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Datasheet for the decision of 17 September 2007

Case Number: T 0231/06 - 3.5.02

Application Number: 98109579.7

Publication Number: 0881753

IPC: H02K 9/06

Language of the proceedings: EN

Title of invention:
Cooling arrangement of alternator

Patentee:
Denso Corporation

Opponent:
Valeo Equipements Electriques Moteur

Headword:
-

Relevant legal provisions:
EPC Art. 56

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"Inventive step - no (all requests)"

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-

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Case Number: T 0231/06 - 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 17 September 2007

Appellant: (Opponent)
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Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office posted 14 December 2005 concerning maintenance of European patent No. 0881753 in amended form.

Composition of the Board:

Chairman: M. Ruggiu
Members: M. Rognoni
P. Mühlens

Summary of Facts and Submissions

I. The opponent (appellant) appealed against the interlocutory decision of the opposition division maintaining the European Patent No. 0 881 753 in amended form.

II. In the contested decision, the opposition division considered that the combination of U-turn portions which were inclined and joint portions which blocked the air flow, as specified in claim 1 according to the auxiliary request filed in the oral proceedings on 25 October 2005, were not disclosed in the following documents:

D13: FR-A-2 733 642,

D8: DE-A-40 31 276 (corresponding to WO-A-92/06527).

As the combination of documents D13 and D8 did not lead to an alternator comprising the features of claim 1 of the auxiliary request, in the opinion of the opposition division, the subject-matter of this claim met the requirements of Articles 52(1) and 56 EPC.

III. Of the further prior art cited by the parties in the course of the appeal proceedings, the following documents remain relevant to the present decision:

D2: US-A-5 097 167,

D9: US-A-1 822 261,

D12: FR-A-2 602 925,

C15: "Handbuch der Wickeltechnik elektrischer Maschinen", VEB Verlag Berlin, 1961, pages 387, 393 and 394.

IV. In reply to a communication from the Board accompanying the summons to oral proceedings, the respondent (patent proprietor) filed, with a letter dated 16 August 2007, a new claim 1 by way of auxiliary request.

V. Oral proceedings before the Board were held on 17 September 2007.

VI. The appellant requested that the decision under appeal be set aside and that the patent be revoked.

The respondent requested that the appeal be dismissed (main request), or that the patent be maintained in amended form on the basis of claim 1 of the first auxiliary request filed in the oral proceedings, or, as a second auxiliary request, that the patent be maintained in amended form on the basis of claim 1 filed as "auxiliary request" with letter of 16 August 2007, and dependent claims 2 to 7 as maintained by the opposition division.

VII. Claim 1 as maintained by the opposition division reads as follows:

"An alternator (1) disposed in the engine compartment of a vehicle comprising a rotor (3) having magnetic poles (73) and a field coil (8), a cooling fan member (11, 12), a stator (2) disposed around said

rotor (3) and having a stator core (32) and a multi-phase stator winding (21), wherein

said multi-phase stator winding (21) comprises plurality of conductor segments (33) with a rectangular cross-section each having a U-turn portion (33c) to form a first coil-end group (31c) and a pair of joint portions (33d) to form a second coil-end group (31d);

said first coil-end group (31c) is disposed on an end of said stator core (32) and said second coil-end group (31d) is disposed on said the other end;
characterised in that
said cooling fan member (11, 12) sends cooling air to said first coil-end group (31c) and to said second coil-end group (31d) such that the cooling air flows along an inclined outer periphery of said U-turn portions (33c) of said first coil-end group (31c) and is blocked by said joint portions (33d) of said second coil-end group (31d), and
said cooling fan member (11, 12) sends cooling air to said second coil-end group (31d) less than said first coil-end group (31c)."

Claims 2 to 7 are dependent on claim 1.

Claim 1 according to the first auxiliary request reads as follows:

"An alternator (1) disposed in the engine compartment of a vehicle comprising a rotor (3) having magnetic poles (73) and a field coil (8), a cooling fan member (11, 12), a stator (2) disposed around said rotor (3) and having a stator core (32) and a multi-phase stator winding (21), wherein

said multi-phase stator winding (21) comprises a plurality of U-shaped conductor segments (33) with a rectangular cross-section, each having an inner conductor (33a), an outer conductor (33b), a U-turn portions (33c), a joint portion (33d) and inclined portions (33e, 33f), wherein each of said U-turn portions (33c) is disposed on the same axial end of the stator core (32) to form a first coil-end group (31c), each of outer conductors (33b) is inserted into the outer side of one of the slots (35), each of inner conductors (33a) is inserted into the inner side of the slot (35), each of a pair of joint portions (33d) is bent to be inclined outward, each of the joint portions (33d) in one of the outer and inner sides of the slots (35) is connected to one of joint portions of conductor segments (33) in another of the inner and outer sides of the slots (35) to form a second coil-end group (31d), the inclined portions (33e, 33f) of each conductor segments (33) are inclined in opposite directions at a certain angle so that a plurality of phase-windings can be disposed without interference,

said first coil-end group (31c) is disposed on an end of said stator core (32) and said second coil-end group (31d) is disposed on said the other end;
said cooling fan member (11, 12) sends cooling air to said first coil-end group (31c) and to said second coil-end group (31d) such that the cooling air flows along an inclined outer periphery of said U-turn portions (33c) of said first coil-end group (31c) and is blocked by said joint portions (33d) of said second coil-end group (31d), and

said cooling fan member (11, 12) sends cooling air to said second coil-end group (31d) less than said first coil-end group (31c)."

Claim 1 according to the second auxiliary request reads as follows:

"An alternator (1) disposed in the engine compartment of a vehicle comprising a rotor (3) having magnetic poles (73) and a field coil (8), a cooling fan member (11, 12), a stator (2) disposed around said rotor (3) and having a stator core (32) and a multi-phase stator winding (21), wherein

said multi-phase stator winding (21) comprising a plurality of conductor segments (33) with a rectangular cross-section each having a U-turn portion (33c) to form a first coil-end group (31c) and a pair of joint portions (33d) to form a second coil-end group (31d), and

said first coil-end group (31c) is disposed on an end of said stator core (32) and said second coil-end group (31d) is disposed on the other end;
characterised in that

said U-turn portions (33c) of said first coil-end group (31c) have each an inclined outer periphery along which cooling air sent by said cooling fan member (11, 12) can flow,

said cooling fan member (11, 12) sends cooling air to said first coil-end group (31c) and to said second coil-end group (31d) such that the cooling air flows along said inclined outer periphery of said U-turn portions (33c) of said first coil-end group (31c) and is blocked by said joint portions (33d) of said second coil-end group (31d), and

the quantity of cooling air sent by said cooling fan member (11, 12) to said second coil-end group (31d) is smaller than the quantity of cooling air sent to

said first coil-end group (31c), and the speed of cooling air sent to said second coil-end group (31d) is lower than the speed of cooling air sent to said first coil-end group (31d)."

VIII. The appellant's arguments relevant to the present decision may be summarised as follows:

The patent in suit related to a compact alternator which comprised a cooling fan member and a stator with a winding made up of U-shaped conductor segments. One of the essential features of the alternator specified in claim 1 as maintained by the opposition division was that the cooling air generated by the cooling fan member flowed along an inclined outer periphery of the U-turn portions of the conductor segments. The wording used in the claim to describe this aspect of the alleged invention was, however, ambiguous and neither the description nor the drawings of the patent specification clarified it. Figure 2, which presented a lateral view of the stator core and winding, indicated that the conductor segments 33 had portions 33e and 33f inclined in opposite directions. As shown in D8 or D9, this arrangement was typical for multi-phase windings. On the basis of Figure 6, which was a top view of a bent conductor segment and showed the inclined top and lateral surfaces of a U-turn portion, it was not possible to determine what constituted an inclined outer periphery in the sense of claim 1.

Document D13 showed a compact alternator having the same structure as the alternator of Figure 1 of the contested patent, apart from the stator winding which in the case of the alleged invention was formed by

U-shaped conductor segments. As specified in the description (page 4, lines 1 to 7), the cooling fan 14, which was located on the same side as the rectifier and the brushes, generated a stronger air flow than the fan 12 arranged on the pulley side.
Starting from D13, the problem addressed by the patent in suit was to provide an alternator with increased output power.

It was generally known in the art that windings made of conductor segments with a rectangular cross-section could carry stronger currents and offered a better form factor. This made them particularly suitable for the construction of high output alternators. Document D8 related to a winding for a stator of an alternator made up of U-shaped conductor segments and comprising terminals located on the side of the U-turn portions. D8 did not specify the cross-section of the conductor segments. However, it was implicit for a person skilled in the art that the teaching of D8 was independent of the cross-section of the conductor segments. For a person skilled in the art, it would have been obvious to apply the teaching of D8 or D9 to an alternator according to D13 and to use segments with a rectangular cross-section in order to arrive at a compact alternator with increased output power.

As to the feature of claim 1 concerning the inclined periphery of the U-turn portions along which air could flow smoothly, C15 (Figure 5.111) showed that it resulted from bending conductor segments of rectangular cross-section into a U-shape. Thus, a stator comprising a multi-phase winding formed by joining together the free ends of U-shaped conductor segments with a

rectangular cross-section had the inherent property of having U-turn portions along which the cooling air flowed smoothly while the joint portions of the conductor segments tended to block the air flow.

In other words, simply by applying the teaching of D8 to a compact alternator, a skilled person would have arrived at an alternator falling within the terms of the claim 1 as maintained by the opposition division. Hence, the subject-matter of this claim did not involve an inventive step within the meaning of Article 56 EPC.

Claim 1 of the first auxiliary request further comprised features detailing the different portions of the conductor segments used for the stator winding. As shown in D8 and D9, conductor segments as specified in the claim were common in the art and could not contribute to the inventive step of the claimed subject-matter.

As far as the inclined outer periphery of the U-turn portions was concerned, claim 1 according to the second auxiliary request suffered from the same lack of clarity as the independent claims of the other requests. As to the feature that the quantity of air directed to the coil-end group formed by the joint portions and its speed were lower than the quantity and the speed of cooling air sent to the U-turn side of the winding, the contested patent failed to teach explicitly how this should be achieved and only specified that in the alternator of Figure 1 the outside diameter of the fan 11 was smaller that the outside diameter of the fan 12. It was, however, evident to a person skilled in the art that a stronger

air flow was generated by increasing the amount of air moved by the fan and its speed, and that air speed was linked to the diameter of the fan blades, in the sense that a higher tangential velocity of the fan blades resulted in an increased speed of the air flow. Hence, also the subject-matter of claim 1 according to the second auxiliary was obvious to a skilled person in the light of D13, D8 and of the general knowledge common in the art.

IX. The respondent's arguments relevant to the present decision may be summarised as follows:

The contested patent addressed the problem of increasing the output power of an alternator for a vehicle without increasing the noises produced by the alternator's cooling system. The gist of the present invention consisted essentially in forming first and second coil-end groups of a multi-phase stator winding, which comprised conductor segments with a rectangular cross-section, and in reducing the quantity of cooling air sent to the second coil-end group as compared to the first coil-end group. The first coil-end group was formed such that the U-turn portions had an inclined outer periphery along which cooling air could flow whereas the second coil-end group was made up of joint portions which blocked the cooling air.

In fact, the solution to the problem of reducing noise could not be restricted to the reduction of the quantity of cooling air sent to the second coil-end group as compared to the quantity of cooling air sent to the first coil-end group. On the contrary, it was to be seen in the combination of the special design of the

coil-end groups of the stator winding formed of a plurality of conductor segments, as specified in the claim, and of the configuration of the cooling fan member so that the quantity of cooling air sent to the second coil-end group was lower than the quantity of cooling air sent to the first coil-end group of the stator winding.

As to the interpretation to be given to the feature "inclined outer periphery of the U-turn portions", Figure 6 clearly showed that the U-turn portions were not radially arranged around one side of the stator core, but that they were inclined at a certain angle with respect to the radial direction. Furthermore, this figure showed that the cooling air was directed to the first coil-end group so that it flowed smoothly along the side of the U-turn portions.

D12 and D13 related to compact-type alternators comprising a conventional wire-type multi-phase stator winding, which formed a first coil-end group on the rectifier side and a second coil-end group on the pulley side, and a cooling fan member which sent less air to the second coil-end group than to the first coil-end group.

Document D8 showed a stator with U-turn portions and joint portions which were radially oriented with respect to the axis of the alternator. In fact, the main method for making a stator winding described in D8 used a holding ring and a bending ring for respectively fixating the U-turn portions and the joint portions of the conductor segments while the segments were bent apart. In this way, both the U-turn portions and the

joint portions were kept in radial planes with respect to the axis of the stator winding. Even if it were assumed that the person skilled in the art could have used a stator according to D8 to make a compact alternator as shown in D12 or D13, D8 would not have suggested providing the U-turn portions of the first coil-end group with an inclined outer periphery along which cooling air could flow smoothly. Actually, none of the prior art documents could have prompted the skilled person to modify a stator winding made of conductor segments of the kind known from D8, so as to provide the U-turn portions with an inclined outer periphery along which the cooling air could easily flow. In conclusion, the subject-matter of claim 1 as maintained by the opposition division involved an inventive step within the meaning of Article 56 EPC.

C15 showed how U-shaped conductor segments of rectangular cross-section to be used for a stator or rotor winding should be bent. However, it did not teach to bend them so that the inclination of the U-turn portions matched the direction of the air flow sent to them by the cooling fan. In fact, there was no suggestion in C15 that the sense of rotation of the rotor (*i.e.* of the cooling fan) should depend on the inclination of the U-turn portions of the conductor segments, as taught by the present invention.

Claim 1 according to the first auxiliary request differed from claim 1 as maintained by the opposition division in that it comprised further features directed to clarifying that the expression "the inclined outer periphery of said U-turn portions" corresponded to the arrangement shown in Figure 6 of the patent in suit.

Claim 1 according to the second auxiliary request specified in addition to claim 1 of the patent as maintained by the opposition division that the speed of the cooling air sent to the second coil-end group was lower than the speed of the cooling air sent to the first coil-end group. As known to a person skilled in the art, the speed of the cooling air depended on many factors and not just on the size or outer diameter of the fan blades used to generate it. From the schematic representation of fan blades given in D12, it was not possible to draw any conclusion as to the speed of the air flow generated by the cooling members. In fact, none of the cited prior art documents mentioned speed as a parameter which was relevant for decreasing the noise generated by a fan, or suggested that reducing speed of the air flow on the side where the joint portions of the conductor segments were located contributed to reducing the noise generated by the cooling fan member. Hence, the subject-matter of claim 1 according to the second auxiliary request involved an inventive step within the meaning of Article 56 EPC.

Reasons for the Decision

1. The appeal is admissible.

2. The patent in suit is concerned with an alternator for a vehicle *"which can increase output power without increasing noises"* (published patent, column 1, lines 54 to 56).

Respondent's main request

3.1 Claim 1 as maintained by the opposition division relates to an alternator disposed in the engine compartment of a vehicle and comprising the following features:

(a) a rotor having magnetic poles and a field coil, a cooling fan member, a stator disposed around said rotor and having a stator core and a multi-phase stator winding,

(b) said multi-phase stator winding comprises a plurality of conductor segments,

(c) with a rectangular cross-section,

(d) each having a U-turn portion to form a first coil-end group and

(e) a pair of joint portions to form a second coil-end group,

(f) said first coil-end group is disposed on one end of said stator core and said second coil-end group is disposed on the other end,

(g) said cooling fan member sends cooling air to said first coil-end group and to said second coil-end group such that the cooling air flows along an inclined outer periphery of said U-turn portions of said first coil-end group and is blocked by said joint portions of said second coil-end group, and

(h) said cooling fan member sends cooling air to said second coil-end group less than to said first coil-end group.

3.2 Document D13 (Figure 1) shows an alternator to be disposed in the engine compartment of a vehicle and comprising a rotor 16 having magnetic poles and a field coil, cooling fans 12 and 14, a stator disposed around the rotor and having a stator core 36 and a winding 38. Slip rings 34, a brush unit 32 and a rectifier are arranged inside the alternator on the side opposite the pulley 18. As pointed out in D13 (page 4, lines 1 to 7) the part of the alternator which is more sensitive to temperature increases is the brush unit which includes the electronic components of the current regulator. This area of the alternator is cooled by the fan 14 which generates a greater air flow than the fan 12.

As pointed out by the appellant, it is, in fact, a common feature of a compact alternator for automotive applications to have two cooling fans with different air outputs arranged on either side of the rotor and to locate the fan which generates the greater air output on the side where the electronic components are located, i.e. on the side opposite the pulley. This arrangement is also due to the fact that the smaller bearing on the side opposite the pulley leaves more room for a bigger and thus more powerful fan (cf D13, Figure 1, bearings 26 and 24).

3.3 Another example of an alternator comprising features (a) and (h) recited in claim 1 of the main request, and

in particular a more powerful cooling member on the side opposite the pulley, is shown in D12.

4.1 The subject-matter of claim 1 according to the main request differs from the alternator known from D13 or D12 in that the stator comprises features (b) to (g). As pointed out in the contested patent (see patent specification, column 1, lines 41 to 44) and generally known in the art, a multi-phase stator with a winding made of U-shaped conductors has a better space factor and can thus contribute to increasing the alternator's power output.

4.2 Starting from a conventional compact alternator as known from D13 or D12, a problem solved by the present invention can be seen in providing a compact alternator with increased output power.

5.1 D8 relates to a multi-phase stator for electric machines, such as alternators, comprising a winding made of conductive rods. As shown in Figure 3 of D8, the stator rods have U-turn portions (14b, 19b and 20b), which form a first coil-end group 18 of the winding (see Figures 1 and 2), and joint portions (14a, 19a and 20a), which constitute a second coil-end group. The first coil-end group is disposed on one side of the stator core 11 and the second coil-end group is disposed on the other side (see Figure 1). The stator disclosed in D18 thus comprises features (b), (d), (e) and (f) of claim 1 of according to the main request.

5.2 It is implicit to a skilled person that a stator as shown in Figure 1 of D8 is suitable for being used in a compact alternator as known from D13 or D12. This

stator further comprises terminals U, X, V and Y of the three-phase winding which are located on the same side as the U-turn portions of the conductive rods. A stator according to D18 would then be mounted in a compact alternator of the kind shown in D12 or D13 with its first coil-end group facing the electronic components to which the terminals are to be connected, so that the first coil-end group would be located on the side where the air flow generated by the cooling fan is stronger.

A straightforward combination of the stator of D8 with a standard alternator as known from D12 and D13 would therefore result in an alternator comprising features (a), (b), (d) to (f) and (h) of claim 1 according to the main request.

5.3 As to feature (c), D8 does not specify the cross-section of the conductor segments and from the schematic drawings of D8 it could be assumed that the conductor segments have a round cross-section. However, it is evident that the teaching of this document relating to the structure and the manufacturing of a stator winding made of conductor segments applies to conductors of any cross-section and, in particular, to stator windings comprising conductor segments with a rectangular cross section, which are *per se* known in the art (see C15, page 394 or D2, Figures 13 and 15) and have the advantage of allowing a better winding space factor.

In other words, feature (c) of claim 1 is an obvious option available to the skilled person wishing to apply the teaching of D8 to an alternator with higher output power.

6.1 As to the remaining feature (g) of claim 1 according to the main request, the appellant has essentially argued that its wording was unclear and that the patent specification did not support any interpretation which went beyond what was already an inherent characteristic of a stator with a winding made up of U-shaped conductive rods.

6.2 According to the respondent, feature (g) of claim 1 related to structural characteristics of the first and second coil-end groups of a multi-phase stator winding formed of a plurality of conductor segments with a rectangular cross-section as well as of the cooling fan member. Thus, the gist of the invention lay in combining the special structure of the first and second coil-end groups of the stator winding with a particular configuration of the cooling fan member.

6.3 The wording of feature (g) does not correspond exactly to any passage of the description of the patent as published. For its interpretation, it may be referred to paragraphs [0023] and [0024] of the description.

In paragraph [0023] it is specified that the *"cooling air flows along the inclined outer periphery of U-turn portion of first coil-end group 31c as shown in Fig. 6. On the other hand, the cooing* [*sic*] *air is blocked by joint portions 33d of second coil-end group 31d as shown in Fig. 7"*.

According to paragraph [0024] (emphasis added), *"the quantity of the cooling air sent to second coil-end group 31d is smaller than the quantity of the cooling*

air sent to the first coil-end group 31c, and the speed of cooling air sent to second coil-end group 31d is lower than the speed of the cooling air sent to first coil-end group 31c. Thus, the interference noises on the second coil-end group 31d can be reduced".

In other words, the description of the contested patent does not refer to any special features of the *"inclined outer periphery of U-turn portion of first coil-end group".* In particular, it does not specify with respect to which reference plane this periphery should be inclined. As to the diagrams of the contested patent, they show different conductor portions with an inclined outer periphery. According to Figure 5, the U-turn portions appear to have two parallel lateral faces which are substantially arranged in a radial direction and one top face which presents a variable inclination with respect to a plane perpendicular to the axis of the stator core. On the other hand, Figure 6 shows a top view of the U-turn portion of a particular conductor segment with a top face and lateral surfaces which are twisted 180° so that each lateral surface has portions which are inclined with respect to both the radial and the axial directions of the stator core.

In the light of the description, feature (g) of claim 1 appears therefore merely to imply that the conductor segments of the winding, which comprise features (c), (d) and (e), are such that the cooling air sent to them by the cooling fan member flows smoothly on the side of the first coil-end group but tends to be blocked by the joint portions of the second coil-end group.

6.4 As it can be seen from Figures 1 and 3 of D8, conductor segments bent into a U-shape present a "profile" which is curved and thus "inclined" with respect to a plane perpendicular to the stator core axis. Furthermore, the outer and inner legs of the U-turn portions of the stator core winding are arranged so as to be inclined with respect to the stator's axis. The outer periphery of the U-turn portions constitute a smooth surface which is inclined both with respect to the radial and axial directions of the stator along which the cooling air can flow. On the other hand, the soldered portions of the conductor segments on the other side of the stator form an uneven surface which tends to obstruct the air flow.

This arrangement of the winding rods implies that feature (g) would be present also in a conventional alternator as shown in D12 or D13 but equipped with a stator according to Figure 1 of D8, in the sense that the cooling air generated by the fan 14 (see D13, Figure 1) would flow along the inclined outer periphery of the corresponding U-turn portions of the winding, whereas on the other side of the stator the joint portions of the conductor segments would tend to block the air flow. The same will happen if the conductor segments used to build the stator have a rectangular cross-section, because the cooling air will flow more easily along the continuous outer periphery of the bent portions than on the side of the stator where the straight ends of the conductor segments are joined together.

6.5 According to the respondent the expression *"an inclined outer periphery of said U-turn"* portions, interpreted

in the light of the disclosed invention, clearly implied that the tangent at the point of inflection of the curve representing the top profile of the U-turn portion shown in Figure 6 was inclined with respect to a radial line passing through said point.

6.6 However, the inclination of the top periphery of the bent portions of a stator winding made of conductor segments with a rectangular cross-section, as shown in Figure 6 of the contested patent, appears to be merely a consequence of the fact that the legs of each U-turn portion have to be twisted apart in order to be arranged in two different slots formed in the stator core at different distances from the axis of the stator (see C15, page 394, Figure 5.111).

Furthermore, a person skilled in the art would realize that *"an inclined periphery"* of the U-turn necessarily implies an inclined preferential direction of the air flow and that effective cooling and low noise generation depend on a smooth air flow. The skilled person would then obviously choose between the two possible directions of rotation of the fans the one which produces an air flow with an orientation matching the inclination of the outer periphery of the U-turn portions.

6.7 Hence, even assuming the restrictive interpretation given by the respondent and only derivable from Figure 6, the Board is of the opinion that feature (g) expresses an effect that results from a mere implementation of the teaching of document D8, relating to the structure of a stator, with conductor segments having a rectangular cross-section.

7.1 In the result, the Boards considers that it would be obvious to a person skilled in the art, wishing to increase the output power of a compact alternator shown in document D12 and D13, to apply the teaching of D8, relating to the construction of a stator for an alternator comprising U-shaped conductor segments, and also to consider the possibility of using conductor segments with a rectangular cross-section. In doing so, the skilled person would arrive at an alternator having a stator with coil-ends disposed as specified in claim 1 and such that, in operation, the U-shaped coil-ends would receive from the cooling fan member a stronger air flow than the joint portions, as specified by feature (g).

7.2 As the subject-matter of claim 1 results from an obvious combination of the teachings of D13 (or D12) and D8 and of the general knowledge common in the art, it does not involve an inventive step within the meaning of Article 56 EPC.

Respondent's first auxiliary request

8.1 Claim 1 according to the first auxiliary request differs from claim 1 as maintained by the opposition division essentially in that it comprises the following features:

- an inner conductor (33 a), an outer conductor (33b), a U-turn portion (33c), a joint portion (33d) and inclined portions (33e, 33f),

- wherein each of said U-turn portions (33c) is disposed on the same axial end of the stator core (32) to form a first coil-end group (31c), each of outer conductors (33b) is inserted into the outer side of one of the slots (35), each of inner conductors (33a) is inserted into the inner side of the slots (35), each of a pair of joint portions (33d) is bent to be inclined outward, each of the joint portions (33d) in one of the outer and inner sides of the slot (35) is connected to one of joint portions of conductor segments (33) in another of the inner and outer sides of the slots (35) to form a second coil-end group (31d),

- the inclined portions (33e, 33f) of each conductor segments (33) are inclined in opposite directions at a certain angle so that a plurality of phase-windings can be disposed without interference.

8.2 As pointed out by the respondent, the addition of the above features was merely directed to clarifying that the expression *"inclined outer periphery of said U-turn portions"* related to the top part of the U-shaped conductor segments and not to the inclined legs of such segments.

8.3 According to the appellant, the features added to the claim as maintained by the opposition division simply described the different parts of U-shaped conductor segments and their arrangement around the core of a multi-phase stator. As shown in D8, these features were known in the art and thus did not contribute to the inventive step of the claimed subject-matter.

8.4 As the interpretation of claim 1 according to the main request given above already implies the distinction between the different parts of the conductor segments which the added features seek to clarify, the assessment of the inventive step of the subject-matter of claim 1 of the first auxiliary request remains the same as the one given for the main request.

Hence, the subject-matter of claim 1 according to the first auxiliary request does not involve an inventive step in the light of documents D13 (or D12), D8 and of the skilled person's general knowledge.

Respondent's second auxiliary request

9.1 Claim 1 according to the second auxiliary request differs from claim 1 of the main request essentially in that it further comprises the following feature:

(i) said U-turn portions (33c) of said first coil-end group (31c) have each an inclined outer periphery along which cooling air sent by said cooling fan member (11, 12) can flow.

Furthermore feature (h) of the claim according to the main request is reworded as follows:

(h') the quantity of cooling air sent by said cooling fan member (11, 12) to said second coil-end group (31d) is smaller than the quantity of cooling air sent to the first coil-end group (31c), and the speed of cooling air sent to said second coil-end

group (31d) is lower than the speed of cooling air sent to said first coil-end group (31d).

9.2 Hence, claim 1 of the auxiliary request comprises a feature (i) which refers to *"an inclined outer periphery of the U-turn portions along which cooling air can flow"*. As pointed out above, this feature is known from the prior art in the sense that it is an inherent characteristic of conductor segments with a rectangular cross-section once they are bent and twisted into a U-shape with two legs which can be inserted into corresponding slots provided in the stator core.

9.3 As to feature (h'), the claim now recites that the quantity of air sent to the first coil-end group is less than the air sent to the second coil-end group and that its speed is lower.

According to the appellant, the patent in suit did not specify what technical features of the alternator should achieve the effect recited in feature (h'). Figure 1 simply showed that the blades of the fan located on the pulley side of the alternator had a smaller surface and a smaller outer diameter than the blades of the other fan. An alternator with cooling fans having the same features was generally known, and in particular disclosed in D12.

The respondent pointed out that the size of the blades and the outer diameter were not necessarily linked to the speed of cooling air because this depended on many factors such as the inclination of the blades with respect to the radius of the rotor and their shape.

Thus, no conclusion as to the speed of the air flow could be drawn from figures which gave only a schematic illustration of the fan blades. Anyway, a person skilled in the art given the indication that the air speed should be lower on one side than on the other side would know how to implement this feature by appropriately choosing the shape, size and number of fan blades.

9.4 Several documents cited in the course of the appeal proceedings (see in particular D12 and D13) teach that the air flow should be higher on the side of the alternator where the electronic components are located. As well known to a person skilled in the art, air flow depends on the quantity of air passing through a given cross-section in a given time interval, so that control of a flow of cooling air implies that both the quantity of air and its speed are controlled. In fact, the effectiveness of a cooling air flow, whose purpose is the evacuation of heat, depends both on the quantity of air and on the speed with which the air flows along the surface to be cooled. It is, therefore, obvious to a skilled person to implement the teaching of D12 and D13 relating to the cooling of a compact alternator by increasing both the quantity and the speed of cooling air generated by one of the two cooling fans.

9.5 In summary, the amendments to claim 1 of the main request proposed by the respondent by way of auxiliary request 2, apart from not removing the objection of lack of clarity under Article 84 EPC, involve only a feature which is obvious to a person skilled in the art.

10. As none of the respondent's requests satisfies the requirements of the EPC, there is no basis for maintaining the patent in amended form.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

U. Bultmann M. Ruggiu