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D E C I S I O N
of 15 January 2004

Case Number: T 0063/02 - 3.5.2

Application Number: 95302626.7

Publication Number: 0684682

IPC: H02K 1/32

Language of the proceedings: EN

Title of invention:

Improvements in or relating to cooling arrangements for
rotating electrical machines

Patentee:

Alstom UK LTD

Opponent:

Siemens Aktiengesellschaft, Berlin und München

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56

Keyword:

"Novelty (yes)"
"Inventive step (yes)"

Decisions cited:

G 0004/95

Catchword:

-



Case Number: T 0063/02 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 15 January 2004

Appellant: Siemens Aktiengesellschaft,
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Representative: -

Respondent: Alstom UK LTD
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Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
26 November 2001 concerning maintenance of
European patent No. 0684682 in amended form.

Composition of the Board:

Chairman: F. Edlinger
Members: M. Ruggiu
P. Mühlens

Summary of Facts and Submissions

- I. The opponent filed an appeal against the interlocutory decision of the opposition division to maintain European patent No. 0 684 682 in amended form.
- II. The appellant relied on the following prior art documents:
- E2: DE-A-2 365 453;
- E3: DE-C-586 175;
- E5: DE-B-1 090 750; and
- E7: SU-A-710 090 and its Derwent abstract.
- III. Following a communication of the board accompanying summons to oral proceedings, the respondent patentee, by letters received at the EPO on 28 November 2003 and 16 December 2003, requested permission for the inventor to accompany the representative at the oral proceedings and address the board concerning the technical functioning and structure of the invention and the prior art.
- IV. Oral proceedings took place before the board on 15 January 2004. During the oral proceedings, the appellant submitted that the conditions specified in decision G 4/95 were not met and requested that the inventor not be allowed to address the board. After deliberation, the board decided to allow the inventor to make submissions to the board.

V. The appellant (opponent) requested that the decision under appeal be set aside and that the patent be revoked.

VI. The respondent (patentee) requested that the patent be maintained in amended form in the following version:

claims:

- 1 to 4 filed in the oral proceedings
- 5 to 15 as approved by the opposition division

description:

- page 3 filed in the oral proceedings
- pages 2, 4, 5, 6 as approved by the opposition division

drawings:

- Figures 1 to 12 of the patent specification.

VII. Present claim 1 of the patent in suit reads as follows:

"A rotor core for a cage induction machine, comprising a plurality of teeth (109), a plurality of rotor bar slots (118) and a rotor bar (111) contained in each slot, each one of said plurality of teeth being provided with a recess (110) in an outer corner of one side of the tooth, such that in conjunction with a corresponding rotor bar (111), each recess (110) forms an air ventilation duct extending along the axial length of the rotor core, the recess being of such radial depth as to expose a significant proportion of one face (113) of the rotor bar to the duct such that the rotor bar is directly cooled by the contacting air."

Claims 2 to 15 are dependent on claim 1.

VIII. The appellant essentially argued as follows:

Document E2 concerned a rotor core for a cage induction machine. Figure 3 of E2 showed radially oriented incisions on two sides of each rotor bar, which incisions exposed radial faces of the rotor bar. E2 also disclosed that the incisions could be open to the periphery of the rotor. In this case, the incisions exposing radial faces of rotor bars would in fact form recesses in outer corners of the teeth of the rotor core. E2 further specified that the incisions should reach to at least half the depth of the slots occupied by the rotor bars as measured from the surface of the rotor. According to E2, at least some of the incisions contained a rod of insulating material in order to prevent current from flowing between the rotor bars. It was apparent that a single incision on one side of each rotor bar was sufficient to achieve this purpose. Furthermore, E2 envisaged that all rotor laminations could present incisions and that the insulating rods in the incisions could be replaced by air. The incisions would then form air ventilation ducts extending along the axial length of the rotor core. Indeed E2 indicated that the invention described there improved the cooling ("Wärmeabgabe") of the rotor. Thus, the subject-matter of claim 1 of the patent in suit lacked novelty with respect to the prior art disclosed in E2.

Document E3 concerned an arrangement in which, in order to improve cooling, recesses were formed in the top parts of slots, close to the surface of the rotor of an

electrical machine. It could in particular be seen from the right hand part of Figure 1 of E3, which showed a slot with a rotor bar in it, that the bar did not completely occupy the slot but left an empty space therein. This empty space included a recess formed in one side of the adjacent tooth and extended from the top of the slot, which was open to the air gap of the machine, to the bottom of the slot. As could be seen from the right hand part of Figure 2 of E3, the empty space formed an air ventilation duct extending along the length of the rotor. The subject-matter of claim 1 of the patent in suit therefore lacked novelty with respect to the disclosure of E3. Document E3 further disclosed the combination of semi-closed slots with axial cooling channels. As was well known, semi-closed slots allowed dispensing with wedges for retaining the rotor bars in the slots. Therefore, the top side of a bar in a semi-closed slot was exposed to air in an axial cooling channel formed by the part of the slot above the bar and claim 1 of the patent in suit also lacked novelty or at least did not involve an inventive step with respect to a rotor core with semi-closed slots.

Document E7 described a rotor core for a cage induction machine comprising sections made of different types of laminations. A first type of lamination had holes formed in the teeth. Another type of lamination had a recess in an outer corner of each tooth. This recess was of such radial depth as to expose a face of a rotor bar, such that the rotor bar was directly cooled by contacting air. Packets of the first type of lamination formed closed ventilation ducts. Packets of the other type of lamination allowed the air in the air gap of

the machine to be transported to/from the ventilation ducts in the packets of the first type of lamination. It was obvious to the skilled person that using different types of laminations was expensive. It was also obvious that closed ventilation ducts were inefficient and that laminations with recesses that opened to the air gap would provide a better cooling. Thus, it would be obvious to the skilled person, in order to reduce manufacturing costs and improve cooling, to manufacture the rotor entirely with laminations of the other type. The skilled person would thereby arrive in an obvious manner at the subject-matter of claim 1 of the patent in suit. E2 was also concerned with reducing manufacturing costs and improving cooling. It was thus obvious to a skilled person to combine the teachings of E7 and E2. It was also obvious to combine E7 with E3 and E5.

IX. The arguments of the respondent can be summarised as follows:

Document E2 was concerned with insulation between rotor bars, not with actively cooling the rotor bars, and referred to air only for its insulating ability. E2 disclosed either incisions in the middle of the teeth between the rotor bars or incisions on two sides of each rotor bar. By contrast, claim 1 of the patent in suit defined only one recess on one side of a rotor bar. The skilled person would not consider having incisions opening to the air gap on two sides of a rotor bar because this would result in insufficient support for the bar. Furthermore, the end laminations of the rotor core described in E2 did not include any

incision, so that the incisions did not form axial air ventilation ducts.

E3 described a rotor core in which windings or rotor bars were retained in slots by means of wedges that thermally isolated the windings or bars from the air in the air gap of the machine. The right hand parts of Figures 1 and 2 of E3 showed empty slots, without bars or windings therein and without wedges. Thus, E3 did not show any empty space left by a bar in a slot. Furthermore, E3 only concerned cooling of the active iron and did not contain any incentive to remove the wedges. E3 also mentioned semi-closed slots. However, with semi-closed slots, cooling was purely incidental to the purpose of retaining the bars.

Document E5 was concerned with cooling the teeth, not the rotor bars. E5 showed semi-closed slots which received rotor bars and were open to the air gap of the machine. However, the openings of the slots to the air gap were too small to provide cooling to the bars.

The ventilation ducts in the rotor of the machine of E7 were sectionalised and separate from the slots containing the rotor bars. The packets of laminations provided with recesses for input/output of air to the sectionalised axial ventilation ducts constituted only a minor proportion of the axial length of the rotor. Thus, no significant proportion of a face of a rotor bar was exposed to the cooling air in the machine of E7. The reasoning suggesting that it was obvious to remove the packets forming the sectionalised ventilation ducts from the rotor core of E7 was inadmissible as it amounted to a reconstruction of the prior art with

knowledge of the invention. A combination of E7 with E2 was impermissible in particular because E2 did not concern ventilation but insulation between the rotor bars. A combination of E7 with E3 was also impermissible because E3 was not at all concerned with direct cooling of the rotor bars.

Reasons for the Decision

1. The appeal is admissible.
2. *Procedural matters*

The board considered the request of the appellant that the inventor not be allowed to address the board in the oral proceedings. The board was of the opinion that the subject-matter of the proposed oral submissions had been sufficiently specified in the proprietor's letter, i.e. the board expected to hear technical arguments presented by the inventor about the patent and the invention and aspects of the relevant prior art under the control of the professional representative. Thus, in the view of the board, the conditions set out in decision G 4/95 were met and the board allowed the submissions.

3. *Amendments*

No objection under Article 123(2) or 123(3) EPC has been raised against the amendments made to the patent in suit, neither in the decision under appeal (which was based on a claim 1 that differed from present claim 1 only in that it was drafted in two part form),

nor on the side of the appellant. The board also has no objection on this basis. Thus, the amendments made to the patent do not contravene Articles 123(2) and 123(3) EPC.

4. *Novelty*

4.1 Document E2 discloses a rotor core for a cage induction machine, comprising a plurality of rotor bars arranged in slots, wherein incisions containing an insulating material that can be air are provided between the slots. The incisions are substantially radially directed and can be either closed or open to the circumference of the rotor. In the case of rotors with welded cages, all laminations of the rotor may be provided with said incisions. Figure 3 of E2 illustrates a lamination of a rotor in which radial incisions are provided on two sides of each rotor bar. These incisions, which are not open to the circumference of the rotor, are contiguous to the rotor bar. E2 explains that the incisions insulate the rotor bars from each other but does not make any mention of ventilating the rotor by means of the incisions. Improved cooling as mentioned in E2 (page 7, last sentence) is achieved in that the insulation of the rotor bars, which would reduce the thermal dissipation from the bars, can be dispensed with (see E2, page 4, second and third paragraphs). The board takes therefore the view that E2 does not disclose an air ventilation duct extending along the axial length of the rotor core. Furthermore, the skilled person would not seriously contemplate opening the incisions shown in Figure 3 of E2 to the circumference of the rotor because this would remove support for the rotor bar contained in the slot. There

is also no teaching in E2 to use air as an insulating material in the incisions shown in Figure 3. Thus, the subject-matter of claim 1 of the patent in suit is not anticipated by the disclosure of E2.

- 4.2 Document E3 concerns an arrangement for improving cooling of the rotor of an electrical machine. The improvement is achieved by, on the one hand, sinking the wedges retaining the windings or bars in the slots of the rotor with respect to the cylindrical surface formed by the active iron of the rotor and, on the other hand, arranging the slots of the rotor at an angle to the axis of the machine. As shown in Figure 1 of E3, the wedges are received in recesses provided on the mutually facing sides of two adjacent teeth. In conjunction with the top part of the slot, i.e. that part of the slot between the wedge and the circumference of the rotor, the recesses form air ventilation ducts extending along the axial length of the rotor. E3 (page 3, lines 24 to 30) mentions that the arrangement described therein increases the surface of the active iron in contact with the cooling air from the air gap because the lateral faces of the top parts of the slots are directly in contact with the ventilating air. E3 does not mention that another part of a slot is left empty, especially not the part between the wedge and the bottom of the slot, or that a part of the rotor bars extends between the wedges and the circumference of the rotor. Therefore, the board takes the view that E3 does not disclose directly cooling by contacting air the windings or rotor bars contained in the slots. The introductory portion of E3 indicates that semi-closed slots are not to be favoured because only a very small surface of active iron is in

contact with the cooling air. It is therefore apparent that a skilled person would not regard a semi-closed slot as providing an air ventilation duct or exposing a significant proportion of a rotor bar such that the rotor bar would be directly cooled by the contacting air. Thus, the board considers that the subject-matter of claim 1 of the patent in suit is not anticipated by the disclosure of E3.

4.3 It is not in dispute that neither document E5 nor document E7 discloses a rotor core in which each of the teeth is provided with a recess in an outer corner of one side of the tooth which forms an air ventilation duct extending along the axial length of the rotor core and exposes a significant proportion of one face of a rotor bar.

4.4 The subject-matter of present claim 1 is therefore considered as being new in the sense of Article 54(1) EPC.

5. *Inventive step*

5.1 Document E7 discloses a rotor core, apparently for a cage induction machine, comprising a plurality of teeth, a plurality of rotor bar slots and a rotor bar contained in each slot. According to E7, different types of laminations are used in the rotor core. A first type of lamination has round holes in the teeth. Packets of laminations of the first type form sectionalised axial ventilation ducts in the core. Each tooth of a lamination of the other type is provided with a recess in an outer corner of one side of the tooth. Packets of laminations of the other type are

placed at the ends of the packets of laminations of the first type for input/output of cooling air from the air gap into/from the axial ventilation ducts. Since the packets of laminations of the other type only occupy a relatively small proportion of the axial length of the core, it is apparent that the recesses in these laminations do not form air ventilation ducts extending along the axial length of the rotor core and do not expose a significant proportion of one face of a rotor bar.

- 5.2 The problem solved by these novel features of the invention is that of providing a more efficient ventilation of the rotor. As explained before, document E2 is not concerned with the ventilation of a rotor core and especially not with direct ventilation of rotor bars. It would therefore not be obvious to the skilled person to resort to the teaching of E2 in order to solve the problem tackled by the invention. A combination of E7 and E2 would thus be based on hindsight. Using semi-closed slots, which are generally known (see E5 and E3), in the rotor core described in E7 would also not be contemplated by the skilled person wanting to improve ventilation, because it is known, in particular from E3, that semi-closed slots do not provide efficient ventilation. Furthermore, E3 is concerned with cooling of the active iron in a rotor core, not with direct cooling of rotor bars and nothing in E3 suggests exposing a significant proportion of one face of a rotor bar to cooling air. Thus, a combination of E7 and E3 would not lead the skilled person to the subject-matter defined by claim 1 of the patent in suit. It might be obvious that the use of different types of laminations makes the rotor core of E7 expensive.

However, the state of the art does not contain any suggestion that using only laminations provided with recesses would provide ventilation ducts suitable for cooling the rotor and especially the rotor bars. Thus, the board considers that, without hindsight, it was not obvious to a skilled person to reconstruct the rotor of E7 using only laminations provided with recesses.

5.3 Therefore, the board concludes that, having regard to the state of the art, the subject-matter of claim 1 of the patent in suit is not obvious to a person skilled in the art. The subject-matter of claim 1 is thus to be considered as involving an inventive step in the sense of Article 56 EPC.

6. Claims 2 to 15 of the patent in suit are dependent on claim 1. Their subject-matter is therefore considered as being new and involving an inventive step.

Order

For these 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 in amended form in the following version:

claims:

- 1 to 4 filed in the oral proceedings
- 5 to 15 as approved by the opposition division

description:

- page 3 filed in the oral proceedings
- pages 2, 4, 5, 6 as approved by the opposition division

drawings:

- Figures 1 to 12 of the patent specification.

The Registrar:

The Chairman:

D. Sauter

F. Edlinger