



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**15.01.2014 Bulletin 2014/03**

(51) Int Cl.:  
**F01D 5/14 (2006.01)**

(21) Application number: **12176275.1**

(22) Date of filing: **13.07.2012**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**

(71) Applicant: **Alstom Technology Ltd**  
**5400 Baden (CH)**

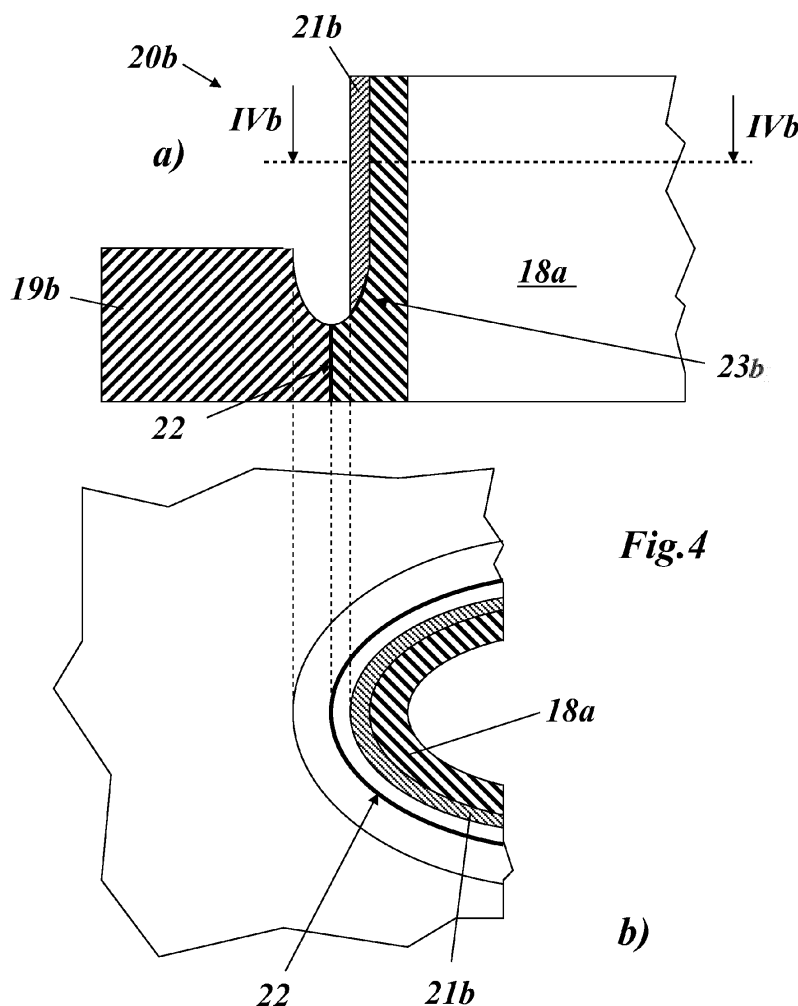
(72) Inventor: **Brandl, Herbert**  
**79761 Waldshut-Tiengen (DE)**

(54) **Modular vane/blade for a gas turbine and gas turbine with such a vane/blade**

(57) A modular vane/blade (20b) for a gas turbine comprises a basic element (18a) made of a first material, which is provided with at least one insert/inlay (21 b) made of a second material, which is integrally joined with

said basic element (18a) and has at least one runout (23a-c).

An improved mechanical stability and integrity by placing said at least one runout (23a-c) in a region of low mechanical stress within said vane/blade (20b).



**Fig.4**

## Description

### BACKGROUND OF THE INVENTION

**[0001]** The present invention relates to the technology of gas turbines. It refers to a modular vane/blade according to the preamble of claim 1. It further refers to a gas turbine with such a blade.

### PRIOR ART

**[0002]** Ever increasing hot gas temperatures in gas turbines require the use of special materials and/or designs (e.g. cooling schemes) to prevent excessive usage of cooling air. The usage of special materials and/or designs partly done by means of inlays and/or inserts to the main structure of the part. To avoid having runouts of inserts/inlays in high stressed areas it is proposed change design in a way that runouts can be placed in low stressed areas.

**[0003]** Documents US 5,348,446 and W02011/058043 A1 propose to use inserts/inlays (special material and/or design) in parent metal to cope with special requirements. Fig. 1, which is a replica of Fig. 4 of document W02011/058043 A1, shows a modular turbine blade 10, where additional parts made of different material are joined with a central airfoil 11, said additional parts comprising a leading edge 13, a trailing edge 15 and a blade tip 12. A buffer layer 14 may be provided between the leading edge part 13 and the central airfoil 11. The central airfoil 11 and the edges 13 and 15, at their lower ends, pass into a platform 16, which borders the hot gas channel and protects the blade root 17 below.

**[0004]** However, the runouts of these designs ending at high stressed areas (e.g. the transition fillet between airfoil and platform). Due to high stresses at runouts, crack initiation and/or delamination of inserts/inlay is very likely. As a result, lifetime of the component and the gas turbine as a whole is reduced.

**[0005]** Document US 201012450 A1 (EP 2 189 626 A1) discloses a rotor blade arrangement, especially for a gas turbine, which can be fastened on a blade carrier and includes in each case a blade airfoil element and a platform element, wherein the platform elements of a blade row form a continuous inner shroud. With such a blade arrangement, a mechanical decoupling, which extends the service life, is achieved by the blade airfoil element and the platform element being formed as separate elements and by being able to be fastened in each case separately on the blade carrier.

**[0006]** In one embodiment shown in Fig. 4 of this prior art document the blade airfoil element is constructed in different sections of different materials, especially also in the region of the blade airfoil. In an embodiment, the leading edge and the trailing edge of the rotor blade arrangement are formed totally of a material that is different from that of the remaining blade airfoil. As a result, particularly loaded regions of the blade airfoil can be differently designed with regard to materials than the remain-

ing regions. In this case, it is said to be advantageous if the regions which are formed of a different material, extend downwards into the region of the blade airfoil element which is shrouded by the platform element, because the discontinuity which is associated with the transition between the regions of different material is then not exposed to the extreme temperature conditions which prevail in the region of the blade airfoil.

**[0007]** However, this known solution is based on a design where the airfoil with its root and the platform are and remain separate elements with separate mounting means. Furthermore, this design addresses a temperature problem without effect on or mention of the problem of mechanical stress.

### SUMMARY OF THE INVENTION

**[0008]** It is an object of the present invention to provide a modular gas turbine vane/blade, wherein the integrally joined insert/inlays are arranged in a way to improve the mechanical stability and integrity of the vane/blade.

**[0009]** It is another object of the invention to provide a gas turbine with such a blade.

**[0010]** This and other objects are obtained by means of the subject matter of the independent claims. Advantageous embodiments are given in the dependent claims.

**[0011]** An aspect provides a modular vane/blade for a gas turbine which comprises the modular components of:

a platform with a essentially planar surface; and an airfoil, extending out from the essentially planar surface, having: a basic element made of a first material; and at least one insert/inlay that forms an outer surface portion of the basic element and is integrally joined with said basic element wherein the insert/inlay is made of a second material and has a runout that defines an end nearest the essentially planar surface. It is characterized in that said at least one runout is located either below or above the essentially planar surface.

**[0012]** A further aspect provides that the runout is located above the essentially planar surface.

**[0013]** An alternative aspect provides that the runout is located radially below the essentially planar surface.

**[0014]** A further aspect provides that the insert/inlay is joined to the platform.

**[0015]** A further aspect provides that the insert/inlay covers a portion of the basic element.

**[0016]** A further aspect provides that airfoil has a wall and the insert/inlay is a complete wall portion of the wall.

**[0017]** A further aspect provides that said joint is a welding joint.

**[0018]** A further aspect provides that said joint is a brazing joint.

**[0019]** A further aspect provides that said joint is a retainer joint. Retainer joint in this case means a joint as disclosed in document US 5,797,725 A in Fig. 5 and 6

and col. 5 and 6 of the respective description.

**[0020]** An aspect provides a gas turbine according to the invention comprises a modular vane/blade according to the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0021]** By way of example, an embodiment of the present disclosure is described more fully hereinafter with reference to the accompanying drawings, in which:

Fig. 1 shows a modular gas turbine blade known from the prior art (W02011/058043 A1);

Fig. 2 shows a schematic drawing of a modular turbine vane design suitable for the present invention;

Fig. 3 shows a side view (a) and a top view (b) of a vane according to an embodiment of the invention;

Fig. 4 shows a side view (a) and a top view (b) of a vane according to another embodiment of the invention and

Fig. 5 shows a side view (a) and a top view (b) of a vane according to a further embodiment of the invention.

#### DETAILED DESCRIPTION OF DIFFERENT EMBODIMENTS OF THE INVENTION

**[0022]** Exemplary embodiments of the present disclosure are now described with references to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth to provide a thorough understanding of the disclosure. However, the present disclosure may be practiced without these specific details, and is not limited to the exemplary embodiment disclosed herein.

**[0023]** Fig. 2 shows a schematic drawing of a modular turbine vane design suitable for the present invention. The vane 20 comprises an airfoil 18, an upper platform or shroud 19a and a lower platform 19b, which are separately manufactured by means of molding, or the like, are then put together, and finally joined by means of brazing, welding or a special retainer connection or joint as disclosed in document US 5,797,725 A in Fig. 5 and 6, and col. 5 and 6 of the respective description. The separate manufacture so as to require joining defines the vane as a modular turbine vane.

**[0024]** The airfoil 18, which extends out from the essentially planar surface of the platform(s) comprises a main airfoil body (18a in Fig. 3-5) made of the first material, and one or more inserts/inlays made of a second, special material, which is/are suitable for high-tempera-

ture applications with reduced cooling air consumption compared to conventional vane/blade constructions. The inserts/inlays are integrally joined with the main airfoil body, for example by means of brazing.

**[0025]** In this specification, essentially planar surface is defined as a surface with contours typical of the surface of a platform of a blade/vane. Blade/vane surfaces typically range from planar to contoured surface. An example of a contoured platform surface is provided in U.S. Patent Application No US2010/0143139 A1.

**[0026]** For a given insert/inlay 21 a-c has as many runouts 23a-c as platforms, wherein a runout 23a-c is defined as a distal end of the insert/inlay 21 a-c that is closest to a platform. For example, in an embodiment have two platforms as shown in Fig. 2, the insert/inlay 21 a-c has two runouts 23a-c.

**[0027]** The runout 23a-c of exemplary embodiments are located in regions of low mechanical stress within said vane/blade, for example, by locating the runout 23a-c either below the essentially planar surface the platform 19a,b as shown in Figs 3, 4 and 5 or having the runout 23 b,c located above the essentially planar surface of the platform 19a,b. In this context, the essentially planar surface of the platform a,b is the reference point from which above and below are defined, wherein the direction of extension of the airfoil 11 is referred to as "above" while the direction into the platform 19 a,b, including through the platform 19a,b is referred to as "below". Examples of runouts located below the essential plant surface as shown in Figs 3,4 and 5.

**[0028]** Fig. 3 shows a side view (Fig. 3a) and a top view (Fig. 3b) of a vane 20a according to an embodiment of the invention. In this case, an inlay/insert 21 a, which is joined with a main airfoil body 18a by means of joint 22, makes up the leading edge of the airfoil. The joint 22 is therefore established between the lower platform 19b and the inlay/insert 21 a, so that the lower runout 23a of the inlay/insert 21 lies well below the essentially planar (upper) surface of the lower platform 19b.

**[0029]** Fig. 4 shows a side view (Fig. 4a) and a top view (Fig. 4b) of a vane 20b according to another embodiment of the invention. In this case, an inlay/insert 21 b covers the main airfoil body 18a at the leading edge. "Covers", in this context, means compromises only a portion of the wall thickness of the airfoil as opposed to a complete wall portion that makes up the complete wall thickness of at least a portion of the airfoil. In this case a joint 22 is established between the lower platform 19b and the main airfoil body 18a. However, the inlay/insert 21 b extends with its lower runout 23b well into the groove above said joint 22, so that again the runout is placed well below the platform's essentially planar surface.

**[0030]** Fig. 5 shows a side view (Fig. 5a) and a top view (Fig. 5b) of a vane 20c according to a further embodiment of the invention. In this case, again, an inlay/insert 21 c, which is joined with the main airfoil body 18a by means of joint 22, makes up the leading edge of the airfoil so as to be a complete wall portion of the airfoil. Different to

the embodiment of Fig. 3, the inlay/insert 21 c does not take part in the joint 22, but ends above joint 22, but with its runout 23c extending into the groove and in this way well below the platform's essentially planar surface, so that this embodiment can be considered a combination of the embodiments of Fig. 3 and 4.

**[0031]** Although the disclosure has been herein shown and described in what is conceived to be the most practical exemplary embodiments, the present disclosure can be embodied in other specific forms. The presently disclosed embodiments are therefore considered in all respects to be illustrative and not restrictive. The scope of the disclosure is indicated by the appended claims rather than the foregoing description and all changes that come within the meaning and range and equivalences thereof are intended to be embraced therein.

#### LIST OF REFERENCE NUMERALS

##### **[0032]**

|             |                       |
|-------------|-----------------------|
| 10,20,20a-c | turbine blade/vane    |
| 11          | airfoil               |
| 12          | blade tip             |
| 13          | leading edge          |
| 14          | buffer layer          |
| 15          | trailing edge         |
| 16          | platform              |
| 17          | root                  |
| 18          | airfoil               |
| 18a         | (main) airfoil body   |
| 19a         | upper platform        |
| 19b         | lower platform        |
| 21 a-c      | inlay/insert          |
| 22          | joint                 |
| 23a-c       | runout (inlay/insert) |

#### Claims

1. A modular vane/blade (10, 20a-c) for a gas turbine which comprises the modular components of:

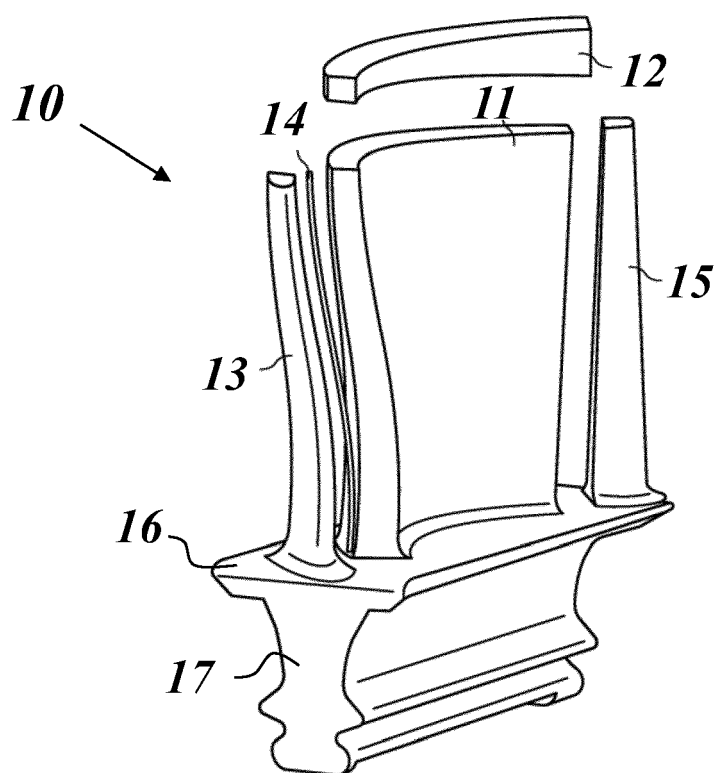
a platform (19a,b) with a essentially planar surface; and  
an airfoil, extending out from the essentially planar surface, having:

a basic element (18a) made of a first material;  
at least one insert/inlay (21 a-c) that forms an outer surface portion of the basic element; and  
a first joint that integrally joins said basic element (18a) to said insert/inlay (21 a-c), wherein the insert/inlay (21 a-c) is made of a second material and has a runout (23a-c) that defines an end nearest the

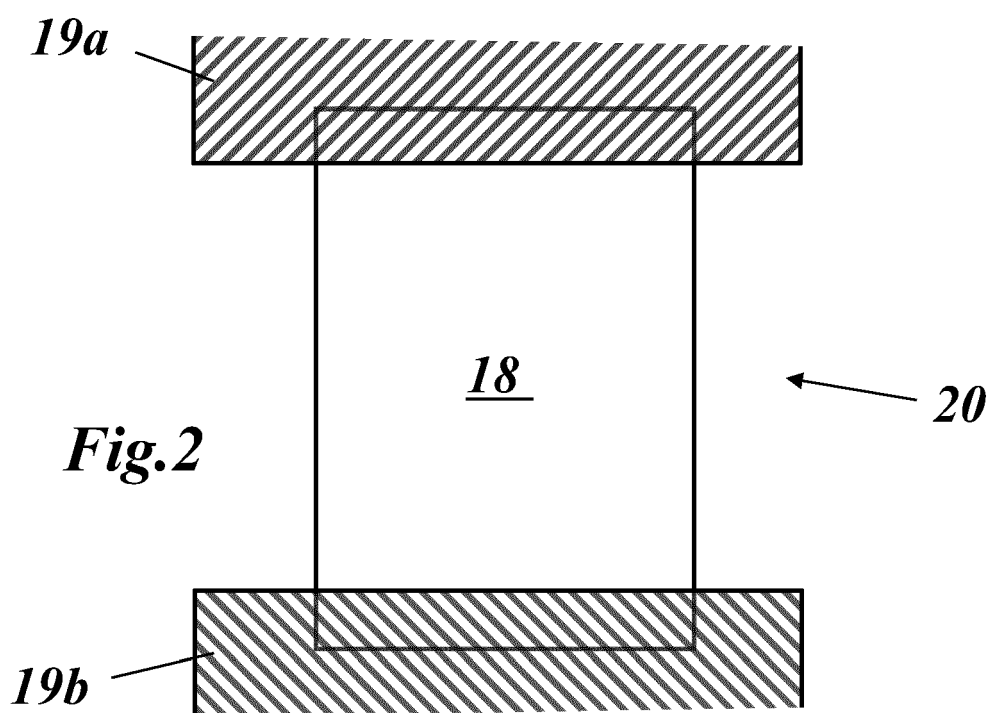
essentially planar surface,

**characterized in that** said at least one runout (23a-c) is located either below or above the essentially planar surface.

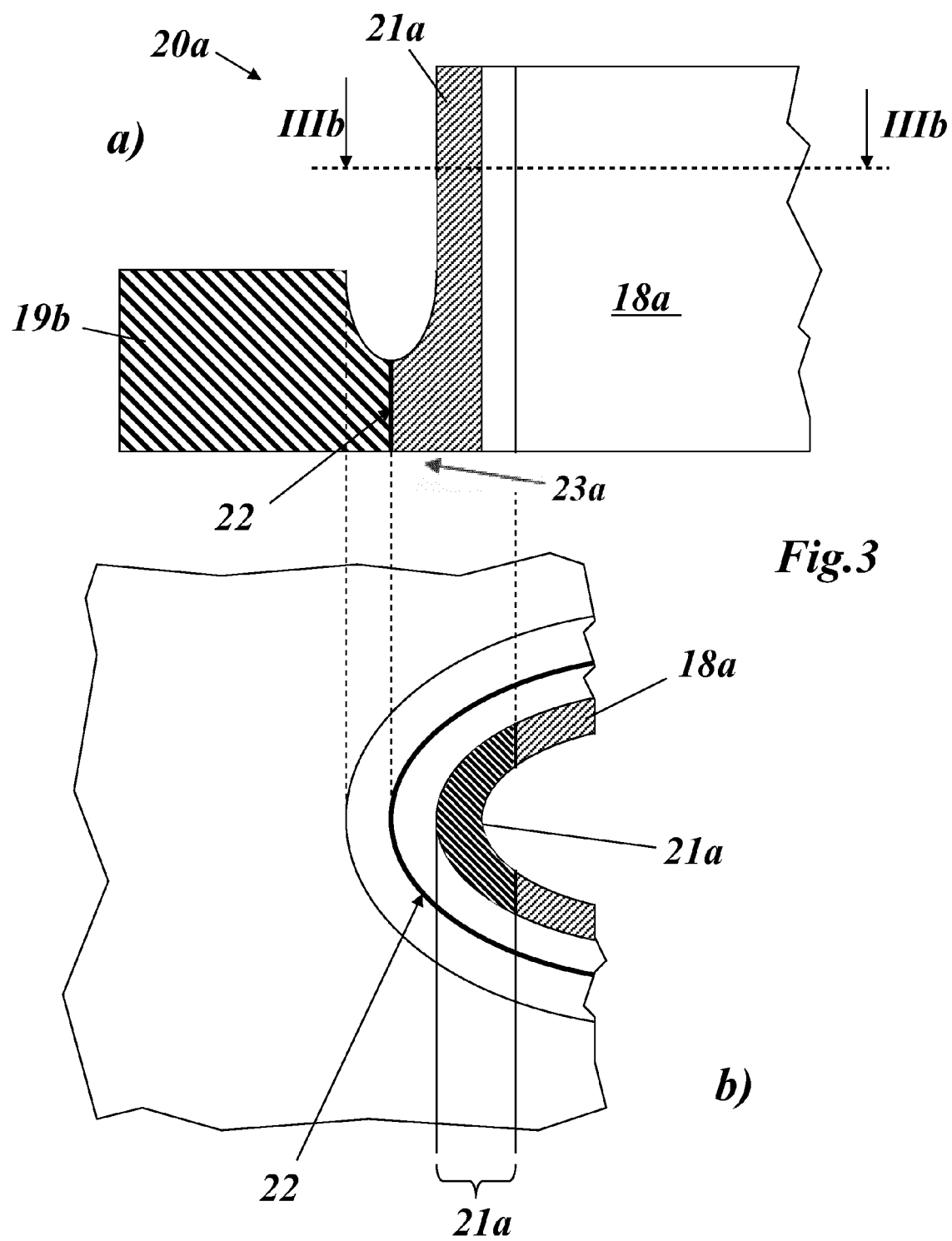
2. The modular vane/blade (10, 20b-c) of claim 1 wherein the runout (23) is located above the essentially planar surface.
3. The modular vane/blade (10, 20a-c) of claim 1 wherein the runout (23a-c) is located radially below the essentially planar surface.
4. The modular vane/blade (10, 20a) of claim 3 further comprising a second joint (22) that joins the insert/inlay (21 a) to the platform (19a,b).
5. The modular vane/blade (10, 20a) of claim 4 wherein said second joint (22) is a welded joint.
6. The vane/blade (10, 20a) of claim 4 wherein said second joint (22) is a brazed joint.
7. The vane/blade (10, 20a) of claim 4 wherein said second joint (22) is a retainer joint.
8. The modular vane/blade (10, 20a-c) of any one of claims 1 to 7 wherein the insert/inlay (21 a-c) covers a portion of the basic element (18a).
9. The modular vane/blade (10, 20a-c) of any one of claims 1 to 7 wherein airfoil has a wall and the insert/inlay (21 a-c) is a complete wall portion of the wall.
10. A gas turbine with a modular vane/blade, wherein said modular vane/blade is a vane/blade according to one of the claims 1-9.

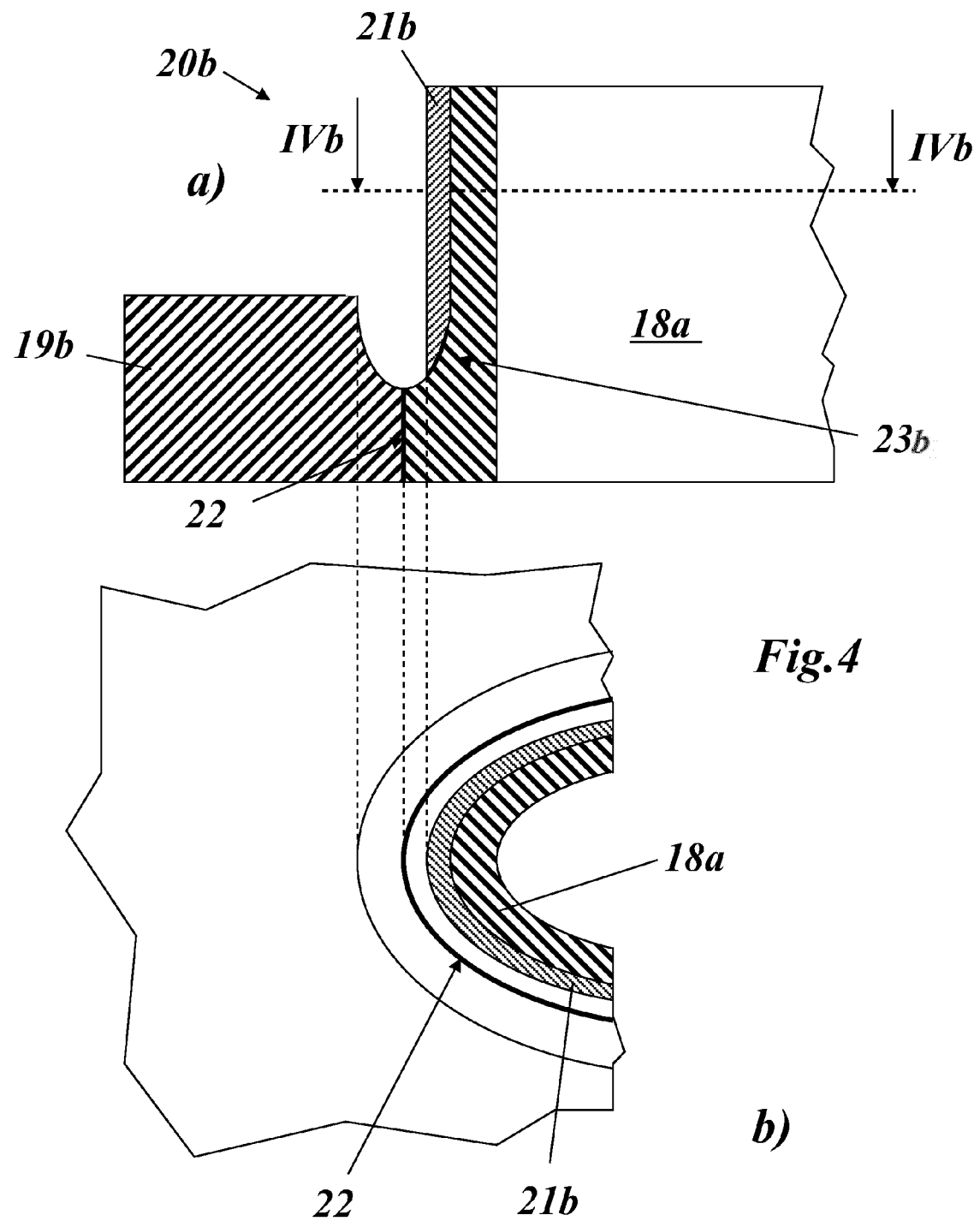


**Fig.1**  
**Prior Art**

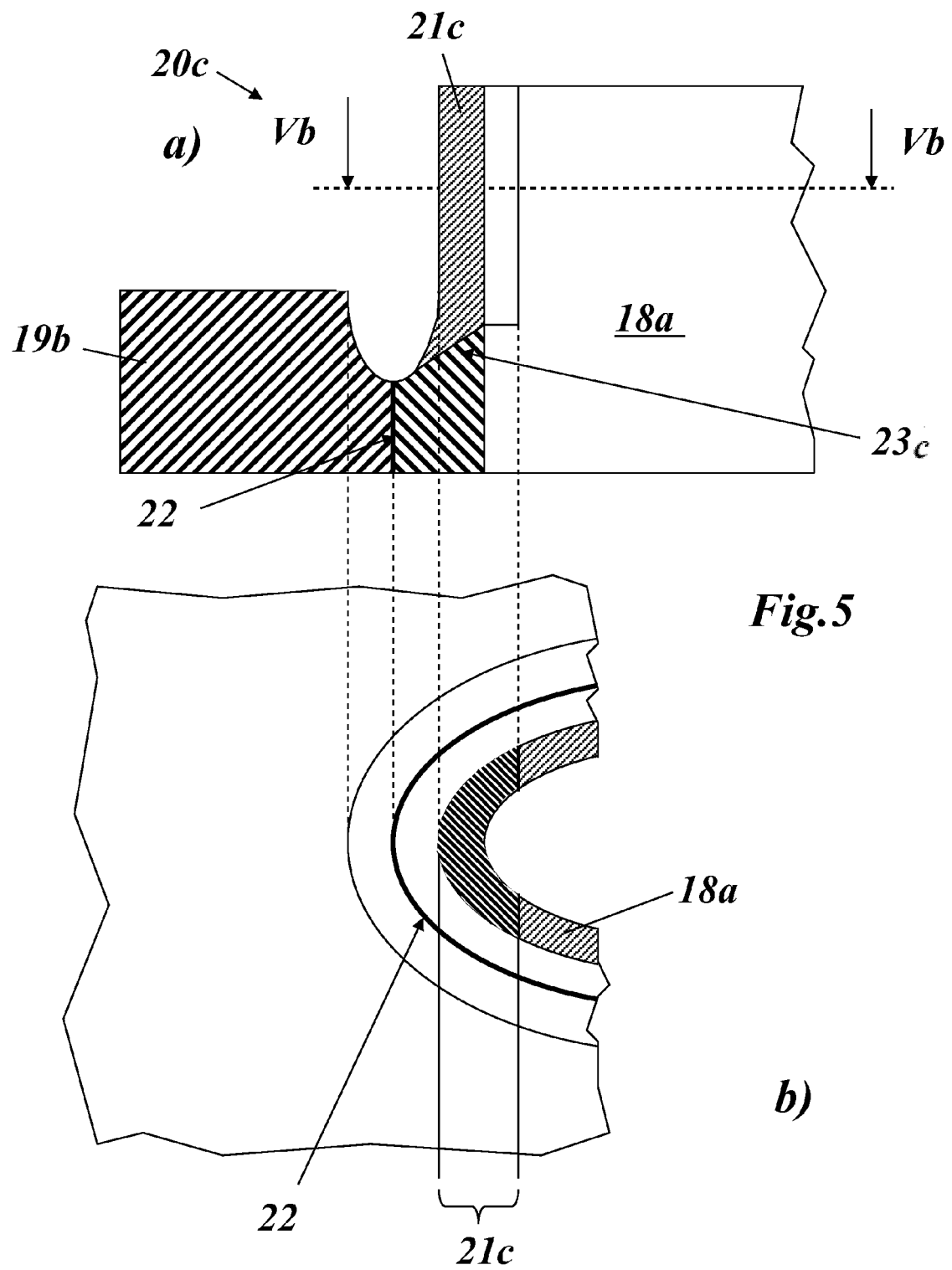


**Fig.2**





**Fig.4**







## EUROPEAN SEARCH REPORT

Application Number  
EP 12 17 6275

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                              |                                                     |                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Citation of document with indication, where appropriate, of relevant passages                                                                | Relevant to claim                                   | CLASSIFICATION OF THE APPLICATION (IPC) |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 4 650 399 A (CRAIG HAROLD M [US] ET AL) 17 March 1987 (1987-03-17)                                                                        | 1,3,4,7,9,10                                        | INV.<br>F01D5/14                        |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | * column 6, line 5 - column 8, line 33; figures 2,3,5,6 *                                                                                    | 2                                                   |                                         |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 2006/228211 A1 (VANCE STEVEN J [US] ET AL) 12 October 2006 (2006-10-12)<br>* page 3, paragraph 41 - page 4, paragraph 48; figures 3,4,7 * | 1,3-8,10                                            |                                         |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 2010/080687 A1 (VANCE STEVEN J [US]) 1 April 2010 (2010-04-01)<br>* page 1, column 8 - page 3, paragraph 30 *                             | 1,3,4,7,8,10                                        |                                         |
| X,D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | EP 2 189 626 A1 (ALSTOM TECHNOLOGY LTD [CH]) 26 May 2010 (2010-05-26)<br>* page 6, paragraph 36 - page 7, paragraph 40; figures 4-6 *        | 1,3,8,10                                            |                                         |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | EP 2 362 067 A2 (UNITED TECHNOLOGIES CORP [US]) 31 August 2011 (2011-08-31)<br>* column 5, paragraph 27 - column 7, paragraph 33; figure 2 * | 2                                                   | TECHNICAL FIELDS SEARCHED (IPC)<br>F01D |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                              |                                                     |                                         |
| Place of search<br>Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                              | Date of completion of the search<br>23 January 2013 | Examiner<br>Rau, Guido                  |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                              |                                                     |                                         |

 1  
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 17 6275

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-01-2013

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                       | Publication<br>date                                  |
|-------------------------------------------|---------------------|------------------------------------------------------------------|------------------------------------------------------|
| US 4650399 A                              | 17-03-1987          | NONE                                                             |                                                      |
| US 2006228211 A1                          | 12-10-2006          | NONE                                                             |                                                      |
| US 2010080687 A1                          | 01-04-2010          | NONE                                                             |                                                      |
| EP 2189626 A1                             | 26-05-2010          | AT 540197 T<br>CH 700001 A1<br>EP 2189626 A1<br>US 2010124502 A1 | 15-01-2012<br>31-05-2010<br>26-05-2010<br>20-05-2010 |
| EP 2362067 A2                             | 31-08-2011          | EP 2362067 A2<br>SG 173944 A1<br>US 2011211967 A1                | 31-08-2011<br>29-09-2011<br>01-09-2011               |

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- US 5348446 A [0003]
- WO 2011058043 A1 [0003] [0021]
- US 201012450 A1 [0005]
- EP 2189626 A1 [0005]
- US 5797725 A [0019] [0023]
- US 20100143139 A1 [0025]