Sept. 8, 1970 K. P. ZEMAN 3,527,546

TIE PINS FOR TURBINE BUCKETS

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FIG.1

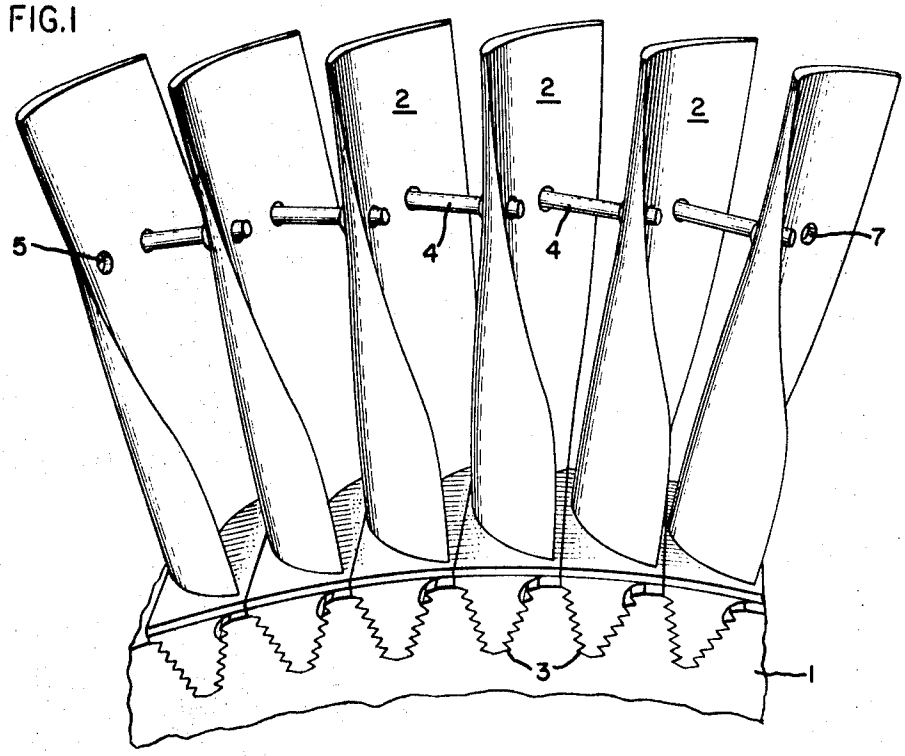


FIG.2

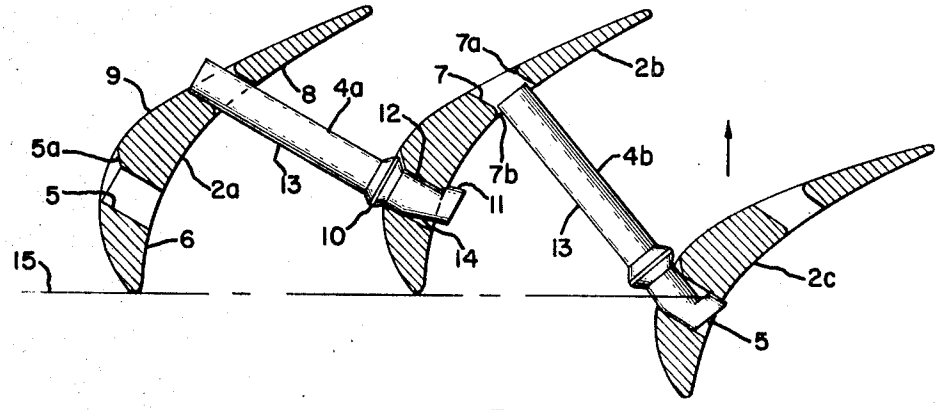
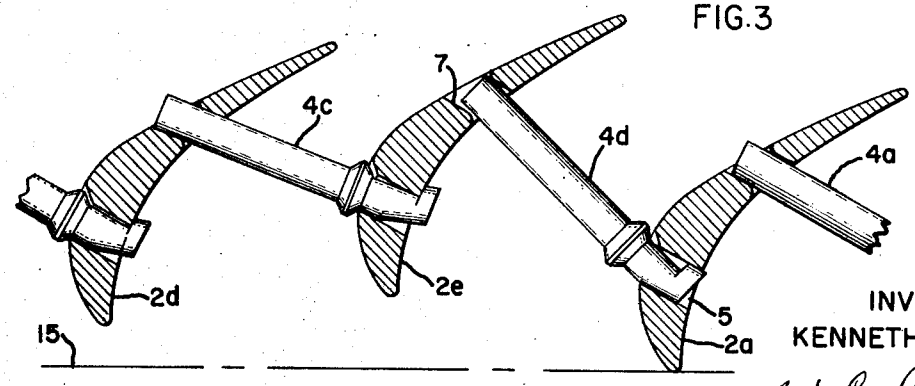


FIG.3



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TIE PINS FOR TURBINE BUCKETS

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ABSTRACT OF THE DISCLOSURE

A turbomachine rotor having buckets with loosely disposed diagonal tie pins connecting adjacent buckets so as to damp out torsional vibration. One end of each tie pin has a tapered hook portion so as to allow easy assembly but providing a locked orientation after final assembly.

BACKGROUND OF THE INVENTION

This invention relates generally to turbo machinery rotors and more particularly to an improved lashing or tying construction for turbine rotor buckets.

As many of the turbo machinery rotors are brought up to speed, torsional resonance occurs in the buckets or blades. Consequently, it is desirable to provide means for damping out this vibration. Various means have been utilized to provide this function.

It is a common practice to provide tie wires between groups of adjacent buckets. Usually, a group of buckets are connected together, generally at a point midway between root and tip, by a rod or wire of small diameter which runs through holes in each bucket and which may be loose or brazed to the buckets. However, this type of tie wire is not effective in all cases.

Another method commonly used is to dispose individual diagonal tie pins between adjacent buckets. A short pin is inserted between buckets which runs from the leading edge region of one bucket to the trailing edge region of the adjacent bucket. These may be loosely disposed or tightly disposed, an example of the latter being seen in U.S. Pat. 3,131,461 issued to A. J. Miller on May 5, 1964.

The shortcomings in the prior art with loosely disposed diagonal tie pins lie in the fact that they must be designed so they will slip into place with ease during assembly. However then they may tend to fall out when the buckets rock apart at the critical frequency or during start up or shutdown if not securely fastened to the bucket. On the other hand, if the tie pins are tightly disposed, i.e., welded or otherwise permanently joined to the buckets, then additional steps are required during assembly.

Accordingly, one object of the present invention is to provide an improved diagonal tie pin that decreases the chances of the pin coming out when the buckets rock apart.

Another object is to provide a pin which requires no cold working or welding to restrain the pin in only one of two supporting buckets.

Still a further object is to provide a bucket-tie pin assembly wherein no special tie pin is required for the last assembled bucket.

DRAWING

These and many objects of the invention may best be understood by reference to the following description taken in connection with the accompanying drawing, in which:

FIG. 1 is a perspective view of a partial turbine stage embodying this invention.

FIG. 2 is a radially inward view, partly in section, of two assembled buckets and the next to be assembled bucket and tie pin of the turbine stage of FIG. 1.

FIG. 3 is a radially inward view, partly in section, of the last two buckets and pins to be assembled with the first assembled bucket.

SUMMARY OF THE INVENTION

Briefly stated, my invention is practiced in one form by providing a hooked diagonal tie pin between two adjacent buckets which are disposed on a turbine wheel. The diagonal tie pin is loosely disposed in holes in each bucket but maintains a locked orientation after final assembly by the tapered hook, partially tapered neck, and flange portion of the tie pin which is disposed in the hole toward the leading edge.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a typical environment of this invention is shown including a turbine rotor **1**, comprising one stage of a steam or gas turbine. The rotor **1** has buckets **2** mounted thereon by some form of dovetail **3**. Buckets **2** are of the axially insertable type with means provided to lock the buckets in place after final assembly. In the area intermediate the roots and tips of buckets **2** are the hooked and flanged diagonal tie pins **4** connecting adjacent buckets to provide torsional vibration damping. The pins **4** are loosely disposed and in a locked position so they cannot come out, except by special procedure to be described later.

Referring now to FIG. 2, there are shown buckets **2***a*, **2***b*, and **2***c* in developed plan view. Toward the leading edge region **6** of the buckets there are formed transverse holes **5** and in the trailing edge region **8** there are formed transverse holes **7**. Transverse holes **5** and **7** are formed such that an extension of their centerlines would meet and be substantially coplanar with the other. On the convex side **9** of the buckets, transverse hole **5** is formed such that a partially tapered surface **5***a* is provided. Transverse hole **7** is formed, such that its corners **7***a*, **7***b* are rounded so as to allow a pivoting motion of the pin during assembly.

Referring further to FIG. 2, there are shown the hooked diagonal tie pins **4***a* and **4***b* in relation to buckets **2***a*, **2***b* and **2***c*. The hooked diagonal tie pin is formed in any suitable manner, such as casting, so that it is comprised of a flange portion **10**, a tapered hook portion **11**, a partially tapered neck portion **12**, and the remaining body **13**.

Flange **10** is formed generally in the shape of a cone extending around the circumference of the pin. The hook **11** and part of neck portion **12** have a tapered offset generally shown at **14**, with respect to the circumference of the pin. It is the purpose of the various parts just described to maintain the tie pin in a locked orientation after final assembly, but allowing sufficient clearance between bucket and pin so as to facilitate easy assembly. It is understood that after final assembly, the pins are loosely disposed in the bucket holes but in a locked orientation.

The three buckets shown in FIG. 2 with diagonal tie pins **4***a* and **4***b* are shown with respect to reference plane **15**, which represents the plane on which the leading edge of the buckets rest when all buckets are finally assembled. This shows the first two assembled buckets **2***a* and **2***b* with tie pin **4***a* disposed diagonally therebetween with the next assembled bucket **2***c* and tie pin **4***b* axially displaced so as to allow axial insertion of the bucket and pin by the use of dovetail **3**.

The method of assembly for all but the last pin will now be described. Still referring to FIG. 2, bucket **2***c* is axially displaced in its dovetail **3** toward the upstream side of reference plane **15**. The body portion **13** of tie pin **4***b* is inserted through transverse hole **7**. Due to rounded

corners 7*a*, 7*b* of hole 7, tie pin 4*b* is allowed to pivot as previously mentioned. As bucket 2*c* is moved axially toward reference plane 15, a position is reached whereby the tapered hook and tapered portion of neck 12 are aligned with transverse hole 5. When this position is reached, the tapered hook portion is freely slidable into hole 5. Further movement causes the diagonal tie pin 4*b* to move into its locked orientation as bucket 2*c* is aligned with reference plane 15. After axial insertion and locking of bucket 2*c* in place, tapered hook 11 extends over the leading edge region 6 while the flange 10 rests on tapered surface 5*a* providing the locked orientation. The next bucket and tie pin is inserted in the same manner following a left to right sequence around turbine rotor 1.

The method for inserting the last tie pin is a simple matter requiring a slightly different technique as compared to normal assembly. Referring now to FIG. 3, that method will be described. The first assembled bucket 2*a* and partially drawn tie pin 4*a* are shown in their final assembled position, i.e., directly aligned with reference plane 15. The next-to-the-last pin to be assembled 4*c* is inserted between adjacent buckets 2*d* and 2*e* by the normal method previously described. The last two buckets to be assembled 2*d* and 2*e* are then moved axially along their dovetails 3 to a downstream position with respect to reference plane 15 so that there is sufficient clearance for the insertion of last pin 4*d*. It will now be apparent that pin 4*d* will slide into holes 5 and 7 when the last buckets are moved toward reference plane 15 from their downstream position. The last pin reaches a locked orientation as the last bucket 2*e* reaches reference plane 15. The last assembled buckets are then locked in place.

Thus, it will be appreciated that in the final assembled position, the hook, neck, and flange portions of the tie pin provide a locked orientation while not requiring any cold working or welding to secure the tie pin in place. It will be further appeciated that by using the tie pin of the present invention, no special design will be required for the last assembled tie pin or bucket. Thus, there has been described an improved diagonal tie pin and bucket assembly for a turbine rotor which provides ease of assembly while providing an effective damping means for torsional vibration. Other modifications will occur to those skilled in the art, and it is desired to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A turbomachine rotor having a plurality of axially-insertable buckets disposed thereon with a diagonal tie pin dampening structure comprising:

a first bucket defining a tie pin hole toward the leading edge,

a second bucket defining a tie pin hole toward the trailing edge,

a diagonal tie pin loosely disposed between adjacent buckets in said holes but in a locked orientation,

said pin having a hook portion on one end thereof shaped so that the pin will slide into one of said bucket holes when the buckets are axially offset relative to one another.

2. A turbomachine rotor according to claim 1 in which said tie pin comprises a flange portion toward one end thereof, a tapered hook portion on said end thereof, a partially tapered neck portion between said flange and said hook, and a remaining body portion.

3. A turbomachine rotor according to claim 1 in which said tapered hook and partially tapered neck portions are disposed through said tie pin hole toward the leading edge.

4. A turbomachine rotor according to claim 1 in which said tie pin hole toward the leading edge has a partially tapered surface to provide a resting surface for said flange portion.

5. A turbomachine rotor according to claim 1 in which said tie pin hole toward the trailing edge has rounded corners to allow pivoting motion of the tie pin.

6. A turbomachine rotor having a plurality of axially-insertable buckets disposed thereon,

each of said buckets defining a first tie pin hole toward the trailing edge, said first hole having rounded corners, and also defining a second tie pin hole located toward the leading edge, said second hole having a partially tapered surface,

a plurality of tie pins loosely disposed diagonally between adjacent buckets and in a locked orientation, each of said pins comprising:

a body portion extending between buckets and passing through said first hole, a flange portion toward one end thereof and abutting said second hole tapered surface,

a hook portion on the end of the pin and preventing movement through the second hole, and

a tapered neck portion connecting said flange and hook.

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U.S. Cl. X.R.

416—190