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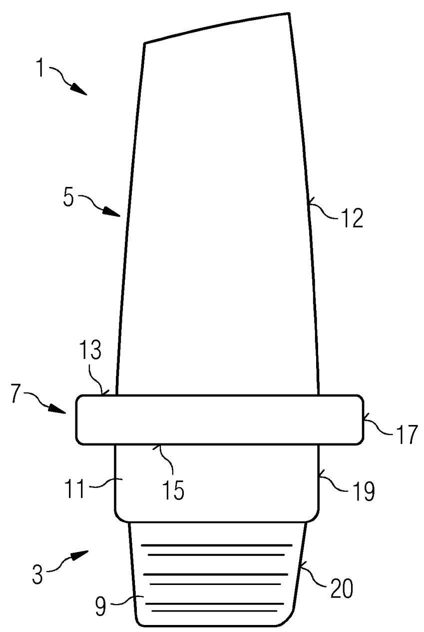
(54) **Coated turbine component and method of forming a coating on a turbine component**

(57) A coated turbine component and a method of forming a coating on a turbine component (1) are provided. The method comprises:
- a plating step in which at least one selected portion (12, 13) of the component (1) is plated with platinum;
- a chromising step in which at least a portion (12, 13, 15, 17, 19) of the component (1) is chromised where said portion (12, 13, 15, 17, 19) includes said at least one selected portion (12, 13); and
- an aluminising step in which at least one portion (12, 13, 15, 17, 19) of the component (1) is aluminised where the at least one portion (12, 13, 15, 17, 19) which is aluminised includes the at least one portion (12, 13, 15, 17, 19) which has been chromised.

FIG 1



EP 2 937 438 A1

Description

[0001] The present invention relates to coated turbine components such as, in particular, coated turbine blades and vanes. In addition, the invention relates to a method of forming a coating on turbine components, in particular on turbine blades and vanes.

[0002] Gas turbine components such as, for example, gas turbine blades and vanes are exposed to severe environmental conditions due to the hot and the corrosive combustion gases which form the working medium of a gas turbine. The environmental conditions thus require turbine blades and vanes made of heat resistant superalloys such as nickel-based superalloys and cobalt-based superalloys. However, even such superalloys experience corrosion damage and oxidation damage caused by the hot and corrosive combustion gases.

[0003] To protect the surfaces of the turbine blades and vanes from corrosion and/or oxidation attack blades and vanes are typically provided with a corrosion and/or oxidation resistant coating in order to slow down corrosion and/or oxidation attack thus prolonging the operating time to a refurbishment or a replacement of the respective component. Often used corrosion and/or oxidation resistant coatings are chromium diffusion coatings, aluminide diffusion coatings and chromium aluminide diffusion coatings as, for example, described in US 2009/0185912 A1 and US 8,277,195 B2.

[0004] Since refurbishment, and even more so replacement, of gas turbine blades and vanes or other gas turbine components entails considerable costs not only due to the actual refurbishment or replacement process but also due to stand still of the gas turbine one aims to prolonging intervals between refurbishment or replacement. Hence, it is always a desire to improve the corrosion and/or oxidation resistant coating to achieve this aim.

[0005] In view of the above mentioned state of the art it is a first objective of the present invention to provide a method of forming an advantageous coating on a turbine component. A second objective of the present invention is to provide an advantageous coated turbine component.

[0006] The first objective is achieved by a method of forming a coating on a turbine component, as claimed in claim 1. The second objective is achieved by a turbine component as claimed in claim 11. The depending claims contain further developments of the invention.

[0007] The inventive method of forming a coating on a turbine component comprises:

- a plating step in which at least one selected portion of the component is plated with platinum (Pt);
- a chromising step in which at least a portion of the component is chromised where said portion includes said at least one selected portion; and
- an aluminising step in which at least a portion of the component is aluminised where the portion which is aluminised includes the portion which is chromised in the chromising step.

[0008] In particular, the at least one portion of the component which is aluminised may be identical to the portion which is chromised. Please note that the plating step and the chromising step may be performed in either order, i.e. the plating step may be performed after the chromising step or before the chromising step, so that the portion of the component which is chromised includes the selected portion(s) which has/have already been plated with platinum in a preceding step or will be plated with platinum in a subsequent step.

[0009] It has been found that the addition of the noble metal platinum to a chromium aluminide diffusion coating significantly improves the oxidation and corrosion resistance of the coating as compared to a chromium aluminide diffusion coating without platinum.

[0010] A further enhancement of the coating may be achieved by introducing silicon (Si) and/or hafnium (Hf) and/or yttrium (Y) into the coating. The introduction of Si and/or Hf and/or Y may be done during either of the chromising step, the aluminising step and the plating step. However, it is also possible to introduce Si and/or Hf and/or Y into the coating during two of the mentioned steps or even during all three of these steps.

[0011] The inventive method may, in particular, be used for coating a turbine blade or vane including an airfoil section with an airfoil surface, a root section with a root surface and a platform section being located between the airfoil section and the root section and having a platform surface including a platform surface portion showing towards the airfoil section. In this case, the at least one selected portion which is plated in the plating step includes at least the airfoil surface and the platform surface portion showing towards the airfoil section. By introducing Pt into the airfoil surface and the platform surface portion showing towards the airfoil section the coating on those surfaces which are in direct contact with the hot and corrosive combustion gases is modified with platinum and, hence, shows improved oxidation and corrosion resistance.

[0012] The at least one portion which is chromised in the chromising step may include the airfoil surface, the platform surface and at least a portion of the root surface. By this measure, also parts of those surfaces which are not directly exposed to the hot and corrosive combustion gases but which may nevertheless experience some corrosion and/or oxidation due to hot temperatures are protected by a cheaper coating.

[0013] An inventive turbine component is coated with a coating and includes at least one selected portion in which the coating is a chromium aluminide coating that is modified with platinum. The inventive turbine component thus comprises a coating with improved oxidation and corrosion resistance as compared to a chromium aluminide diffusion coating without platinum.

[0014] The coated turbine component may also include at least one portion other than the selected portion(s) in which the coating is a chromium aluminide coating that is not modified with platinum. This development of the inventive turbine component allows those areas of the component which are not directly exposed to the hot and corrosive combustion gases to be coated with a less expensive chromium aluminide coating and to apply the more expensive platinum modified chromium aluminide coating only where it is necessary.

[0015] In a further development of the coated turbine component the chromium aluminide coating that is modified with platinum may also include silicon and/or hafnium and/or yttrium to further enhance the oxidation resistance of the coating. A further option is to also enhance the oxidation resistance of the chromium aluminide coating that is not modified with platinum by including silicon and/or hafnium and/or yttrium.

[0016] The coated turbine component may, in particular, be a turbine blade or vane comprising an airfoil section with an airfoil surface, a root section with a root surface and a platform section being located between the airfoil section and the root section and having a platform surface including a platform surface portion showing towards the airfoil section. In this case, the at least one selected portion in which the coating is a chromium aluminide coating that is modified with platinum includes at least the airfoil surface and the platform surface portion showing towards the airfoil section. As already mentioned, these surfaces are those surfaces which are directly exposed to the hot and corrosive combustion gases and, hence, require the highest oxidation and/or corrosion resistance. Those surfaces which are not directly exposed to the hot and corrosive combustion gases such as the platform surface portions other than the platform surface portion showing towards the airfoil section and the root surface do not need to have a platinum modified chromium aluminide coating. Hence, at least a portion of the root surface and the platform surface portions other than the platform surface portion showing towards the airfoil section may be provided with a chromium aluminide coating without platinum. Please note that there may also be root surface portions which do not need to be coated at all.

[0017] Further features, properties and advantages of the present invention will become clear from the following description of embodiments in conjunction with the accompanying drawings.

Figure 1 shows a gas turbine rotor blade as an example for an inventive turbine component.

Figure 2 shows flow diagram representing a first embodiment of the inventive method of coating a turbine component.

Figure 3 shows a flow diagram representing a second embodiment of the inventive method of coating a turbine component.

Figure 4 shows an example of a gas turbine engine in a sectional view.

[0018] Although the inventive turbine component could be any turbine component exposed to a hot and corrosive medium the present invention will be described with respect to a gas turbine rotor blade as an exemplary embodiment of such a turbine component. The gas turbine rotor blade is shown in Figure 1. It comprises a root section 3, an airfoil section 5 and a platform section 7 located between the root section 3 and the airfoil section 5.

[0019] The root section 3 includes a root 9 with a fir-tree shape which can be inserted into a correspondingly shaped notch of a rotor disk to fix the turbine blade 1 to the disk. The root section 3 of the present embodiment also includes an extended root 11 which does not show the fir-tree shape and which is not located in the notch when the turbine blade 1 is fixed to a rotor disk. Often those extended root portions serve to define a space between the platform 7 and the rotor disk for allowing flow of a cooling fluid, e.g. compressor air, therethrough. In addition, the extended root may include openings through which allow entering of internal cooling passages of the turbine blade by a cooling fluid.

[0020] The airfoil 5 extends into the flow path of the hot and corrosive combustion gases and has an airfoil surface 12 the shape of which allows extracting momentum from the combustion gases passing by the airfoil surface 12 so as to impart a rotational movement to a rotor formed by an assembly of rotor disks through the disk to which the rotor blade 1 is fixed.

[0021] The platform 7 comprises a platform surface portion 13 which shows towards the airfoil section 5 and a platform surface portion 15 which shows towards the root section 3. Both surface portions are connected to each other by a circumferential surface 17.

[0022] The gas turbine rotor blade 1 of the present embodiment is coated with an oxidation and/or corrosion resistant coating. However, this coating is not a uniform coating applied to all of the surfaces of the turbine blade 1. Instead, different surface portions of the turbine blade 1 are coated with different coatings. In the present embodiment, the airfoil surface 12 is coated with a chromium aluminide diffusion coating that is modified with platinum. The same coating is also present on the platform surface portion 13 showing towards the airfoil section 5. On the other hand, the circumferential surface 17 and the platform surface portion 15 showing towards the root section 3 are coated with a chromium aluminide diffusion coating without platinum. The same coating, i.e. a chromium aluminide diffusion coating without platinum, is also present on the surface 19 of the extended root 11. The surface 20 of the root 9 with the fir-tree shape is not coated in the present embodiment.

[0023] The coating of the gas turbine blade 1 is such that those portions of its surface which come into direct contact with the hot and corrosive combustion gases forming the working medium of the gas turbine are coated with the platinum modified chromium aluminide coating. Those portions which are still in a hot environment but not in direct contact with the combustion gases are coated with a chromium aluminide coating that is not modified by platinum. However, it would as well be possible to apply a platinum modified chromium aluminide coating also onto the circumferential surface 17 of the platform, onto the platform surface section 15 showing towards the root section 3 and onto the surface 19 of the extended root.

[0024] The chromium aluminide diffusion coatings described above have a coating thickness in the range between 5 to 25 micrometer and contain between 15 to 30 % by weight aluminium and between 5 and 15 % by weight chromium. The remaining constituents depend on the substrate material, i.e. the superalloy material of the gas turbine blade. Chromium aluminide layers have been found to show good corrosion and oxidation protection. However, although chromium aluminide layers already provide a good protection the chromium aluminide diffusion coating of those surface portions which are exposed to the hot and corrosive combustion gases are modified by the addition of platinum in the range between 5 to 15 % by weight. Moreover, both the unmodified chromium aluminide coating as well as the platinum modified chromium aluminide coating may further contain elements which are effective in pinning an aluminium oxide scale thereby improving stability of the oxide, thus increasing life time of the coating. Elements which could assist in pinning the oxide scale are silicon (Si), hafnium (Hf) and yttrium (Y). Therefore, in a special development of the present embodiment, at least the platinum modified chromium aluminide coating also contains at least one of the elements Si, Hf, Y where the amount of each of the elements is in the range between 0.5 and 1.5 % by weight. However, if more than one of these elements are present the total amount will sum up to not more than 3 % by weight. Aside from unavoidable impurities and elements of the superalloy material other elements are typically not present in the coating.

[0025] Embodiments of a method of forming the coating on the surface portions of the turbine blade 1 will now be described with respect to Figures 2 and 3 which show flow diagrams of the embodiments. In both embodiments, the coating process is a three step process with a plating step in which the airfoil surface 12 and the surface portion 13 of the platform section 7 which shows towards the airfoil section 5 are plated with platinum, a chromising step in which all surfaces of the turbine blade 1 except the surface 20 of the fir-tree shaped root 9 are chromised, and an aluminising step in which those surface portions, which have been chromised are aluminised.

[0026] In the first embodiment, which is shown in Figure 2, the plating step S1 forms the first step of the method. The plating can be done with any known method suitable for plating platinum onto the surface of the gas turbine rotor blade 1. In particular, an electrochemical plating process, which is well-known in the art, may be used. If at least one of silicon, hafnium and yttrium shall be added to the coating during the plating step S1, as it is shown by optional step S3, Si and/or Hf and/or Y could be added to the plating solution.

[0027] The chromising step S5 of the present embodiment follows on the plating step S1. In the chromising step S5, chromium is diffused into the airfoil surface 12, all surfaces of the platform section 7 and the surface 19 of the extended root 11 by a suitable process. For example, a diffusion process using pack cementation, above the pack cementation, or chemical vapour deposition (CVD) may be applied. The chromising step 5 produces a chromium-rich surface layer which typically contains between 15 and 30 % by weight chromium and is typically between 5 and 25 μm thick.

[0028] As an option, silicon and/or hafnium and/or yttrium may be introduced into the coating during the chromising step S5 as it is indicated by step S7. Adding at least one of Si, Hf, Y may be done, for example, by a CVD-process.

[0029] The last step of the present embodiment representing the inventive coating method is the aluminising step S9. In this step, all surface portions that have been chromised in the chromising step S5 are aluminised. At it is known from the art, aluminising may be done, for example, by pack cementation, above the pack cementation, or by CVD. This process results in a chromium aluminide coating with typically about 15 to 30 % by weight aluminium and about 5 to 15 % by weight chromium. The amount of platinum in this final coating will be in the range between 5 and 15 % by weight. Again, Si and/or Hf and/or Y may optionally be introduced into the coating during the aluminising step S9, as it is indicated by step S11. Introducing Si and/or Hf and/or Y can, for example, be done by means of a chemical vapour deposition process.

[0030] Other elements than platinum, chromium, aluminium, and optionally silicon and/or hafnium and/or yttrium which are present in the resulting coating will depend on the superalloy material of the gas turbine blade.

[0031] By the method described with respect to Figure 2, the coating of the turbine component 1 described in Figure 1 can be produced.

[0032] An alternative embodiment of the method for applying a coating is shown in Figure 3. Like the embodiment shown in Figure 2 in the embodiment of Figure 3 includes a plating step S101, a chromising step S105 and an aluminising step S109. However, in difference to the process shown in Figure 2 the order of the plating step S101 and the chromising step S105 are reversed. In other words, according to the second embodiment of the inventive method the airfoil surface 12, all surfaces portions of the platform 7, and the surface 19 of the extended root 11 are chromised before the airfoil surface 12 and the surface portion 13 of the platform 7 showing towards the airfoil portion 5 are plated with platinum. Like in the first embodiment, the final step of the method is aluminising the airfoil surface 12, all surfaces portions of the platform 7, and the surface 19 of the extended root 11. The result of the second embodiment of the inventive method is the same as the result of the first embodiment, and the processes used for plating, chromising and aluminising which have been described with respect to Figure 2 are also applicable in case of the embodiment shown in Figure 3. In addition, Si and/or Hf and/or Y may be added to the coating during either one of the plating step S101, the chromising step S105 and the aluminising step S109. Like in the process of Figure 2 it is also possible to add Si and/or Hf and/or Y during two steps of the plating step S101, the chromising step S105 and the aluminising step S109, or even during all three steps.

[0033] As has been mentioned above, a rotor blade as described with respect to figure 1 will be inserted into a notch of a rotor disk of a gas turbine rotor. In the following, such a gas turbine will be shortly described with respect to figure 4.

[0034] In the following description, the terms upstream and downstream refer to the flow direction of the airflow and/or working gas flow through the engine unless otherwise stated. The terms forward and rearward refer to the general flow of gas through the engine. The terms axial, radial and circumferential are made with reference to a rotational axis 20 of the engine.

[0035] Figure 4 shows an example of a gas turbine engine 210 in a sectional view. The gas turbine engine 210 comprises, in flow series, an inlet 212, a compressor section 214, a combustor section 216 and a turbine section 218 which are generally arranged in flow series and generally in the direction of a longitudinal or rotational axis 220. The gas turbine engine 210 further comprises a shaft 222 which is rotatable about the rotational axis 220 and which extends longitudinally through the gas turbine engine 210. The shaft 222 drivingly connects the turbine section 218 to the compressor section 212.

[0036] In operation of the gas turbine engine 210, air 224, which is taken in through the air inlet 212 is compressed by the compressor section 212 and delivered to the combustion section or burner section 216. The burner section 216 comprises a burner plenum 226, one or more combustion chambers 228 defined by a double wall can 249 and at least one burner 230 fixed to each combustion chamber 228. The combustion chambers 228 and the burners 230 are located inside the burner plenum 226. The compressed air passing through the compressor 212 enters a diffuser 232 and is discharged from the diffuser 232 into the burner plenum 226 from where a portion of the air enters the burner 230 and is mixed with a gaseous or liquid fuel. The air/fuel mixture is then burned and the combustion gas 234 or working gas from the combustion is channeled via a transition duct 251 to the turbine section 218.

[0037] The turbine section 218 comprises a number of blade carrying discs 236 attached to the shaft 222. In the present example, two discs 236 each carry an annular array of turbine blades 238. However, the number of blade carrying discs could be different, i.e. only one disc or more than two discs. In addition, guiding vanes 240, which are fixed to a stator 242 of the gas turbine engine 210, are disposed between the turbine blades 238. Between the exit of the combustion chamber 228 and the leading turbine blades 238 inlet guiding vanes 244 are provided.

[0038] The combustion gas from the combustion chamber 228 enters the turbine section 218 and drives the turbine blades 238 which in turn rotates the shaft 222. The guiding vanes 240, 244 serve to optimise the angle of the combustion or working gas on to the turbine blades 238. The compressor section 212 comprises an axial series of guide vane stages 246 and rotor blade stages 248.

[0039] The present invention has been described with respect to exemplary embodiments of the invention for illustrative reasons. However, as it is apparent for a person skilled in the art one may deviate from the embodiments described with respect to the Figures. For example, the turbine component does not need to be a gas turbine blade but may also be a gas turbine vane or any other turbine component, in particular such a turbine component which is located in the hot gas path of the turbine. A person skilled in the art will appreciate that in particular those surfaces of the turbine component which come into direct contact with the hot and corrosive combustion gases will be coated with the platinum modified chromium aluminide coating whereas other surfaces may be coated with a chromium aluminide coating without platinum. However, it is also possible to provide also such coated surface sections which are not directly exposed to the hot and corrosive combustion gases with the platinum modified chromium aluminide coating. Other possible modifications of the embodiments have already been described with respect to the embodiments. Hence, the invention shall not be restricted to the specific embodiments described with respect to the Figures but only by the appended claims.

Claims

1. A method of forming a coating on a turbine component (1), the method comprising:

- a plating step (S1, S101) in which at least one selected portion (12, 13) of the component (1) is plated with platinum;
- a chromising step (S5, S105) in which at least a portion (12, 13, 15, 17, 19) of the component (1) is chromised where said portion (12, 13, 15, 17, 19) includes said at least one selected portion (12, 13) ; and
- an aluminising step (S9, S109) in which at least a portion (12, 13, 15, 17, 19) of the component (1) is aluminised where the portion (12, 13, 15, 17, 19) which is aluminised includes the portion (12, 13, 15, 17, 19) which is chromised in the chromising step (S5, S105).

2. The method as claimed in claim 1, in which the plating step (S101) is performed after the chromising step (S105).

3. The method as claimed in claim 1 or claim 2, in which the chromising step (S5) is performed after the plating step (S1).

4. The method as claimed in any of the claims 1 to 3, in which Silicon and/or Hafnium and/or Yttrium is/are introduced into the coating.

5. The method as claimed in claim 4, in which the Silicon and/or the Hafnium and/or the Yttrium is/are introduced into the coating during the chromising step (S5, S105).

6. The method as claimed in claim 4 or claim 5, in which the Silicon and/or the Hafnium and/or the Yttrium is/are introduced into the coating during the aluminising step (S9, S109).

7. The method as claimed in any of the claims 4 to 6, in which the Silicon and/or the Hafnium and/or the Yttrium is/are introduced into the coating during the plating step (S1, S101).

8. The method as claimed in any of the claims 1 to 7, in which said at least one portion (12, 13, 15, 17, 19) which is chromised in the chromising step (S5, S105) and said at least one portion (12, 13, 15, 17, 19) which is aluminised in the aluminising step (S9, S109) are identical to each other.

9. The method as claimed in any of the claims 1 to 8, in which the turbine component (1) is a turbine blade or vane comprising an airfoil section (5) with an airfoil surface (12), a root section (3) with a root surface (19, 20) and a platform section (7) being located between the airfoil section (5) and the root section (3) and having a platform surface (13, 15, 17) including a platform surface portion (13) showing towards the airfoil section (5), and in which the at least one selected portion which is plated in the plating step (S1, S101) includes at least the airfoil surface (12) and the platform surface portion (13) showing towards the airfoil section (5).

10. The method as claimed in claim 9 in which said at least one portion (12, 13, 15, 17, 19) which is chromised in the chromising step (S5, S105) includes the airfoil surface (12), the platform surface (13, 15, 17) and at least a portion (19) of the root surface (19, 20).

11. A turbine component (1) coated with a coating, which includes at least one selected portion (12, 13) in which the coating is a chromium aluminide coating that is modified with platinum.

12. The coated turbine component (1) as claimed in claim 11, in which the coating includes at least one portion (15, 17, 19) other than the selected portion (12, 13) in which the coating is a chromium aluminide coating that is not modified with platinum.

13. The coated turbine component (1) as claimed in claim 11 or in claim 12, in which the chromium aluminie coating that is modified with platinum also includes Silicon and/or Hafnium and/or Yttrium, and/or in which the chromium aluminie coating that is not modified with platinum also includes Silicon and/or Hafnium and/or Yttrium.

14. The coated turbine component (1) as claimed in any of the claims 11 to 13, in which the turbine component (1) is a turbine blade or vane comprising an airfoil section (5) with an airfoil surface (12), a root section (3) with a root surface (19, 20) and a platform section (7) being located between the airfoil section (5) and the root section (3) and having a platform surface (13, 15, 17) including a platform surface portion (13) showing towards the airfoil section (5), and in which the at least one selected portion (12, 13) in which the coating is a chromium aluminide coating that is modified with platinum includes at least the airfoil surface (12) and the platform surface portion (13) showing towards the airfoil section (5).

15. The coated turbine component (1) as claimed in claim 14, in which a chromium aluminide coating without platinum is present on the platform surface (15, 17) other than the platform surface portion (13) showing towards the airfoil section and on at least a portion (19) of the root surface (19, 20).

FIG 1

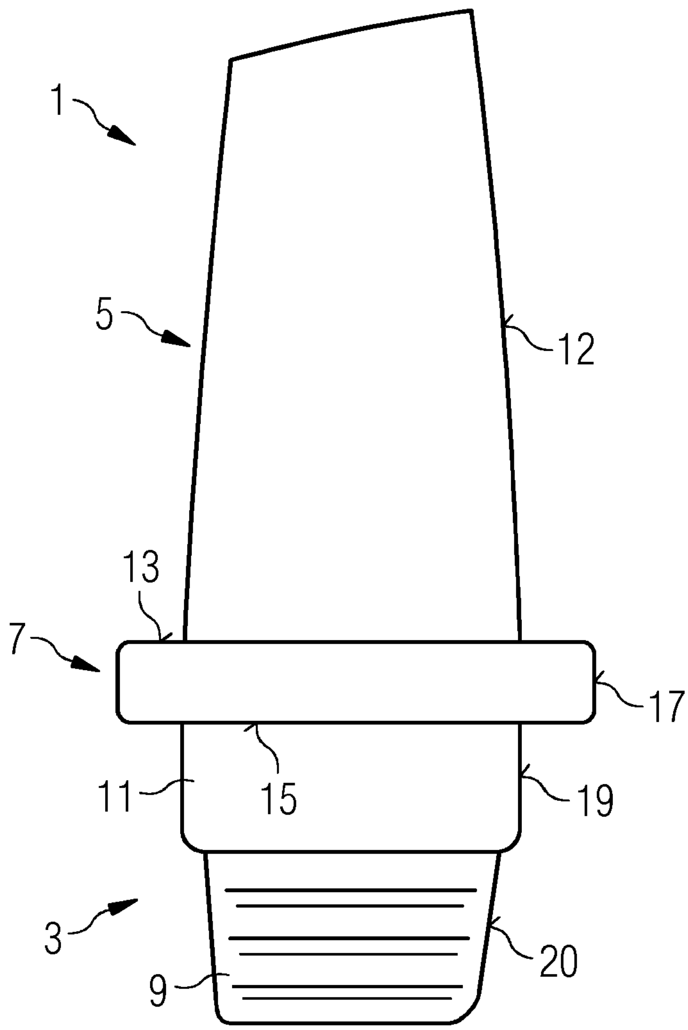


FIG 2

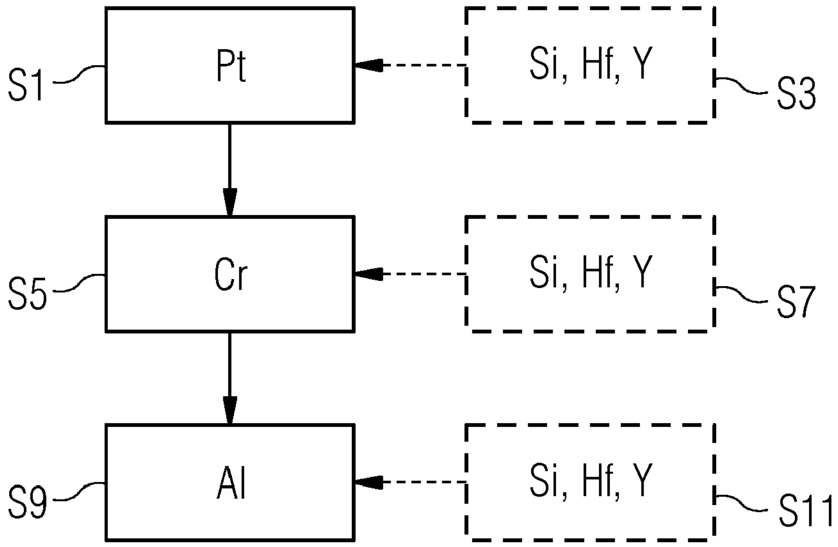

S1
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FIG 3

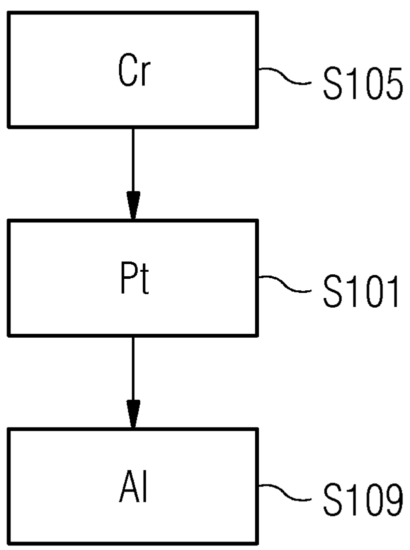
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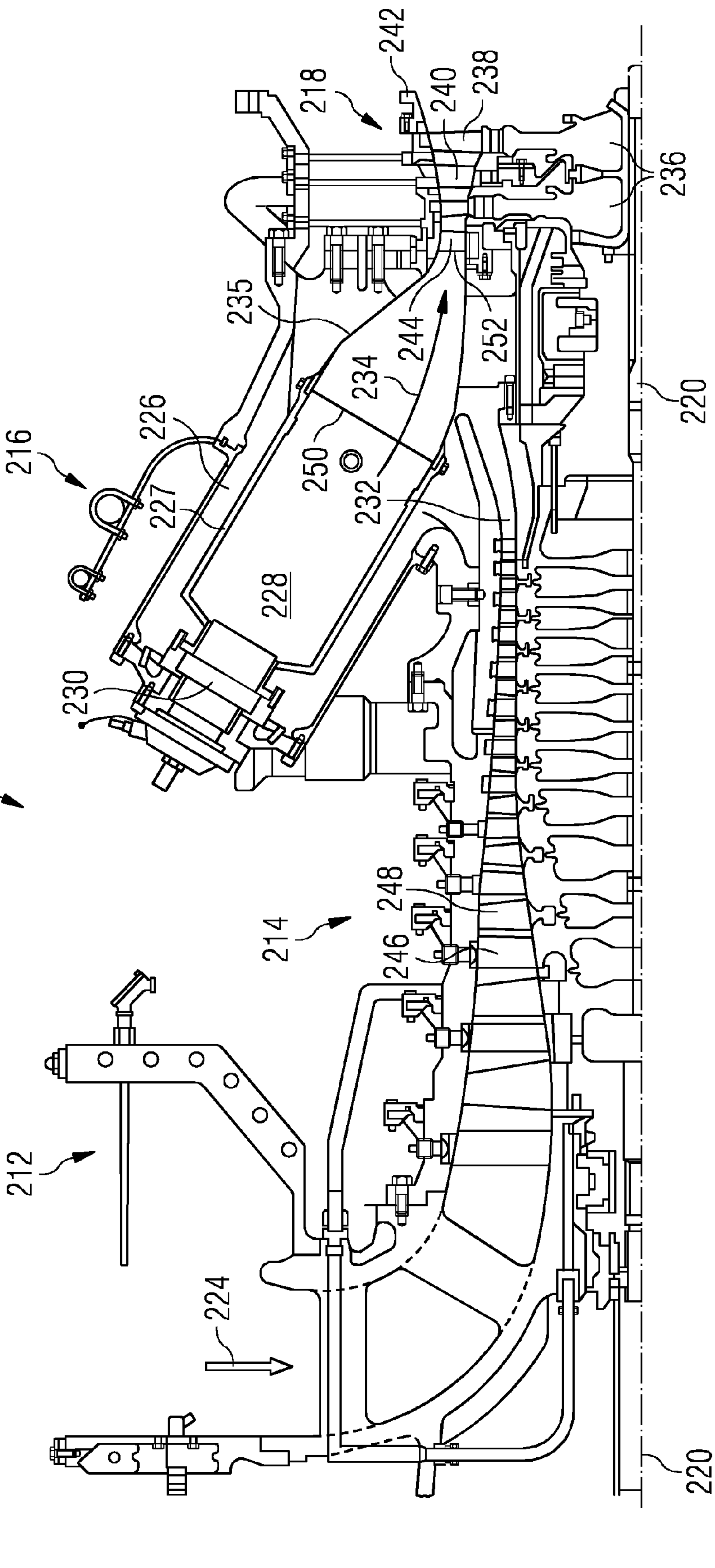
FIG 4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EUROPEAN SEARCH REPORT

Application Number
EP 14 16 5485

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 2006/046091 A1 (MADHAVA MURALI [US] ET AL) 2 March 2006 (2006-03-02) * page 2, paragraph 14 * * page 4, paragraph 49 - page 5, paragraph 64; table 1 * * column 6, paragraph 68-71 * * column 7, paragraph 77-81 * -----	1-15	INV. C23C10/58 C23C10/02 C23C10/16
X	US 2006/141283 A1 (MADHAVA MURALI N [US]) 29 June 2006 (2006-06-29) * page 3, paragraphs 27,28; figures 4,5 * * page 3, paragraph 35 - page 4, paragraph 48 * * page 5, paragraph 57-61 * -----	1-15	
X	US 4 526 814 A (SHANKAR SRINIVASAN [US] ET AL) 2 July 1985 (1985-07-02) * column 1, lines 31-34 * * column 1, line 48 - column 2, line 15 * * column 2, lines 36-60 * * column 3, lines 1-28 * * figures 1,3 * -----	1-15	TECHNICAL FIELDS SEARCHED (IPC) C23C
X	EP 0 821 076 A1 (ROLLS ROYCE PLC [GB]; CHROMALLOY UK LTD [GB]) 28 January 1998 (1998-01-28) * column 7, paragraph 45 - column 8, paragraph 45 * * column 1, lines 6-18 * -----	1-15	
X	EP 1 652 965 A1 (GEN ELECTRIC [US]) 3 May 2006 (2006-05-03) * column 2, paragraph 8 - column 3, paragraph 10; figures 2,3 * * column 6, paragraph 21 - column 9, paragraph 30 * ----- -/--	1-6,8-15	

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	12 December 2014	Joffreau, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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EUROPEAN SEARCH REPORT

Application Number
EP 14 16 5485

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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E	EP 2 743 369 A1 (SIEMENS AG [DE]) 18 June 2014 (2014-06-18) * column 5, paragraph 30 - column 7, paragraph 44 * -----	1,11	

TECHNICAL FIELDS SEARCHED (IPC)

1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 December 2014	Joffreau, P

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