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(54) Benævnelse: **ROTORBLADSKAL, ROTORBLAD OG VINDKRAFTANLÆG**

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ROTOR BLADE SHELL, ROTOR BLADE AND WIND TURBINE

The invention relates to a rotor blade shell for a rotor blade of a wind energy installation, a rotor blade for a wind energy installation having at least one such rotor blade shell and a wind energy installation having such a rotor blade.

Rotor blades for wind energy installations are frequently composed of two rotor blade shells produced separately from one another. The two rotor blade shells are bonded together on adhesive surfaces provided in the region of the so-called leading edge or nose and the so-called trailing edge. Furthermore, one or more spar caps can be provided inside the rotor blade or the rotor blade shells, which spar caps extend substantially along a longitudinal axis of the rotor blade from the rotor blade root to the rotor blade tip and provide additional stability or influence elastic properties of the rotor blade. In particular, such spar caps can ensure sufficient rigidity of the rotor blade in the impact and pivot direction.

US 2010/296941A1 discloses a rotor blade of a wind energy installation and is regarded as a relevant example for the prior art.

It is an object of the invention to specify improved rotor blade shells and corresponding rotor blades as well as a corresponding wind energy installation. It is in particular an object of the invention to increase flexibility in the shaping of rotor blade shells or rotor blades.

This object is achieved by a rotor blade shell, a rotor blade having such a rotor blade shell and a wind energy installation having such a rotor blade according to the independent claims.

According to a first aspect of the invention, the rotor blade shell for a rotor blade of a wind energy installation extends, in a longitudinal direction, from a root of the shell to a tip of a shell and, in a transverse direction, from a trailing edge of the shell, which can also be referred to as profile depth or profile direction, to a leading edge of the shell. A layer system extending in the longitudinal direction of the rotor blade shell comprises at least one core layer and two laminates, which are arranged on sides of the core layer which are opposite to one another. In this case, a part of the core layer in a first portion of the rotor blade shell is formed by a rotor blade spar cap which extends in the longitudinal direction and which terminates at an end of the first portion which faces towards the tip of the shell. In addition, at least one of the two laminates in a second portion of the rotor blade shell, which second portion of the rotor blade shell is joined onto the first portion at the end of the first portion which faces towards the tip of the shell and which second portion extends substantially to the tip of the shell, comprises at least one fiber layer. Said fiber layer extends in the transverse direction from the trailing edge of the shell to the leading edge of the shell and contains fibers, a predominant part of which, preferably more than 60 %, in particular more than 80 %, extends in the longitudinal direction.

According to a second aspect of the invention, a rotor blade for a wind energy installation comprises at least one rotor blade shell according to the first aspect of the invention.

According to a third aspect of the invention, a wind energy installation comprises at least one rotor blade according to the second aspect of the invention.

Preferred aspects of the invention are based on the approach of providing a rotor blade shell having a rotor blade spar cap, which does not extend over substantially the entire length of a rotor blade shell, i.e., in a longitudinal direction from a region at a root of the shell up to a region on a tip of the shell, but instead only in a first portion that is shorter in relation to the overall length. In order to ensure the stability, in particular the flexural rigidity, of the rotor blade shell or of a corresponding rotor blade, which comprises the rotor blade shell over its entire length, at least one fiber layer is arranged in a second portion which is joined onto an end of the first portion which faces towards the tip of the shell, said fiber layer extending in a transverse direction from a trailing edge of the rotor blade shell to a leading edge of the rotor blade shell and the fibers of which are predominantly oriented along the longitudinal direction of the rotor blade shell. Due to this orientation of the fibers, the necessary rigidity in the impact and pivot direction in the region of the tip of the rotor blade shell or of the corresponding rotor blade can be achieved. In other words, the at least one fiber layer in the second portion can act as a spar cap replacement.

This is advantageous, for example, since the shape of the rotor blade shell or of the rotor blade comprising the rotor blade shell is thus freely selectable in the region of the tip. For instance, it is conceivable for the so-called threading axis of the rotor blade to be curved in the region of the tip in the direction of the trailing edge or for the rotor blade to have a so-called sweep in the region of the tip, wherein the leading and trailing edges are curved in the longitudinal direction in such a way that a rotor blade comb, which is defined by the way in which the maximum structural height of the cross-sectional profile of the rotor blade shell or of the rotor blade develops along the longitudinal direction, has a continuously increasing distance from the so-called pitch axis about which the rotor blade can be rotated during operation in order to adjust an angle of attack. This can be advantageous, for example, for reducing the acting loads. Such a configuration of the rotor blade would not be possible with a linear development of the rotor blade spar cap up to the vicinity of the blade tip. Furthermore, omitting the rotor blade spar cap in the second portion can also save weight.

The rotor blade spar cap in the first portion, which is shortened in comparison with the overall length of the rotor blade shell, for example by 10 % or more, preferably by 20 % or more, in particular by 40 % or more, and the at least one fiber layer in the second portion can be part of a layer system which extends in the longitudinal direction. The rotor blade spar cap is preferably contained in a core layer, which core layer is enclosed by two laminates on sides which are opposite to one another, in particular in a thickness direction perpendicular to the longitudinal and transverse directions, in which the structural height of the rotor blade shell or of the corresponding rotor blade is also defined. In the second region, at least one of the two laminates comprises the at least one fiber layer, which predominantly comprises fibers in the longitudinal direction of the rotor blade. In addition, the laminates preferably also contain one or more fiber composite materials or fiber composite layers, e.g., glass fiber fabric and/or woven, which stabilize the layer system. This arrangement is advantageous, for example, since the conventional construction of rotor blade shells having a rotor blade spar cap in the form of a sub-assembly can thus be adopted substantially unchanged.

The at least one fiber layer can be designed, for example, as a so-called multiaxial fabric which, in addition to the fibers extending in the longitudinal direction, also comprises fibers which are oriented in further directions, for example 45° or 60° with respect to the longitudinal direction. As a result, the rigidity of the rotor blade shell or of the corresponding rotor blade can be at least influenced, in particular increased, with respect to further directions. In this case, a thickness or strength of the at least one fiber layer, which is optionally reduced relative to the rotor blade spar cap, can be compensated by the extension from the trailing edge of the shell to the leading edge of the shell.

Overall, the invention specifies an improved rotor blade shell and a corresponding rotor blade and a wind energy installation having such a rotor blade.

In a preferred embodiment, substantially all fibers of the at least one fiber layer are oriented in the longitudinal direction. Alternatively or additionally, the at least one fiber layer is designed as a unidirectional layer. Such fiber layers, which extend in the transverse direction from the trailing edge of the shell to the leading edge of the shell, are also referred to as full-chord UD layers. The fibers, which are at least substantially oriented in the longitudinal direction, preferably act as an extension of the rotor blade spar cap that is likewise oriented substantially in the longitudinal direction, in the first portion. A crack in the rigidity of the rotor blade shell in the longitudinal direction can thus be effectively avoided or at least reduced.

In a further preferred embodiment, the first portion comprises a transition region at the end which faces towards the tip of the shell, in which transition region the rotor blade spar cap becomes narrower. In particular, the rotor blade spar cap can comprise a bevel, also referred to as a scarf joint, in the transition region. It is preferred that the at least one fiber layer extends from the second portion at least partially into the transition region, i.e., projects at least partially into the first portion. In particular, it is conceivable that the number of fiber layers having fibers, a predominant part of which extends in the longitudinal direction, increases from the transition region to the second portion in order to at least partially compensate for the decreasing rigidity of the rotor blade spar cap which becomes narrower. In a preferred manner, the proportion of fibers extending in the longitudinal direction in at least one of the two laminates, in particular in the at least one fiber layer, increases to the extent that the rotor blade spar cap becomes narrower. This can ensure that a substantially continuous transition from the first portion to the second portion is created with respect to the rigidity.

In a further preferred embodiment, the core layer comprises a core material, which surrounds the rotor blade spar cap in the first portion. In this case, the core layer contains the core material, e.g. foam or balsa, preferably over the entire length of the rotor blade shell, that is to say in the second portion as well as in the first portion, wherein the core material in the first portion is preferably divided by the rotor blade spar cap. The core material can be arranged, for example, in the transverse direction on both sides of the rotor blade spar cap. The core material serves, in the first portion, preferably together with the rotor blade spar cap, as a carrier for the laminates, which influence the mechanical properties of the rotor blade shell or of the corresponding rotor blade. In the second portion, the core material can flexibly specify the shape of the rotor blade shell, since it no longer has to be arranged around the rotor blade spar cap.

In a further preferred embodiment, the layer system comprises at least one cover layer, which is arranged on a side of at least one of the laminates which faces away from the core layer, and which at least one cover layer forms an outer side or an inner side of the rotor blade shell. The cover layer can, for example, be designed as a coating, for example as a lacquer, which protects the layer system from environmental influences, such as moisture.

In a further preferred embodiment, the leading edge of the shell and the trailing edge of the shell have a curvature along the longitudinal direction, so that this results in a comb of the rotor blade, which comb of the rotor blade is curved in the direction of the trailing edge and which comb of the rotor blade is defined by the way in which the maximum structural height of the cross section of the rotor blade shell develops along the longitudinal direction. In particular, the leading and trailing edges are curved in such a way that the rotor blade comb, in particular in the second portion, no longer extends along a pitch axis about which the rotor blade shell or the corresponding rotor blade can be rotated for adjusting an angle of attack. For example, a distance between the pitch axis and the rotor blade comb, in particular in the second portion, can increase substantially continuously towards the tip of the shell.

Such a curvature of the rotor blade shell or of the corresponding rotor blade is also referred to as a sweep. The loads acting on the rotor blade and the entire wind energy installation can be reduced in the corresponding rotor blade by the rotor blade shell curved in this way. In particular, the so-called bend-twist-coupling effect in the rotor blade structure can be utilized.

The ends of the rotor blade spar cap at the end of the first portion which faces towards the tip of the shell and the at least one fiber layer in the second region make it possible here to achieve particularly strong curvatures of the rotor blade shell, since the shape of the rotor blade shell in the second region is not limited by the linearly extending rotor blade spar cap. In particular, curvatures can thus be achieved in which a conventional rotor blade spar cap comprising substantially the length of the rotor blade shell would penetrate the leading edge of the shell.

As a result of the above-described sweep of the rotor blade, it is possible to significantly reduce the necessary use of material in the entire rotor blade in order to achieve the necessary strength and rigidity. It is also possible to reduce the manufacturing effort in this way.

In a further preferred embodiment, the position of the end of the first portion which faces towards the tip of the shell is defined by a predetermined distance between the rotor blade spar cap and the leading edge, which, in particular due to the profile depth of the rotor blade that decreases steadily in the direction of the blade tip, further approaches the trailing edge of the rotor blade. In this case, the distance between the rotor blade spar cap and the leading edge in the longitudinal direction can be reduced from the root of the shell to the end of the first portion which faces towards the tip of the shell, in particular continuously. The first portion then preferably ends on a side facing the tip of the shell, where the distance corresponds at least substantially to the predetermined distance. The structure of the rotor blade shell can thereby be flexibly adapted to the development of the leading edge. In the case of a rotor blade shell which narrows towards the tip of the shell, at least the stiffness of the rotor blade spar cap can be utilized as a result.

Further advantages, features and possible applications of the present invention will become apparent from the following description in conjunction with the figures. The drawings show:

Fig. 1 an example of a rotor blade in cross section along a transverse direction through a first portion;

Fig. 2 an example of the rotor blade of Fig. 1 in cross section along the transverse direction through a second portion;

Fig. 3 an example of a part of a rotor blade shell in cross section through a transition region;

Fig. 4 an example of a swept rotor blade shell; and

Fig. 5 an example of a swept rotor blade shell having a rotor blade spar cap extending in a first portion from a root of the shell only over a part of the total length of the rotor blade shell along a longitudinal direction of the rotor blade shell.

Figure 1 shows an example of a rotor blade 100 in cross section in a transverse direction Q through a first portion extending along a longitudinal direction perpendicular to the drawing plane. The rotor blade 100 comprises two rotor blade shells 110a, 110b, which are curved in the transverse direction Q and are connected to one another at their shell leading edges 9, at their shell trailing edges 8 and via a web having a leading edge web element 7 and a trailing edge web element 6. Each of the rotor blade shells 110a, 110b comprises a layer system composed of a core layer, an outer laminate 1a, 1b and an inner laminate 5a, 5b, wherein the outer laminates 1a, 1b and the inner laminates 5a, 5b are each arranged on two sides of the core layer which are opposite to one another. Furthermore, a cover layer 10 is arranged on the outer laminates 1a, 1b, which cover layer 10 forms the surfaces of the rotor blade shells 110a, 110b corresponding to the outer side of the rotor blade 100.

The core layers are formed in the first portion by rotor blade spar caps 2a, 2b and a core material 4a, 4b, 3a, 3b, wherein a part of the core material 4a, 4b is arranged between the rotor blade spar caps 2a, 2b and the leading edges 9 of the shell and a further part of the core material 3a, 3b is arranged between the rotor blade spar caps 2a, 2b and the trailing edges 8 of the shell. In other words, the rotor blade spar caps 2a, 2b are surrounded in the first portion by the core material 4a, 4b, 3a, 3b, at least in the transverse direction Q. The core layers serve here over the entire cross section as a carrier for the laminates 1a, 1b, 5a, 5b and provide the shape of the rotor blade shells 110a, 110b or of the rotor blade 100, in particular their curvature.

For example, a foam or balsa wood can be used as core material 4a, 4b, 3a, 3b, thereby achieving dimensional stability with a simultaneously low weight. The laminates 1a, 1b, 5a, 5b are, on the other hand, preferably formed by fiber-containing, in particular glass fiber-containing, woven or fabric layers, which are impregnated with resin for stiffening and for connecting to the core layer. The cover layer 10 can contain a lacquer with which the laminates 1a, 1b, 5a, 5b are coated.

The elastic properties of the rotor blade shells 110a, 110b or of the rotor blade 100 are at least in the first portion substantially influenced by the rotor blade spar caps 2a, 2b, which are produced, for example, from a material which is particularly rigid in a longitudinal direction perpendicular to the drawing plane. The rotor blade spar caps 2a, 2b are preferably extruded fiber composites, such as so-called carbon pultrudates.

In addition, at least one of the rotor blade shells 110a, 110b can also comprise an additional spar cap in the region of the trailing edge 8 of the shell. Alternatively or additionally, rotor blade shells 110a, 110b are also conceivable in which the spar caps 2a and 2b are each divided into two spar cap parts.

Figure 2 shows the rotor blade 100 from Figure 1 with the two rotor blade shells 110a, 110b connected by a leading edge web element 17 and a trailing edge web element 16 in cross section in the transverse direction Q through a second portion extending along a longitudinal direction perpendicular to the drawing plane and adjoining the first portion. In contrast to the first portion, the core layers in the second portion no longer comprise rotor blade spar caps, but are formed exclusively by the core material 14a, 14b, which extends continuously substantially, in the transverse direction Q, from the leading edges 9 of the shell to the trailing edges 8 of the shell. In addition, the outer and inner laminates are formed by outer fiber layers 11a, 11b or inner fiber layers 15a, 15b, which extend, in the transverse direction Q, substantially continuously from the leading edges 9 of the shell to the trailing edges 8 of the shell and contain fibers, a predominant part of which, preferably more than 60 %, in particular more than 80 %, extends in the longitudinal direction, i.e., perpendicular to the plane of the figure.

As fiber layers 11a, 11b, 15a, 15b, which at least approximately ensure the flexural rigidity in the longitudinal direction, which is achieved in the first portion by the rotor blade spar caps, in the second portion as well, so-called full-chord UD layers are preferably used, in which substantially all fibers are oriented unidirectionally, in particular along the longitudinal direction. Alternatively, however, it is also conceivable to use so-called multiaxial fabrics, in which only a part of the fibers is in the longitudinal direction, and another portion of the fibers is oriented in one or more other directions. As a result, the flexural rigidity can also be influenced, in particular increased, in said other directions.

Figure 3 shows an example of a part of a rotor blade shell 110a in cross section along a longitudinal direction L through a transition region U, in which a rotor blade spar cap 12 becomes narrower towards an end A of a first portion A facing a tip of the shell (not shown) of the rotor blade shell 110a. The rotor blade spar cap 12 adjoins a core material 30, which abuts in particular against the end face of the rotor blade spar cap 12 formed by the narrowing and forms a core layer of a layer system with the rotor blade spar cap 12. In this case, the layer system extends, in the longitudinal direction L, from a root of the shell (not shown) of the rotor blade shell 110a in the first portion A to the tip of the shell in a second portion B, which adjoins the end a of the first portion A, which faces towards the tip of the shell and comprises two laminates 21, 51 which surround, in particular enclose, the rotor blade spar cap 12 or the core material 30 on both sides.

In this case, the laminate, which is arranged on a convexly curved side of the rotor blade shell 110a (see Fig. 1 and 2), is also referred to as outer laminate 21 and the laminate on the concavely curved side of the rotor blade shell 110a is referred to as inner laminate 51. At least a part of the outer and inner laminates 21, 51, both in the first and in the second portion A, B, is preferably formed by a fiber composite material, which is shown as a solid line and contains fibers, at least a predominant part of which extends at an angle, for example 45° or 60°, to the longitudinal direction L. Preferably, said fiber composite material, which extends over the entire length of the rotor blade shell L, is designed as a multiaxial fabric or woven in which the fibers extend in a plurality of directions. A cover layer 10 is additionally applied on the fiber composite material of the outer laminate 21, which cover layer 10 protects the laminates 21, 51 lying therebeneath and/or the core layer, in particular the rotor blade spar cap 12 and/or the core material 30, against external influences, e.g., moisture.

Both the outer laminate 21 as the inner laminate 51 each comprise in the second portion B a plurality of fiber layers 20, 50 which comprise fibers, a predominant part of which, preferably more than 60 %, in particular more than 80 %, extends in the longitudinal direction L. Said fiber layers 20, 50 are shown as dot-dash lines and are preferably designed as so-called full-chord UD layers, in which all fibers extend unidirectionally, in particular in the longitudinal direction L. The full-chord UD layers extend from the second portion B into the transition region U, in particular up to the beginning of the narrowing of the rotor blade spar cap 12. The number of said layers in the transition region U increases to the extent that the thickness of the rotor blade spar cap 12 decreases. This gradation is achieved, for example, in that the full-chord UD layers close to the outer or inner laminate 21, 51 are longer than the full-chord UD layers close to the core material 30.

As a result of the orientation of the fibers of the full-chord UD layers along the longitudinal direction L, the flexural rigidity of the rotor blade shell 110a in the longitudinal direction L in the second portion B is increased compared to conventional rotor blade shells, which only comprise an outer and inner laminate 21, 51 having fiber composite materials, the fibers of which extend at an angle to the longitudinal direction L. The fiber layers 20, 50 thus act as an extension of the rotor blade spar cap 12 in the second portion B without the shape of the rotor blade shell 110a being limited by the linear development of the rotor blade spar cap 12.

Figure 4 shows an example of a swept rotor blade shell 110a in plan view, wherein the rotor blade shell 110a extends, in a longitudinal direction L, from a root of the shell 400 to a tip of the shell 401 and, in a transverse direction Q, from a shell trailing edge 8 to a leading edge 9 of the shell. In this case, the leading edge 9 of the shell and the trailing edge 8 of the shell are curved along the longitudinal direction L, so that a development of a rotor blade comb 403, which is curved in the direction of the trailing edge and defines the maximum structural height of the cross section of the rotor blade shell 110a along the longitudinal direction L, is obtained.

Figure 4 also shows a pitch axis 404, about which the rotor blade shell 110a or the corresponding rotor blade can be rotated during operation for adjusting an angle of attack. The curve of the rotor blade comb 403 deviates from the development of the pitch axis 404 due to the curvature of the trailing edge and leading edge of the shell 8, 9. In particular, the rotor blade comb 400 curves away from the pitch axis 404 in the direction of the trailing edge 8 in the region of the tip of the shell 401.

Figure 5 shows an example of a swept rotor blade shell 110a having a rotor blade spar cap 12, which extends in a first portion A from a root of the shell 400 only over a part of the overall length of the rotor blade shell 110a along a longitudinal direction L of the rotor blade shell 110a. In particular, the rotor blade spar cap 12 terminates at an end a of the first portion A, which end, onto which a second portion B joins, faces towards a tip of the shell 401. In this case, the end a of the first portion A which faces towards the tip of the shell 401 rests where a distance between a leading edge of the shell 9 and the rotor blade spar cap 12 assumes a predetermined value.

In order to also at least partially maintain the stability of the rotor blade shell 110a achieved by the rotor blade spar cap 12 in the second region B, the rotor blade shell 11a comprises at least one fiber layer 50 in the second region B, which extends in a transverse direction Q from a trailing edge 8 to the leading edge 9 of the shell and comprises fibers, a predominant part of which, preferably more than 60 %, in particular more than 80 %, extends in the longitudinal direction L. This fiber layer 50 can in particular be designed as a so-called full-chord UD layer in which all fibers extend unidirectionally in the longitudinal direction L. In addition, the fiber layer 50 is part of a layer system (not shown), which extends along the longitudinal direction from the root of the shell 400 to the tip of the shell 401, i.e., both in the first and in the second portion A, B.

As can be seen in Figure 5, the rotor blade spar cap 12 is arranged substantially along a pitch axis 404, about which the rotor blade shell 110a can be rotated during operation for adjusting an angle of attack. A rotor blade comb 403 also extends in the first region A, which rotor blade comb 403 defines the structural height of the rotor blade shell 110a along the longitudinal direction L, along the pitch axis 404, wherein the rotor blade comb 403 is curved towards the trailing edge 8 due to the sweep of the rotor blade shell 110a in the second region B. The rotor blade spar cap 12 thus ends at the end a of the first portion A facing the tip of the shell 401 where the rotor blade comb 403 begins to deviate substantially from the straight development of the pitch axis 404, and the rotor blade spar cap 12 of the leading edge of the shell 9 comes so close as a result that it can no longer be continued in the longitudinal direction L.

PATENTKRAV

1. Rotorbladskal (110a, 110b) til et rotorblad (100) i et vindkraftanlæg, hvor rotorbladskallen (110a, 110b) strækker sig i en længderetning (L) fra en skalrod (400) til en skalspids (401) i en tværretning (Q) fra en skalbagkant (8) til en skalforkant (9) og indeholder et lagsystem, som strækker sig i længderetningen (L), og som indeholder mindst ét kernelag og to laminater (1a, 2b, 5a, 5b, 21, 51), der er anbragt på over for hinanden liggende sider af kernelaget, hvor

- en del af kernelaget i et første afsnit (A) af rotorbladskallen (110a, 110b) dannes af en rotorbladflange (2a, 2b, 12), som forløber i længderetningen (L), og som ender ved en ende (a) af det første afsnit (A), der vender mod skalspidsen, og

- mindst ét af de to laminater (1a, 2b, 5a, 5b, 21, 51) i et andet afsnit (B) af rotorbladskallen (110a, 110b), der ved enden (a) af det første afsnit (A), der vender mod skalspidsen, grænser op til det første afsnit (A) og i det væsentlige strækker sig indtil skalspidsen, indeholder mindst ét fiberlag (11a, 11b, 15a, 15b, 20, 50), der strækker sig i tværretningen (Q) fra skallens bagkant (8) til skallens forkant (9),

kendetegnet ved, at

det i det mindste ene fiberlag (11a, 11b, 15a, 15b, 20, 50) indeholder fibre, af hvilke en overvejende del, fortrinsvis mere end 60 %, særligt mere end 80 %, strækker sig i længderetningen (L), det første afsnit (A) ved enden (a), der vender mod skalspidsen, har et overgangsområde (U), i hvilket rotorbladflangen (2a, 2b, 12) tilspidses, og fiberlag (11a, 11b, 15a, 15b, 20, 50) fra det andet afsnit (B) i det mindste delvist strækker sig ind i overgangsområdet (U), hvor antallet af fiberlag (11a, 11b, 15a, 15b, 20, 50) med fibre, af hvilke en overvejende del strækker sig i længderetningen (L), tiltager fra overgangsområdet (U) og hen til det andet afsnit (B).

2. Rotorbladskal (110a, 110b) ifølge krav 1, hvor i det væsentlige alle fibre i det i det mindste ene fiberlag (11a, 11b, 15a, 15b, 20, 50) er orienteret i længderetningen (L), og/eller det i det mindste ene fiberlag (11a, 11b, 15a, 15b, 20, 50) er udformet som et ensrettet lag.

3. Rotorbladskal (110a, 110b) ifølge et af kravene 1 eller 2, hvor antallet af fiberlag (20, 50) i overgangsområdet (U) tiltager i det omfang, som tykkelsen af rotorbladflangen (12) aftager.

4. Rotorbladskal (110a, 110b) ifølge et af de foregående krav, hvor kernelaget indeholder et kernemateriale (4a, 4b, 3a, 3b, 14a, 14b, 30), der omgiver rotorbladflangen (2a, 2b, 12) i det første afsnit (A).

5. Rotorbladskal (110a, 110b) ifølge et af de foregående krav, hvor lagsystemet omfatter mindst ét dæklag (10), der er anbragt på en side, der vender væk fra kernelaget, på mindst et af laminaterne (1a, 2b, 5a, 5b, 21, 51) og danner en yderside eller en inderside af rotorbladskallen (110a, 110b).

6. Rotorbladskal (110a, 110b) ifølge et af de foregående krav, hvor skallens forkant (9) og skallens bagkant (8) i længderetningen (L) har en krumning, således at en rotorbladkam (400), som er buet i retning af bagkanten (9), og som defineres af forløbet af den maksimale konstruktionshøjde af rotorbladskallens (110a, 110b) tværsnit i længderetningen (L).

7. Rotorbladskal (110a, 110b) ifølge krav 6, hvor positionen af enden (a), der vender mod skalspidsen, af det første afsnit (A) er defineret af en på forhånd fastlagt afstand mellem rotorbladflangen (2a, 2b, 12) og den buede forkant (9).

8. Rotorblad (100) til et vindkraftanlæg, hvor rotorbladet (100) omfatter mindst én rotorbladskal (110a, 110b) ifølge et af de foregående krav.

9. Vindkraftanlæg med mindst ét rotorblad (100) ifølge krav 8.

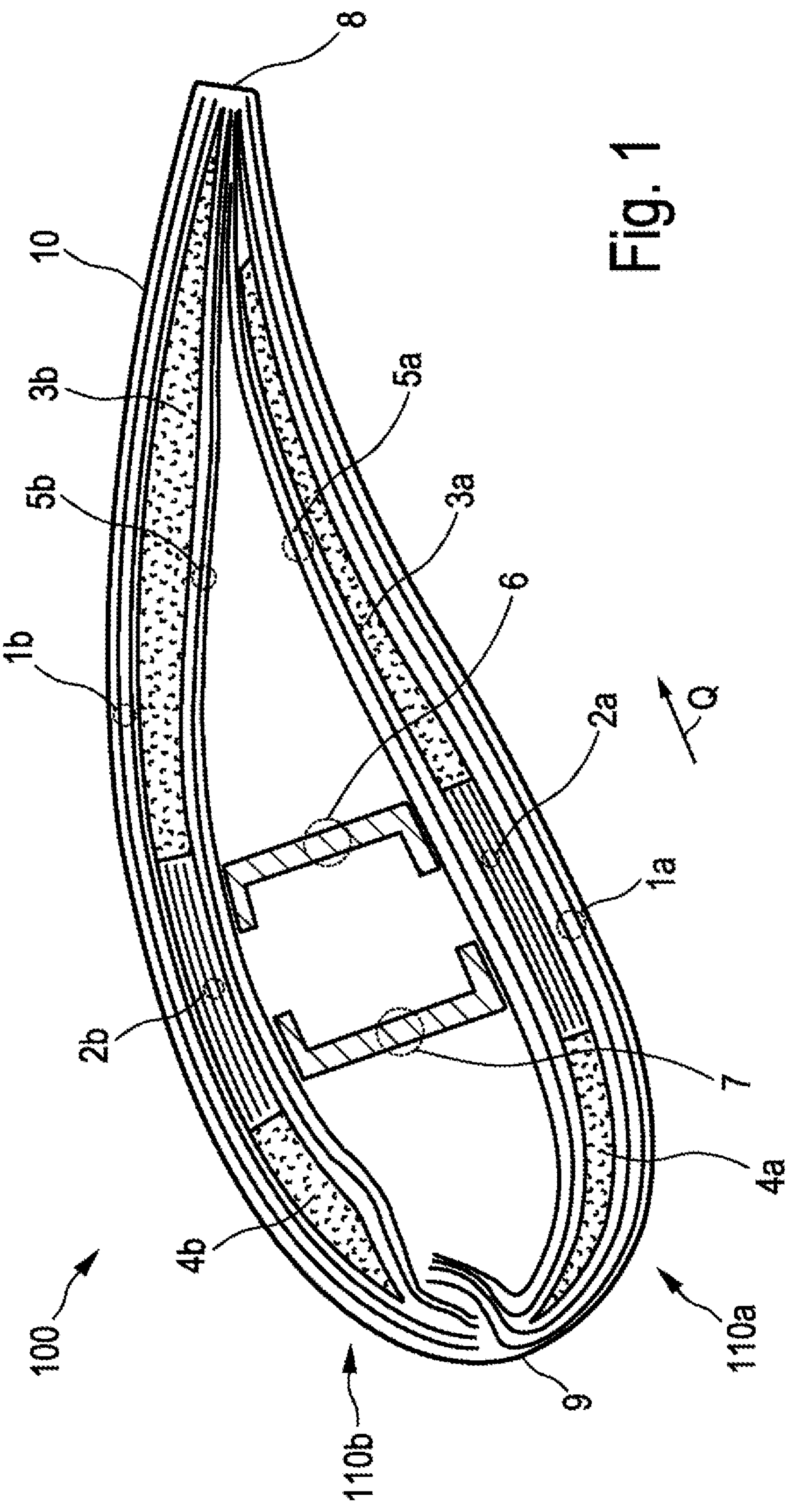

Fig. 1

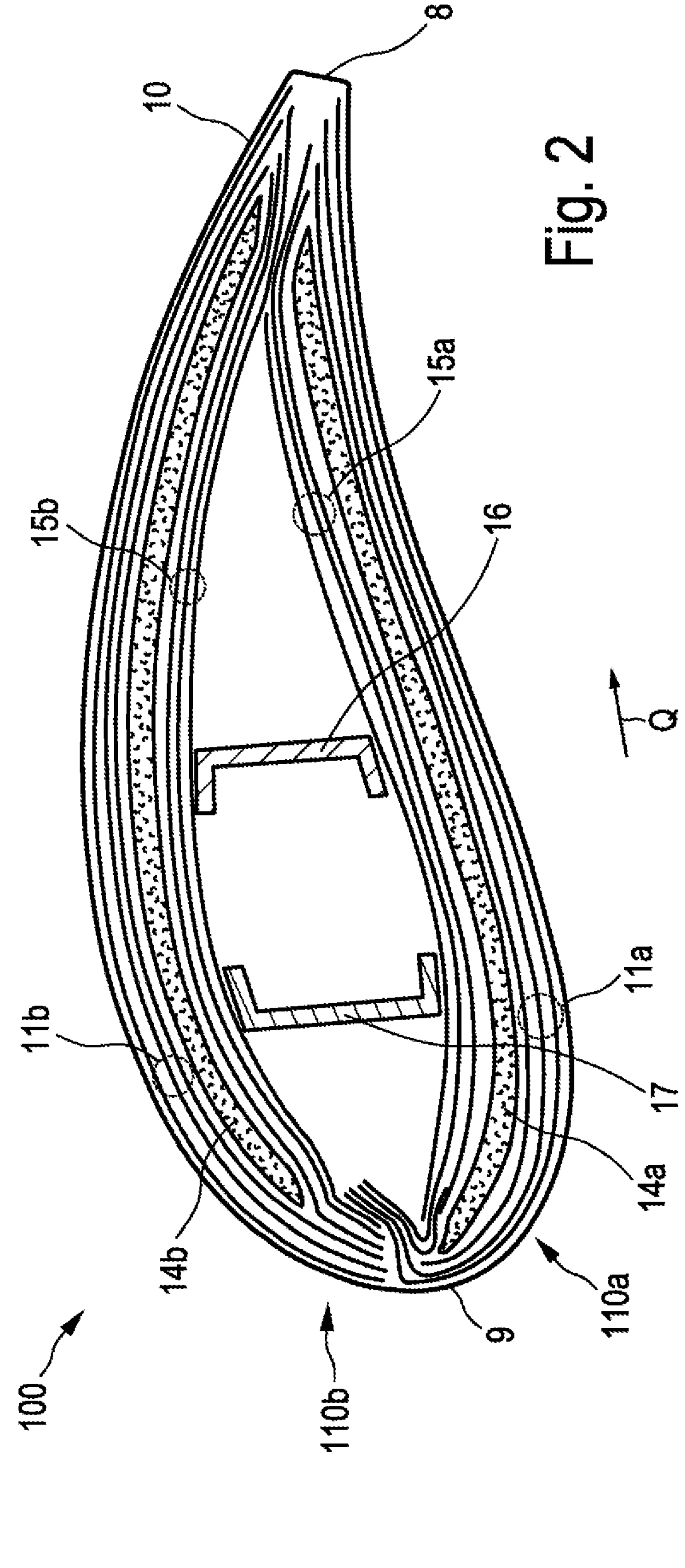

Fig. 2

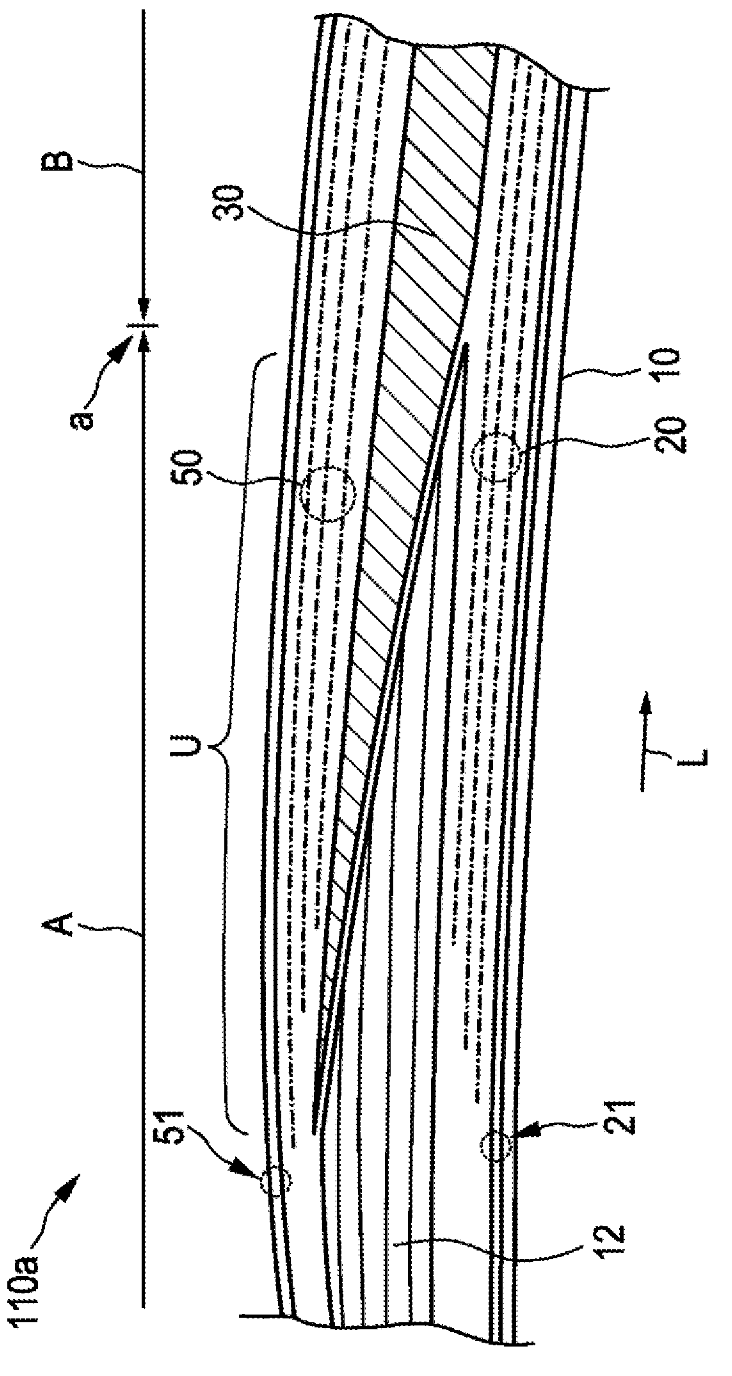

Fig. 3

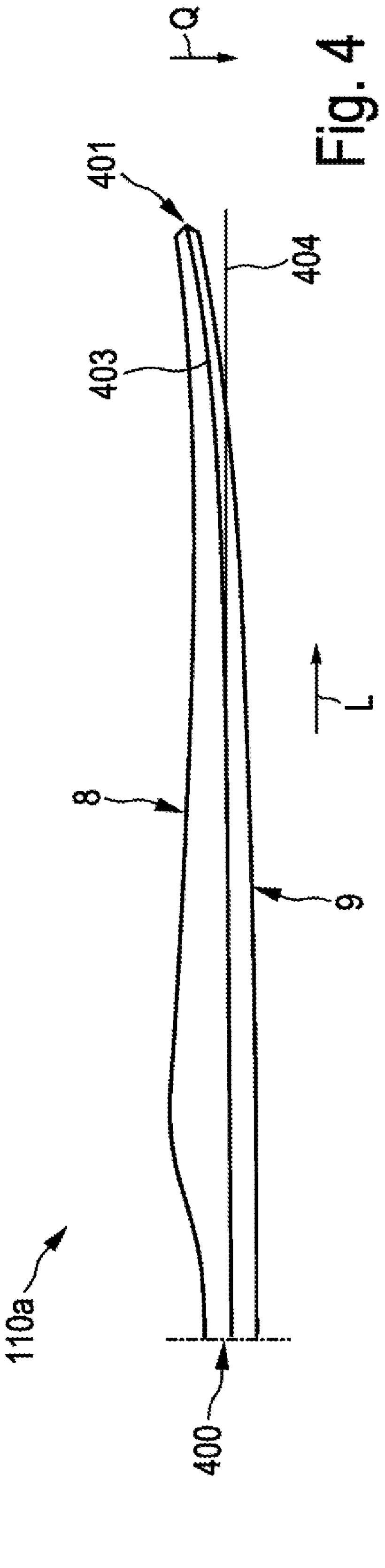

Fig. 4

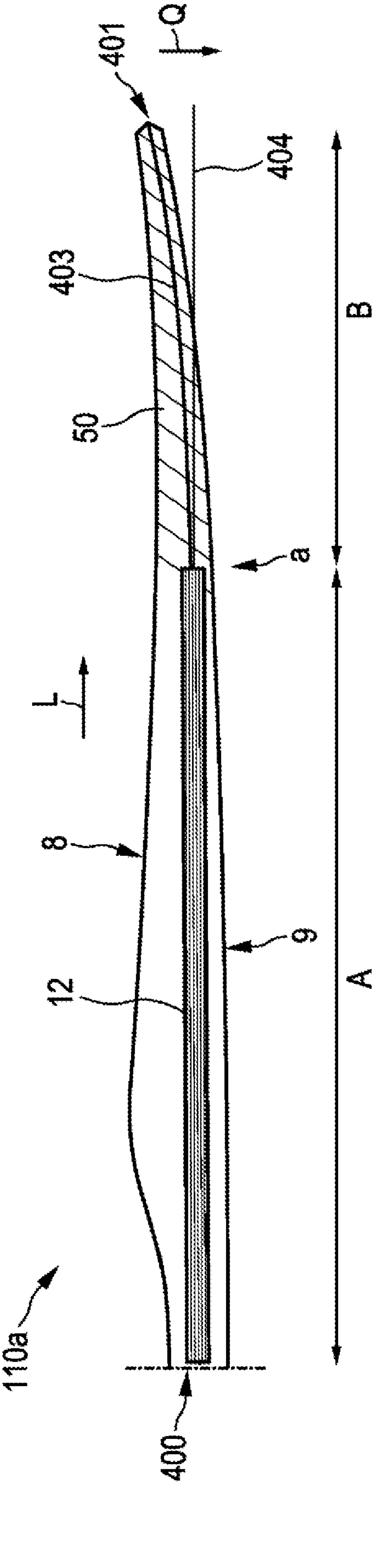

Fig. 5