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Datasheet for the decision of 12 November 2018

Case Number: T 2191/14 - 3.2.04

Application Number: 09180594.5

Publication Number: 2216547

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Language of the proceedings: EN

Title of invention:
Compact geared drive train for wind turbine

Patent Proprietor:
General Electric Company

Opponents:
Finnish Patent Engineering Service Ltd./
Väänänen, Janne
Vestas Wind Systems A/S

Headword:

Relevant legal provisions:
EPC Art. 56, 123(2)

Keyword:
Inventive step - main request (no) - auxiliary requests 1 to 3 (no)
Amendments - auxiliary request 4 - intermediate generalisation

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 2191/14 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 12 November 2018

Appellant: (Patent Proprietor)	General Electric Company 1 River Road Schenectady, NY 12345 (US)
Representative:	Bedford, Grant Richard GPO Europe GE International Inc. The Ark 201 Talgarth Road Hammersmith London W6 8BJ (GB)
Respondent: (Opponent 1)	Finnish Patent Engineering Service Ltd./ Väänänen, Janne Alhaistenojankatu 18 Laaksolahdentie 74 21200 Raisio/02730 Espoo (FI)
Representative:	Finnpatent Oy Smart Chemistry Park Raisionkaari 55 21200 Raisio (FI)
Respondent: (Opponent 2)	Vestas Wind Systems A/S Hedeager 44 8200 Aarhus N (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 22 September 2014 revoking European patent No. 2216547 pursuant to Article 101(3)(b) EPC.**

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 24 November 2014 against the decision of the opposition division dispatched on 22 September 2014 on the revocation of the patent EP 2 216 547, and simultaneously paid the appeal fee. The statement setting out the grounds of appeal was received on 29 January 2015.

II. Two oppositions had been filed and were based on Article 100(a) together with Articles 52(1), 54(1) and 56 EPC. The Opposition Division came to the conclusion that the subject-matter of claim 1 according to the main and auxiliary requests was not inventive having regard to the following documents:

D2 US 2007/0108776 A1
D3 US 2006/0104815 A1
D18 M. Calistrat et al.:"Insulating Rotating Machinery Against Stray Electrical Currents", Predictive Maintenance Technology National Conference - 1997
OD2 EP 1 289 099 A2

III. Oral proceedings were held on 12 November 2018.

IV. The appellant requests that the decision under appeal be set aside, and the patent be upheld as granted, as main request, or, alternatively, that the decision under appeal be set aside and the patent be maintained in an amended form on the basis of the First or Second Auxiliary Requests filed with letter dated 1 August 2014, or further on the basis of the Third Auxiliary Request filed during the oral proceedings on 3 September 2014 before the Opposition Division, or

further on the basis of the Fourth Auxiliary Request filed with the grounds of appeal dated 29 January 2015.

V. The respondents (opponent 1 and opponent 2) request that the appeal be dismissed and that the revocation of European patent No 2 216 547 be confirmed.

VI. The wording of the independent claim 1 of the relevant requests reads as follows:

Main request

"A drive train for a wind turbine (100), said wind turbine (100) comprising a rotor, said drive train comprising a low speed shaft (210) connectable to said rotor, the low speed shaft being connected to a gearbox (310; 400), said gearbox having a high speed shaft connected to a generator (350), said generator (350) comprising a generator rotor (360) and a stator (365), said drive train further comprising: a bearing (385) interposed between said gearbox (310; 400) and said generator (350); a rotating hub (380; 480) connected to said generator and said bearing; a gearbox lubrication medium at least partially contained within said gearbox; wherein said bearing shares said gearbox lubrication medium with said gearbox; and characterised in that: said generator (350) is connected to said rotating hub (380; 480) with insulating fasteners (512, 514), said insulating fasteners providing substantial electrical isolation between said generator rotor (360) and said gearbox (310; 400)."

Auxiliary request 1

1. A drive train for a wind turbine (100), said wind turbine (100) comprising a rotor, said drive train comprising a low speed shaft (210) connectable to said rotor, the low speed shaft being connected to a gearbox (310; 400); said gearbox having a high speed shaft connected to a generator (350), said generator (350) comprising a generator rotor (360) and a stator (365), said drive train further comprising:

rotor bearings (385) interposed between said gearbox (310; 400) and said generator (350);

a rotating hub (380; 480) connected to said generator and said rotor bearings (385);

a gearbox lubrication medium at least partially contained within said gearbox;

wherein said rotor bearings (385) share said gearbox lubrication medium with said gearbox; and

characterised in that:

said generator (350) is connected to said rotating hub (380; 480) with insulating fasteners (512; 514), said insulating fasteners providing substantial electrical isolation between said generator rotor (360) and said gearbox (310; 400).

Auxiliary request 2

1. A drive train for a wind turbine (100), said wind turbine (100) comprising a rotor, said drive train comprising a low speed shaft (210) connectable to said rotor, the low speed shaft being connected to a gearbox (310; 400); said gearbox having a high speed shaft connected to a generator (350), said generator (350) comprising a generator rotor (360) and a stator (365), said drive train further comprising:

rotor bearings (385) interposed between said gearbox (310; 400) and said generator (350);

a rotating hub (380; 480) connected to said generator and said rotor bearings (385);

a gearbox lubrication medium at least partially contained within said gearbox;

wherein said rotor bearings (385) share said gearbox lubrication medium with said gearbox; and

characterised in that:

said generator (350) is connected to said rotating hub (380; 480) with insulating fasteners (512; 514), said insulating fasteners providing substantial electrical isolation between said generator rotor (360) and said gearbox (310; 400), and wherein said generator (350) is attached to a housing (312; 412) of said gearbox (310; 400).

Auxiliary request 3

1. A drive train for a wind turbine (100), said wind turbine (100) comprising a rotor, said drive train comprising a low speed shaft (210) connectable to said rotor, the low speed shaft being connected to a gearbox (310; 400), said gearbox having a high speed shaft connected to a generator (350), said generator (350) comprising a generator rotor (360) and a stator (365), said drive train further comprising:

rotor bearings (385) interposed between said gearbox (310; 400) and said generator (350);

a rotating hub (380; 480) connected to said generator and said rotor bearings (385);

a gearbox lubrication medium at least partially contained within said gearbox; **characterised in that**:

said rotor bearings (385) share said gearbox lubrication medium with said gearbox; and

wherein said generator (350) is connected to said rotating hub (380;480) with insulating fasteners (512, 514), said insulating fasteners providing substantial electrical isolation between said generator rotor (360) and said gearbox (310;400);

wherein said generator (350) is attached to a housing (312;412) of said gearbox (310;400);

wherein said high speed shaft is connected to said rotating hub (280;480), and wherein said rotor bearings (385) are interposed between said rotating hub (380; 480) and said gearbox housing.

Auxiliary request 4

1. A drive train for a wind turbine (100), said wind turbine (100) comprising a rotor, said drive train comprising a low speed shaft (210) connectable to said rotor, the low speed shaft being connected to a gearbox (310; 400); said gearbox having a high speed shaft connected to a generator (350), said generator (350) comprising a generator rotor (360) and a stator (365), said drive train further comprising:

rotor bearings (385) interposed between said gearbox (310; 400) and said generator (350);

a rotating hub (380; 480) connected to said generator and said rotor bearings (385);

a gearbox lubrication medium at least partially contained within said gearbox;

wherein said rotor bearings (385) share said gearbox lubrication medium with said gearbox; and

characterised in that:

said generator (350) is connected to said rotating hub (380; 480) with insulating fasteners (512; 514), said insulating fasteners providing substantial electrical isolation between said generator rotor (360) and said gearbox (310; 400), and wherein said generator (350) is attached to a housing (312; 412) of said gearbox (310; 400), wherein the generator rotor (360) is mounted on the rotating hub (380) via a flange mounting arrangement (361), the rotating hub (380) being tightly mounted over an outer race of the rotor bearings (385), the rotor bearings (385) being tightly mounted over a tubular extension of the housing (312) of the gearbox (310), and wherein a seal unit (386) is provided between the rotating hub (380) and the gearbox housing (312).

VII. The appellant's arguments are as follows:
- In addition to the insulating fasteners that are neither disclosed in D2 or D3, these documents also fail to disclose a rotating hub that, read in the context of claim 1, should be a separate component, as well as lubrication common to the bearing and gearbox. These features have a synergetic effect and allow easy disassembly of the generator.

- The auxiliary requests 1 to 3 further clarify the difference of the rotary hub being a separate component, a feature that is not derivable from D2 or D3.
- As for auxiliary request 4 the amendments include features from the description that were disclosed in combination, and only omit optional or non essential features. This request is clearly allowable.

VIII. The respondents' arguments are as follows:
- The wording of Claim 1 is broad, and in particular does not require the rotating hub to be a separate component. Lubrication is mandatory and thus implicit for the skilled person, and has to be common to the gearbox and bearing in D3. D2 explicitly mentions such a common lubrication on page 2, paragraph 20.
- D2 and D3 also disclose the additional features of auxiliary request 1, 2 and 3 and they cannot contribute to inventive step.
- Claim 1 according to the auxiliary request 4 contains features isolated from the broader content of the application as filed resulting in an unallowable intermediate generalisation. Apart from the extension of subject-matter, the request was not filed before the first instance and as such it was filed late. It should not be admitted.

Reasons for the Decision

1. The appeal is admissible.

2. Background of the invention
The invention concerns a drive train for a wind turbine of the type disclosed in document D3. The preamble of the claim 1 has been drafted on the basis of that disclosure (see paragraph 009 of the patent

specification). The characterising features of claim 1 of the patent require that the generator is connected to the rotating hub with insulating fasteners that provide substantial electrical isolation between said generator rotor and said gearbox.

3. Main request - Inventive step

3.1 Since the patent explicitly acknowledges D3 as disclosing a drive train according to the preamble of claim 1 (paragraph 9) it therefore represents a promising starting point for assessing inventive step. It is undisputed that D3 discloses a drive train comprising a low speed shaft 9 connected to a gearbox 19, said gearbox having a high speed shaft in the form of driven shaft 27 (paragraph 27) connected to a generator comprising a rotor 31 and a stator 33.

3.2 Differences

3.2.1 It is however disputed that the flanged part of the driven shaft 27 shown in the figure at its outer end and connecting to the rotor 31 via connecting gear 29 is a rotating hub as defined in claim 1. According to the appellant the rotating hub should be understood within the context of claim 1 to be a separate component. As a consequence, the bearing shown on the right hand side of figure 2 positioned between the driven shaft 27 and the gearbox is not interposed between the gearbox and a separate rotating hub connected to said generator and said bearing, as required by claim 1.

3.2.2 The Board does not share the appellant's interpretation of claim 1, that the rotary hub needs to be separate and independent from the gearbox. The fact that the

claim explicitly requires the drive train to "further" comprise a bearing and a rotating hub connected to the generator and bearing, this does not necessarily imply that this hub is to be understood as a separate part independent of the gearbox, in particular a separate part of the high speed output shaft defined in the claim.

Reading the claim in context and using normal reading skills the skilled person understands the high speed output shaft and rotating hub to be elements of the kinematic drive train, with the hub connecting the shaft to the generator rotor to transmit rotation from the shaft to the rotor. Without any indication in the claim to the contrary, either explicit or implicit, he will understand this formulation to include assemblies in which shaft and hub are formed separately or as a one piece assembly.

Figure 2 of D3 corresponds to this latter case, and describes the kinematic assembly in paragraph 27 as follows: "By means of the driven shaft 27 of the gear 19, the connecting gear 29 is driven and is once again connected to the generator rotor."

As a consequence at least the bearing shown in figure 2 of D3 mounted between the flange on the driven shaft 27 and the inner (sun) gear of the gearbox planetary holding frame matches the requirement of the claim to provide a rotary hub (integral or not with the gear box high speed shaft) connected to the generator and bearing, the bearing itself being interposed between the gearbox and generator.

3.2.3 The appellant furthermore contests that D3 directly and unambiguously discloses a bearing that shares the gearbox lubrication medium with said gearbox.

Indeed D3 makes no mention of lubrication of the gearbox at all. However, the skilled person, a mechanical engineer in the field of wind turbines, knows from his basic knowledge in that field that for the gearbox of a wind turbine, which must operate at high torques, internal lubrication is indispensable. For them lubrication is thus an implicit feature of a wind turbine gearbox. Looking at the configuration of the drive train shown in Fig. 2, the skilled person immediately recognises that all the bearings shown in Fig. 2 at least have a surface facing the inner side of the lubricated gearbox (gear box housing 21). Therefore the bearings are in fluid communication with the medium used to lubricate the intermeshing teeth of the planetary gears with the sun gear, and therefore share lubricant with it. This will be immediately clear to the skilled person when considering the drive train shown in figure 2.

3.2.4 From the above the Board concludes that all the features of the preamble of claim 1 are known from D3, as also acknowledged in paragraph 009 of the patent.

Otherwise it is undisputed that D3 does not disclose the characterizing features of claim 1 as granted. These features, namely that "the generator is connected to said rotating hub with insulating fasteners, said insulating fasteners providing substantial electrical isolation between said generator rotor and said gearbox" are the sole differences of the claimed drive over D3.

3.3 Formulation of the technical problem

3.3.1 The technical effect of such insulating fasteners is indicated in the claim itself, namely to provide electric isolation between the generator rotor and gearbox. This effect also corresponds to the effect sought for and defined in the last sentence of paragraph 30 of the patent, which is to protect the bearings of the generator from current damage. The associated objective technical problem may be formulated accordingly as how to prevent damage of the bearings.

3.3.2 Based on the advantage to ease disassembly, as shown in figure 5 of the patent, and the related advantage to allow access to the bearings for maintenance, as cited in the last sentence of paragraph 18, the appellant submits that the technical problem also encompasses providing an improved design for disassembly and maintenance. Furthermore pointing at the additional risks for electric current conduction related to shared lubrication, the Appellant also submits that this synergetic relationship should be taken into account in formulating the problem.

3.3.3 This argument is based in part on the assertion that the rotating hub is necessarily a separate component, a feature that the Board is unable to read in claim 1, see above. The alleged further advantage of facilitating disassembly relates to features not found in claim 1, as is apparent from paragraphs 0032 to 0034. As is established case law the formulation of the objective technical problem cannot be based on limitations that are not present in the independent claim. For the same reason any alleged synergy based

on features not in the claim must be disregarded when formulating the objective technical problem.

3.4 Obviousness of the solution

3.4.1 To solve the technical problem posed, the skilled person will turn to D18, which is expressly concerned with the problem of electric insulation in rotating machines in general, and especially electrical machinery (page 53, right hand column, first bullet point) with generators cited as examples (page 54, left hand column, first two lines). To address this problem D18 suggests the use of insulation in bearings and couplings (page 53, abstract) "to block flow of stray electricity", i.e. stray voltage and stray currents in a variety applications including bearings, seals, gears and couplings (page 53, right hand column, third paragraph).

3.4.2 In particular, the various examples of insulating couplings discussed in the chapter "Insulating couplings" on page 55 present the skilled person person with a range of very suitable "off the shelf" solutions for preventing current damage to bearings and other components of the drive train of the gearbox of a wind turbine generator as in D3 as a particular subclass of electrical rotary machines. This is in particular so as this chapter also mentions generators as an application.

By simple application of one of these insulating couplings, e.g in the form of insulating fasteners as shown in figure 7 of D18, to connect the flange portion of the hub 27 of D3 to the generator rotor, the skilled person would arrive without inventive skill at a drive train according to claim 1.

3.4.3 The Board also observes that the skilled person would also arrive at the same solution considering the disclosure of OD2. OD2 concerns a starter generator for a turbine engine, and indeed discloses in paragraph 25 an insulator member interposed between a coupling member 40 located on the generator side and coupling member 42 on a drive member of an output shaft ([0024], figure 1). This type of coupling can directly be applied to attach the flange portion of the hub 27 of D3 thereby arriving at a solution including insulating fasteners.

3.5 From the above, the Board concludes that the subject-matter of claim 1 according to the main request lacks an inventive step, starting from D3 and applying the teaching of either D18 or OD2.

3.6 The Board is also convinced that the same negative conclusion on inventive step would be drawn when starting from the drive train of the wind turbine disclosed in D2 and directly applying the teachings of any one of D18 or OD2. D2 discloses a similar drive train of a wind turbine (figure 3) as defined in the preamble of claim 1 with a the wind turbine rotor shaft 20 connected to a gearbox in the form of gear mechanism 24 housed within housing 18 which drives generator shaft 50 as high speed shaft connected to generator 26. This drive comprises in particular a bearing (front bearing 54) interposed between the gearbox and the generator 26. While the appellant also disputes that D2 discloses a rotating hub according to claim 1, the Board is of the opinion that the part of the generator shaft 50 where it connects to gear pinion 48 and is enclosed within bearing 54 in figure 3 forms a hub in its broadest sense, which is integrally formed with the

generator shaft, which, as already explained above in relation to D3, is included within the scope of granted claim 1. This hub is clearly connected to the generator (through its shaft) and it is also connected to the inner race of the bearing 54. Concerning shared lubrication, D2 expressly mentions, paragraph 20, that bearing 54 is lubricated with the lubricant of the gear mechanism 24, i.e. shares the gear box lubrication. That the further bearing 56 supporting shaft 50 at its other end (away from the gear mechanism) does not share the gearbox lubrication is immaterial, as claim 1 only require the bearing between gearbox and generator to share lubricant with the gearbox.

4. Auxiliary requests

4.1 Claim 1 of the auxiliary request 1 is amended by replacing the bearing by rotor bearings. This amendment merely requires the bearing to be at least two in number and to be associated in some way with the rotor. D3, figure 3, shows two sets of bearings supporting the rotary hub and shaft 27 and connected rotor and therefore correspond to the amended wording of claim 1. Because the amendment does not add any further distinguishing feature, the above conclusion of lack of an inventive step also applies to the subject-matter of claim 1 containing this further limitation.

4.2 Claim 1 of the auxiliary request 2 further adds to claim 1 according to auxiliary request 1 the features of claim 2, that requires the generator to be attached to the gearbox housing. The appellant's observation that the elastic elements 23 in figure 2 of D3 serve as damping means is indeed derivable from paragraph 26. Nonetheless this paragraph also explicitly explains that the gear casing 21 is supported by these elements

23 with respect to the base plate 25. The base plate 25 also forms the front part of the generator casing 35 (paragraph 28). This configuration therefore matches the features added in claim 1. A similar attachment of the generator is also shown in D2 where main generator housing 18 is integrally connected to the gearbox housing attached to a front gearbox lid (see fig 3). Thus the features added in claim 1 of the auxiliary request 2 are known from either starting point document D3 or D2 and cannot contribute to provide the necessary inventive step.

4.3 Compared to claim 1 of auxiliary request 2, claim 1 of the auxiliary request 3 further requires the bearings to be interposed between the rotating hub and the gearbox housing. A corresponding location of the bearings is shown in D2. In figure 3 of D2 the bearing 54 is depicted as located within a housing portion of the gearbox in the form of a separation wall between the generator and gearbox, where it also supports the left hand side of the generator shaft. As the features added to claim 1 according to the auxiliary request 3 are already known from D2, they cannot contribute to inventive step.

4.4 In auxiliary request 4, claim 1 adds features concerning the way the generator rotor is mounted on the rotating hub via a flange mounting arrangement. These features have been extracted in isolation from paragraph 0016 of the published description as originally filed. The Board concurs with the respondents' opinion that this isolation results in an intermediate generalisation that is not allowable under the provision of Article 123(2) EPC.

Paragraph 0016, which describes one aspect of the embodiment shown in figure 3, is to be read in conjunction with the relevant passages that describe that embodiment. In particular, paragraph 0020 describes the flange mounting arrangement in more detail as containing an insulating layer and insulating bolts to provide electrical isolation between the rotor and hub. Though paragraph 0020 of the application as filed describes these features as optional, they in fact provide the only detail of the insulating fasteners. Indeed in corresponding paragraph 0024 of the patent specification the word "optionally" has been deleted. It is thus clear that in relation to the invention directed at insulating fasteners and in the context of its specific realization according to figure 3 the feature of the flange mounting arrangement and those of the insulating layer and insulating bolts are intricately linked, as it is exactly these features that realize the claimed insulating fasteners. As these features have not been included in claim 1 of auxiliary request 4, whereas those of the flange arrangement have, claim 1 is unallowably generalized with respect to the original specific disclosure.

From the above the Board concludes that without prejudice of the question of its admission into the proceedings, claim 1 according to auxiliary request 4 contains subject-matter extending beyond the content of the application as filed.

5. Since none of the submitted requests is allowable, the Board can but confirm the impugned decision to revoke the patent.

Order

For these reasons it is decided that:

The appeal is dismissed

The Registrar: The Chairman:

G. Magouliotis A. de Vries

Decision electronically authenticated