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**Datasheet for the decision
of 23 January 2023**

Case Number: T 0155/21 - 3.2.04

Application Number: 08700938.7

Publication Number: 2122161

IPC: F03D1/06

Language of the proceedings: EN

Title of invention:

WIND TURBINE BLADE WITH STRAIN SENSING MEANS, WIND TURBINE,
BLOCK SENSOR UNIT AND USES HEREOF

Patent Proprietor:

Vestas Wind Systems A/S

Opponent:

LM WP Patent Holding A/S
LM Wind Power A/S

Headword:

Relevant legal provisions:

EPC Art. 54(2), 83, 123(2), 56

Keyword:

Novelty - main request (no) - auxiliary request (yes)
Sufficiency of disclosure - auxiliary request (yes)
Amendments - allowable (yes)
Inventive step - auxiliary request (yes)

Decisions cited:

Catchword:



Beschwerdekammern
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Chambres de recours

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Case Number: T 0155/21 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 23 January 2023

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Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted on
7 December 2020 concerning maintenance of the
European Patent No. 2122161 in amended form.**

Composition of the Board:

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

Summary of Facts and Submissions

- I. The proprietor and the opponent both appeal against the interlocutory decision of the Opposition Division of the European Patent Office posted on 7 December 2020 concerning maintenance of the European Patent No. 2122161 in amended form.

- II. The Opposition Division held that claims 1 and 9 amended according to an auxiliary request 2 met the requirements of the EPC having regard to the following documents in particular:

D3: WO 2008/020242 A2
D6: EP 1 249 692 A1
D7: US 4 636 638

- III. Oral proceedings were held on 23 January 2023 by videoconference.

- IV. The appellant (opponent) requests that the decision be set aside and the patent be revoked.

- V. The appellant (patent proprietor) requested that the decision under appeal be set aside and the patent be maintained as granted (main request), auxiliarily that the patent be maintained on the basis of one of the auxiliary requests 1, 2, 3a, 4, 4a, 5 or 6.

VI. The wording of the relevant independent claims of the relevant requests reads as follows:

Main request (as granted):

1."Wind turbine blade (5) with strain sensing means, said blade comprising a surface structure (9), a block sensor unit (26) including optical sensor means (14) for sensing strain in the blade, characterised in said blade further comprising an intermediate connection plate (16) positioned in between said optical sensor means (14) and said surface structure (9), where said intermediate connection plate (16) is adhesively connected to said surface structure (9) and connected to said optical sensor means (14), and where the modulus of elasticity of said intermediate connection plate (16) is similar to or less than the modulus of elasticity of said surface structure (9)."

10."Block sensor unit (26) for mounting in a wind turbine blade (5), said unit comprising optical sensor means (14) for sensing strain in the wind turbine blade, and preferably a protective cover (18) protecting the optical sensor means, characterised in that said unit comprises an intermediate connection plate (16), in that said intermediate connection plate (16) on one side includes an area for connection with a blade surface structure (22b) and on the other side includes an area for connection with the optical sensor means (22a), and in that the modulus of elasticity of said intermediate connection plate (16) is similar to or less than the modulus of elasticity of the surface structure to which the block sensor unit (26) is to be mounted."

Auxiliary requests 1 and 2:

The independent claim 1 is as granted.

Auxiliary request 3a:

The independent claim 1 (as upheld) adds to granted claim 1 the following final feature:

"wherein said optical sensor means includes light emitting means and light receiving means which in a transition zone are displaceable in relation to each other."

The independent claim 9 adds to granted claim 10 the following final feature:

"and in that the optical sensor means includes light emitting means and light receiving means which in a transition zone are displaceable in relation to each other."

VII. The appellant proprietor argues as follows:

- The subject-matter of claims 1 and 10 as granted is novel over D3 because it discloses a sensor that is embedded in the support plate rather than connected thereto in the sense of claims 1 and 10.
- Claim 1 of auxiliary request 3a incorporates the features of claim 8 as filed and does not include added subject-matter.
- The subject-matter of claims 1 and 9 of auxiliary request 3a is also sufficiently disclosed.
- Starting from D3, the skilled person cannot derive from the cited prior art the use of light emitting means and light receiving means which are displaceable

in relation to each other as claimed in the independent claims of auxiliary request 3a.

VIII. The appellant opponent argues as follows:

- D3 also discloses a light sensor that is mounted on a substrate and is therefore novelty destroying for claims 1 and 10.

- As claim 8 as filed was dependent only on claim 1 to the wind turbine, the same features added to the independent claim directed at the sensor unit result in added subject-matter.

- The subject-matter of claims 1 and 9 of auxiliary request 3a is insufficiently disclosed across its whole scope.

- D3 discloses a sensor that may be of the Bragg sensor type and thus falls under the broad scope of claims 1 or 9 of the auxiliary request 3a. The skilled person would also have used the teaching of either D6 or D7 to arrive at a light emitter and receiver according to claims 1 or 9 of this request.

Reasons for the Decision

1. The appeals are admissible.

2. Technical background of the patent

The patent concerns a wind turbine blade with strain sensing means and a block sensor unit of the optical type. To allow retrofitting on a manufactured blade, paragraph 005, and avoid accuracy problems related to previous fixing means such as brackets, see paragraph 006, claims 1 and 9 provide an intermediate connection plate between the sensor unit and the surface of the blade on which it should be mounted. By providing a modulus of elasticity of the intermediate connection

plate similar to or less than the modulus of elasticity of the surface structure, the strain on the wind turbine is transmitted without influence and allows a reliable measurement.

3. Main request - novelty with respect to D3

3.1 D3 relates to the structural monitoring of wind turbine blades using fibre optic strain sensors. The wind turbine blades are made of glass reinforced plastics on a sub structure made of e.g. glass fibre or carbon or graphite fibre in epoxy resin, lines 14 to 21 of page 1. Several different connection arrangements of sensors 5 mounted on a wind turbine rotor with three blades are represented in figures 1 to 3. Figure 4 to 9 then show a temperature compensation scheme which serves to remove the effect of temperature on a strain sensor. This is done by placing the last sensor of an array in a capillary tube 6 to isolate this sensor from strain to remove the temperature related component of strain measured on the other sensors, page 8, lines 13 to 23. How each of the strain sensors in these arrangements is physically mounted on the blade is detailed starting from the last paragraph of page 10, in relation to figures 11 to 13. The strain sensors are optical fibre strain sensors, such as Bragg fibre grating sensors, paragraph bridging pages 2 to 3, applied to the inside of a blade section, before or after the sections are assembled into a whole blade, lines 22 to 24 of page 3. The sensor itself is further disclosed to be a pre-formed component comprising an optical fibre. It is thus undisputed that D3 discloses the features of the preamble of claim 1: A wind turbine blade 1 with strain sensing means 5, the blade comprising a surface structure (e.g. inner surface), and a block sensor unit (pre-formed component) including optical sensor means

(optical fibre, Bragg fiber grating) for sensing strain in the blade.

- 3.2 Page 5, line 15 onwards explains how exactly the wind turbine blade is equipped with a sensor. Thus, pre-formed component comprises an optical fibre strain sensor "*mounted to a substrate*", page 5, lines 17-18, or "*located on the substrate*" in a predetermined position, page 5, line 25. The pre-formed component is the subject of claims 11, 12 and 14, which uses the very same formulations.

The Board reads the term "substrate" in its usual sense of "a thing which underlies or forms the basis of another; a substratum, a foundation", see OED. Consequently, it reads the expressions "*mounted to a substrate*" or "*located on a substrate*" in the various cited passages in the description and claims as meaning that the optical fibre is placed or fixed on an underlying element (the substrate), a reading that is further supported by the verb "to mount" (meaning "to fix or attach to a mount", OED, sense IV,26.b) and the preposition "on" ("above and in contact with; at rest on the upper surface of; above and supported by", OED, sense I.1.a.). As "pre-formed" undoubtedly refers to assembly or manufacture of the component before its placement on the blade the Board understands these passages to describe a component formed in advance by an optical fibre strain sensor fixedly positioned on an underlying substrate.

- 3.3 According to the last sentence on page 5, the pre-formed strain sensors may be fixed to the blade structure "prior to the structure being infused with resin or prior to the resin being cured". In the latter case the sensor is fixed after resin has already been

infused into the blade structure, and thus necessarily at the -inner- surface of the blade. This way of fixing the strain sensor on the inner surface of the blade is also confirmed on page 9, first two lines, which explains that the temperature compensating sensor is within the bulk material, whereas the strain sensors are rather located at the surface of the blade.

3.4 The only practical realisation of the pre-formed component comprising the optical fibre sensor and substrate is detailed in relation to figures 11 and 12, on page 10, last paragraph. Optical sensors 5 are located on a pre-cured composite patch 9 which may be made of wood or plastics, but also a laminate (line 31) to form a patch that "has a degree of stiffness and can be handled without special care" (lines 20-22) as a "single functioning unit that can be tested prior to leaving the factory" (lines 24-25). The patch of material, certainly after curing or when made of wood and of rectangular shape as shown in figures 11 to 13 can be considered a plate.

3.5 The opening sentence of the paragraph (lines 21 and 22) states that "a pre-cured composite patch of material includes *embedded* optical fibre sensors..." (italics added by the Board), from which the appellant proprietor infers that D3 only concretely teaches locating the optical fibre sensors within the patch rather than on it. At least this statement would render the disclosure of D3 ambiguous as regards the position and nature of the patch/substrate.

The Board sees this differently. This passage on page 10 cannot detract from the fact that page 5 unambiguously teaches placement on an underlying substrate. The question is then how to reconcile these

apparently disparate indications on pages 5 and 10. In the Board's view it is highly unlikely that the only passage describing a concrete example would relate to an alternative not covered by the claims of D3 that mention the substrate. In the Board's reading, embedding taken in context (page 10, line 18) may be seen as the result of the *pre-curing* of the patch and sensor. If the patch with sensors placed on it is encapsulated as a *whole* within resin and then cured, the result will be a pre-formed component with sensors embedded within the resin. Alternatively or additionally, embedding may refer to the elements being sunk in the top surface of the patch. Either reading fits perfectly with a sensor location on an underlying substrate, and also accords well with the mention of wood as patch material (where it is hard to imagine embedding within the patch body) as well as with figures 11 to 13, which, though not stated, appear to the skilled reader's eye to be top views of the preformed device, with all components visible.

- 3.6 The patch is placed on the blade, that is onto its surface prior to curing, and temporarily held there, for example by staples, before being fixed permanently in place by curing of the resin (lines 28-30), similar to the screws used to hold the block unit in place before curing in the patent, cf. paragraph [0021] of the patent specification. In the same manner as in the patent, the resin then also acts as an adhesive permanently holding the pre-formed component in place. Furthermore, because the patch is made of a composite material - resin and wood or other material - which is of the same or similar composite material as the wind turbine blade (see page 1, lines 19-21), it will necessarily exhibit a similar modulus of elasticity. Indeed it goes without saying that for the optical

strain sensor to be able to measure strain in the blade, the patch material cannot be stiffer than the blade material, i.e. must have a modulus of elasticity at most equal to that of the blade material.

- 3.7 In the above configuration the pre-formed component, which is made of the optical fibre strain sensor placed on and connected to the patch as underlying substrate by embedding both in resin and then curing, is a block sensor unit in the sense of claim 1. When placed on the blade surface as described at the bottom of page 5 and on page 10 the patch/substrate can be seen as an intermediate connection plate between sensor and blade surface, which (after curing) is adhesively connected to the surface (by the cured resin). As stated the patch material has a modulus of elasticity similar to (or less than) the modulus of elasticity of the blade's surface structure. Thus D3 discloses all the features of granted claim 1.
- 3.8 It follows that the disclosure of D3 is novelty destroying for the subject-matter of claim 1 as granted and the main request thus fails.
4. Auxiliary requests 1 and 2 in which claim 1 is unchanged also fail for the same reason.
5. Auxiliary request 3a
- 5.1 Admissibility

The appellant proprietor filed auxiliary request 3a with letter of 14 January 2022 after filing the statement of grounds for its own appeal and its reply to the appeal of the opponent. It is thus a change to their appeal case in the sense of Article 13(1) RPBA

which is subject to justification by the appellant proprietor and may be admitted only at the Board's discretion. As explained in the accompanying letter this request differs from former, subsequently withdrawn auxiliary request 3, which corresponded to auxiliary request 2 held allowable in the decision under appeal, but for a corrected dependency of claim 8 (now dependent on claims 1 to 7). This correction addressed a lack of clarity raised by the appellant opponent in their submissions in relation to the incorrect dependency. The correction resolves the issue in straightforward and self-evident manner, without raising new ones. As otherwise the issues were the same as raised against former (upheld) auxiliary request 3, it is not detrimental to procedural economy. The Board therefore decided to admit it into the proceedings.

5.2 Added Subject-Matter

5.2.1 Claims 1 and 9 of this request are the same as in auxiliary request 2 held allowable in the impugned decision. In both independent claims 1 and 9 features are added from granted claim 8 providing further detail of the optical sensor means of the claimed wind turbine. These require a light emitting means and a light receiving means that are displaceable with respect to each other in a transition zone, corresponding to (though not limited by) the embodiment shown in figure 3 and detailed in paragraphs 0034 to 0036.

5.2.2 The main idea of the original application is to simplify placement of an optical strain gauge on a rotor blade by providing the sensor as a block unit that can be placed on the blade surface via an intermediate connection plate, cf. page 2, lines 23-27,

page 4, lines 23-25. The only sensor ever discussed in detail is that shown in figure 3, which (in generic) terms is the subject of as filed claim 8 and the corresponding first paragraph on page 4, which present the basic components of the optical sensor means: a light emitting means and light receiving means which are displaceable in relation to each other. From the main idea of simplified placement of a sensor as block unit it is immediately clear to the skilled person that the block unit is a separate entity and that any features of that sensor that are not intricately linked to its application to the wind turbine blade can be considered in separation from that application. This concerns in particular the inner workings of the sensor which are the subject of claim 8. It is thus immediately clear to the skilled reader that this generic detail of the sensor is not only disclosed in application to a wind turbine blade but is also the essence of the particular type of sensor of the preformed unit that is to be so applied. The Board is thus unable to see any new information extending beyond the original disclosure in adding these features to the claim to the block unit which defines the sensing arrangement as separate unit.

- 5.2.3 As claim 8 considered in the context of the overall disclosure and the main idea it presents provides the basis for adding those features to the claim to the block unit alone, the argument that their addition would represent an unallowable intermediate generalization vis-a-vis the first three paragraphs on page 8 in reference to figure 3 is moot.
- 5.2.4 The Board concludes that the amendments to the claims of auxiliary request 3A meet the requirements of Article 123(2) EPC.

5.3 Sufficiency

5.3.1 Modulus of elasticity is sufficiently well known to the skilled person from their common general knowledge for them to know how to realize it and measure it, if needed, on the wind turbine blade of claim 1. That there may be different ways of measuring is immaterial, as, whatever method is chosen, it goes without saying that this would be applied to both connection plate and surface structure thus ensuring comparison of like for like. Where a blade is already manufactured and needs to be retrofitted, as further submitted, its material composition including fiber orientation and thus elastic modulus should be a known design parameter. The Board furthermore concurs with the appellant proprietor, that at least by selecting the same material for the intermediate plate as the surface of the blade on which it is adhered, the skilled person is able to realise the claimed relationship between the elastic modulus of the plate and blade surface.

5.3.2 As explained above in relation to added subject-matter the features of as filed claim 8, added to claims 1 and 9, are detailed in relation to figure 3 in the first three paragraphs on page 8 of the application. The Board would agree that the feature is not particularly clear and complete in its own right, especially for the claim to the block unit alone. However such an issue of clarity, as it pertains to a granted claim, is not open to examination, G3/14.

In accordance with established jurisprudence this issue of clarity can be resolved in reference to the description. Referring to the third paragraph on page 8, displacement of the light emitting means, at the end of one coil, causes the amount of light entering the

light receiving means, at the end of another or other coils to vary. The underlying principle (displacement causes variation of light amount) is easily understood from that example, and can be realized in other variations of the example that might spring to mind without great effort.

- 5.3.3 The further argument that this aspect would not be disclosed across the full scope fails to convince the Board, not least because it misapplies case law developed in the field of chemistry. In that case law a claimed invention resides in a compositional range or other range of values but the associated effect may not be proven or plausible for large parts of that range. In the present case, the claimed invention is to a structural devices but claims no compositional range or range of values. By its very nature a claim to a device, which - possibly in functional or other generic terms - attempts to capture the essence of its basic structure and operation, is schematic allowing for some breadth of interpretation. It may be that on clever construction subject-matter can be found to be covered within that breadth that may not solve the problem or achieve the desired effect. However, this is normally not an issue of lack of disclosure, but rather of claim construction. Whether claims, description and figures provide the skilled person with sufficient information to carry out an invention, is a purely technical question, that is separate from that of what reasonably falls within the ambit of claim wording. In the Board's view if the skilled person upon consideration of the entire disclosure possibly using common general knowledge can infer what will and what will not work, a claimed invention is sufficiently disclosed, even if a broad construction might also encompass what doesn't work. Indeed that inference from the whole disclosure

might lead to a more limited construction of the claim. Furthermore the lack of reproducibility over the whole scope has not been substantiated by any evidence, and thus fails to convince.

5.3.4 The Board concludes that the invention now defined in claim 1 and 7 is sufficiently disclosed, Article 83 EPC.

5.4 Novelty and Inventive Step

The appellant opponent challenges novelty and inventive step in the light of D3 and D6. At the oral proceedings they also referred to D7 cited against the granted claims.

5.4.1 The features added in claims 1 and 9 specify light emitting means and light receiving means that are displaceable with respect to each other in a transition zone. In a reasonable and technically sensible reading of the claim these features identify two distinct means that are moreover displaceable with respect to each other in a transition zone, that is an area located there between. Thus, the two means are distinct and separate entities, which the skilled person would recognize as such, and which move with respect to each other in a specific area. They would not reasonably identify these means as portions or slices of a single fibre either side of a Bragg grating, as does the appellant opponent.

In particular, a single fiber including Bragg grating which becomes distorted by strain does not imply a displacement of receiving and transmitting means. Rather it uses pitch variation between gratings that result in a shift in the wavelength of light received

by a remote receiver. The displacement now defined in claim 1 is understood as an effective change of distance or alignment between a first distinct source of light and a second distinct light receiver through an implicit gap there between, the transition zone. The displacement in this context occurs between the light source and light receiver themselves on either side of a gap, causing the intensity of light received to vary, rather than its wavelength.

The fact that the granted patent mentioned a Bragg grating as possible strain sensor in its last generalising paragraph 051 does not change the above conclusion, as the added features are sufficiently clear to differentiate what is now claimed from such sensors. In any case this passage, because it referred to an embodiment no longer covered by the claims, has been removed from the adapted description.

- 5.4.2 In the above reading, which excludes Bragg gratings, none of the document cited by the opponent appellant teaches such an optical sensor arrangement.

D3 discloses a Bragg sensor as sole embodiment for the strain sensors 5 (page 12, lines 12 to 21).

D6 discloses a single fiber 3 embedded within a matrix transducer 4, one end of which is connected to a remote light emitter and the other to a light receiver, paragraph 011. If, as argued by the appellant opponent, the two ends correspond to the emitter and receiver respectively of the claim, these are not distinct means, nor are they provided in the block unit sensor in a transition zone. Here it is not a displacement between receiver and emitter that figures in the measurement methodology but rather changes in the

optical properties in the section under strain. The only mention in D6 of any specific methodology is in paragraph 0011, which cites D5, col.3, ln.51-52, where again Bragg gratings are mentioned.

D7 detects cracks in material by detecting breaks in a fibre as result of the cracks. Once the fiber 20 is broken, light transmission is terminated (column 3, lines 1-5) and the sensor ceases to operate. In that it senses breakage and not the force resulting in a continuum deformation of a body (or that continuum deformation itself) conventionally denoted as "strain" it is not a strain sensor, certainly not one the skilled person would recognize as such.

5.4.3 As is apparent from the above the features added to claims 1 and 9 are not known from either D3 or D6 so that they establish novelty over these documents. These features, which define an alternative strain sensing arrangement, are also not known or otherwise suggested by D7. Combination of any of these documents would therefore not as a matter of obviousness result in the wind turbine with sensor of claim 1 or the block sensor unit of claim 9 characterized by those features.

5.4.4 The Board can but conclude that the subject-matter of independent claims 1 and 9 is novel and involves an inventive step over that prior art, Art 52(1) with Art 54 and 56 EPC.

6. The appellant proprietor has withdrawn auxiliary request 3 corresponding to the request held allowable in the decision under appeal, so that that decision must be set aside. As the patent amended according to the auxiliary request 3a meets the requirements of the EPC the Board can maintain the patent in that form, pursuant to Art 101(3) (a) EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside
2. The case is remitted to the opposition division with the order to maintain the patent as amended in the following version:

Claims:

No. 1 to 16 of auxiliary request 3a filed with the letter of 14 January 2022

Description and drawings:

Amended description and figures on which the decision under appeal was based.

The Registrar:

The Chairman:



G. Magouliotis

A. de Vries

Decision electronically authenticated