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Datasheet for the decision of 29 November 2018

Case Number: T 0455/14 - 3.2.04

Application Number: 07704711.6

Publication Number: 2004989

IPC: F03D1/06, F03D11/00

Language of the proceedings: EN

Title of invention:
WIND TURBINE ROTOR BLADE

Patent Proprietor:
Siemens Aktiengesellschaft

Opponent:
Vestas Wind Systems A/S

Headword:
Wind Turbine/SIEMENS

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - obvious alternative

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

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Case Number: T 0455/14 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 29 November 2018

Appellant: (Patent Proprietor)	Siemens Aktiengesellschaft Werner-von-Siemens-Straße 1 80333 München (DE)
Representative:	Siemens AG Postfach 22 16 34 80506 München (DE)
Appellant: (Opponent)	Vestas Wind Systems A/S Hedeager 44 8200 Aarhus N (DK)
Representative:	Kent, Peter Joseph Keltie LLP No.1 London Bridge London SE1 9BA (GB)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 2 January 2014 concerning maintenance of the European Patent No. 2004989 in amended form.**

Composition of the Board:

Chairman	A. de Vries
Members:	S. Oechsner de Coninck
	T. Bokor

Summary of Facts and Submissions

I. The appellant-proprietor lodged an appeal, received on 27 February 2014, against the interlocutory decision of the Opposition Division, dispatched on 2 January 2014 on the amended form in which the patent No. 2 004 989 can be maintained and paid the appeal fee the same day. The statement setting out the grounds of appeal was received on 9 May 2014.

The appellant-opponent likewise lodged an appeal, received on 28 February 2014 against the interlocutory decision of the Opposition Division and paid the appeal fee the same day. The statement setting out the grounds of appeal was received on 28 April 2014.

II. Opposition was filed against the patent as a whole and based on Article 100(c) with Article 123(2) and on Article 100(a) with Articles 52(1), 54(3) and 56 EPC. The opposition division held that the patent as amended according to the auxiliary request met the requirements of the EPC, and considering the following documents in particular:

E1: US 2004/0013512 A1
E2a: DK 95 00009 U3
E2b: English translation of E2a
E4: J. Kentfield e.a.: "The Flow Physics of Gurney Flaps, Devices for Improving Turbine Blade Performance", SED, Vol.14, Wind Energy, ASME, 1993

III. Oral proceedings were held on 29 November 2018.

IV. The appellant-proprietor requested that the decision under appeal be set aside, and the patent be upheld as

granted, as main request or, as an auxiliary request, that the appeal of the opponent be dismissed, i.e. that the patent be maintained in amended form on the basis of the Auxiliary Request filed with letter of 10 April 2012 and allowed by the Opposition Division.

The appellant-opponent requested that the decision under appeal be set aside and the patent be revoked.

V. The independent claim 1 of the relevant requests read as follows:

Main request (as granted, reference signs omitted)

"A wind turbine rotor blade with a suction side and a pressure side, comprising

- a cylindrical root portion,
- an airfoil portion defining the suction side and the pressure side, and
- a transition portion which is located between the airfoil portion and the root portion and which has a transition profile changing from the airfoil of the airfoil portion to the cylindrical profile of the root portion, wherein the maximum chord length of the airfoil portion is at least the maximum chord length of the transition portion and wherein the transition profile comprises a section with a concave curvature on the pressure side of the rotor blade and has a convex curvature on the suction side of the rotor blade, wherein the leading section of the transition profile is cylindrical and the trailing section of the transition profile is elongated, characterised

-in that the section with the concave curvature is formed as an area added to the transition profile's cross section as compared to a transition profile in which the curvature of the pressure side is symmetric about the chord to the curvature of the suction side and

-in that the area added to the transition profile's cross section is delimited by a straight line which extends from the suction side in a perpendicular direction to the chord at 100% of the chord length."

Auxiliary request
"A wind turbine rotor blade with a suction side and a pressure side, comprising
- a cylindrical root portion,
- an airfoil portion defining the suction side and the pressure side, and
- a transition portion which is located between the airfoil portion and the root portion and which has a transition profile changing from the airfoil of the airfoil portion to the cylindrical profile of the root portion, wherein the maximum chord length of the airfoil portion is at least the maximum chord length of the transition portion and wherein the transition profile comprises a section with a concave curvature on the pressure side of the rotor blade and has a convex curvature on the suction side of the rotor blade, wherein the leading section of the transition profile is cylindrical and the trailing section of the transition profile is elongated, characterised
-in that the section with the concave curvature is formed as an area added to the transition profile's cross section as compared to a transition profile in which the curvature of the pressure side is symmetric about the chord to the curvature of the suction side
-in that the area added to the transition profile's cross section is delimited by a straight line which extends from the suction side in a perpendicular direction to the chord at 100% of the chord length, and
- in that the section with the concave curvature extends from 80% of the chord length to 100% of the chord length."

VI. The appellant-proprietor argues as follows:
- In addition to the added area that is not disclosed in E1, the profile in the transition part of the blade does not have a cylindrical leading section, nor a symmetrical profile. The added area on such a symmetrical cross section achieves a synergistic effect that the skilled person would not obtain by the mere adaptation of a Gurney flap on the transition section of E1.
- With respect to the auxiliary request both E2 and E4 disclose Gurney flaps having an extension much smaller than the claimed range of 80% to 100% of the chord, nor do they suggest such a large device.

VII. The appellant-opponent argues as follows:
- E1 depicts a connection portion transitioning from a tubular to an airfoil section, it therefore has to exhibit a profile according to the preamble of claim 1. Therefore no additional difference can be acknowledged between E1 and the subject-matter of claim 1 of the main request.
- Page 5, line 15 of E2 describes a foam core for the lift list, necessarily leading to an added area having certain dimensions. As E4 in figure 1 shows thin profiles, the skilled person would adapt the size of the added area to thicker profiles in the transition region to adapt to the boundary layer. Thus, applying these teachings to the transition portion of E1 having a thicker profile, the skilled person would arrive at Claim 1 according to the auxiliary request without an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. Subject-matter of the invention

3. The patent concerns a wind turbine blade and seeks to improve aerodynamic efficiency of the transition section between the root and the aerodynamic profile, see specification paragraphs 0004 and 0012. To achieve such an improvement claim 1 proposes to provide a section with a concave curvature formed as an area added to (an area defined by) the transition profile's cross section and delimited by a straight line which extends from the suction side in a perpendicular direction to the chord at 100% of the chord length.

4. Main request - inventive step

4.1 *Closest prior art*

4.1.1 The document E1, cited in paragraph 6 of the patent, concerns a wind turbine blade with features improving the aerodynamic performance, which in addition to vortex generators 8 in particular includes a member or rib 6 on a connection part between hub and blade of a wind turbine (paragraphs 22 and 24). The rib is in particular meant to improve or optimize the predominantly structural connection part for absorption of wind energy, i.e. for its aerodynamic properties, see paragraph 0003, similar to the main problem addressed by the patent. E1 therefore represents a promising starting point for the assessment of inventive step.

4.1.2 The configuration of the connection part 2 in the first embodiment of E1 is shown in figures 1 and 2 and described in paragraph[22] to have a connection to a hub 3 with a flange connection and to be of tubular cross section (see also at paragraph [23]: "circular design and comprises a simple tube"). At its other end towards the blade, the connection part is connected to the wind energy absorbing profile 5 which is an airfoil profile. The connection part includes a transition portion, see claim 5, where the profile changes from an initial circular cross section to an aerodynamic profile where it meets the blade, see also figure 1. Consequently it necessarily includes a section with concave curvature on the pressure side of the rotor blade and a convex curvature on the suction side of the rotor blade. According to claim 1 the member or rib 6 is arranged in a plane that forms an angle on the pressure side between 45° to 135° to the chordal plane of the blade's profile. In the embodiment of figure 1, furthermore, the rib or member 6 is shown in the transition area as extending from the trailing edge of the profile.

4.2 *Differences over E1*

4.2.1 It is undisputed that claim 1 differs from E1 by its characterising features according to which a concave curvature is formed as an area added to the transition profile's cross section delimited by a straight line extending from the suction side in a perpendicular direction at 100% of the chord length. This area is further defined as being added to a given (area of the) cross section of the transition profile with respect to a notional symmetric profile.

4.2.2 The parties however contest whether E1 also discloses that the transition portion profile is cylindrical at its leading edge and elongated at its trailing edge as required by the final feature of the preamble. The Board is inclined to agree with the appellant-proprietor that the transition profiles of the examples shown in figures 1 and 2 may be elongated at their trailing edge but are not inevitably cylindrical at their leading edge, as the tubular connection part 2 is offset away from the front of the blade.In the examples of figures 5 and 6 the connection part 12 is in line with the leading edge, but it is unclear that it is tubular in cross section.

4.3 *Problem to be solved : partial problems*

4.3.1 The added area is said to introduce considerable aft loading on the transition portion and increase lift in the same way as a Gurney flap, in comparison to a more or less symmetric state of the art profile, see patent specification paragraphs 0019 and 0021. Thus, it improves the aerodynamic properties in the transition area of the blade, paragraph [0010] of the patent specification. In this connection the patent specification, see paragraph [0007], formulates the broad objective of providing an improved wind turbine blade.

Starting with the feature of the added area, the same effect of improved aerodynamic properties in the transition area is already achieved by the rib of E1. As stated, the rib 6 of E1 is meant to optimize wind absorption, and thus aerodynamics of the mainly structural connection part. Consequently the objective technical problem, expressed rather generally in the patent specification as providing an improved wind

turbine, requires reformulation. In the Board's view it can be formulated more accurately as providing an alternative solution to improve aerodynamic efficiency of a transition section.

4.3.2 The appellant-proprietor has further asserted a synergy between the added area and the different transition profile with cylindrical leading edge. Such an assertion, which has not otherwise been substantiated, is not supported by the information in the patent or subsequently provided. Firstly, the claimed transition profile comprises the undoubtedly commonly known, more or less symmetric" profile of figure 3 and specification paragraph [0019], also acknowledged there as a state of the art profile. It is with respect to this common profile that the added area is defined in claim 1 and aerodynamic effects are measured, see patent specification paragraph [0023]. In particular, the additional aerodynamic lift obtained from the added area is plotted in figure 5 and 6 of the patent. The curves shows increased lift and drag coefficients for all angles of attack, which is what the skilled person would expect from a device known to increase lift. Nor is there any evidence that this effect would be surprisingly pronounced for this particular transition profile. It would rather seem that this commonly known transition profile is used as nothing more than a representative reference for measuring the aerodynamic effects of the added area.

4.3.3 In the absence of any synergistic effect, at most an additional partial problem of providing an alternative shape of the transition profile can be formulated. That partial problem is unrelated to that associated with that of the transition profile. In the absence of any synergy between the two features they can be considered

separately for inventive step in accordance with established jurisprudence.

4.4 *Obviousness of the claimed solution*

4.4.1 In seeking a suitable alternative to the rib of the connection part of a blade as taught by E1, the skilled person would draw on the teaching of either of documents E2a or E4. Both are concerned with ways of improving aerodynamic properties of airfoils on wind turbine blades in particular through the use of devices extending from from the trailing edge of an air profile.

More specifically, figure 1 of E2a shows different geometries of a lift list 2 mounted on the trailing edge and extending from the suction side. The corresponding passage on page 5, lines 9-13 of E2b discloses different shapes of the lift list amongst which the embodiments numbered 5 and 6 also include a concave surface and a straight line at the trailing edge enclosing an area as defined in claim 1 of the patent. This solution would be considered by the skilled person as particularly suitable to replace the rib 6 of E1, figure 1, for which he would expect at least an equivalent increase in the aerodynamic behaviour of the transition portion. In doing so he would arrive at a transition portion having a transition profile cross section with an added area compared to a -notional- profile in which the curvature of the pressure side is symmetric -or quasi symmetric- about the chord to the curvature of the suction side.

4.4.2 The Board also observes that the skilled person would reach the same conclusion when considering the teaching of E4 instead of E2a. E4 is a technical discussion of

the flow physics of Gurney flaps on wind turbine profiles. In this document the different configurations of the flaps shown in figure 1 a,b or c in light of the disclosure in the passage in the second paragraph, left hand column of page 30 provide the same readily applicable solution of an area having a concave surface and straight edge located at the air profile trailing edge and extending from its suction side (Fig 1b and c) with corresponding improvement in lift coefficient (figures 2 and 3 left hand curves).

4.4.3 The appellant-proprietor does not contest that an area according to granted claim 1 in the form of Gurney flaps or lift list is per se known, as also acknowledged in specification paragraph [0021]. Indeed at the oral proceedings before the Board it was acknowledged that it might be obvious to replace the transition portion rib in E1 by known trailing edge devices such as those of E2a or E4. The appellant-proprietor rather submits that the skilled person by applying it would not arrive at a wind turbine rotor blade according to claim 1, because E1 does not directly and unambiguously disclose a profile in the transition part with a cylindrical leading edge section. This combination of the added area on such specific shape of the transition profile would provide a synergistic effect not achievable by the combination of E1 with E2a or E4.

The Board is unconvinced. As noted above, the Board is unable to see such a synergetic effect between the two differences and treats them separately. Regarding the particular transition profile, the overall teaching of E1 is much broader than the first embodiment of figures 1 and 2. In particular it is not limited to the specific arrangement of connection part to blade as

shown in those figures. This is particularly apparent from claim 1 of E1, being directed at the use of a rib on a connection part in general, and is further evident from figures 5 and 6 showing application to alternative blade connections. Consequently, E1 contemplates application to any known transition profile as a matter of obviousness. The connection part, as has been noted in relation to claim 5 of E1, includes the transition portion from purely tubular hub connection to the aerodynamic profile of the blade. A well known connection arrangement has the tubular connection arranged in line with the leading edge resulting in a more or less symmetric transition profile identified by the patent as "state of the art". In the Board's view, given that such a transition profile is well known, the skilled person would as a matter of obviousness contemplate applying E1's general teaching embracing all connections with transitions thereto. In such an obvious application the rib would run, most obviously, as in the example of figure 1, along the trailing edge of the profile, i.e. at 100% chordal length.

4.5 As the skilled person would obviously replace the transition portion rib in E1 by a device as in E2a or E4 as an alternative way of improving the aerodynamic properties in the transition portion, and would also obviously apply the teaching of E1 to any well known transition profile, such as a symmetric one with cylindrical leading edge and elongated trailing edge, the combination of these two unrelated features must also be obvious. Stated otherwise, the obvious replacement of such a transition portion rib by the devices of E2a or E4 in transition profiles in general cannot be rendered inventive by merely limiting application to a particular known one of those transition profiles. Therefore the Board confirms the

conclusion drawn in the impugned decision that the subject-matter of claim 1 as granted lacks an inventive step in view of E1 and the skilled person knowledge of transition portion shapes supplemented by E2a or E4, Articles 100(a), 52 and 56 EPC.

5. Auxiliary request - inventive step

5.1 Claim 1 of this request adds in the characterising portion that the section with concave curvature extends from 80 to 100% of the chord. This additional feature specifies the dimension of the added area along the chord of the profile and in relation to its length for which the aerodynamic effects are maximized or optimized. The corresponding objective technical problem may be formulated as further improving or optimizing the added area.

5.2 In realizing the obviously modified general teaching of E1 to a well known transition profile the skilled person will engage as a matter of course in routine optimization to determine those dimensions that maximize aerodynamic effect. The question is whether the dimension now claimed is the result of such routine optimization or not. The appellant-proprietor submits that 20% of the chord is an order of magnitude reaching far beyond what the skilled person might reasonably contemplate in the light of E1 and E2a or E4. The Board is unconvinced that this is so. Further considering the practical adaptation of the added area the skilled person would necessarily need to select its size in order to adapt it to the dimensions of the profile on which it is mounted, and to the prevailing wind field to which it will be exposed. It is commonly known that the relative wind to which the transition portion is exposed is smaller than that to which radially outward

parts of the blade is exposed due to the smaller component resulting from rotation of the blade and thus closer to the wind speed of 5 to 12 m/s mentioned in paragraph 9 of E1. Therefore, as compared to a wing or the outer, predominantly aerodynamic active part of the wind turbine blade, where side length or depth of Gurney flap of about 1 to 2 % of the chord (E2b, page 3, lines 10 to 16; E4, page 29, right-hand column, top paragraph) is enough to provide a suitable increase in lift, when applying such a device to the connecting portion of the blade closer to the hub which is predominantly structural with compromised aerodynamic properties (cf. E1, paragraph 3) and where wind speed is considerably smaller, a substantial increase in size to achieve a similar effect will be necessary. As much is stated in E2b, on page 4, lines 5 to 8, where the size of the lift list decreases radially outward, i.e. increases inwardly.

Elongated lift lists (E2a, figure 1, reference sign 6) or Gurney flaps (E4, figure 1,(c)) may have a chord width (in the direction of the airfoil chord), that is a multiple of their depth. Indeed if the depth of the added area is measured from the inflection point on the pressure side (see figure 7 of the patent), figure 1(c) of E4 in particular would point to a chord width as much as 4 or 5 times cord depth.

Finally, E1 itself mentions rib dimensions from 5% to 30% of the tube diameter (paragraph 11, last sentence but one), the analogue of chord length for the tubular section of the connection part.

The Board holds, that taken together these various considerations will lead the skilled person, when routinely optimizing the obvious application of the

modified teaching of E1 to symmetric transition profiles, to seriously consider dimensioning the lift list or Gurney flap along the airfoil chord to an extent well beyond the 1 to 2% chord length common for the more outward parts of a blade. Nor would he have any great difficulty in performing the necessary calculations or simulations. The Board thus arrives at a different conclusion to the division, who held that E2 and E4 pointed to design starting points a magnitude smaller than what was claimed. The skilled person would therefore arrive at the claim magnitude of 80 to 100% of the chord length by simply increasing the surface of the area until he achieves a suitable aerodynamically optimized design. This is all the more so, as the patent does not describe a surprising effect related to the claimed range, but only depicts a number of different curvature of the trailing edge concave lines 25 in figure 7.

5.3 In view of the above the Board concludes that the subject-matter of claim 1 of the auxiliary request, contrary to the the decision's positive assessment, does not involve an inventive step in the light of the prior art cited as required by Articles 52(1) and 56 EPC.

6. As neither the patent as granted (main request) nor as amended according to the auxiliary request meet the requirements of the EPC, the patent must be revoked in accordance with Article 101(3)(b) EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

G. Magouliotis A. de Vries

Decision electronically authenticated