May 7, 1963 S. J. FEINBERG 3,088,708

COMPRESSOR BLADE LOCKING DEVICE

Filed Dec. 29, 1961 2 Sheets-Sheet 1

FIG. 1

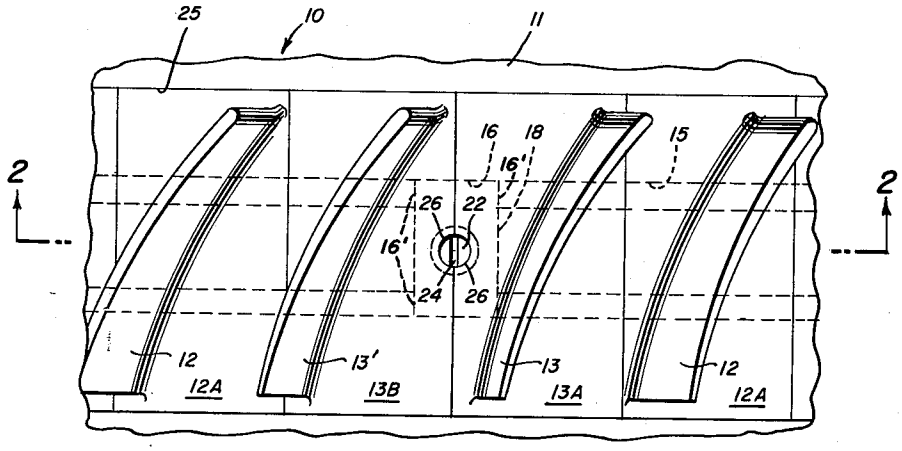

FIG. 2

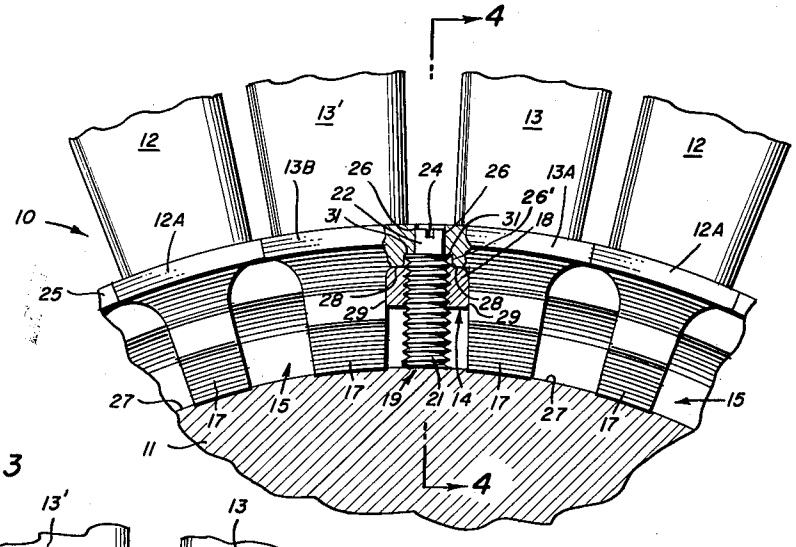

FIG. 3

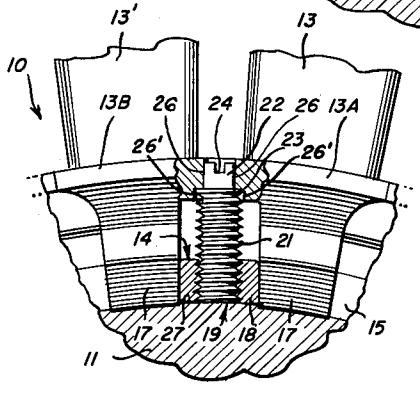

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FIG. 4

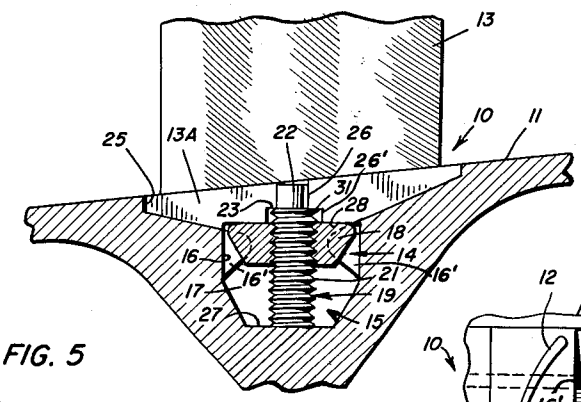


FIG. 5

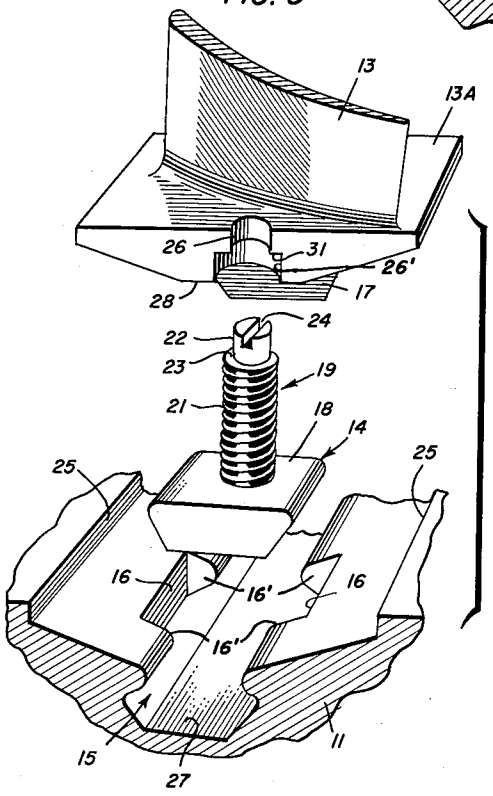


FIG. 6

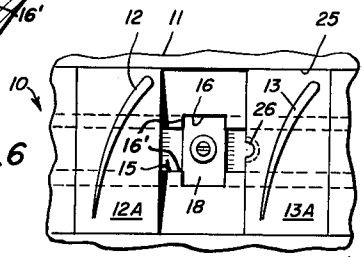


FIG. 7

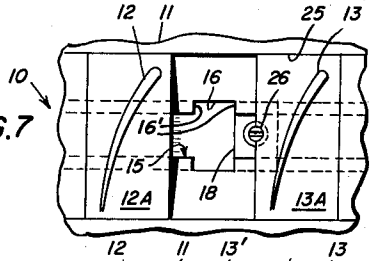


FIG. 8

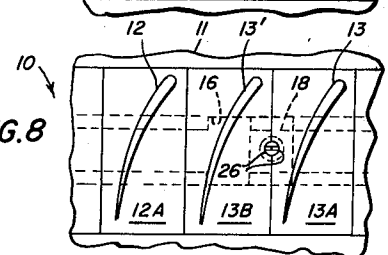
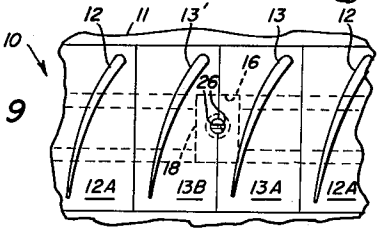


FIG. 9



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3,088,708

COMPRESSOR BLADE LOCKING DEVICE

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Filed Dec. 29, 1961, Ser. No. 163,374
5 Claims. (Cl. 253—77)

The present invention relates to compressor blade securing means and more particularly to a locking device for locking compressor blades to the rotor or spool of a compressor. More specifically, the invention relates to a blade locking device adapted for use with attachable and detachable turbine blades for positively locking the blades in the circumferentially disposed slot or groove formed in the rotor or spool of the turbine in such a manner as to prevent circumferential rotation of the blades within the slot or groove and also prevent displacement or flying out of the locking device when centrifugally loaded.

Heretofore, compressor blades were locked in position by staking the spool such, for example, as disclosed in Patent No. 2,931,625, to L. H. Lechthaler et al. While such arrangements proved adequate for the initial assembly it proved inadequate when the blade replacement became necessary. Another disadvantage of the aforesaid arrangement is that the stator vanes will rub on the locking screw since its height is dependent on the thickness of the blade platform on which it engages or rests. Since such is the case, a thin platform will allow the locking screw to extend above the spool in the path of travel of the rotor, which results in improper operation of the compressor.

The present invention overcomes all the disadvantages encountered in the aforesaid devices by providing a new and improved locking device which positively locks the compressor blades in position and which is arranged in such a manner as to provide proper operation of the compressor. Moreover, the invention provides a locking device for compressor blades wherein individual blades may be attached and detached from the rotor or spool of the compressor in a minimum period of time and without the necessity of utilizing complicated accessory tools.

An object of the invention is to provide a new and improved blade securing means which is particularly applicable to wheels or other rotary members having relatively narrow rims and which obviates the above disadvantages in a convenient and relatively simple manner.

Another object of the invention is to provide a new and improved blade locking means which permits blade replacement and removal to be effected when required.

A further object of the invention is to provide blade securing means wherein the blades may be attached and detached from the rotor without removing any parts other than the blades, and in which the only parts which must be handled during disassembling and assembling the blades comprises a simple screw actuated locking device, such device being easily accessible while the rotor is installed, and in which the only manipulation other than movement of the blades themselves required to assemble and disassemble the blades is a simple turning movement of a single screw threadedly engaging the locking device.

A still further object of the invention is to provide a blade lock for rotors and the like having self locking means so that vibrations during running will not unlock the blade and which will be retained from flying out when centrifugally loaded.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following

detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a partly developed plan view of a turbine rotor illustrating the locking device of the present invention;

FIG. 2 is a central longitudinal sectional view taken substantially on the line 2—2 of FIG. 1, with the locking device in a locked condition;

FIG. 3 is a view similar to FIG. 2 illustrating the locking device in an unlocked condition;

FIG. 4 is a transverse sectional view taken on the line 4—4 of FIG. 2, illustrating the locking device in a locked condition;

FIG. 5 is an exploded view in perspective illustrating a fragmental portion of the rotor, the blade, and the locking device constructed in accordance with the present invention; and

FIGS. 6 through 9 are partially plan views illustrating the essential steps during assembly and locking of the blades to the rotor in accordance with the device of the present invention.

Referring now to the drawings and more particularly to FIGS. 1 and 2, a turbine bucket assembly, which may be used in steam or gas turbine construction, is indicated generally by the numeral **10**, comprising a rotor or turbine disc **11** having a plurality of buckets or blades **12**, **13** and **13'** mounted in uniform spaced relationship around the periphery thereof, the blade being locked to the rotor by the locking device of the present invention indicated generally by the numeral **14**.

It will be noted, FIGS. 4 and 5, that the periphery of the spool **11** has a blade-holding, dovetail-shaped slot or groove **15** extending circumferentially therearound and an entrance slot **16** in communication with the dovetail **15** for slidably receiving the dovetail roots **17** of the blades **12**, **13** and **13'** and locking block **18** of the locking device **14**, the locking block **18** having an actuating member **19** in threaded engagement therewith, as by a threaded portion **21**, for moving the block from an initial unlocked condition, FIG. 3, to a final locked condition, FIG. 2, when all the blades have been attached to the spool **11** thereby to lock the roots **17** of the blades within the groove **15**. The member **19** is further provided with an end portion **22** somewhat smaller in diameter than the portion **21** and forming a shoulder **23** at the junction of the portions **21** and **22**. The portion **22** is provided with a slot or kerf **24** for receiving a suitable tool such, for example, as a screw driver when it is desired to rotate the member **19** and move the block **18** from the aforesaid initial unlocked condition to the aforesaid final locked condition.

The roots **17** of blades **12** are provided with a substantially rectangular shaped platform **12A**, the roots **17** of blades **13** and **13'** being each provided with similar platforms **13A** and **13B**, the aforesaid platforms being disposed within a circumferential recess **25** formed in the spool **11** and providing a platform seat, as best shown on FIGS. 4 and 5, the entrance slot **16** communicating with the recess and the dovetail groove in such a manner as to provide a plurality of walls or shoulders **16'**.

The aforesaid platforms **13A** and **13B** are each provided with a semi-circular recess **26** and an arcuate opening **26'** providing a shoulder **31** at the junction of the recesses **26** and openings **26'**, the recesses **26** forming a circular access opening for receiving the end portion **22** of member **19** when all the blades are attached to the rotor **11** and the locking block **18** is in a final locked condition, as best shown on FIG. 1. It will be noted, FIG. 3, that when the block **18** is in an unlocked condition, the block is in engagement with the wall **27** defining the bottom of the dovetail groove **15** with the end portion **22** of member **19** disposed within the aforesaid circular

opening formed by recesses **26** in platforms **13A** and **13B**. When the locking block **18** is actuated to a locked condition in response to rotation of member **19** and by reason of the threaded connection between the block and threaded portion **21** of member **19**, the block is slidably moved from an initial position, FIG. 3, to a locked position, FIG. 4. In the locked condition the block **18** is confined within the entrance opening **16** in abutting engagement with the aforesaid shoulders **16'** each platform **13A** and **13B**, as at **28** and with each root **17** thereon, as at **29**, the shoulder **23** on member **19** being in abutting engagement with platforms **13A** and **13B**, shoulders **31**, with end portion **22** disposed in the opening formed by recesses **26** and the terminal end of threaded portion **21** in engagement with bottom wall **27**. Thus, by this arrangement the compressor blades are positively locked and retained in the dovetail slot **15** in the rotor **11** and, furthermore, the locking device **14** will not fly or fall out when centrifugally loaded.

For a more complete understanding of the blade assembly and locking operation attention is directed to FIGS. 6 through 9. In FIG. 6, for example, it will be noted that all the blades except blade **13'** have been attached to the rotor **11** and the locking block **18** has been inserted in entrance **16**. It will be understood that during the blade assembly operation the roots **17** of the blades are inserted into the entrance slot **16** and thereafter each blade is moved circumferentially about the spool **11** until the blade assumes a position, as shown on FIG. 6. With the blades in this position the actuating member **19** is moved to a position as shown on FIG. 7, with the end portion **22** on threaded portion **21** of actuating member **19** seated in recess **26** on platform **13A** of blade **13** and sufficient space between platforms **12A** and **13A** to receive the platform **13B** of blade **13'** as the blade **13'** is attached to the rotor in like manner to blades **12** and **13**. It will be noted FIG. 8 that when the blade **13'** is positioned on the rotor, the locking device **14** remains in the same position as the position of FIG. 7. However, the end portion **22** of member **19** is seated in recess **26** on platform **13B** of blade **13'** and all the platforms are in abutting relationship, FIG. 8. By reason of the shape and position of the locking block **18** within groove **15**, the entire blade assembly is moved circumferentially about the rotor from the position of FIG. 8 to the position of FIG. 9, with the locking block **18** in its initial position in registration with the entrance opening **16**. When this has been done a suitable tool (not shown) is inserted in the slot **24** in end portion **22** of actuating member **19** for rotating the member and thus by reason of the aforesaid threaded connection between the actuating member and the locking block, the block is moved from an initial position FIG. 3 to a locking position FIGS. 2 and 4, with the block **14** disposed in the entrance slot **16** in abutting engagement with the walls or shoulders **16'** bordering on the entrance slot and thus the roots of the blades are locked to the rotor with the platforms thereof in abutting relationship and the entrance slot totally blocked by the locking block thereby to prevent the roots from moving circumferentially about the rotor and into the entrance slot.

From the foregoing, it will be apparent that a new and improved turbine blade locking device has been devised which conforms to the spool dovetail form for ease of assembly, utilizes the entrance slot in the spool for locking through which only the blades must shift to escape, does not impose a stress concentration on the spool and which utilizes a screw and locking block for ease of assembly and disassembly, the screw having a shoulder for engagement with the blade platforms and which will be retained from flying out when centrifugally loaded thereby making the screw self locking so that any vibration during running of the turbine will not unlock the blade locking device.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a high speed rotary compressor, the combination of a rotor having a dovetail groove extending fully around the circumference thereof in spaced relation with respect to the outer diameter thereof, a platform seat formed on the outer diameter of the rotor in communication with said dovetail groove and extending fully around the circumference thereof, a plurality of bladed platforms mounted in said platform seat in abutting engagement with respect to each other, a dovetail root carried by each platform and disposed within said dovetail groove in spaced relation with respect to each other, an entrance slot in the rotor and extending radially inwardly from the platform seat into said dovetail groove and providing a plurality of walls on the rotor so that the dovetail roots may be inserted therein and into said dovetail groove and the bladed platform into the platform seat for movement circumferentially therein, a locking device disposed within the entrance slot between and in engagement with a pair of the roots and movable to a position in abutting engagement with a pair of the bladed platforms of said plurality of bladed platforms, an arcuate opening formed in each bladed platform of said pair of bladed platforms, a recess in each bladed platform of said pair of bladed platforms in communication with said arcuate openings therein and forming a shoulder on each bladed platform of said pair of platforms at the junction of the recess and arcuate opening in each bladed platform, actuating means rotatably mounted in said pair of platforms, a threaded portion on said actuating means and threadedly connected to said locking device for moving the locking device between said pair of roots into abutting engagement with said pair of platforms and said plurality of walls on the rotor thereby to maintain the roots in the dovetail groove against circumferential movement and the platforms in abutting engagement and an actuating head on the actuating means and rotatably mounted in the arcuate opening in said pair of bladed platforms, said head being of a diameter less than the diameter of the threaded portion and providing a shoulder at the junction of the head and the threaded portion and engageable with the shoulder on each said pair of bladed platforms for preventing displacement of the actuating means as the threaded portion thereof is threaded into said locking device.

2. The combination according to claim 1 wherein said locking device includes a block insertable into the entrance slot between said pair of dovetail roots and having a platform engaging surface engageable with the shoulders on said pair of platforms, root-engaging surfaces engageable with the roots of said pair of platforms, and additional surfaces engageable with said walls on the rotor, a threaded opening therein in threaded engagement with threaded portion on said actuating means.

3. In a bladed rotor for a compressor

the combination of a rotor body having a dovetail slot extending entirely around the circumference of the rotor body,

a plurality of blades each having a platform mounted on the circumferential surface of the rotor body,

a dovetail root carried by each platform and movable in said dovetail slot,

an entrance opening in the rotor body and providing a plurality of abutments on the body and extending from the outer circumferential surface thereof into the dovetail slot and providing a passageway for receiving the dovetail root of each platform during assembly of the blades on the rotor body,

means slidably mounted within said entrance opening between and in abutting engagement with a pair of dovetail roots and movable into abutting engagement with said abutments, and with a pair of platforms and the roots thereon,

an actuating pin having a threaded portion in engagement with said slidable means for moving the slidable means into abutting engagement with said abutments, the pair of platforms and the roots thereon as the actuating pin is rotated,

an actuating head on the actuating pin and rotatably mounted in said pair of platforms for rotating the pin,

a recess formed in said pair of platforms for receiving and rotatably mounting said head on the pair of platforms, and

shoulder means formed on the pin at the junction of said threaded portion and actuating head in engagement with said pair of platforms for preventing displacement of the actuating pin as the pin is rotated.

4. In a high speed rotary compressor, the combination of a rotor body having a circumferentially disposed dovetail slot extending entirely around the rotor body in spaced relation with respect to the outer diameter thereof,

a circumferentially disposed recess in communication with said dovetail slot and extending entirely around the outer diameter of the body,

a plurality of platforms fitted into said recess in circumferential abutting engagement,

a blade carried by each platform of said plurality of platforms,

a dovetail root carried by each platform of asid plurality of platforms and fitted into said dovetail slot in mutually spaced relationship,

an entrance opening in the rotor body in communication with said recess and forming a plurality of shoulders on the body, said entrance opening extending inwardly from the recess into the dovetail slot for allowing the dovetail roots to be inserted into the dovetail slots so that the platforms may seat in said recess,

locking means slidably disposed within said entrance opening between and in engagement with a pair of dovetail roots and movable into abutting engagement therewith and with the pair of platforms thereof and the plurality of shoulders when all of said platforms are fitted in said recess in said circumferential abutting engagement and all of said dovetail roots are fitted into said dovetail slot,

actuating means disposed between said pair of roots and having one end in engagement with the rotor body and the other end thereof rotatably mounted in said pair of platforms,

a threaded portion on said actuating means and threadedly connected to said locking means for moving said locking means,

recess means in said pair of platforms for receiving and rotatably mounting the other end of said actuating means,

tool receiving means on said other end of the actuating means to facilitate rotation thereof,

shoulder means on the actuating means,

complementary shoulder means on said pair of platforms and cooperating with the shoulder means on the actuating means for preventing displacement of the actuating means as the actuating means is rotated and the locking means is moved between the pair of roots into abutting engagement therewith and with the pair of platforms and the plurality of shoulders thereby to prevent circumferential movement of the dovetail roots within the dovetail slot.

5. In a combination according to claim 4, wherein said slidable means includes a block of a shape conforming generally to the configuration of said dovetail slot in an axial plane and having a threaded opening therethrough for receiving the threaded portion of the actuating means and an upper blade platform engaging and locking surface,

a pair of root engaging side surfaces, and a pair of shoulder engaging end surfaces.

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