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(54) Title: WIND TURBINE BLADE WITH TRAILING EDGE FLAP

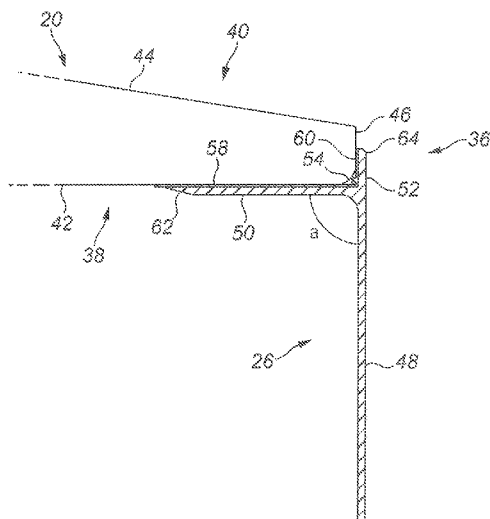


FIG. 5a

(57) Abstract: A wind turbine blade is described that extends in a spanwise direction between a root end and a tip end and extends in a chordwise direction between a leading edge and a trailing edge. The blade has a pressure side comprising a pressure surface, a suction side comprising a suction surface and a trailing edge surface between the pressure surface and the suction surface. The trailing edge surface at least partially defines the trailing edge of the blade, and the blade further comprising a trailing edge flap extending along at least a portion of the trailing edge. The trailing edge flap comprises an upstand, a first mounting flange, and a second mounting flange. The first mounting flange is mounted to the pressure surface of the blade, the second mounting flange is mounted to the trailing edge surface of the blade, and the upstand extends from the trailing edge on the pressure side of the blade.

Wind turbine blade with trailing edge flapTechnical field

- 5 The present invention relates generally to wind turbine blades, and more specifically to a wind turbine blade having a trailing edge flap for increasing lift.

Background

- 10 It is known to fit lift-enhancing devices to the trailing edge of wind turbine blades to increase the lift of the blade and hence to increase the energy capture of the blade. One example of such a device is a so-called 'Gurney flap'. In its simplest form, a Gurney flap comprises an elongate plate mounted on the pressure side of the blade at the trailing edge of the blade. The flap is typically orientated perpendicular to the pressure surface of  
15 the blade, and typically projects from the pressure surface by about 1-5% of the local chord length of the blade.

- Trailing edge flaps, such as Gurney flaps, are often provided in the form of an elongate structure having an L-shaped cross section. An L-shaped flap 1 is shown by way of  
20 example in Figure 1a. The base of the L serves as a convenient mounting flange 2 for the flap, and is typically mounted to the pressure side 3 of the blade 4 using adhesive and/or mechanical fixings such as screws or rivets.

- Trailing edge flaps are subject to substantial peel forces in use. One of the challenges  
25 faced in the art is to ensure that the connection between the flap and the blade is sufficiently robust so that the flap does not become detached from the blade in use. Whilst mechanical fixings such as screws provide a strong attachment to the blade, these fixings necessarily require holes to be formed in the blade, which can create weak points in the blade structure. It is therefore desirable to minimise the number of  
30 mechanical fixings required where possible.

- Various shapes of trailing edge flap have been suggested in the prior art. For example, T-shaped flaps 5 are known (see Figure 1b), in which the upstand 6 of the flap 5 is centrally located with respect to the mounting flange 7. Whilst T-shaped flaps provide a  
35 more stable connection to the pressure surface of the blade, which is better able to withstand peel forces, the upstand is necessarily spaced forwardly of the trailing edge by

at least half the width of the mounting flange. It is therefore not possible to locate the upstand 6 of such a T-shaped flap 5 at, or at least very close to, the extreme trailing edge of the blade, which is often the optimal location.

## 5 Summary of the invention

Against this background, the present invention provides a wind turbine blade extending in a spanwise direction between a root end and a tip end and extending in a chordwise direction between a leading edge and a trailing edge, the blade having a pressure side comprising a pressure surface, a suction side comprising a suction surface and a trailing edge surface between the pressure surface and the suction surface, the trailing edge surface at least partially defining the trailing edge of the blade, and the blade further comprising a trailing edge flap extending along at least a portion of the trailing edge, the trailing edge flap comprising an upstand, a first mounting flange, and a second mounting flange, wherein the first mounting flange is mounted to the pressure surface of the blade, the second mounting flange is mounted to the trailing edge surface of the blade, and the upstand extends from the trailing edge on the pressure side of the blade.

The second mounting flange, which is mounted to the trailing edge surface of the blade, provides a stable connection between the trailing edge flap and the blade. As a result, the trailing edge flap of the present invention is more resistant to peel forces than prior art flaps which are only mounted to the pressure surface of the blade. The provision of the second mounting flange also advantageously enables the upstand of the flap to be positioned substantially at the extreme trailing edge of the blade whilst still providing a peel resistant connection between the flap and the blade.

The wind turbine blade according to the present invention has a so-called 'flat-back' profile, in which the trailing edge comprises a trailing edge surface, which is preferably substantially flat, and which joins the pressure and suction surfaces at the trailing edge of the blade. The upstand of the flap is preferably substantially perpendicular to the pressure surface at the trailing edge of the blade

The upstand of the trailing edge flap preferably extends substantially parallel to the second mounting flange. In a first embodiment of the invention, the upstand and the second mounting flange are located substantially in the same plane. In this arrangement, the upstand may form a continuation of the trailing edge surface. In a second

embodiment of the invention, the upstand and the second mounting flange are in staggered relation. In this case, the upstand is located slightly inboard of the second mounting flange. For example, the upstand may be located a few millimetres inboard of the second mounting flange. The corner of the trailing edge may be curved and adhesive  
5 may be provided between the trailing edge flap and this corner. By positioning the upstand of the flap slightly inboard of the second mounting flange, the upstand can be located against the flat pressure surface of the blade rather than against the adhesive in the corner of the trailing edge. This arrangement therefore improves load transfer between the flap and the blade.

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In preferred embodiments of the invention, the trailing edge flap is substantially T-shaped in cross-section. The first mounting flange is preferably transverse to the upstand and transverse to the second mounting flange. The upstand and the first mounting flange together may substantially form an L-shape. The first mounting flange may be  
15 substantially perpendicular to the upstand. The first mounting flange may be substantially perpendicular to the second mounting flange.

20

The trailing edge flap may conveniently encapsulate the corner of the trailing edge between the pressure surface and the trailing edge surface. Preferably the first and second mounting flanges together substantially form an L-shape (effectively an L-shaped bracket) and are fitted around this corner of the trailing edge. This corner may be curved (as mentioned above), and is often not well defined during the manufacturing stage. By encapsulating this corner with the flap, additional shaping and finishing operations on the corner are then not required, hence the provision of the trailing edge flap of the present  
25 invention obviates the need for costly and time-consuming manufacturing operations on the trailing edge.

30

The first mounting flange and/or the second mounting flange may advantageously have a tapered edge. The tapered edges form a smooth continuation between the flap and the surfaces of the blade, which reduces the drag on the blade and reduces the peel forces acting on the flap.

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In one embodiment of the invention, the trailing edge flap extends from a point close to the root of the blade up to a point at approximately 50% span. In other embodiments, the trailing edge flap may extend along substantially the entire length of the blade, e.g. from root to tip. The height of the flap may vary along the length of the blade. The upstand preferably has a maximum height substantially at a spanwise location along the blade

where the blade has its maximum chord. Moving in a direction towards the tip of the blade, the height of the upstand preferably tapers substantially to zero.

5 The first mounting flange preferably includes a plurality of slots along its length configured to enable the trailing edge flap to conform to the curvature along the trailing edge. The slots may have any suitable shape, but in a preferred embodiment of the invention the slots are substantially V-shaped. The spacing between slots may vary along the length of the first mounting flange. For example, the slots may be closer together in regions of the trailing edge having a greater curvature as compared to the  
10 spacing between slots in regions of the trailing edge having a lesser curvature.

The trailing edge flap may be made from any suitable material, for example plastics, metal or composites or a combination of such materials, but in preferred embodiments of the invention the flap is made from plastics material. The flap may be formed as a single  
15 section or as a plurality of sections. In preferred embodiments of the invention, at least a section of the trailing edge flap is an extruded component. Also, in a preferred embodiment, a section of the flap between the root of the blade and the maximum chord (i.e. in the 'transition region' of the blade) is a moulded component. This region of the blade has a high degree of curvature and this section of the flap may advantageously be  
20 moulded to have the required curvature without the need for slots.

The invention also provides a wind turbine having one or more wind turbine blades as described above.

25 Brief description of the drawings

Figures 1a and 1b have already been described above by way of background to the present invention. In order that the present invention may be more readily understood, non-limiting examples of the invention will now be described in detail with reference to  
30 Figures 2 to 7, in which:

Figure 2 is a schematic front view of a wind turbine according to an embodiment of the present invention;

Figure 3 is a perspective view of a wind turbine blade of the wind turbine of Figure 2, and showing a trailing edge flap mounted along a trailing edge of the blade;

5 Figure 4 is a schematic cross-sectional view of the wind turbine blade of Figure 3;

Figure 5a is an enlarged cross-sectional view of the trailing edge region of the blade of Figures 3 and 4 and showing a trailing edge flap according to a first embodiment of the invention in more detail;

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Figure 5b is an enlarged cross-sectional view of the trailing edge region of the blade of Figures 3 and 4 and showing a trailing edge flap according to a second embodiment of the invention in more detail;

15 Figure 5c is a perspective view of the trailing edge flap of the second embodiment of the invention;

Figure 6 shows part of the wind turbine blade of Figures 3 to 5 as viewed along the trailing edge looking towards a root end of the blade; and

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Figure 7 is a schematic plan view of a pressure side of an inboard region of the wind turbine blade of Figures 3 to 6.

#### Detailed description

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Referring to Figure 2, this shows a wind turbine 10 according to the present invention. The wind turbine 10 comprises a tower 12 supporting a nacelle 14 at an upper end of the tower 12. A rotor 16 is mounted to the nacelle 14. The rotor 16 comprises a hub 18 and three wind turbine blades 20 are mounted to the hub 18. The three blades 20 are equally spaced about the periphery of the hub 18 and extend in a longitudinal direction from a root end 22, which is mounted to the hub 18, towards a tip end 24. Each blade 20 includes a trailing edge flap 26, which will be described in further detail later.

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Referring to Figure 3, this shows part of one of the wind turbine blades 20 in more detail. Here it can be seen that the root end 22 of the blade 20 is generally circular. Moving in a spanwise direction S from the root end 22 towards the tip end 24 of the blade 20 (the tip

35

end 24 of the blade 20 is not shown in Figure 3), it can be seen that the width (i.e. chord) of the blade 20 rapidly increases up to a maximum width (i.e. maximum chord, as indicated by the line  $C_{MAX}$  in Figure 3). The width of the blade 20 then steadily decreases moving towards the tip (not shown) of the blade 20.

5

The part of the blade 20 between the root end 22 of the blade 20 and the maximum chord  $C_{MAX}$  is referred to herein as the 'transition portion' 30 of the blade 20. The transition portion 30 of the blade 20 has a cross-sectional profile that transitions from a circular profile at the root end 22 of the blade 20 into an aerodynamically-optimised airfoil profile at maximum chord  $C_{MAX}$ , as will be readily apparent to persons skilled in the art. The region of the blade 20 between the maximum chord  $C_{MAX}$  and the tip of the blade 20 is referred to herein as the 'outer portion' 32 of the blade 20. This portion 32 of the blade 20 has an airfoil profile of varying geometry along its length.

15 The blade 20 extends in a chordwise direction  $C$  between a leading edge 34 and a trailing edge 36. The trailing edge flap 26 referred to above is mounted at the trailing edge 36. The trailing edge flap 26 extends longitudinally along the trailing edge 36, from a point close to the root end 22 of the blade 20 to a point at approximately 50% span, including along the transition portion 30 of the blade 20 inboard of maximum chord  $C_{MAX}$ .  
20 In other embodiments of the invention, the trailing edge flap 26 may have a different longitudinal extent, for example the flap 26 may extend substantially along the entire spanwise length of the blade 20, i.e. from the root end 22 of the blade 20 to the tip end 24 of the blade 20.

25 Referring now to Figure 4, which is a cross-sectional view through the blade 20 at maximum chord  $C_{MAX}$ , the blade 20 comprises a pressure side 38 and a suction side 40, which are made primarily from glass-fibre reinforced plastic (GFRP). The pressure side 38 comprises a pressure surface 42 of the blade 20, and the suction side 40 comprises a suction surface 44 of the blade 20. The pressure surface 42 and the suction surface 44  
30 meet at the leading edge 34 of the blade 20, which has a convex-curved shape. The blade 20 in this example is a so-called 'flat-back' blade, which has a blunt trailing edge 36. Here, the pressure and suction surfaces 42, 44 are joined by a substantially flat trailing edge surface 46 of the blade 20. The trailing edge surface 46 in this section is substantially perpendicular to the chord line  $C$  of the blade 20, which is the line joining  
35 the leading and trailing edges 34, 36 of the blade 20. The trailing edge flap 26 is

mounted to the trailing edge 36 as will now be described in further detail with reference to Figure 5a.

Referring to Figure 5a, this shows a first embodiment of the trailing edge flap 26, which is substantially T-shaped in cross-section and comprises a substantially flat upstand 48 or 'flap portion' and first and second mounting flanges 50, 52. The first mounting flange 50 is substantially flat and extends substantially perpendicular to the upstand 48, such that the upstand 48 and first mounting flange 50 form an L shape, with the first mounting flange 50 forming the base of the L. The second mounting flange 52 is parallel to the upstand 48 and lies in the same plane as the upstand 48, but is on the other side of the first mounting flange 50 to the upstand 48. Expressed in other terms, the upstand 48 and the second mounting flange 52 form a plane from which the first mounting flange 50 projects at a substantially perpendicular angle to the plane to form a T-shape.

The first mounting flange 50 is mounted to the pressure surface 42 of the blade 20 near the trailing edge 36, whilst the second mounting flange 52 is mounted to the trailing edge surface 46 which forms the flat back of the airfoil. The trailing edge surface 46 and the pressure surface 42 near the trailing edge 36 are substantially perpendicular to one another and form a corner 54. The first and second mounting flanges 50, 52 are also substantially perpendicular to one another and form an L-shape bracket that mounts to the corner 54, thereby encapsulating the corner 54.

The upstand 48 projects from the trailing edge 36 on the pressure side 38 of the blade 20. An angle  $\alpha$  is defined between the upstand 48 and the pressure surface 42 at the trailing edge 36. In this example  $\alpha$  is approximately ninety degrees, i.e. the upstand is substantially perpendicular to the pressure surface 42 at the trailing edge 36. The upstand 48 is approximately straight and hence extends substantially parallel to the flat trailing edge surface 46. In this way, the upstand 48 effectively forms a continuation of the flat trailing edge surface 46. The upstand 48 in this example extends from the extreme trailing edge of the blade 20, i.e. it is located substantially at 100% chord, which is an aerodynamically optimal position for the flap 26.

The corner 54 of the trailing edge between the pressure surface 42 and the trailing edge surface 46 is slightly curved and is often not well defined during manufacture of the blade 20. In the absence of the trailing edge flap 26, additional manufacturing steps such as profiling and finishing may previously have been required to define and seal the corner.



However, the trailing edge flap according to the present invention advantageously encapsulates the corner 54 and therefore these additional steps are not required.

5 In this example, the first mounting flange 50 is mounted to the pressure surface 42 of the blade 20 using a pressure-sensitive adhesive in the form of double-sided self-adhesive tape 58. The second mounting flange 52 is mounted to the trailing edge surface 36 of the blade 20 using a contact adhesive 60 such as Araldite® 2021 adhesive. Other suitable adhesives will be readily apparent to persons skilled in the art. Mechanical fixings in the form of screws may also be used at intervals along the length of the flanges 50, 52 to  
10 connect the flanges 50, 52 to the respective surfaces 42, 46, although these are not necessarily required.

In contrast to the prior art L-shape flaps described above with reference to Figure 1a, the trailing edge flap 26 of the present invention is more resistant to peel forces by virtue of  
15 having multiple mounting flanges 50, 52. Consequently, fewer or no mechanical fixings are required in the present invention. Whereas the upstand 6 of the T-shaped flap 5 described above with reference to Figure 1b is necessarily located forward of the trailing edge, the upstand 48 of the flap 26 according to this embodiment of the present invention is located at the extreme trailing edge of the blade 20, which is an  
20 aerodynamically optimal position for the upstand 48.

The first mounting flange 50 in this example is approximately one hundred millimetres in length and has a tapered edge 62 which tapers towards the pressure surface 42 of the blade 20 to form a smooth transition between the pressure surface 42 and the first  
25 mounting flange 50. The taper length in this example is approximately twenty five millimetres. The second mounting flange 52 has a length of approximately thirty millimetres in this example and also has a tapered edge 64, which tapers towards the trailing edge surface 46 to form a smooth transition between the trailing edge surface 46 and the second mounting flange 52. The taper length in this example is approximately  
30 five millimetres. An edge sealant is provided along the tapered edges 62, 64 to seal the edges to the surfaces 42, 46 of the blade 20 and thereby to prevent moisture ingress etc.

Referring now to Figures 5b and 5c, these show a trailing edge flap 26a according to a second embodiment of the invention. The trailing edge flap 26a is similar to the trailing  
35 edge flap 26 described above and shown in Figure 5a, except that the upstand 48a and the second mounting flange 52a in the second embodiment are slightly staggered with

respect to one another and hence do not lie in the same plane. Specifically, the upstand 48a is slightly inboard (i.e. towards the leading edge) of the second mounting flange 52a. In this example, the upstand is approximately 4 mm inboard of the second mounting flange 52a, and hence is effectively located at the extreme trailing edge 36 of the blade 20. The flap 26a is still substantially T-shaped in cross section, with the upstand 48a and the second mounting flange 52a extending substantially parallel to one another, and the first mounting flange 50a extending substantially perpendicular to both.

A particular advantage of the flap 26a of the second embodiment is that the upstand 48a is located (at least partially) against the flat pressure surface 42 of the blade 20 instead of against the adhesive 60 at the curved corner 54 of the trailing edge 36. Accordingly, load transfer from the flap 26a to the blade 20 is improved in this embodiment.

Referring now to Figure 6, which is a perspective view of part of the pressure surface 42 of the blade 20, looking along the trailing edge 36 towards the root end 22 of the blade 20, it can be seen that the first mounting flange 50/50a of the trailing edge flap 26/26a includes a plurality of slots 66 provided at intervals along its length. The slots 66 are V-shaped, with the mouth 68 of the V located at the tapered edge 62 of the first mounting flange 50/50a and the apex 70 of the V pointing towards the upstand 48/48a of the flap 26/26a. The slots 66 allow the flap 26/26a to conform to the curved contour of the blade 20 along the trailing edge 36. Whilst the slots 66 in this example are V-shaped, in other embodiments the slots may have other shapes, for example parallel-sided slots.

Referring now to Figure 7, it can be seen that the spacing between slots 66 varies along the length of the flap 26/26a, or in other words, the slots 66 are closer together in certain regions of the blade 20 than in others. In general, the slots 66 are closer together in areas of relatively high curvature, such as near the maximum chord  $C_{MAX}$ , where the curvature of the trailing edge 36 is greatest. The relatively close together slots 66 in this region of the flap 26/26a enable the flap 26/26a to conform to the highly pronounced curvature of the trailing edge 36 in such regions.

The flap 26/26a in this example is formed by extrusion, and is an extruded length of acrylonitrile styrene acrylate (ASA). In other embodiments the flap 26/26a may be made from other plastics materials or from other suitable material such as metal or composites. The tapered edges 62, 64 of the flap 26/26a are formed as a further manufacturing step following the extrusion process. The flap 26/26a is formed in a number of sections 72a,

72b, 72c etc, which are mounted end to end along the length of the trailing edge 36. However, it will be appreciated that a single longer length could be used. In this example, a moulded flap section 74 is employed in part of the transition portion 30 of the blade 20. The transition portion 30 has a high degree of curvature and the moulded flap section 74 is shaped to conform to this curvature without the need for slots in the first mounting flange 50. The moulded flap section 74 is located end to end with the extruded flap sections to form a substantially continuous trailing edge flap. In other examples an extruded flap may be used along the entire blade 20, including in the transition region 30, or a moulded flap may be used along the entire length of the blade 20, or moulded flap sections may be used in other regions of the blade 20, according to the particular requirements.

The height of the upstand 48/48a in these examples varies along the length of the blade 20. For example, the upstand 48/48a has a height of approximately 100 mm at the root end 22 of the blade 20, which corresponds to 5% chord; moving longitudinally along the blade 20, the height of the upstand 48/48a steadily increases to reach a maximum height at maximum chord  $C_{MAX}$ ; here the upstand 48/48a has a height of approximately 170 mm, which corresponds to approximately 4.75% chord; thereafter, the height of the upstand 48/48a gradually decreases moving towards the tip end 24 of the blade 20, with the upstand 48/48a tapering towards zero height near the tip 28 of the blade 20.

Many modifications may be made to the examples described above without departing from the scope of the present invention as defined in the following claims.

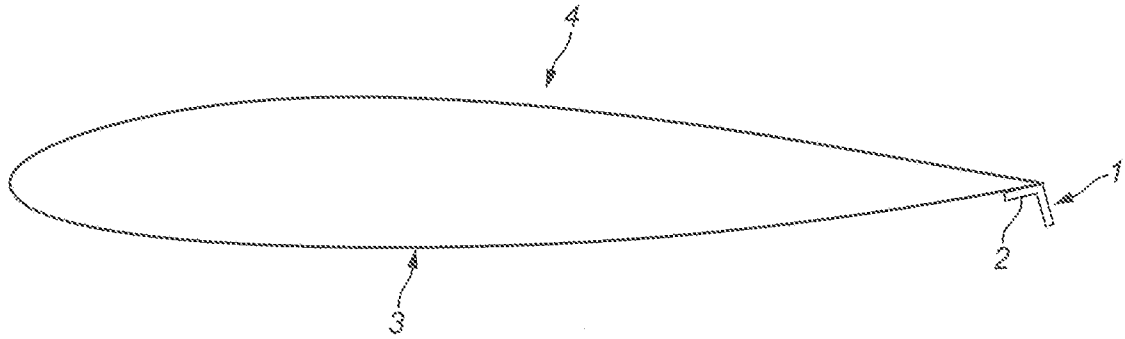
Claims

1. A wind turbine blade extending in a spanwise direction between a root end and a tip end and extending in a chordwise direction between a leading edge and a trailing edge, the blade having a pressure side comprising a pressure surface, a suction side comprising a suction surface and a trailing edge surface between the pressure surface and the suction surface, the trailing edge surface at least partially defining the trailing edge of the blade, and the blade further comprising a trailing edge flap extending along at least a portion of the trailing edge, the trailing edge flap comprising an upstand, a first mounting flange, and a second mounting flange, wherein the first mounting flange is mounted to the pressure surface of the blade, the second mounting flange is mounted to the trailing edge surface of the blade, and the upstand extends from the trailing edge on the pressure side of the blade.
2. The wind turbine blade of Claim 1, wherein the upstand is located substantially at the extreme trailing edge of the blade.
3. The wind turbine blade of Claim 1 or Claim 2, wherein the trailing edge surface is substantially flat.
4. The wind turbine blade of any preceding claim, wherein the upstand extends substantially parallel to the second mounting flange.
5. The wind turbine blade of any preceding claim, wherein the upstand and the second mounting flange are located substantially in the same plane.
6. The wind turbine blade of any preceding claim, wherein the upstand forms a continuation of the trailing edge surface.
7. The wind turbine blade of any of Claims 1 to 4, wherein the upstand and the second mounting flange are in staggered relation.
8. The wind turbine blade of Claim 7, wherein the upstand is located inboard of the second mounting flange.
9. The wind turbine blade of any preceding claim, wherein the trailing edge flap is substantially T-shaped in cross-section.

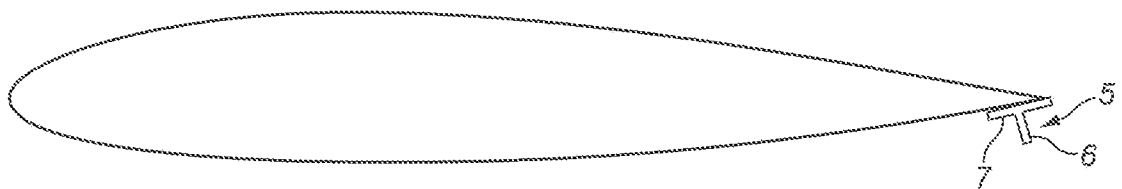
10. The wind turbine blade of any preceding claim, wherein the upstand is substantially perpendicular to the pressure surface at the trailing edge of the blade.
- 5 11. The wind turbine blade of any preceding claim, wherein the first mounting flange is transverse to the upstand and transverse to the second mounting flange.
12. The wind turbine blade of any preceding claim, wherein the upstand and the first mounting flange together substantially form an L-shape.
- 10 13. The wind turbine blade of any preceding claim, wherein the first mounting flange is substantially perpendicular to the upstand.
14. The wind turbine blade of any preceding claim, wherein the first mounting flange is substantially perpendicular to the second mounting flange.
- 15 15. The wind turbine blade of any preceding claim, wherein the trailing edge flap encapsulates a corner of the trailing edge defined between the pressure surface and the trailing edge surface.
- 20 16. The wind turbine blade of Claim 15, wherein the first and second mounting flanges together substantially form an L-shape and are fitted at the corner of the trailing edge between the pressure surface and the trailing edge surface.
- 25 17. The wind turbine blade of any preceding claim, wherein the first mounting flange has a tapered edge.
18. The wind turbine blade of any preceding claim, wherein the second mounting flange has a tapered edge.
- 30 19. The wind turbine blade of any preceding claim, wherein the trailing edge flap extends along substantially the entire length of the blade.
20. The wind turbine blade of any preceding claim, wherein the height of the flap varies along the length of the blade.
- 35 21. The wind turbine blade of any preceding claim, wherein the upstand has a maximum height substantially at a spanwise location along the blade where the blade has its maximum chord.

22. The wind turbine blade of any preceding claim, wherein the height of the upstand tapers to zero moving in a direction towards the tip of the blade.
23. The wind turbine blade of any preceding claim, wherein the first mounting flange  
5 includes a plurality of slots along its length configured to enable the trailing edge flap to conform to the curvature along the trailing edge.
24. The wind turbine blade of Claim 23, wherein the slots are substantially V-shaped.
- 10 25. The wind turbine blade of Claim 23 or Claim 24, wherein the spacing between slots varies along the length of the first mounting flange, and the slots are closer together in regions of the trailing edge having a greater curvature as compared to the spacing between slots in regions of the trailing edge having a lesser curvature.
- 15 26. The wind turbine blade of any preceding claim, wherein the trailing edge flap is an extruded component.
27. A wind turbine comprising the wind turbine blade of any preceding claim.

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*FIG. 1a*  
*PRIOR ART*



*FIG. 1b*  
*PRIOR ART*

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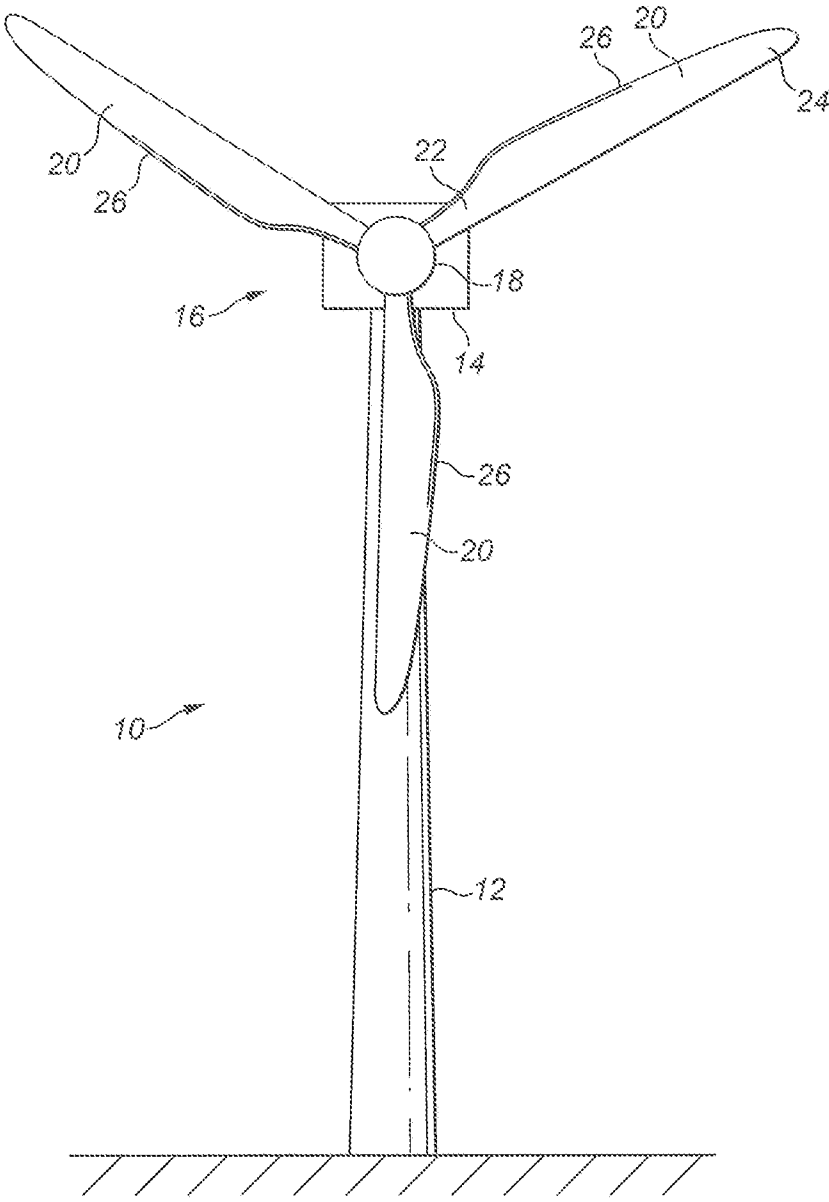
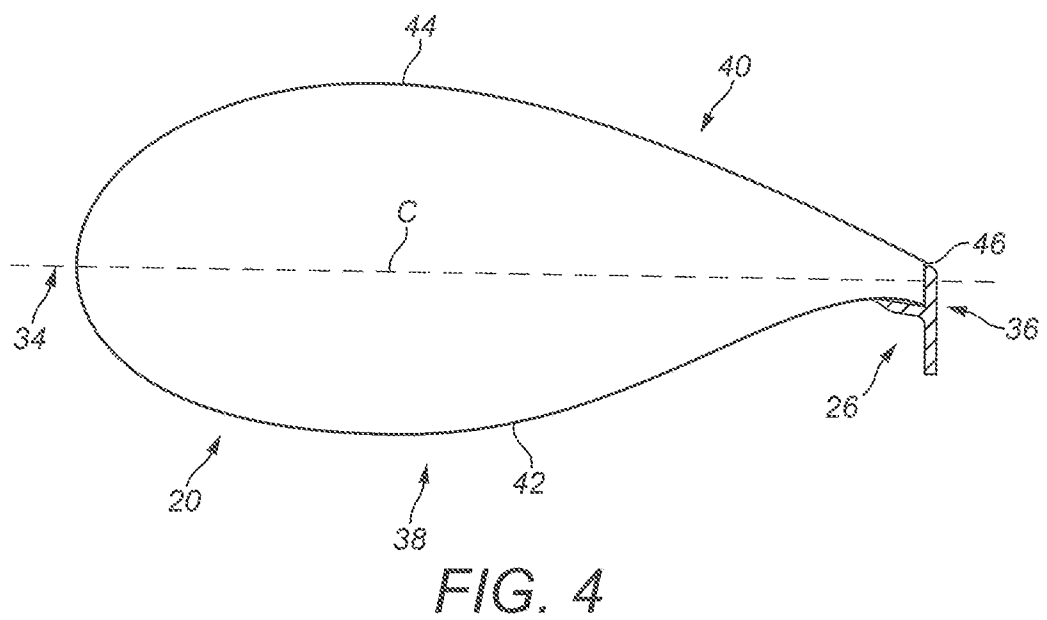
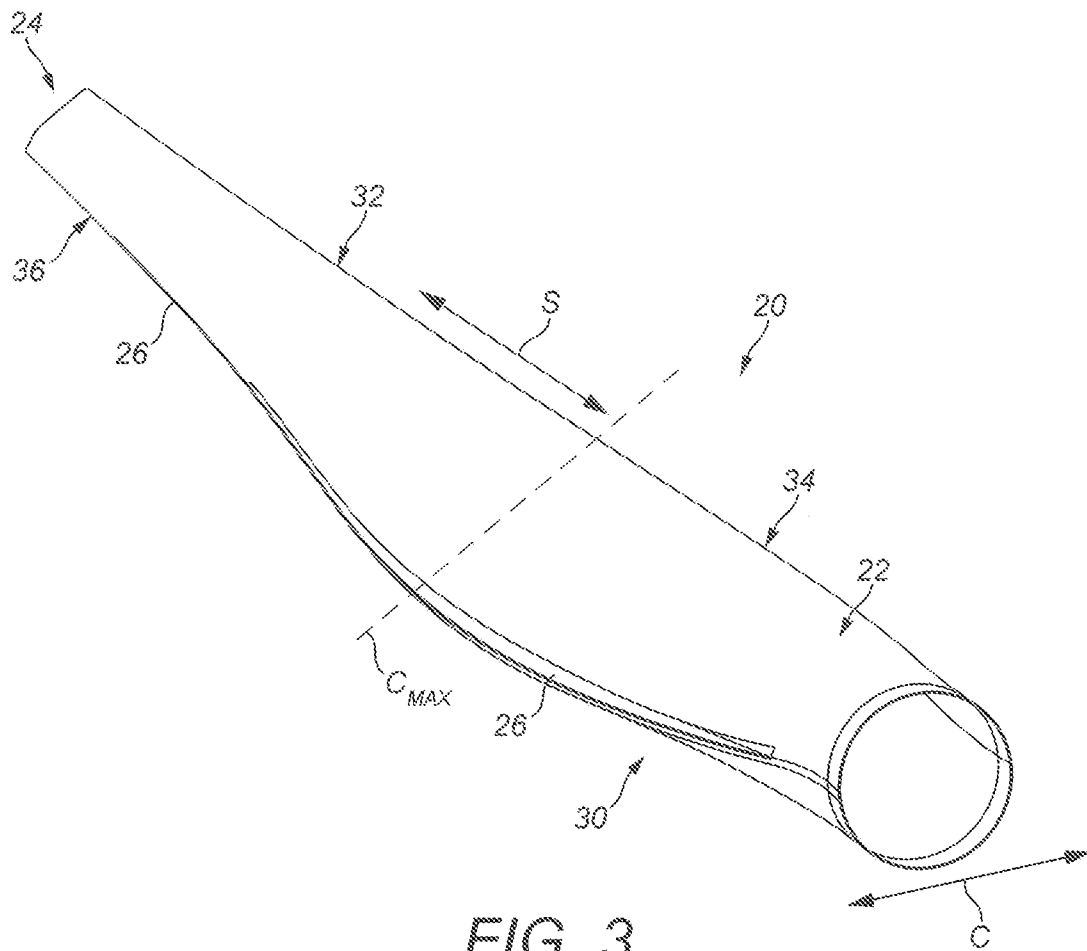


FIG. 2



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4 / 6

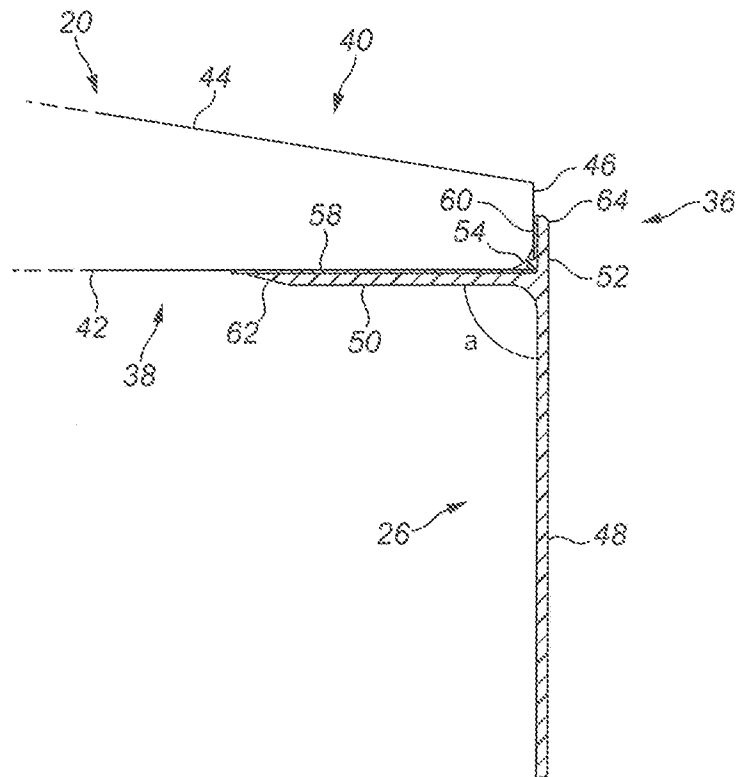


FIG. 5a

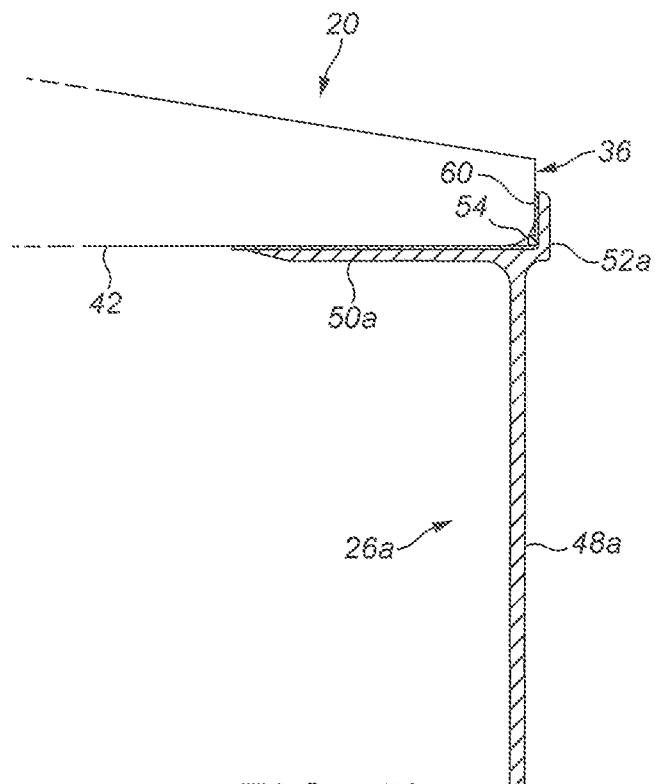


FIG. 5b

5 / 6

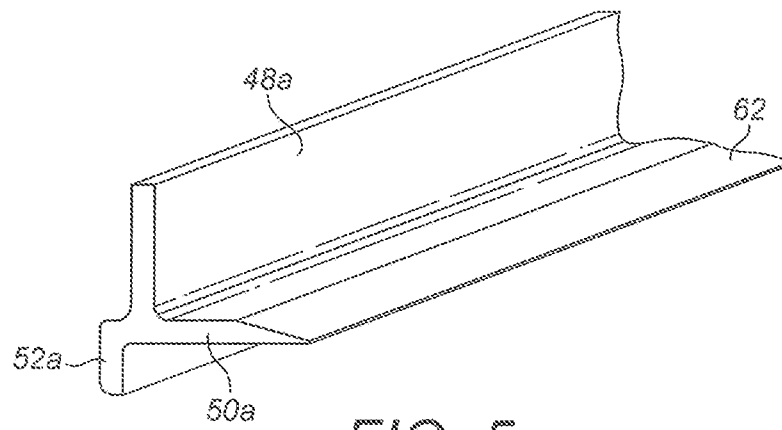


FIG. 5c

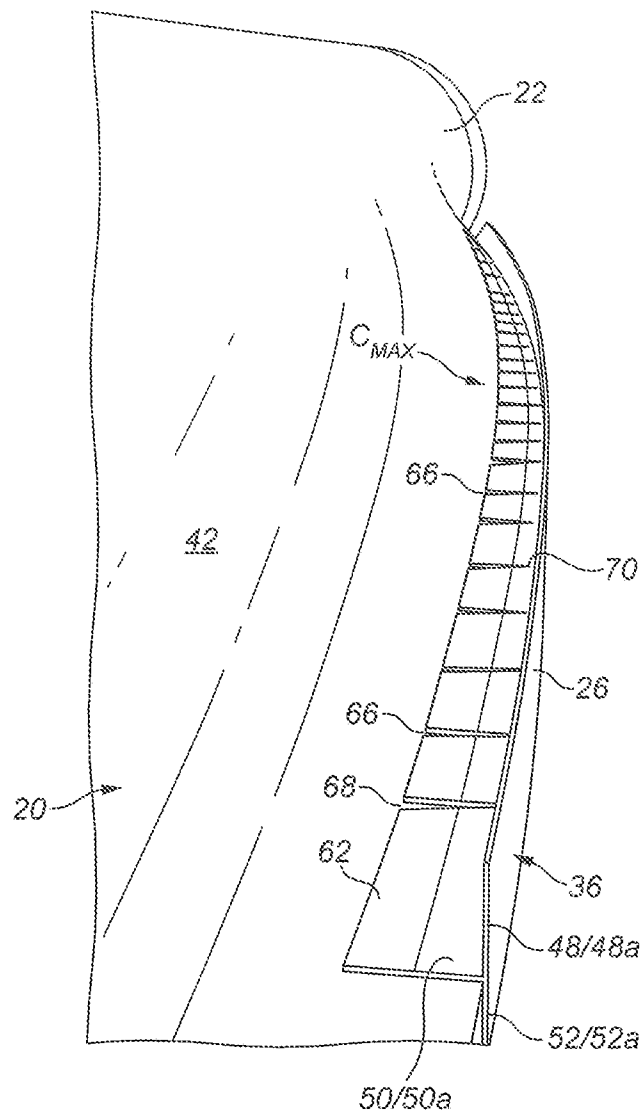


FIG. 6

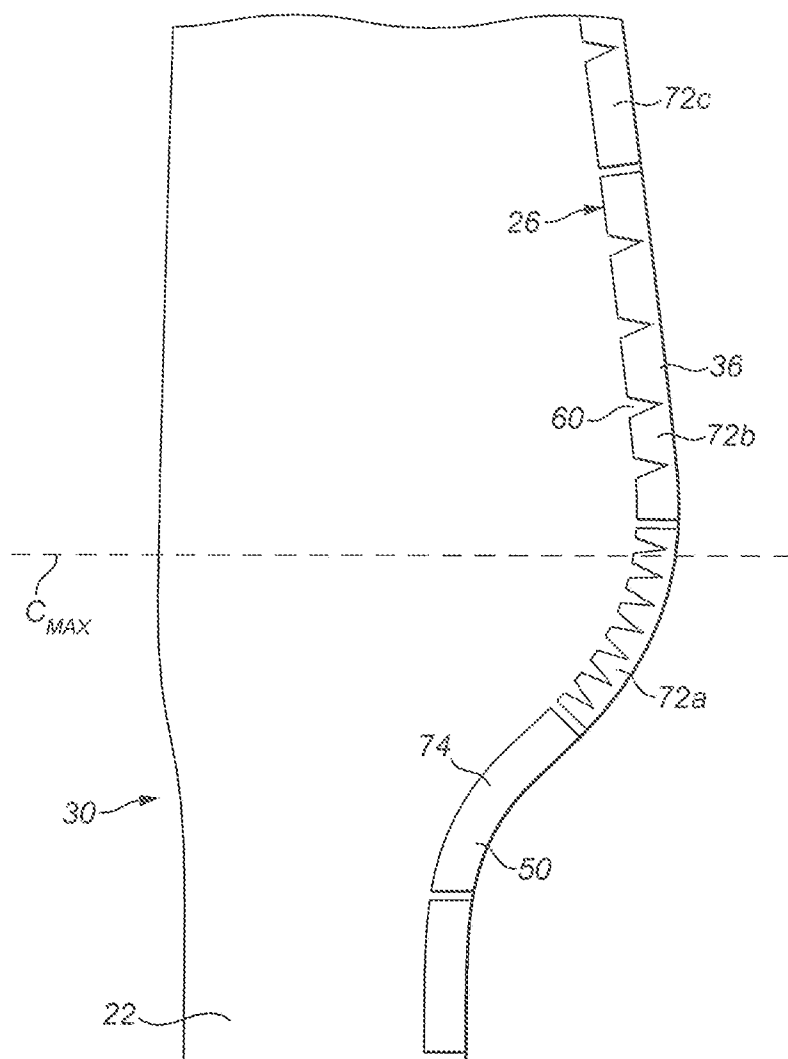


FIG. 7

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/DK2015/050129

A. CLASSIFICATION OF SUBJECT MATTER  
INV. F03D1/06  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
F03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 514 961 A1 (SIEMENS AG [DE]) 24 October 2012 (2012-10-24)  figures 1, 5 paragraphs [0014], [0023] -----	1-3,6-8, 10-22, 26,27
X	US 8 419 373 B1 (FUKAMI KOJI [JP]) 16 April 2013 (2013-04-16) figures 11, 12 column 20, line 28 - column 21, line 21 -----	1-4,6, 10-27 1-27
Y		
X	EP 0 615 903 A1 (WESTLAND HELICOPTERS [GB]) 21 September 1994 (1994-09-21) figures 12 F, 12 D, 12 H -----	1-27
Y		1-27
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Further documents are listed in the continuation of Box C.



See patent family annex.

\* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

30 July 2015

Date of mailing of the international search report

05/08/2015

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
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Authorized officer

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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/DK2015/050129

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Information on patent family members

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