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(54) **OXIDATION PROTECTED BLADE AND
METHOD OF MANUFACTURING**

Related U.S. Application Data

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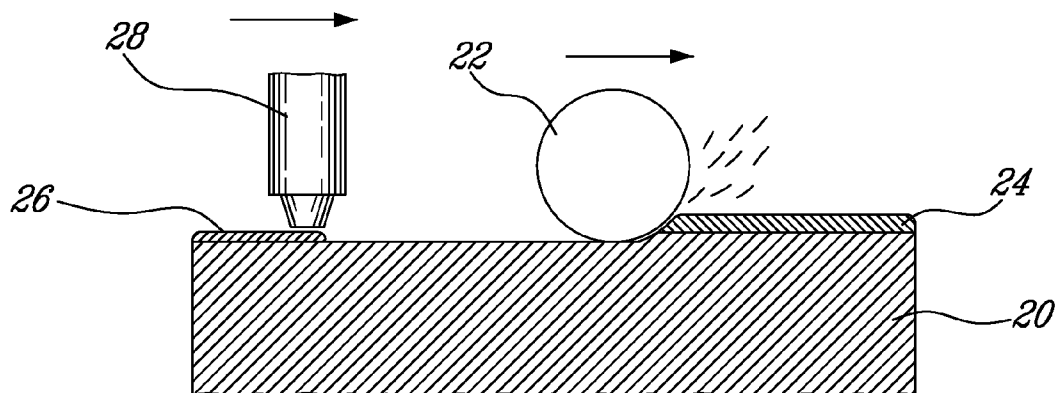
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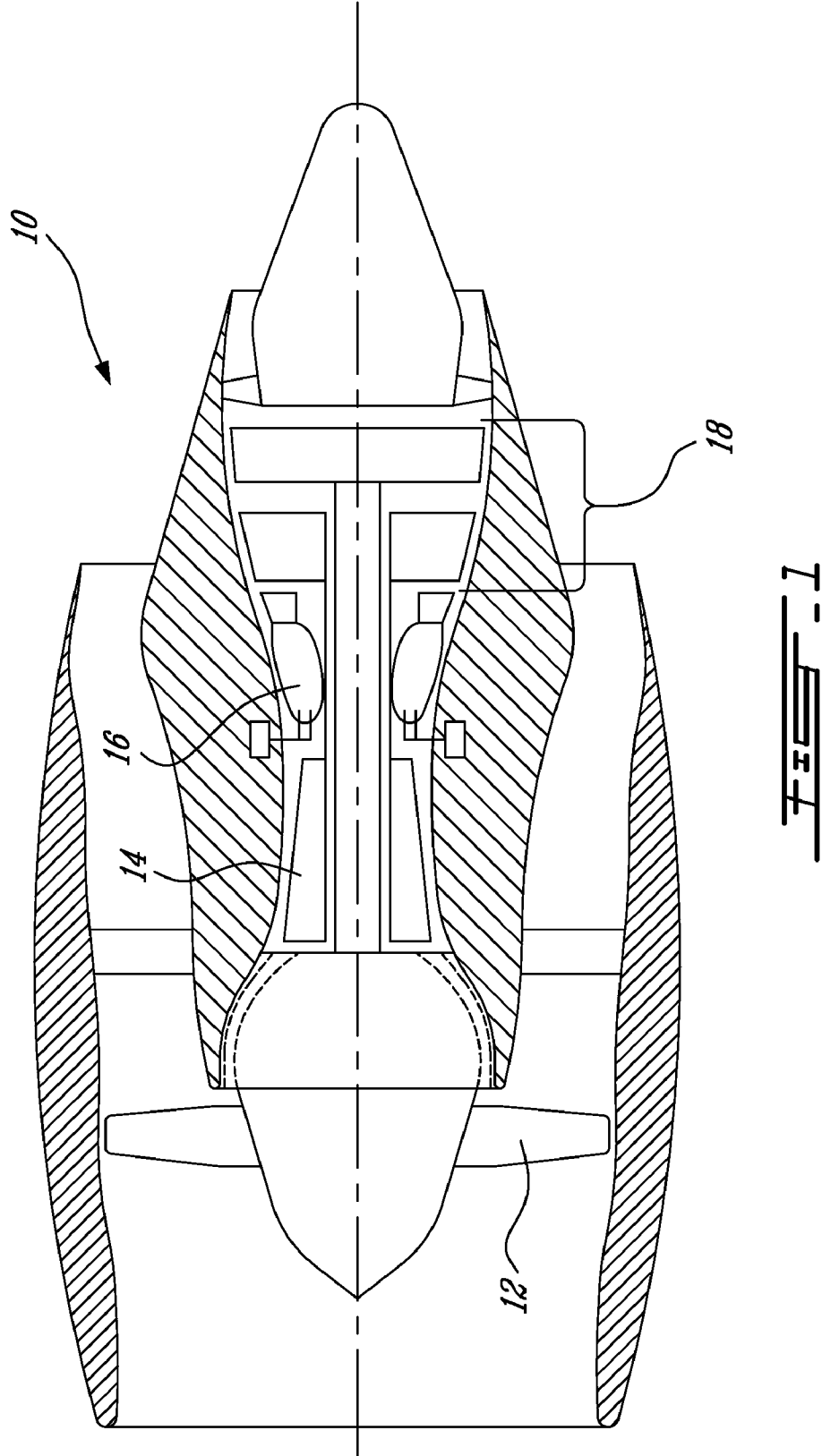
(57) **ABSTRACT**

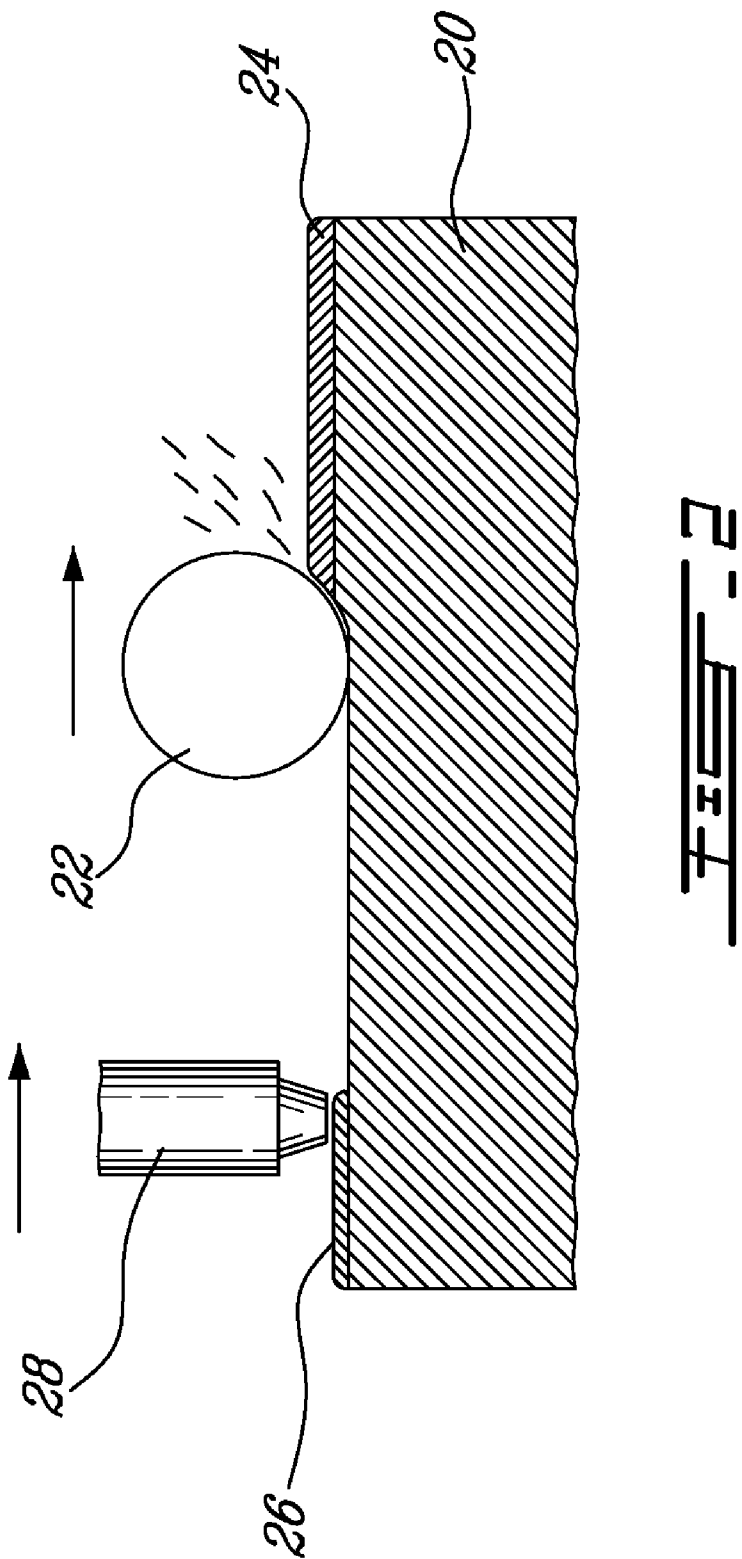
The surface of a gas turbine blade is machined with a material-removing tool and simultaneously, an anti-oxidation coating is deposited on the surface using eletrospark deposition.

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OXIDATION PROTECTED BLADE AND METHOD OF MANUFACTURING

CROSS-REFERENCE TO RELATED U.S. APPLICATION

[0001] The present application is a continuation of U.S. patent application Ser. No. 11/231,829 filed Sep. 24, 2005, which application is hereby incorporated by reference.

TECHNICAL FIELD

[0002] The field of invention relates generally to the protection of blades in a gas turbine engine and, more particularly, to a blade provided with an oxidation protection layer and a method of manufacturing the same.

BACKGROUND OF THE ART

[0003] In small gas turbine engines, the shrouds located around the turbine blades are generally not provided with a layer of abradable material, as is the case for some larger engines. Reasons for this include the facts that large engines may have more carcass distortions and more misalignment between centerlines of the rotor and shrouds. A distortion or misalignment may cause a localized rub between a shroud segment and all blades. Without an abradable system, this may leave a relatively large gap around the periphery of the rotor and reduce the efficiency of the engine. Smaller engines take advantage of having less carcass distortions and misalignments by designing to have tighter tip clearances. One method of achieving tight tip clearances on smaller engines is to machine blades to their final dimensions so that the designed tip clearance is achieved even without a running-in period.

[0004] Whenever parts are machined to their final dimension, for instance using a grinder, some material is removed. Since the parts are coated with one or more protective layers before the final machining process, removing more material than the thickness of the protective layer or layers will leave the base material exposed. The exposed areas will then be prone to oxidation. Oxidation is particularly severe at the edge of the pressure side of blades. This ultimately results in a premature wear of the blades.

[0005] Accordingly, there is a need to provide an improved way of protecting from oxidation the surfaces of the blades that are machined because their base material is exposed once machined to their final dimension.

SUMMARY OF THE INVENTION

[0006] In one aspect, the present invention provides a method of providing oxidation protection to an airfoil blade of a gas turbine engine, the method comprising the steps of: providing the airfoil blade with a first anti-oxidation coating applied to an outer surface thereof, adjusting a tip clearance dimension of the airfoil blade by grinding a tip portion of the blade, thereby at least partially removing a layer; and then depositing a second oxidation-resistant coating to at least said ground tip portion using electrospark deposition.

[0007] In another aspect, the present invention provides a method of providing oxidation protection to a coated airfoil blade of a gas turbine engine, the method comprising the steps of: removing at least a portion of a coating from a tip

portion of the blade; and then depositing an oxidation-resistant coating to said tip portion using electrospark deposition.

[0008] Further details of these and other aspects of the present invention will be apparent from the detailed description and accompanying figures.

DESCRIPTION OF THE DRAWINGS

[0009] Reference is now made to the accompanying figures depicting aspects of the present invention, in which:

[0010] FIG. 1 is a schematic view of a gas turbine engine showing an example of a possible environment in which the turbine blades are used; and

[0011] FIG. 2 is a schematic view of the manufacturing process, in accordance with a preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] FIG. 1 illustrates a gas turbine engine **10** of a type preferably provided for use in subsonic flight, generally comprising in serial flow communication a fan **12** through which ambient air is propelled, a multistage compressor **14** for pressurizing the air, a combustor **16** in which the compressed air is mixed with fuel and ignited for generating an annular stream of hot combustion gases, and a turbine section **18** for extracting energy from the combustion gases. This figure shows one possible environment in which blades with oxidation protection can be used. It should be noted at this point that the invention is equally applicable to other kinds of gas turbine engines, such as turbo shafts or turbo props.

[0013] FIG. 2 schematically shows a surface of a blade **20** being manufactured in accordance with the present invention. It shows that material is removed from the surface using a material-removing tool, for instance a grinder **22**. If the grinder **22** removes more material than the thickness of the original anti-oxidation layer **24** of the blade **20**, the base material will be exposed. However, at the same time, a very thin layer of anti-oxidation coating **26** is applied using an electrospark applicator **28** to solve that problem.

[0014] Electrospark deposition (ESD) is a pulsed micro-welding process. Based on short duration, high current pulses, ESD imparts a low heat input to the base material, resulting in little or even no modification of the substrate microstructure. The base material remains near to ambient temperature so that thermal distortion, shrinkage and high residual stresses are avoided. The precision of the machining is thus intact. An example of a corrosion resistant material is MCrAlY .

[0015] The grinder **22** and the applicator **28** can be mounted on the same frame (not shown), which will preserve the datum line and increase the precision of the machining. The frame can be movable with reference to the blade **20**, or vice-versa. Another possibility is to mount the blade **20** on a rotating support while the grinder **22** and the applicator **28** are fixed. This rotating support can be a rotor disk.

[0016] The combined machining and electrospark deposition can be repeated one or more times for each surface until

the final dimension is obtained. The machining may, in that case, even remove some of the anti-oxidation coating 26 previously laid by the ESD as part of the material being removed. Likewise, the anti-oxidation coating 26 can be applied on a partially-removed anti-oxidation layer 24.

[0017] The ESD tool may be designed to have a conformal shape to the blade 20 or its tip. This way, it is possible to apply the coating on the whole surface simultaneously. Yet, the ESD tool may be a rotating tool mounted on a wheel-like support.

[0018] Overall, the apparatus and the method of the present invention allow blades of gas turbine engines to have tight tip clearances, which is particularly useful in the case of small gas turbine engines. It allows the blades to have these tight tip clearances without leaving the base surface with no protection, thus prone to oxidation.

[0019] If desired, the gap at the tip of a blade 20 may receive additional coating using the electrospark deposition. It is possible to superpose multiple layers of anti-oxidation coating 26 to increase the protection. Some areas may still be prone to wear with only one layer and accordingly, the additional thickness of many layers of anti-oxidation coating 26 will prevent the base material from being uncovered.

[0020] Recessed portions of blades can receive more anti-oxidation coating than non-recessed portions without affecting the tip clearance.

[0021] The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without departing from the scope of the invention disclosed. For example, the material-removing tool can be different than a grinder and may include any other equivalent machining device, such as a milling cutter. The coating material is not limited to MCrAlY and other anti-oxidation coatings can be used, as apparent to a person skilled in the art. The process being disclosed herein is not limited to new blades and can be used for refurbished blades. Still other modifications which fall within the scope of the present invention will be apparent to those skilled in the art, in light of a review of this disclosure, and such modifications are intended to fall within the appended claims.

What is claimed is:

1. A method of providing oxidation protection to an airfoil blade of a gas turbine engine, the method comprising the steps of:

providing the airfoil blade with a first anti-oxidation coating applied to an outer surface thereof;

adjusting a tip clearance dimension of the airfoil blade by grinding a tip portion of the blade, thereby at least partially removing a layer; and then

depositing a second oxidation-resistant coating to at least said ground tip portion using electrospark deposition.

2. The method of claim 1 wherein the oxidation-resistant coating material applied by electrospark deposition is MCrAlY.

3. The method of claim 1 wherein the tip portion includes an edge of a pressure side of the blade.

4. The method of claim 1 wherein the steps of grinding and electrospark deposition are repeated, in sequence, at least once.

5. The method of claim 4 wherein said repeated grinding step partially removes a coating layer previously deposited by said electrospark deposition.

6. The method of claim 1 wherein the step of electrospark deposition includes applying said second coating in at least some areas where said first coating remains.

7. The method of claim 1 further comprising providing additional second coating material at a gap at the tip portion of the blade.

8. The method of claim 1 further comprising superposing multiple layers of said second coating on top of one another.

9. The method of claim 1 further comprising providing a recessed portion of the tip portion with additional layers of said second coating relative to non-recessed portions of the blade.

10. A method of providing oxidation protection to a coated airfoil blade of a gas turbine engine, the method comprising the steps of:

removing at least a portion of a coating from a tip portion of the blade; and

then

depositing an oxidation-resistant coating to said tip portion using electrospark deposition.

11. The method of claim 10 wherein a portion of a parent material of the blade is also removed with the at least a portion of the coating.

12. The method of claim 11 wherein the parent material and coating are removed to adjust a tip clearance height of the blade.

13. The method of claim 10 wherein the step of removing is performed by grinding.

14. The method of claim 10 wherein the oxidation-resistant coating is MCrAlY.

15. The method of claim 10 wherein the oxidation-resistant coating applied to at least an edge of the tip portion adjacent a pressure side of blade.

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