March 3, 1970 J. A. MARTIN, JR., ET AL 3,498,727

BLADE RING SUPPORT

Filed Jan. 24, 1968 2 Sheets-Sheet 1

FIG. 1

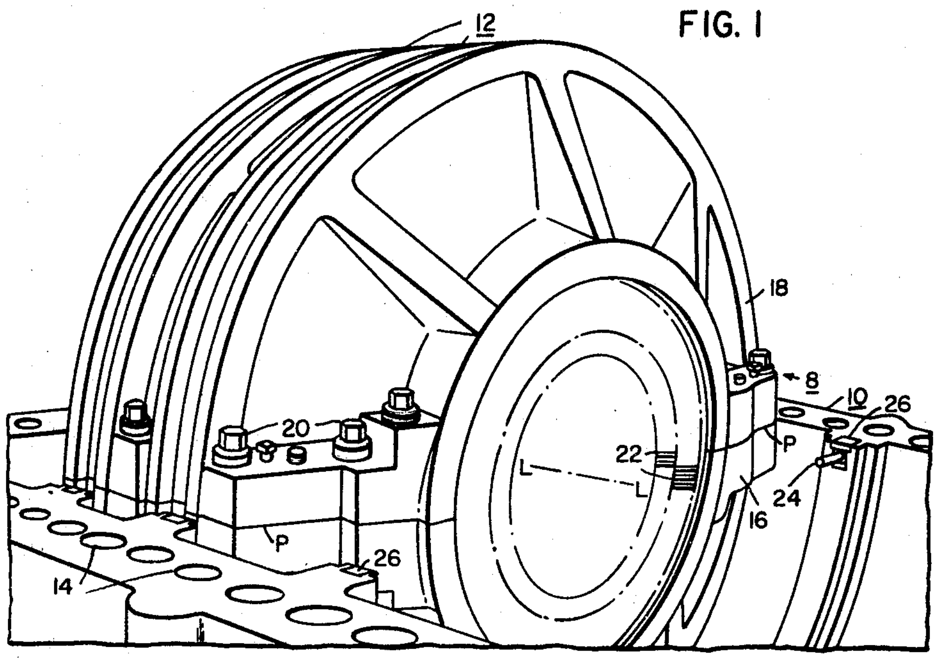
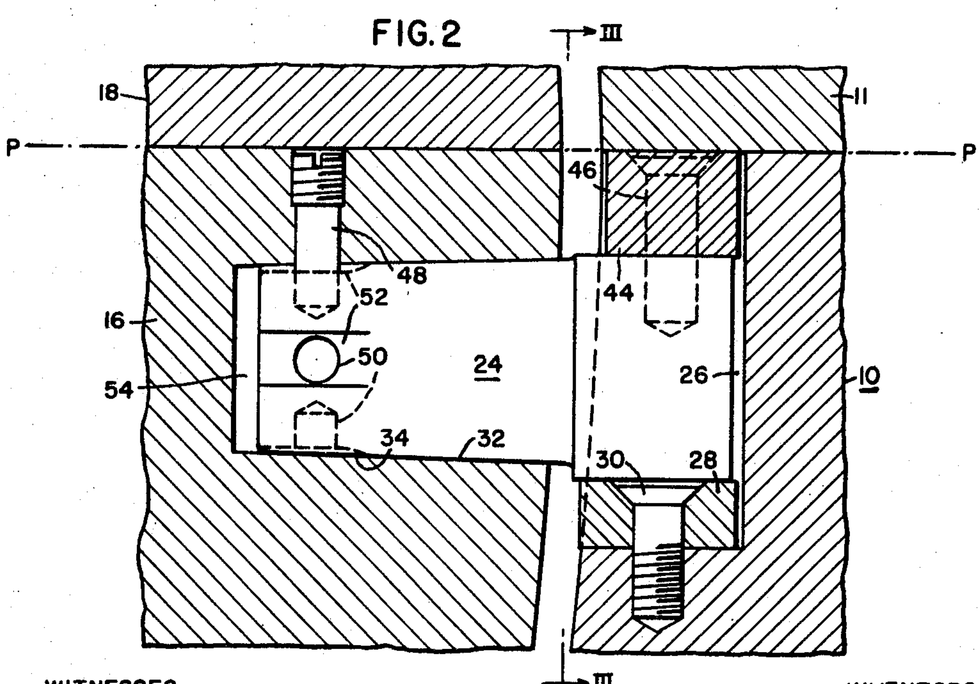



FIG. 2




WITNESSES

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FIG. 3

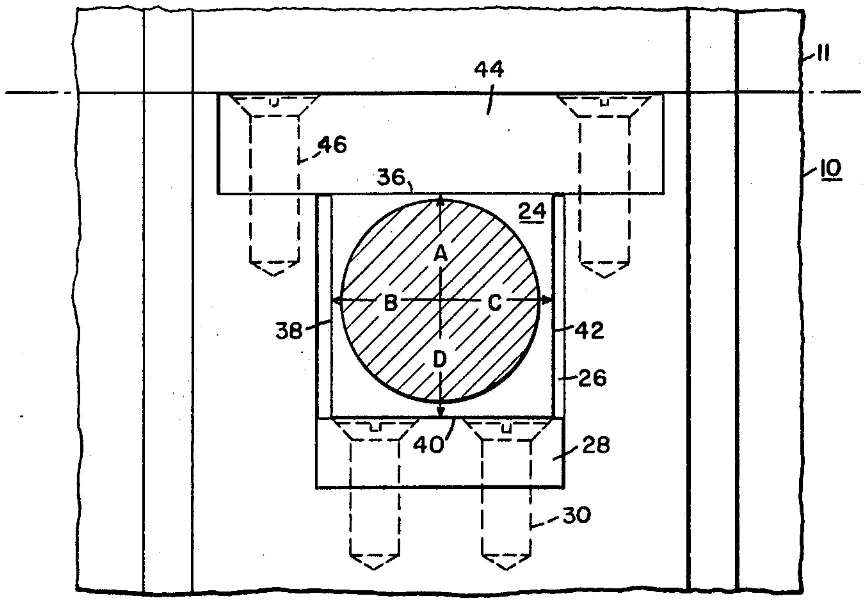
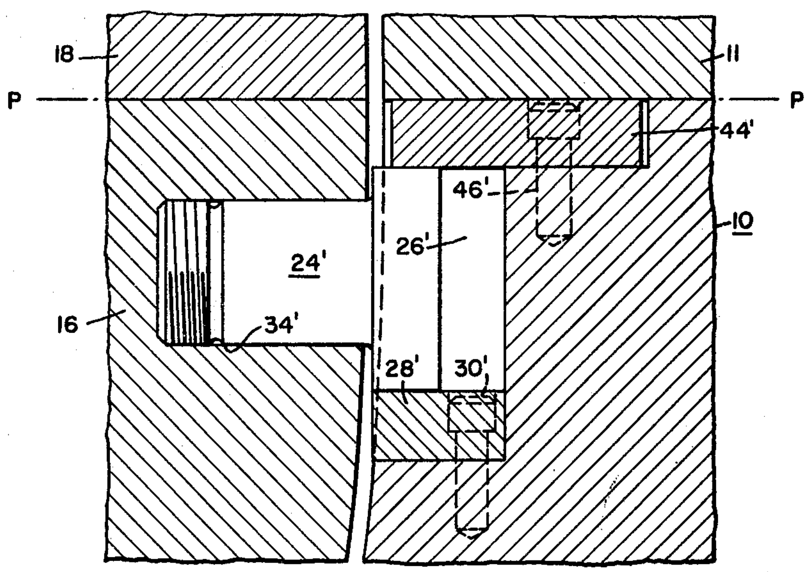

44
11
46
10
36
24
A
B
C
38
42
D
26
40
28
30

FIG. 4


18
11
P
P
44'
46'
10
26'
24'
16
34'
28'
30'

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# 3,498,727
# BLADE RING SUPPORT

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U.S. Cl. 415—136 13 Claims

## ABSTRACT OF THE DISCLOSURE

Blade rings of a turbine are adjustably supported in the turbine outer cylinder or casing on dowel pins which rest on liners in the casing in a manner to provide for differential thermal expansion between the blade rings and the casing. The head of each dowel pin has four flat surfaces each machined to a different dimension from the dowel center line to provide adjustable elevation alignment of the blade ring relative to the outer cylinder by rotation of the dowel to the desired head position.

## BACKGROUND OF THE INVENTION

This invention relates to elastic fluid utilizing machines and particularly to steam turbines of the axial flow type.

In an axial flow turbine having a series of expansion stages, blade rings containing stationary blades which cooperate with blades carried by the turbine rotor may be mounted in the outer cylinder or casing of the turbine. The casing and the blade rings are split along a horizontal plane into upper and lower half portions. In order to permit differential thermal expansion between the blade rings and the casing, it is necessary to provide a movable support for the blade rings in the casing. Also, it is necessary to maintain proper clearance between the stationary blades and the rotor blades during operation of the turbine.

A prior method of supporting steam turbine blade rings in the outer cylinder or casing is by bolting a separate key to each side of the blade ring base half. Each key rests on a liner bolted to the outer cylinder. The costly key design requires special fitting to the blade ring halves. Also, expensive machining is incurred in the blade ring for the key slot.

An object of this invention is to simplify the structure and reduce the cost of manufacturing and installing blade ring supports for elastic fluid utilizing machines, such as steam turbines.

Another object of the invention is to provide for adjusting the elevation alignment of each blade ring relative to the outer cylinder or casing of a turbine.

Other objects of the invention will be explained hereinafter or will be apparent to those skilled in the art.

## SUMMARY OF THE INVENTION

In accordance with one embodiment of the invention, the outer cylinder or casing and the blade rings of a turbine are split along a horizontal plane into upper and lower half portions. Circular dowel pins are secured in the base portion of each blade ring. The pins extend outwardly horizontally along a plane parallel to the vertical plane of the ring and their heads rest on liners disposed in recesses in opposite sides of the outer cylinder base. The head of each pin has a plurality of flat surfaces each machined to a different dimension from the dowel centerline to provide adjustable elevation alignment of the blade ring relative to the outer cylinder by rotation of the dowel pin to the desired head position.



## BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the nature and objects of the invention, reference may be had to the following detailed description, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is an isometric view of a portion of a steam turbine embodying principal features of the invention;

FIG. 2 is an enlarged fragmentary detail view in vertical section, of one of the blade ring supports utilized in the structure shown in FIGURE 1;

FIG. 3 is a view, in section, taken along the line III—III in FIG. 2, and

FIG. 4 is a view, similar to FIG. 2, of a modified blade ring support.

## DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to the drawing, particularly to FIGURE 1, the structure shown therein comprises a turbine outer cylinder or casing **8**, with only the base portion **10** being shown in FIGURE 1, and a plurality of blade rings **12** mounted inside the turbine casing. The turbine casing is divided along a horizontal plane P—P into a base portion **10** and a cover portion **11** (see FIG. 2) which may be attached to the base portion **10** by means of bolts threaded into holes **14** in the base portion. Likewise, the blade rings **12** are each divided along the horizontal plane P—P into a lower half portion **16** and an upper half portion **18**. The upper portion **18** is attached to the lower portion **16** by means of bolts **20**. Each blade ring **12** contains a plurality of circular rows of stationary blades **22** which cooperate with blades carried by the turbine rotor (not shown) which extends through the turbine along the longitudinal axis L—L and is supported by suitable bearings (not shown) in the casing **8**. The number of blade rings provided depends upon the size of the turbine and the number of expansion stages.

In order to provide for differential thermal expansion between the blade rings and the casing, each blade ring **12** is supported on horizontally oppositely disposed dowel pins **24** secured in the lower portion **16** of the blade ring. The dowel pins **24** extend outwardly horizontally in a plane parallel to the vertical plane of the ring into horizontally oppositely disposed recesses **26** in the base **10** of the casing **8**. The dowel pins **24** are disposed in the recesses for axially slidable movement, thereby permitting radial thermal expansion between the blade ring and the casing to occur without stress therein.

As shown more clearly in FIGS. 2 and 3, each dowel pin **24** rests on a flat liner **28** disposed at the bottom of the recess **26** and attached to the casing **10** by screws **30**. The dowel pin **24** has a circular tapered portion **32** received in a tapered opening **34** in the lower portion **16** of the blade ring.

In order to provide adjustable elevation alignment of the blade ring relative to the outer cylinder or casing, the head of each dowel pin **24** has a plurality of, in this case, four flat surfaces **36**, **38**, **40** and **42** as shown in FIG. 3. Each surface is machined to a different dimension from the dowel pin centerline. By way of example, if the dimension A is considered to be 1.000 inches, the dimension of B may be 1.005 inches, the dimension C may be 1.010 inches and the dimension D may be 1.015 inches. Thus, each dowel pin may be rotated during assembly to select the dimension providing the required elevation of the blade ring for proper clearance between the blades **22** in the ring and the blades carried by the turbine rotor which rotates about the longitudinal axis L—L.

As shown, the surface **40** of the dowel pin **24** rests on the liner **28** with the surface **36** being engaged by a liner **44** retained in the recess **26** by screws **46**. Since the surface **36**, which is the shortest distance from the centerline of the dowel pin, is opposite the surface **40**, which is the greatest distance from the dowel centerline, the liner **44** engages the head of the dowel pin to prevent riding-up of the blade ring. Since the sum of the dimensions B and C (1.005+1.010) equals the sum of the dmiensions A and D (1.000+1.015) the liner **44** will also engage the head of the dowel pin when either of the surfaces **38** or **42** is resting on the liner **28** at the bottom of the recess **26**. In this manner compensation may be made for manufacturing inaccuracy by rotating the dowel pins **24** to secure the desired elevational alignment of the blade ring. Likewise, compensation may be made for wear of the supporting parts by replacing the liners **28** and **44**.

The dowel pin **24** may be secured in the tapered opening **34** by the friction of the tapered fit. If desired, however, a locking pin **48** may be inserted into one of four radial holes **50** in the dowel pin to secure the pin. The holes **50** correspond with the four flat surfaces on the head of the dowel pin. The locking pin **48** may be threaded into the lower portion **16** of the blade ring.

In order to assist in removing the dowel pin **24** from the opening **34**, for example during service or repair, a passageway **52** is provided from each opening **50** to the inner end of the dowel pin **24**, the tapered portion of which is shorter than the depth of the opening **34** to provide a chamber **54** between the inner end of the dowel pin and the inner end of the opening **34**. The locking pin **48** may be removed and a proper fitting utilized in its place to inject a liquid into the chamber **54** through the communicating passageway **52** to apply hydraulic pressure on the inner end of the dowel pin to assist in removing the dowel pin.

In the modification of the invention shown in FIG. 4, a cylindrical opening **34'** is provided for the dowel pin **24'** which is threaded into the opening **34'** to retain the pin in the opening. The head of the dowel pin **24'** is constructed in the manner hereinbefore described and may be rotated to secure the desired elevation of the blade ring. The liners **28'** and **44'**, which are similar to the liners **28** and **44**, respectively, but of different dimensions, cooperate with the head of the dowel pin **24'** in the manner hereinbefore described to permit differential thermal expansion between the blade ring and the turbine casing and prevent riding-up of the blade ring. The liners **28'** and **44'** are retained in position by screws **30'** and **46'**, respectively.

From the foregoing description, it is apparent that the invention provides an improved arrangement for supporting blade rings in a turbine casing in a manner to so provide for differential thermal expansion between the blade rings and the outer cylinder or casing of the turbine. Also, provision is made for adjusting the elevation alignment of the blade rings relative to the casing to maintain proper clearance between the stationary blades of the turbine and the blades carried by the rotor of the turbine which rotates about the longitudinal axis of the turbine. The supporting structure is relatively simple and it is relatively inexpensive to manufacture and install.

Since numerous changes may be made in the above-described construction and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all subject matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

**1.** In an elastic fluid utilizing machine of the axial flow type, in combination,
a casing divided along a horizontal plane into a base portion and a cover portion,
a blade ring disposed inside the casing and divided along a horizontal plane into upper and lower portions,
said base portion having horizontally oppositely disposed recesses therein,
horizontally oppositely disposed dowel pins having generally circular portions secured in the lower portion of the blade ring,
said dowel pins extending outwardly horizontally into said recesses to slidably support the blade ring,
the circular portion of at least one of said dowel pins being shorter than the depth of the opening for the pin and jointly forms a chamber therewith, and
a passageway communicating with said chamber to permit injection of a pressurized liquid into the chamber to apply hydraulic pressure on the inner end of the pin to assist in removing the pin.

**2.** The combination defined in claim **1**, wherein
the head of each dowel pin has a plurality of flat surfaces each machined to a different dimension from the dowel centerline.

**3.** The combination defined in claim **1**, including
liners disposed in said recesses upon which the dowel pins rest.

**4.** The combination defined in claim **2**, including
a liner at the bottom of each recess upon which a flat surface of a dowel pin rests, and
another liner at the top of each recess cooperating with a flat surface of the dowel pin opposite the flat surface at the bottom of the pin and retaining said dowel pin against upward movement.

**5.** The combination defined in claim **1**, wherein
the dowel pins have a taper fit in openings in the blade ring.

**6.** The combination defined in claim **1**, including
a locking pin inserted into the circular portion of each dowel pin.

**7.** The combination defined in claim **1**, wherein
each dowel pin is retained in the blade ring by a portion threaded into the blade ring.

**8.** The combination defined in claim **1**, including
means for attaching the upper portion of the blade ring to the lower portion.

**9.** The combination defined in claim **5**, wherein
the head of each dowel pin has a plurality of flat surfaces each machined to a different dimension from the dowel centerline,
the tapered portion of each dowel pin has radial holes corresponding with the flat surfaces on its head, and
a locking pin inserted into one of the holes.

**10.** The combination defined in claim **1**, wherein
the circular portion of the dowel pin has a radial hole therein, and
the dowel pin has a groove therein communicating between the radial hole and the chamber, said hole and said groove forming the passageway.

**11.** The combination defined in claim **10**, wherein
a locking pin is inserted in the radial hole, and
the locking pin is removable to permit the application of the hydraulic pressure.

**12.** The combination defined in claim **4**, wherein
the head of the dowel pin has at least two pairs of opposed surfaces and the distance between each pair is substantially identical.

**13.** The combination defined in claim **12**, wherein the head of the dowel pin is of square shape.


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U.S. Cl. X.R.

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