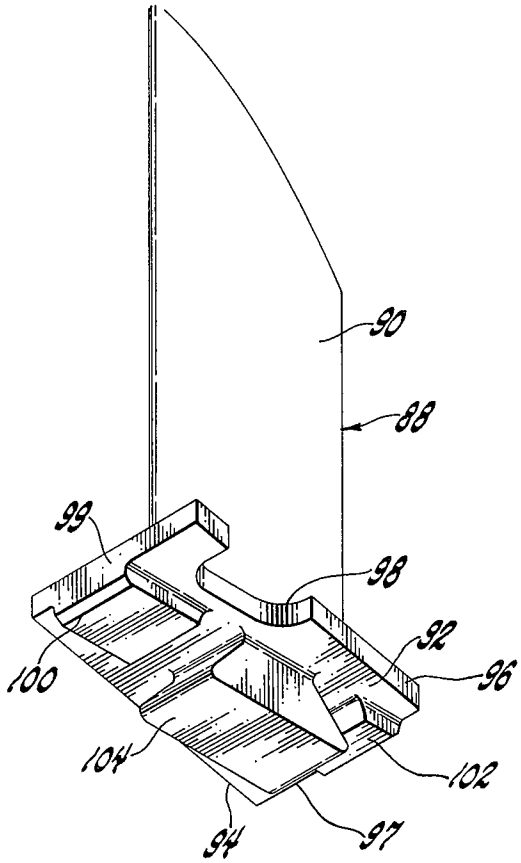


Fig. 5

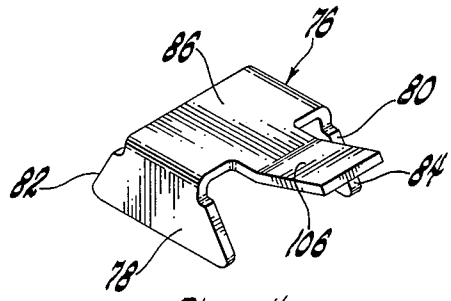


Fig. 4

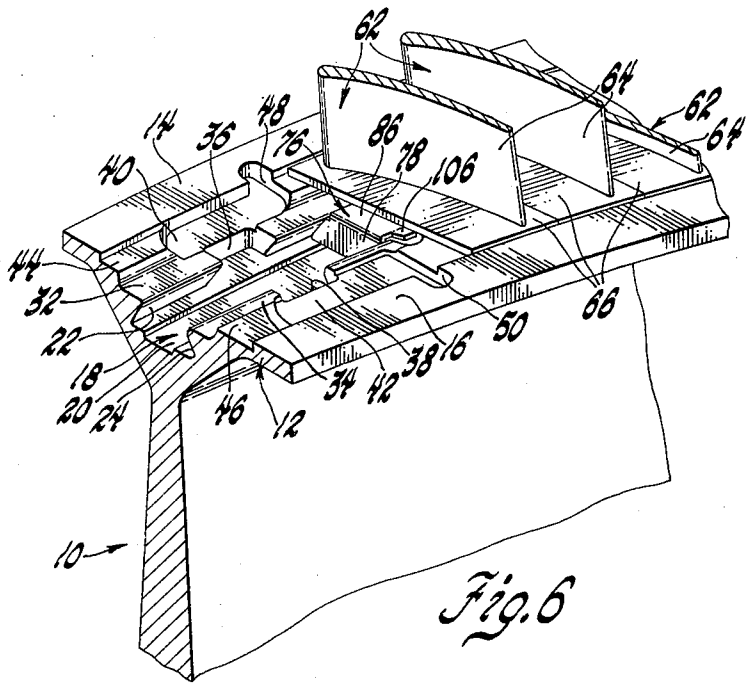


Fig. 6

BLADE LOCK

The invention herein described was made in the course of work under a contract or subcontract thereunder with the Department of Defense.

This invention relates to axial flow turbomachine devices and more particularly to means for retaining a ring of bladed airfoil members to a rotor wheel against relative circumferential movement on the wheel rim portion of the rotor structure.

Turbomachine rotor wheels have a rim with a circumferential retaining groove thereon including a loading slot into which root portions of individual airfoil blades are assembled into the rim groove and moved around the circumference of the rotor wheel to form a complete ring of blades. In such arrangements, it is necessary to include a lock device that will prevent circumferential movement of the ring of airfoil blades after the ring has been assembled on the rim of the wheel. It is desirable to arrange the lock device with respect to the retaining groove and the individual blades so that the blades will be retained in an indexed circumferential position out of radial alignment with the loading slot to the circumferential retaining groove. Gas loads on the airfoils should be directed to the wheel rim without excess stress on the lock device components of the assembly.

An example of rotor blade locking devices of this type is set forth in U.S. Pat. No. 3,383,094 issued May 14, 1968, to C. W. Diggs, which includes a locking device that is inserted into the loading slot of the retaining groove following insertion of a ring of individual blade elements. The arrangement requires two separate locking blade components and a two-stage index and lock sequence during the assembly operation.

Another example of compressor blade retaining means is set forth in U.S. Pat. No. 3,597,112 issued Aug. 3, 1971, to Herbert Garten, which discloses a yieldable locking member **46** that underlies a loading slot and is spring biased to a locked position following the insertion of a last pair of individual blade elements in a wheel rim retaining groove. This arrangement, however, requires that the locking member be continually reversely stressed during the blade loading operation.

An object of the present invention is to provide a simplified blade locking arrangement for maintaining a ring of individual air foil blades in a retaining groove of a rotor wheel by means of a single sheet metal spacer and lock element that is indexed into a locking position by means of a single locking blade in the ring of blades and wherein the rim of the wheel and a base platform of the locking blade are configured to direct all loads from the individual blade elements into the wheel rim to maintain the lock element free of gas loads.

Another object of the present invention is to provide a simplified, easily assembled blade lock arrangement including a rotor wheel rim having a continuously formed circumferential retaining groove therein and including a loading slot into which the root of individual blade elements is directed for insertion into interlocked relationship with the groove and wherein means are formed to define a circumferentially extending index surface to cooperate with index lugs on the underside of a base platform of a locking blade so as to locate a sheet metal spacer element between the roots of adjacent blades in an interlocked relationship with a lock notch on the wheel rim with the spacer element being accessible through cutout means formed in the locking blade to be bent into the lock notch so as to secure the roots of the ring of blades against circumferential movement into radial alignment with the loading slot.

Still another object of the present invention is to improve blade lock arrangements for rotor wheels having a continuously formed circumferential retaining groove therein and a loading slot into which the root portions of individual blade elements are assembled and moved around the circumference of the wheel into interlocked relationship with the groove and wherein a single sheet metal spacer and lock element is insertable through the loading slot along with a single locking blade to complete the ring of blade elements and wherein coacting means are provided on the single locking blade and the rim of the wheel to index all of the blades along with the locking blade out of circumferential and radial alignment with the loading slot and wherein base platforms on the locking blade and one of the retained blades serve to completely cover the loading slot when the blade elements are in their circumferentially indexed position and wherein the lock element has a tab portion thereon aligned with a cut-out in the single locking blade and a lock notch in the wheel rim to be bent by insertion of a tool through the locking blade cutout into the lock notch for securing each of the blades in the ring against circumferential movement from their indexed position; and wherein coacting means on the locking blade and the wheel rim insure that gas loads on the blades are conducted into the wheel rim without stressing the lock element as it maintains the individual ring of blades out of circumferential and radial alignment with the loading slot.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

FIG. **1** is a plan view of a portion of a partially completed rotor assembly including the present invention;

FIG. **2** is a plan view like FIG. **1** showing the rotor assembly with a spacer and lock element and locking blade in place thereon;

FIG. **3** is a fragmentary, enlarged vertical sectional view taken along the line **3—3** of FIG. **2** looking in the direction of the arrows;

FIG. **4** is a perspective view of a spacer and lock element of the present invention;

FIG. **5** is a perspective view of the locking blade in the combination of the present invention; and

FIG. **6** is a perspective view of a rotor wheel showing individual blades indexed in place thereon by the spacer lock element of the combination with the locking blade omitted.

Referring now to the drawings, in FIG. **1** a rotor wheel **10** is illustrated including a wheel rim **12** having a fore flange **14** formed continuously circumferentially therearound and an aft flange **16** also formed continuously circumferentially therearound. The wheel further includes a retaining groove **18** continuously circumferentially formed therearound having a bottom floor **20** and a pair of spaced sidewalls **22, 24** defining a dovetail configuration for interlocking dovetail root portions of individual blade elements to be described.

The sidewalls 22, 24 also include ridges 26, 28, respectively, that engage the upper surface of dovetail roots on the blades to secure them against radially outward separation from the grooves.

The retaining groove 18 has a loading slot 30 thereto which is formed in a pair of spaced parallel surfaces 32, 34 on the wheel rim having a fore and aft width between sidewalls 36, 38 that enable a blade root to be assembled onto the rim and shifted circumferentially into the groove 18. Additionally, the wheel rim includes a pair of index grooves 40, 42 formed, respectively, in a second pair of annular surfaces 44, 46 on the wheel rim that are depressed with respect to the fore and aft flanges 14, 16. The index grooves 40, 42 are located fore and aft of the sidewalls 36, 38 of the loading slot 30 and extend, as shown in FIG. 1, circumferentially to the right to terminate at flat index surfaces 48, 50 each of which are formed perpendicularly of the groove 18.

The surface configuration of the periphery of the wheel 10 further includes a retainer notch 60 that is cutout of the ridge 28 and sidewall 24 of the groove 18 at a point circumferentially spaced from the index surfaces 48, 50.

The wheel 10 carries a ring of individual airfoil blades, one of which is illustrated at 62 in FIG. 1. Each of the blades are configures like blade 62 and include an airfoil blade portion 64 having a base platform 66 with spaced apart parallel side edges 68, 70 that are in abutment with like edges on an adjacent blade when in a retained position within the groove 18. Each blade platform 66 includes fore and aft edges 71, 73 that fit in the annular surfaces 44, 46. Each of the blades 62 includes a depending root having a generally rectangular bottom surface as shown in dotted lines in FIG. 1. The root 72 has a dovetail peripheral surface 74 that is slidably fit into the groove 18 between the sidewalls 22, 24 thereof to underline the groove ridges 26, 28 so as to interlockingly connect each of the individual blades 62 against radial movement with respect to the wheel 10.

In the illustrated embodiment a predetermined number of the individual blades 62 are each located so that the root 72 thereon will overlie the loading slot 30. The fore to aft dimension of the root 72 is accommodated between the sidewalls 36, 38 of the slot 30 so that each of the individual blades can be assembled in the continuously formed circumferential retaining groove 18 and move circumferentially therealong until all the blades are in place with the exception of a single locking blade and a stamped sheet metal spacer and lock member 76. The lock member 76, as best seen in FIG. 4, includes a pair of spaced apart leg portions 78, 80 each having outer peripheral surfaces 82, 84 respectively of a dovetail configuration to slidably fit into retained relationship within the groove 18. The element 76 includes a bight portion 86 joining the legs 78, 80 having a length that bridges between two of the blade roots 72 as shown in FIG. 2 to serve as a spacer therebetweeen. Thus, the element 76 serves to space the last blade element 62 in the ring of blades and a locking blade 88 illustrated in FIG. 2.

The locking blade 88 as best seen in FIG. 5, includes an airfoil 90 connected at its base to a platform 92 having spaced apart side edges 94, 96 thereon corresponding to side edges 68, 70 of the individual blades 62 and fore and aft edges 97, 99 corresponding to edges 71, 73. The side edge 96 includes a cutout 98 therein on one side of a pair of lugs 100, 102 dependent from the undersurface of the platform 92 on either side of a dovetail configured root 104 corresponding to the root segment 72 in an adjacent blade 62.

When the last blade has been inserted into the groove the spacer and lock element 76 are assembled through the slot 30 so that the bight portion 86 will be located above the side ridges 26, 28 of the groove and so that a side tab 106 on the lock element 76 will be slipped above the ridge 28 until it is aligned with the notch 60. At this point the leg 80 is in abutment with one side of the dovetail root 72 of the last assembled one of the blade elements 62 as shown in FIG. 2.

The last step of the assembly and the locking process is to locate the root 104 of the locking blade 88 in the slot 30 and assemble it by movement to the right as viewed in FIG. 1 to the position shown in FIG. 2 at which point the sides of the dependent lugs 100, 102 will be indexed against the surfaces 48, 50 and the side of the root 104 of the locking blade 88 will be in engagement with the leg 78 of the lock element 76 to cause it to be spaced and indexed with respect to the lock notch 60. Further, the tab 106 will be accessible through the cutout 98 in the locking blade 88. Thus a simple tool can be directed through the cutout 98 to bend the tab 106 downwardly into interlocked relationship with the notch 60.

In the index position, as shown in FIG. 2, the root 104 of the locking blade 88 is located to one side of the loading slot 30 and the side edge 94 of the locking blade 88 is in engagement with the side edge 70 of an adjacent one of the regular blade elements 62 shown to the left of blade 88 in FIG. 2 so as to locate its root 72 to the opposite sides of the loading slot 30. Thus with the blade elements, spacer element and locking blade components positioned as shown in FIG. 2 the blades are all locked against circumferential movement by a single locking blade element and all of the root portions of the blade elements are located in spaced relationship to the slot so as to be securely held against radial separation from the retaining groove 18.

Another feature of the above-described arrangement is the fact that the platform 92 of the locking blade 88 and the platform 66 of the blade element 62 whose edge 70 engages the locking blade edge 94 will both completely block and cover the loading slot 30 following the assembly operation. Another feature is that the connected blade elements 62 and locking blade 88 will define a continuous aerodynamic flow surface from the front flange 14 through the rear flange 16 of the wheel 10 across the outer periphery thereof.

Another feature is that the platform configuration of each of the blades 62 are in supported relationship with the fore and aft depressed surfaces 44, 46 and the location of their dovetail roots 72 in interlocked relationship with the retaining groove 18 will cause gas forces on the blades to be directly transferred to the rim of the wheel. The locking blade 88 similarly is configured to produce this effect in that the lugs 100, 102 thereon are supported respectively on the index grooves 40, 42 so that gas loads on the airfoil 90 of the locking blade 92 will act to force the lugs 100, 102 into abutment with the sidewalls of the index grooves 40, 42 thereby to maintain the spacer member 76 unloaded during rotor operation so as to avoid excessive stress build up therein and deformations thereof that will affect its

ability to retain the blades in their circumferentially locked relationship out of alignment with the loading slot to the retaining groove.

While the embodiments of the present invention, as herein disclosed, constitute a preferred form, it is to be understood that other forms might be adopted.

What is claimed is:

1. A blade lock assembly for interconnecting a plurality of blades in a continuously formed circumferential retaining groove on a rotor wheel comprising: a wheel rim having a continuously formed circumferential groove with spaced sidewall ridges thereon, a loading slot formed in said rim having a width greater than that between said ridges, a forward flange and a rearward flange on said rim, a groove formed in each of said flanges below the outer peripheral surface of said flanges to form an indexing track fore and aft of said slot, each of said groove including an index surface thereon formed perpendicular to said groove, a plurality of airfoil blades, each of said blades including a root portion fit through said slot and slidable within said retaining groove to be interlocked to said rim, each of said blades having a platform with an underside slidably supported on said wheel rim and with spaced parallel side edges thereon engageable with side edges on adjacent blades to form a continuous aerodynamic flow surface fore and aft across the periphery of the rotor, each blade root being circumferentially spaced from an adjacent root when the blades are retained in said groove, a locking blade having a root insertable through said slot and a platform with side edges thereon engageable with side edges of adjacent platforms to space the root of said locking blade with respect to roots on adjacent blades, said locking blade including lugs on the underside of its platform located fore and aft of said locking blade root, said lugs being supported in said groove and engageable with said index surface to locate the root of said locking blade in said groove to one side of said loading slot while positioning the root on an adjacent airfoil blade in said groove on the opposite side of said loading slot with platform segments of said locking blade and an adjacent airfoil blade closing said slot, said locking blade platform including a side cutout therein, one of said groove ridges having a lock notch therein at a location spaced circumferentially from said loading slot to be aligned with said blade cutout when said locking blade is in its index position, and sheet metal spacer means located in said groove between said locking blade root and an adjacent airfoil blade root, means on said spacer element accessible through said cutout and deformable into interlocked relationship with said rim when the locking blade is in its indexed position for locking each of said blades in an index circumferential position wherein each of the roots therein are locked against circumferential movement into alignment with said loading slots.

2. In a turbomachine rotor assembly of the type including a wheel rim having a continuously formed circumferential blade retaining groove with a loading slot to receive individual blade root portions configured to slidably fit into the groove in interlocked relationship therewith the improvement comprising: an arcuate wheel rim surface with a pair of spaced surfaces formed thereon below the outer peripheral surface of the wheel rim on either side of the loading slot, each of said surfaces having a flat index surface thereon spaced circumferentially of said loading slot and extending generally perpendicularly of the retaining groove, a notch in the sidewall of the retaining groove spaced circumferentially of said index surface, each air foil blade having blade platforms with a circumferential dimension greater than the circumferential dimension of the loading slot, said rim having fore and aft portions thereon supportingly receiving the underside of each of said blade platforms, each of said blade platforms having side edges engageable with those of adjacent platforms to define a continuous aerodynamic flow surface fore and aft across the outer periphery of the rotor when the blades are inserted in the retaining groove, each of said blade roots being circumferentially spaced from one another when the blades are retained in the groove, a locking blade having a platform with a side cutout therein, a locking blade root interlocked in the groove and a pair of lugs dependent from said locking blade platform and supported on each of said spaced apart surfaces when the locking blade is located in the loading slot, said lugs being engageable with said index surfaces to locate said locking blade in a circumferentially indexed position within the retaining groove, a spacer and lock element having a pair of legs interconnected by a bight portion, each of said legs being shaped to conform with the surfaces of the retaining groove and being located between the root of the locking blade and a root of a next adjacent blade when the locking blade is in its indexed position, said lock element having a side tab thereon positioned in alignment with said lock notch and said side cutout when the locking blade is in its indexed position and deformable into interlocked relationship with said notch by insertion of a tool through said cutout thereby to lock each of the blades retained in the groove against circumferential movement with respect thereto, said locking blade cooperating with another adjacent blade when in its index position to space a blade root on either side of the loading slot and to locate the platform of said locking blade and the other adjacent blade platform to cover the loading slot when the blades are in their locked indexed circumferential position on the wheel rim.

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