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**Datasheet for the decision
of 12 September 2013**

Case Number: T 0355/10 - 3.5.02

Application Number: 99125812.0

Publication Number: 1014542

IPC: H02K 21/16, H02K 1/27

Language of the proceedings: EN

Title of invention:
Motor having a rotor with interior split-permanent-magnet

Patent Proprietor:
Panasonic Corporation

Opponent:
Siemens Aktiengesellschaft

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - no (all requests)"

Decisions cited:
-

Catchword:
-



Case Number: T 0355/10 - 3.5.02

DECISION
of the Technical Board of Appeal 3.5.02
of 12 September 2013

Appellant: Siemens Aktiengesellschaft
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 15 December 2009 rejecting the opposition filed against European patent No. 1014542 pursuant to Article 101(2) EPC.**

Composition of the Board:

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

Summary of Facts and Submissions

- I. The opponent (appellant) has appealed against the decision of the opposition division rejecting the opposition against European patent no. 1 014 542.
- II. In the contested decision, the opposition division came, *inter alia*, to the conclusion that the subject-matter of claim 1 involved an inventive step with respect to the following documents:

D9: EP-A1-0 823 771

D10: JP-A-8-280146 and English translation.

Furthermore, the opposition division referred in the reasons for the decision (paragraph 4.2.2) to the following prior art:

D3: EP-A1-0 285 990.

- III. With a letter dated 15 June 2010, the respondent (patent proprietor) filed new claims 1 to 3 as auxiliary request I and new claims 1 and 2 as auxiliary request II.
- IV. In reply to a communication from the Board accompanying the summons to oral proceedings, the respondent filed an auxiliary request III with letter dated 29 August 2013.
- V. On 12 September 2013, oral proceedings were held before the Board.

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

VII. The respondent requested that the appeal be dismissed (main request), or that the patent be maintained in amended form on the basis of one of the auxiliary requests I and II filed with letter dated 15 June 2010, or on the basis of auxiliary request III filed with letter dated 29 August 2013.

VIII. Claim 1 of the patent in suit reads as follows:

"An electric motor comprising:

a stator (15) having teeth (17) wound by concentric windings (18) and

a rotor (14, 44) having a rotating shaft (16, 46) and interior permanent magnets (12, 22, 42) in cross-sectional V- or I-shape embedded in respective recesses of corresponding shape at the poles of the rotor,

characterized in that

the permanent magnets embedded within the respective recesses are split in the axial direction of the rotor (14), along at least one plane orientated toward said stator into a plurality of magnet pieces (13), the magnet pieces (13) being applied with electrically insulating coating material to their overall surface to provide a space between the stacked-up magnet pieces of not less than 0,03mm corresponding to the thickness of the coating material."

Claim 1 according to the auxiliary request I differs from claim 1 of the main request in that it specifies that the electric motor comprises a "rotor (14, 44) with a salient pole".

Claim 1 according to the auxiliary request II differs from claim 1 of the auxiliary request I in that its last feature reads as follows:

"the magnet pieces (13) being divided electrically applying insulating epoxy resin coating material to their overall surface to provide a space between the stacked-up magnet pieces of not less than 0,03mm corresponding to the thickness of the coating material."

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

"An electric motor comprising:

a stator (15) having teeth (17) wound by concentric windings (18) and

a rotor (14, 44), having a rotating shaft (16, 46) and interior permanent magnets (12, 22, 42) in cross-sectional V- or I-shape embedded in respective recesses of corresponding shape at the poles of the rotor, and being arranged so that the rotor can produce a salient pole rate;

characterized in that

the permanent magnets embedded within the respective recesses are split in the axial direction of the rotor (14), along at least one plane oriented toward said stator into a plurality of magnet pieces (13),

the magnet pieces (13) being divided electrically to a sufficient extent for restraining eddy currents by applying electrically insulating epoxy resin coating material to their overall surface,

wherein the epoxy resin coating provides a space between the stacked-up magnet pieces of not less than 0,03 mm corresponding to the thickness of the coating material."

IX. The appellant's arguments may be summarized as follows:

D9 related to a synchronous motor with a rotor comprising V-shaped embedded permanent magnets. The only features recited in claim 1 of the patent in suit which were not disclosed in D9 were that the two magnet pieces making up each permanent magnet were covered with an electric insulating coating and that such pieces were separated by a gap of 0.03 mm. These features had the effect of limiting the circulation of eddy currents in the permanent magnets and accordingly prevented demagnetization caused by overheating. Thus, the objective problem solved by the contested patent could be defined as the protection from demagnetization of the rotor of an electric motor according to D9.

To solve the above problem the person skilled in the art would consult D10 which related to synchronous motors with permanent magnets and also dealt with the same issue. In paragraph [0010], D10 pointed out that permanent magnets were usually coated with a resin to protect them from corrosion and that, at least for low power electric motors, such coating could be sufficient to electrically insulate the individual magnet pieces and thus interrupt eddy current paths. D10 did not disclose any values for the coating thickness. However, it was implicit in the teaching of D10 that the thickness of an insulating coating should be selected according to electric motor's operating conditions in order to provide effective electric insulation. In any case, the skilled person was aware that if a protective coating did not provide sufficient insulation, its thickness should be increased until the required electric insulation was achieved. In doing so, the skilled person would necessarily arrive at a thickness which guaranteed a separation of the magnet pieces of at least 0,03 mm, in particular because such gap between magnet pieces would already be ensured by the epoxy resin coating normally used to protect magnets from corrosion, as shown in Table 1 of D3. Furthermore, a lower limit for a thickness range provided no special technical effect and simply reflected what was known in the art. Thus, the subject-matter of claim 1 did not involve an inventive step within the meaning of Article 56 EPC.

As to the auxiliary requests I to III, they did not contain any features which could make the claimed subject-matter inventive over the teachings of D9 and D10.

X. The arguments of the respondent may be summarized as follows:

Document D9, which represented the closest prior art, did not disclose that the permanent magnets of the rotor were split in an axial direction and embedded in recesses of the rotor in a stacked-up manner. Consequently, and in contrast to the appellant's argument, the last three features of claim 1 of the contested patent were not known from D9. These distinguishing features caused a reduction of eddy currents generated by a change in the magnetic flux resulting from the rotation of the electric motor as set forth on page 3, lines 4 to 7 of the application as originally filed. The reduction of eddy currents limited heating of the permanent magnets and prevented demagnetization caused by overheating. Therefore, when starting from the disclosure of D9, the objective technical problem to be solved by a person skilled in the art was to improve the synchronous motor shown in D9 so as to avoid overheating and demagnetization of the permanent magnets due to eddy currents.

D10 solved the problem of providing sufficient insulation between a plurality of permanent magnets which were fixed on the surface of a rotor iron core. As specified in paragraph [0003] of the English translation, the presence of the plurality of permanent magnets resulted from manufacturing limitations, *i.e.* the circumstance that rare earth magnets could not be fabricated in sufficient size for the high-power applications envisaged in D10. Furthermore, D10 emphasized that problems with eddy currents and

demagnetization due to overheating were the result of this manufacturing limitation, *i.e.* of having to use multiple magnets, and only occurred in magnet synchronous motors for high-power applications. Therefore, D10 focused on electric motors of significant power and size whereas D9 was clearly concerned with electric motors intended for low-power applications. As the problem faced by D10, namely the incapability of manufacturing a magnet pole of sufficient size, did not arise for the kind of motors considered in D9, it was questionable why the skilled person would modify the design of the motor of D9 by using multiple magnets to form a V-shaped magnet pole. Furthermore, as D9 focused on low-power applications, which according to D10 did not suffer from eddy currents and demagnetization due to overheating, it could not be understood why the skilled person would have considered D10 to solve the objective technical problem underlying the present invention. In fact, the specific teaching of D10 was that the individual parts of composite permanent magnets had to be additionally insulated when using them with a surface permanent magnet motor for high-power applications in order to prevent excessive local heating of the magnets. This teaching was not related to the technical problem underlying the invention when starting from D9. As a result, the person skilled in the art would have had no incentive to combine the teachings of D9 and D10.

However, even taking into account D10 the person skilled in the art would not have arrived at the subject-matter of claim 1 of the granted patent. Firstly, D10 disclosed a permanent magnet motor with a rotor having surface mounted magnets (*cf.*

paragraph [0003]), whereby the magnets were fixed to the iron core of the rotor by an adhesive binder or a plurality of holes. Furthermore, this document showed that an epoxy resin might be cast over these magnet tiles to prevent corrosion (cf. paragraph [0003]). The permanent magnets of D10 were arranged to form an assembled magnet whereas the permanent magnets of the patent in suit were split in the axial direction into magnet pieces. Still in contrast to the claimed invention, D10 did not show that the permanent magnets were interior to the rotor and that they were stacked. Moreover, D10 remained silent as to how to assemble such magnet pieces within corresponding recesses formed in the rotor. Consequently, a person skilled in the art found no hint as to how to modify a salient pole motor with interior magnets, as known from D9, to solve the technical problem of the present invention. The skilled person would only perceive from D10 that in high-power application a surface permanent magnet motor with a mosaic of permanent magnets applied thereto would probably have fewer problems with eddy currents. Thus, even if it were assumed that a person skilled in the art would have tried to combine D10 and D9, the only perceivable and straightforward solution would have been to change the rotor design of D9 and replace it with the rotor of D10.

Apart from the above considerations, D10 did not disclose the feature of granted claim 1 according to which the magnet pieces of the invention were covered by a uniform insulation layer having a particular minimal thickness of coating material. This thickness, which resulted from choosing the resin properties so as to form a defined layer of 0,015 mm on all surfaces of

the permanent magnet pieces, was by no means a natural result of usual trial and error when considering the teaching of document D10. In D10 the skilled person was taught that the protective resin coating applied to the magnets did not provide sufficient electric insulation. In fact, D10 suggested using wound polyester polyamide film layers arranged between the magnet blocks. The resin was applied on the surface of the permanent magnets and just filled clearances between the permanent magnets wound with polyester polyamide film layers. Therefore, the gist of D10 for preventing eddy currents from flowing between the permanent magnets was to provide an insulation layer in form of a polyester tape wound around the side surface of the magnets while a resin was applied to fill the remaining clearances to prevent corrosion. Thus, even under the assumption that the teaching of D10 might have been applied to D9, the skilled person would have provided an electric insulation by means of an adhesive layer made of polyester wound around the permanent magnet pieces.

As it could not be understood how the skilled person would have arrived at the claimed invention on the basis of the cited documents, the subject-matter of claim 1 involved an inventive step.

The auxiliary requests I to III highlighted that the present invention pertained to a salient pole electric motor, as shown in D9, and was thus essentially different from D10, whereas auxiliary requests II and III further clarified that the electric insulation was provided only by the epoxy resin coating.

Reasons for the Decision

1. The appeal is admissible.

Main request

2.1 Claim 1 of the contested patent relates to the following subject-matter according to the itemization adopted by the opposition division:

- (A) An electric motor comprising a stator having teeth wound by concentric windings and
- (B) a rotor having a rotating shaft and interior permanent magnets
- (C1) [the interior permanent magnets being] in cross-sectional V- or I-shape embedded in respective recesses of corresponding shape at the poles of the rotor,
- (C2) the permanent magnets embedded within the respective recesses are split in the axial direction of the rotor, along at least one plane orientated toward said stator into a plurality of magnet pieces,
- (D) the magnet pieces being applied with electrically insulating coating material to their overall surface
- (E) to provide a space between the stacked-up magnet pieces of not less than 0,03 mm corresponding to the thickness of the coating material.

2.2 There is agreement between the parties that D9 constitutes the closest prior art and that this document shows an electric motor comprising features (A), (B) and (C1) of claim 1. Both parties also agree that features (D) and (E) are not disclosed in D9.

2.3 As to feature (C2), the appellant has essentially submitted that Figure 5 of D9 showed that, in the axial direction of the rotor, the V-shaped magnets were split into two magnet pieces along one plane oriented toward said stator, as indicated by the radial line drawn across each magnet.

On the contrary, the respondent has argued that there was no suggestion in D9 that the V-shaped magnets were composed of several pieces. In particular, there was no reason to assume that a short line drawn across the rotor magnets in the embodiment of Figure 5 provided information about the physical structure of the magnets. Furthermore, the terms "forward portion 39a" and "backward portion 39b" used to define the two branches of the V-shaped magnets and, in particular, the original Japanese wording did not denote separate pieces but parts of a whole.

2.4 The Board agrees with the respondent that D9 does not explicitly disclose feature (C2), although the expression the "*permanent magnet 39 is composed of a permanent magnet forward portion 39a and a permanent magnet backward portion 39b in the rotor normal rotating direction F*" (D9, column 9, lines 18 to 21) could indeed be interpreted as implying that the permanent magnet 39 is made up of two separate pieces.

On the other hand, it seems to be reasonable for the skilled reader of D9 to assume that in a practical implementation of the motor shown in D9 each V-shaped permanent magnet should be composed of two separate pieces, in particular because such magnets would be easier to manufacture and to insert into their corresponding slots due to their simpler forms and smaller sizes.

2.5 Hence, the Board considers that D9 implicitly discloses also feature (C2) to the skilled person.

3.1 The subject-matter of claim 1 according to the main request differs from the electric motor known from D9 in that:

- the magnet pieces are applied with electrically insulating coating material to their overall surface (feature (D)),
- a space of no less than 0,03 mm corresponding to the thickness of the coating material is provided between the stacked-up magnet pieces (feature (E)).

3.2 As to the problem solved by the patent in suit, the respondent has essentially submitted that the inventors had realized that an electric motor with embedded permanent magnets as shown in D9 suffered from excessive heat generated by eddy currents circulating in the permanent magnets. This caused progressive demagnetization and a consequent loss of performance of the electric motor, as described in paragraph [0009] of the application as published.

This problem was solved by the combination of features [C2], [D] and [E] recited in claim 1 of the patent in suit.

3.3 The appellant has essentially agreed that the problem addressed by the present invention is to avoid demagnetization of the rotor's magnets caused by heat generated by eddy currents. In the appellant's view, however, the proposed solution aiming at restraining the circulation of eddy currents in the permanent magnets was known from D10.

3.4 As to D10, the respondent has not contested that this document deals with the problem of restraining eddy currents circulating in the permanent magnets of an electric motor in order to prevent demagnetization. However, in the respondent's view, there was no reason for a skilled person wishing to address the problem of demagnetization in a synchronous motor with embedded permanent magnets, as known from D9, to rely on D10, as the latter was essentially concerned with a high power electric motor having a plurality of small magnets arranged on the periphery of the rotor. In fact, D10 suggested a completely different solution, which consisted in inserting an insulating layer between the magnets. Thus, if consulted, document D10 would have led the skilled person away from the invention.

4.1 D10 relates to a synchronous electric motor having a rotor with permanent magnets, in particular rare-earth magnets. As pointed out in paragraph [0003], rare-earth magnets for electric motors are usually made up of smaller pieces which are easier to manufacture.

Furthermore, as they are prone to corrosion, it is customary to protect them with a resin coating.

Paragraphs [0004] and [0005] identify and describe the problem of overheating and demagnetization caused by eddy currents induced in the permanent magnets. Thus, as stated in paragraph [0007], D10 seeks to reduce eddy currents in the permanent magnets of the rotor of a synchronous motor.

In paragraph [0010], D10 points out that the resin coating used to protect the magnets from corrosion may be sufficient to interrupt the eddy current paths which may exist between the different magnetic pieces making up the rotor's magnets and that this coating would in effect solve the problem addressed by D10. However, this coating cannot be expected to provide sufficient insulation for a high power electric motor.

- 4.2 In summary, D10 identifies the same problem addressed in the contested patent and explains that certain features of the rotor which constitute essential aspects of the solution of the present invention, such as a permanent magnet split into different magnet pieces and the provision of a coating layer on the magnet's surface, are required because it is not easy or even possible to manufacture rare earth magnets of sufficient sizes and such magnets have to be protected against corrosion. Furthermore, D10 acknowledges that these features would also solve the problem of restraining eddy current and thus avoiding overheating in the permanent magnets of a synchronous motor.

- 4.3 In the Board's view, D10 is relevant to the present case not just because it discloses a particular solution to the problem of overheating and demagnetization in high power synchronous motors, but because it shows that both this problem and essential aspects of its solution, such as the constitution of a permanent magnet of a plurality of electrically insulated magnet pieces, were well-known before the priority date the contested patent.
- 4.4 This implies that the skilled person wishing to implement the electric motor shown in D9 and simply relying on background technical knowledge, as reflected in D10, would arrive at a motor comprising features (A) to (D).
- 4.5 As to feature (E), it merely specifies that the space between the magnet pieces should be not less than 0.03 mm corresponding to the thickness of the coating material.
- 4.6 Apart from the fact that the normal coating used to protect rare earth magnets from corrosion would fall within the range defined in claim 1, as argued by the appellant with reference to D3, the technical meaning of feature (E) appears to be questionable as the setting of a lower limit for the separation of the individual magnet pieces seems to be more or less arbitrary. In fact, it is evident that the thickness of the coating layer which ensures sufficient insulation depends on the operating conditions of the electric motor and in particular on the voltage induced by the magnetic flux of the rotary magnetic field produced by the stator windings in the permanent magnets. Thus, it

is evident that, depending on the motor's specifications, the lower limit for the separation of the magnet pieces specified in the claim may not be sufficient to interrupt eddy current paths and thus cannot constitute a meaningful contribution to the solution of the addressed problem.

In any case, for the skilled person, who is aware that the insulating property of an insulating and corrosion preventing coating depends on its thickness, it would be obvious to select a coating thickness apt to provide the required electrical insulation and thus at least equal to or greater than the thickness appropriate for corrosion protection. In doing so, the skilled person would arrive at an electric motor falling within the terms of claim 1 of the main request.

- 4.7 As the subject-matter of claim 1 results from an obvious application to the electric motor known from D9 of technical background knowledge which, as suggested by D10, was available to the skilled person before the priority date of the contested patent, it does not involve an inventive step within the meaning of Article 56 EPC.

Auxiliary request I

- 5.1 Claim 1 according to the auxiliary request I differs from claim 1 according to the main request in that it specifies that the rotor has a salient pole.
- 5.2 According to the respondent, this feature, which is also disclosed in D9, was added to claim 1 of the patent in suit to underline the difference between the

electric motor of the present invention and the electric motor referred to in D10.

- 5.3 As pointed out above, it is not the particular embodiment of a synchronous motor disclosed in D10 which is relevant to the contested patent, but rather the general underlying teaching which consists in dividing a permanent magnet into magnet pieces and in electrically insulating them with a coating layer so as to restrain the eddy current paths within a rotor magnet. Thus, the lack of inventive step of the subject-matter of claim 1 cannot be overcome just by limiting claim 1 to a motor having a rotor with salient poles (Article 56 EPC).

Auxiliary request II

- 6.1 Claim 1 according to the auxiliary request II differs from claim 1 of the main request in that the magnet pieces are divided electrically by applying electrically insulating epoxy resin coating material.
- 6.2 Apart from the evidence provided by the appellant with reference to Table 1 of D3, the respondent has not contested that it is well-known in the art to protect permanent magnets with a resin and in particular with an epoxy resin. Thus, this feature cannot contribute to the inventive step of the claimed subject-matter (Article 56 EPC).

Auxiliary request III

- 7.1 Claim 1 of the auxiliary request III differs from claim 1 of the contested patent in that it specifies

that the poles are *"arranged so that the rotor can produce a salient pole rate"*, and in that features (D) and (E) are worded as follows:

(D') the magnet pieces being divided electrically to a sufficient extent for restraining eddy currents by applying electrically insulating epoxy resin coating material to their overall surface

(E') wherein the epoxy resin coating provides a space between the stacked-up magnet pieces of not less than 0,03 mm corresponding to the thickness of the coating material.

7.2 Despite the slightly different wording, claim 1 of auxiliary request III is essentially based on a combination of claim 1 of auxiliary requests I and II. For the same reasons given above and in view of the fact that the reference to a salient pole or a salient pole rate was added to claim 1 of the main request to highlight that D9 and D10 related to different electric motors, the Board comes to the conclusion that also the subject-matter of claim 1 of the auxiliary request III does not involve an inventive step within the meaning of Article 56 EPC.

8. As none of the appellant's requests satisfies the requirements of Article 56 EPC, the patent has to be revoked.

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

P. Mühlens