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**Datasheet for the decision  
of 22 June 2011**

**Case Number:** T 0541/08 - 3.5.02

**Application Number:** 00200159.2

**Publication Number:** 1024580

**IPC:** H02K 1/32

**Language of the proceedings:** EN

**Title of invention:**  
Rotary electric machine

**Patentee:**  
ABB AB

**Opponent:**  
SIEMENS AKTIENGESELLSCHAFT

**Headword:**  
-

**Relevant legal provisions:**  
EPC Art. 56, 113

**Relevant legal provisions (EPC 1973):**  
-

**Keyword:**  
"Right to be heard - no judgement on the question of added  
subject-matter"  
"Inventive step - no"

**Decisions cited:**  
-

**Catchword:**  
See point 2 of the reasons



Case Number: T 0541/08 - 3.5.02

**D E C I S I O N**  
of the Technical Board of Appeal 3.5.02  
of 22 June 2011

**Appellant:** SIEMENS AKTIENGESELLSCHAFT  
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**Representative:** -

**Respondent:** ABB AB  
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**Representative:** Karlsson, Leif Karl Gunnar  
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**Decision under appeal:** Interlocutory decision of the Opposition  
Division of the European Patent Office posted  
17 January 2008 concerning maintenance of  
European patent No. 1024580 in amended form.

**Composition of the Board:**

**Chairman:** M. Ruggiu  
**Members:** G. Flyng  
P. Mühlens

## Summary of Facts and Submissions

- I. The opponent has 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 following documents were mentioned in the contested decision, with only E1 and D1 being referred to in detail in the reasons:

E1: DE 1 488 657 A  
E2: GB 2 012 118 A  
E3: DE 1 767 892 U  
E4: CH 660 263 A5  
D1: DE 44 43 427 A1.

- II. With a letter dated 28 April 2008, setting out the grounds for appeal, the appellant (opponent) filed the following document, together with an English translation thereof:

E5: SU 760903.

The appellant argued that the subject-matter of independent claims 1, 6, 15 and 22 lacked novelty from document E5 and also lacked an inventive step from the combination of documents E1 and D1.

- III. The respondent (proprietor) replied to the appeal in a letter dated 16 September 2008, arguing essentially

that E5 did not add anything of interest when evaluating the patentability of the invention.

IV. The Board summoned the parties to oral proceedings to be held on 22 June 2011. In an annex to the summons the Board set out its preliminary observations on the appeal.

V. In a letter dated 17 May 2011 the respondent announced that he would not be present at the oral proceedings and filed a new main request and first, second and third auxiliary requests to replace those on file.

VI. Oral proceedings were held as scheduled. As announced, the respondent was not present.

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

The respondent (patentee) had requested in writing that the patent be maintained in amended form on the basis of the main request or on the basis of the first, second or third auxiliary requests, all filed with letter of 17 May 2011.

VII. Each of the respondent's requests includes a plurality of independent claims, with an apparatus claim thereof directed to a "rotor of a rotary electric machine", see:

- main request - claim 11;
- first auxiliary request - claim 13;
- second auxiliary request - claim 9; and
- third auxiliary request - claim 8.

These will be referred to hereinafter as the "independent rotor claims". Each request further includes an independent claim directed to "A method of improving the performance utilization of a rotary electric machine" and an independent claim directed to a "Rotary electric machine". These correspond in essence to the independent rotor claims, so this decision concentrates on the latter.

All of the independent rotor claims commence with the following features (feature referencing in parentheses added by the Board):

- (a) "Rotor of a rotary electric machine, having rotor winding grooves (14; 24; 34; 44) provided around its circumference and having cooling channels (15; 25; 35; 45; 55; 65; 75; 85; 85') radially inwardly of the rotor winding grooves extended in the axial direction of the rotor, characterized in that that [sic] the cooling channels (15; 25; 35; 45; 65; 75; 85; 85') or alternatively groups of cooling channels (55) that are mainly active in cooling the machine
- (b) are provided with an elongated cross section shape (15; 25; 35; 45; 85; 85') in the radial direction of the rotor, and
- (c) are provided distributed around the longitudinal axis (C) of the machine,
- (d) symmetrically with respect to the magnetic flow paths in the rotor and
- (e) symmetrically in relation to the rotor winding grooves,
- (f) and the number of cooling channels is directly related to the number of rotor winding grooves,

(g) whereby symmetry is achieved in the magnetic circuit of the rotor, and ..."

**Claim 11 of the main request** comprises the following additional feature (reference added):

(h) "... in that each of the cooling channels (25; 35; 65; 75; 85; 85') or alternatively groups of cooling channels (55) that are mainly active in cooling the machine are provided substantially in a radial plane passing midway between two adjacent rotor grooves (24; 34)."

**Claim 13 of the first auxiliary request** comprises the following additional feature (reference added):

(i) "... which cooling channels (15; 25; 35; 45; 65; 75; 85; 85'), or alternatively groups of cooling channels (55) in the rotor, are provided in a number that is half the number of rotor grooves."

**Claim 9 of the second auxiliary request** comprises both of the above mentioned additional features (h) and (i).

**Claim 8 of the third auxiliary request** comprises both of the additional features (h) and (i), as well as the following additional feature (reference added):

(j) "... in that the cooling fluid being mainly active in cooling the machine is conducted through cooling channels (15; 65; 75) that are formed having an enlarged peripheral surface and/or cross section area."

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

All of the independent claims of all requests claim, in one alternative, that the "groups of cooling channels (55) that are mainly active in cooling the machine are provided with an elongated cross section shape (15; 25; 35; 45; 85; 85') in the radial direction of the rotor". The application as filed discloses separate channels that have an elongated cross section shape in the radial direction of the rotor (see EP 1 024 580 A2, figures 2 to 7 and 10). Also disclosed is a variant in which these separate channels are replaced by groups of cooling channels 55 (see EP 1 024 580 A2, paragraph [0039] and figure 11a). In figure 11a the cooling channels are shown as being circular in cross section. Groups of cooling channels provided with an elongated cross section shape are not directly and unambiguously derivable from the application as filed. The inclusion of this combination of features adds subject-matter contrary to Article 123(2) EPC.

Document E5 discloses a rotor of an electrical machine that has all of the features referenced (a) to (g) above. In particular, it discloses cooling channels that are radially elongate (figure 2.3) and are positioned in direct proximity to the anchor winding formed by the slots, i.e. grooves (see page 2, lines 21 to 24) to improve heat transfer. Furthermore, it is evident for the skilled person that the cooling channels of E5 are positioned symmetrically with respect to the magnetic flow paths in the rotor and symmetrically in relation to the rotor winding grooves, and that the number of cooling channels is directly

related to the number of rotor winding grooves (i.e. 1:1).

Considering the main request, the subject-matter of feature (h) amounts to shifting the channels of E5 circumferentially by half the tooth pitch. This is merely an alternative arrangement of the cooling channels that the skilled person would consider, without involving an inventive step. The contested patent does not disclose any technical effect achieved by this arrangement of cooling channels. Furthermore, document E2 discloses a rotor with axial cooling channels (axial passages 35) and states that a significant consideration for the construction of the axial passage 35 is whether it should be aligned with each rotor bar 41, as shown in FIG. 2, or should be positioned between the rotor bars (see page 2, lines 25 to 29). In the light of this disclosure it would be obvious for the skilled person to position the cooling channels of document E5 in the manner set out in feature (h).

Considering the first auxiliary request (feature (i)), it would be a routine matter for the skilled person starting from document E5 to reduce the number of cooling channels, while keeping a magnetically and mechanically balanced arrangement. Furthermore, it is known from document E1 to provide a rotor with a regular pattern of winding grooves and cooling channels, with each cooling channel being centred on a tooth (figure 13) and cooling several winding grooves. The contested patent does not disclose any technical effect achieved by providing half the number of cooling channels as winding grooves, indeed this goes against



the aim of positioning the cooling channels close to the winding grooves. Also, E1 discloses stator arrangements with one cooling channel for each two winding grooves (see figures 3 and 4 and page 5, second paragraph). In the light of this disclosures it would be obvious for the skilled person to provide the rotor of document E5 with a number of cooling channels as set out in feature (i).

There is no interrelationship between the features (h) and (i) and their combination does not yield any synergetic effect, such that combining them as in the second auxiliary request amounts to a mere aggregation of obvious measures.

Considering the third auxiliary request (feature (j)), it is well known that heat transfer from a body can be increased by increasing its surface area. Furthermore, the patent discloses that one measure to increase the surface area of the cooling channels is to make them radially elongate. The cooling channels of document E5 are radially elongate and hence must also provide an increased surface area. Thus, feature (j) is known from document E5.

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

The claims of all requests comply with Article 123(2) EPC.

All the documents E1, E2, D1 and E4 fail to disclose at least feature (b), which is present in all independent claims of all requests.

E5 does not disclose the features (d), (e), (f) and (g), which are present in the independent claims of all requests.

The independent claims of the main request are further distinguished from E5 by feature (h). By this feature it will be possible to arrange the cooling channels radially further out than if they were located in radial planes radially inside the rotor grooves. This increases the cooling area due to the increased circumferential length. Furthermore it reduces the distance to the heat sources, i.e. the rotor windings in the grooves. The cooling thereby is improved making a higher power output possible. E5 does not address the effect of the location of the cooling channels in the circumferential direction relative to the grooves. Nothing in E5 points toward any hint that the relative circumferential position affects the cooling efficiency. Thus, when starting from E5, the skilled person would not come to a solution where the circumferential relative position is of importance, in particular not to the specific solution according to the independent claims of the main request, where the cooling channels are in the middle between two grooves. None of the documents E1, E2, D1 and E4 contains any hint that cooling efficiency could be increased by arranging each cooling channel in the middle between two adjacent grooves as claimed. A combination of E5 with any of these documents would therefore not lead the skilled person any closer to the present invention. The independent claims of the main request therefore meet the requirement of inventive step over any combination of the cited documents.

The independent claims of the first auxiliary request are further distinguished from E5 by feature (i), that the number of cooling channels is half the number of rotor grooves. This is particularly advantageous when the groove pitch is relatively small, i.e. small circumferential width of the channels and of the intermediate teeth. With a number of cooling channels corresponding to that of the grooves this would lead to cooling channels that are narrow in the circumferential direction. This would lead to a relatively high pressure fall for a given air flow due to less favourable relation between a channels dimensions in the radial and the circumferential direction. In order to avoid the high pressure fall it is in such a case necessary to reduce the air flow entailing the drawback of reduced cooling. By reducing the number of channels this can be avoided, and by making the reduction such that the number equals half the number of grooves the symmetry is maintained. With the reduced number of channels the circumferential width of each channel can be increased resulting in a lower pressure fall at maintained air flow. This is particularly important when there is a high number of grooves. In those cases the cooling efficiency will be much higher with a cooling channel for each second groove in comparison with a cooling channel for each groove. Also in this respect E5 is silent regarding this aspect of the cooling efficiency. Not even the problem of the effect of the circumferential width of the channels on the cooling efficiency is identified, and thus there is of course no hint to a solution of this problem. Also in this respect E5 teaches away from the present invention as defined in this request, since a number of cooling

channels that is equal to the number of grooves is disclosed. The skilled person therefore would not arrive at the invention as claimed in this request starting from E5. Since none of the documents E1, E2, D1 or E4 discloses a number of cooling channels that are half the number of grooves, any combination of E5 with any of these documents would not lead the skilled person towards the claimed solution. The independent claims according to the first auxiliary request therefore meet the requirement of inventive step.

As to the second auxiliary request, the combined effect of locating the cooling channels in the middle between the grooves and reducing the number of cooling channels to half the number of grooves leads to a particularly effective cooling.

The independent claims according to the third auxiliary request contain the further feature that the cooling channels have enlarged peripheral surface and/or cross section area. This feature further increases the cooling efficiency. Neither E5 nor any of the other cited documents mentions the effect of the shape of the channels regarding the cooling and do not contain any hint that would lead toward this solution. The independent claim of this request thus contain a plurality of features that cooperate with each other to achieve a solution providing a very efficient cooling.

## Reasons for the Decision

1. The appeal is admissible.
2. **Amendments, Article 123(2) EPC**
  - 2.1 Regarding the question whether groups of cooling channels provided with an elongated cross section shape are directly and unambiguously derivable from the application as filed, the Board notes that this combination of features was already present in the claims which, in the contested decision, were held to meet the requirements of the convention. Nevertheless, this question was apparently not raised at all in the first instance proceedings, nor in the written stage of the appeal procedure, but was raised by the appellant for the first time during the oral proceedings before the Board, proceedings at which the respondent had chosen not to be present.
  - 2.2 As this question does not arise from the amendments made by the respondent during the appeal proceedings (a situation different to that encountered in T341/92, cf. Case Law of the Boards of Appeal of the EPO, 6th edition, 2010, VI.B.3.1), the Board considers that in this case the respondent could not have expected to have to defend himself on this issue before the oral proceedings. Thus, it was questionable whether this issue could be treated at the oral proceedings without offending the respondent's right to be heard (Article 113 EPC). Therefore, the board refrained from judging on this point.

3. **Main request**

3.1 It is not contested that document E5 discloses a rotor of a rotary electric machine (see E5, figure 2 and its translation, page 1, lines 54 and 55), that the rotor has rotor winding grooves (slots 17) provided around its circumference (see E5, figure 2 and its translation, page 2, lines 12 to 24) and that the rotor has cooling channels 19 radially inward of the rotor winding grooves 17, that extend in the axial direction of the rotor (see E5, figures 2 and 3 and its translation, page 2, lines 12 to 15).

Furthermore, it is not contested that the cooling channels of E5 have an elongated cross-sectional shape in the radial direction of the rotor and are provided distributed around the longitudinal axis of the machine (see E5, figures 2 and 3 and its translation, page 2, lines 36 to 39 "*it is thus possible to create a turbulent flow in a channel of much smaller cross-section*" and page 3, lines 16 and 17 "*Because of the reduced specific volume of compressed air, the air channels may be narrower ...*").

Also, it is not contested that the cooling channels shown in figures 2 and 3 of E5 are those mainly active in cooling the machine.

Hence, features (a), (b) and (c) of the independent rotor claims are known from document E5.

3.2 According to page 2, lines 14 and 15 of the translation of E5, the axial cooling channels 19 are located in the ferromagnetic core 3 between the slots 17 and the

yoke 18. Furthermore, according to page 2, lines 21 and 22, "The cooling channels ... are positioned in direct proximity to the anchor winding formed by the slots 17 of the section 21, ..." (emphasis added). In view of these disclosures, taken together with the arrangement of the cooling channels shown in figures 2 and 3, the Board concludes that E5 directly and unambiguously discloses to provide one cooling channel radially inward of and in direct proximity to each winding groove.

This arrangement is symmetrical with respect to the magnetic flow paths in the rotor and in relation to the rotor winding grooves. Furthermore, the number of cooling channels is directly related to the number of rotor winding grooves (i.e. 1:1). Also, if this arrangement achieves symmetry in the magnetic circuit of the rotor in the patent, then it must also do so in E5. Hence, the Board concludes that even if features (d), (e), (f) and (g) of the independent rotor claims, are not explicitly mentioned in E5, they are implicit from the disclosed arrangement of the cooling channels.

- 3.3 Given that document E5 discloses providing a cooling channel radially inward of and in direct proximity to each winding groove, it evidently does not disclose feature (h), which requires that each cooling channel (or alternatively group of cooling channels) ... is provided substantially in a radial plane passing midway between two adjacent rotor grooves. Hence independent claim 11 of the main request is considered to be novel over E5, Article 54 EPC.

3.4 The subject-matter of claim 11 of the main request differs from the disclosure of document E5 in that the cooling channels are shifted circumferentially by half the tooth pitch, such that they are positioned not radially inward of and in direct proximity to each winding groove, but midway between two adjacent grooves. In other words, the cooling channels according to claim 11 are centred on the rotor teeth.

3.5 Whereas figures 2 and 5 of the patent, like E5, show rotors with cooling channels centred on the rotor grooves, figures 3 and 4 of the patent in suit show embodiments in which the cooling channels are centred on the rotor teeth. According to paragraph [0031] of the patent (see EP 1 024 580 B1), positioning the cooling channels on a radius passing centrally through every other tooth provides the symmetry in relation to the [magnetic] flow paths. The patent does not indicate any other effect that would be achieved by centring the cooling channels on the rotor teeth rather than on the rotor grooves.

According to the respondent, this feature allows the cooling channels to be located radially further out than if they were located in radial planes radially inside the rotor grooves and reduces the distance to the heat sources, i.e. the rotor windings in the grooves. The Board is not convinced by these arguments, as they fail to take into account the magnetic flow path passing through the rotor tooth. Locating the cooling channel radially further outwards would reduce the amount of magnetic material at the base of the rotor teeth, leading to undesirable saturation. Furthermore, shifting the cooling channels



circumferentially from a position inward of the grooves to a position inward of the teeth evidently moves them further from the heat sources, i.e. the rotor windings in the grooves.

For these reasons, the Board considers that starting from E5, the objective problem solved by the feature (h) is to find an alternative arrangement of the cooling channels.

3.6 As was indicated in the grounds for opposition (see letter dated 27 June 2005, paragraph spanning pages 3 and 4), document E2 discloses a rotor with axial cooling channels (axial passages 35) and states at page 2, lines 25 to 29:

"Another significant consideration for the construction of the axial passage 35 is whether it should be aligned with each rotor bar 41, as shown in FIG. 2, or should be positioned between the rotor bars".

At page 2, lines 65 to 69, E2 states:

"The axial cooling passages 35 were aligned with the individual rotor bars 41 because in the multi-stamp operation utilized to fabricate the rotor, this entailed minimum indexing and thus least manufacturing expense".

3.7 In the Board's view, the skilled person starting from document E5 would take the disclosure of E2 into account, as it evidently discusses alternative cooling channel arrangements for rotors.

Furthermore, the skilled person would learn from E2 that one option, albeit one with certain disadvantages, is to position the cooling channels between the rotor bars. Following E2, it would be an obvious matter for the skilled person to try this option in E5, accepting the known disadvantages. According to established case law, a disadvantageous modification does not involve an inventive step if the skilled person could clearly predict these disadvantages, if his assessment was correct and these predictable disadvantages were not compensated by any unexpected technical advantage (see Case Law of the Boards of Appeal of the EPO, 6th edition, 2010, I.D.8.5 Foreseeable disadvantageous or technically non-functional modifications). This applies to the present case, particularly as no unexpected technical advantage has been demonstrated.

When positioning the cooling channels between the rotor grooves it would be obvious to place them centrally for reasons of mechanical and magnetic balancing, which are basic considerations in motor design.

3.8 Thus, starting from E5 and taking the teachings of E2 into account, the skilled person would come to the subject-matter of claim 11 of the main request, without involving an inventive step, Article 56 EPC.

4. **First auxiliary request**

4.1 Claim 13 of the first auxiliary request differs from claim 11 of the main request in that feature (h) is replaced by feature (i), which specifies in essence that the number of cooling channels (or groups thereof) is half the number of rotor grooves.

4.2 Figures 3 and 5 of the patent in suit show embodiments in which the number of cooling channels is half the number of rotor grooves (see also paragraphs [0031] and [0035] of the patent), however the patent does not mention whether there is any particular technical effect achieved by using this number of cooling channels, rather than one for each winding groove.

According to the respondent, this arrangement is particularly advantageous in motors with a high number of grooves, where the groove pitch is relatively small, i.e. the circumferential width of the channels and of the intermediate teeth is small. The respondent alleges that with a cooling channel for each second groove the cooling efficiency will be much higher than with a cooling channel for each groove, but has not adduced any evidence in support of this claim.

For these reasons, the Board considers that starting from E5, the objective problem solved by the feature (i) is also to find an alternative arrangement of the cooling channels.

4.3 In the grounds for opposition (see letter dated 27 June 2005, paragraph spanning pages 6 and 7), it was indicated that figures 3 and 4 of document E1 show arrangements in which the number of cooling channels is half the number of rotor winding grooves and there are two rotor winding grooves for each cooling channel (see page 5, lines 16 to 18).

In fact, figures 3 to 12 of E1 are disclosed as showing not rotor cooling arrangements, but stator cooling

arrangements (see page 4, second paragraph). Only figures 13 and 14 of E1 show rotor cooling arrangements. Nevertheless, the Board considers that it would be evident to the skilled person that an arrangement of axial cooling channels for a stator could be applied just as well to a rotor. Hence, it would in the Board's view be obvious for the skilled person, motivated by E1, to consider modifying the disclosure of E5 to use only half the number of cooling channels as there are rotor winding grooves.

4.4 Thus, starting from E5 and taking the teachings of E1 into account, the skilled person would come to the subject-matter of claim 13 of the first auxiliary request, without involving an inventive step, Article 56 EPC.

## 5. **Second auxiliary request**

5.1 Claim 9 of the second auxiliary request includes feature (h) and feature (i).

5.2 As set out above, the skilled person starting from document E5 would come to each of the features separately without involving an inventive step.

The respondent has not demonstrated that there is an interrelationship between the features (h) and (i) or that their combination yields any synergetic effect.

Furthermore, given that in figure 4 of document E1 there are two winding grooves for each cooling channel and each cooling channel is positioned midway between two adjacent winding grooves, it is evident that it is

possible to combine features (h) and (i) without any technical difficulty.

Hence, the Board shares the appellant's view that combining features (h) and (i) amounts to a mere aggregation of obvious measures.

5.3 Thus, starting from E5 and taking the teachings of E1 and E2 into account, the skilled person would come to the subject-matter of claim 9 of the second auxiliary request, without involving an inventive step, Article 56 EPC.

## 6. **Third auxiliary request**

6.1 Claim 8 of the third auxiliary request comprises the additional features (h) and (i), as well as the following additional feature (j), that the cooling fluid mainly active in cooling the machine is conducted through cooling channels that are formed having an enlarged peripheral surface and/or cross section area.

6.2 According to the contested patent, one measure to increase the inner peripheral surface of the cooling channels is to make them radially elongate (see paragraphs [0011], [0022] and [0040]). The cooling channels of document E5 are radially elongate and hence must also provide an enlarged peripheral surface, when compared for example to a circular channel. Thus, feature (j) is disclosed implicitly in document E5.

6.3 Thus, starting from E5 and taking the teachings of E1 and E2 into account, the skilled person would come to the subject-matter of claim 8 of the third auxiliary

request, without involving an inventive step,  
Article 56 EPC.

7. In view of the above, none of the respondent's requests provides a basis for maintenance of the patent in amended form. Hence, the board has to accede to the appellant's request for revocation of the patent.

## **Order**

### **For the above reasons it is decided that:**

1. The decision under appeal is set aside.
2. The patent is revoked.

The Registrar:

The Chairman:

C. Moser

M. Ruggiu