(19) DANMARK

(10) DK/EP 3734062 T3

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: *F 03 D 1/06 (2006.01)*

(45) Oversættelsen bekendtgjort den: **2023-05-30**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2023-03-29**

(86) Europæisk ansøgning nr.: **18893995.3**

(86) Europæisk indleveringsdag: **2018-05-21**

(87) Den europæiske ansøgnings publiceringsdag: **2020-11-04**

(86) International ansøgning nr.: **CN2018087621**

(87) Internationalt publikationsnr.: **WO2019128052**

(30) Prioritet: **2017-12-25 CN 201711418464**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

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(54) Benævnelse: **Segmenteret vinge, fremgangsmåde til at forbinde segmenterede vinger og vindmøllegeneratorsæt**

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DESCRIPTION

FIELD

[0001] The present application relates to the technical field of wind turbines, and particularly to a segmented blade, a method for forming a segmented blade, and a wind turbine.

BACKGROUND

[0002] Wind turbines are used to convert wind energy into electrical energy. At present, with the increase of the megawatt level of the wind turbines, the length of the blade gradually increases. For the manufacture and transportation of the blade, the gradually increasing length of the blade becomes a prominent problem that restricts the development of the wind turbines.

[0003] EP 2746573A2 discloses methods of assembling rotor blades include providing a first blade segment comprising a first shell portion and at least two first spar cap segments and providing a second blade segment comprising a second shell portion and at least two second spar cap segments. An access region is defined in at least one of the first shell portion and the second shell portion. The second blade segment is then inserted into the first blade segment, such that a spar cap cavity is formed between each set of corresponding first and second spar cap segments, and wherein an access window is defined by the access region at an interface between the first blade segment and the second blade segment, the access window providing access to the spar cap cavities. The method further includes sealing the spar cap cavities and injecting an adhesive into the spar cap cavities to bond the blade segments together, wherein a scarf joint is formed between each set of corresponding first and second spar cap segments.

[0004] EP2815861A1 discloses a method for producing a belt segment for a wind turbine rotor blade, and the wind turbine rotor blade comprises a longitudinal section, which has the belt segment, and at least one further longitudinal section which has a further Having belt segment, the belt segment being produced in a molding tool and having a connecting portion for connection to the further belt segment and the method comprising the following steps: a) providing a first molding tool part, b) arranging a first layer package of reinforcing fibers in the first molding tool part and arranging a second molding tool part, so that a first gap between the first molding tool part and the second molding tool part is formed, in which a part of the first layer package of the reinforcing fibers is arranged, c) arranging a second layer package from verse reinforcing fibers and arranging a third mold part, so that a second space is formed between the third mold part and the second mold part, in which a part of the second layer package of the reinforcing fibers is arranged, d) curing a plastic material surrounding the reinforcing fibers, and e) removing the belt segment from the mold, the first and second intermediate spaces being shaped and arranged relative to one another in such a way that the sections of the belt segment manufactured therein reach the connecting section for connection

to the other Form the connecting section of the further belt segment.

SUMMARY

[0005] An object of the present application is to provide a segmented blade, which substantially do not increase the weight of the blade and has high reliability, a method of forming the segmented blade, and a wind turbine.

[0006] According to an aspect of the present application, a segmented blade is provided. The segmented blade includes a first blade segment having a first main spar, a second blade segment having a second main spar, and an outer shell. The first blade segment is close to a blade root, the first main spar includes a first body portion arranged in the first blade segment and a first clamping portion extending from an end of the first body portion toward a direction away from a blade root, and a height of the first clamping portion is gradually decreased in the direction away from the blade root. The second blade segment is close to a blade tip, the second main spar includes a second body portion arranged in the second blade segment and a second clamping portion extending from an end of the second body portion toward a direction getting close to the blade root, and a height of the second clamping portion is gradually increased in the direction getting close to the blade root. The second clamping portion is clamp-fitted into the first clamping portion. The outer shell is configured to encase a clearance between the first blade segment and the second blade segment. The first clamping portion is formed by extending any three of two main spar caps and two shear webs of the first main spar in the direction away from the blade root and the second blade segment is inserted chordwise into the first blade segment.

[0007] According to another aspect of the present application, a method of forming a segmented blade is provided. The method includes: providing a first blade segment having a first main spar, wherein the first blade segment is close to a blade root, the first main spar includes a first body portion arranged in the first blade segment and a first clamping portion extending from an end of the first body portion toward a direction away from the blade root, and a height of the first clamping portion is gradually decreased in the direction away from the blade root, and the first clamping portion is formed by extending any three of two main spar caps and two shear webs of the first main spar in the direction away from the blade root and the second blade segment is inserted chordwise into the first blade segment; providing a second blade segment having a second main spar, wherein the second blade segment is close to a blade tip, the second main spar includes a second body portion arranged in the second blade segment and a second clamping portion extending from an end of the second body portion toward a direction getting close to the blade root, and a height of the second clamping portion is gradually increased in the direction getting close to the blade root; clamp-fitting the second clamping portion into the first clamping portion; and encasing, by an outer shell, a clearance between the first blade segment and the second blade segment.

[0008] According to yet another aspect of the present application, a wind turbine is provided.

The wind turbine includes the above segmented blade.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Through the following detailed description in conjunction with the drawings, the above and other objects, features and advantages of the present application will become more apparent.

Figure 1 is a schematic view of an outline of a conventional blade;

Figure 2 is a schematic view showing a main spar of the blade;

Figure 3 is a schematic view showing the main spar of the blade in Figure 2 in another direction;

Figure 4 is a schematic view showing a first blade segment according to an embodiment of the present application;

Figure 5 is an enlarged schematic view showing a portion P1 of the first blade segment in Figure 4;

Figure 6 is a schematic view showing a first main spar of the first blade segment in Figure 4;

Figure 7 is a schematic view showing a second blade segment according to the embodiment of the present application;

Figure 8 is an enlarged schematic view showing a portion P2 of the second blade segment in Figure 7;

Figure 9 is a schematic view showing a second main spar of the second blade segment in Figure 7;

Figure 10 is a schematic view showing that the first main spar in Figure 6 and the second main spar in Figure 9 are connected;

Figure 11 is a schematic view showing that the first blade segment in Figure 5 and the second blade segment in Figure 7 are connected;

Figure 12 is an enlarged schematic view showing a portion P3 in Figure 11; and

Figure 13 is a schematic view showing that a clearance between the first blade segment and the second blade segment is encased by using an outer shell.

[0010]

Reference Numerals:

1	blade,	2	main spar,
21	main spar cap,	22	shear web,
100	first blade segment,	110	leading edge shell,
120	trailing edge shell,	130	first body portion,
140	first clamping portion,	150	first main spar,
151	main spar cap of the first main spar,	152	shear web of the first main spar,
153	gap,	200	second blade segment,
210	leading edge shell,	220	trailing edge shell,
230	second body portion,	240	second clamping portion,
250	second main spar,		
251	main spar cap of the second main spar,		
252	shear web of the second main spar,		
300	reinforcing member,	400	outer shell.

DETAILED DESCRIPTION

[0011] First, a shape of a conventional blade will be described with reference to Figures 1 to 3. Figure 1 is a schematic view of the shape of the conventional blade, Figure 2 is a schematic view showing a main spar of the blade, and Figure 3 is a schematic view showing the main spar of the blade in Figure 2 in another direction.

[0012] A wind turbine may include a blade 1 in Figure 1. As shown in Figure 1, the blade 1 becomes thinner and thinner from a blade root to a blade tip. A main spar 2 in Figures 2 and 3 may be arranged in the blade 1. The main spar 2 may include two main spar caps 21 and two shear webs 22. One of the two main spar caps 21 may be arranged at an upper housing of the blade 1, and the other of the two main spar caps 21 may be arranged at a lower housing of the blade 1. The two shear webs 22 are configured to support the two main spar caps 21 at two sides of the two main spar caps 21. As shown in Figure 3, heights of the shear webs 22 become smaller and smaller, that is, a distance between the two main spar caps 21 becomes smaller and smaller. In addition, a distance between the two shear webs 22 may become smaller and smaller, or may be unchanged.

[0013] A segmented blade according to an embodiment of the present application makes full use of a feature that the blade 1 shown in Figure 1 becomes thinner and thinner from the blade root to the blade tip, and the main spar 2 of the segmented blade is used for clamping and limiting connection. Hereinafter, the segmented blade according to the embodiment of the present application will be described in detail with reference to Figures 4 to 13.

[0014] As shown in Figures 4 to 13, the segmented blade may include: a first blade segment 100 having a first main spar 150, wherein the first blade segment 100 is close to the blade root, the first main spar 150 includes a first body portion 130 arranged in the first blade segment 100 and a first clamping portion 140 extending from an end of the first body portion 130 toward a direction D1 away from the blade root, and a height of the first clamping portion 140 is gradually decreased in the direction D1 away from the blade root; a second blade segment 200 having a second main spar 250, wherein the second blade segment 200 is close to a blade tip, the second main spar 250 includes a second body portion 230 arranged in the second blade segment 200 and a second clamping portion 240 extending from an end of the second body portion 230 toward a direction D3 getting close to the blade root, and a height of the second clamping portion 240 is gradually increased in the direction D3 getting close to the blade root, where the second clamping portion 240 is clamp-fitted into the first clamping portion 140; and an outer shell 400 configured to encase a clearance G between the first blade segment 100 and the second blade segment 200.

[0015] As shown in Figures 4 to 6, at a side of the first blade segment 100 close to the blade root, the first blade segment 100 may include a leading edge shell 110 and a trailing edge shell 120. An upper half housing of the leading edge shell 110 and an upper half housing of the trailing edge shell 120 may form an upper housing of the first blade segment 100, and a lower half housing of the leading edge shell 110 and a lower half housing of the trailing edge shell 120 may form a lower housing of the first blade segment 100.

[0016] The first main spar 150 may include two main spar caps 151 and two shear webs 152, wherein the two main spar caps 151 may be arranged at the upper housing and the lower housing of the first blade segment 100, respectively, and the two shear webs 152 may be arranged at two sides of the two main spar caps 151 respectively, to support the two main spar caps 151.

[0017] Optionally, the first clamping portion 140 may be formed by extending any three of the two main spar caps 151 and the two shear webs 152 of the first main spar 150 in the direction D1 away from the blade root.

[0018] Figures 4 and 5 shows an example in which the first clamping portion 140 is formed by extending the two main spar caps 151 and one shear web 152. However, the present application is not limited thereto, and the first clamping portion 140 may also be formed by extending one main spar cap 151 and the two shear webs 152. A gap 153 is formed in the first clamping portion 140 because one of the main spar caps 151 or one of the shear webs 152 is not extended. Hereinafter, description will be made by taking a case that the gap 153 is formed because the shear web 152 is not extended as an example.

[0019] Referring to Figures 1 and 3, the heights of the shear webs 22 are gradually decreased from the blade root to the blade tip of the blade 1. Therefore, according to the embodiment of the present application, as shown in Figure 6, along the direction D1 away from the blade root,

a height of the first clamping portion 140 in a thickness direction D2 of an airfoil (that is, the heights of the shear webs 152 in Figure 4) is gradually decreased. Therefore, in general, the first clamping portion 140 may be formed in a tubular shape having an opening gradually decreasing in the direction D1 away from the blade root and having the gap 153.

[0020] In addition, as shown in Figure 6, according the embodiment of the present application, each of the main spar caps 151 of the first clamping portion 140 may be concaved with respect to an extension line of the corresponding main spar cap 151 in the first body portion 130, to form a first step t1 between the first clamping portion 140 and the first body portion 130, and a height of the first step t1 may range from 6 mm to 10 mm.

[0021] When the first main spar 150 is manufactured, each of the main spar caps 151 of the first clamping portion 140 may be concaved by an amount of the first step t1 in the thickness direction D2 of the airfoil, that is, each of the main spar caps 151 of the first clamping portion 140 may be concaved by the amount of the first step t1 with respect to the design of an original main spar cap, thereby providing a space for the subsequent process of winding a reinforcing member 300 (described in detail below).

[0022] As shown in Figures 7 to 9, at a side of the second blade segment 200 close to the blade root, the second blade segment 200 may include a leading edge shell 210 and a trailing edge shell 220. An upper half housing of the leading edge shell 210 and an upper half housing of the trailing edge shell 220 may form an upper housing of the second blade segment 200, and a lower half housing of the leading edge shell 210 and a lower half housing of the trailing edge shell 220 may form a lower housing of the second blade segment 200.

[0023] The second main spar 250 may include two main spar caps 251 and two shear webs 252, wherein the two main spar caps 251 may be arranged at the upper housing and the lower housing of the second blade segment 200, respectively, and the two shear webs 252 may be arranged at two sides of the two main spar caps 251 respectively, to support the two main spar caps 251.

[0024] Considering the clamping stability between the second clamping portion 240 and the first clamping portion 140 and the stability of the blade after the segmented blade is formed, preferably, the second clamping portion 240 may be formed by extending the two main spar caps 251 and the two shear webs 252. However, the present application is not limited thereto. Similar to the first clamping portion 140, the second clamping portion 240 may also be formed by extending any three of the two main spar caps 251 and the two shear webs 252. An example in which the second clamping portion 240 is formed by extending the two main spar caps 251 and the two shear webs 252 will be described hereinafter.

[0025] According to the embodiment of the present application, as shown in Figure 9, the height of the second clamping portion 240 in the thickness direction D2 of the airfoil becomes greater and greater in the direction D3 getting close to the blade root.

[0026] In addition, according to the embodiment of the present application, as shown in Figure 9, each of the two main spar caps 251 in the second clamping portion 240 is concaved with respect to an extension line of the corresponding main spar cap 251 in the second body portion 230, to form a second step t2 between the second clamping portion 240 and the second body portion 230, where a height of the second step t2 is equal to a sum of the height of the first step t1 and a thickness of the main spar cap 151 of the first main spar 150. In addition, the two shear webs 252 of the second clamping portion 240 offset respectively, in a direction allowing the two shear webs 252 to get close to each other, by a predetermined distance with respect to extension lines of the shear webs 252 of the second body portion 230, and the predetermined distance is a thickness of a shear web 152 of the first main spar 150.

[0027] In a case that the main spar caps 251 in the second clamping portion 240 are manufactured according to the design of the original main spar, when the second clamping portion 240 is to be clamp-fitted into the first clamping portion 140, the main spar caps 251 in the second clamping portion 240 and the main spar caps 151 in the first clamping portion 140 may get stuck, and thus the second clamping portion 240 cannot be clamp-fitted into the first clamping portion 140. Therefore, according to the embodiment of the present application, when the second main spar 250 is manufactured, each of the two main spar caps 251 in the second clamping portion 240 is concaved by the second step t2 in a direction allowing the two main spar caps 251 to get close to each other.

[0028] In addition, if the shear webs 252 in the second clamping portion 240 are manufactured according to the design of the original main spar, dimensions of the shear webs 252 in the second clamping portion 240 and dimensions of the shear webs 152 in the first clamping portion 140 in a chord direction of the blade are identical to each other. In order to avoid interference between the shear webs 252 and the shear webs 152 in a case that the second clamping portion 240 is clamp-fitted into the first clamping portion 140, the two shear webs 252 of the second clamping portion 240 may offset respectively, in the direction allowing the two shear webs 252 to get close to each other, by the predetermined distance with respect to extension lines of the shear webs 252 of the second body portion 230, and the predetermined distance may be the thickness of the shear web 152.

[0029] According to the embodiment of the present application, in order to reduce stress when the first clamping portion 140 and the second clamping portion 240 are clamp-fitted to each other, as shown in Figure 6 and Figure 9, thicknesses of the main spar caps 151 of the clamping portion 140 are gradually decreased in the direction D1 away from the blade root, and thicknesses of the main spar caps 251 of the second clamping portion 240 are gradually decreased in the direction D3 getting close to the blade root. In addition, thicknesses of the shear webs 152 of the first clamping portion 140 may also be gradually decreased in the direction D1 away from the blade root, and thicknesses of the shear webs 252 of the second clamping portion 240 may also be gradually decreased in the direction D3 getting close to the blade root, to reduce the stress when the first clamping portion 140 and the second clamping portion 240 are clamp-fitted to each other.

[0030] In addition, according to the embodiment of the present application, the main spar caps 151 of the first clamping portion 140 may have flat inner surfaces, and the main spar caps 251 of the second clamping portion 240 may have flat outer surfaces. Specifically, due to a shape of the blade, the main spar caps 151 in the first main spar 150 and the main spar caps 251 in the second main spar 250 may be arc-shaped. Therefore, when the first main spar 150 and the second main spar 250 are manufactured, the inner surfaces of the main spar caps 151 in the first clamping portion 140 and the outer surfaces of the main spar caps 251 in the second clamping portion 240 may be flattened, to avoid a gap between the main spar caps 151 in the first clamping portion 140 and the main spar caps 251 in the second clamping portion 240 during assembly.

[0031] In addition, according to the embodiment of the present application, lengths of the first clamping portion 140 and the second clamping portion 240 may be determined according to the shape and load of the blade, which are not specifically limited. In an example, the lengths of the first clamping portion 140 and the second clamping portion 240 may range from 0.5 m to 5 m.

[0032] The second clamping portion 240 in Figure 8 may be clamp-fitted into the first clamping portion 140 through the gap 153 of the first clamping portion 140 in Figure 5. That is, the second clamping portion 240 in Figure 8 may enter the first clamping portion 140 from the gap 153 in Figure 5 in a chord direction of the first blade segment 100, and thus is clamp-fitted into the first clamping portion 140. In a clamp-fitting state, the two main spar caps 251 of the second clamping portion 240 may be abutted against the two main spar caps 151 of the first clamping portion 140 respectively (as shown in Figure10), and one of the shear webs 252 of the second clamping portion 240 may be abutted against the shear web 152 of the first clamping portion 140 in Figure 5.

[0033] As described above, a gap may also be formed in a case that one of the spar caps 151 is not allowed to extend. In this case, the second clamping portion 240 may enter the first clamping portion 140 from the gap in the thickness direction D2 of the airfoil of the first blade segment 100, and thus is clamp-fitted into the first clamping portion 140.

[0034] According to the embodiment of the present application, the segmented blade may further include a filling member (not shown), which may be used to fill the gap 153. For example, as shown in Figure 5, in a case that the gap 153 is formed by a shear web 152 which is not allowed to extend, the filling member may be formed by a material same as that of the shear web 152, to fill the gap 153, so as to ensure the reliability of the blade. In addition, it should be understood that, in a case that the gap is formed by a spar cap 151 which is not allowed to extend, the filling member may be formed by a material same as that of the spar cap 151, to fill the gap.

[0035] According to the embodiment of the present application, in order to further ensure the stability of the clamping connection between the second clamping portion 240 and the first clamping portion 140, the segmented blade may further include a reinforcing member 300, as

shown in Figure 10. For example, after the gap 153 is filled by the filling member, the reinforcing member 300 may be wound around an outer periphery of the first clamping portion 140, to achieve smooth transition between the first main spar 150 and the second main spar 250.

[0036] The reinforcing member 300 may be an insulating material, so as to prevent lightning strikes. Preferably, the reinforcing member 300 may be a reinforcing material impregnated with resin (not shown), so as to provide a stronger fastening force. Optionally, the reinforcing material may be a fiberglass cloth, such as a triaxial fiberglass cloth. However, the present application is not limited thereto, and the reinforcing member 300 may be other string-like members.

[0037] According to the embodiment of the present application, the outer shell 400 (as shown in Figure 13) may be configure to encase the clearance G between the first blade segment 100 and the second blade segment 200 (as shown in Figure 12).

[0038] Specifically, a first bonding angle and a second bonding angle may be formed at a portion of the first blade segment 100 and a portion of the second blade segment 200 adjacent to each other, respectively; the first bonding angle is formed by concaving the first blade segment 100 inwardly, and the second bonding angle is formed by concaving the second blade segment 200 inwardly. The outer shell 400 may be covered on the first bonding angle and the second bonding angle, to allow the first bonding angle and the second bonding angle to be flush with other portions of the segmented blade. For example, the outer shell 400 may be adhered to the first bonding angle and the second bonding angle by a liquid structural adhesive, and then the structural adhesive is cured.

[0039] According to the embodiment of the present application, on the basis of ensuring an aerodynamic shape of the blade, seams between the outer shell 400 and the first blade segment 100 and between the outer shell 400 and the second blade segment 200 may be reinforced. For example, the reinforcing material such as the fiberglass cloth may be laid at the seams between the outer shell 400 and the first blade segment 100 and between the outer shell 400 and the second blade segment 200, and then the resin is poured; or, the reinforcing material impregnated with the resin may be directly laid to form a reinforcing layer for reinforcement.

[0040] In addition, a reinforcing area may be polished and sprayed with a surface protective layer, and a segmented position may be sprayed with a pigment having a color different from that of a surface of the blade, so as to facilitate subsequent inspection of the blade.

[0041] It should be understood that, although the segmented blade according to the present application is described hereinbefore by taking a segmented blade including two blade segments as an example, the present application is not limited thereto, and the segmented blade may include three or more blade segments, wherein two adjacent blade segments may be connected to each other by the above-described manner of connecting through a main

spar.

[0042] According to another embodiment of the present application, a wind turbine may be provided. The wind turbine may include the segmented blade as described above.

[0043] As described above, the segmented blade according to the present application makes use of a feature that the blade becomes thinner and thinner from the blade root to the blade tip, and the blade segments may be clamp-fitted together by the main spar. Compared with the bolted connection, the segmented blade according to the present application substantially does not increase the weight of the blade, therefore, a load in an oscillation direction and a fatigue load of the blade can be reduced, and the inconvenience that pre-tightening is required in the bolted connection can be avoided. In addition, compared with the structural adhesive connection, a distance between the main spar caps of the main spar becomes smaller and smaller in the direction from the blade root to the blade tip, therefore, the blade segment close to the blade tip does not come out of the blade segment close to the blade root, and thus the connection reliability is higher.

[0044] In addition, according to the embodiment of the present application, a fastener (the reinforcing material impregnated with the resin is preferably employed) can be employed to wind a portion where the two clamping portions are clamp-fitted to each other, and thus the reliability of the clamping connection between the main spars of the two blade segments clamp-fitted to each other can be further improved.

[0045] Furthermore, the number of bolts is limited in the bolted connection, therefore, it cannot be realized that the blade can be segmented at any position. However, according to the segmented blade of the present application, the blade can be segmented at any position, and therefore a degree of freedom of segmentation is increased.

[0046] In addition, a manner such as plug connection or bolted connection or the like is usually employed between conventional blade segments, and metal materials are inevitably used, which not only increases the weight of the blade itself, but also may cause lightning strikes. However, according to the segmented blade of the present application, the blade segments are directly connected by insulating materials, so that the blade is light-weight and lightning strikes can be avoided.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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- EP2815861A1 [0004]

Patentkrav

1. Segmenteret blad, omfattende:

et første bladsegment (100) med en første hovedring (150), hvor det første bladsegment (100) er tæt på en bladrod, hvor den første hovedring (150) omfatter en første kropsdel (130), der er anbragt i det første bladsegment (100), og en første klemdel (140), der strækker sig fra en ende af den første kropsdel (130) mod en retning (D1) væk fra en bladrod, og hvor en højde af den første klemdel (140) formindskes gradvist i retningen (D1) væk fra bladroden;

et andet bladsegment (200) med en anden hovedring (250), hvor det andet bladsegment (200) er tæt på en bladspids, hvor den anden hovedring (250) omfatter en anden kropsdel (230), der er anbragt i det andet bladsegment (200), og en anden klemdel (240), der strækker sig fra en ende af den anden kropsdel (230) mod en retning (D3), der kommer tæt på bladroden, hvor en højde af den anden klemdel (240) øges gradvist i den retning (D3), der kommer tæt på bladroden, og den anden klemdel (240) er tilpasset ved klemning ind i den første klemdel (140); og

en ydre skal (400), der er konfigureret til at indkapsle et mellemrum (G) mellem det første bladsegment (100) og det andet bladsegment (200),

kendetegnet ved, at den første klemdel (140) er dannet ved at strække en hvilken som helst tre af to hovedringkapper (151) og to forskydningsbaner (152) af den første hovedring (150) i retningen (D1) væk fra bladroden, og det andet bladsegment (200) indsættes aksialt i det første bladsegment (100).

2. Segmenteret blad ifølge krav 1, hvor enhver af hovedringkapperne (151) i den første klemdel (140) er konkave i forhold til en forlængelseslinje af den tilsvarende hovedringkappe (151) i den første kropsdel (130), for at danne et første trin mellem den første klemdel (140) og den første kropsdel (130).

3. Segmenteret blad ifølge krav 2, hvor den anden klemdel (240) er dannet ved at strække to hovedringkapper (251) og to forskydningsbaner (252) af den anden hovedring (250) i den retning (D3), der kommer tæt på til bladroden.

4. Segmenteret blad ifølge krav 3, hvor enhver af de to hovedringkapper (251) i den anden klemdel (240) er konkav i forhold til en forlængelseslinje af den tilsvarende hovedringkappe (251) i den anden kropsdel (230), for at danne et andet trin mellem den anden klemdel (240) og den anden kropsdel (230), og hvor en højde af det andet trin er lig med summen af en højde af det første trin og en tykkelse af hovedringkappen (151) af den første hovedring (150); og hvor de to forskydningsbaner (252) af den anden klemdel (240) er forskudt henholdsvis i en retning, der tillader de to forskydningsbaner (252) at komme tæt på hinanden med en forudbestemt afstand i forhold til forlængelseslinjerne af forskydningsbanerne (252) af den anden kropsdel (230), og hvor den forudbestemte afstand er en tykkelse af en forskydningsbane (152) af den første hovedring (150).

5. Segmenteret blad ifølge krav 1, yderligere omfattende:
et fyldningselement, hvor fyldningselementet er konfigureret til at udfylde et mellemrum (153), der er dannet i den første klemdel (140) på grund af, at en af hovedringkapperne (151) eller det ene af forskydningsbanerne (152) af den første hovedring (150) ikke strækker sig i retningen (D1) væk fra bladroden.

6. Segmenteret blad ifølge krav 2, yderligere omfattende:
et forstærkningselement (300), hvor forstærkningselementet (300) er viklet rundt om en ydre periferi af den første klemdel (140), for at opnå en jævn overgang mellem den første hovedring 150) og den anden hovedring (250).

7. Segmenteret blad ifølge krav 6, hvor forstærkningselementet omfatter et forstærkningsmateriale, der er imprægneret med harpiks.

8. Segmenteret blad ifølge krav 3, hvor
i retningen (D1) væk fra bladroden, formindskes tykkelserne af hovedringkapperne (151) og forskydningsbanerne (152) af den første klemdel (140) gradvist; og
i retningen (D3), der kommer tæt på bladroden, formindskes tykkelserne af hovedringkapperne (251) og forskydningsbanerne (252) af den anden klemdel (240) gradvist.

9. Segmenteret blad ifølge krav 1, hvor en første bindingsvinkel og en anden bindingsvinkel er dannet ved henholdsvis en del af det første bladsegment (100) og en del af det andet bladsegment (200) stødende op til hinanden; den første bindingsvinkel er dannet ved at gøre det første bladsegment (100) konkavt indad, og den anden bindingsvinkel er dannet ved at gøre det andet bladsegment (200) konkavt indad; og
den ydre skal (400) er dækket af den første bindingsvinkel og den anden bindingsvinkel for at gøre det muligt for den første bindingsvinkel og den anden bindingsvinkel at flugte med andre dele af det segmenterede blad.

10. Segmenteret blad ifølge krav 1, yderligere omfattende:
et forstærkende lag, som er monteret på sømme mellem den ydre skal (400) og det første bladsegment (100) og mellem den ydre skal (400) og det andet bladsegment (200).

11. Fremgangsmåde til dannelse af et segmenteret blad, omfattende:
tilvejebringelse af et første bladsegment (100) med en første hovedring (150), hvor det første bladsegment (100) er tæt på en bladrod, hvor den første hovedring (150) omfatter en første kropsdel (130), der er anbragt i det første

bladsegment (100), og en første klemdel (140), der strækker sig fra en ende af den første kropsdel (130) mod en retning (D1) væk fra bladroden, og hvor en højde af den første klemdel (140) formindskes gradvist i retningen (D1) væk fra bladroden, og den første klemdel (140) dannes ved at forlænge en hvilken som helst tre af to hovedringkapper (151) og to forskydningsbaner (152) af den første hovedring (150) i retningen (D1) væk fra bladroden, og det andet bladsegment (200) indsættes aksialt i det første bladsegment (100);

tilvejebringelse af et andet bladsegment (200) med en anden hovedring (250), hvor det andet bladsegment (200) er tæt på en bladspids, hvor den anden hovedring (250) omfatter en anden kropsdel (230), der er anbragt i det andet bladsegment (200), og en anden klemdel (240), der strækker sig fra en ende af den anden kropsdel (230) mod en retning (D3), der kommer tæt på bladroden, og en højde af den anden klemdel (240) øges gradvist i retningen (D3), der kommer tæt på bladroden;

tilpasning af den anden klemdel (240) ved klemning ind i den første klemdel (140); og

indkapsling, ved hjælp af en ydre skal (400), af et mellemrum (G) mellem det første bladsegment (100) og det andet bladsegment (200).

12. Fremgangsmåde ifølge krav 11,

dannelse af den anden klemdel (240) ved at forlænge to hovedringkapper (251) og to forskydningsbaner (252) af den anden hovedring (250) i den retning (D3), der kommer tæt på bladroden; og

da der er dannet et mellemrum (153) i den første klemdel (140) på grund af, at den ene af hovedringkapperne (151) eller en af forskydningsbanerne (152) af den første hovedring (150) ikke strækker sig i retningen (D1) væk fra bladroden, når den anden klemdel (240) er tilpasset ved klemning ind i den første klemdel (140), tilpasning af den anden klemdel (240) ved klemning ind i den første klemdel (140) fra mellemrummet (153).

13. Fremgangsmåde ifølge krav 12, yderligere omfattende:
efter at den anden klemdel (240) er tilpasset ved klemning ind i den første klemdel (140) og før indkapsling af mellemrummet (G) mellem det første bladsegment (100) og det andet bladsegment (200), fyldning af mellemrummet (153) med et fyldningselement; og
efter fyldning af mellemrummet (153) med fyldningselementet og før indkapsling af mellemrummet (G) mellem det første bladsegment (100) og det andet bladsegment (200), vikling af et forstærkningselement (300) rundt om en ydre periferi af det første klemdel (140), for at opnå en jævn overgang mellem den første hovedring (150) og den anden hovedring (250).

14. Vindmølle, omfattende det segmenterede blad ifølge et hvilket som helst af kravene 1 til 10.

DRAWINGS

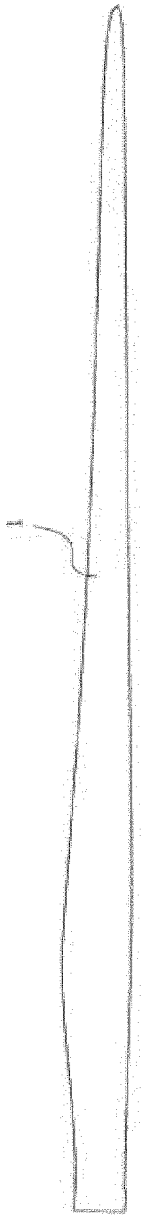

Figure 1

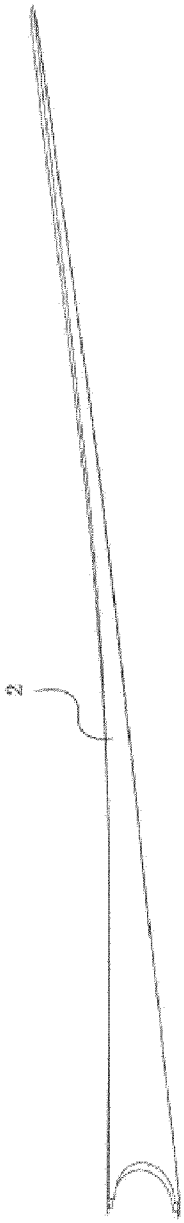

Figure 2

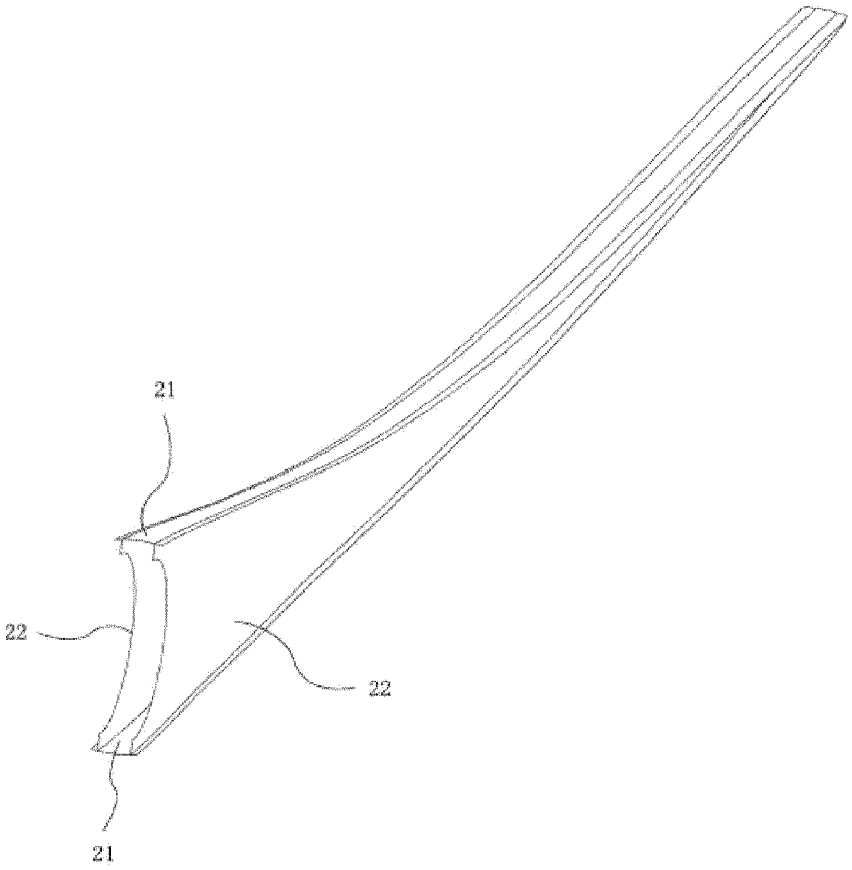

Figure 3

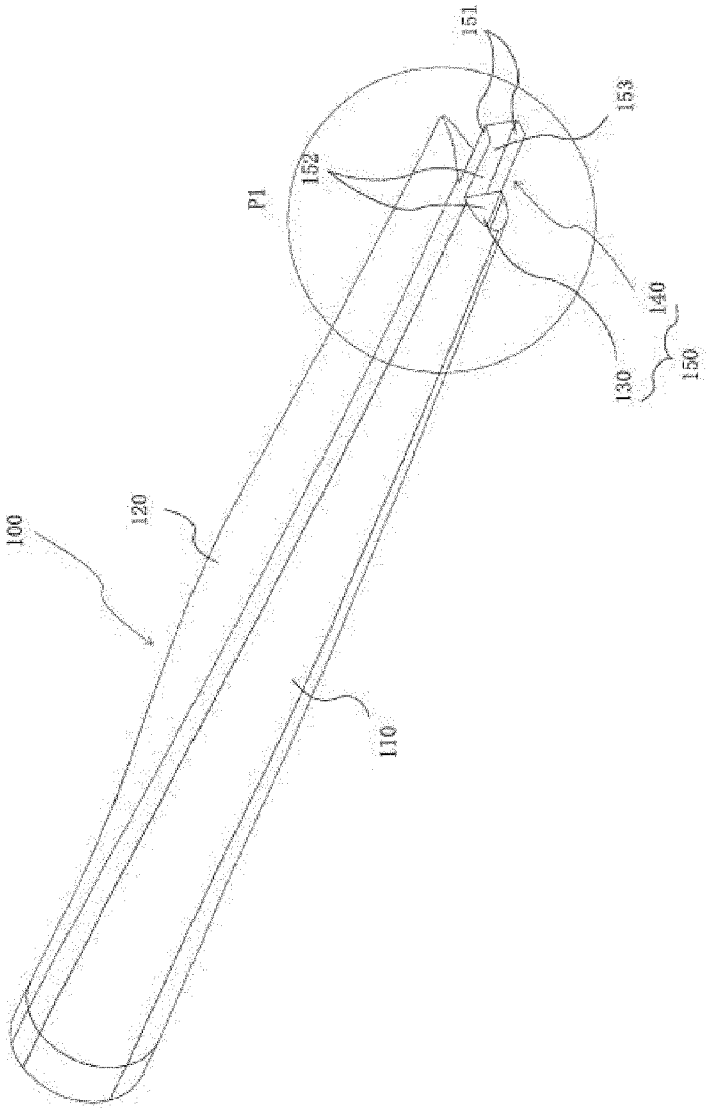

Figure 4

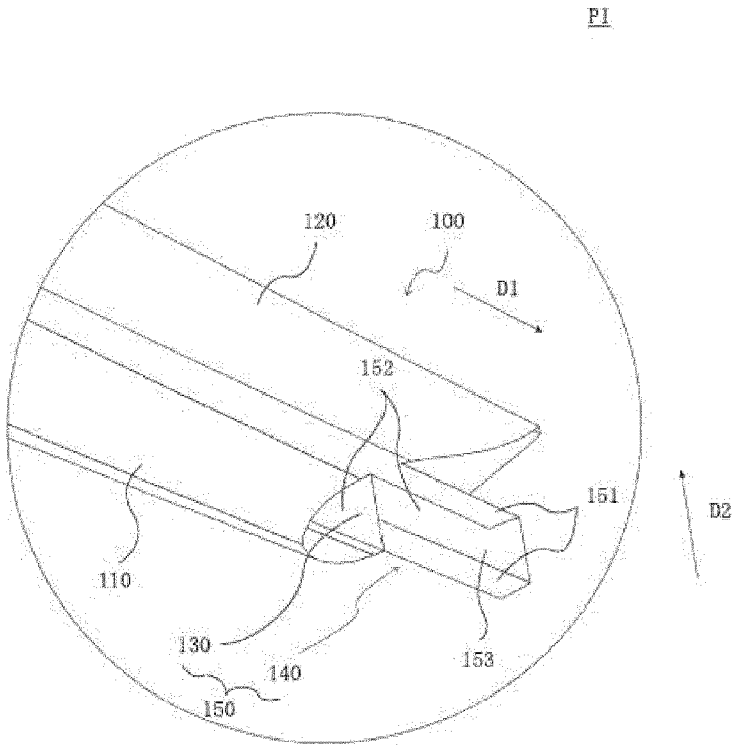

Figure 5

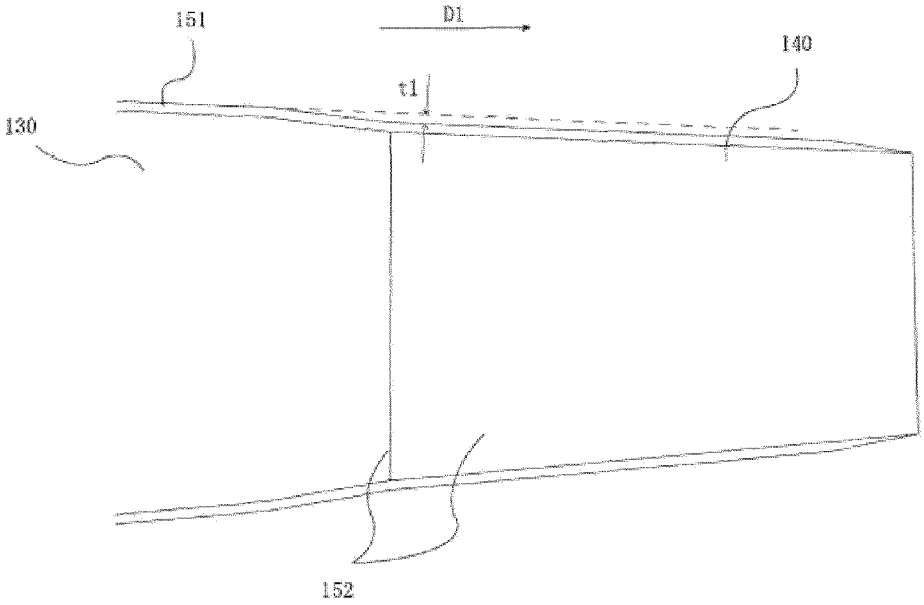

Figure 6

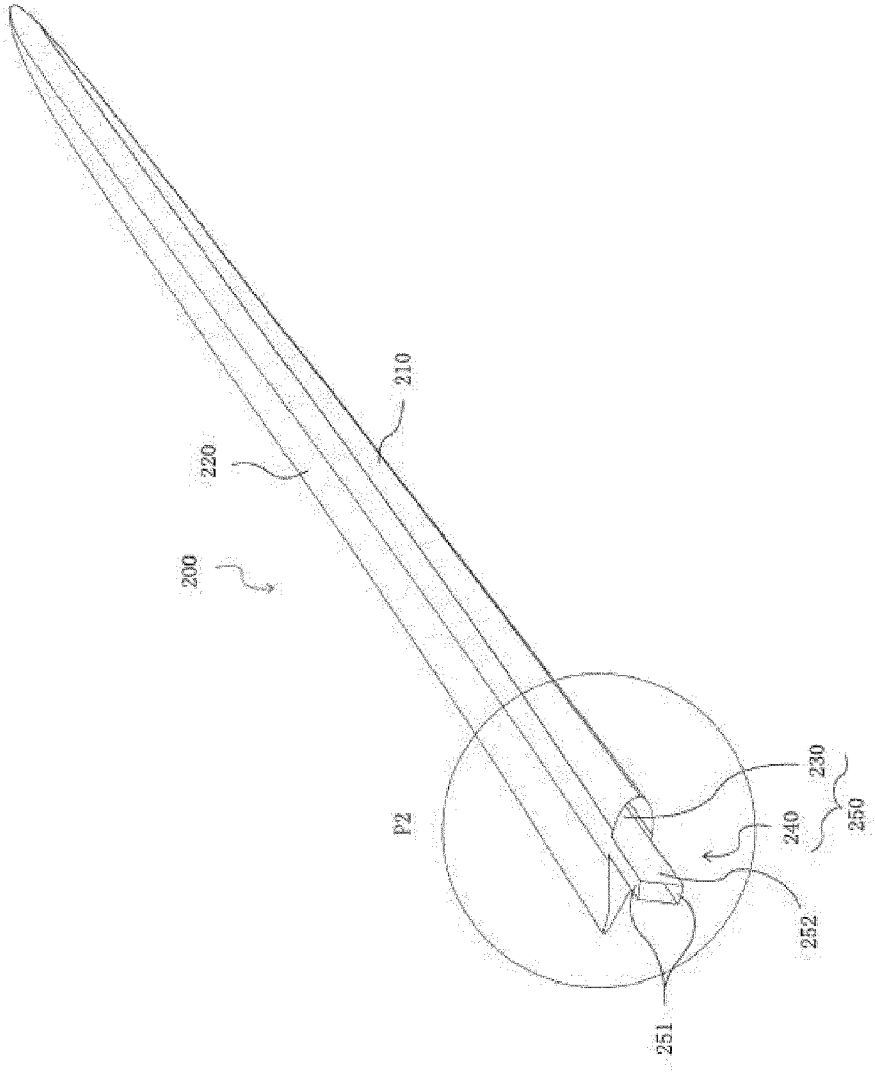

Figure 7

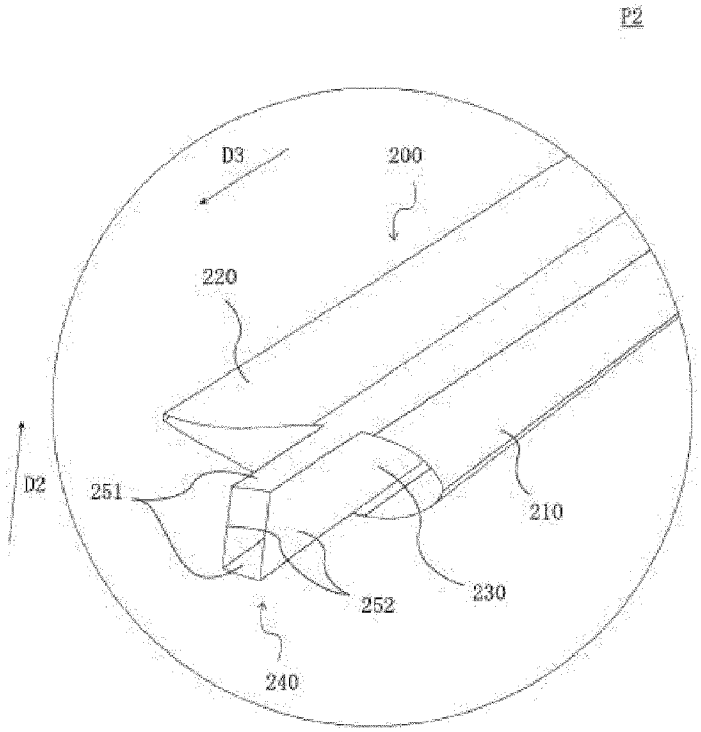

Figure 8

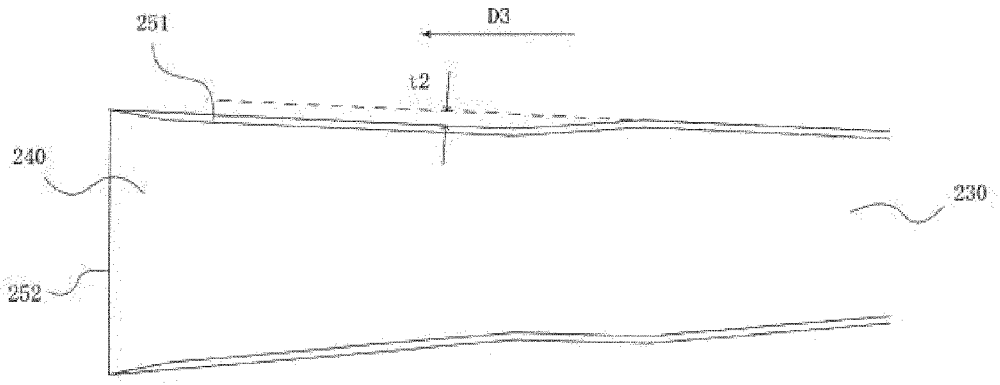

Figure 9

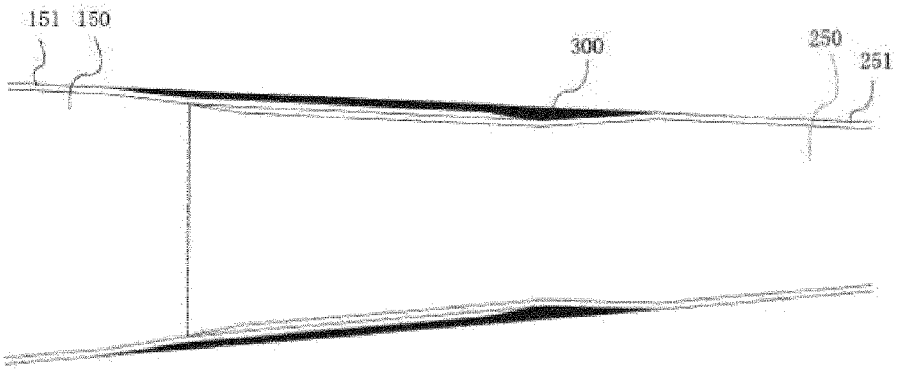

Figure 10

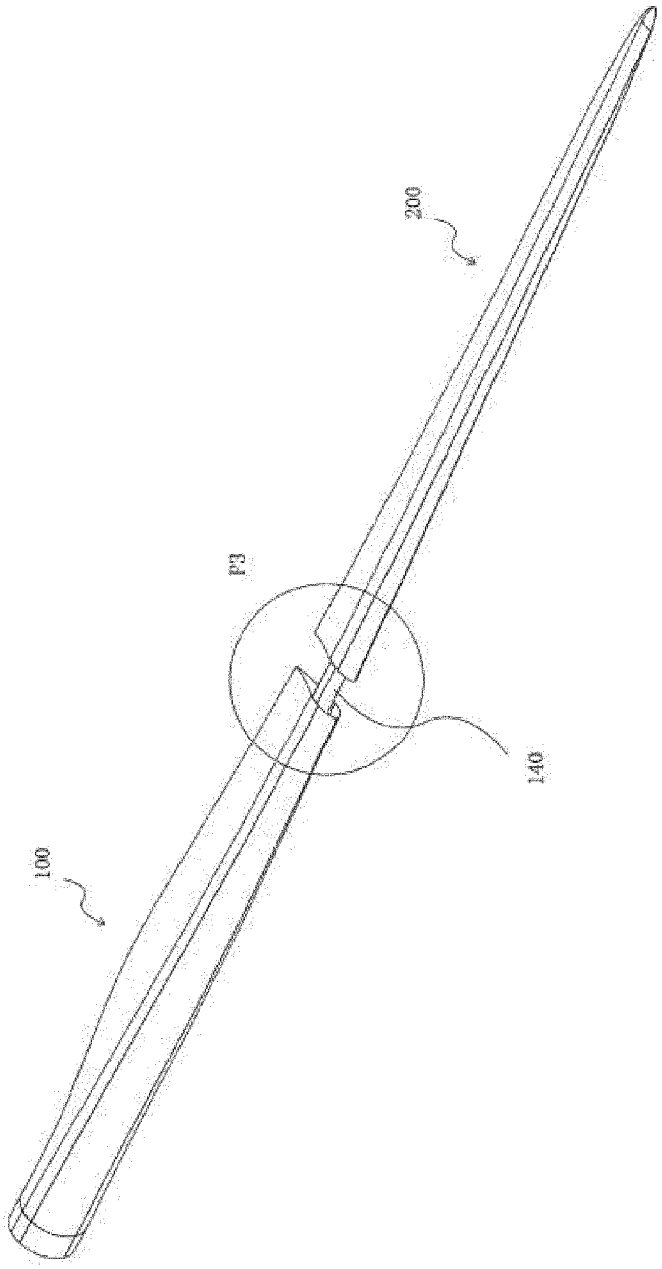

Figure 11

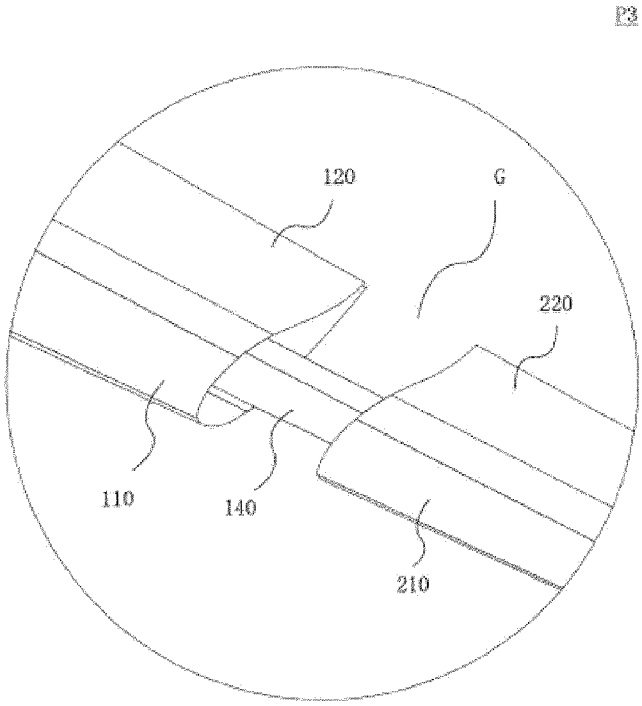

Figure 12

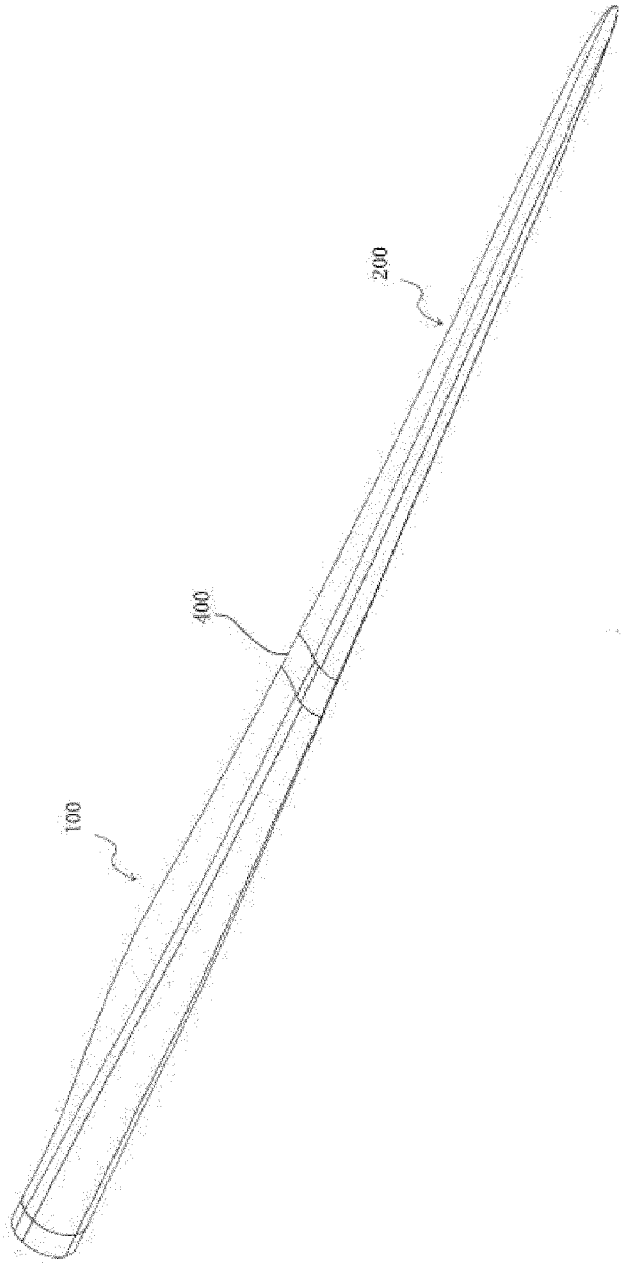

Figure 13