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Datasheet for the decision
of 17 February 2020

Case Number: T 1650/14 - 3.4.01

Application Number: 08009630.8

Publication Number: 1956375

IPC: G01P3/22, G01P3/44, F03D7/04, G01P15/18

Language of the proceedings: EN

Title of invention:
Wind turbine and method determining at least one rotation parameter of a wind turbine rotor

Patent Proprietor:
Siemens Gamesa Renewable Energy A/S

Opponent:
Vestas Wind Systems A/S

Headword:
Rotation parameter/SIEMENS GAMESA

Relevant legal provisions:
EPC Art. 100(c)

Keyword:
Grounds for opposition - extension of subject-matter (yes)

Beschwerdekammern

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Case Number: T 1650/14 - 3.4.01

D E C I S I O N
of Technical Board of Appeal 3.4.01
of 17 February 2020

Appellant: (Patent Proprietor)	Siemens Gamesa Renewable Energy A/S Borupvej 16 7330 Brande (DK)
Representative:	Aspacher, Karl-Georg Siemens Gamesa Renewable Energy GmbH & Co. KG Otto-Hahn-Ring 6 81739 München (DE)
Respondent: (Opponent)	Vestas Wind Systems A/S Alsvej 21 8940 Randers SV (DK)
Representative:	Samson & Partner Patentanwälte mbB Widenmayerstraße 6 80538 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 20 May 2014 revoking European patent No. 1956375 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman	T. Zinke
Members:	B. Noll
	R. Winkelhofer

Summary of Facts and Submissions

I. European patent EP1956375 was revoked on the ground that Article 100 (c) EPC was prejudicial to the maintenance of the patent as granted or in amended form according to an auxiliary request.

II. The patent proprietor lodged an appeal against the decision. With the statement of grounds of appeal, a set of claims as a first auxiliary request was submitted. With a further submission, the appellant filed further claim sets as second and third auxiliary requests.

III. The Board gave a preliminary opinion on the case in a communication accompanying a summons to oral proceedings.

IV. The patent proprietor (appellant) requests that the decision under appeal be set aside and the opposition be rejected (main request), or the patent be maintained on the basis of one of three auxiliary requests.

The opponent (respondent) requests that the appeal be dismissed.

V. Claim 1 of the patent as granted reads as follows [feature labels added by the Board]:

[a] *A method of determining at least the phase* (θ_{Rotor}) [b] *of a wind turbine rotor (4) rotating with a rotation speed* (ω_{Rotor}) *relative to the earth as a global reference frame, comprising the steps of:*

- [c] *measuring a first effective centrifugal force (F_x) acting in a first pre-determined direction, which is defined in a co-ordinate system rotating synchronously with the rotor (4), on at least one reference object (11) located in or at the rotor (4),*

- [d] *measuring a second effective centrifugal force (F_y) acting in a second pre-determined direction, which is defined in a co-ordinate system rotating synchronously with the rotor (4) and which is not parallel to the first pre-determined direction, on at least one reference object (11) located in or at the rotor (4),*

- [e] *determining the direction the gravitational force is acting in with respect to the rotating coordinate system on the basis of variations in the measured first and second effective forces (F_x , F_y) acting in the first and second directions due to gravitational force (F_g), and*

- [f] *establishing the phase (θ_{Rotor}) of the rotor relative to the global reference frame on the basis of variations in the measured first and second effective forces (F_x , F_y) acting in the first and second directions due to gravitational force (F_g) and the direction the gravitational force is acting in.*

Claim 1 of the first auxiliary request differs from claim 1 as granted in that the feature [f] is replaced by the following feature:

- *establishing the phase (θ_{Rotor}) of the rotor relative to the global reference frame on the basis of variations in the measured first and second effective* *forces (F_x , F_y) acing [sic] in the first and second directions due to gravitational force (F_g) and the direction the gravitational force is acting in, where the variations in the measured first and second effective forces (F_x , F_y) acing in the first and second directions due to gravitational force (F_g) are used for determining the direction the gravitational force is acting in with respect to the rotating coordinate system.*

The claims of the second and the third auxiliary request are identical to the method claims 1 to 6 of the main request and the first auxiliary request, respectively, the device claims 7 to 11 being cancelled.

Reasons for the Decision

Background and claim construction

1. The patent relates to detecting the circular position of a rotating turbine rotor of a wind turbine mounted on a tower. In the wording of the patent, the instantaneous angular position of the rotor relative to ground is designated as a phase.

2. The introductory part of the patent specification (cf. paragraph 5) states that the angular velocity and the phase of the rotor are conventionally measured by an inductive sensor at the low-speed or high-speed shaft of the rotor and an absolute encoder mounted at the slip ring of the rotor. It is further said that these measurements are erroneous when the top of the tower is moving relative to ground, that the angular velocity sensor does not provide any information on the phase

when mounted at a high-speed shaft of the rotor, and that the accuracy of measured phase may suffer from including torsion oscillations.

The patent aims at improving the measurement of the rotor phase against ground.

The solution suggested by the patent is defined as a method. A reference object is provided at the rotor. The reference object measures two forces acting on it along two radial directions of the rotor which are not parallel to each other. In operation, when the rotor is rotating in the presence of a constant gravitational field, the forces measured by the reference object are effective centrifugal forces, as indicated by features [c] and [d] in claim 1. Each measured force is the result of a superposition of the "true" centrifugal force acting on the reference object due to the rotation of the rotor and the gravitational force. The "true" centrifugal force always points away in a direction from the rotation axis to the reference object; for an observer on the ground, the "true" centrifugal force continuously changes its direction when the rotator is rotating; the gravitational force always points from the reference object towards ground. The effective centrifugal force therefore varies in magnitude over time.

For determining the phase, the claimed method defines a 2-step-process. In a first step (feature [e]), the direction of the gravitational force of the rotor is determined in a coordinate system which is synchronously rotating with the rotor. This coordinate system is referred to, in claim 1, as the rotating coordinate system. The method only defines that the direction of the gravitational force is obtained "on the basis of variations of the measured first and second effective forces". The method does not define in further detail how the gravitational force is obtained.

In a second step (feature [f]), the phase of the rotor relative to the global reference frame is established. The global reference frame is the coordinate system, which is constant relative to earth. The phase is obtained "on the basis of variations in the measured effective forces and the direction of the gravitational force". The method does not define in further detail how the phase is established.

The main request - Article 100 (c) EPC

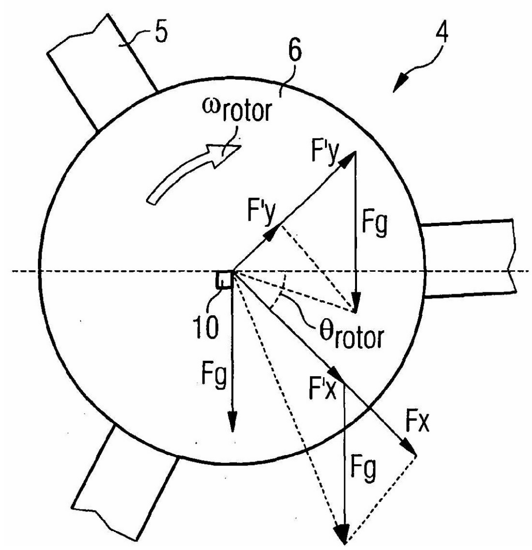
3. For assessing compliance with Article 100 (c) EPC, the disclosure of the earlier application as filed is considered from the perspective of a person skilled in the art of measuring rotation parameters of wind turbines. References to the application relate to EP 1 835 293 A1, the A-publication of the earlier application.

4. Paragraph 13, starting from column 4, line 11, is the most relevant passage relating to measuring the phase. It reads as follows:

With measuring the effective centrifugal force in a second non-parallel direction it is possible also to determine the vector of the gravitational force with respect to the rotating coordinate system, i.e. direction the gravitational force is directing in with reference to the rotating coordinate system. From the direction the gravitational force is acting in with respect to the rotating coordinate system, the phase of *the rotation can be determined. Please note that although the vector components of the gravitational force are determined in the rotating coordinate system the frame of reference is still a global frame of reference as the basis of establishing the phase is the vector of the gravitational force which always points towards the earth. Please note that determining of the phase is easiest when the two non-parallel directions in which the effective centrifugal forces are measured are perpendicular to each other.*

5. The relationships between the forces acting on the reference object are explained in paragraphs 27 to 30 in conjunction with figure 2, which is shown below.

FIG 2



6. In the figure, the effective centrifugal forces are indicated as arrows *Fx* and *F'y* (i.e. the shorter of the two vectors so labeled; for easier understanding, it will be referred to as *Fy* in the following). The skilled person would understand that *Fx* (or *Fy*) is the

vector sum of the "real" centrifugal force *F'x* (or *F'y*) acting on the dual-axis accelerometer 10 and the component of the gravitational force *Fg* along the direction of *F'x* (or *F'y*). The skilled person, taking into account basic physical laws of elementary dynamics of a circular motion, would understand that the magnitude and the direction of the "real" centrifugal force vector are constant, and that the gravitational force vector is rotating when the motion is observed from a reference system rotating with the rotor. Further, using general knowledge in the field of ordinary vector geometry, the skilled person would understand that the direction of the gravitational force when observed in the rotating reference system is equivalent to the angle between *Fx* (or *Fy*) and the instantaneous direction of the gravitational force observed in the rotating reference system. In the same way, the skilled person would understand that the "real" centrifugal force vector is rotating, and the magnitude and the direction of the gravitational force vector are constant when the motion is observed from the global reference system. The skilled person would appreciate that the relationship between the directions of the "real" centrifugal force and the gravitational force is unaffected by whether it is observed in the rotating reference system or in the global reference system. The skilled person would further appreciate that the magnitude of the effective centrifugal force *Fx* (or *Fy*) as measured by the dual axis accelerometer 10 oscillates synchronously with the rotation of the rotor and, therefore, corresponds to the angular velocity of the rotor. The magnitude varies between a maximum, at which the "real" centrifugal force and the gravitational force point in the same direction, and a minimum, at which the "real" centrifugal force and the gravitational force point in opposite directions according to a sinusoidal function defined by the angle between the direction of the gravitational force and the instantaneous direction of the centrifugal force *Fx* (or *Fy*). Consequently, the skilled person would appreciate, from the passages cited above, that in the method as disclosed, with the determination of the direction of the gravitational force relative to the rotating reference frame, the angle between the "real" centrifugal force *Fx* (or *Fy*) vector and the gravitational force vector is simultaneously and completely determined in the rotating reference frame and in the global reference frame.

7. The skilled person would therefore infer, from the application documents as filed, that the phase of the rotor relative to the Earth in the global reference system is completely determined, once the direction of the gravitational force in the rotating reference system is determined.

8. Claim 1 defines a second step (feature [f], see above), by which the phase is established on the basis of variations in the measured effective forces <u>and</u> the direction of the gravitational force. This step is separate from the step by which the direction of the gravitational force relative to the rotating coordinate system is determined (feature [e], see above).

9. It is not directly and unambiguously derivable from the earlier application that the phase is established by considering <u>both</u> the variations of effective forces due to gravitational force and the direction of the gravitational force. The above-cited passages in paragraph 13 do not provide a direct and unambiguous basis for establishing the phase in this way. Hence,

the subject-matter of claim 1 extends beyond the content of the earlier application.

10. The appellant argues only that the direction of the gravitational force relative to the rotating reference system obtained in feature [e] was as a vector defined by Cartesian components parallel and orthogonal to the direction *Fx*. These coordinates did not represent the phase of the rotor. Obtaining the phase would require an additional step of converting the coordinates of the vector into a form in which the phase was explicit. Such conversion required, again, a consideration of the magnitudes of the measured effective centrifugal forces, together with the gravitational force.

11. This argument is not persuasive. The determination of the phase of a vector which is presented in Cartesian coordinates requires only a transformation of its coordinates into a polar representation, in which the phase is explicit. This transformation is generally known and completely defined, in itself, as a mathematical transformation which requires no other inputs than the Cartesian coordinates. Additionally considering the variations of the measured forces for obtaining the phase is not required, and the application does not disclose a combined consideration of the variations of measured forces and the direction of the gravitational force, or any effect which results from a combined consideration.

12. For these reasons, the Opposition Division was correct in finding that the ground for opposition pursuant to Article 100 (c) EPC prejudices the maintenance of the patent as granted.

The first auxiliary request

13. Claim 1 of the first auxiliary request is different from claim 1 as granted only in that the step of establishing the phase is described before the step of determining the direction of the gravitational force. This is a difference in wording only, but not in substance. Hence, there is no reason to arrive at a different conclusion as regards compliance with Article 100 (c) EPC. The first auxiliary request does not comply with Article 100 (c) EPC for the same reasons as the main request.

14. The appellant did not separately argue on the first auxiliary request.

The second and third auxiliary requests

15. Claims 1 of the second and third auxiliary requests are identical to the versions of claim 1 in the main and first auxiliary requests, respectively. Therefore, the above reasons apply equally.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

D. Meyfarth T. Zinke

Decision electronically authenticated