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H02K 9/14 (2006.01)

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29.09.2010

(73) Octrooihouder(s):
XEMC DARWIND B.V. te Hilversum.

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(74) Gemachtigde:
B.S.F. Altenburg te Culemborg.

(54) **A wind turbine and a direct-drive generator.**

(57) The invention relates to a wind turbine of the horizontal axis, direct-drive type, wherein the wind turbine comprises
- a hub provided with one or more blades,
- a generator with a centreline that is technically horizontal, the generator comprising an inner rotor which is driven by the hub and an outer stator, the stator comprising a front plate, a back plate and stacked, arcuate laminates. The wind turbine according to the invention is characterized in that the front plate and the back plate are connected by tension rods so as to form a stator unit with the stacked, arcuate laminates being sandwiched between the back plate and the front-plate under compression, the arcuate laminates having protrusions over the circumference of the stator for dissipating heat to the atmosphere. The invention also relates to a direct-drive generator.

NL C 1036733

A wind turbine and a direct-drive generator

The present invention relates to a wind turbine of the horizontal axis, direct-drive type, wherein the wind turbine comprises

- a hub provided with one or more blades,
- a generator with a centreline that is technically horizontal, the generator comprising an inner rotor which is driven by the hub and an outer stator, the stator comprising a front plate, a back plate and stacked, arcuate laminates.

Such a wind turbine is known in the art. In particular CN101222159 discloses a wind turbine according to the preamble wherein the stator is in thermal contact with an outer shell, the shell being provided with ribs to allow dissipation of heat from the generator to the atmosphere.

There is a trend toward larger and larger wind turbines. A major problem designing larger wind turbines is the way power and weight scale. A hypothetical doubling of the length of the rotor diameter of a wind turbine will square its output, but increase its weight with a power of three. An increase in weight has a detrimental effect, in that it increases cost tremendously. This has an adverse effect on the cost of the electricity produced with the wind turbine. Thus, there is a major challenge to design a wind turbine that is both strong and light (for its size).

The object of the present invention is to provide a wind turbine with a reduced weight.

To this end, the wind turbine according to the preamble is characterized in that the front plate and the back plate are connected by tension rods so as to form a stator unit with the stacked, arcuate laminates being sandwiched between the back plate and the front-plate under compression, the arcuate laminates having protrusions over the circumference of the stator for dissipating heat to the atmosphere.

A major saving in weight is achieved by eliminating the shell, allowing the heat from the generator to dissipate into the atmosphere via the protrusions on the convex side of the arcuate laminates. The arcuate laminates provide for the structural integrity of the generator, more specifically of the stator. In general, one of the front plate and the back plate, usually the back plate, will be provided

directly or indirectly (usually via a carrier cone) with one or more bearings, the inner bearing of which is connected to the rotor of the generator. Direct-drive generators tend to have a very large diameter. For this reason, the laminates are generally arcuate segments placed end-to-end. Generally, the laminate segments will independently be of a size of 360° / n where n is an integer $\geq$ 2. They are generally placed staggered (i.e. overlapping) with respect to each other to provide the greatest mechanical strength. The stack will usually be impregnated with a resin, for example using vacuum pressure impregnation. US6467725 in the name of Lucas Industries Ltd discloses an electrical generator for use with a gas turbine, the rotor of which comprises a stack of laminations held under compressive load. It is mentioned that it is advantageous if the stator is made of laminates as well. Laminates, or laminations as they are also called, are quite thin, such as in the order of 0.2 mm. The term "technically horizontal" means that the centreline of the generator makes an angle with the horizontal of up to +15°, in practice usually +4-8°.

According to a preferred embodiment, the protrusions of stacked adjacent laminate segments are in register, forming ribs.

Such a wind turbine is cheaper because the generator is cheaper thanks to the use of the majority of the laminate segments being identical.

According to a preferred embodiment, the outer surface of the stator is covered with a water-impermeable protective coating.

This helps to ensure the longevity of the generator, which is especially important for placement of wind turbines at sea, where the cost of maintenance is very high.

According to a preferred embodiment, the arcuate segments have at least one through-hole, and the tension rods pass through the through-holes.

This allows for a very rigid stator structure.

According to a preferred embodiment, the back plate has a sandwich structure.

This brings the weight of the generator even further down.

According to a preferred embodiment, the centreline of the generator is at an angle of >2° to the horizontal.

This helps to ensure that water runs of the outside of the stator, improving the longevity of the generator and reducing the cost of maintenance.

The present invention also relates to a direct-drive generator comprising an inner rotor and an outer stator, the stator comprising a front plate, a back plate and stacked, arcuate laminates, characterized in that the front plate and the back plate are connected by tension rods so as to form a stator unit with the stacked arcuate laminates being sandwiched between the back plate and the front-plate under compression, the arcuate laminates having protrusions over the circumference of the stator for dissipating heat.

This generator is very suitable for wind turbines or other open-air applications.

The present invention will now be illustrated with reference to the drawing, wherein

fig. 1 shows the top part of a wind turbine according to the invention;

fig. 2 shows a frontal cross-sectional view of the top half of a direct drive generator; and

fig. 3 shows a cross-sectional view of a detail of a generator according to the invention.

Fig. 1 shows a wind turbine 100 with a tower 101, a nacelle 102, a hub 103 and blades 104. The nacelle 102 comprises a direct drive generator 105 with cooling ribs 106 and strengthening ribs 107. The hub 103 and generator 105 are at an angle of 6° to the horizontal, allowing any rainwater falling on the generator 105 to be drained easily.

Fig. 2 shows a cross-sectional view of the top half of the generator 105 with the rotor 109 and stator 111 of the generator 105. Permanent magnets (not shown here but indicated in fig. 3) of the rotor 109 face arcuate laminates 110 of the stator 111. The arcuate laminates 110 are made of a ferro-metal and have a thickness of 0.6 mm (the thickness is shown exaggerated in fig. 3). The arcuate laminates 110 have through-holes 112 for tension rods, as will be explained later. Not visible in figure 2 (but visible in fig. 3) is that the arcuate laminates are provided as a stack of arcuate laminates 110. In the stack, the end-to-end region of two arcuate laminates are covered by another arcuate laminate. An arcuate laminate

110 overlaps with 2 arcuate laminates behind it; with one of the two for 2/3rd of its length, and for the remainder with the other arcuate laminate. The end-to-end regions of the visible arcuate laminates 110 are indicated with 120'; the end-to-end regions of arcuate laminates behind these visible arcuate laminates are indicated with reference number 120'', and the end-to-end regions of the arcuate laminates behind these are indicated with reference number 120'''. The through-holes 112 of adjacent laminates of the stack are in register so as to allow the tension rods to pass through the full stack of arcuate laminates 110.

Fig. 2 shows the teeth 130 of the arcuate laminates 110 in which the copper windings (not shown) are inserted. More importantly, it shows the protrusions 151 over the outer circumference of the stator 111 for dissipating heat to the atmosphere. The protrusions 151 of stacked arcuate laminates 110 form the cooling ribs 106 of the generator 105.

There are also strengthening ribs 107 provided over the circumference of the generator 105, which cover the end-to-end regions (120) of the arcuate laminates 110 to help ensure that no moisture enters the generator 105. They are welded over their full length to the stator 111 (before being impregnated with resin).

The outside of the generator 105, more specifically the stator 111 is coated with a weather-resistant and in particular moisture-impermeable coating. This can be done in accordance to well-established ISO standards, in particular those for Class 5 protection in marine environments, which offer protection for 20 years and more. Here, the stator is provided with Thermally Sprayed Aluminium, a coating well-known for components used in the off-shore industry. If desired, a sealant may be applied on top of the TSA layer for even better protection against corrosion.

Fig. 3 shows part of the stator 111, and in particular a section of the stack of arcuate laminates 110 under compression between a front plate 161 and a back plate 162. A threaded tension rod 171 is with its threaded end inserted in a threaded hole of the back plate 162, and at the other end of the tension rod 171 a nut 172 has been provided. Hydraulic pressure is applied to the tension rod 171 while the nut 172 is being tightened.

The back plate 162 has a sandwich structure and more specifically a nose 163 to create room (circular space 164) for the end turns of the copper windings 207 around the teeth 130 shown in fig. 2 (this figure doesn't show the windings 207 but this is well known to the person skilled in the art). Also at the front end there is a circular space 165 for this purpose.

The back plate 162 is rigidly connected to a carrier cone 165, which in turn is rigidly connected with the inner bearing ring 197 of a bearing 166 (schematically shown). The outer bearing ring 196 of the bearing 166 is rigidly connected to a first rotor flange 167. To ensure rigidity of the rotor 109, there is a second flange 170 parallel to the first rotor flange 167 that is connected to the second rotor flange 170 by a stiffening plate 293. At its outer circumference, the rotor 109 is provided with magnets 168. The inner circumference of the second flange 197 is used as an annular brake disk 169 (braking callipers not shown). There is an air gap at 181 between the inner circumference of the annular break disk 169 and the carrier cone 165. The rotor 109 and the stator 111 are separated by a small air gap 281

The gap 211 between housing member 201 and the bearing section 166 is preferably provided with a seal 202, as is known in the art.

While several components of the generator 105 have been discussed, and steps in the manufacture thereof have been indicated (such as creating the stack of arcuate laminates), it is remarked that both these components and these steps are known. The invention differs in the presence of the arcuate laminations having protrusions for direct cooling of the stator to the atmosphere.

C O N C L U S I E S

1. Windturbine van het horizontale as, direct-aangedreven type, waarbij de windturbine omvat

- een naaf voorzien van een of meer bladen,
- een generator met een hartlijn die technisch horizontaal is, waarbij de generator een inwendige rotor die door de naaf wordt aangedreven en een buitenste stator omvat, waarbij de stator een voorplaat, een achterplaat en gestapelde, boogvormige laminaten omvat, **met het kenmerk**, dat de voorplaat en de achterplaat door trekstangen zijn verbonden voor het vormen van een stator-eenheid waarbij de gestapelde, boogvormige laminaten tussen de achterplaat en de voorplaat zijn geklemd, en waarbij de boogvormige laminaten uitsteeksels over de omtrek van de stator bezitten voor het dissiperen van warmte naar de atmosfeer.

2. Windturbine volgens conclusie 1, waarbij de uitsteeksels van de gestapelde aanliggende laminaat-segmenten in register zijn, onder vorming van ribben.

3. Windturbine volgens een der voorgaande conclusies, waarbij het buitenoppervlak van de stator is bedekt met een voor water ondoordringbare beschermende coating.

4. Windturbine volgens een der voorgaande conclusies, waarbij de boogvormige segmenten ten minste een doorgaand gat bezitten, en de trekstangen door de doorgaande gaten gaan.

5. Windturbine volgens een der voorgaande conclusies, waarbij de achterplaat een sandwichstructuur bezit.

6. Windturbine volgens een der voorgaande conclusies, waarbij de hartlijn van de generator een hoek van >2° ten opzichte van de horizontaal maakt.

7. Direct-aangedreven generator welke een inwendige rotor en een buitenste stator omvat, waarbij de stator een voorplaat, een achterplaat

en gestapelde boogvormige laminaten omvat, **met het kenmerk**, dat de voorplaat en de achterplaat zijn verbonden door trekstangen voor het vormen van een stator-eenheid waarbij de gestapelde boogvormige laminaten tussen de achterplaat en de voorplaat zijn geklemd, waarbij de boogvormige laminaten uitsteeksels over de omtrek van de stator bezitten voor het dissiperen van warmte naar de atmosfeer.

Fig. 1

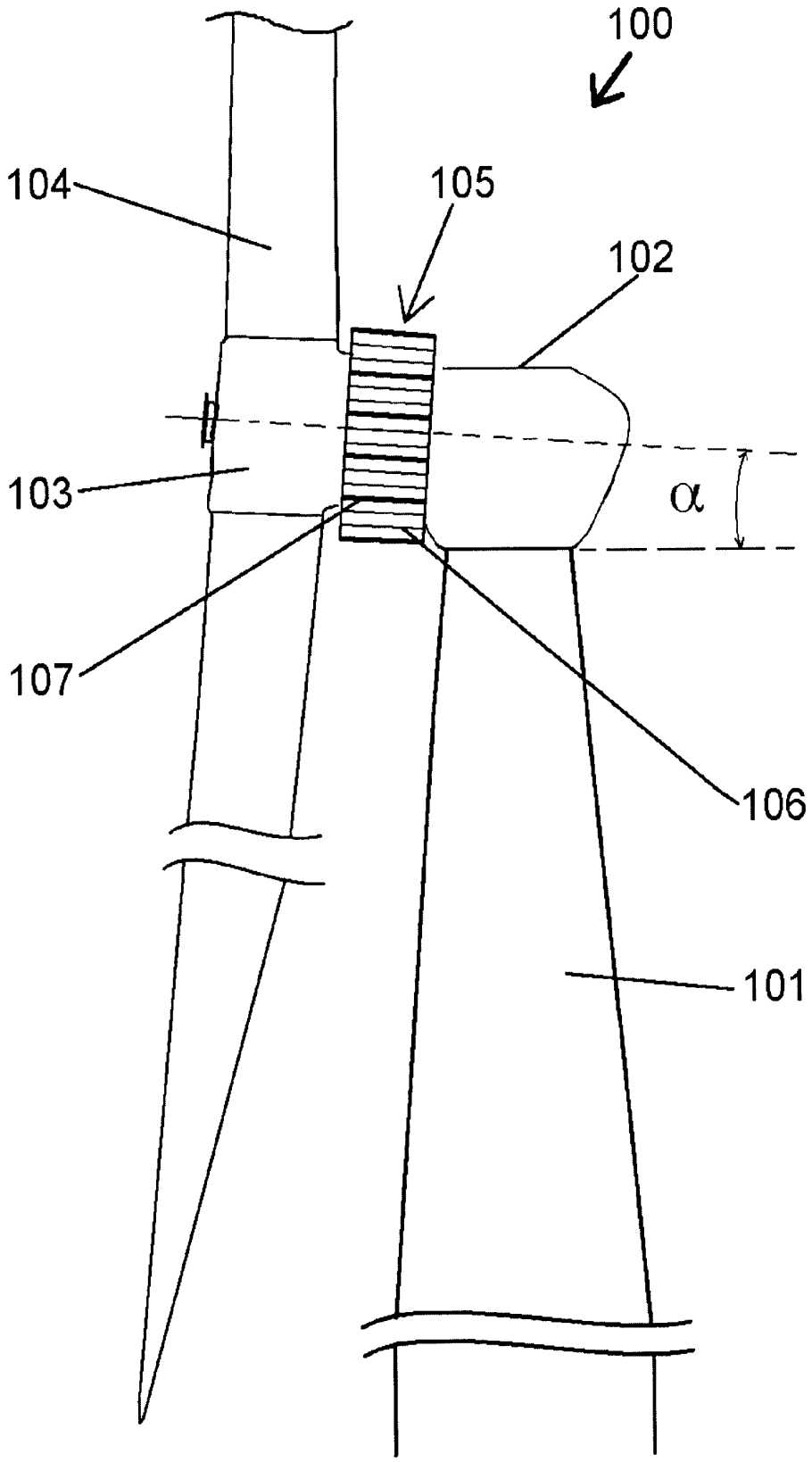


Fig. 2

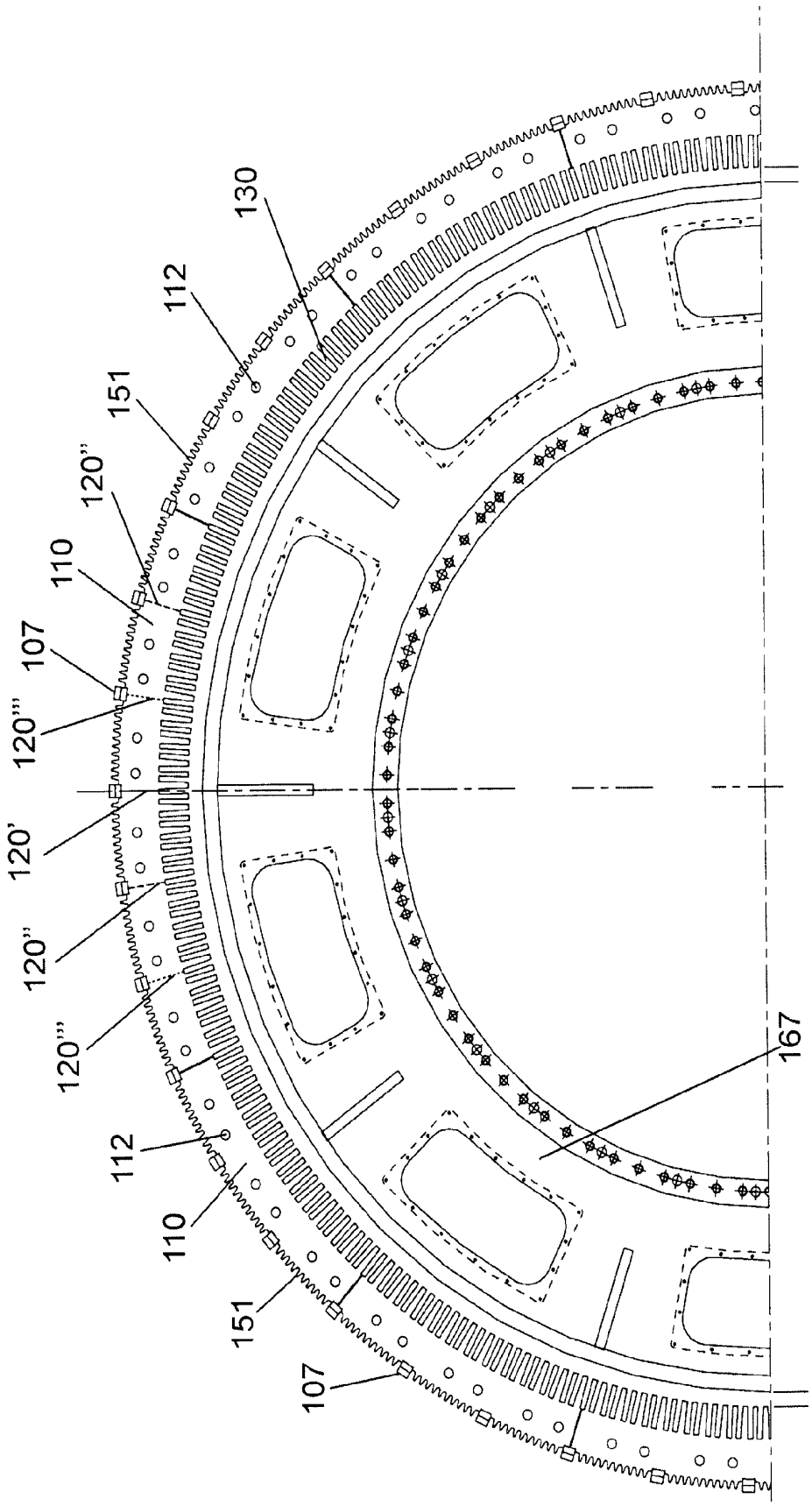
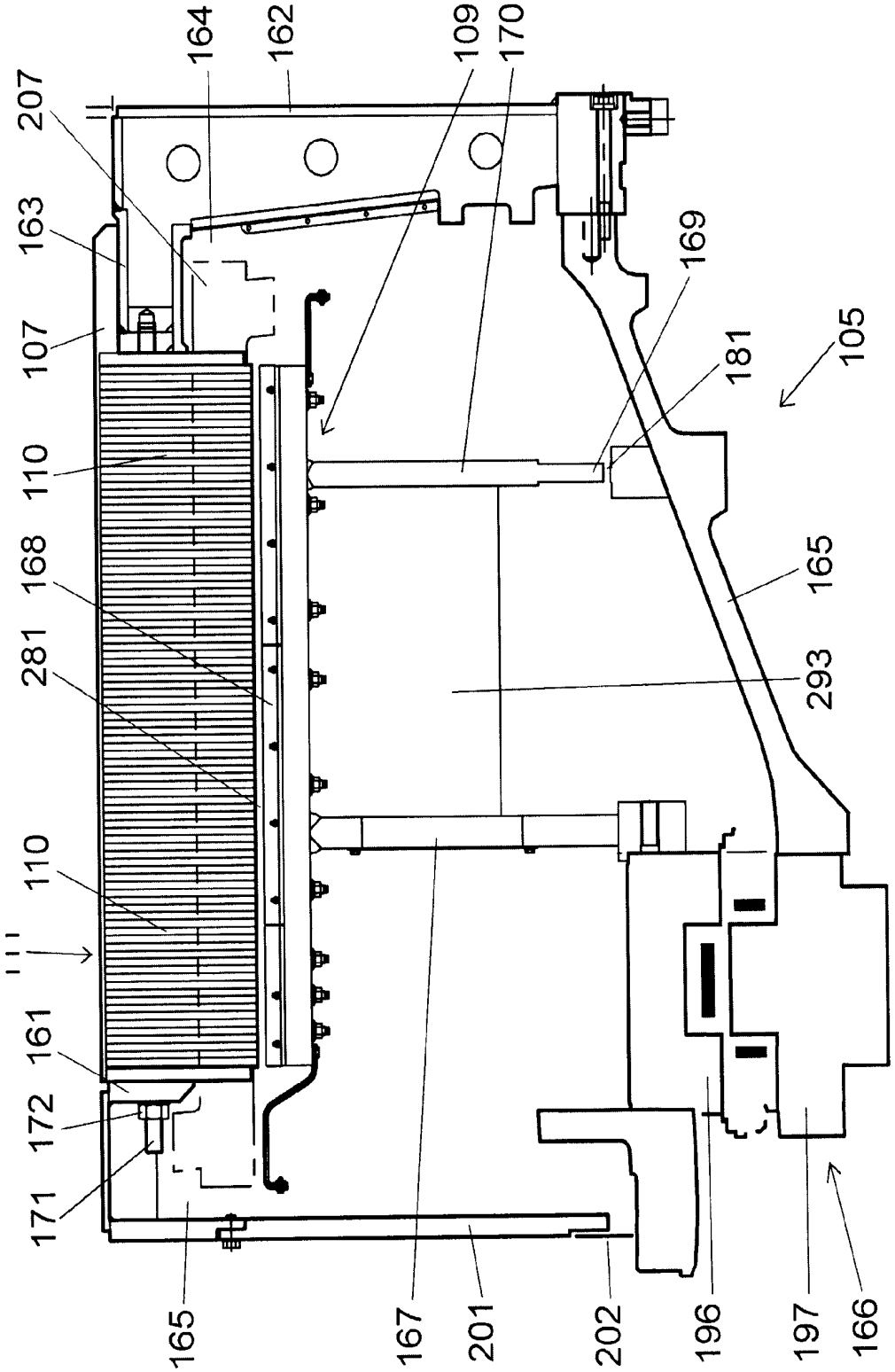


Fig. 3


164
162
109
170
207
163
169
107
181
105
110
168
165
281
293
110
III
161
172
171
165
167
201
202
196
197
166

OCTROOICENTRUM NEDERLAND

OCTROOIAANVRAAG NR.:
NO 136532
NL 1036733

ONDERZOEKSRAPPORT

BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

RELEVANTE LITERATUUR

Categorie[1]	Literatuur met, voor zover nodig, aanduiding van speciaal van belang zijnde tekstgedeelten of figuren.	Van belang voor conclusie(s) nr:	Classificatie (IPC)
E	WO 2009/091248 A (LAGERWEY WIND BV [NL]; LAGERWEIJ HENDRIK LAMBERTUS; PUBANZ ANDRE HEINZ) 23 juli 2009 (2009-07-23) * het gehele document * -----	1-4,7	INV. H02K1/16 H02K1/20 H02K7/18 H02K9/14
Y	WO 02/095222 A (WOBBEN ALOYS [DE]) 28 november 2002 (2002-11-28) * bladzijde 3, alinea 1 - bladzijde 4, alinea 1; figuur 1 * -----	1-5,7	F03D9/00 ADD. H02K9/02
Y	JP 58 192453 A (OKUMA MACHINERY WORKS LTD) 9 november 1983 (1983-11-09) * samenvatting; figuren 3,4 * -----	1-5,7	
A	FR 2 793 084 A (VALEO EQUIP ELECTR MOTEUR [FR]) 3 november 2000 (2000-11-03) * bladzijde 1, regel 21 - bladzijde 2, regel 5 * * bladzijde 2, regel 15 - regel 17 * * bladzijde 3, regel 21 - bladzijde 4, regel 24; figuren 1,4 * -----	1-3,7	
A	JP 60 204236 A (MATSUSHITA ELECTRIC IND CO LTD) 15 oktober 1985 (1985-10-15) * figuren 1,2,6,7 * -----	1,7	
Y,D	CN 101 222 159 A (XIANGTAN ELECTRIC MFG CO LTD [CN]) 16 juli 2008 (2008-07-16) * samenvatting; figuur * -----	1-5,7	

-/--

Onderzochte gebieden van de techniek

H02K
F03D

Indien gewijzigde conclusies zijn ingediend, heeft dit rapport betrekking op de conclusies ingediend op:

Plaats van onderzoek:	Datum waarop het onderzoek werd voltooid:	Bevoegd ambtenaar:
's-Gravenhage	26 November 2009	Zanichelli, Franco

[1] CATEGORIE VAN DE VERMELDE LITERATUUR

X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur
Y: de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht
A: niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft
O: niet-schriftelijke stand van de techniek
P: tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur
T: na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
E: eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven
D: in de octrooiaanvrage vermeld
L: om andere redenen vermelde literatuur
&: lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

EOB FORM 02.83 (P0414B)

RELEVANTE LITERATUUR

Categorie[1]	Literatuur met, voor zover nodig, aanduiding van speciaal van belang zijnde tekstgedeelten of figuren.	Van belang voor conclusie(s) nr:
Y	EP 1 641 102 A (GEN ELECTRIC [US]) 29 maart 2006 (2006-03-29) * alinea [0014]; figuren 1,2 *	1-5,7
Y	US 2006/284511 A1 (EVON STEVE T [US] ET AL) 21 december 2006 (2006-12-21) * alinea [0004] - alinea [0008] * * alinea [0014] - alinea [0017] * * alinea [0022] - alinea [0025]; figuren *	1-5,7
A	WO 00/74214 A (ABB AB [SE]; LEIJON MATS [SE]; GERTMAR LARS [SE]) 7 december 2000 (2000-12-07) * bladzijde 14, regel 26 - bladzijde 15, regel 31; figuur 5 *	1,3
A	DE 18 08 577 A1 (CEM COMP ELECTRO MEC) 14 augustus 1969 (1969-08-14) * bladzijde 4, regel 1 - bladzijde 5, regel 6; figuren 1,2 *	1,7
A	EP 1 988 282 A (TORRES DISENOS IND S A U M [ES]) 5 november 2008 (2008-11-05) * figuur 6 *	1,7

[1] CATEGORIE VAN DE VERMELDE LITERATUUR

X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur
Y: de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht
A: niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft
O: niet-schriftelijke stand van de techniek
P: tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur
T: na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
E: eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven
D: in de octrooiaanvrage vermeld
L: om andere redenen vermelde literatuur
&: lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK, UITGEVOERD IN DE OCTROOIAANVRAGE NR.

NO 136532
NL 1036733

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octrooifamilie), die overeenkomen met octrooischriften genoemd in het rapport.
De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per
De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door het Bureau voor de Industriële eigendom gegarandeerd; de gegevens worden verstrekt voor informatiedoeleinden.

26-11-2009

In het rapport genoemd octrooigeschrift		Datum van publicatie	Overeenkomend(e) geschrift(en)		Datum van publicatie
WO 2009091248	A	23-07-2009	NL	2001190 C1	20-07-2009
WO 02095222	A	28-11-2002	AT	335927 T	15-09-2006
			AU	2002256732 B2	27-04-2006
			BR	0209683 A	14-09-2004
			CA	2446632 A1	28-11-2002
			CN	1599839 A	23-03-2005
			DE	10124268 A1	28-11-2002
			DK	1395752 T3	27-11-2006
			EP	1395752 A1	10-03-2004
			ES	2266491 T3	01-03-2007
			JP	3862659 B2	27-12-2006
			JP	2004525600 T	19-08-2004
			NO	20035126 A	17-11-2003
			NZ	529356 A	29-07-2005
			PT	1395752 E	30-11-2006
			US	2004179934 A1	16-09-2004
			ZA	200308882 A	17-02-2004
JP 58192453	A	09-11-1983	GEEN		
FR 2793084	A	03-11-2000	GEEN		
JP 60204236	A	15-10-1985	GEEN		
CN 101222159	A	16-07-2008	GEEN		
EP 1641102	A	29-03-2006	CN	1756051 A	05-04-2006
			US	2006066110 A1	30-03-2006
US 2006284511	A1	21-12-2006	WO	2007002216 A1	04-01-2007
WO 0074214	A	07-12-2000	AU	5261900 A	18-12-2000
			CA	2375426 A1	07-12-2000
			CN	1357165 A	03-07-2002
			EP	1186089 A1	13-03-2002
			JP	2003501996 T	14-01-2003
			NO	20015788 A	27-11-2001
			SE	9901919 A	28-11-2000
DE 1808577	A1	14-08-1969	BE	723017 A	01-04-1969
			FR	1550471 A	20-12-1968
			NL	6816279 A	20-05-1969
EP 1988282	A	05-11-2008	US	2008265585 A1	30-10-2008

Algemene informatie over dit aanhangsel is gepubliceerd in de 'Official Journal' van het Europees Octrooibureau nr 12/82 blz 448 ev

OCTROOICENTRUM NEDERLAND

SCHRIFTELIJKE OPINIE

DOSSIER NUMMER	INDIENINGSDATUM	VOORRANGSDATUM	AANVRAAGNUMMER
NO136532	19.03.2009		NL1036733

CLASSIFICATIE
INV. H02K1/16 H02K1/20 H02K7/18 H02K9/14 F03D9/00
ADD. H02K9/02

AANVRAGER
Darwind Holding B.V. te Utrecht

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

- ☒ Onderdeel I Basis van de schriftelijke opinie
- ☐ Onderdeel II Voorrang
- ☐ Onderdeel III Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
- ☐ Onderdeel IV De aanvraag heeft betrekking op meer dan één uitvinding
- ☒ Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid
- ☒ Onderdeel VI Andere geciteerde documenten
- ☐ Onderdeel VII Overige gebreken
- ☒ Onderdeel VIII Overige opmerkingen

DE BEVOEGDE AMBTENAAR
Zanichelli, Franco

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL1036733

Onderdeel I Basis van de Schriftelijke Opinie

1. Deze schriftelijke opinie is opgesteld op basis van de meest recente conclusies ingediend voor aanvang van het onderzoek.

2. Met betrekking tot **nucleotide en/of aminozuur sequenties** die genoemd worden in de aanvraag en relevant zijn voor de uitvinding zoals beschreven in de conclusies, is dit onderzoek gedaan op basis van:

   a. type materiaal:

   ☐ sequentie opsomming

   ☐ tabel met betrekking tot de sequentie lijst

   b. vorm van het materiaal:

   ☐ op papier

   ☐ in elektronische vorm

   c. moment van indiening/aanlevering:

   ☐ opgenomen in de aanvraag zoals ingediend

   ☐ samen met de aanvraag elektronisch ingediend

   ☐ later aangeleverd voor het onderzoek

3. ☐ In geval er meer dan één versie of kopie van een sequentie opsomming of tabel met betrekking op een sequentie is ingediend of aangeleverd, zijn de benodigde verklaringen ingediend dat de informatie in de latere of additionele kopieën identiek is aan de aanvraag zoals ingediend of niet meer informatie bevatten dan de aanvraag zoals oorspronkelijk werd ingediend.

4. Overige opmerkingen:

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL1036733

Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid

1. Verklaring

Nieuwheid	Ja:	Conclusies 1-7
	Nee:	Conclusies
Inventiviteit	Ja:	Conclusies 6
	Nee:	Conclusies 1-5,7
Industriële toepasbaarheid	Ja:	Conclusies 1-7
	Nee:	Conclusies

2. Citaties en toelichting:

Zie aparte bladzijde

Onderdeel VI Andere geciteerde documenten

☒ Andere geciteerde openbaarmakingen

Zie aparte bladzijde

☐ Niet schriftelijke openbaarmakingen

Onderdeel VIII Overige opmerkingen

De volgende opmerkingen met betrekking tot de duidelijkheid van de conclusies, beschrijving, en figuren, of met betrekking tot de vraag of de conclusies nawerkbaar zijn, worden gemaakt:

Zie aparte bladzijde

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: WO 02/095222 A (WOBBEN ALOYS [DE]) 28 november 2002 (2002-11-28)

D2: JP 58 192453 A (OKUMA MACHINERY WORKS LTD) 9 november 1983 (1983-11-09)

D3: FR-A-2 793 084 (VALEO EQUIP ELECTR MOTEUR [FR]) 3 november 2000 (2000-11-03)

D4: JP 60 204236 A (MATSUSHITA ELECTRIC IND CO LTD) 15 oktober 1985 (1985-10-15)

D5: CN 101 222 159 A (XIANGTAN ELECTRIC MFG CO LTD [CN]) 16 juli 2008 (2008-07-16)

D6: EP-A-1 641 102 (GEN ELECTRIC [US]) 29 maart 2006 (2006-03-29)

D7: US 2006/284511 A1 (EVON STEVE T [US] ET AL) 21 December 2006 (2006-12-21)

D8: WO 00/74214 A (ABB AB [SE]; LEIJON MATS [SE]; GERTMAR LARS [SE]) 7 December 2000 (2000-12-07)

D9: DE 18 08 577 A1 (CEM COMP ELECTRO MEC) 14 augustus 1969 (1969-08-14)

D10: EP-A-1 988 282 (TORRES DISENOS IND S A U M [ES]) 5 november 2008 (2008-11-05)

1. **Introductory remarks.**

The present application does not appear to meet the criteria of patentability, because the subject-matter of claims 1-5, 7 does not appear to involve an inventive step, the reasons being as follows.

2. **Independent claim 7, dependent claim 1.**

It is noted that since claim 1 comprises all the features of claim 7, it should be reformulated as a claim dependent on the latter.

2.1 Inventive step (document D1 as closest state of the art).

a. The document D1 is regarded as being the closest prior art to the subject-matter of claims 1 and 7 and discloses (the references in parentheses applying to this document): a wind turbine of the horizontal axis, direct-drive type, wherein the wind turbine comprises:
- a hub (12) provided with one or more blades (11),
- a generator with a centerline that is horizontal, the generator comprising an inner rotor (18) which is driven by the hub (12) and an outer stator (16).

The stator of the generator from D1 although not described in details, because of its size has to consist of arcuate laminates. The same stator is clearly not supported by an external supporting shell (see e.g. the abstract or page 3, paragraphs 1 - 4) and therefore has to be supported by a structure that is positioned axially behind it, between the stator itself (16) and the rear part (14) of the nacelle.
In other words, although not explicitly described, the stator of the generator of D1 must consist of a rigid self supporting unit like the one claimed in the application, and the by far most likely way to achieve this result is to use the very well known type of construction proposed in the application and very well known in many type of machines of any shape and size and consisting of pressing the lamination package between two plates by means of bolts (see e.g. among many others documents D6 figure 2, document D9 figures 1, 2, or even document D7, the bolts 71, in the holes 61, the plates 54 and the end shields 14, 16).

b. The subject-matter of claims 1 and 7 therefore differs from this known stator in that:
- the arcuate laminates have protrusions over the circumference of the stator for dissipating heat to the atmosphere.

c. The problem to be solved by the present invention may therefore be regarded as how to improve the cooling of the generator (the problem of reducing the weight of the generator being already been solved by the stator of document D1, in which the supporting shell has been replaced by a much lighter, e.g. aluminium, cover element (20), which has only the function of protecting the generator and transmitting the heat to the atmosphere.

d. The skilled person which is faced with the above problem is expected to take into consideration prior art publications in the field of electric machine cooling and will

therefore have knowledge of documents like e.g. D2, D3, D7, describing (among many others) the very common solution of improving the cooling of an electric machine by eliminating part of the outer housing and by building cooling fins directly by punching protrusions in the outer periphery of the stator laminations, which are exposed to a cooling medium, e.g. the air surrounding the machine (see e.g. D2, abstract and figures 3, 4; D3, page 1 line 21 - page 2 line 5, page 4 lines 3-24, figures 1, 3; D7, paragraphs 14-17, figures).

e. The skilled person would therefore solve said problem by applying the solution of e.g. documents D2, D3, D7 to the generator described in document D1 thus obtaining generator / wind turbine which correspond to that claimed in claims 1 and 7.
It is therefore apparent that the subject matter of claims 1 and 7 does not involve an inventive step.

2.2 Inventive step (document D5 as closest state of the art).
Similar conclusions can be reached if document D5 is considered as the closest state of the art.

a. Document D5, as acknowledged by the applicant, discloses a generator with all the features of the preamble of claims 1 or 7.

b. From which the subject-matter of claims 1 and 7 differs in that:
b.1 the front plate and the back plate are connected by tension rods so as to form a stator unit with the stacked, arcuate laminates being sandwiched between the back plate and the front-plate under compression,
b.2 the arcuate laminates have protrusions over the circumference of the stator for dissipating heat to the atmosphere.

c. There are different technical effects associated with these differences and namely:
c.1 the elimination of the need of an outer supporting member for the stator (because the stator is rigid enough to be supported by a side);
c.2 an improved cooling of the stator which is in direct contact with the atmosphere.

d. The combined technical effect c.1 plus c.2 does not seem to differ from the mere

sum of the separate technical effects, c.1 and c.2, of the individual features b.1 and b.2.
Said features have therefore to be considered merely as a juxtaposition and not a as combination of features (a combination implying a synergistic effect, in this case absent, due to the combined presence of the individual features b.1 and b.2).

e. It is apparent form the point c. above that the objective technical problem to be solved according to the present invention must be regarded as an aggregation of two "partial problems", independently solved by the above mentioned different sets of distinguishing features, and namely:

e.1 how to reduce the weight of the stator and its supporting structures;

e.2 how to improve the cooling of the stator.

f. The skilled person which is faced with the above mentioned problems is expected to take into consideration prior art publications in the field of the manufacturing of stators of electrical machines and will therefore have knowledge respectively of:

f.1 document D6 describing (the references in parentheses applying to this document cf. figure 2) a stator for wind turbine direct driven generator wherein the stator is made by using the very common technique (see also point 2.1.a above) of clamping the laminations (66) between two plates (82) by means of tension rods (68);

f.2 documents D2, or D3, or D7 each describing (see also point 2.1.d above) laminations with protuberances for improving the cooling.

g. Since the documents D6 and D2, or D3, or D7 clearly solve the objective problems referred to respectively at point 2.2.e.1 and 2.2.e.2 above, the skilled person would therefore solve said problems by applying the corresponding features in the generator of D5 thus obtaining a turbine / generator which corresponds to that claimed in claims 1 and 7.
Since the subject matter of claims 1, 7 seems to merely consist of a juxtaposition of features (see point 2.2.d above), and that said separate features taken by themselves appear to be known and obvious the whole subject matter of claims 1 and 7 appears to be obvious and therefore not to involve an inventive step.

3. Dependent claims 2-5.

Dependent claims 2-5 do not seem to contain any features which, in combination with the features of any claim to which they refer, meet the requirements of patentability with respect of inventive step, the reasons being as follows.

a. Claim 2: the protuberances of documents D2 and D7 at least are aligned to form a cooling rib.
b. Claim 3: a coating on the exposed laminations to protect the core from corrosion is clearly an obvious feature and it is explicitly mentioned in D3 (page 2, lines 15-17) or in D8 (page 15, second paragraph), which describes a generator for a wind turbine directly exposed to the wind.
c. Claim 4: the features of this claim are always present in stators clamped with bolts (see e.g. D6, figures 2, 6; D7, figure 4; D9, figures 1, 2).
d. Claim 5: the use of sandwich structures in order to reduce the weight is clearly an obvious, per se well known feature.

4. Dependent claim 6.

The combination of the features of dependent claim 6 with the features of claim 1 and 3 is neither known from, nor rendered obvious by, the available prior art.
It therefore appears that it would require more than an obvious modification of the prior art teachings to arrive to the invention defined by the combination of said features that thus appear to involve an inventive step.

Re Item VI
Certain documents cited

Certain published documents

Application No Patent No	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date *(valid claim)* *(day/month/year)*
WO2009091248	23.07.2009	15.01.2009	16.01.2008

Re Item VIII

Certain observations on the application

1. the expression *"technisch horizontaal"* should be defined also in claim 1 (as it is in the description on page 2).

2. In claim 1 the expression *"...voor het dissiperen van warmte naar de atmosfeer..."* does not seem to necessarily imply that the stator of the generator is in fact exposed to the atmosphere (for example a flux of air could be directed inside the nacelle on the stator periphery, see e.g. document D3, figure 2).
   Since it appears that the exposed periphery of the stator is an essential feature of the invention, this feature should be explicitly mentioned in claim 1.