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(54) Rotor with groove having a compliant layer

(57) The invention relates to a rotor (10) for a turbomachine that has a groove (12) with a surface (14) defining the groove (12) wherein the groove (12) is configured and arranged to retain a blade root (20) therein. At least a portion of the surface (14) of the groove (12) has a layer configured as a compliant layer (16).

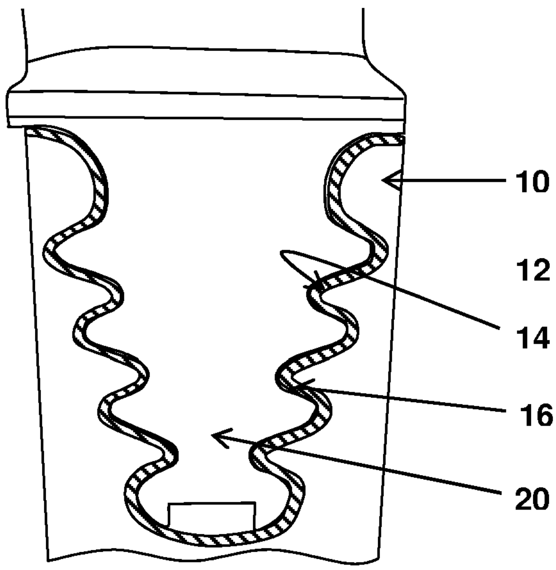

FIG. 1a

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Description

TECHNICAL FIELD

[0001] The invention refers to a method for increasing the fatigue life of a blade root of a turbomachine blade. Furthermore, the invention refers to a turbomachine blade with an increased fatigue life of the blade root of the turbomachine blade.

BACKGROUND INFORMATION

[0002] The inverted T-root type of construction, and also the fir-tree type of construction, are blade root types of construction which are known from the prior art and which are largely common. In the blade root, which in most cases is formed in a triangular shape, at least one slot for a back-gripping fixing in an adjoining component is arranged in each case on the two free sides of the triangle. The groove which adjoins the blade root in the rotor the turbomachine is a groove which corresponds to the contour of the blade root, for positive-locking retention of the blade root. Ribs or thickenings which engage in the slots of the blade root in the groove are arranged in the rotor. The blade root of the blade, therefore, can be inserted in a positive locking manner in the groove, and fixed in the groove by means of the ribs or thickenings which engage in a back-gripping manner in the slots.

[0003] During operation, the blade roots of turbomachine blades are exposed to high mechanical loads. This especially applies to the blade roots of rotor blades, via which the flow-induced forces which act upon the respective blades during operation, and also the centrifugal forces which act upon the respective blades, are diverted into the groove adjoining the blade to the rotor. In addition to mechanical loads, thermal loads can occur, particularly in turbine blades. These forces which act upon the blade are subsequently borne by the groove via the root of the blade. While groove designs such as the fir- tree design have the objective of evening out the stress load across the surface of the groove and blade roots, peak stress concentration, whether caused by the operation, a result of manufacturing imperfections or else transient force may result in damage or cracking of either or both the blade root or the groove. There is therefore a continuing need to find solutions to this problem.

SUMMARY

[0004] A rotor for a turbine comprising blade retaining grooves that can overcome the problem of peak stresses in the groove during operation of the turbine.

[0005] It attempts to addresses this problem by means of the subject matter of the independent claim. Advantageous embodiments are given in the dependent claims.

[0006] The disclosure is based on the general idea of providing the groove with a compliant layer that, upon deformation caused by high stress loads, can redistribute load and avoid localised peak point loadings on the blade root and/or groove.

[0007] In an aspect a rotor for a turbine comprises a groove with a surface. The groove is configured and arranged to retain a turbine blade root therein. At least a portion of the surface has a layer that is configured as a compliant layer of the groove which enables redistribution of load through deformation.

[0008] In a further aspect the fundamental shape of the groove is formed by a first material of the rotor while the compliant layer is made of a second material, located on the first material, wherein the compliance property of the compliant layer is defined by one or more intensive properties of the second material being different from that of the first material. In different aspects the intensive properties is either elastic modulus or yield stress wherein the material of the compliant layer has a lower elastic modulus than the groove material and/or a lower yield stress. This enables the compliant layer to deform when exposed to peak stresses.

[0009] In different aspects, the compliant layer selectively coats the groove at one or more points of changing angle that are susceptible to peak stresses under operation. Alternatively the compliant layer may cover the entire surface of the groove.

[0010] In another aspect, the compliant layer comprises voids that modify the compliance property of the layer.

[0011] It is a further object of the invention to overcome or at least ameliorate the disadvantages and shortcomings of the prior art or provide a useful alternative.

[0012] Other aspects and advantages of the present disclosure will become apparent from the following description, taken in connection with the accompanying drawings which by way of example illustrate exemplary embodiments of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] By way of example, an embodiment of the present disclosure is described more fully hereinafter with reference to the accompanying drawings, in which:

Figure 1 a and 1 b are schematic views of a fir tree groove with and without a fitted blade root and further including a compliant layer of a preferred embodiment;

Figure 2 is a schematic view of T-shaped groove respectively with a compliant layer of a preferred embodiment of the disclosure; and

Figure 3a/b/c are sectional views of the compliant layer both with and without voids of difference configurations.

DETAILED DESCRIPTION

[0014] 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 embodiments disclosed herein.

[0015] In an exemplary embodiment, shown in Fig. 1 a/b and Fig. 2, groove 12 formed in a rotor 10 has a surface 14 that define the groove as a fir tree groove 12 and a T-shaped groove 12 respectively. In both Figs. 1 a Fig 2 a groove is shown with a fitted blade root 20, while Fig. 1 b shows a groove without a blade root 20. A compliant layer 16 is located on at least part of the surface 14. The rotor groove itself is formed rotor material that in itself defines the basic configuration of the groove 12 and thus defines shape of the groove 12 as. Although only fir tree groove 12 and a T-shaped groove are exemplified in Fig1. 1 a/b and Fig. 2 the compliant layer 16 may be applied to any known shaped groove 12 of the art suitable for retaining a blade root 20 therein.

[0016] The term compliant and compliant layer in the context of this description is to be understood in reference to the properties of the material that forms the underlying shape of the feature. That is, the compliant layer 12 is defined by the fact that it deforms - that is, is compliant, - at lower point stress than the material of the groove 12. The actual property of compliance may further be defined as the inverse of stiffness and thus be defined for a given structure, as load divided by deformation. This can be influenced by either or both extensive properties of the material, such as structure or intensive properties, such as elastic modulus, in case of elastic or plastic compliance or yield stress, in the case of non-elastic /non-plastic compliance.

[0017] In an exemplary embodiment, shown in Fig 3a/b, the compliant layer 16 is defined by its extensive properties based on its configuration below an outer surface the compliant layer 16. As shown in Fig 3a, voids are formed on the inner surface of the compliant layer that is in contact with the surface 14 of the groove. In an alternate or complementary arrangement shown in Fig 3b the compliant layer 16 includes subsurface voids 18. In these exemplary embodiments, the compliant layer 16 may be made of either the same or different material to that of the rotor material of the groove 12. In this way the compliant layer 16 may be defined by either extensive properties or both extensive and intensive properties.

[0018] In another exemplary embodiment, shown in Fig. 3c, the compliant layer 16 is defined by its intensive properties compared to the groove shape defining rotor material. In a related exemplary embodiment this is achieved by the elastic modulus of the compliant layer 16 being greater than the elastic modulus of the groove shape defining rotor material. In another related exemplary embodiment achieves this by the yield stress of the compliant layer 16 being greater than the yield stress of the groove shape defining rotor material.

[0019] In a not shown exemplary embodiment the compliant layer 16 is formed on parts of the groove 12 that are particularly susceptible to high localised stresses, for example, portions of the groove 12 where the groove 12 changes direction or angle such as the T portion of a T-shaped groove 12 or tangs of a fir tree shaped groove 12. Alternatively the complaint layer 16 may cover the entire groove surface 14, as shown in Fig. 1 ab and Fig. 2.

[0020] Although the disclosure has been herein shown and described in what is conceived to be the most practical exemplary embodiment, 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 restricted. The scope of the disclosure is indicated by the appended claims rather that the foregoing description and all changes that come within the meaning and range and equivalences thereof are intended to be embraced therein.

REFERENCE NUMBERS

[0021]

10	Rotor
12	Groove
14	Surface
16	Layer
18	Void
20	Blade root

Claims

1. A rotor (10) for a turbo-machine comprising a groove (12) with a surface (14) defining the groove (12) wherein the groove (12) is configured and arranged to retain a blade root (20) therein,
characterised by at least a portion of the surface (14) having a layer configured as a compliant layer (16).

2. The rotor (10) of claim 1 wherein:

   the groove (12) is formed by a first material of the rotor (10); and
   the compliant layer (16) is made of a second material,
   wherein the compliance property of the compliant layer (16) is defined by one or more intensive properties of the second material being different from that of the first material.

3. The rotor (10) of claim 2 wherein the elastic modulus of the second material is less than that of the first material.

4. The rotor (10) of claim 2 wherein the yield stress of

the second material is less than that of the first material.

5. The rotor (10) of claim 1 wherein the compliance layer comprises voids,

6. The rotor (10) of any one of claims 1 to 5 wherein the compliant layer (16) covers the entire surface (14).

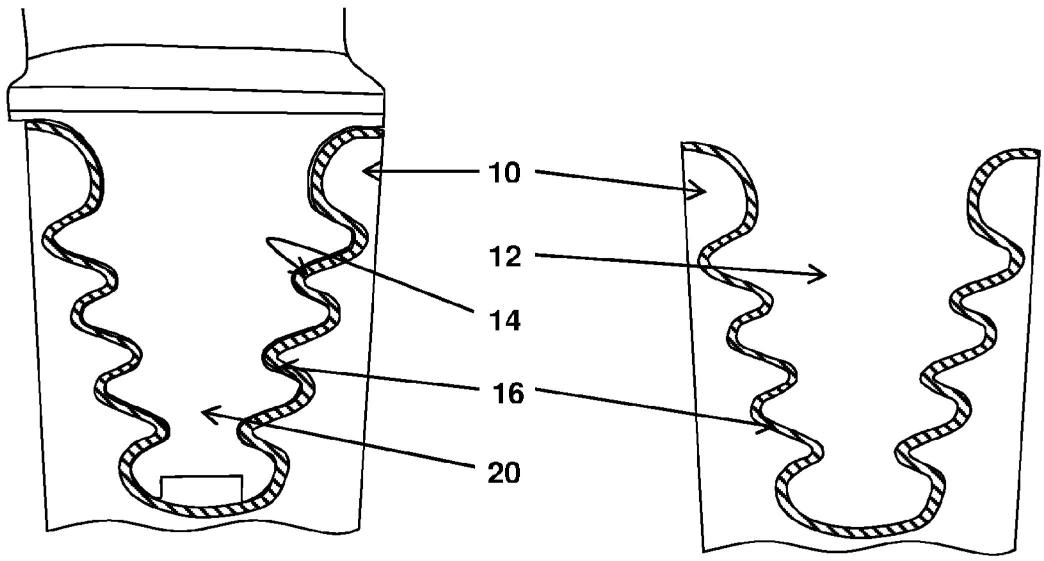

FIG. 1a

FIG. 1b

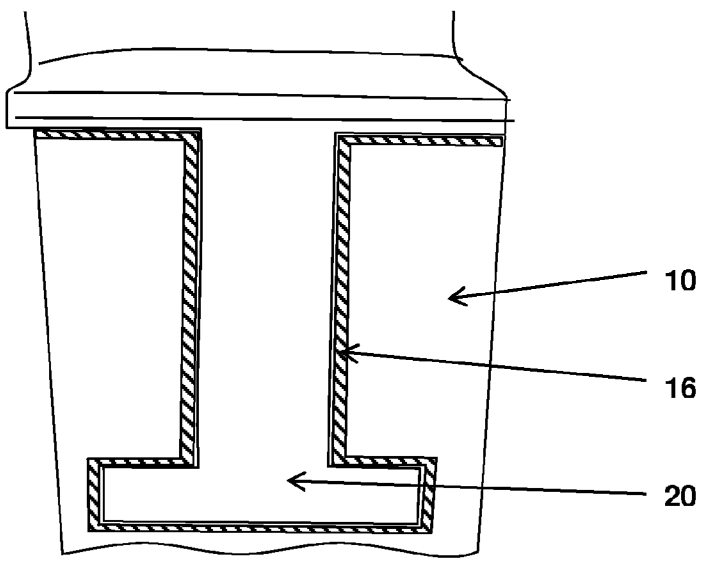

FIG. 2

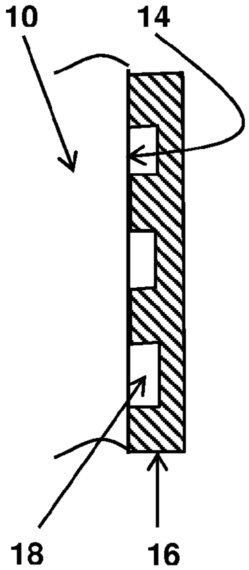

FIG. 3a

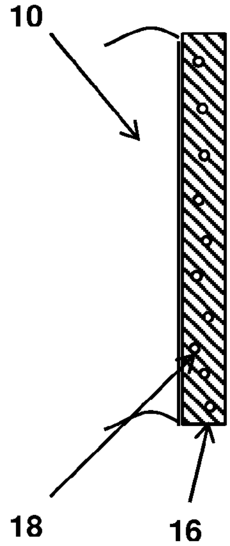

FIG. 3b

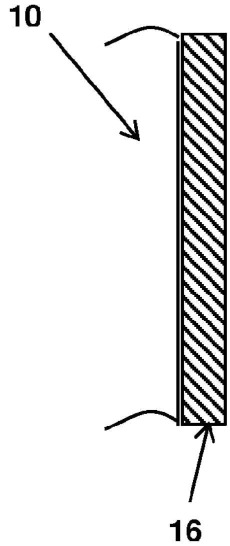

FIG. 3c

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EUROPEAN SEARCH REPORT

Application Number
EP 13 17 8656

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 September 2013	Raspo, Fabrice

EPO FORM 1503 03.82 (P04C01)

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 17 8656

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