BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS | BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE | CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 10 October 1996

Case Number: T 0779/94 - 3.5.2

Application Number: 84114880.2

Publication Number: 0300063

IPC: H02K 9/06

Language of the proceedings: EN

Title of invention:
An alternative current generator with a voltage regulator unit for use in vehicles

Patentee:
NIPPONDENSO CO.,LTD.

Opponent:
Valeo Equipements Electroniques Moteurs

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no; obvious aggregate of known features to solve separate problems)"

Decisions cited:
-

Catchword:
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0779/94 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 10 October 1996

Appellant: (Opponent)
Valeo Equipements Electroniques Moteurs
2 rue André Boulle
F-94000 CRETEIL (FR)

Representative:
Le Forestier, Eric
Cabinet Regimbeau
26, avenue Kléber
75116 Paris (FR)

Respondent: (Proprietor of the patent)
NIPPONDENSO CO., LTD.
1-1, Showa-cho
Kariya-shi
Aichi-ken (JP)

Representative:
Klingseisen, Franz, Dipl.-Ing.
Patentanwälte
Dr. F. Zumstein
Dipl.-Ing. F. Klingseisen
Bräuhausstrasse 4
80331 München (DE)

Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 12 July 1994 concerning maintenance of the European patent No. 0 300 063 in amended form.**

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: M. R. J. Villemin
C. Holtz

Summary of Facts and Submissions

I. The Appellant opposed European patent No. 0 300 063 and now contests the interlocutory decision of the Opposition Division that, account being taken of the amendments made during the opposition proceedings, the patent and the invention to which it relates meet the requirements of the EPC.

The Opposition Division considered that the subject-matter of Claim 1 involved an inventive step over the prior art known from the following documents:

D1: Book "Les alternateurs d'automobile", G. Gory, 5th edition, Editions SEMIS, 1972, pages 117, 129 to 133, 186, 241 and 242,

D2: GB-A-1 149 856,

D3: US-A-3 184 625 and

D6: US-A-4 162 419.

II. In the grounds of appeal, the Appellant cited a further document:

D10: "SKF LA REVUE DES ROULEMENTS", Numéro spécial de 1972, article entitled: "Intraduct - un système de palier pour moteurs électriques", S. Hallerbäck et al., pages 4 to 8.

III. Claim 1 of the patent as maintained by the Opposition Division is worded as follows:

"1. An alternate current generator comprising a shaft (5), pole cores (6, 6') of a rotor fixed to said shaft, a rotor winding (7) wound around said pole cores, a

stator core (3a) arranged around said rotor, a stator winding (3b) wound around said stator core, a housing encasing said rotor and said stator and comprising a pair of frame pieces (1, 1'),

a pair of fans (8, 8') fixed to the side surface of said pole cores of said rotor, at least one of said fans being of a centrifugal type,

a pair of bearings (4, 4') which are arranged in the central portion of the frame pieces (1, 1'), supporting rotatably said shaft (5),

a plurality of intake windows (1b, 1b') which are formed adjacent to said bearings (4, 4') in said frame pieces (1, 1'), so that coolant air, which is generated by said fans, is drawn inside of the housing through said intake windows,

a plurality of exhaust windows (1c, 1c') which are formed adjacent to said stator so that heated coolant air is exhausted through said exhaust windows,

characterized in that,

the frame pieces (1, 1') are coupled directly to each other at their circular edges,

said stator core (3a) is fixed directly to one (1) of said frame pieces,

the bearings (4, 4') are arranged adjacent to said respective pole cores,

a pair of shrouds (1a, 1a') is formed adjacent to said fans (8, 8') and between the intake windows (1b, 1b') and the exhaust windows (1c, 1c'),

slip rings (9) are arranged on the shaft (5) outside of the frame pieces (1, 1'),

the associated elements including brushes (16a), rectifiers (15) and a voltage regulator unit (17) are located outside of said housing formed by said frame pieces, and

a pulley (11) fixed to the end of said shaft (5) and having a plurality of grooves for a poly V belt in order to make the diameter of said pulley small, whereby the effective area of said intake windows (1b, 1b') which is not hindered by said pulley becomes wide so that said fan draws much air through said intake windows."

IV. In the course of oral proceedings held before the Board on 10 October 1996, the Respondent filed a main request and an auxiliary request.

V. Claim 1 according to the main request differs from Claim 1 maintained by the Opposition Division in that:

- the expression "arranged in", in line 14, is replaced by "respectively arranged in a pair of bearing boxes (41, 41') being fixed to",

- the expression "bearings 4, 4'", in line 18, is replaced by "bearing boxes (41, 41')",

- the word "and" in line 43 is cancelled,

- the full stop at the end of the claim is replaced by ", and wherein the bearing boxes (41, 41') are directly exposed to the coolant air flowing through the adjacent intake windows (1b, 1b')."

Claim 1 of the auxiliary request differs from Claim 1 of the main request in that:

- the word "and" in line 50 is cancelled,

- the full stop at the end of the claim is replaced by ", and wherein said slip rings (9) are connected to said rotor winding (7) through conductors (10) arranged in two slots (5a, 5a') in said shaft (5), one slot being disposed opposite the other slot."

VI. The Appellant argued essentially as follows:

The problem of improving the lifetime of an alternate generator was known from the prior art. The mechanical requirements of rigid construction, reduction of vibration and cooling of the bearings were described in D10.

Document D3 acknowledged this problem and disclosed an alternator rectifier unit having all the features of the preamble of Claim 1 of both requests.

Concerning the features in the characterising part of the Claim 1 of the main request:

- an alternator in which the frame pieces were coupled directly to each other at their circular edges, the stator core was fixed directly to one of the frame pieces and the bearings were arranged adjacent to their respective pole cores was disclosed in D2;

- a pair of shrouds was formed adjacent to the fans and between the intake windows and the exhaust windows in the alternator rectifier unit described in D3;

- in D2, the slip rings were arranged on the shaft outside of the frame pieces and the associated elements including brushes, rectifiers and a voltage regulator unit were located outside of said housing formed by said frame pieces;

- alternators in which a pulley was fixed to the end of the shaft and had a plurality of grooves for a poly V belt in order to make the diameter of said pulley small were known from D1 or D6; and

- in D3, the effective area of the intake windows which was not hindered by the pulley was wide so that the fan drew much air through said intake windows.

The necessity of cooling bearings had become evident to the skilled person long before the date of priority of the opposed patent and was attested in document D10. It was clear from D3 that the cooling of both bearing boxes of the alternator described in this document was achieved by air flowing through intake windows disposed directly adjacent to the bearing boxes. As in the claimed alternate current generator, the cooling of the bearings themselves was obtained by thermal conduction through the bearing boxes. The direction of the air flow in the vicinity of the bearings of the alternator known from D2 was obviously axial so that the bearing boxes were directly exposed to the coolant air flowing through the adjacent windows. The separate problem of reducing vibration was also mentioned in D10 and a solution to it was known from D2. Thus, the subject-matter of Claim 1 of the main request amounted to no more than the aggregate of two known solutions to two known problems and did not involve an inventive step.

Regarding the auxiliary request, it was obvious to the person skilled in the art of rotating electric machines that if the slip rings are outside the bearing (as in D2) the connections between them and the rotor winding must pass through inside the bearing. The obvious way to do this was through conductors arranged in slots in the shaft of the rotor. Thus, the additional features in Claim 1 of the auxiliary request, that slip rings (9) are connected to said rotor winding (7) through conductors arranged in two slots (5a, 5a') in the shaft (5), one slot being disposed opposite the other slot, could not render inventive the subject-matter of this claim.

VII. The Respondent pointed out that the main object of the invention of the patent in suit was to provide a high-speed alternate current generator with an acceptable lifetime. The problem of lifetime was more acute than before because a high speed meant production of more heat, more vibrations and a higher load on the bearings. The features specified in Claim 1 of the main request worked together to solve this one problem.

The need for such a high speed did not exist when the alternate current generators disclosed in D2 and D3 were developed in the 1960s. Neither of these documents hinted at cooling the bearings.

High speed rotation was only possible with a poly V-belt pulley. D6 described an alternator having a double-belt pulley and an improved rectifier cooling system, but there was no efficient cooling of the bearings. D2 was concerned with providing improved cooling for the windings, but neither of these documents suggested the idea of improving the cooling in a high speed alternator.

The inventors were the first to recognize that the lifetime of bearings could be increased in spite of the production of heat produced in high-speed alternate current generators now available on the market. To achieve this result demanded, as taught by the patent in suit, an efficient cooling of the bearings. Especially, the front bearing on the side of the pulley had to be efficiently cooled, because the load applied to the front bearing was higher than the load applied to the rear bearing. This was not acknowledged in the prior art documents. In particular, since the fan 84 of the generator described in D6 extracted the cooling air radially from the housing there was no interaction between the air flow and the diameter of the pulley.

VIII. The Appellant requests that the decision under appeal be set aside and that the patent in suit be revoked in its entirety.

IX. The Respondent requests that the patent be maintained in amended form, according to:

Main request, consisting of

Claim 1 as presented in the oral proceedings under the heading of "main request",

Claims 2 to 4 as maintained in the decision under appeal.

Description and drawings as printed in the patent specification.

Auxiliary request, consisting of

Claim 1 as presented in the oral proceedings under the heading of "auxiliary request",

Claims 2 and 3 as maintained in the decision under appeal.

Description and drawings as printed in the patent specification.

Reasons for the Decision

1. The appeal is admissible.

2. The amended forms of the patent according to the main and auxiliary requests comply with paragraphs (2) and (3) of Article 123 EPC.

3. In order to avoid unnecessary repetitions, the numbering C1 to C11 and C14 to C16, proposed by the Opponent in the notice of opposition for designating features of the claimed alternate current generator will be used in the present decision, together with C17 introduced by the Board.

3.1 With this numbering, features of Claim 1 of the main request read as follows:

C1: An alternate current generator comprising a shaft (5), pole cores (6, 6') of a rotor fixed to said shaft, a rotor winding (7) wound around said pole cores, a stator core (3a) arranged around said rotor, a stator winding (3b) wound around said stator core, a housing encasing said rotor and said stator and comprising a pair of frame pieces (1, 1'),

C2: a pair of fans (8, 8') fixed to the side surface of said pole cores of said rotor, at least one of said fans being of a centrifugal type,

C3: a pair of bearings (4, 4') which are respectively arranged in a pair of bearing boxes (41, 41') being fixed to the central portion of the frame pieces (1, 1'), supporting rotatably said shaft (5),

C4: a plurality of intake windows (1b, 1b') which are formed adjacent to said bearings boxes (41, 41') in said frame pieces (1, 1'), so that coolant air, which is generated by said fans, is drawn inside of the housing through said intake windows,

C5: a plurality of exhaust windows (1c, 1c') which are formed adjacent to said stator so that heated coolant air is exhausted through said exhaust windows,

characterized in that,

C6: the frame pieces (1, 1') are coupled directly to each other at their circular edges,

C7: said stator core (3a) is fixed directly to one (1) of said frame pieces,

C8: the bearings (4, 4') are arranged adjacent to said respective pole cores,

C9: a pair of shrouds (1a, 1a') is formed adjacent to said fans (8, 8') and between the intake windows (1b, 1b') and the exhaust windows (1c, 1c'),

C10: slip rings (9) are arranged on the shaft (5) outside of the frame pieces (1, 1'),

C11: the associated elements including brushes (16a), rectifiers (15) and a voltage regulator unit (17) are located outside of said housing formed by said frame pieces,

C14: a pulley (11) fixed to the end of said shaft (5) and having a plurality of grooves for a poly V belt in order to make the diameter of said pulley small,

C15: whereby the effective area of said intake windows (1b, 1b') which is not hindered by said pulley becomes wide so that said fan draws much air through said intake windows,

C17: and wherein the bearing boxes (41, 41') are directly exposed to the coolant air flowing through the adjacent intake windows (1b, 1b').

3.2 Claim 1 of the auxiliary request differs from Claim 1 of the main request by the addition at its end of the following feature:

C16: wherein said slip rings (9) are connected to said rotor winding (7) through conductors (10) arranged in two slots (5a, 5a') in said shaft (5), one slot being disposed opposite the other slot.

4. *Novelty*

It was not disputed in the oral proceedings that the alternate current generator defined by Claims 1 of both requests was new over the prior art cited by the Appellant.

5. *Problem to be solved*

5.1 It belongs to the general technical knowledge of the skilled person that the rotational speed of an alternate current generator can be increased by using a poly V belt driving a small diameter pulley. An alternate current generator driven by a pulley having a small diameter and a plurality of V grooves is known from D6 (see Figure 1, coolant air flowing out of window 86 with no screening from pulley 46 with V grooves). D1 shows an alternate current generator having a double-V pulley (see Figure 9 on page 186, Figure 2 on page 241 and Figure 3 on page 242).

5.2 It appears that a high rotational speed results in excessive vibration and overheating, reducing the lifetime of the generator. In particular, the bearings are liable to premature failure. As may be seen from D10, these problems were already known in connection with electric motors, and they must have also appeared in practice in connection with generators. D10 points the way to solutions of these problems: a rigid construction with precise alignment of the bearings, placing the bearings more closely together, effective cooling of the bearings.

5.3 The fundamental problem dealt with by the patent in suit is to provide an alternate current generator which is able to withstand a high speed of rotation (see the published patent specification, column 1, lines 17 to 43). Although it is not explained anywhere in the patent in suit what is meant by "a high speed of rotation", it appears that this problem resolves itself into two sub-problems: firstly, to improve the mechanical strength, to reduce flexion of the axis of the generator and reduce vibrations; secondly to provide effective cooling of all parts of the generator, including the bearings for the rotor.

5.4 As the problem must have presented itself in practice, it cannot contribute to an inventive step.

6. *Inventive step - Main request*

6.1 Starting from a basic conventional alternator according to feature C1 equipped with a pulley according to feature C14 to drive it at "a high speed of rotation", the subject-matter of Claim 1 solves the two sub-problems mentioned in paragraph 5.3 by respective technical means:

- mechanical means for improving the structural strength of the generator and reducing vibrations: features C3, C6, C7, C8, C10, C11; and

- cooling means providing an efficient cooling of the windings and the rectifiers and, more particularly, of the bearings: features C2, C4, C5, C9, C15, C17.

6.2 A solution to the mechanical sub-problem along the lines suggested in D10 is known from D2, which describes an alternator having the features C1, C3, C6, C7, C8, C10 and C11 (see Figures 1 to 3, frame pieces 31 and 32; stator core 38 fixed to 32; bearings 33 and 34 arranged adjacent to rotor pole cores 39, 41; slip rings 36, 37 mounted outside of the housing formed by frame pieces 31 and 32; brushes 24 and 25, rectifiers 16, 17 and 18, voltage regulator unit 27 located outside the housing formed by frame pieces 31 and 32).

6.3 A solution to the cooling sub-problem along the lines suggested in D10 (see Figure 6) is known from D3. Even though D3 does not expressly mention a cooling of the bearings, it is immediately apparent to the skilled person that such a cooling is obtained. In particular, Figures 2 and 3 of D3 show that the front bearing

assembly situated near the pulley, is directly exposed to the coolant air flowing through the adjacent intake windows 24, 25 and 65 so that it can be cooled. It may be that the clamp 77 or the rather thick wall of the bearing box results in a reduced thermal conduction between the bearings and the air flow, but it is noted that Claim 1 contains no specific technical features for improving the efficiency of the thermal conduction. In any case, if the mechanical construction of the bearing boxes shown in D2 or D10 is adopted, the clamp 77 would not be required. D3 shows wall portions (i. e. "shrouds") formed adjacent to fans 26 and 27 and between the intake windows 24, 25, 65 and the exhaust windows 23, 66. In fact, D3 discloses an alternator rectifier unit having features C1 to C5, C9 and C15. When the cooling air flow arrangement shown in D3 is applied to an alternator with bearings arranged as shown in D2, feature C17 is also present.

6.4 Summarising, the skilled person seeking a solution to the obvious problem discussed in section 5 above, following the suggestions given in D10 (which are obviously directly applicable to generators), finds the answer in D2 and D3. There is no difficulty to be overcome in applying the cooling air flow pattern shown in D3 to an alternator whose housing, stator, rotor and bearings are arranged as shown in D2. In this way, the skilled person arrives at a generator according to Claim 1.

6.5 Consequently, the subject-matter of Claim 1 of the main request does not involve an inventive step within the meaning of Article 56 EPC. The request must therefore be rejected.

7. *Auxiliary request*

7.1 Claim 1 of the auxiliary request differs from Claim 1 of the main request by the presence of the additional feature

C16: wherein said slip rings (9) are connected to said rotor winding (7) through conductors (10) arranged in two slots (5a, 5a') in said shaft (5), one slot being disposed opposite the other slot.

7.2 Given that the slip rings and the rotor windings are on opposite sides of the bearing, it is obvious that the connections therebetween have to pass through or around the bearing. Furthermore, in view of the need for mechanical strength and reduction of vibration, this must be done in a manner which does not impair the mechanical strength of the rotor shaft or the bearing, or introduce a lack of balance, which would cause vibrations. The provision of conductors arranged in two slots in said shaft, one slot being disposed opposite the other slot, appears to be the most obvious solution and cannot contribute to an inventive step.

7.3 Consequently, the subject-matter of Claim 1 of the auxiliary request does not involve an inventive step within the meaning of Article 56 EPC. The auxiliary request must therefore also be rejected.

Order

for these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar:

M. Kiehl

The Chairman:

W. J. L. Wheeler