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DESCRIPTION

Description

FIELD

[0001] The present disclosure relates to fastener assemblies, and more particularly fastener assemblies to connect a first web with a second web. The present disclosure further relates to main web assemblies for wind turbine blades and to methods for assembling and disassembling two webs.

BACKGROUND

[0002] Modern wind turbines are commonly used to supply electricity into the electrical grid. Wind turbines of this kind generally comprise a tower and a rotor arranged on the tower. The rotor, which typically comprises a hub and a plurality of blades, is set into rotation under the influence of the wind on the blades. Said rotation generates a torque that is normally transmitted through a rotor shaft to a generator, either directly ("directly driven") or through the use of a gearbox. This way, the generator produces electricity which can be supplied to the electrical grid.

[0003] In order to extract more energy from the wind, the size of the rotor diameter is increased by increasing the dimensions of the wind turbine blades. To reduce the overall weight of the wind turbine blades, these may generally comprise composite materials and are often manufactured with resin-infused glass fiber composites. The manufacturing of wind turbine blade shells using composite materials allows them to meet the requirements with respect to size, geometry, and weight. Further, fibers can be aligned with load paths, generating blades with anisotropic mechanical properties and with enhanced mechanical properties. The possibility of fiber alignment allows placing the fibers at the exact position and direction as needed to provide the component with the required stiffness and strength.

[0004] The shells of the wind turbine blades carry part of the load and maintain an aerodynamic shape. The main load bearing structures in wind turbine blades are formed by spars. A spar in a wind turbine blade may comprise a spar cap near the suction side of the blade and a spar cap near the pressure side of the blade, and a shear web between the spar caps. The shear web is generally formed like a plate configured to be subjected to shear loads.

[0005] Depending on the length, and configuration of the blades, and depending on the design

loads, spars with different configurations may be used. In some examples, a blade may include a main web assembly, including a leading edge main web and a trailing edge main web, i.e. two main webs, the former of which is arranged closer to the leading edge, and the latter being arranged closer to the trailing edge of the blade. The main web assembly may extend from a root of a blade to close to a tip of the blade. The blade may further comprise a third shear web which may extend from a root towards about half or about two thirds of the blade, and may also comprise a C-shaped stiffener in an inboard section of the blade near the trailing edge.

[0006] During manufacturing, a shell of the blade may be formed, e.g. two half-shells, particularly a downwind shell (for the suction side of the blade) and an upwind shell (for the pressure side of the blade) may be formed. The webs may be positioned in a mold in one half-shell and the other half-shell may be positioned on top, after which the parts are joined.

[0007] It is known for the main web assembly to be assembled before positioning in the mold. The main leading edge web, and the trailing edge web are connected to each other through a plurality of staybolts. The staybolts comprise a shaft with threaded portions on each end. A tubular spacer is arranged around the shaft. Between each end of the tubular spacer and the corresponding web a washer may be arranged. At both ends of the shaft, on the outside of the assembly, an additional washer may be arranged, and nuts are mounted on the ends of the shaft. Each of the webs is thus retained between a washer and tube on an inside of the web assembly, and a washer and nut on the outside of the web assembly.

[0008] Since the webs may be arranged close to each other (particularly for portions closer to the tip of the blade), it is a complicated manual process to fix the washers, and tubular spacers of the different staybolts in place. Additionally, after the main web assembly has been joined to the blade shells, the staybolts are to be removed, but this means that an operator needs to enter the space inside the main web assembly to remove the washers, and tubular spacers. This is a cumbersome manual process which poses significant safety and health concerns. In practice not all spacers, and washers on an inside of the main web assembly can be removed.

[0009] EP2742234 B1, CN213331389 U, WO 2020/216924 A1 show different known examples of a fastener assembly for connecting a first web to a second web.

[0010] The present disclosure provides examples of systems and methods that at least partially overcome some of the drawbacks of existing wind turbine blade manufacturing processes, and in particular facilitate assembling and disassembling main web assemblies.

SUMMARY

[0011] In a first aspect, a fastener assembly for connecting a first web to a second web is disclosed. An inside is defined between the first and second webs, and an inner surface of the first web faces an inner surface of the second web, an outer surface of the first web being arranged on an outside of the first web, and an outer surface of the second web being

arranged on an outside of the second web. The fastener assembly comprises a shaft, a first fastener, and a second fastener.

[0012] The shaft has a first end configured to be arranged with the first web, a second end configured to be arranged on the outside of the second web, and a central portion configured to be arranged between the first and second webs. The central portion includes one or more stoppers near the first end, the stoppers having a retracted position wherein the stoppers substantially do not protrude beyond an outer surface of the central portion and a deployed position wherein the stoppers protrude beyond the outer surface of the central portion such that the first web can be fixed between the stoppers and the first fastener when mounted on the first end of the shaft.

[0013] The central portion has a cross-sectional area that is larger than the cross-sectional area of the second end such that the second web can be fixed between the second fastener when mounted on the second end of the shaft and the central portion of the shaft, and the stoppers are configured to be deployed from the outside of the first web.

[0014] In accordance with this aspect, a fastener assembly is provided which can connect two webs to each other, wherein the assembly of the two webs can be mounted and unmounted from an outside of the assembly. I.e. an operator does not have to reach into the space between the webs to mount or unmount the fasteners. The fastener assembly may be used e.g. in the assembly of a main shear web assembly, and in the manufacture of a wind turbine blade, but other implementations are possible as well.

[0015] On one end, a web is fixed between a fastener on an outside and a portion of the shaft of the fastener assembly. Due to an increase in dimensions, e.g. diameter, of the central portion of the shaft with respect to the second end of the shaft, the web will inevitably engage and be nested against the portion of the shaft with increased size. At the opposite end, the web is also fixed and retained between a fastener on the outside and stoppers on an inside. The stopper can be deployed to perform their stopper function from an outside of the web assembly.

[0016] Throughout the present disclosure, a web may be regarded as any form of plate i.e. any relatively flat and thin piece of material. Thin herein may be understood to mean that length and width of the plate are orders of magnitude larger than the thickness. The webs may be made of any suitable structural material, in particular they may be made of composite or metal material. The webs may form part of an assembly including caps or flanges at the ends of the webs.

[0017] In a further aspect, a main web assembly for a wind turbine blade is disclosed. The main web assembly comprises a first shear web and a second shear web. An inside is defined between the first and second shear webs, and an inner surface of the first web faces an inner surface of the second web, an outer surface of the first web being arranged on an outside of the first web, and an outer surface of the second being arranged an on outside of the second

web.

[0018] The first and second shear webs are connected through a plurality of fastener assemblies comprising a shaft, a first fastener, and a second fastener. The shaft has a first end arranged with the first shear web, a second end arranged on the outside of the second shear web, and a central portion arranged between the first and second shear webs. The central portion includes one or more stoppers near the first end, the stoppers having a retracted position wherein the stoppers substantially do not protrude beyond an outer surface of the central portion and a deployed position wherein the stoppers protrude beyond the outer surface of the central portion such that the first shear web is fixed between the stoppers and the first fastener mounted on the first end of the shaft.

[0019] The central portion has a cross-sectional area that is larger than a cross-sectional area of the second end and the second shear web is fixed between the second fastener mounted on the shaft and the central portion of the shaft, and wherein the stoppers are configured to be deployed from an outside of the first shear web.

[0020] In yet a further aspect, a method for assembling a main web assembly of a wind turbine blade is disclosed. The method comprises arranging a leading edge shear web with a trailing edge shear web such that an inner surface of the leading edge shear web faces an inner surface of the trailing edge shear web, an inside of the main web assembly being defined between the leading edge shear web and the trailing edge shear web. The method further comprises connecting the leading edge shear web to the trailing edge shear web by mounting a plurality of fastener assemblies.

[0021] The mounting of one of the fastener assemblies comprises introducing a shaft from an outside of the main web assembly through a hole in a first shear web selected from the leading and trailing edge shear webs and subsequently through a hole in a second shear web selected from the leading and trailing edge shear webs, until a second end of the shaft extends through the second shear web to an outside of the main web assembly, and a central portion of the shaft engages with the second shear web.

[0022] The method further comprises deploying one or more stoppers in the central portion to protrude beyond an outer surface of the central portion of the shaft and mounting a first fastener on the first end of the shaft to retain the first shear web between the stoppers and the first fastener and mounting a second fastener on the second end of the shaft to retain the second shear web between the second fastener and the central portion of the shaft, wherein the stoppers are deployed from an outside of the main web assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Non-limiting examples of the present disclosure will be described in the following, with reference to the appended drawings, in which:

Figure 1 illustrates a perspective view of a wind turbine according to one example;

Figure 2A is a schematic diagram illustrating a wind turbine blade according to one example;

Figure 2B schematically illustrates an internal structure of a wind turbine blade;

Figure 2C illustrates a molding system which may be used in the manufacture of a wind turbine blade;

Figure 3A schematically illustrates an example of a fastener assembly which may be used to connect a first web to a second web;

Figure 3B shows one web and fastener of the example of figure 3A in more detail;

Figure 4A schematically illustrates an example of another web assembly; and

Figures 4B and 4C schematically illustrate elements of the example of figure 4A in more detail.

DETAILED DESCRIPTION OF EXAMPLES

[0024] Reference now will be made in detail to embodiments of the present disclosure, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation only, not as a limitation. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present disclosure. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present disclosure covers such modifications and variations as come within the scope of the appended claims.

[0025] Fig. 1 illustrates a conventional modern upwind wind turbine 2 according to the so-called "Danish concept" with a tower 4, a nacelle 6 and a rotor with a substantially horizontal rotor shaft. The rotor includes a hub 8 and three blades 10 extending radially from the hub 8, each having a blade root 16 nearest the hub and a blade tip 14 furthest from the hub 8.

[0026] Fig. 2A shows a schematic view of an exemplary wind turbine blade 10. The wind turbine blade 10 has the shape of a conventional wind turbine blade with a root end 17 and a tip end 15 and comprises a root region 30 closest to the hub, a profiled or an airfoil region 34 furthest away from the hub and a transition region 32 between the root region 30 and the airfoil region 34. The blade 10 comprises a leading edge 18 facing the direction of rotation of the blade 10, when the blade is mounted on the hub, and a trailing edge 20 facing the opposite direction of the leading edge 18.

[0027] The airfoil region 34 (also called the profiled region) has an ideal or almost ideal blade shape with respect to generating lift, whereas the root region 30 due to structural

considerations has a substantially circular or elliptical cross-section, which for instance makes it easier and safer to mount the blade 10 to the hub. The diameter (or the chord) of the root region 30 may be constant along the entire root area 30. The transition region 32 has a transitional profile gradually changing from the circular or elliptical shape of the root region 30 to the airfoil profile of the airfoil region 34. The chord length of the transition region 32 typically increases with increasing distance from the hub. The airfoil region 34 has an airfoil profile with a chord extending between the leading edge 18 and the trailing edge 20 of the blade 10. The width of the chord decreases with increasing distance from the hub.

[0028] A shoulder 40 of the blade 10 is defined as the position, where the blade 10 has its largest chord length. The shoulder 40 is typically provided at the boundary between the transition region 32 and the airfoil region 34.

[0029] It should be noted that the chords of different sections of the blade normally do not lie in a common plane, since the blade may be twisted and/or curved (i.e. pre-bent), thus providing the chord plane with a correspondingly twisted and/or curved course, this being most often the case in order to compensate for the local velocity of the blade being dependent on the radius from the hub. The wind turbine blade 10 comprises a blade shell comprising two blade shell parts or half shells, a first blade shell part 24 and a second blade shell part 26, typically made of fiber-reinforced polymer. The wind turbine blade 10 may comprise additional shell parts, such as a third shell part and/or a fourth shell part. The first blade shell part 24 is typically a pressure side or upwind blade shell part. The second blade shell part 26 is typically a suction side or downwind blade shell part. The first blade shell part 24 and the second blade shell part 26 are fastened together with adhesive, such as glue, along bond lines or glue joints 28 extending along the trailing edge 20 and the leading edge 18 of the blade 10. Typically, the root ends of the blade shell parts 24, 26 have a semi-circular or semi-oval outer cross-sectional shape.

[0030] Fig. 2B is a schematic diagram illustrating a cross sectional view of an exemplary wind turbine blade 10, e.g. a cross sectional view of the airfoil region of the wind turbine blade 10. The wind turbine blade 10 comprises a leading edge 18, a trailing edge 20, a pressure side 24, a suction side 26, a first spar cap 74, and a second spar cap 76. The wind turbine blade 10 comprises a chord line 38 between the leading edge 18 and the trailing edge 20. The wind turbine blade 10 comprises shear webs 42, such as a leading edge shear web and a trailing edge shear web. The shear webs 42 could alternatively be a spar box with spar sides, such as a trailing edge spar side and a leading edge spar side. The spar caps 74, 76 may comprise carbon fibers while the rest of the shell parts 24, 26 may comprise glass fibers.

[0031] Fig. 2C is a schematic diagram illustrating an exemplary mold system for molding a blade shell of a wind turbine blade. The mold system 100 comprises a first mold 102 and a second mold 112. The first mold 102 is configured for manufacturing a first blade shell part of a wind turbine blade, such as an upwind shell part of the wind turbine blade (forming the pressure side). The second mold 112 is configured for manufacturing a second blade shell part of the wind turbine blade, such as a downwind shell part of the wind turbine blade (forming the

suction surface).

[0032] Figure 3A schematically illustrates an example of a fastener assembly for connecting a first web 52 to a second web 54. Note that in the figures only a small portion of the webs are shown, and only a single fastener assembly. It should be clear that the webs may be significantly wider and longer than what is shown in the schematic figured. Also a plurality of fastener assemblies may typically be used to connect the webs.

[0033] An inside is defined between the first and second webs 52, 54, and an inner surface 53 of the first web 52 faces an inner surface 55 of the second web 54, an outer surface 51 of the first web 52 being arranged on an outside of the first web 52, and an outer surface 56 of the second web 54 being arranged an on outside of the second web 54.

[0034] The fastener assembly comprises a shaft 90, a first fastener 140, and a second fastener (not shown in figure 3A). The shaft has a first end 91 configured to be arranged with the first web 52, a second end 93 configured to be arranged on the outside of the second web 54, and a central portion 92 configured to be arranged between the first and second webs 52, 54.

[0035] The central portion 92 includes one or more stoppers 64 near the first end 91. The stoppers have a retracted position wherein the stoppers substantially do not protrude beyond an outer surface of the central portion 92 and a deployed position (such as shown in figure 3A) wherein the stoppers 64 protrude beyond the outer surface of the central portion 92 such that the first web 52 can be fixed between the stoppers 64 and the first fastener 140 when mounted on the first end 91 of the shaft 90.

[0036] The central portion 92 has a cross-sectional area that is larger than the cross-sectional area of the second end 93 such that the second web 54 can be fixed between the second fastener (not shown in figure 3A) when mounted on the second end 93 of the shaft 90 and the central portion 92 of the shaft 90.

[0037] The stoppers 64 are configured to be deployed from the outside of the first web 52.

[0038] In examples, the first end 91 of the shaft 90 may comprise a first thread configured to mate with a thread of the first fastener 140, and the second end 93 of the shaft 90 may comprise a second thread configured to mate with a thread of the second fastener 150. For example, the second fastener may be a nut 150 with an internal thread. The nut 150 may be mounted around the second end 93 of shaft 90. In other examples, alternative ways of coupling the fasteners on the shaft may be used, e.g. a bayonet coupling.

[0039] In the example of figure 3A, the first fastener 140 is configured to deploy the stoppers 64. The stoppers 64 in this example may be formed by spring biased pins 64 arranged inside the central portion 92 of the shaft 90. I.e. the default position of the pins 64 may be a retracted position wherein the pins do not significantly protrude beyond the outer surface of central

portion 92. In the retracted position, the pins 64 may be substantially inside the shaft and do not impede movement of the shaft 90 through a hole in one of the webs.

[0040] The first fastener 140 may comprise a head portion 142, a threaded portion 144, and a distal tapered portion 146, see the example of figure 3B. The head portion 142 is shown to be proximally arranged in this example, and the head portion 142 is configured to engage the first web 52. The threaded portion 144 may mate with an internal thread inside the first end 91 of shaft 90. As the first fastener is threaded onto the shaft 90, the first fastener is displaced laterally, in the shown example, from the left to the right. As the first fastener 140 is displaced, the distal tapered portion 146 protrudes further into the inside of shaft 90 and can engage with the spring biased pins 64. As the tapered portion 146 continues to be displaced laterally, the spring biased pins 64 are progressively pushed into their deployed position. The first web 52 may thus be retained between the head portion 142 and the spring biased pins 64.

[0041] Although not shown in the example of figure 3A, on one or both outsides of the webs one or more washers may be arranged. I.e. the first web may be clamped or retained between the first fastener (in this example, the head portion 142 of fastener 140), one or more washers and the stoppers 64. The second web may be clamped or retained between the second fastener (e.g. a threaded nut), one or more washers and the central portion 92 of the shaft 90. The washers may be plain washers.

[0042] Figures 4A - 4C schematically illustrate another example of a fastener assembly which may be used in a similar manner. In figure 4A, a web assembly 50 is illustrated. The web assembly may be a main web assembly for a wind turbine blade. The main web assembly comprises a first shear web 52, and a second shear web 54. An inside is defined between the first and second shear webs 52, 54, and an inner surface 53 of the first web 52 faces an inner surface 55 of the second web 54, an outer surface 51 of the first web 52 being arranged on an outside of the first web 52, and an outer surface 56 of the second web 54 being arranged an on outside of the second web 54, similarly to what was depicted in the example of figure 3A.

[0043] The first and second shear webs 52, 54 are connected through a plurality of fastener assemblies. Note that only a single fastener assembly is shown in both examples, in reality a plurality of fastener assemblies may be used. The fastener assembly comprises a shaft 90, a first fastener 97, and a second fastener 96. The shaft 90 has a first end 91 arranged with the first shear web 52, a second end 93 arranged on the outside of the second shear web 54, and a central portion 92 arranged between the first and second shear webs 52 ,54.

[0044] The central portion 92 includes one or more stoppers 84 near the first end, the stoppers 84 having a retracted position wherein the stoppers substantially do not protrude beyond an outer surface of the central portion 92 and a deployed position wherein the stoppers 84 protrude beyond the outer surface of the central portion 92 such that the first shear web is fixed between the stoppers 84 and the first fastener 94 mounted on the first end 91 of the shaft 90.

[0045] As in the example of figure 4A, the central portion 92 has a cross-sectional area that is larger than a cross-sectional area of the second end 93 and the second shear web 54 is fixed between the second fastener 96 mounted on the shaft 90 and the central portion 92 of the shaft 90. The stoppers 84, 86 are configured to be deployed from an outside of the first shear web 52.

[0046] The first end 91 in this example extends through the first shear web 52 and is arranged on an outside of the first web 52. Both on the outside of the first shear web 52 and on the outside of the second shear web 54, washers 94 are arranged.

[0047] In the example of figure 4B, a fastener assembly includes a split pin 80 with resilient tines 83, 85. The tines 83, 85 comprise an upstanding portion 84, 86 at their distal ends 82. An operator can compress the split pin 80, pushing the resilient tines 83, 85 towards each other. The upstanding portions 84,86 in that situation may be regarded to be in a retracted position. The split pin 80 has a reduced height in cross-section and may be moved into the shaft 90 or be removed from the shaft.

[0048] As may be seen in figure 4C, the first end 91 of the shaft 90 comprises a slit 99. The upstanding portions 84, 86 are configured to extend through the slit 99 and form the stoppers. In the example, two slits 99 (one on the top and another at the bottom) are provided.

[0049] The slits 99 extend from the first portion 91 into the central portion 92. In the shown example, the slits 99 have a rounded opening 87 at the distal ends, through which the upstanding portions 84, 86 protrude outwardly to their deployed position.

[0050] One of the first and second shear webs 52, 54 may be a leading edge shear web, and the other of the first and second shear webs 52, 54 may be a trailing edge shear web. In a further aspect of the present disclosure, a wind turbine blade comprising such a main web assembly 50 is provided.

[0051] In the example of figure 4A, the second end 93 of the shaft 90 comprises a thread, and the second fastener 96 is a nut configured to mate with this thread.

[0052] In a further aspect, a method for assembling a web assembly is provided, particularly for a main web assembly of a wind turbine blade. The method comprises arranging a leading edge shear web with a trailing edge shear web such that an inner surface of the leading edge shear web faces an inner surface of the trailing edge shear web, an inside of the main web assembly being defined between the leading edge shear web and the trailing edge shear web.

[0053] The method further comprises connecting the leading edge shear web to the trailing edge shear by mounting a plurality of fastener assemblies. Either of the examples of figures 3A-3B and 4A-4C may be used. The mounting of one of the fastener assemblies comprises introducing a shaft 90 from an outside of the main web assembly through a hole in a first shear web 52 selected from the leading and trailing edge shear webs and subsequently through a

hole in a second shear web 54 selected from the leading and trailing edge shear webs, until a second end 92 of the shaft 90 extends through the second shear web 54 to an outside of the main web assembly, and a central portion 92 of the shaft 90 engages with the second shear web 54. The first web may be the leading edge shear web, and in that case, the second web is the trailing edge shear web. The first web may be the trailing edge shear web, and in that case, the second web is the leading edge shear web.

[0054] The method further comprises deploying one or more stoppers (pins 64, or upstanding portions 84, 86) in the central portion 92 to protrude beyond an outer surface of the central portion 92 of the shaft 90 and mounting a first fastener 140, 97 on the first end 91 of the shaft 90 to retain the first shear web 52 between the stoppers 64, 84 and the first fastener 140, 97.

[0055] A second fastener 96 is mounted on the second end 93 of the shaft 90 to retain the second shear web 54 between the second fastener 96 and the central portion 92 of the shaft 90, the stoppers 64, 84 being deployed from an outside of the main web assembly.

[0056] It is noted that the fastener assemblies in the examples of figures 3A-3B and 4A-4C can be mounted from outside of the web assembly. No washers or other fasteners are arranged at an inside of the main web assembly. No operators need to access the space inside the web assembly. It should be clear that the order of the several method steps of this method can be changed.

[0057] In some examples, deploying of the stoppers comprises introducing a split pin 80 from an outside of the main web assembly through the first end 91 of the shaft 90, wherein the split pin comprises two tines 83, 85 comprising an upstanding portion 84, 86 at distal end 82 of the tines 83, 85 to form the stoppers. An operator may compress the split pin 80 to put the stoppers (upstanding portions 84, 86) into a retracted position for their introduction. In the retracted position, the upstanding portions 84, 86 do not extend beyond the outer surface of the shaft 90. After introduction, the upstanding portions 84, 86 extend through slits 99 in the central portion of the shaft.

[0058] In other examples, the central portion 92 comprises two spring biased pins forming the stoppers, the pins being deployed by mounting the first fastener, as was illustrated with respect to figures 3A-3B, the first fastener comprising a tapered portion which engages the spring biased pins as the first fastener is mounted at the first end of the shaft.

[0059] The method may further comprise removing the fastener assemblies after attaching the main web assembly to an upwind blade shell and a downwind blade shell, and particularly removing the fastener assemblies from the outside of the main web assembly.

[0060] This written description uses examples to disclose the present teaching, including the preferred embodiments, and also to enable any person skilled in the art to practice it, including making and using any devices or systems and performing any incorporated methods. The patentable scope is defined by the claims.

[0061] If reference signs related to drawings are placed in parentheses in a claim, they are solely for attempting to increase the intelligibility of the claim, and shall not be construed as limiting the scope of the claim.

REFERENCES CITED IN THE DESCRIPTION

Cited references

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP2742234B1 [0009]
- CN213331389U [0009]
- WO2020216924A1 [0009]

KRAV

1. En fastgørelsesanordning til at forbinde et første web (52) til et andet web (54),
hvor en inderside er defineret mellem det første (52) og det andet web (54), og en indre overflade (53) af det første web (52) vender mod en indre overflade (55) af det andet web (54), og en ydre overflade (51) af det første web (52) er anbragt på en yderside af det første web (52), og en ydre overflade (56) af det andet web (54) er arrangeret på en yderside af det andet web (54), hvor fastgørelsesanordningen omfatter:

en aksel (90), et første fastgørelseselement (97; 140) og et andet fastgørelseselement (96; 150),
hvor akslen (90) har en første ende (91) konfigureret til at blive arrangeret med det første web (52), en anden ende (93) konfigureret til at blive anbragt på ydersiden af det andet web (54), og en central del (92) konfigureret til at blive anbragt mellem det først (52) og det andet web (54), hvor
den centrale del (92) indbefatter en eller flere stoppere (64; 84, 86) nær den første ende, hvor stopperne (64; 84, 86) har en tilbagetrukket stilling hvor stopperne (54; 84, 86) i det væsentlige ikke rager ud over en ydre overflade af den centrale del (92), og en udfoldet stilling (eng: deployed position) hvor stopperne (64; 84, 86) rager ud over den ydre overflade af den centrale del (92), således at det første web (52) kan fastgøres mellem stopperne og det første fastgørelseselement (97; 140), når monteret på den første ende (91) af akslen (90), hvor
den centrale del (92) har et tværsnitsareal der er større end tværsnitsarealet af den anden ende (93), således at det andet web (54) kan fastgøres mellem det andet fastgørelseselement (150; 96), når monteret på den anden ende (93) af akslen (90), og den centrale del (92) af akslen, og
hvor stopperne (64; 84, 86) er konfigureret til at blive udfoldet fra ydersiden af det første web (52).

2. Fastgørelsesanordning ifølge krav 1, hvor den første ende (91) af akslen omfatter et første gevind, der er konfigureret til at passe med et gevind (144) på det første fastgørelseselement (140; 97), og den anden ende (93) af akslen (90) omfatter et andet gevind, der er konfigureret til at passe med et gevind på det andet fastgørelseselement (150; 96).

3. Fastgørelsesanordning ifølge krav 1 eller 2, hvor det første fastgørelseselement (140) er konfigureret til at udfolde stopperne (68).

4. Fastgørelsesanordning ifølge krav 3, hvor stopperne er fjederforspændte stifter (64) anbragt inden i den centrale del (92) af akslen (90).

5. Fastgørelsesanordning ifølge krav 4, hvor det første fastgørelseselement (140) omfatter en hoveddel (142), en gevindskåren del (144) og en distal tilspidset del (146), og hvor den distale tilspidsede del er konfigureret til at udfolde stopperne (64).

6. Fastgørelsesanordning ifølge krav 5, hvor den første ende (91) af akslen (90) har et indvendigt gevind, og den gevindskårne del af det første fastgørelseselement (140) er konfigureret til at passe med det indvendige gevind.

7. Fastgørelsesanordning ifølge krav 1 eller 2, hvor fastgørelsesanordningen omfatter en splitstift (80) med fjedrende tænder (83, 85), hvor tænderne omfatter en opretstående del (84, 86) ved deres distale ender (82), og den første ende af akslen omfatter en slids (99), og de opretstående dele (84, 86) er konfigureret til at strække sig gennem slidsen og udgøre stopperne.

8. Fastgørelsesanordning ifølge et hvilket som helst af kravene 1-7, yderligere omfattende en spændeskive (84; 94) mellem det første fastgørelseselement og det første web og/eller mellem det andet fastgørelseselement og det andet web.

9. En hovedwebsamling (eng: main web assembly) (50) til en vindmøllevinge, omfattende:

et første shearweb (eng: shear web) (52); og

et andet shearweb (54); hvor en inderside er defineret mellem det første og andet shearweb (52, 54), og en indre overflade (53) af det første web (52) vender mod en indre overflade af det andet web (54), og en ydre overflade (51) af det første web (52) er anbragt på en yderside af det første web, og en ydre overflade af det andet web er anbragt på en yderside af det andet web, og

det første og det andet shearweb (52, 54) er forbundet gennem en flerhed af fastgørelsesanordninger ifølge et hvilket som helst af kravene 1-8.

10. Hovedwebsamling ifølge krav 9, hvor et af det første og det andet shearweb (52, 54) er et forkantsshearweb og det andet af det første og det andet shearweb er et bagkantsshearweb.

13. Fremgangsmåde til samling af en hovedwebsamling (50) til en vindmøllevinge, omfattende:

anbringelse af et forkantshearweb med et bagkantshearweb således at en indre overflade af forkantsshearwebbet vender mod en indre overflade af bagkantsshearwebbet, hvor en inderside af hovedwebsamlingen er defineret mellem forkantsshearwebbet og bagkantsshearwebbet;

forbindelse af forkantsshearwebbet med bagkantsshearwebbet ved montering af en flerhed af fastgørelsesanordninger, hvor monteringen af en af fastgørelsesanordningerne omfatter:

indføring af en aksel (90) fra en yderside af hovedwebsamlingen gennem et hul i et første shearweb (52) udvalgt af forkantsshearwebbet og bagkantsshearwebbet og efterfølgende gennem et hul i et andet shearweb (54) udvalgt af forkantsshearwebbet og bagkantsshearwebbet, indtil en anden ende (93) af akslen (90) strækker sig gennem det andet shearweb (54) til en yderside af hovedwebsamlingen, og en central del af akslen (90) går i indgreb med det andet shearweb (54);

udfoldelse af en eller flere stoppere (64; 84, 86) i den centrale del (92) så de rager ud over en ydre overflade af den centrale del (92) af akslen (90) og montering af et første fastgørelseselement (97; 140) på den første ende (91) af akslen for at fastholde det første shearweb (52) mellem stopperne og det første fastgørelseselement;

montering af et andet fastgørelseselement (96; 150) på den anden ende (93) af akslen (90) for at fastholde det andet shearweb (54) mellem det andet fastgørelseselement (96; 150) og den centrale del (92) af akslen (90), hvor stopperne (64; 84, 86) udfoldes fra ydersiden af hovedwebsamlingen (50).

14. Fremgangsmåde ifølge krav 13, hvor udfoldelsen af stopperne omfatter indføring af en splitstift (80) fra en yderside af hovedwebsamlingen gennem den første ende (91) af akslen (90), hvor splitstiften (80) omfatter to tænder (83, 85) der omfatter en opretstående del (84, 86) ved distal ende (82) af tænderne til dannelse af stopperne.

15. Fremgangsmåde ifølge krav 13, hvor den centrale del (92) omfatter to fjederforspændte stifter (64) der udgør stopperne, og hvor stifterne (64) udfoldes ved at montere det første fastgørelses-element (140).