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(54) **METHOD FOR REMOVING A ROTOR BUCKET FROM A TURBOMACHINE ROTOR WHEEL**

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(51) **Int. Cl.**

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F01D 5/30	(2006.01)
F01D 25/28	(2006.01)

(52) **U.S. Cl.**

CPC ***F01D 5/005*** (2013.01); ***F01D 5/3038*** (2013.01); ***F01D 5/32*** (2013.01); ***F01D 25/285*** (2013.01); *F05D 2230/68* (2013.01); *Y10T 29/49318* (2015.01)

(58) **Field of Classification Search**

CPC F05D 2230/70; F05D 2230/72; F05D 2230/80; B23P 6/045; B23P 6/002; B23P 6/005; F01D 5/005; F01D 5/303; F01D 5/3038; F01D 5/32; F01D 25/285; Y10T 29/49318; Y10T 29/49321

See application file for complete search history.

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(57) **ABSTRACT**

A method of removing a bucket from a turbomachine rotor wheel includes exposing a base portion of the bucket, positioning a pulling device radially outwardly of the base portion, connecting the base portion of the bucket to the pulling device through a linking rod, exerting an axially outwardly directed force on the linking rod through the pulling device, and removing the base portion from the rotor wheel.

18 Claims, 9 Drawing Sheets

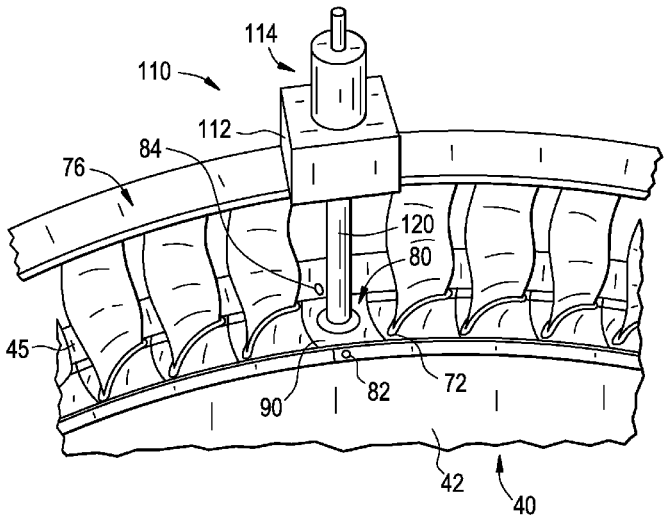

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FIG. 1
PRIOR ART

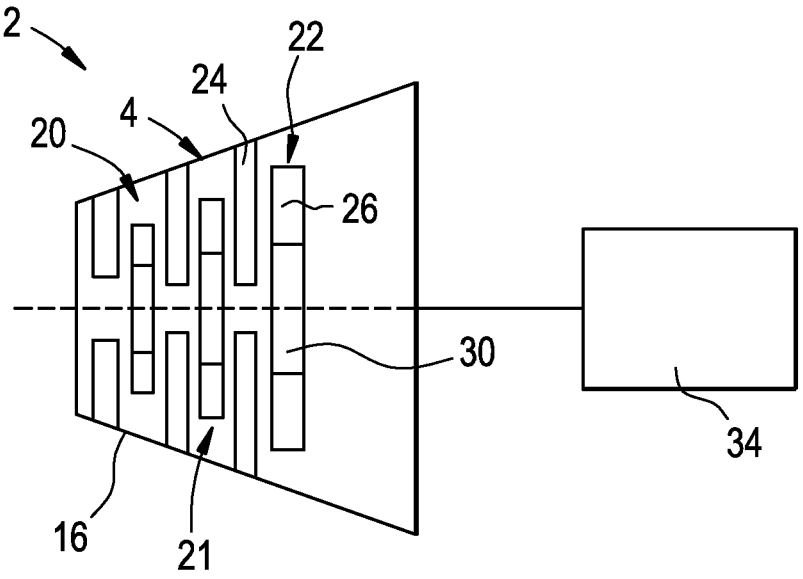


FIG. 2
PRIOR ART

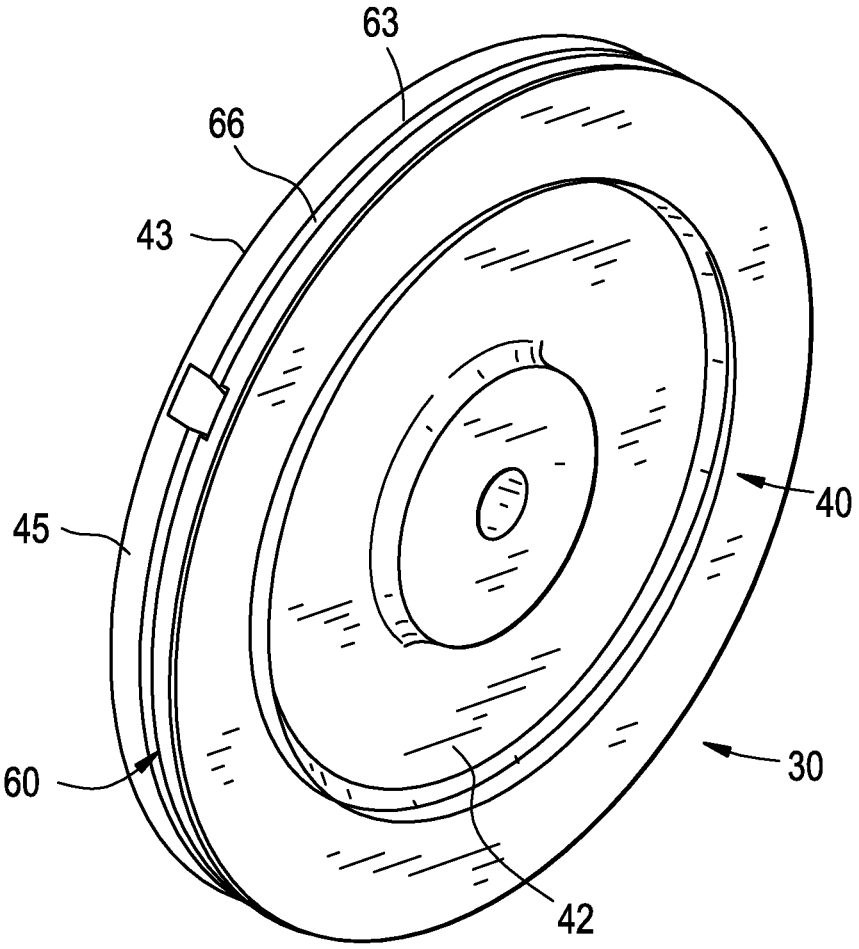


FIG. 3
PRIOR ART

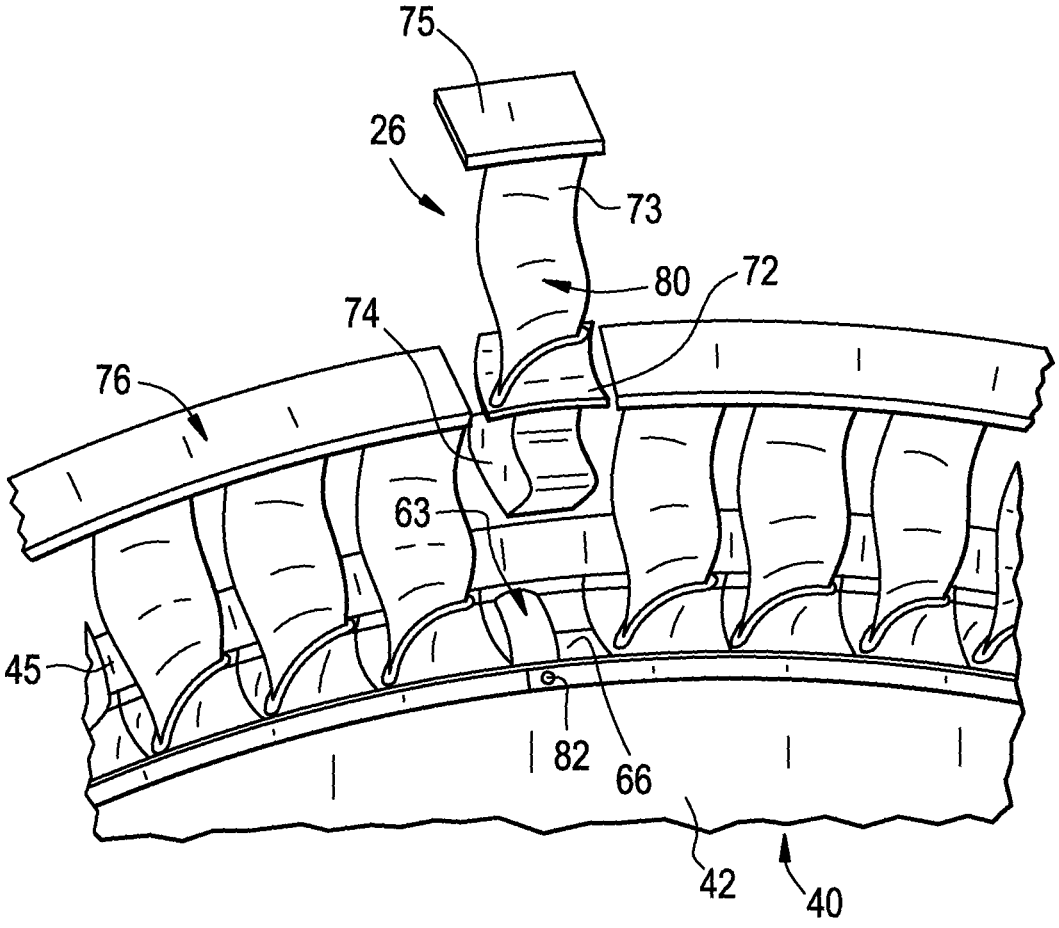


FIG. 4
PRIOR ART

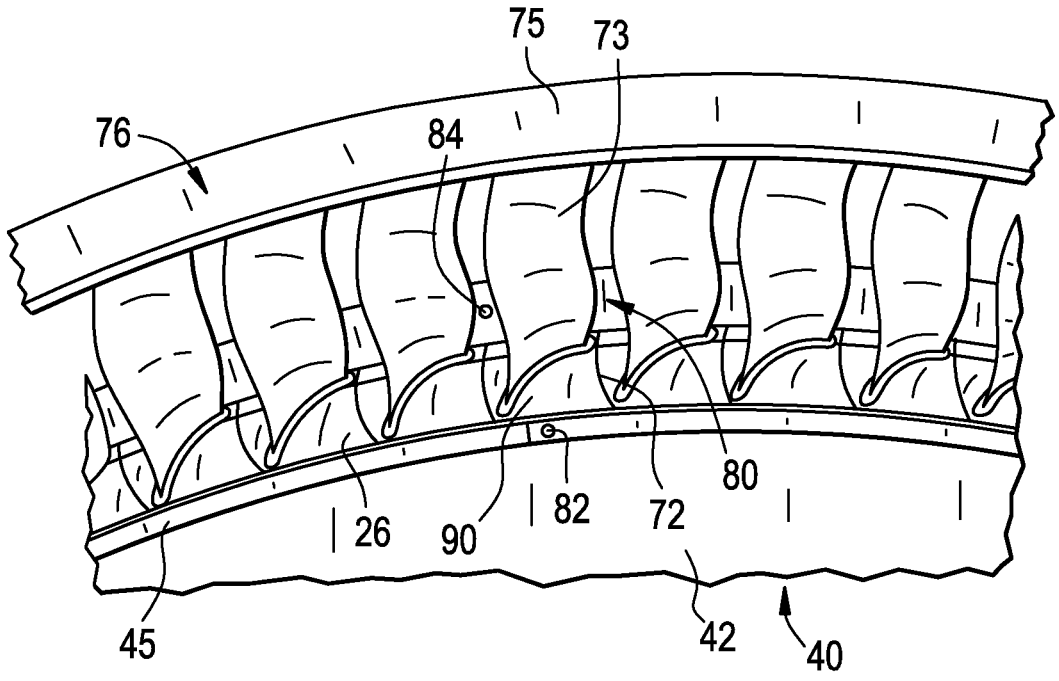


FIG. 5

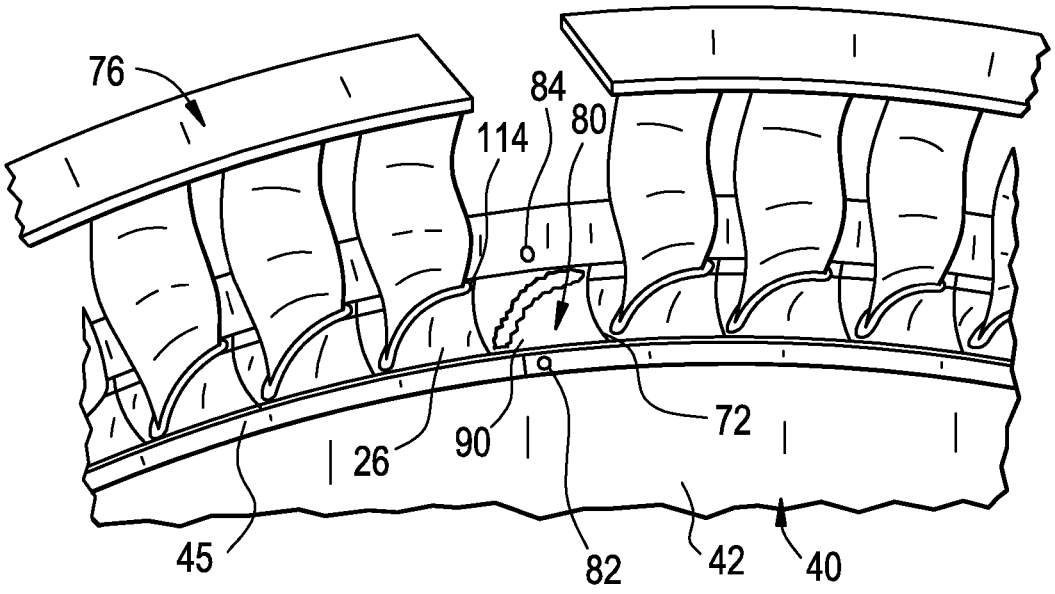


FIG. 6

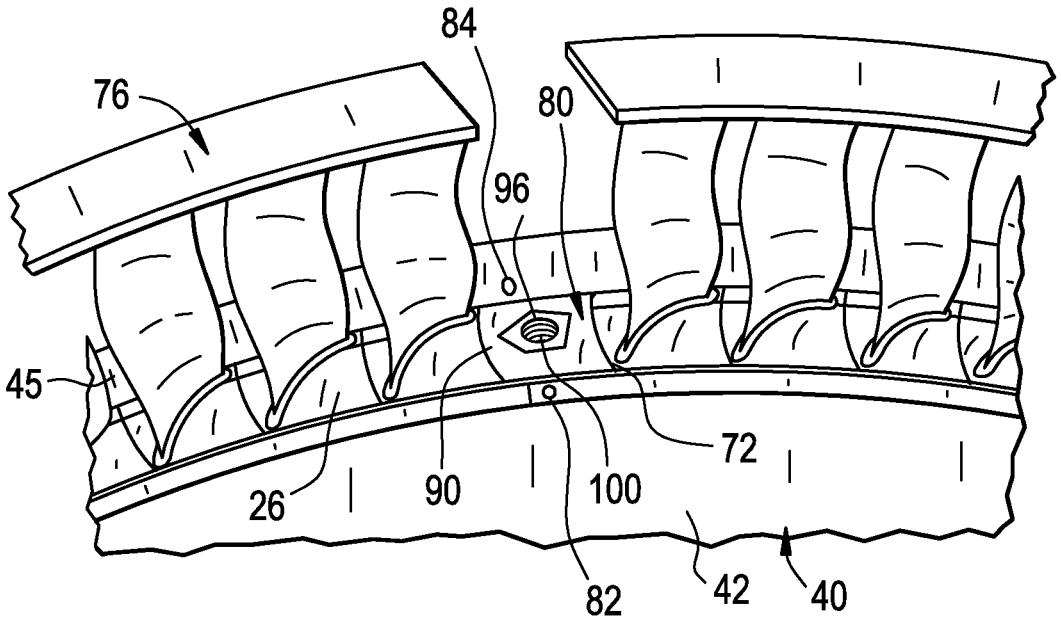


FIG. 7

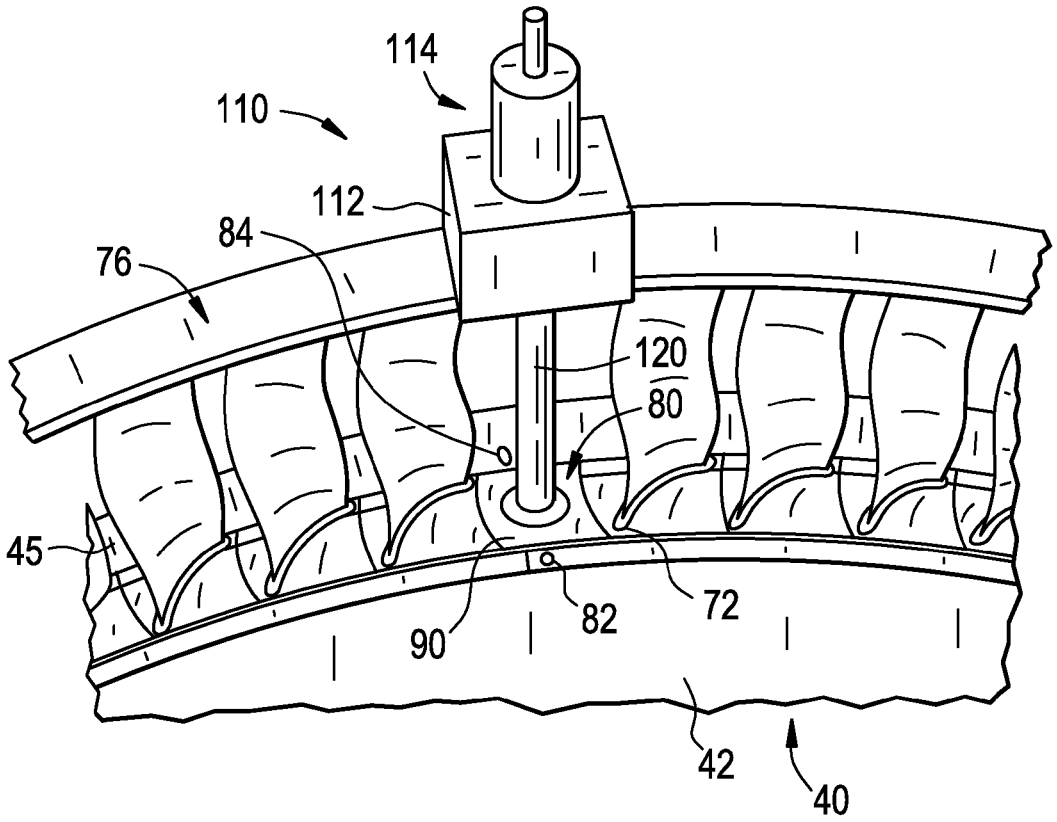


FIG. 8

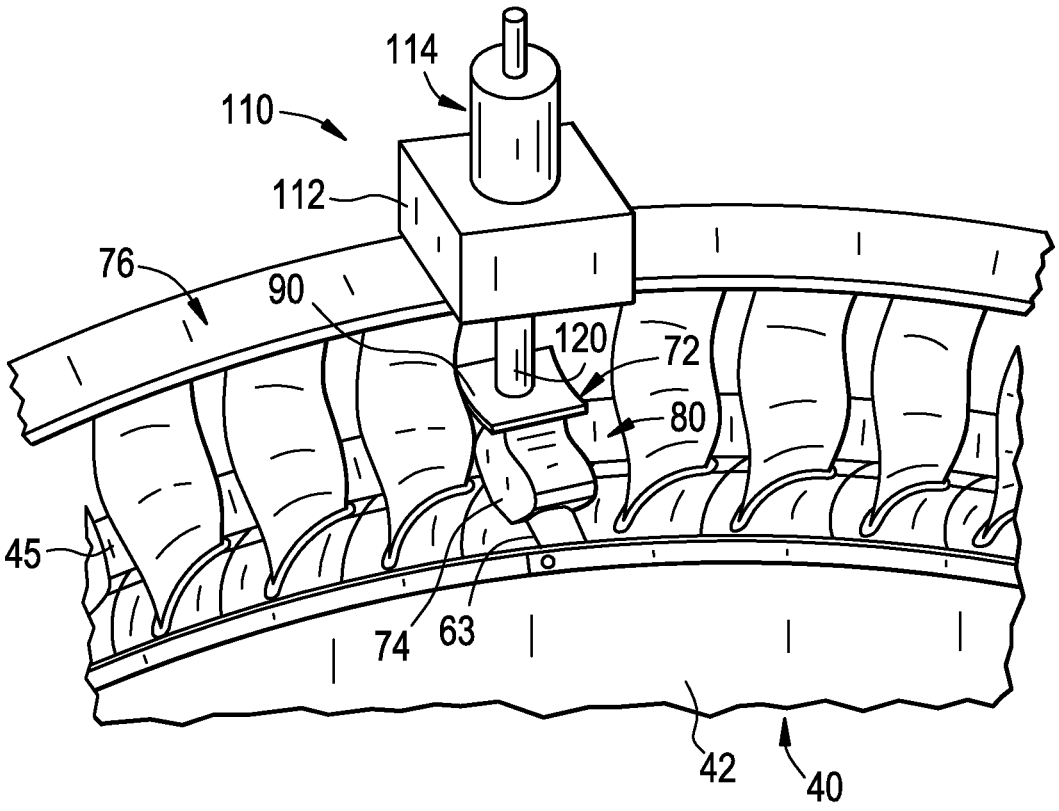
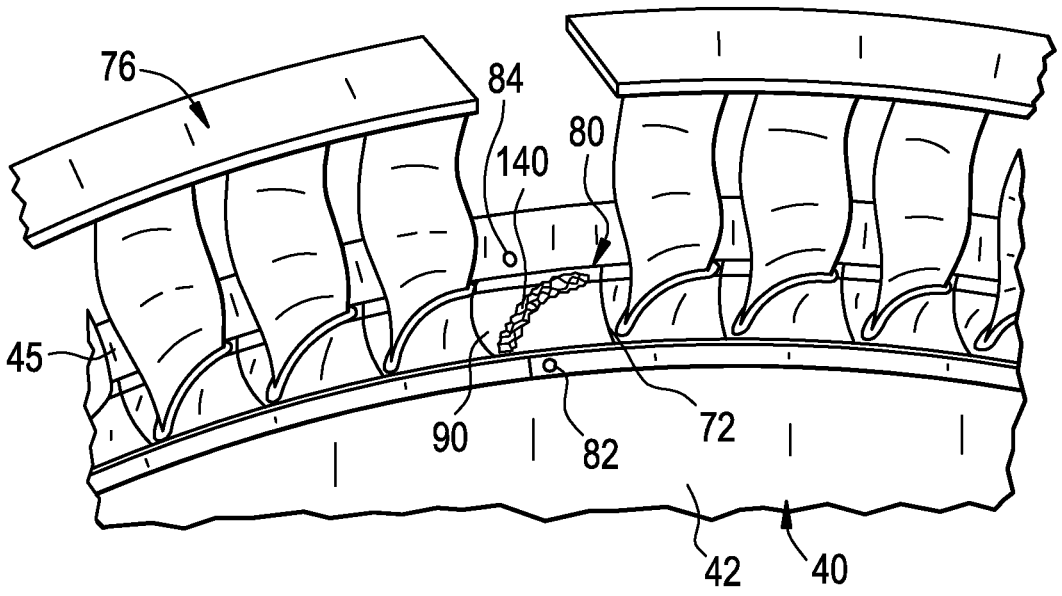


FIG. 9



METHOD FOR REMOVING A ROTOR BUCKET FROM A TURBOMACHINE ROTOR WHEEL

BACKGROUND OF THE INVENTION

The subject matter disclosed herein relates to the art of turbomachines and, more particularly, to a method of removing a rotor bucket from a turbomachine rotor wheel.

Steam turbines typically include rotating buckets or blades and stationary nozzles. Steam is passed through a number of turbine stages. Each stage includes a row of stationary nozzles and rotating blades mounted to a rotor wheel. Steam expands through the number of turbine stages to rotate rotor wheel creating work.

The buckets are typically mounted to the rotor wheel through a dovetail attachment. The rotor wheel may include an internal, circumferential dovetail. Each bucket or blade has a corresponding dovetail that cooperates with the internal, circumferential dovetail. Generally, each rotor wheel features a loading position or gate opening configured to receive each bucket. Each bucket is mounted to the rotor wheel and manipulated into place about the outer diametric surface. Once all buckets are mounted, a closure bucket is installed in the loading portion and secured to the rotor wheel to prevent bucket liberation.

BRIEF DESCRIPTION OF THE INVENTION

According to one aspect of an exemplary embodiment, a method of removing a bucket from a turbomachine rotor wheel includes exposing a base portion of the bucket, positioning a pulling device radially outward of the base portion, connecting the base portion of the bucket to the pulling device through a linking rod, exerting a radially outwardly directed force on the linking rod through the pulling device, and removing the base portion from the rotor wheel.

According to another aspect of an exemplary embodiment, a method of removing a bucket from a rotor wheel includes positioning a ram radially outward of the base portion, connecting the base portion of the bucket to a ram, exerting a radially outwardly directed force on the base portion, and removing the base portion from the rotor wheel.

These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF DRAWINGS

The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** is schematic view of a turbomachine shown in the form of a steam turbine in accordance with the prior art

FIG. **2** is a perspective view of a rotor wheel of the turbomachine of FIG. **1**;

FIG. **3** is a perspective view of a closure bucket spaced from the rotor wheel of FIG. **2**;

FIG. **4** is a perspective view of the closure bucket of FIG. **3** installed in the rotor wheel;

FIG. **5** is a perspective view of a bucket portion of the closure bucket removed, in accordance with an exemplary embodiment;

FIG. **6** is a perspective view of a threaded opening formed in a base portion of the closure bucket of FIG. **5**, in accordance with an exemplary embodiment;

FIG. **7** is a perspective view of a pulling device coupled to the base portion of the closure bucket of FIG. **6**, in accordance with an exemplary embodiment;

FIG. **8** is a perspective view of the base portion of the closure bucket being removed from the rotor wheel by the pulling device, in accordance with an aspect of an exemplary embodiment; and

FIG. **9** is a perspective view of the base portion of the closure bucket being removed in pieces, in accordance with another aspect of an exemplary embodiment.

The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

DETAILED DESCRIPTION OF THE INVENTION

A turbomachine is illustrated generally at **2** in FIG. **1**. Turbomachine **2** is shown in the form of a steam turbine **4** having a turbine housing **16** that encloses a number of turbine stages three of which are indicated at **20**, **21** and **22**. Of course, it would be appreciated by one of ordinary skill in the art that the number of turbine stages could vary. Each turbine stage **20-22** includes a corresponding plurality of stationary airfoil members or nozzles, such as indicated at **24** in connection with stage **22**, arranged upstream from a plurality of rotating airfoil members or buckets, such as shown at **26**. Rotating airfoil members **26** are mounted to a rotor wheel **30** within steam turbine **4**.

With this arrangement, steam from a boiler or similar arrangement (not shown) is directed into steam turbine **4**. The steam expands through stages **20-22** creating work that is used to power an external component **34**. External component **34** may take on a variety of forms including a generator or a pump or other mechanically driven systems. That is, steam turbine **4** could also be used as a power source for a vehicle.

In accordance with the exemplary embodiment illustrated in FIG. **2**, rotor wheel **30** includes a rotor wheel body **40** having a first face **42** and an opposing, second face **43** that are joined by an outer diametric surface **45**. A bucket receiving slot **60** is formed in outer diametric surface **45**. Bucket receiving slot **60** supports plurality of rotating airfoil members **26** about outer diametric surface **45**. Bucket receiving slot **60** includes a bucket mounting opening **63** and interior cavity **66** formed in rotor wheel body **40**. Each of the plurality of rotating airfoil members **26** includes a base portion **72** (FIG. **3**) that supports an airfoil portion **73** and a mounting member or dovetail **74**. Airfoil portion **73** includes a ring element **75** that forms part of a circumferentially extending rotor ring **76**. Dovetail **74** is shaped to nest within bucket receiving slot **60**. Each of the plurality of rotating airfoil members **26** is guided into bucket receiving slot **60** and manipulated into position. Once all buckets are installed, a closure bucket **80** is installed into bucket receiving slot **60** and held in place by mechanical fasteners or grub screws **82** and **84**, such as shown in FIG. **4**

Over the course of time, steam turbine **4** may be taken offline for maintenance and/or repair. Maintenance includes an inspection of the buckets. During operation a bucket(s) may become damaged. The damaged bucket(s) is removed and replaced. Removing the damaged bucket first requires removal of the closure bucket **80** which may, itself, be damaged. In accordance with an aspect of an exemplary embodiment, removal of a damaged closure bucket **80** includes removing grub screws **82** and **84** and airfoil portion **73**, as shown in FIG. **5**, to expose an upper surface **90** of base portion

72. After removing airfoil portion 73, a bore 96 is formed in closure bucket 80, as shown in FIG. 6. Bore 96 extends radially inwardly into base portion 72. A plurality of threads 100 are formed in base portion 72 along bore 96.

After forming threads 100, a pulling device 110 is arranged radially outward of closure bucket 80, as shown in FIG. 7. Pulling device 110 includes a base 112 supported by rotor ring 76 and a ram 114. Pulling device 110 may rely upon air pressure, hydraulic pressure, or electrical current to operate ram 114. Ram 114 is connected to base portion 72 through a linking rod 120. Linking rod 120 includes a plurality of threads (not separately labeled) that engage with threads 100 in base portion 72. Ram 114 is actuated to exert a radially outwardly directed force on base portion 72 through linking rod 120. The radially outwardly directed force may cause base portion 72 to release from rotor wheel 30, as shown in FIG. 8. At this point, the remaining buckets may be circumferentially shifted to bucket mounting opening 63 and removed from rotor wheel 30 for inspection and/or replacement.

At this point it should be understood that the exemplary embodiments describe a method for removing a closure bucket from a rotor wheel. In the event that the closure bucket may does not release from rotor wheel, base portion and pin may be broken up into a plurality of pieces, indicated generally at 140, and removed, as shown in FIG. 9. At this point, the remaining buckets may be circumferentially shifted to bucket mounting opening 63 and removed. If the additional buckets resist removal efforts, all airfoil portions may be removed and corresponding base portions broken up into pieces 140 to enable removal. It should also be understood that while described in terms of removing a bucket from a rotor wheel in a steam turbine, the method may also be employed to remove buckets from rotor wheels arranged in other turbomachine systems including compressors and gas turbines. Further, it should be understood that the method may be used to remove the closure bucket without requiring that the rotor wheel be separated from other rotor wheels or removed from the turbine rotor. The destruction of a single bucket, in situ, reduces downtime and overall maintenance costs associated with the steam turbine 4.

While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

What is claimed is:

1. A method of removing a bucket from a turbomachine rotor wheel, the method comprising:

exposing a base portion of the bucket, wherein exposing the base portion of the bucket includes removing an airfoil portion from the base portion;

positioning a puffing device radially outwardly of the base portion;

connecting the base portion of the bucket to the pulling device through a linking rod;

exerting a force on the linking rod, the force being exerted through the pulling device, the force being directed radially outwardly of the rotor wheel, the force forcing the linking rod radially outwardly from the rotor wheel into the pulling device; and

removing the base portion from the turbomachine rotor wheel.

2. The method of claim 1, wherein connecting the base portion of the bucket includes forming a bore into the base portion.

3. The method of claim 2, further comprising: forming a plurality of threads along the bore.

4. The method of claim 1, wherein positioning the pulling device includes supporting the pulling device on a rotor ring surrounding the turbomachine rotor wheel.

5. The method of claim 1, wherein positioning the pulling device includes supporting a ram radially outwardly of the base portion.

6. The method of claim 1, wherein exerting the radially outwardly directed force includes directing a hydraulic fluid into the pulling device.

7. The method of claim 1, wherein exerting the radially outwardly directed force includes operating a screw in the pulling device.

8. The method of claim 1, wherein removing the base portion further comprises:

breaking the base portion into multiple pieces; and

removing each of the multiple pieces from the turbomachine rotor wheel.

9. A method of removing a bucket from a rotor wheel comprising:

exposing a base portion of the bucket, the exposing including removing an airfoil portion from the base portion;

positioning a ram radially outwardly of the bucket;

connecting a base portion of the bucket to the ram;

exerting a radially outwardly directed force on the base portion, the exerting the radially outwardly directed force on the base portion includes forcing a linking rod radially outwardly from the rotor wheel into the ram; and

removing the base portion from the rotor wheel.

10. The method of claim 9, wherein connecting the base portion of the bucket includes forming a bore into the base portion.

11. The method of claim 10, further comprising: forming a plurality of threads along the bore.

12. The method of claim 11, wherein connecting the base portion to the ram includes establishing a threaded connection between the ram and the plurality of threads.

13. The method of claim 9, wherein positioning the ram includes supporting the ram on a rotor ring surrounding the rotor wheel.

14. The method of claim 9, wherein forcing the linking rod radially outwardly includes directing pressurized fluid into the ram.

15. The method of claim 14, wherein directing a pressurized fluid into the ram include urging hydraulic fluid into the ram.

16. The method of claim 9, wherein exerting the radially outwardly directed force includes directing an electrical current to the ram.

17. The method of claim 16, wherein the electrical current powers a screw.

18. The method of claim 9, wherein removing the base portion further comprises:

breaking the base portion into multiple pieces; and

removing each of the multiple pieces from the rotor wheel.

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