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Datasheet for the decision of 21 April 2008

Case Number: T 1273/05 - 3.5.02

Application Number: 98118195.1

Publication Number: 0917278

IPC: H02K 9/06

Language of the proceedings: EN

Title of invention:
Alternator for vehicle

Patentee:
Denso Corporation

Opponent:
Valeo Equipements Electriques Moteur

Headword:
-

Relevant legal provisions:
EPC Art. 56, 84, 100

Relevant legal provisions (EPC 1973):
-

Keyword:
"Inventive step - yes"

Decisions cited:
T 0030/87

Catchword:
see point 5.2 of the reasons

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1273/05 - 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 21 April 2008

Appellant: (Opponent)
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Respondent: (Patent Proprietor)
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Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office posted 25 July 2005 concerning maintenance of European patent No. 0917278 in amended form.

Composition of the Board:

Chairman: M. Ruggiu
Members: G. Flyng
H. Preglau

Summary of Facts and Submissions

I. The opponent appealed against the interlocutory decision of the opposition division that, account being taken of the amendments made by the patent proprietor during the opposition proceedings, the patent and the invention to which it relates were found to meet the requirements of the EPC. The opposition division considered that the patent could be maintained in the following version:

- Description:
  - columns 1 to 4 received during the oral proceedings of 15 June 2005;
  - columns 5 to 12 of the patent specification;
- Claims:
  - nos. 1 to 4 received during the oral proceedings of 15 June 2005;
- Drawings:
  - figures 1 to 13 of the patent specification.

II. Using the feature numbering established in the interlocutory decision, claim 1 of the patent as maintained by the opposition division specifies:

"An alternator for a vehicle, comprising:

1) a stator (2) including a stator iron core (32) and a stator winding,

2) the stator iron core (32) having a plurality of slots (35),

3) the stator winding being provided on the stator iron core (32) and extending in the slots (35),

4) the stator winding forming coil end groups (31a, 31b) at two ends of the stator iron core (32) in an axial direction; and

5) a rotor (3) including a set of field iron cores (7) and a cooling fan (12, 13),

6) the field iron cores (7) being opposed to and located inward of the stator (2),

7) the field iron cores (7) having magnetic pole claws,

8) the cooling fan (12, 13) being located at an end of one of the field iron cores (7) in an axial direction;

9) wherein 70% or more of an axial-direction height of one of the coil end groups (31a, 31b) which is located radially outward of the cooling fan (12, 13) overlaps the cooling fan with respect to a radial direction;

10) wherein a wind flow passage through which a cooling wind generated by the cooling fan passes is formed in the one of the coil end groups (31a, 31b);

11) wherein the one of the coil end groups (31a, 31b) has inclined portions extending slant with respect to an axial direction, and the wind flow passage is formed between the inclined portions; and

12) wherein an outside diameter of the cooling fan (12, 13) is between 90% and 96% of an outermost diameter of the field iron cores (7) of the rotor (3)."

Claims 2 to 4 are dependent on claim 1.

III. The statement of grounds of appeal was filed in three parts, a letter dated 25 November 2005 and two letters both dated 28 November 2005. The statement of grounds of appeal mentioned the following documents:

D7: US-A-5 233 255 (3 August 1993)

D8: US-A-5 543 676 (6 August 1996)

D9: DE-A-40 31 276 (9 April 1992)

D10: US-A-2 928 963 (15 March 1960)

D11: US-A-2 407 935 (25 May 1944)

D15: JP-A-6 121 497 (28 April 1994) (with translation in French)

D16: JP-A-7 222 415 (18 August 1995) (with abstract in English and a "machine translation" in English)

D20: FR-A-1 467 310 (27 January 1967)

C5: Bosch "Automotive electric/electronic systems", 1994

C8: Bosch "Compact liquid cooled Alternator" 6. Aachener Kolloquium, Fahrzeug- und Motorentechnik, 20.-22.10.1997

Cl0: "Électrotechnique à l'usage des ingénieurs", A. Fouille (1952)

C11: "Machines Synchrones", A. Guilbert, (1965)

C12: "Handbuch der Wickeltechnik elektrischer Maschinen", C. Bala et al., (1961)

A1: BOSCH, Baureihe B, Compakt-Generatoren, Typ GCB, KCB, NCB (according to the appellant 1977)

A2: BOSCH EQUIPEMENTS, Véhicule: PORSCHE / Boxster 2.5i / <986> / 1996 (date 21.06.02, time 11:39:29)

A3: BOSCH INFORMATION VEHICULE, Modèle Porsche Boxster 2.5i (date 21.06.02, time 11:25:01)

A4: BOSCH EQUIPEMENTS, Véhicule: PORSCHE / Boxster 2.5i / <986> / 1997 (date 21.06.02, time 11:33:51)

A5: Porsche Boxster 2.5, internet printout from WWW.automobile-sportive.com (28/11/2005)

A6: BOSCH ESI[tronic] Electronic Service Information, Pièces détachées, Produit 0 124 515 001 Alternateur NCB1 (>) 14V 70/120A, (02/07/2002, 12:31:24)

A7: BOSCH ESI[tronic] Electronic Service Information, Utilisation: Pièce -> produit, F 00M 131 607 - Rotor (02/07/2002, 12:34:09)

A8: BOSCH ESI[tronic] Electronic Service Information, Utilisation: produit -> véhicule, Utilisation pour 0 124 515 001 - Alternateur (02/07/2002, 12:33:09)

A9: computer screen print showing "Boxster 2.5i" "Année de fabric. 10.96"

A10: Valeo Dossier no. 114, Etude no. 3657, Date Arrivée 04/11/96, BOSCH NCB1, 120A, reference 0 124 515 001

IV. The documents A1 to A10 were cited for the first time in the statement of grounds of appeal.

V. In the statement of grounds of appeal, the appellant did not contest the novelty of claim 1, but argued that claim 1 lacked an inventive step with respect to:

- document D8 combined with the general knowledge of the skilled person as demonstrated by documents A1 to A10, C10, C11, D9, D10 and D20;
- document D15 combined with document D16; or
- document D7 combined with the general knowledge of the skilled person.

VI. The respondent, proprietor of the patent, replied to the statement of grounds of appeal with a letter dated 18 April 2006. The respondent argued that the important features of an alternator in accordance with the opposed patent were:

a) a high percentage of overlap of the axial dimension of the coil end groups on the one side and of the cooling fan output, on the other side (feature 9);

b) cooling air flow passages in the coil end groups (feature 10);

c) a stator winding structure with inclined portions of the conductors of the coil end groups slant with respect to the axial direction with the wind flow passages being formed between said inclined portions (feature 11); and

d) an outside diameter of the cooling fan approximately between 90 % and 96 % of the outside diameter of the rotor (feature 12).

The respondent explained the combinative effect of these features as being that the comparatively high overlap in axial direction of the coil end groups and the fan output as well as providing air flow passages in the coil end groups, of course, served for an improved cooling of the coil end groups, as did a comparatively close distance between the fan and the coil end groups to be cooled. The high overlap percentage in axial direction between the coil end groups and the cooling fan output and a comparatively small distance between the cooling fan output and the axially overlapping coil end groups, however, might let one expect an increased siren-effect or fan noise as the price to be paid for the improved cooling effect. However, quite unexpectedly, by combining the special structure of the coil end groups having a plurality of conductor slant portions crossing each other and forming practically a grid in shape of a hollow cylinder surrounding the fan output supplying a high speed cooling air flow in all radial directions, the

siren effect was remarkably reduced while maintaining the improved cooling effect of this design.

The respondent analysed the documents cited by the appellant and refuted the appellant's arguments that claim 1 lacked an inventive step.

VII. Thereafter, the board summoned the parties to oral proceedings. In an annex to the summons the board considered all of the various documents submitted by the appellant and noted that document D16 seemed to constitute the most relevant state of the art, as it was the only document which clearly disclosed features 1 to 8, 10 and 12.

VIII. With a further letter dated 20 March 2008 the appellant referred to a number of further documents that had been cited in the proceedings before the opposition division, in particular:

D2: US-A-5 097 167 (17 March 1992)
D12: JP-A-57-3540 (09 January 1982)
D13: US-A-1 822 261 (08 September 1931)
D14: SU-A-1 377 964 (29 February 1988)

IX. Oral proceedings were held before the board on 21 April 2008. During the oral proceedings the respondent filed an amended column 12 (page 7 of the description).

X. The appellant argued during the oral proceedings that claim 1 lacked clarity and support in the description (Article 84 EPC) because:

– Feature 1 covered both a continuously wound winding and a segmented winding, whereas in the

embodiments the windings described were always segmented and never continuously wound.

– Feature 12 specified the outside diameter of only one cooling fan. Thus claim 1 covered alternators having:
  – 2 fans, both of which fulfil the specified diameter requirement;
  – only one fan, which fulfils the specified diameter requirement; and
  – 2 fans, only one of which fulfils the specified diameter requirement.

  This latter alternative was not supported by the description.
– Paragraph [0044] of the patent (EP 0 917 278 B1) contradicted feature 11 of claim 1.

Furthermore, the appellant accepted document D16 as closest prior art and argued that claim 1 lacked an inventive step with respect to both:

– document 16 combined with document D15; and
– document D16 combined with documents D8 and D2.

XI. The appellant (opponent) requested that the decision under appeal be set aside and that the European patent No. 0917278 be revoked.

XII. The respondent (patentee) requested that the decision under appeal be set aside and the patent be maintained in the version as upheld by the opposition division with the exception that column 12 of the description be replaced by the version filed during the oral proceedings of 21 April 2008.

Reasons for the Decision

1. The appeal is admissible.

2. The patent in suit as maintained by the opposition division is concerned with "*a compact, high-power, and low-noise alternator for a vehicle*" (column 1, lines 22 and 23). As further specified in paragraph [0003], "*one way of enabling a compact design and a high power output of an alternator for a vehicle is to improve the cooling performance of a stator winding which has the greatest heat loss*". According to paragraph [0009] "*it is an object of this invention to provide a compact, high-power, and low-noise alternator for a vehicle which improves the cooling performance of a stator winding, and which reduces fan noise*".

3. **The closest prior art**

3.1 Several of the prior art documents submitted by the appellant could be considered as potential starting points for the assessment of inventive step. In particular, the features 1 to 8 of claim 1 are known from the alternators disclosed in each of the documents D7, D8 and D16 and from the Bosch NCB1 alternator reference 0 124 515 001 as evidenced by documents A1 to A10. However, documents D7, D8 and D16 do not disclose the construction of their stator cores and stator windings in any great detail, such that features 2 and 3 can only be said to be implicitly disclosed therein.

3.2 None of the documents A1 to A10 demonstrates that in the NCB1 alternator 70% or more of the axial height of

one of the stator coil end groups overlaps the cooling fan (feature 9). Furthermore, none of the documents A1 to A10 suggests that the NCB1 alternator comprises wind flow passages in its stator coil end groups (feature 10). As far as can be established from the cover photograph and figure 1 of document A1, the stator winding of the NCB1 alternator is comprised of many turns of wire, which pass through the stator slots and then circumferentially around the ends of the stator core as a bundle. It is not possible to identify "inclined portions" in the sense of feature 11. According to document A10, Valeo measured and recorded that the NCB1 alternator has a rotor external diameter of 103,33 mm, a front fan diameter of 94 mm and a rear fan diameter of 101 mm. These measured values would give fan/core diameter relationships of 90.97% and 97.75%. Thus, at least according to document A10, the NCB1 alternator has a front fan and core which do fulfil the 90% to 96% relationship specified in feature 12.

3.3 In document D8, the focus is on the design of the rotor of the alternator and little specific information is given about the stator. D8 merely states that:
"*FIG. 1 is a side view, of rotor 10 and a partial cross-section of a stator 12 according to one embodiment of the present invention*" (column 2, lines 44 to 46); and
"*Stator 12 is a conventional stator known in the art of alternators*" (column 2, lines 60 and 61).
In the cross-section of figure 1, the stator is depicted rather schematically and no specific features of the stator are identified.

In the contested decision (see paragraph 3.4.1), the opposition division considered that document D8 disclosed feature 9 of claim 1. The board is not convinced that this is the case. In view of the schematic depiction of the stator in figure 1 of D8, the board doubts that the skilled reader would draw any particular conclusion about the axial extent to which the coil end groups overlap with the cooling fan.

Document D8 does not mention a wind flow passage formed in either of the coil end groups of the stator. Neither is any such wind passage implied. Features 10 and 11 of claim 1 are thus not known from D8.

Considering feature 12 of claim 1, it can be observed in figure 1 of D8 that the fans 26 and 28 have a smaller diameter than the rotor cores 14, 16. In the text, however, there is no mention of this feature, or the extent to which the rotor is smaller that the core, or the technical effect achieved. Thus, D8 does not disclose the complete feature 12.

3.4 Document D7 does not mention the axial height of the stator coil end groups or the extent to which they overlap with the cooling fan. It appears from figure 1 of D7 that the fan only overlaps about half of the coil end group, so it cannot be said that D7 discloses feature 9.

Regarding features 10 and 11, figure 1 of D7 does include arrows that are indicative of cooling air flow (see column 3, lines 15 to 19) and these arrows are drawn on top of the outline of the coil end groups of the stator 33. However, this depiction is schematic and

does not necessarily imply the presence of wind flow passages in the coil end groups (feature 10). The detailed construction of the coil end groups is not shown and there is no evidence of "inclined portions" in the sense of feature 11.

Regarding feature 12, it can be seen that in figure 1 of document D7, like in D8, the fans have a smaller outside diameter than the outermost diameter of the field iron cores, but again there is no mention in the text of this feature, its extent or its effect. Hence, the board considers that D7 does not disclose feature 12.

3.5 The abstract and machine translation of document D16, do not mention the axial height of the coil end groups or the extent to which they overlap with the cooling fan. From figure 1 it can be observed, at least with hindsight, that the fans are offset axially from and extend beyond the ends of the coil end groups and that the fans overlap less than half of the coil end groups. Thus, it cannot be said that D16 discloses feature 9.

On the other hand, figure 1 of D16 does show coil end groups 8b, 8c having portions which extend axially from the stator core 8a and portions of roughly oval cross-section, which are marked with a cross, indicating that they are cut-through in the cross-sectional view. This shows that they extend circumferentially. Figure 1 furthermore shows arrows which clearly indicate air flow passages between the stator core 8a and the circumferentially extending oval portions of the coil end groups. Hence, the board considers feature 10 of claim 1 to be known from D16. However here again, there

is no evidence of "inclined portions" in the sense of feature 11.

Considering feature 12, document D16 is very relevant because it specifically mentions the relationship between the diameters of the fan and the core and the effects achieved. In the abstract of D16, the purpose of the invention is stated as being "*to provide an AC generator which can reduce wind noise due to rotation of a centrifugal fan without decreasing the cooling efficiency of the coil end of a stator*". The abstract further states that "*the fans have side plates 13a, 13b at its end and an outer diameter of the fans and the side plates should be 85% or above and 96% or below of the outer diameter of the core 4a*". Thus, feature 12 is disclosed in document D16.

3.6 Document D16 is thus the only cited document which clearly discloses features 1 to 8, 10 and 12 and for this reason the board considers that D16 constitutes the most relevant state of the art for the purposes of assessing inventive step.

4. **Inventive step**

4.1 As set out above, document D16 does not disclose features 9 and 11 of claim 1.

4.2 Feature 11 of claim 1 can be considered in two parts, namely that:

11a) the one of the coil end groups has inclined portions extending slant with respect to an axial direction; and

11b) the wind flow passage is formed between the inclined portions.

4.3 The first of these features describes a structure which is commonly formed in practice when stator windings are formed from stiff linear bars or U-shaped (hairpin) bars. When such bars are mounted on the stator and connected together at their ends, coil end portions have to span between two stator slots and to achieve this they are often formed such that they extend slant with respect to the axial direction. The respondent (patentee) concedes (letter of 18 April 2006, page 6, section IV) that such a coil end group structure, as disclosed in documents C10, C11, D9, D10 and D20, belongs to the prior art and is part of the general knowledge of the person skilled in the art. It is well known in the field of electrical machines that by using such stiff bars to form the stator winding, maximum use can be made of the space available in the stator slots (high fill factor) and therefore high output power can be achieved for a given machine size. Seeking to increase the output power of the alternator of D16 (the objective problem), it would be an obvious matter for the skilled person to replace its bundled, multi-turn winding with a bar winding as known from any of the documents C10, C11, D9, D10 and D20. Thus, the skilled person would come to feature 11a without involving an inventive step.

4.4 However none of the documents C10, C11, D9, D10 and D20 mentions that wind flow passages are formed between the inclined portions (feature 11b) and none of them gives any hint as to the axial height of the coil end groups or the extent to which they overlap with the cooling

fan. Indeed the board has not found an explicit disclosure of feature 9 in any of the documents cited by the appellant.

4.5 The appellant has argued that the skilled person would come to the subject-matter of claim 1 by combining document D16 with document D15.

4.6 Document D15 discloses an improvement on a previously known method for impregnating a stator winding with varnish. According to the French translation of D15 filed by the appellant, it is stated in paragraphs [0003] and [0004] of D15 that the previously known method consisted of taking a stator (3) comprising a bobbin (2) wound on an iron stator core (1), placing it in a bag containing a quantity of varnish and applying a vacuum to the bag so that the varnish impregnates the stator. In paragraph [0006], D15 identifies the problem with the previous method that in the case of a stator as shown in figure 9, in which it is proposed to provide air passages (6) at the winding turns (2a) where they exit the core, the air passages (6) get blocked by the varnish. To overcome this problem D15 proposes in paragraphs [0012] and [0013] to use a band (21) having bosses (26) which are inserted into the air passages (19) at the base of the winding turns as shown in figure 3. The bosses prevent the air passages formed where the winding turns exit the core from being blocked by the varnish.

4.7 Focussing as it does on the method of impregnation of the stator, document D15 gives little information about the construction of the stator winding itself. The only feature of the winding that D15 specifically mentions

is the air passages 19 provided between the windings at the point where they exit from the stator core (see figure 3). Figure 3 of D15 does show a coil end group that has inclined portions extending slant with respect to an axial direction (feature 11a). However, the air passages 19 are not formed between the inclined portions as required by feature 11b.

4.8 It might be argued that a skilled person, having started from the alternator of document D16 and having replaced its bundled, multi-turn winding with a bar winding might look to the teachings of document D15 to improve the ventilation of the bar winding. By such a hypothetical course of action the skilled person might come to the idea to use a band with bosses, during impregnation, to maintain air flow passages where the turns of the bar windings exit the core. However there would be no incentive for the skilled person to go beyond the teachings of D15 and provide air passages between the inclined portions of the winding turns as required by feature 11b. Furthermore, in the absence of air passages between the inclined portions there would be no incentive for the skilled person to arrange the ventilation fan such that it overlaps a large proportion (i.e. 70% or more) of the axial-direction height of the coil end group as required by feature 9.

4.9 For these reasons the board considers that the subject-matter of claim 1 is not obvious in view of the combination of D16 and D15.

4.10 The appellant also argued that the skilled person would come to the subject-matter of claim 1 by combining document D16 with documents D8 and D2. The appellant

referred in particular to figures 12 to 15 of document D2. These show an embodiment of an alternator in which "*the stator coil 52, as shown in FIG. 15, comprises coil conductor segments each having an upper arm 53a and a lower arm 53b branched out from the center of each segment 53 made of a single copper plate*" (column 7, lines 17 to 20). These arms are mounted inside a cylindrical stator core 51. Contrary to features 2 and 3 of claim 1, the D2 stator core is not provided with slots and the conductor segments do not extend in such slots. Rather, "*an iron plate 54 of the same length as the axial length of the stator core 51*" is welded to each arm (column 7, lines 20 to 25).

"*The stator coil 52 ... is provided with a first resin member 57 in spaced relations from the ends at the central part thereof and a second resin member 56 at the ends thereof to prevent the coil segments 53 from coming into contact with each other*" (column 7, lines 40 to 45). "*Further, a coil segment 53 is exposed between the first resin 57 and the second resin 56, and the exposed portion 52a is disposed at a position opposed to the diametrical periphery of a couple of fans 43 fixed on the ends of the pole core 42. The air from the fans 43 cools the exposed portion 52a acting as fin thereby to cool the whole of the stator coil 52 more effectively*" (column 7, lines 48 to 56). From this disclosure it is evident that in D2 wind flow passages are formed in the coil end groups (feature 10). It can be readily seen from figures 13 and 14 however that the portions 52a of the coil end groups that are exposed to form the fins extend parallel to the axial direction. Any portions of coil end groups that are inclined and extend slant with respect to the axial direction are

apparently covered by the first resin member 57. Thus, D2 does not disclose feature 11b. Furthermore, the fans 43 do not overlap with 70% or more of the coil end group (feature 9).

For the above reasons, the board considers that the disclosure of document D2 does not render feature 11b obvious.

4.11 Indeed none of the prior art cited by the appellant discloses feature 11b. The board therefore considers that the subject-matter of claim 1 as maintained by the opposition division is not obvious to the skilled person and thus involves an inventive step in the sense of Article 56 EPC. Claims 2 to 4 are dependent on claim 1, hence their subject-matter is also considered to involve an inventive step.

5. **Clarity and Support, Article 84 EPC.**

5.1 With the exception of some minor corrections of clerical errors and to bring consistency between the claim and the description (paragraphs [0020] and [0021] "set of field iron cores"), present claim 1 amounts to a combination of granted claim 1 (features 1 to 10), granted claim 3 (feature 12) and granted claim 4 (feature 11).

5.2 Clarity and support by the description are not mentioned as allowable opposition grounds in Article 100 EPC. Thus, in the view of the board, objections based on Article 84 EPC are not to be considered if they do not arise out of the amendments made (T 301/87 OJ 1990, 335). In the present case, the

appellant objected under Article 84 EPC that feature 1 covered both a continuously wound winding and a segmented winding and that features 5 and 12 required only one cooling fan having the specified outside diameter. However these features were present in claims 1 and 3 as granted. Hence any objection to lack of clarity or support of these features in present claim 1 that might *arguendo* exist must have existed in claims 1 and 3 as granted and cannot therefore be said to have arisen out of the amendments made.

5.3 Concerning the appellant's argument that paragraph [0044] of the patent in suit contradicts feature 11 of claim 1, the board notes that paragraph [0044] states that "*in the case where the coil end groups are coated with thick films of resin to provide vibration proof, the gaps between the coil ends are absent*" (emphasis added). This statement does not refer to the case described being in accordance with the invention and may be understood as referring to a hypothetical case that is not covered by the invention. For this reason the board considers that the statement in paragraph [0014] does not contradict claim 1 and hence does not render claim 1 unclear, Article 84 EPC.

Order

For the above reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to maintain the patent as amended in the following form:
   - Description:
     - columns 1 to 4 received during the oral proceedings of 15 June 2005;
     - columns 5 to 11 of the patent specification;
     - column 12 received during the oral proceedings of 21 April 2008;
   - Claims:
     - nos. 1 to 4 received during the oral proceedings of 15 June 2005;
   - Drawings:
     - figures 1 to 13 of the patent specification.

The Registrar: The Chairman:

U. Bultmann M. Ruggiu