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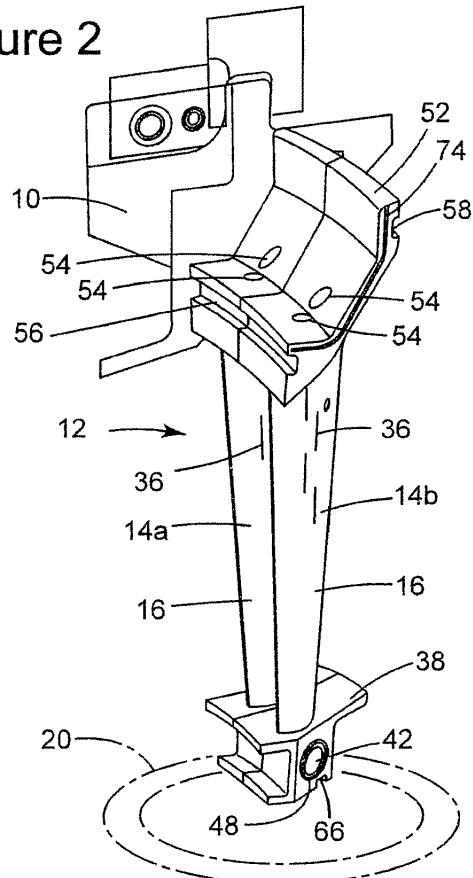
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(54) Brazed steam turbine guide vane module

(57) A stator blade ring 12 for the last stage of a multi-stage steam turbine 400 includes a plurality of stator blade modules 14a, 14b defining an annular chamber 20, each stator blade module including an elongated blade portion 16. The elongated blade portion further includes a longitudinal passageway 26 and an inner portion 38 brazed to a first longitudinal end of the blade portion, the inner portion 38 including a through hole 42 forming a portion of the annular chamber 20 and an inner passageway extending from the through hole to the longitudinal passageway. An outer portion 52 is brazed to a second longitudinal end of the blade portion and engaged to the steam turbine. The outer portion 52 includes an outer passageway open to a surface of the steam turbine and the longitudinal passageway.

Figure 2



Description**BACKGROUND****TECHNICAL FIELD**

[0001] The present invention relates generally to steam turbines and, more specifically, to a stator blade ring for a steam turbine and a method of making a stator blade ring.

DISCUSSION OF THE BACKGROUND

[0002] A steam turbine is a turbo machine which converts thermal and pressure energy of steam into rotary motion which may be used to perform work. Steam turbines may be used, for example, to drive electrical generators or compressors.

[0003] To enhance steam turbine efficiency, steam is often expanded through a number of stages. Each stage typically includes a stator blade diaphragm and a bearing mounted rotor assembly including at least one impeller.

[0004] As steam progresses through the latter stages of the steam turbine, sufficient energy may be absorbed from the steam to cause portions of the steam to condense, and thus, to become so called, wet steam. In addition to having a potential corrosive effect, when wet steam impinges against the stator blade diaphragm, the condensate tends to violently impact the stator blades and other parts of the diaphragm. As a result, the stator blades and other portions of each stator blade diaphragm in the latter stages of the steam turbine may be damaged, for example, during prolonged exposure to wet steam having a high proportion of condensate.

[0005] In modern steam turbines, the manufacture of stator blade diaphragms represents a significant cost, particularly in multi stage steam turbines having three or more stages each of which may include one or more separate stator blade diaphragms.

[0006] If a stator blade diaphragm is damaged, the steam turbine may need to be shut down and the damaged stator diaphragm removed for servicing. If on site repair is not possible, the entire diaphragm may need to be sent for repair or alternatively, an entire new stator diaphragm must be installed. Worse yet, if a replacement is available, a new stator blade diaphragm must be fabricated. Thus, in addition to the cost of the stator diaphragm, costs associated with the extended downtime of the steam turbine are also incurred. Accordingly, what is needed is a replacement for the conventional stator blade diaphragm, which is easily serviced and/or replaced, which is capable of successful operation in the presence of wet steam, and which provides a simple design which is easier manufactured.

SUMMARY

[0007] According to an exemplary embodiment, a sta-

tor blade ring for a steam turbine includes a plurality of stator blade modules defining an annular chamber, each stator blade module including an elongated blade portion including a first blade shell portion and a second blade shell portion brazed to the first blade shell portion. The elongated blade portion further includes a longitudinal passageway and at least one opening extending through one of the first blade shell portion and the second blade shell portion to the longitudinal passageway. An inner portion brazed to a first longitudinal end of the blade portion, the inner portion including a through hole forming a portion of the annular chamber, the inner portion further including an inner passageway extending from the through hole to the longitudinal passageway. An outer portion brazed to a second longitudinal end of the blade portion and engaged to the steam turbine, the outer portion including an outer passageway open to a surface of the steam turbine and the longitudinal passageway.

[0008] According to another exemplary embodiment, a turbo machine includes a rotor assembly including at least one impeller, a bearing connected to, and for rotatably supporting, the rotor assembly, and a stator blade ring having a plurality of stator blade modules defining an annular chamber. Each blade module includes at least one elongated blade portion including a first blade shell portion and a second blade shell portion brazed to the first blade shell portion, an inner portion brazed to a first longitudinal end of the at least one blade portion, the inner portion including a through hole forming a portion of the annular chamber, and an outer portion brazed to a second longitudinal end of the at least one blade portion and engaged to a surface of the steam turbine. At least one of the blade modules includes a longitudinal passageway and at least one opening in the at least one blade portion for liquid to enter the longitudinal passageway and an inner passageway in the inner portion extending from the through hole to the longitudinal passageway for allowing the liquid to flow between the annular chamber and the longitudinal passageway. At least one of the blade modules includes a longitudinal passageway in the at least one blade portion, an inner passageway in the inner portion extending from the through hole to the longitudinal passageway for allowing the liquid to flow between the annular chamber and the longitudinal passageway and an outer passageway in the outer portion extending from the longitudinal passageway and opening to the surface of the turbo machine for allowing the liquid to flow out of the stator blade ring.

[0009] According to another exemplary embodiment, a method of making a blade module for a stator blade ring can include the steps of brazing first and second edges of a first blade shell portion to first and second edges of a second blade shell portion to provide an elongated blade portion having a longitudinal passageway, forming a through hole in the inner portion, forming an inner passageway in the inner portion extending from a surface of the inner portion to the through hole, brazing a first longitudinal end of the blade portion to the surface

of the inner portion such that the longitudinal passageway is open to the inner passageway, forming an outer passageway in the outer portion extending from a first surface to a second surface of the outer portion, and, brazing a second longitudinal end of the blade portion to the first surface of the outer portion such that the longitudinal passageway is open to the outer passageway.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate one or more embodiments and, together with the description, explain these embodiments. In the drawings:

Figure 1 depicts a steam turbine.

Figure 2 shows a perspective view of an exemplary embodiment.

Figure 3 shows a side view of the exemplary embodiment of Figure 2.

Figure 4 shows a cross-sectional view of the exemplary embodiment shown in Figure 2.

Figures 5 to 7 show an inner portion of the exemplary embodiment shown in Fig. 2.

Figures 8 to 10 show an outer portion of the exemplary embodiment shown in Fig. 2.

Figure 11 is a flowchart illustrating a method of making a blade module for a stator blade ring according to an exemplary embodiment.

DETAILED DESCRIPTION

[0011] The following description of the exemplary embodiments refers to the accompanying drawings. The same reference numbers in different drawings identify the same or similar elements. The following detailed description does not limit the invention. Instead, the scope of the invention is defined by the appended claims. The following embodiments are discussed, for simplicity, with regard to the terminology and structure of a turbo machine that has a stator and a rotor. However, the embodiments to be discussed next are not limited to these exemplary systems, but may be applied to other systems.

[0012] Reference throughout the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with an embodiment is included in at least one embodiment of the subject matter disclosed. Thus, the appearance of the phrases "in one embodiment" or "in an embodiment" in various places throughout the specification is not necessarily referring to the same embodiment. Further, the particular features, structures or character-

istics may be combined in any suitable manner in one or more embodiments.

[0013] To provide some context for the subsequent discussion relating to stator blades according to these exemplary embodiments, Figure 1 schematically illustrates a turbo machine in the form of a multistage steam turbine 400. Therein, the steam turbine 400 includes a housing (stator) 420 within which a number of stator blade diaphragms 430 are disposed along with a rotor shaft 450 provided with a plurality of impeller rotors 440. The shaft 450 is supported radially and axially through bearings 480.

[0014] During operation, the steam turbine takes a steam input from an inlet 460 through various stages of expansion, to an outlet 470 leading to a condenser. At each turbine stage, steam is directed by a stator diaphragm 430 onto an impeller rotor 440 thereby converting the temperature and pressure energy of the steam into rotating energy available for work at the rotor shaft 450.

[0015] Figure 2 shows a portion of a stator blade ring 12 according to an exemplary embodiment of the present invention. Stator blade ring 12 includes a plurality of individual stator blade modules 14 extending around rotor 28 (Fig. 3) in steam turbine 10. Figure 2 shows two such blade modules 14a and 14b.

[0016] Each stator blade module 14a, 14b includes an elongated blade portion 16, as shown in Figs. 2 and 3. Fig. 4 shows a cross-sectional view of an elongated blade portion 16 having a longitudinal reinforcing rib 24 and longitudinal passageways 26. As is further shown in Fig. 4, a blade portion 116 may also be provided without reinforcing rib 24 and may thus have a single longitudinal passageway 26. As will be discussed in further detail below, each blade portion 16 is made by brazing a first blade shell portion 18 to a second blade shell portion 22 along the upstream edge 32 and the downstream edge 34 thereof.

[0017] As further shown in Figs. 2 to 4, each blade portion 16 includes a plurality of openings 36 in at least one of blade shell portion 22 and blade shell portion 24. In the embodiment of Figs. 2 to 4, each opening 36 is a slot formed by electric discharge machining. Alternatively, openings 36 may be formed by other machining processes such as drilling or milling, or, openings 36 may be formed during the initial manufacture of blade shell portion 22 and blade shell portion 24, for example, by a mold insert.

[0018] Each blade module 14 includes an inner portion 38 connected to a first longitudinal end of at least one blade portion 16, as shown in Fig. 2. In the embodiment shown in Figs. 2 to 4, inner portion 38 is brazed to blade portion 16, as will be discussed further below. Each inner portion 38 includes a through hole 42 extending transversely to the longitudinal axis 46 (Fig. 3) of blade portion 16. Through hole 42 forms a part of an annular chamber 20 in stator blade ring 12 when each of the blade modules are installed into the steam turbine 10. In order to enhance the seal between through holes 12 in adjacent

blade modules 14, at least one end of each through hole 12 may be provided with a groove 48 configured to receive a sealing gasket. In the embodiment of Figs. 2 to 4, groove 48 is configured to receive an O-ring.

[0019] Each inner portion 38 also includes at least one inner passageway 44, as shown in Fig. 3, extending from through hole 42 to each longitudinal passageway 26. Alternatively, if reinforcement rib 24 is terminated prior to the longitudinal end of blade portion 16, then a single inner passageway 44 may be open to both longitudinal passageways 26.

[0020] Each stator blade module 14 also includes an outer portion 52 connected to a second longitudinal end of at least one blade portion 16, as shown in Figs. 2 and 3. Each outer portion 52 includes at least one outer passageway 54 which is open to each longitudinal passageway 26 and to an interior surface of steam turbine 10, as shown in Figs. 2, 9 and 10. Further, in the embodiment of Figs. 2 to 4 and 8-10, each outer portion may include a groove 74 on at least one side thereof. Groove 74 may be configured to receive a gasket for sealing adjacent outer portions 52 to each other and/or for providing a dampening effect to stator blade ring 12. Stator blade ring 12 may be used in one of the latter stages of the steam turbine 10, as shown in Fig. 2. During operation, condensate from the wet steam impinging against each blade portion 14 may enter the longitudinal passageway 26 of a blade portion 16 through one of the openings 36. Multiple paths are available for the condensate to travel within the blade modules 14 before exiting outside stator blade ring 12 at a location where the condensate may be less likely to cause damage to the components of steam turbine 10. In one path, which may include stator blade modules 14 above the rotor shaft, the condensate may travel downwardly through each longitudinal passageway 26 and inner passageway 44 into through hole 42. The open through holes 42 in adjacent blade modules 14 that form the annular chamber 20 extending around stator blade ring 12 allow the condensate to continue flowing downwardly with gravity. The condensate may exit the annular chamber 20 and continue on a downward path through an inner passageway 44 of a blade module 14 below the rotor shaft of steam turbine 10. Finally, the condensate may flow through an outer passageway 54 to a surface of steam turbine outside of blade ring 12.

[0021] In another path, condensate may enter a longitudinal passageway 26 of a blade portion 16 below the rotor shaft of steam turbine 10 and flow out through outer passageway 54 without first travelling through the annular chamber 20 formed by through holes 42.

[0022] The removal of condensate from the wet steam progressing through the latter stages of steam turbine 10 may prevent damage to the stator blade ring 12 as well as to the turbine blades 16 and other downstream components of steam turbine 10. Moreover, stator blade ring 12 allows for the collection of condensate which may include residual heat for use in other processes.

[0023] Some blade modules, for example, blade mod-

ules above the rotor shaft of steam turbine 10, may be provided without an outer passageway 54, for example, to reduce manufacturing costs, since the downward flow of condensate may obviate the need for outer passageways 54 in blade modules 14 above the rotor shaft. Further, some blade modules 14 may be provided with blade portions 16 without slots, for example, to further reduce manufacturing costs. Alternatively, and as shown in the embodiment of Figs. 2-3 and 5-10, each of the blade

modules 14 may be identical to one another. This feature provides a number of benefits. For example, the manufacturing process is rendered more uniform. Also, servicing of steam turbine 10 is also more convenient in that, during repair or replacement of a single blade module 14 which is made possible by the exemplary embodiment, only a single part number is necessary since all blade modules 14 are identical within the stator blade ring 12.

[0024] In addition to providing cost savings over stator blade diaphragms which may need to be serviced or replaced as a unit, blade modules 14 provide a simple one piece design which is easier to install and/or replace than conventional stator blade diaphragm rings. As shown in Figs. 2, 3 and 8 to 10, the outer portion 52 of each stator blade module 14 is engaged directly to steam turbine 10.

Specifically, each outer portion 52 includes an upstream groove 56 and a downstream groove 58. Steam turbine 10 includes an upstream ridge 62 engaging groove 56 and a downstream ridge 64 engaging groove 58. Groove 56 is offset closer to inner portion 38 than groove 58. The offset between grooves 56 and 58 may allow each stator blade module to better conform to the desired flow path of the steam through steam turbine 10, and may also prevent a technician from inadvertently installing a blade module 14 in an improper orientation during construction or servicing of stator blade ring 12.

[0025] As shown in Figs. 2 and 3, outer passageway 54 opens to a surface of steam turbine 10 between ridge 62 and ridge 64. Note that a chamber 76 is formed between the outer surface of blade ring 12 and the surface of steam turbine 10. Chamber 76 may facilitate convenient collection of condensate which flows out of outer passageways 54.

[0026] A groove 66 in each inner portion 38 forms a continuous circumferential groove facing a center of stator blade ring 12, as shown in Figs. 2, 3, and 5-7. As shown in Fig. 3, each groove 66 is engaged by a metal ring 68 which locks the stator blade modules 14 together.

[0027] As further shown in Figs. 2, 3 and 5 to 7, the inner portion 38 of each stator blade module 14 defines an inner brazing platform 72 surrounding the first longitudinal end of each blade portion 16. Also, as shown in Figs. 2, 3 and 8 to 10, the outer portion 52 of each stator blade module defines an outer brazing platform 74 surrounding the second longitudinal end of each blade portion 16.

[0028] Brazing platform 72 and brazing platform 74 provide a convenient surface for brazing the longitudinal ends of each blade portion 16 as well as defining a portion

of a stage and/or steam flow path within steam turbine 10. Note from Figs. 2 and 3 that the brazing platform 74 of each outer portion 52 transitions evenly to the surrounding surfaces of steam turbine 10.

[0029] In the embodiment of Figs. 2 to 4, blade shell portion 18 may be vacuum brazed to blade shell portion 22. The first and second longitudinal ends of the resulting blade portion 16 may then be vacuum brazed to the inner portion 38 and outer portion 52 of each stator blade module 14. The vacuum brazing equipment used to perform the vacuum brazing of diaphragm 14 can be standard vacuum brazing equipment as, for example, disclosed in U.S. Patent Nos. 4,874,918 and 4,401,254, the disclosures of which are incorporated here by reference.

[0030] Thus, according to an exemplary embodiment shown in Fig. 11, a method (1000) of making a blade module for a stator blade ring, the blade module including an elongated blade portion, an inner portion, and an outer portion, can include the steps of brazing (1002) first and second edges of a first blade shell portion to first and second edges of a second blade shell portion to form a longitudinal passageway in the elongated blade portion, forming (1004) a through hole in the inner portion, forming (1006) an inner passageway in the inner portion extending from a surface of the inner portion to the through hole, brazing (1008) a first longitudinal end of the blade portion to the surface of the inner portion such that the longitudinal passageway is open to the inner passageway, forming (1010) an outer passageway in the outer portion extending from a first surface to a second surface of the outer portion, and, brazing (1012) a second longitudinal end of the blade portion to the first surface of the outer portion such that the longitudinal passageway is open to the outer passageway.

[0031] The above-described exemplary embodiments are intended to be illustrative in all respects, rather than restrictive, of the present invention. Thus the present invention is capable of many variations in detailed implementation that can be derived from the description contained herein by a person skilled in the art. All such variations and modifications are considered to be within the scope and spirit of the present invention as defined by the following claims. No element, act, or instruction used in the description of the present application should be construed as critical or essential to the invention unless explicitly described as such. Also, as used herein, the article "a" is intended to include one or more items.

Claims

1. A stator blade ring for a steam turbine, said stator blade ring comprising:

a plurality of stator blade modules defining an annular chamber, each stator blade module comprising,
an elongated blade portion including a first blade

shell portion and a second blade shell portion brazed to said first blade shell portion, said elongated blade portion further including a longitudinal passageway and at least one opening extending through at least one of said first blade shell portion and said second blade shell portion to said longitudinal passageway;
an inner portion brazed to a first longitudinal end of said blade portion, said inner portion including a through hole forming a portion of said annular chamber, said inner portion further including an inner passageway extending from said through hole to said longitudinal passageway; and
an outer portion brazed to a second longitudinal end of said blade portion and engaged to said steam turbine, said outer portion including an outer passageway open to a surface of said steam turbine and said longitudinal passageway.

2. The stator blade ring of claim 1, wherein said outer portion includes a first groove configured to engage a first ridge in said surface of said steam turbine and a second groove configured to engage a second ridge in said surface of said steam turbine.

3. The stator blade ring of claim 1 or claim 2, wherein said first groove and said second groove are offset relative to said inner portion.

4. The stator blade ring of any preceding claim, wherein a groove in said inner portion of each said blade module forms a circumferential groove in said stator blade ring and said circumferential groove is engaged by a metal ring for locking said plurality of blade modules together.

5. The stator blade ring of any of preceding claim, wherein said circumferential groove faces inwardly towards a center of said stator blade ring.

6. A steam turbine comprising:

a rotor assembly including at least one impeller;
a bearing connected to, and for rotatably supporting the rotor assembly and
a stator blade ring according to any one of the preceding claims.

50 7. A multi-stage steam turbine comprising:

a rotor assembly including at least one impeller ;
a bearing connected to, and for rotatably supporting, the rotor assembly;
a stator blade ring for the last stage of the steam turbine having a plurality of stator blade modules defining an annular chamber, each blade module comprising,

at least one elongated blade portion including a first blade shell portion and a second blade shell portion brazed to said first blade shell portion; an inner portion brazed to a first longitudinal end of said at least one blade portion, said inner portion including a through hole forming a portion of said annular chamber; and
 an outer portion brazed to a second longitudinal end of said at least one blade portion and engaged to a surface of said steam turbine; wherein said blade portion of at least one of said blade modules includes a longitudinal passageway and an opening for steam condensate to enter said longitudinal passageway, and said inner portion of said at least one blade module includes an inner passageway extending from said through hole to said longitudinal passageway for said steam condensate to flow between said annular chamber and said longitudinal passageway; and
 wherein said blade portion of another of said at least one of said blade modules includes a longitudinal passageway, said inner portion of said another blade module includes an inner passageway extending from said through hole to said longitudinal passageway for allowing said steam condensate to flow between said annular chamber and said longitudinal passageway, and said outer portion of said another blade module includes an outer passageway extending from said longitudinal passageway and opening to said surface of said turbo machine for allowing said steam condensate to flow out of said stator blade ring.

8. The steam turbine of claim 7, wherein a first groove in said outer portion of each said blade module is engaged by a first ridge on said surface of said steam turbine.

9. The steam turbine of claim 7 or claim 8, wherein a second groove in said outer portion of each said blade module is engaged by a second ridge on said surface of said steam turbine.

10. The steam turbine of any of claims 7 to 9, wherein said first groove faces upstream and said second groove faces downstream of a flow of working fluid within said turbo machine.

11. A method of making a blade module for a stator blade ring in the last stage of a steam turbine, the blade module including an elongated blade portion, an inner portion, and an outer portion, said method comprising:

brazing first and second edges of a first blade shell portion to first and second edges of a sec-

ond blade shell portion to form a longitudinal passageway in said elongated blade portion; forming a through hole in said inner portion; forming an inner passageway in said inner portion extending from a surface of said inner portion to said through hole; brazing a first longitudinal end of said blade portion to said surface of said inner portion such that said longitudinal passageway is open to said inner passageway; forming an outer passageway in said outer portion extending from a first surface to a second surface of said outer portion; and brazing a second longitudinal end of said blade portion to said first surface of said outer portion such that said longitudinal passageway is open to said outer passageway.

Figure 1

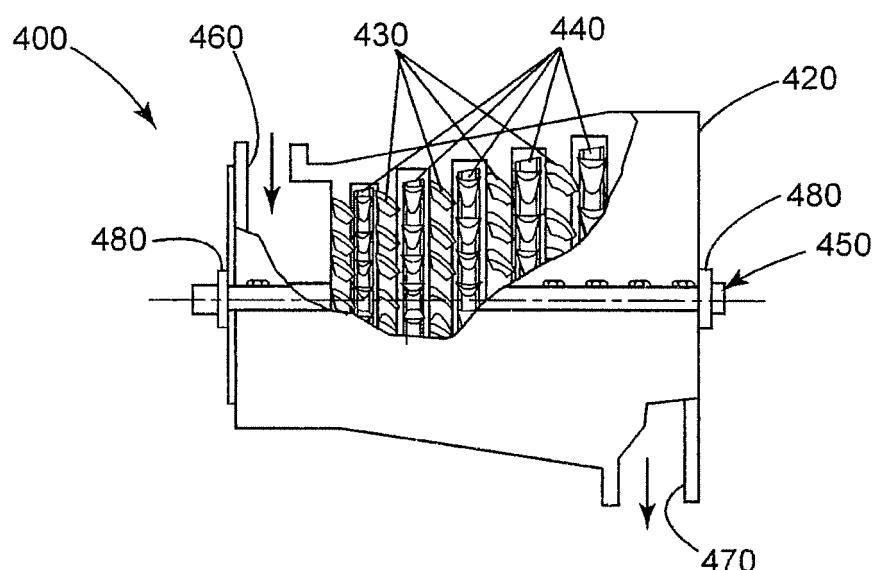


Figure 2

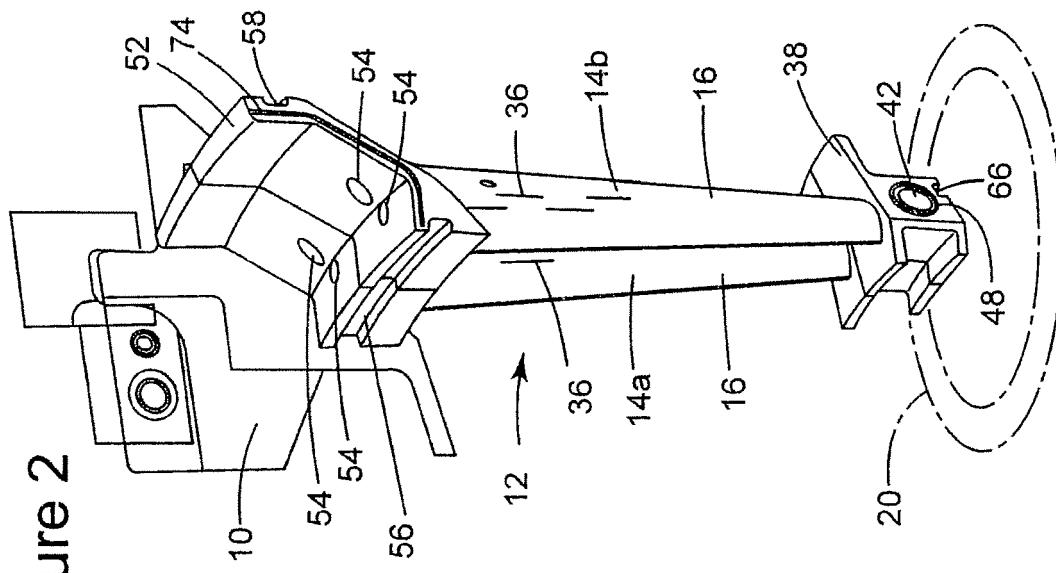


Figure 3

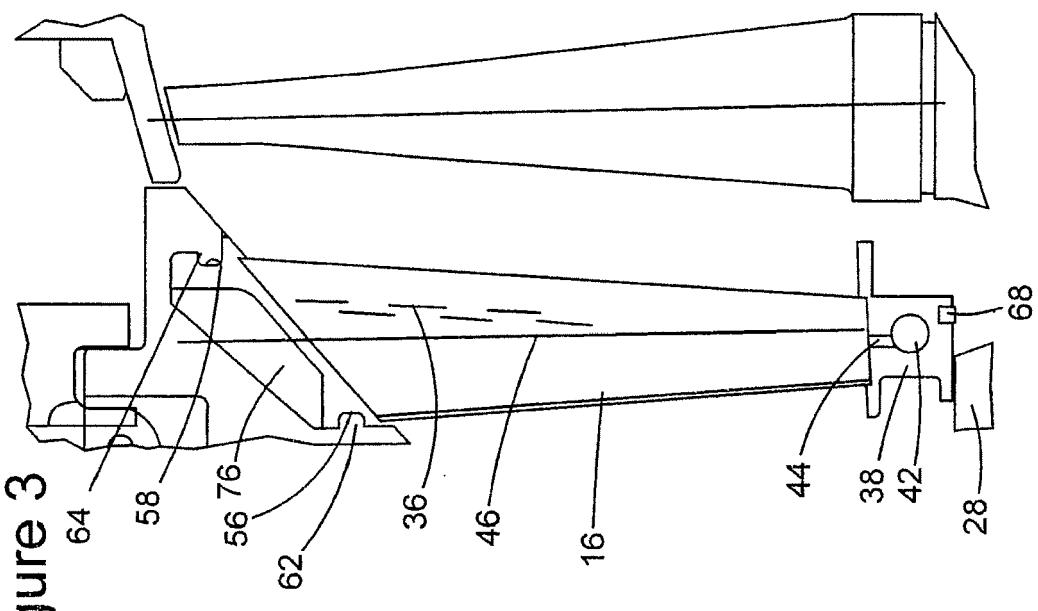
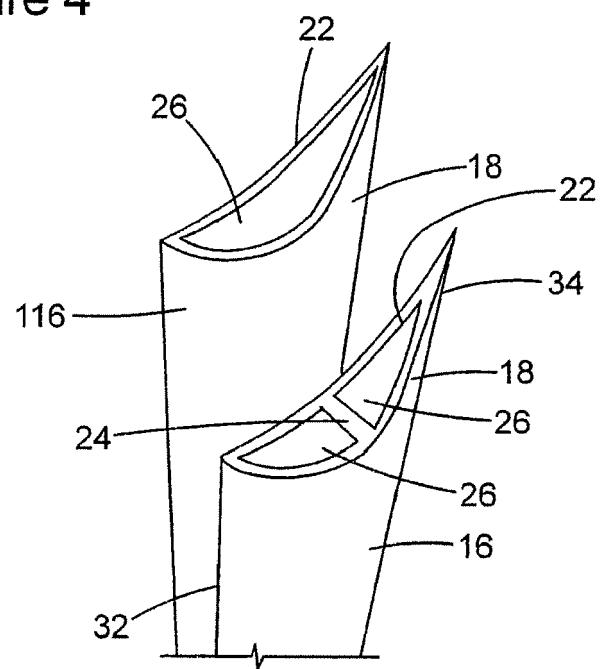


Figure 4



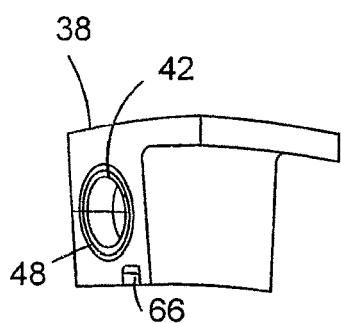


Figure 5

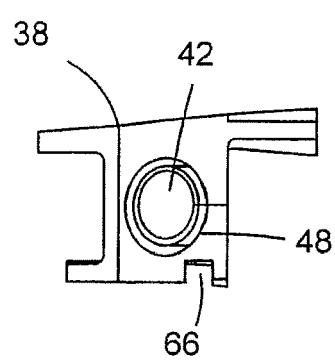


Figure 6

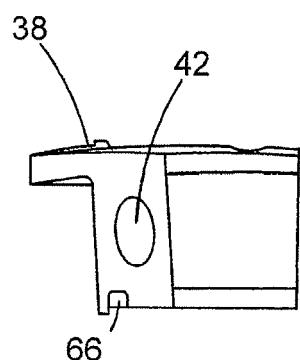


Figure 7

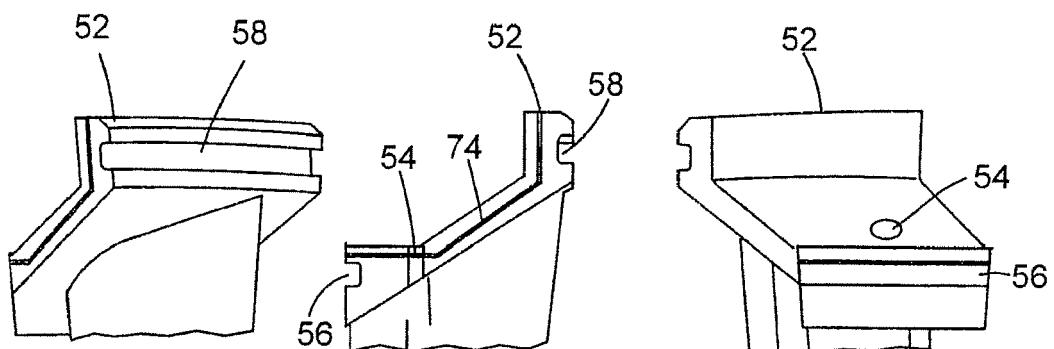
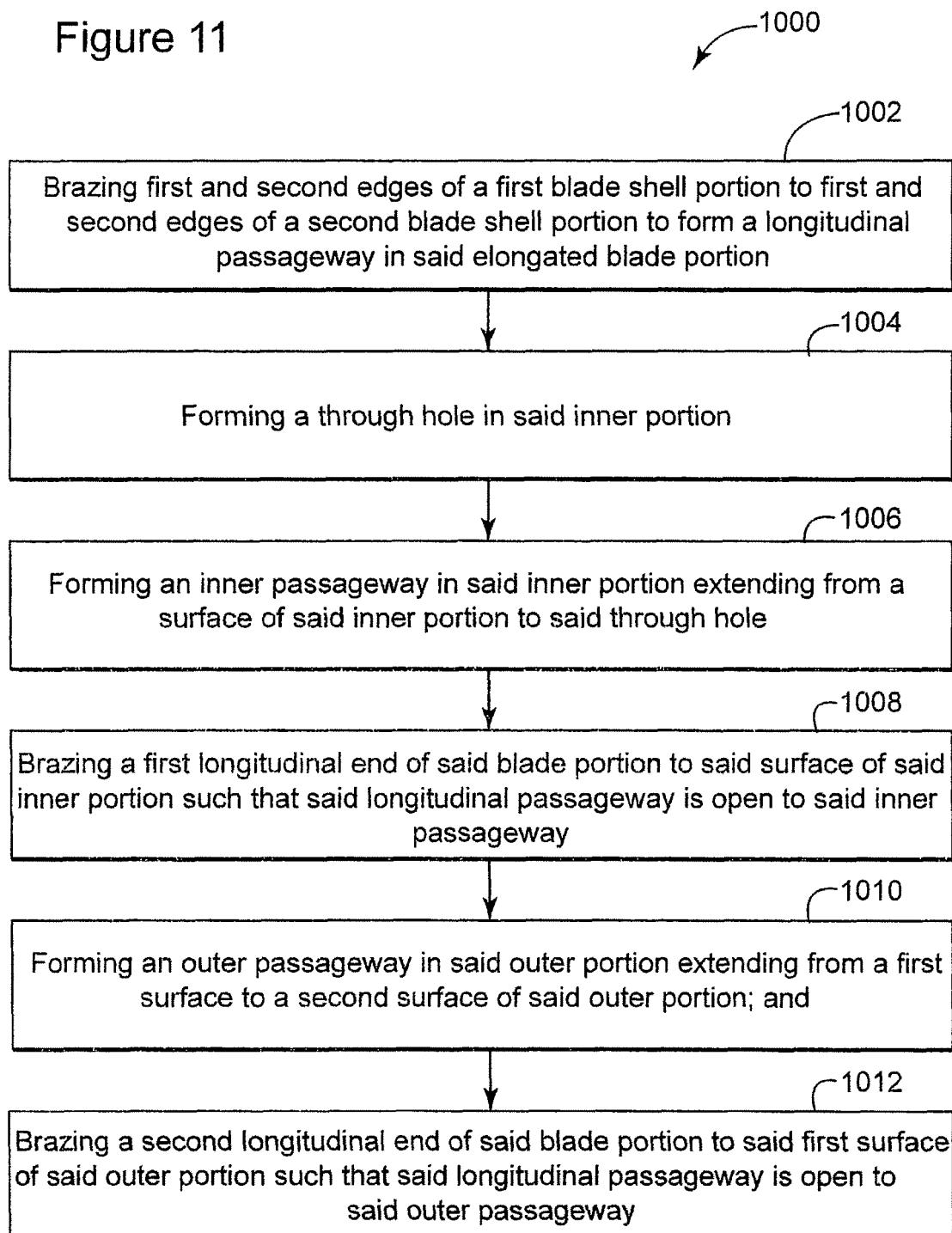


Figure 8

Figure 9

Figure 10

Figure 11





EUROPEAN SEARCH REPORT

 Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (IPC)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
1	Place of search The Hague	Date of completion of the search 20 March 2013	Examiner Gebker, Ulrich
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EP 12 19 5193

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