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Fortsættes ...

DESCRIPTION

Technical Field of the Invention

[0001] The present invention relates to a windmill, and specifically, to a connection structure between a hub of a windmill shaft and a blade root part.

Background Art of the Invention

[0002] A plurality of blades, usually, about three blades, are provided to a windmill, and the root parts thereof are fixed and connected to a hub of a windmill shaft and the blades are rotated along with the rotation of the windmill shaft. In particular, in a small-sized windmill, a method for fixing blade root parts to a hub by fastening due to through bolts is simplest and well employed. Recently, in order to lighten in weight high-strength and high-rigidity blades, the blade body portions have been formed by employing a fiber reinforced plastic (hereinafter, also referred to as merely "FRP"), in particular, a carbon fiber reinforced plastic (hereinafter, also referred to as merely "CFRP") (for example, Patent document 1). Even in such an FRP blade, a blade fixing method due to the fastening using through bolts as described above is employed usually.

[0003] In the fixing method having bolt holes on the blade body and directly fastening the blade body using the bolts, however, a crack starting from the bolt hole generated with a stress concentration may be generated on the blade by the vibration or the centrifugal force generated by the rotation of the windmill, regardless of the bolt fastening force, and a deterioration of an internal material may occur ascribed to penetration of water into the blade.

[0004] Further, in a case where bolt holes are provided on the blade body, it may be necessary to specially insert a solid member into the fastening portion in order to maintain the form and the strength of the bolt hole portion, and in such a case, the weight of the blade may inevitably increase, and the above-described lightening advantage in weight may be damaged. Moreover, the increase in weight of the blade causes an increase of the moment of inertia of the blade and an increase of the kinetic energy of the blade itself, and consequently, causes a cost up of other portions due to improvement of a braking performance, increase of motor capacity and weight, reinforcement of a supporting arm, etc. In addition, the increase of the kinetic energy of the blade may increase a damage to the surroundings if the blade would be broken and scattered.

[0005] Furthermore, because the fastening using bolts requires an installation accuracy, for example, in a case of a small-sized windmill which is frequently built by an individual at a high place of his own house and the like or at a hut in a mountain area and the like, the fastening is likely to cause a vibration. One known arrangement is disclosed by JP-A-2000-120524.

Another arrangement for attaching a blade with an undercut fixing structure is disclosed in DE 199 03 550.

Disclosure of the Invention

Problems to be solved by the Invention

[0006] Accordingly, paying attention to the above-described present circumstances, an object of the present invention is to provide a windmill having a connection structure between a blade and a hub basically without requiring a bolt fastening structure, thereby achieving lightening in weight of the blade and easily ensuring the strength, rigidity and installation accuracy of this connection portion.

Means for solving the Problems

[0007] To achieve the above-described object, a windmill according to the present invention is characterized by connecting a blade root part to a hub in a radial direction of a windmill shaft by an undercut fitting structure. This undercut fitting structure means a structure, for example, wherein a blade root part has a form in which its width is once decreased as approached to a windmill shaft in the radial direction of the windmill shaft and thereafter the width is increased, and on the other hand, a notch portion or a space portion capable of fitting the blade root part is formed on the hub side, and by this fitting, the structure can engage the width increased portion formed on the blade root part against the radially outward direction of the windmill shaft, namely, can perform an undercut function for preventing the blade root part from coming off in the radially outward direction of the windmill shaft.

[0008] In this windmill according to the present invention, it is preferred that, with respect to sections in a direction perpendicular to the radial direction of the windmill shaft in the blade root part forming the undercut fitting structure, a section having a sectional area in a range of 1.1 to 2.0 times a minimum sectional area is disposed at a position closer to the windmill shaft than a section having the minimum sectional area. Further, it is preferred that a gap between the hub and the blade root part in the undercut fitting structure is in a range of 0 to 0.5 mm.

[0009] Further, in the windmill according to the present invention, it is preferred that a portion of the undercut fitting structure is fixed to a positioning surface of the hub in an axial direction of the windmill shaft by a pressing means. Namely, the undercut fitting structure portion is structured so as to be fixed at a predetermined position in the axial direction of the windmill shaft by the contact between the positioning surface of the hub and the pressing means, and fixed in the radial direction of the windmill shaft by the undercut fitting structure. In both directions, the blade root part is fixed without requiring fastening by bolts. It is preferred that at least one of surfaces for fixing of the positioning surface and the pressing means is formed as a surface perpendicular to the axial direction of the windmill shaft.

[0010] In such a structure, it is preferred that the undercut fitting structure is formed on each of surfaces for fixing of the positioning surface and the pressing means. Further, it is also preferred that the hub and the blade root part come into contact with each other at a flat surface or a surface having a radius of curvature within a range of 5 to 100 mm in a portion of the undercut fitting structure forming a part of the positioning surface of the hub.

[0011] Further, in the windmill according to the present invention, a structure can be employed wherein a plurality of blade root parts are connected to a single hub. Further, it is preferred that a plurality of blade root parts are connected to the hub so as to be disposed equally spaced in angle in a circumferential direction around a rotational axis of the windmill shaft.

[0012] Further, in the above-described structure having the pressing means, it becomes possible to easily fix all the blades simultaneously with only one pressing means, by a structure wherein a single fixing means simultaneously fixes undercut fitting structure portions of a plurality of blades. In such a structure; the easiness and accuracy of installation can be easily ensured.

[0013] Further, in the windmill according to the present invention, it is preferred that a blade body part forming a part of the blade root part is formed using a fiber reinforced plastic, from the viewpoint of lightening in weight. In particular, it is preferred that the fiber reinforced plastic comprises a carbon fiber reinforced plastic. In this case, it is preferred that the apparent density of the blade body part is in a range of 0.2 to 1.0 g/cm^3.

[0014] In the case where the blade body part is formed using a fiber reinforced plastic, a structure can be employed wherein the portion of the undercut fitting structure formed on the blade root part is covered with a metal frame material. In particular, as described above, in the case where the portion of the undercut fitting structure is fixed to the surface for fixing of the hub in the axial direction of the windmill shaft by the pressing means, because this surface for fixing becomes a contact surface and higher surface strength and accuracy are required, such a structure covered with a metal frame material is preferred. As the metal frame material, also in consideration of lightening in weight, an aluminum frame material (including an aluminum alloy frame material) is preferable. These undercut fitting structure portion of the blade body part and the metal frame material, for example, may be bonded by an adhesive. The thickness of the layer of the adhesive between the blade body part and the metal frame material forming the portion of the undercut fitting structure is preferably in a range of 0.05 to 0.5 mm.

[0015] Further, in the above-described structure having the metal frame material, it is preferred that the blade body part and the metal frame material forming the portion of the undercut fitting structure are connected to each other by the undercut fitting structure. Further, the metal frame material may be divided into a plurality of parts. The metal frame material may be divided into a plurality of parts at positions except the portion of the undercut fitting structure. Furthermore, a structure may also be employed wherein the undercut fitting structure is formed via a contact between the hub and the metal frame material.

[0016] Further, in the windmill according to the present invention, a structure can be employed wherein a strip having a flexibility for restricting a displacement of a blade relative to the hub when the fixing of the blade to the hub is released is provided at a connecting portion of the blade root part to the hub.

[0017] Namely, in addition to the connection due to the undercut fitting structure according to the present invention, the above-described structure is formed for restricting a displacement of a blade relative to the hub by the strip having a flexibility when the fixing of the blade to the hub is released. Basically, this structure is employed so that, during the time of a normal operation (during the time of a normal rotation of the blade), a force for restricting the blade substantially is not applied to the strip (a force is not applied to the strip), and when the fixing of the blade is released by a fatigue failure of the connecting portion and the like, the blade is restricted by the strip so as not to be left from the hub at a certain distance or more, and the blade is prevented from being scattered. Therefore, a fatigue does not occur in the strip itself, and when the strip is functioned to prevent the blade from being scattered, the strip itself can surely exhibit an expected strength, etc., thereby surely achieving the prevention of blade scattering.

[0018] The tensile strength of the above-described strip is preferably in a range of 1.5 to 5.0 GPa, and the tensile breaking strain of the strip is preferably in a range of 3 to 15%. By such a structure, the scattering of the blade can be properly prevented.

[0019] Further, it is preferred that a tensile stress generated in the strip is 1% or less of a tensile strength of the strip when the windmill operates in a rated range of use. Namely, it is preferred that, as described above, during the time of a normal rotation, the blade is maintained to be connected to the blade at a condition where the strip is deflected so that a tensile load almost is not applied to the strip or at a condition where a surplus is given to the strip utilizing the flexibility of the strip, and only when it is required to prevent the blade from being scattered, the tensile load is applied to the strip for restricting the blade.

[0020] Various embodiments can be employed as the connection structure of the strip to the blade root part. For example, a structure can be employed wherein a part of the strip is placed in a part of the blade. Further, a structure can also be employed wherein a part of the strip is tied to a part of the blade. Furthermore, together with these structures, an adhesive may be used for bonding.

[0021] The above-described strip is not particularly limited, as long as a tensile strength enough to prevent the scattering of the blade and a flexibility enough to achieve a connection structure to the blade, in which a force almost does not act on the strip at the time of a normal operation, are given to the strip. A desirable material for the strip comprises, for example, at least one kind of glass fibers, aramide fibers and a steel wire material.

[0022] Further, with respect to the connection structure between the strip and the blade root part, either a structure wherein a single strip restricts one blade, or a structure wherein a plurality of blades are restricted in displacement by using substantially a single strip, can be employed.

[0023] Although the type of the windmill according to the present invention is not particularly limited, the present invention is suitable, in particular, to a horizontal shaft type windmill whose windmill shaft extends in a horizontal direction.

[0024] In the above-described windmill according to the present invention, the blade acted with a centrifugal force in the radial direction of the windmill shaft by its rotation is connected to the hub by the undercut fitting structure at the root part thereof. In the axial direction of the windmill shaft, by fixing the portion of the undercut fitting structure to the surface for positioning of the hub in the axial direction of the windmill shaft by the pressing means, a desired fixing at a predetermined position can be easily achieved. Therefore, the blade root part basically does not at all require a bolt fastening structure as in the conventional structures, and bolt holes are also unnecessary.

Effect according to the Invention

[0025] Thus, in the windmill according to the present invention, the connection and the fixing between the blade and the hub can be achieved without using the bolt fastening structure directly to the blade body, the problems of occurrence of fatigue and cracks on the blade accompanying with the bolt fastening can be solved, facilitation and improvement of accuracy for installation can be achieved, and further, by making the processing of bolt holes unnecessary and simplifying the forms of the blade and hub portions, the manufacture may be facilitated and the cost therefor may be reduced.

[0026] Further, by making the blade body part with an FRP, while the weight of the blade can be reduced, the strength, the rigidity and the accuracy in installation of the connecting portion to the hub can be easily ensured by the undercut fitting structure. Further, because bolt holes of the FRP blade body part can be made unnecessary, penetration of water into the blade can be easily prevented, and the weather resistance and the like may be improved. Furthermore, because the form is simple, the molding of the blade can be facilitated.

[0027] In particular, in a case of an FRP blade, since a structure for making the inside of the blade body hollow or for interposing a very light core material therein can be employed, it becomes possible to further accelerate the lightening in weight of the blade.

Brief explanation of the drawings

[0028]

[Fig. 1] Fig. 1 is a plan view of a blade portion of a windmill according to an embodiment of the present invention.

[Fig. 2] Fig. 2 is an enlarged plan view of the connecting portion between a blade root part and a hub of the windmill depicted in Fig. 1.

[Fig. 3] Fig. 3 is a sectional view of a portion of an undercut fitting structure formed on the blade root part, as viewed along A-A line of Fig. 2.

[Fig. 4] Fig. 4 is a sectional view of a portion of an undercut fitting structure, showing an example different from the structure depicted in Fig. 3.

[Fig. 5] Fig. 5 is a partial sectional view of a portion of an undercut fitting structure, as viewed along B-B line of Fig. 2.

[Fig. 6] Fig. 6 is a partial sectional view of a portion of an undercut fitting structure, showing another example different from the structure depicted in Fig. 5.

[Fig. 7] Fig. 7 is a partial sectional view of a portion of an undercut fitting structure, showing a further example different from the structure depicted in Fig. 5.

[Fig. 8] Fig. 8 is a partial sectional view, showing an example of a portion of an undercut fitting structure, as viewed along A-A line or C-C line of Fig. 2.

[Fig. 9] Fig. 9 is an enlarged partial plan view, showing an example in a case of adding a strip to the windmill depicted in Fig. 1.

[Fig. 10] Fig. 10 is an enlarged partial plan view, showing another example in a case of adding a strip to the windmill depicted in Fig. 1.

Explanation of symbols

[0029]

1: windmill

2: windmill shaft

3, 18: hub

4: blade

4a: blade body part

5: undercut fitting structure portion

6, 12, 14, 20: undercut fitting structure part formed on blade root part

7, 13, 15, 19: fitting hole portion

7a: positioning surface of fitting hole portion

8: aluminum frame material

9: CFRP surface material

10: acrylic low-density foamed material as core material

11, 21: pressing plate as pressing means

11a: pressing surface of pressing plate

16: surplus space

17: insert member

19a, 20a: taper surface

31, 32: strip

The Best mode for carrying out the Invention

[0030] Hereinafter, desirable embodiments of the present invention will be explained referring to figures.

[0031] Figs. 1 and 2 show a windmill according to an embodiment of the present invention, and in particular, show an example of a case where a blade body part is made from an FRP. Although the FRP used for a blade of a windmill according to the present invention is not particularly limited, as the reinforcing fibers, for example, inorganic fibers such as carbon fibers or glass fibers and organic fibers such as Kevler fibers, polyethylene fibers or polyamide fibers can be exemplified. In particular, carbon fibers are preferred from the viewpoint of easiness of control of the strength and rigidity of a blade. As the matrix resin of the FRP, for example, a thermosetting resin such as an epoxy resin, an unsaturated polyester resin, a vinylester resin or a phenolic resin can be exemplified, and further, a thermoplastic resin such as a polyamide resin, a polyolefin resin, a dicyclopentadiene resin or a polyurethane resin can also be used. Further, as the structure of the FRP blade body part, both of a structure wherein only the outer shell (only the surface material) is made from an FRP and the inside is formed to be hollow and a structure wherein a light core material is interposed or charged in the inside of the FRP outer shell, a so-called sandwich structure, can be employed. As the core material, an elastic material, a foamed material or a honeycomb material can be used, and in particular, a foamed material is preferred for lightening in weight. The material for the foamed material is not particularly limited, and for example, a low-density foamed material of a polymer such as a polyurethane, a polystyrene, a polyimide, a vinyl chloride or a phenol and the like can be used. The honeycomb material is not particularly limited, and for example, an aluminum alloy, a paper, an aramide paper, etc. can be used as the material.

[0032] Fig. 1 depicts a plan view of a blade portion of a horizontal shaft type windmill, and in Fig. 1, symbol 1 shows the whole of the windmill. Windmill 1 has a windmill shaft 2 as the rotational shaft, and a hub 3 rotated integrally with the windmill shaft 2 is provided around the windmill shaft 2. In this embodiment, three blades 4 are connected to this hub 3 at their root parts. A body part 4a of each blade 4 is formed by using an FRP, particularly, a CFRP, and hub 3 and each blade root part are connected to each other in the radial direction of windmill shaft 2 by an undercut fitting structure.

[0033] The portion 5 of this undercut fitting structure comprises an undercut fitting structure part 6 formed on the blade root part, and an fitting hole portion 7 formed on the side of hub 3 and fitted with the undercut fitting structure part 6 formed on the side of blade 4, thereby engaging the undercut fitting structure part 6 against the radially outward direction of windmill shaft 2. In more detail, as shown also in Fig. 2, undercut fitting structure part 6 formed on the blade root part is formed as a shape in which its width observed as a plan view is once decreased as approached to windmill shaft 2 and thereafter the width is increased, and fitting hole portion 7 is formed as a plan shape along the plan shape of this undercut fitting structure part 6 so that the undercut fitting structure part 6 can be fitted with a small clearance (preferably, with a gap in a range of 0 to 0.5 mm).

[0034] In this embodiment, undercut fitting structure part 6 formed on the blade root part is covered with a metal, in particular, an aluminum frame material 8.

[0035] The structure of the section along A-A line in Fig. 2 is formed, for example, as shown in Fig. 3 or 4. Where, with respect to sections in a direction perpendicular to the radial direction of the windmill shaft in the blade root part forming the undercut fitting structure, a section having a sectional area in a range of 1.1 to 2.0 times a minimum sectional area is disposed at a position closer to the windmill shaft than a section having the minimum sectional area. In the structure shown in Fig. 3, the blade body part comprises a CFRP surface material 9 and an acrylic low-density foamed material 10 disposed in the surface material as a core material, and the CFRP blade body part is covered with an aluminum frame material 8. Aluminum frame material 8 comprises two members 8a and 8b, both members cover the CFRP blade body part at a condition where the C-shaped tip portions of both members are abutted to each other, and they are bonded to surface material 9 by an adhesive. In the structure of the blade body part shown in Fig. 4, aluminum frame material 8 covers the CFRP blade body part at a condition where the C-shaped tip portions of two members 8c and 8d are formed as stepped shapes and the tip portions are overlapped with each other, and they are bonded to surface material 9 by an adhesive. By overlapping the stepped-shape portions with each other, a positional shift between both members 8c and 8d can be prevented.

[0036] The structure of the section along B-B line in Fig. 2 is formed, for example, as shown in Figs. 5, 6 or 7. In the structure shown in Fig. 5, one surface 7a of fitting hole portion 7 of hub 3 is formed as a positioning surface, and by pressing undercut fitting structure part 6 formed on the blade root part onto this positioning surface 7a by a pressing plate 11 provided as a pressing means, the undercut fitting structure part 6 is positioned and fixed in the axial direction of the windmill shaft. In this embodiment, the positioning surface 7a of fitting hole portion 7 and a pressing surface 11 a of pressing plate 11 are both formed as surfaces perpendicular to the axial direction of the windmill shaft, blade 4 can be positioned and fixed easily at a predetermined position in the axial direction, and three blades 4 can be fixed simultaneously by a single pressing plate 11.

[0037] In the structure shown in Fig. 6, undercut fitting structure part 12 formed on the blade root part and fitting hole portion 13 of hub 3 are formed as an undercut fitting structure so that they can exhibit an engaging function also in the axial direction of the windmill shaft against the radially outward direction of the windmill shaft as well as an engaging function exhibited by the undercut fitting structure in the plan view direction shown in Fig. 2. Namely, the thickness of undercut fitting structure part 12 is once decreased as approached to the windmill shaft and thereafter the width is increased, and at the same time, the depth of fitting hole portion 13 in the axial direction of the windmill shaft is set as a shape corresponding to the shape in the thickness direction of the undercut fitting structure part 12. In other words, a convex surface 12a of undercut fitting structure part 12 is engaged with a concave surface 13a of fitting hole portion 13 in the axial direction of the windmill shaft. In this case, although only pressing surface 11a of pressing plate 11 is formed as a surface perpendicular to the axial direction of the windmill shaft, even in this structure, three blades 4 can be fixed simultaneously by a single pressing plate 11. As compared with the structure shown in Fig. 5, a force for engaging and connecting (restricting) blade 4 to hub 3 is great, relatively to a centrifugal force applied to the blade 4.

[0038] In the structure shown in Fig. 7, undercut fitting structure part 14 formed on the blade root part and fitting hole portion 15 of hub 3 are formed as an undercut fitting structure so that they can exhibit an engaging function also in the axial direction of the windmill shaft against the radially outward direction of the windmill shaft as well as an engaging function exhibited by the undercut fitting structure in the plan view direction shown in Fig. 2. Namely, a hook-shaped engaging portion 14a is provided on the side of one surface of the inserted tip portion of undercut fitting structure part 14 formed on the blade root part, and also on the deep inside portion of fitting hole portion 15, a hook-shaped concave portion 15a having a shape corresponding to the shape of hook-shaped engaging portion 14a is formed. Further, in the deepest portion of hook-shaped concave portion 15a, a surplus space 16 is formed for inserting hook-shaped engaging portion 14a into hook-shaped concave portion 15a, and in order to prevent occurrence of a rattle after insertion, an insert member 17 is inserted into this surplus space 16. After insertion of insert member 17, blade 4 may be fixed by pressing plate 11. Even in this case, three blades 4 can be fixed simultaneously by a single pressing plate 11.

[0039] Further, as the structures of the sections along A-A line and C-C line in Fig. 2, the outer shapes of undercut fitting structure parts shown in Figs. 3 and 4 may be employed, and a tapered outer shape (taper fitting structure) may also be employed, for example, as shown in Fig. 8. In the structure shown in Fig. 8, side surfaces 19a of fitting hole portion 19 of hub 18 are formed as taper surfaces, and side surfaces 20a of undercut fitting structure part 20 are formed as taper surfaces corresponding to the tapered side surfaces 19a. In such a structure, when each blade is pressed by pressing plate 21, even if a slight dimensional error exists in the fitting portion, it may be absorbed by a fitting structure by biting of taper surfaces to each other.

[0040] Thus, various structures can be employed as the portion of the undercut fitting structure and the pressing structure by the pressing means. In any structure, the bolt fastening structure employed in the conventional technology is not necessary for the connection between the blade root part and the hub, the problems of occurrence of fatigue and cracks on the blade accompanying with the bolt fastening can be solved, and facilitation and improvement of accuracy for installation can be achieved. By making the processing of bolt holes unnecessary, the manufacture may be facilitated and the cost therefor may be reduced by simplifying the forms of the blade and hub portions, and penetration of water into the blade can be easily prevented and the weather resistance and the like may be improved.

[0041] Further, by making the blade body part with an FRP, particularly with a CFRP, while the weight of the blade can be reduced, the strength, the rigidity and the accuracy in installation of the connecting portion to the hub can be easily ensured.

[0042] Furthermore, in the present invention, in addition to the above-described undercut fitting structure, a structure can be added wherein a strip having a flexibility for restricting a displacement of a blade relative to the hub when the fixing of the blade to the hub is released is provided at a connecting portion of the blade root part to the hub.

[0043] For example, as shown in Fig. 9, a structure can be employed wherein a strip 31 is provided around windmill shaft 2, as needed, via a spacer (not shown), and therefrom the strip 31 is connected to the root parts of respective blades 4. Further, as shown in Fig. 10, a structure can also be employed wherein a strip 32 is provided around windmill shaft 2 so as to extend at a position apart from the windmill shaft 2, and the strip 32 is connected to the root parts of respective blades 4 by placing the strip 32 in the root parts of the respective blades 4. In any case, basically, during the time of a normal operation (during the time of a normal rotation of the blades), a force for restricting blades 4 substantially is not applied to strip 31 or 32 (a force is not applied to the strip), and when the fixing of a blade 4 is released by a fatigue failure of the connecting portion and the like, the blade 4 is restricted by the strip 31 or 32 so as not to be left from hub 3 at a certain distance or more, and the blade is prevented from being scattered.

[0044] As aforementioned, the tensile strength of the above-described strip 31 or 32 is preferably in a range of 1.5 to 5.0 GPa, and the tensile breaking strain is preferably in a range of 3 to 15%. Further, it is preferred that a tensile stress generated in the above-described strip 31 or 32 is 1% or less of a tensile strength of the strip when the windmill operates in a rated range of use. Furthermore, a desirable material for the above-described strip 31 or 32 comprises, for example, at least one kind of glass fibers, aramide fibers and a steel wire material.

Industrial Applications of the Invention

[0045] The present invention can be applied to any windmill, and in particular, the present invention is suitable for a small-sized windmill, a windmill having FRP blades and a horizontal shaft type windmill.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- DE19903550 **[0005]**

PATENTKRAV

1. Vindmølle (1) med en vingeroddel forbundet med et nav (3, 18) i en radial retning af en vindmølleaksel (2) ved hjælp af en underskåret pasningskonstruktion (6, 12, 14, 20) af vingeroddelen, **kendetegnet ved, at** et parti (5) af den underskårne pasningskonstruktion (6, 12, 14, 20) er fastgjort på en positioneringsflade (7a) af navet (3, 18) i en aksial retning af vindmølleakslen (2) ved hjælp af en presseplade (11, 21).

2. Vindmølle (1) ifølge krav 1, hvor der med hensyn til afsnit i en retning lodret på den radiale retning af vindmølleakslen (2) i vingeroddelen, der danner den underskårne pasningskonstruktion (6, 12, 14, 20), er anbragt et afsnit med et tværsnitsareal i et område på 1,1 til 2,0 gange et minimumstværsnitsareal ved en position nærmere vindmølleakslen (2) end et afsnit med et minimumstværsnitsareal.

3. Vindmølle (1) ifølge krav 1 eller 2, hvor et mellemrum mellem navet (3, 18) og vingeroddelen i den underskårne pasningskonstruktion (6, 12, 14, 20) ligger i et område på 0 til 0,5 mm.

4. Vindmølle (1) ifølge krav 1, hvor mindst en af fladerne til fastgørelse af positioneringsfladen (7a) og pressepladen (11, 21) er dannet som en flade lodret på den aksiale retning af vindmølleakslen (2).

5. Vindmølle (1) ifølge et hvilket som helst af kravene 1 til 4, hvor den underskårne pasningskonstruktion (6, 12, 14, 20) er dannet på hver af fladerne til fastgørelse af positioneringsfladen (7a) og pressepladen (11, 21).

6. Vindmølle (1) ifølge et hvilket som helst af kravene 1 til 5, hvor navet (3, 18) og vingeroddelen kommer i kontakt med hinanden ved en flad flade eller en flade med en krumningsradius inden for området på 5 til 100 mm i et parti (5) af den underskårne pasningskonstruktion (6, 12, 14, 20), der danner en del af navets (3, 18) positioneringsflade (7a).

7. Vindmølle (1) ifølge et hvilket som helst af kravene 1 til 6, hvor en flerhed af vingeroddele er forbundet med et enkelt nav (3, 18).

8. Vindmølle (1) ifølge et hvilket som helst af kravene 1 til 7, hvor en flerhed af vingeroddele er forbundet med navet (3, 18), så at de er anbragt med ens mellemrum i vinkel i en periferiretning om en rotationsaske for vindmølleakslen (2).

9. Vindmølle (1) ifølge et hvilket som helst af kravene 1 til 8, hvor en presseplade (11, 21) samtidigt fastgør underskårne pasningskonstruktionspartier (5) af en flerhed af vinger.

10. Vindmølle (1) ifølge et hvilket som helst af kravene 1 til 9, hvor en vingekropdel, der danner en del af vingeroddelen, er dannet ved anvendelse af en fiberforstærket plast.

11. Vindmølle (1) ifølge krav 10, hvor den fiberforstærkede plast omfatter en kulfiberforstærket plast.

12. Vindmølle (1) ifølge krav 10 eller 11, hvor en tilsyneladende massefylde af vingekropdelen ligger i et område på 0,2 til 1,0 g/cm^3.

13. Vindmølle (1) ifølge et hvilket som helst af kravene 10 til 12, hvor et parti af vingekropdelen placeret i et parti (5) af den underskårne pasningskonstruktion (6, 12, 14, 20), der er dannet på vingeroddelen, er dækket med et metalindfatningsmateriale.

14. Vindmølle (1) ifølge krav 13, hvor metalindfatningsmaterialet er et aluminiumsindfatningsmateriale.

15. Vindmølle (1) ifølge krav 13 eller 14, hvor vingekropdelen og metalindfatningsmaterialet, der danner partiet (5) af den underskårne pasningskonstruktion (6, 12, 14, 20), er forbundet med et klæbemiddel.

16. Vindmølle (1) ifølge krav 15, hvor en tykkelse af et lag af klæbemidlet mellem vingekropdelen og metalindfatningsmaterialet, der danner partiet (5) af den underskårne pasningskonstruktion (6, 12, 14, 20), ligger i et område på 0,05 til 0,5 mm.

17. Vindmølle (1) ifølge et af kravene 13 til 16, hvor vingekropdelen og metalindfatningsmaterialet, der danner partiet (5) af den underskårne pasningskonstruktion (6, 12, 14, 20), er forbundet med hinanden ved hjælp af den underskårne pasningskonstruktion (6, 12, 14, 20).

18. Vindmølle (1) ifølge et hvilket som helst af kravene 13 til 17, hvor metalindfatningsmaterialet er opdelt i en flerhed af dele.

19. Vindmølle (1) ifølge et hvilket som helst af kravene 13 til 18, hvor den underskårne pasningskonstruktion (6, 12, 14, 20) er dannet via en kontakt mellem navet (3, 18) og metalindfatningsmaterialet.

20. Vindmølle (1) ifølge et hvilket som helst af kravene 1 til 19, hvor et bånd (31, 32) med en fleksibilitet til at begrænse en forskydning af en vinge (4) i forhold til navet (3, 18), når fastgørelsen af vingen (4) på navet (3, 18) løsgøres, er tilvejebragt ved et forbindelsesparti af vingeroddelen med navet (3, 18).

21. Vindmølle (1) ifølge krav 20, hvor en trækstyrke af båndet (31, 32) ligger i et område på 1,5 til 5,0 GPa og en trækbrudbelastning af båndet (31, 32) ligger i et område på 3 til 15%.

22. Vindmølle (1) krav 20 eller 21, hvor en trækstyrke genereret i båndet (31, 32) er 1% eller mindre af en trækstyrke af båndet (31, 32), når vindmøllen (1) arbejder i et nominelt anvendelsesområde.

23. Vindmølle (1) ifølge et hvilket som helst af kravene 20 til 22, hvor en del af båndet (31, 32) er placeret i en del af vingeroddelen.

24. Vindmølle (1) ifølge et hvilket som helst af kravene 20 til 23, hvor båndet (31, 32) omfatter mindst en slags af glasfibre, aramidfibre og et stålwiremateriale.

25. Vindmølle (1) ifølge et hvilket som helst af kravene 20 til 24, hvor en flerhed af vinger (4) er begrænset i forskydning ved anvendelse af i det væsentlige et enkelt bånd (31, 32).

26. Vindmølle (1) ifølge et hvilket som helst af kravene 1 til 25, hvor vindmøllen (1) er en vindmølle af typen med horisontal aksel, hvis vindmølleaksel (2) strækker sig i en horisontal retning.

DRAWINGS

FIG. 1

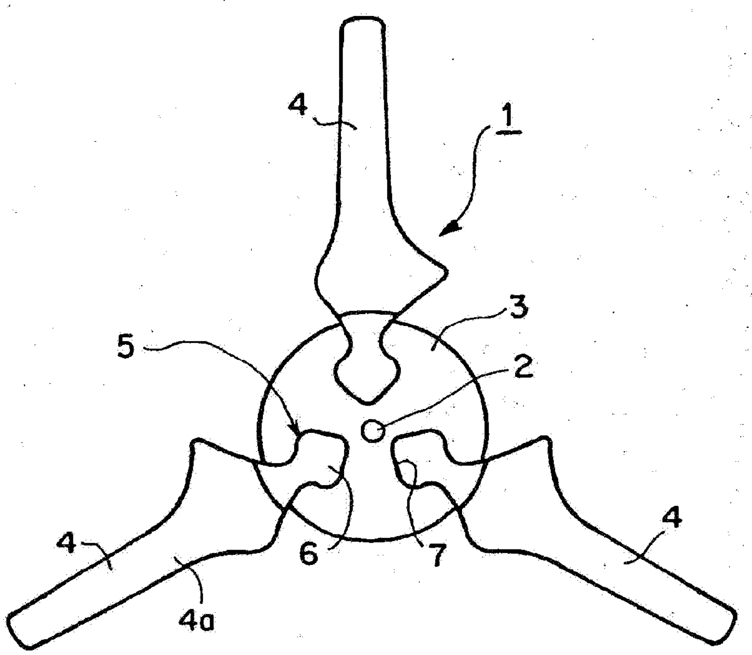

FIG. 2

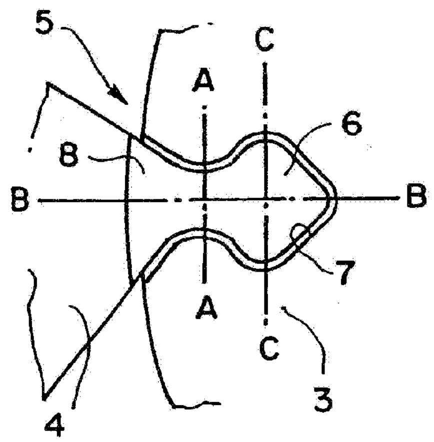

FIG. 3

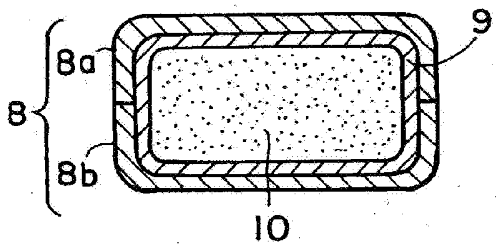

FIG. 4

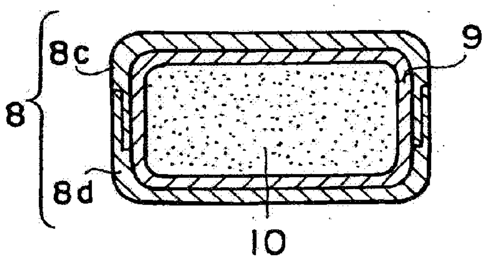

FIG. 5

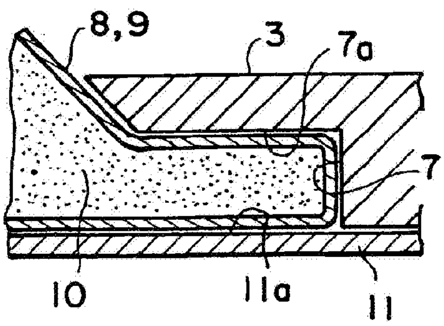

FIG. 6

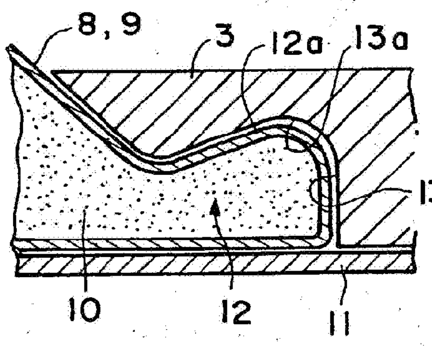

FIG. 7

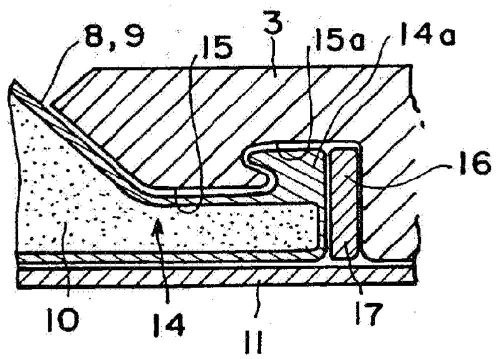

FIG. 8

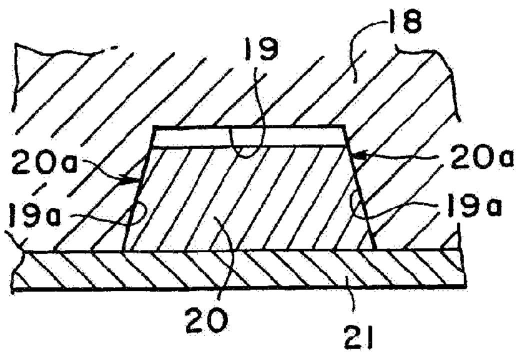

FIG. 9

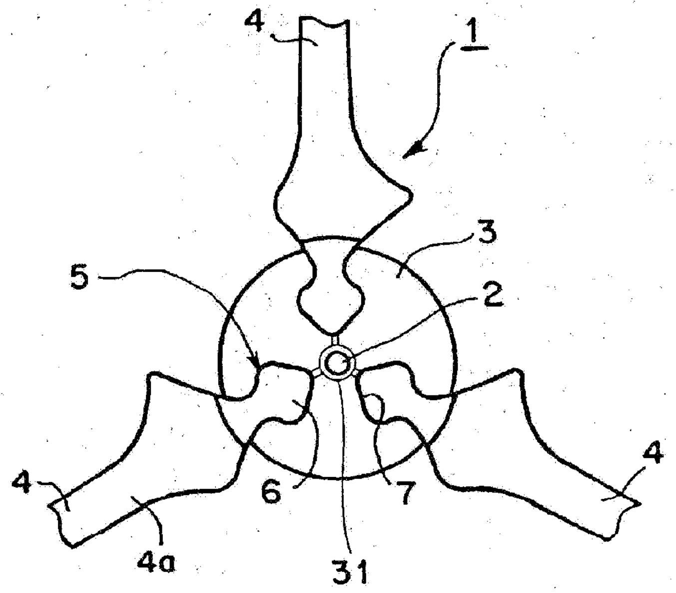

FIG. 10