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Datasheet for the decision of 19 September 2022

Case Number: T 0002/20 - 3.2.04

Application Number: 05739534.5

Publication Number: 1886016

IPC: F03D1/06, F03D7/02

Language of the proceedings: EN

Title of invention:
A PITCH CONTROLLED WIND TURBINE BLADE HAVING TURBULENCE GENERATING MEANS, A WIND TURBINE AND USE THEREOF

Patent Proprietor:
Vestas Wind Systems A/S

Opponents:
SUZLON Energy Ltd.
Siemens Gamesa Renewable Energy GmbH & Co. KG
LM Wind Power A/S

Headword:

Relevant legal provisions:
EPC Art. 54
RPBA 2020 Art. 12(2), 12(4)

Keyword:
Novelty - prior disclosure - implicit features (yes)
Amendment to case - further evidence

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

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Case Number: T 0002/20 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 19 September 2022

Appellant: (Opponent 4)	LM Wind Power A/S Jupitervej 6 6000 Kolding (DK)
Representative:	COPA Copenhagen Patents Rosenørns Allé 1, 2nd floor 1970 Frederiksberg C (DK))
Respondent: (Patent Proprietor)	Vestas Wind Systems A/S Hedeager 42 8200 Aarhus N (DK)
Representative:	Inspicos P/S Agern Allé 24 2970 Hørsholm (DK
Party as of right: (Opponent 1)	SUZLON Energy Ltd. Kühnehöfe 3a 22761 Hamburg (DE)
Representative:	Maikowski & Ninnemann Patentanwälte Partnerschaft mbB Postfach 15 09 20 10671 Berlin (DE)
Party as of right: (Opponent 2)	Siemens Gamesa Renewable Energy GmbH & Co. KG Beim Strohhause 17-31 20097 Hamburg (DE)
Representative:	SGRE-Association Siemens Gamesa Renewable Energy GmbH & Co KG Schlierseestraße 28 81539 München (DE)

Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted on 21 October 2019 concerning maintenance of the European Patent No. 1886016 in amended form.**

Composition of the Board:

Chairman A. de Vries
Members: S. Hillebrand
K. Kerber-Zubrzycka

Summary of Facts and Submissions

I. Appeals were filed by the Proprietor and Opponent 4 against the interlocutory decision of the Opposition Division finding that the patent in suit in amended form according to auxiliary request 3B met the requirements of the EPC.

In particular, the Opposition Division held that the subject-matter of claims 1 and 14 according to auxiliary request 3B was novel and involved an inventive step.

II. In a communication pursuant to Article 15(1) RPBA, the Board in preparation for oral proceedings gave a provisional opinion on the relevant issues.

III. Oral proceedings were held before the Board on 19 September 2022. Opponent 1 (party as of right) did not attend as announced in writing.
At the end of oral proceedings, the Proprietor withdrew their appeal.

IV. The Appellant (Opponent 4) requests that the decision under appeal be set aside and the patent revoked.

The Respondent (Proprietor) requests that the appeal be dismissed.

V. Independent claim 1 of the main request (as upheld by the Opposition Division) reads as follows:
"A variable speed pitch controlled wind turbine (1) comprising at least two pitch controlled wind turbine blades (5), each of the blades (5) comprising a pressure surface side (14) and a leeward surface side

(13)
said surfaces (13, 14) establishing a leading edge (6) and a trailing edge (7)
characterized in that
said blade (5) comprises turbulence generating means (10), wherein said means (10) are placed on said leeward surface sides (13) of said wind turbine blade (5) and at the outer section (OS) of said wind turbine blade (5) in the direction of the blade tip (8), wherein the height of said turbulence generating means (10) is of equal extent or is higher closest to said trailing edge (7) of said wind turbine blade (5) than closest to said leading edge (6) of said wind turbine blade (5), and wherein the highest height (H) of said turbulence generating means (10) is between 0,2% and 0.8% of the chord length (C) of said wind turbine blade (5)."

VI. In the present decision, reference is made to the following documents:

A2: G.E. Miller: "Comparative Performance Tests on the MOD-2 2,5 MW Wind Turbine with and without vortex generators", Department of Energy, NASA "Workshop on Horizontal Axis Wind Turbine Technology", May 1984

A4: E. Hau: "Windkraftanlagen", 3. Auflage,Springer, 2003

A18: G.W. Gyatt: "Development and Testing of Vortex Generators for Small Horizontal Axis Wind Turbines", AeroVironment Inc., July 1986

A28: K.P. Shepard et al.: "Environmental noise characteristics of the MOD-2 (3.2 MW) wind turbine generator", NASA Technical Memorandum 101567, December 1989

A41: D.A. Spera: "Large-scale wind turbine structures", N88-22429, Advanced Concepts and Application Branch, NASA Lewis Research Center, May 1988

VII. The Appellant's and Opponent's 2 arguments can be summarised as follows:
From A28 and A41, both disclosing various aspects of the prior art Mod-5B wind turbine, all features of claim 1 are known.

The Respondent's arguments can be summarised as follows:
It is at least not directly and unambiguously derivable from A28 and A41 that the highest height of turbulence generating means lies within the claimed range. Other heights outside the claimed range are conceivable as well.

Reasons for the Decision

1. The appeal is admissible.

2. **The patent and its technical background**

2.1 The patent aims at reducing noise emissions from variable speed pitch controlled wind turbines by installing turbulence generating means or vortex generators on the rotor blades, paragraphs [0011], [0012].

2.2 By pitch control a rotor blade can be turned into the wind into feathering position (leading edge upwind) in order to keep rotor thrust, loads and rotational speed at increasing wind speeds within structurally imposed limits. Variable speed control by means of the

generator can further assist in adjusting and keeping rotational speed levels of the rotor, thereby reducing the frequency and speed of blade pitch angle adjustment compared to mere pitch control. Stall control turns a rotor blade "out of the wind" (trailing edge upwind) in order to protect the wind turbine from damages in higher wind speeds by provoking the onset of stall/ boundary layer separation on the rotor blade's aerodynamic surface profile. Both pitch and stall control can be effected by rotating the entire blade ("Ganzblattverstellung") or a tip portion of the blade ("Teilblattverstellung"), see for example A4, chapter 5.3.1.

2.3 Vortex generators are used in the prior art in order to delay undesired stall or premature boundary layer separation and to thereby increase aerodynamic efficiency and energy output of the wind turbine. They generate trailing vortices which energize the boundary layer on the rotor blade surface by mixing higher energy air from the free air stream above the boundary layer with boundary layer air (as illustrated for example in Fig. 4 of A2). Their effectiveness depends on their height and their position relative to the point on the surface of an aerodynamic blade profile where separation is liable to occur (see for example A18, page 2, first paragraph). This is because the generated vortices must reach beyond the boundary layer into the free air stream, and the thickness of the boundary layer increases along the surface of the aerodynamic blade profile from the leading edge to the point of boundary layer separation.

3. **Admission of document A41**

3.1 The Appellant-Opponent 4 filed document A41 together with their statement of grounds of appeal. A41 thus represents an amendment in the sense of Article 12(2) RPBA, admission of which is subject to the discretion of the Board pursuant to Art 12(4) RPBA.

3.2 In its communication according to Rule 15(1) RPBA, the Board announced its intention to admit A41 for the following reasons.

"*A41 on page 3-286 provides further information regarding the Mod-5B wind turbine of document A28, which had been cited against inventive step in opposition. It appears that this prior art wind turbine moved into focus at a late stage of the opposition proceedings. Only after the Proprietor filed further evidence A39 and A40 during oral proceedings did the Opposition Division conclude that the Mod-2 wind turbine as disclosed in A1 - A3 was not variable speed controlled and thus not novelty destroying for claim 1 of auxiliary request 3 (see points 3.4.3, 3.6.1 of the annex to the summons and pages 2, 3 of the minutes). Although A28 discloses the Mod-5B wind turbine as being variable speed controlled, the Opposition Division established that - other than A2, Fig. 2 for Mod-2 - it did not detail the dimensions of the vortex generators in terms of chord length ratio for Mod-5B. A41 provides this missing information in a short paragraph "Technical Data" on page 3-292 and a figure on page 3-295.*

A41 can thus be seen to be filed in direct response to unforeseen developments during the oral proceedings as explained in section 5.2 of the grounds of Appellant-

Opponent 4. Taking into account the circumstances of the opposition proceedings, the low complexity of the information added by A41 and its prima facie high relevance for inventive step, the Board is inclined to admit A41 into the appeal proceedings cf. Article 12(4), third paragraph RPBA.
In particular, no fresh case appears to be raised by citing this document, which only provides complementary information for the Mod-5B wind turbine already representing prior art during opposition proceedings.

As also acknowledged by the Appellant-Proprietor in their letter of 28 July 2020, section 3.3.1.3, A28 has been cited against inventive step as a closest prior art for claim 1 as granted and as upheld, though not discussed in great detail in the decision under appeal. Even if lack of novelty in view of the Mod-5B wind turbine had not been raised during opposition proceedings, the question can be considered in the context of assessing the original challenge to inventive step starting from Mod-5B as closest prior art, see G7/95."

3.3 Since the Respondent did not comment and indeed withdrew its objection against admission of A41 during the oral proceedings before the Board, the Board saw no reason to deviate from its preliminary opinion as expressed in its communication. It thus decided to admit A41 to the proceedings under Article 12(2), (4) RPBA.

4. **Main request**

4.1 It is undisputed that the Mod5-B wind turbine, with a two-bladed rotor of 97.6 m diameter, as disclosed in A28 (last paragraph on page 1) is of variable pitch and

variable speed type (see section 10 of the Proprietor's appeal brief). According to the second paragraph on page 2, vortex generators are installed on the outboard 40 m of each blade's suction or leeward side, i.e. from about the blade tip up to an inboard station at about 8.8 m (346 in) of blade length.

A28 does not expressly mention chord lengths at the various stations where the vortex generators are placed on the Mod-5B turbine blade and therefore does also not give values for their height relative to chord length, as held by the Opposition Division in their decision. That missing information is derivable from A41, which provides further information on the Mod-5B. A28 refers to the Mod5-B, but it is clear from the identical location on Oahu, Hawaii - cf. A28, page 2; A41, page 3-285, penultimate paragraph - and the fact that they are the subject of a NASA research project that the same turbine is concerned.

4.2 As indicated on page 2, 2nd paragraph of A28, the vortex generators are positioned in the form of flat plates along the 10% chord line. The plates vary in height from 0.6 to 2 cm and are installed at an angle along the alignment line. Since only one height value and one length value per vortex generator is indicated in A28, it can safely be assumed that the plates are rectangular having the same height closest to leading and trailing edges of the blade and representing the "highest height" in the wording of claim 1.

4.3 A28 does not expressly indicate how the vortex generators are arranged in size along the length of the blade. Indeed the Respondent argues that it is conceivable that the plates of greater height are arranged closer to the tip with the smaller plates

arranged further inward, resulting in values relative to local chord length that possibly lie outside the claimed range. Thus, their argument goes, the claimed height to chord ratio of the vortex generators can not be directly and unambiguously derived from A28 and A41.

4.3.1 The Board is unconvinced that this is so. It will be evident to the skilled person, an engineer specialized in the design and development of wind turbine rotor blades, from straightforward aerodynamic considerations that the smallest plate with a height of 0.6 cm must be arranged close to the blade tip and the largest plate with a height of 2 cm at the inboard station at about 8.8 m.

4.3.2 This is because in order to obtain the desired effect, the vortex generators must sufficiently reach into or even up to the local boundary layer, as set out in point 2.3, above. Their height thus relates directly to the local thickness of the boundary layer: a vortex generator has a lower profile where the boundary layer is thinner and is higher where it is thicker. The boundary layer thickness, however, varies over a rotor blade of a wind turbine. Firstly boundary layer thickness increases in the direction of air flow over a surface. In the Mod-5B wind turbine, the vortex generators are arranged at 10% of the chord length, that is at a distance of about 12.5 cm from the leading edge at the blade tip and at a distance of more than 92 cm from the leading edge at the inboard station (see A41, page 3-292 with a chord length of 4.1 ft or 125 cm for the blade tip and page 3-295 with the chord length at the further outboard station at 363 in or 9.2 m). At the tip the air flow has a much shorter distance to travel to the 10% line than at the inboard station, so that at that line the boundary layer is much thinner at

the tip than at the inward station. This is compounded by the fact that boundary layer thickness is also inversely related to the velocity of air flow. Due to rotation of the rotor blade the speed of air flow over the airfoil surface increases outwardly towards the blade tip, meaning that boundary layer thickness furthermore decreases outwardly, or inversely, increases toward the blade root due to the air speed.

4.3.3 Consequently, for the vortex generators to be effective and to generate vortices reaching out of the thicker boundary layer at the blade root, they must also increase in height towards the root.

4.3.4 The Board sees confirmation of this view of placement of different size vortex generators in A2, as also noted by the Appellant. A2 concerns a similar turbine, the Mod-2, of which, according to A2, page 67, left hand column, Introduction, 2nd paragraph, the Mod-5B turbine is said to be a later development. The A2 has a very similar blade with pitch controlled tip and vortex generators of almost identical dimensional range (cf. figures 7 and 8 of A2: from "0.25 in x 1.0 in" = 0.6 cm x 2.5 cm to "0.8 in x 3.2 in" = 2.0 cm x 8.1 cm), which, as shown in figures 7 and 8 are placed along roughly the same blade span with the smallest vortex generators at the tip and the largest furthest inboard.

4.4 The rotor blade as shown in the figure on page 3-292 of A41 comprises three sections: A pitchable tip section of 16.8 m or 34% of span (table on the same page and A28, last paragraph of page 1), a root section up to a weld or "field weld joint" at 9.2 m (363 in) or 19% of span (A41, page 3-295) and a mid section of 22.8 m length (48.8-16.8-9.2) or 45% of span (100-34-19).

The blade tapers constantly from hub to tip.

4.4.1 At the blade tip the chord length of the Mod-5B rotor blade is 4.1 ft or 125 cm, see A41, page 3-292, so that with the smallest vortex generator having a height of 0.6 cm, the height to chord length ratio will be about 0,48%.
The tallest vortex generator with a height of 2 cm is located at the inboard station of 8.8 m, i.e. on the root section close to its outer end at 9.2 m, where the chord length is 140 in or 356 cm (A41, page 3-295). Due to the blade taper and the chord length increasing towards the hub, its height to chord length ratio at that point is therefore smaller than 0.56% (2/356), but larger than 0.48% (2/418 with the chord length at the hub being 13.7 ft or 418 cm, see table on page 3-292).

4.4.2 It can be excluded that between the blade tip and the inboard station of the last vortex generator at 8.8 m the height to chord length ratio of some vortex generators would be outside the claimed range, since the vortex generators are said to be "varying ... in height from 0.6 to 2 cm" (A28, page 2, second paragraph). In a normal understanding of this formulation there are not only vortex generators with a height of 0.6 cm or 2 cm but also with heights in between. For the reasons given above, the vortex generators will be placed at positions along the blade where their height correlates to boundary layer thickness, i.e. from low to high going from the tip to the root. Therefore, though the number of different heights is not indicated - there might only be three - it is inconceivable to the Board that any group of same height generators will extend over large sections of the outboard 40 m of the blade where there is considerable variation of boundary layer thickness.

Rather, they will be grouped relatively close together, with small spread in height to chord ratio. Indeed, the Board notes that the ratio at the extremes (0.48% and somewhere between 0.48% and 0.56%) is not very different if at all. This stands to reason as boundary layer thickness at 10% chord length and chord length will correlate, so that vortex generator height correlates with chord length.

4.5 Since the highest height of the vortex generators must therefore be within 0,2% to 0,8% of the cord length as claimed, the subject-matter of claim 1 according to the main request (as upheld by the Opposition Division) is not new with regard to the Mod-5B wind turbine as disclosed in A28, A41. Without differentiating features that might contribute to inventive step, it perforce also lacks inventive step.

5. **Conclusion**

With their appeal, Appellant Opponent 4 successfully refutes the findings of the Opposition Division with regard to novelty of the subject-matter of claim 1 as upheld in the light of the prior art Mod-5B wind turbine. Consequently, the decision under appeal to maintain the patent in amended form has to be set aside. In the absence of further requests of the Proprietor, this leads to the revocation of the patent as requested by Appellant Opponent 4 and Opponent 2.

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