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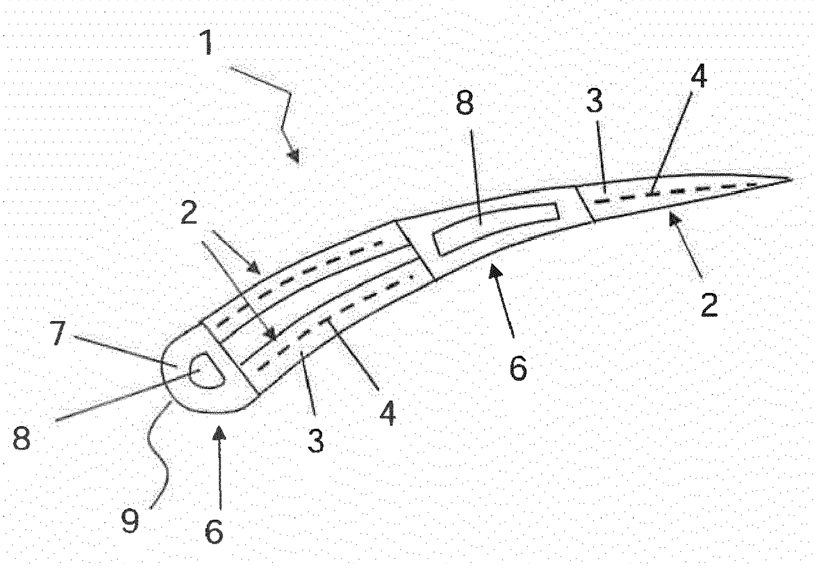
(54) **COMPOSITE COMPONENT AND METHOD FOR MANUFACTURING THE SAME**

(57) The composite component (1) for a gas turbine comprises first parts (2) made out of a metal matrix (3) reinforced with carbon fibres (4) joined to second parts (6) made out of metal (7) without carbon fibres. The second parts (6) can comprise cooling elements (8).

Fig. 1



Description

TECHNICAL FIELD

[0001] The present invention relates to a composite component and a method for manufacturing the same. In particular the composite component is used in a gas turbine; for example the composite component is a compressor blade or vane or a turbine blade or vane for a gas turbine.

BACKGROUND

[0002] Metal matrix composite materials have metal or ceramic reinforcing fibers embedded in a metal matrix; metal matrix composite materials have high strength and, compared to non-metal matrix composite materials, they can typically operate in a wider range of temperatures, do not absorb moisture, have better electrical and thermal conductivity, are less sensitive to stress concentration, for example due to notching effects or impacts of foreign objects. Metal matrix composite materials have a lower density and higher specific strength than non-metal matrix composite materials, thus they allow light weight construction. US 2013/0 259 701 A1 discloses a reinforcing edge of a turbomachine blade having a reinforcing structure of three-dimensionally woven ceramic fibers and a metal or metal alloy matrix.

[0003] Non-metal matrix composite materials are also known, like carbon fiber composites such as carbon-fiber-reinforced carbon (CFRC); these non-metal matrix composite materials can withstand high temperatures but they cannot be exposed to an oxidizing atmosphere at high temperatures, are sensitive to impact damages, their life time or failure is difficult to predict and current inspection technologies do not allow a prediction of the remaining life time.

[0004] The inventors of the present description have found a way to combine the advantages of the metal matrix composite materials with those of the non-metal matrix composite materials.

SUMMARY

[0005] An aspect of the invention includes providing a composite component that is able to operate at high temperatures also in oxidizing atmosphere and at the same time has a reduced sensitiveness to stress concentration, such as notching effects or impacts of foreign objects.

[0006] For example, the composite component combines the impact resistant properties and crack initiation inspection and detection of the metal matrix composite materials with the light weight and temperature resistant fibres of the non-metal matrix composite materials.

[0007] These and further aspects are attained by providing a composite component and a method for manufacturing the same in accordance with the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Further characteristics and advantages will be more apparent from the description of a preferred but non-exclusive embodiment of the composite component and method, illustrated by way of non-limiting example in the accompanying drawings, in which:

Figure 1 shows an embodiment of the composite component;
Figures 2 through 3 show a first embodiment of the method;
Figures 4 through 8 show a second embodiment of the method;
Figures 9 through 12 show a third embodiment of the method;
Figures 13 through 14 show the SLM manufacturing in the area of the fibres.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0009] With reference to the figures, these show a composite component 1 for a gas turbine. The composite component can be a compressor blade or vane or a turbine blade or vane; other components are possible, such as heat shields, etc..

[0010] The component 1 comprises at least a first part 2 made out of a metal matrix 3 reinforced with carbon fibres 4; the at least a first part 2 is joined to at least a second part 6 made out of metal 7 without reinforcing carbon fibres.

[0011] The metal of the metal matrix 3 of the first part 2 can be different from the metal 7 of the second part 6. In this case the metal of the first and second parts 2, 6 can be selected according to the properties desired, such as weight, erosion resistance, corrosion or oxidation resistance, etc.

[0012] Alternatively, the metal of the metal matrix 3 of the first part 2 can be the same as the metal 7 of the second part 6. This solution can be preferred if the manufacturing process so requires or in case the first and second parts 2, 6 require metal having the same properties.

[0013] Components exposed to high temperature gases of a gas turbine (e.g. compressor or turbine blades or vanes) often require large amounts of cooling air, to control their temperature. Components made out of traditional metal matrix composite materials cannot be provided with cooling systems (at the current state of the art), therefore the application of traditional metal matrix composite materials in gas turbine components is limited due to the maximum temperature the metal matrix can withstand.

[0014] Advantageously, in order to improve cooling of the component 1, one or more second parts 6 (in case the component 1 is provided with more than one second part, like in the example shown in figure 1) can comprise at least a cooling element 8.

[0015] The cooling element 8 is preferably a channel, which can carry a cooling fluid, such as air.

[0016] As shown in figure 1, the turbine or compressor blade or vane has a nose 9 that is defined by a second part 6 and opposite sides that are defined by first parts 2. An intermediate section of the component 1 can be defined by an additional second part 6 and the terminal part with the trailing edge can be defined by a first part 2, e.g. to be able to manufacture a thin but at the same time strong trailing edge.

[0017] Advantageously, during operation the composite component 1 can withstand high temperatures, because the first parts 2 include fibres able to withstand high stress also at high temperature. In addition these first parts can be cooled by the second parts that are provided with the cooling elements 8.

[0018] In order to manufacture the composite component described above different embodiments of the method are possible.

[0019] A first embodiment of the method for manufacturing the composite component comprises (figures 2 through 3):

manufacturing at least a first part 2 and a second part 6, then
joining the at least a first part 2 and second part 6.

[0020] Manufacturing of the first and second parts 2, 6 according to this embodiment of the method occurs separately, i.e. the first parts 2 are manufactured separately from the second parts 6; this allows to advantageously select the best method for manufacturing each part 2 or 6, according to the required features thereof. For example possible manufacturing methods for the first and/or second parts are casting, additive manufacturing such as SLM (selective laser melting), machining, spray deposition, etc.

[0021] Joining the first part 2 to the second part 6 comprises laser welding or laser deposition welding.

[0022] For example three first parts 2 are manufactured by casting or SLM or spray deposition of metal on the carbon fibres. Separately two second parts 6 are casted or are manufactured by SLM or are manufactured by spray deposition. The first parts 2 and second parts 6 are then welded together (reference 10 identifies the welding).

[0023] A second embodiment of the method for manufacturing the composite component comprises:

manufacturing the first parts 2,
providing the first parts 2 in a mold 11,
providing metal into the mold 11 to cast the second parts 6 joined to the first parts 2.

[0024] Advantageously, this method allows manufacturing of first parts 2 whose features (e.g. material or geometrical features or manufacturing method or mechanical/thermal treatments) are independent from those of the second parts 6, because the first parts 2 are built before and thus independently of the second parts 6.

[0025] In addition, when the first parts 2 are manufactured, they can be provided with fibres that protrude from them (figure 5), such that when the first parts 2 are housed in the mold 11 and the second parts 6 are casted, the protruding fibres promote holding of the first parts 2 to the second parts 6.

[0026] For example, three first parts 2 are manufactured first, e.g. by casting, additive manufacturing such as SLM (selective laser melting), spray deposition, machining, etc.. Then these first parts 2 are housed in the mold 11 where metal is introduced to manufacture also the second parts 6 directly joined to the first parts 2.

[0027] The cooling elements 8 can be made during casting of the second part 6; alternatively or in addition, the cooling elements 8 can be realized e.g. by machining or in other ways after casting of the second parts 6.

[0028] A third embodiment of the method for manufacturing the composite component 1 comprises:

providing at least a prefabricate structure 16 made of fibres 4 joined at points 17,
providing the structure 16 into a mold 11,
providing a metal into the mold 11 to simultaneously cast the first parts 2 and the second parts 6; these first parts 2 and second parts 6 are in this way realized already joined.

[0029] Bonding of the first part 2 to the second parts 6 is in this embodiment particularly effective, because all parts 2, 6 are made at the same time in the mold 11. In addition, the fibre structure 16 makes it easier and faster handling of the fibres.

[0030] The structure 16 can e.g. be realized by connecting the fibres with metal, such as by laser deposition welding. Other methods can anyhow be used.

[0031] A fourth embodiment of the method for manufacturing the composite component comprises:

providing metal powder,
providing fibres 4,
simultaneously manufacturing the first parts 2 and the second parts 4 by local laser melting technology, such as SLM or direct laser melting,

[0032] This embodiment of the method allows manufacturing of complex three dimensional shapes with high tensile strength. In addition, the design of the first parts 2 can be easily optimized as load carrying sections and the design of the second parts 6 can be easily optimized in view of the required cooling.

[0033] Advantageously, in order to carry out the SLM process, the powder can be deposited by electrostatic deposition, this allows to easily fill in gaps between fibres and to also build in vertical or inclined or downwards direction.

[0034] Advantageously, with direct laser melting, powder deposition along different directions is possible in order to allow deposition between adjacent fibres.

[0035] When in any of the methods above the component is realized by SLM (with metal powder deposited by electrostatic deposition or in other ways), in order to correctly melt the metal powder also below the fibres (with reference to the manufacturing of the first parts 2), the angle A of the laser beam 18 with the support plane 19 of the fibres is between 10-90 degree and preferably between 30-70 degree, with a thickness of the metal powder layer h less than 0.5 times the diameter D of the fibres and preferably the thickness of the metal powder layer is less than 0.3 times the diameter D of the fibres. The distance d between the fibres is greater than 0.6 times the diameter D of the fibres and preferably 0.8 times and is less than 2 times the diameter D of the fibres and preferably 1.2 times. The diameter DL of the laser beam is greater than 1.1 times the diameter D of the fibres and preferably it is 1.5 times greater than the diameter D, such that the laser beam heats the fibres and extends beyond their sides to melt the metal powder.

[0036] According to the present description the advantages of an impact resistant metal matrix are combined with light weight temperature resistant fibers. Further, the surface of the metal matrix allows inspection and detection of crack initiation. E.g. the leading edge can be defined by a first part 2 (to allow for intense cooling via the cooling element 8) and the trailing edge can be defined by a second part 6, to be able to provide a strong, thin trailing edge.

[0037] Naturally the features described may be independently provided from one another. For example, the features of each of the attached claims can be applied independently of the features of the other claims.

[0038] In practice the materials used and the dimensions can be chosen at will according to requirements and to the state of the art.

Claims

1. A composite component (1) for a gas turbine, **characterized by** comprising at least a first part (2) made out of a metal matrix (3) reinforced with carbon fibres (4), the at least a first part being joined to at least a second part (6) made out of metal (7) without carbon fibres.

2. The composite component (1) of claim 1, **characterized in that** the metal of the metal matrix (3) of the at least a first part (2) is different from the metal (7) of the at least a second part (6).

3. The composite component (1) of claim 1, **characterized in that** the metal of the metal matrix (3) of the at least a first part (2) is the same as the metal (7) of the at least a second part (6).

4. The composite component (1) of any of claims 1-3, **characterized in that** the at least a second part (6) comprises at least a cooling element (8).

5. The composite component (1) of claim 4, **characterized in that** the at least a cooling element (8) comprises a channel.

6. The composite component (1) of any of claims 1-5, **characterized in that** it is a turbine or compressor blade or vane.

7. The composite component (1) of claim 6, **characterized in that** the turbine or compressor blade or vane has a nose (9), wherein a second part (6) defines the nose (9).

8. The composite component (1) of claim 6, **characterized in that** opposite sides of the turbine or compressor blade or vane are defined by first parts (2).

9. Method for manufacturing a composite component (1) according to any of claims 1-8 comprising:

   manufacturing at least a first part (2) and a second part (6), then joining the at least a first part (2) and second part (6).

10. The method of claim 9, **characterized in that** joining comprises laser welding or laser deposition welding.

11. Method for manufacturing a composite component (1) according to any of claims 1-8 comprising:

   manufacturing at least a first part (2),
   providing the at least a first part (2) in a mold (11),
   providing metal into the mold (11) to cast at least a second part (6) joined to the at least a first part (2).

12. Method for manufacturing a composite component according to any of claims 1-8 comprising:

   providing at least a prefabricate structure (16) made of fibres (4),
   providing the structure (16) into a mold (11),
   providing a metal into the mold (11) to simultaneously cast at least a first part (2) and at least a second part (6).

13. Method for manufacturing a composite component according to any of claims 1-8 comprising:

   providing metal powder,
   providing carbon fibres (4),
   simultaneously manufacturing the first part (2) and the second part (6) by local laser melting technology, such as SLM or direct laser melting.

14. The method of claim 13, **characterized in that** in order to carry out the SLM process, the powder is deposited by electrostatic deposition.

Fig. 1

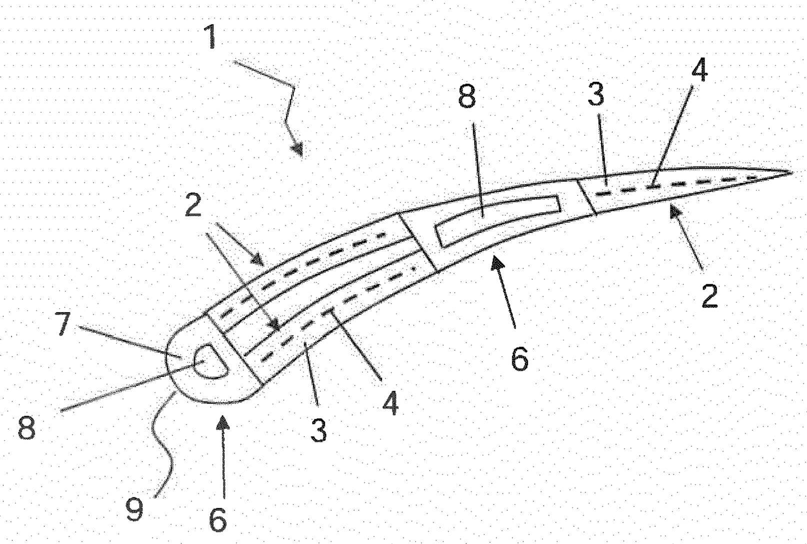


Fig. 2

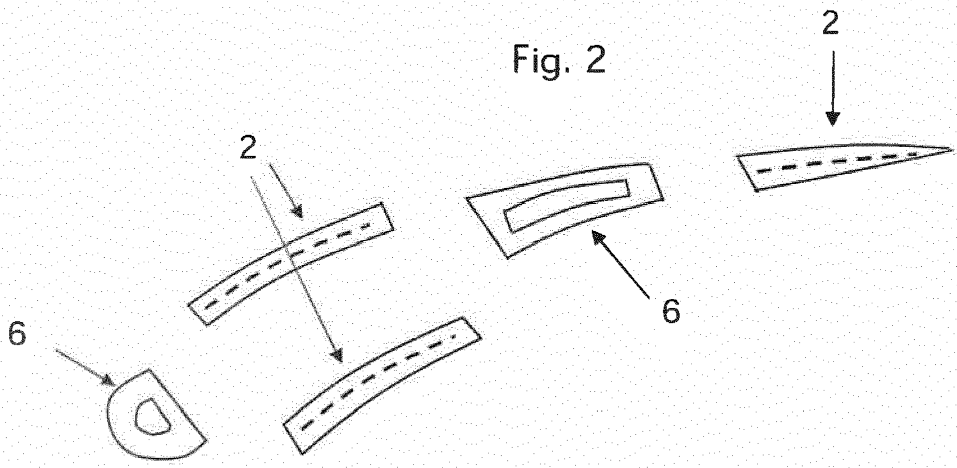
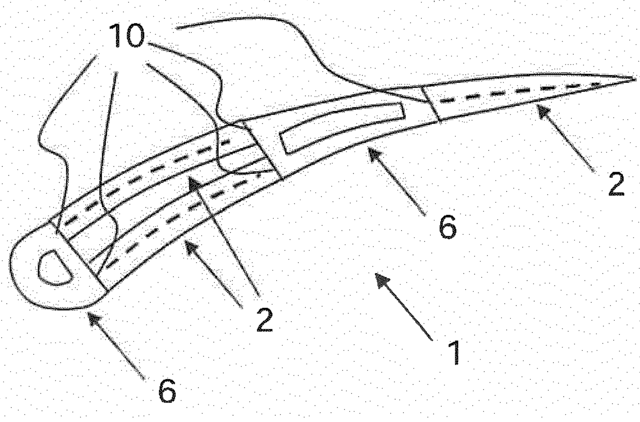


Fig. 3



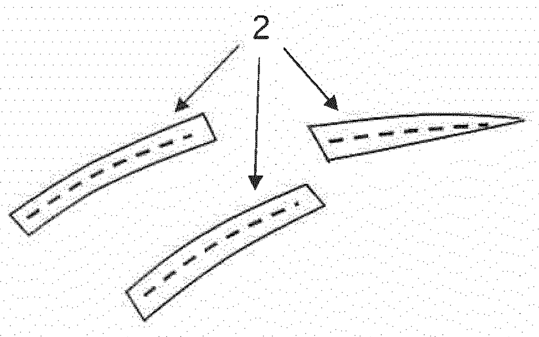


Fig. 4

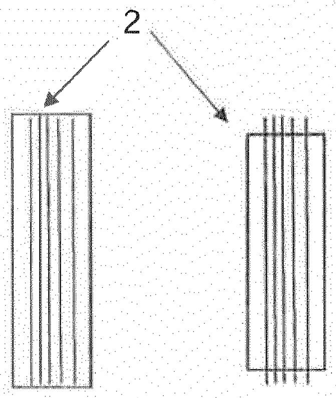


Fig. 5

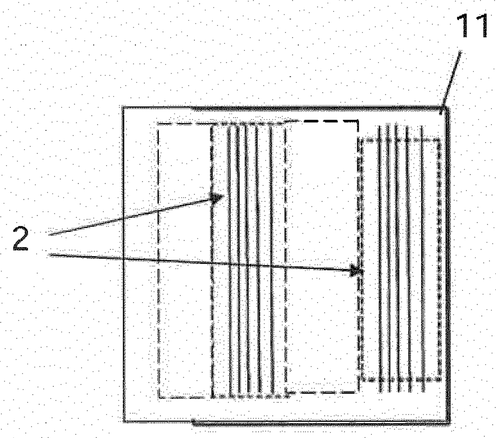


Fig. 6

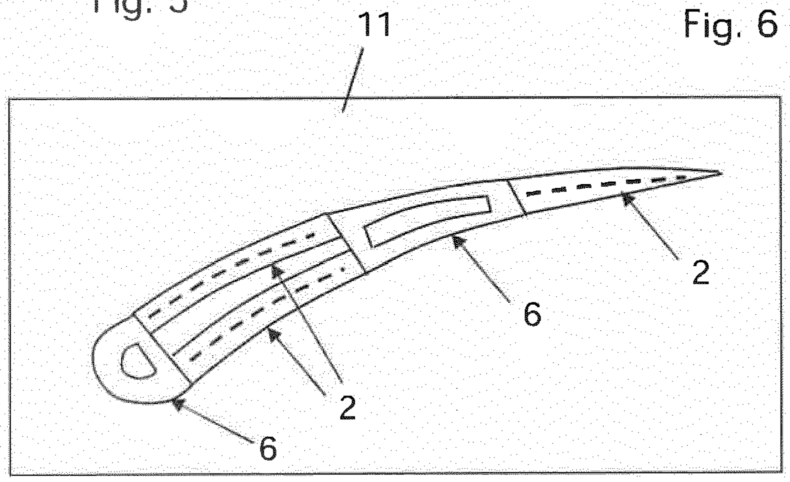


Fig. 7

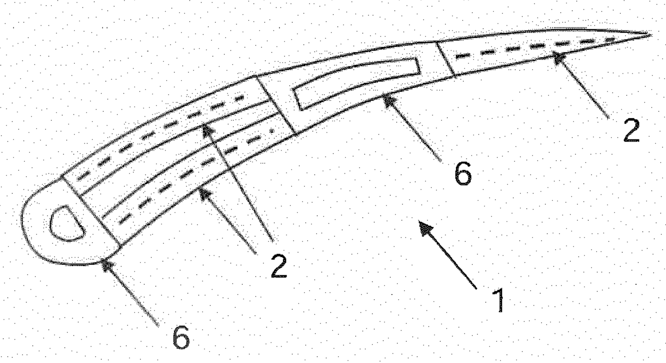


Fig. 8

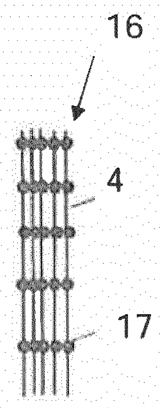


Fig. 9

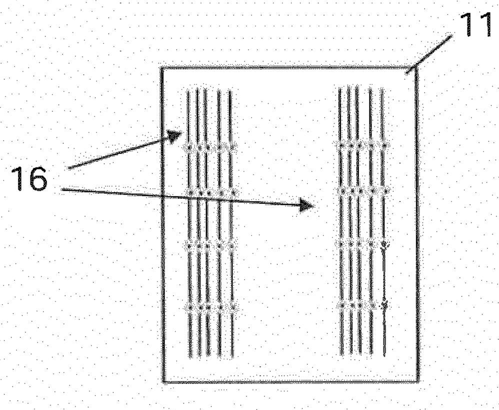


Fig. 10

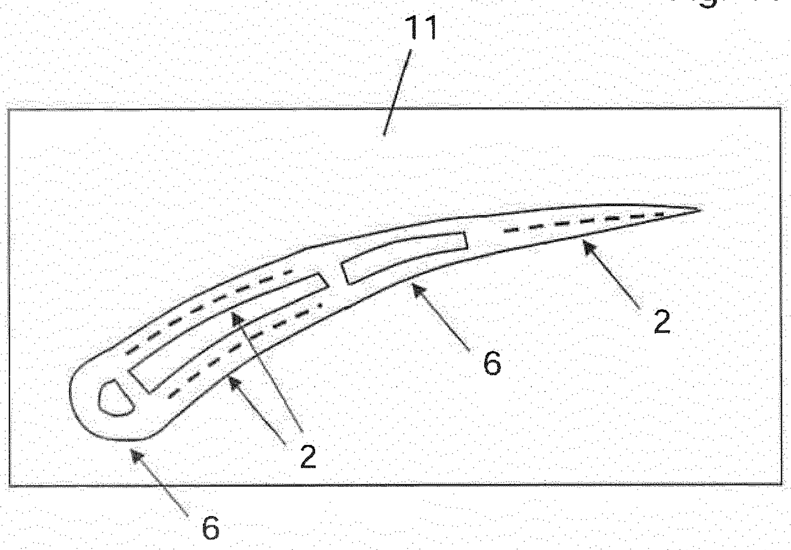


Fig. 11

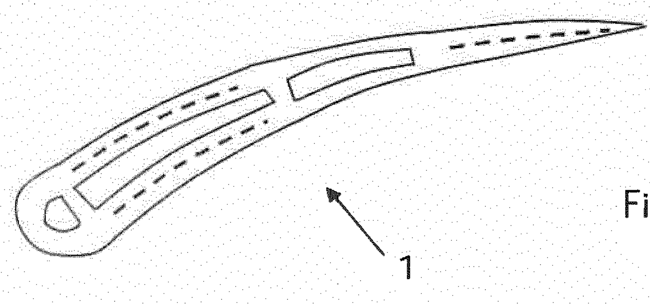


Fig. 12

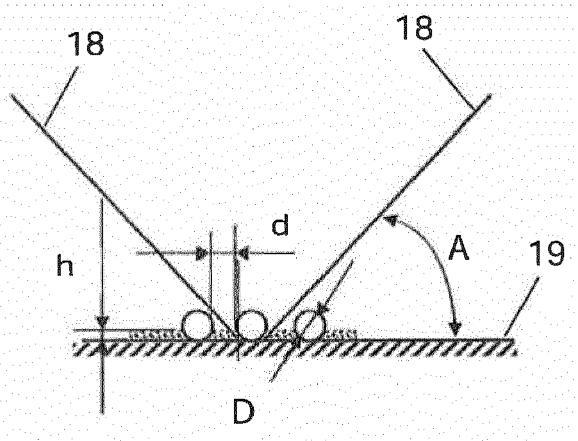


Fig. 13

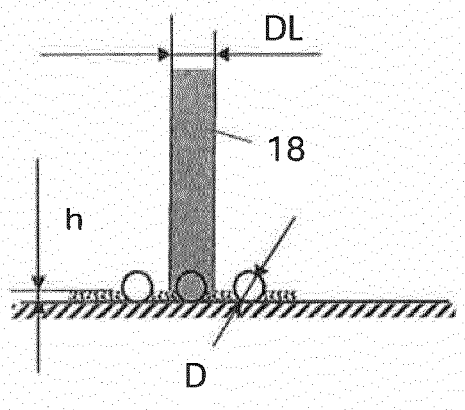


Fig. 14

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 5758

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 A	EP 2 474 638 A2 (GEN ELECTRIC [US]) 11 July 2012 (2012-07-11) * paragraphs [0010] - [0032] * * figures 1-8 *	1,3,6-8, 11,12 2,4,5,9, 10,13,14	INV. F01D5/14 F01D5/28
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X	EP 1 920 869 A1 (GEN ELECTRIC [US]) 14 May 2008 (2008-05-14) * paragraphs [0017] - [0025] * * figures 1-5 *	1,2,4-7, 9,10	

TECHNICAL FIELDS SEARCHED (IPC)

F01D
F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	1 June 2018	de la Loma, Andrés

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CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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