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D E C I S I O N
of 9 November 2005

Case Number: T 0641/03 - 3.5.02

Application Number: 95309246.7

Publication Number: 0718143

IPC: B60L 9/00

Language of the proceedings: EN

Title of invention:
Electric Vehicle Control System

Patentee:
Kabushiki Kaisha Toshiba

Opponent:
Siemens AG

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0641/03 - 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 9 November 2005

Appellant: (Opponent)
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Representative:
-

Respondent: (Proprietor of the patent)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 3 April 2003 rejecting the opposition filed against European patent No. 0718143 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: J.-M. Cannard
C. Holtz

Summary of Facts and Submissions

I. The opponent appealed against the decision of the opposition division rejecting the opposition filed against European patent No. 0 718 143.

II. Prior art documents:

D1: EP-A-0 332 974,

considered during the proceedings before the opposition division, and

D2: DE-A-40 15 760,

D3: JP-A-06 319 263 with the Japanese patent abstract, and

D4: DE-A-43 25 210,

filed for the first time with the opponent's statement of grounds of appeal,

are considered in this decision.

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

"An electric vehicle control system for controlling an electric vehicle, comprising:

an inverter (13) *(sic)* adapted to receive DC power from an overhead power line for converting said DC power into three-phase AC power said inverter including a

plurality of semiconductor devices each having a respective sensor configured to detect the voltage across it; and

an AC motor connected to receive said three-phase AC power from said inverter (13) for driving said electric vehicle;

characterised in that:

said an AC motor is a permanent magnet synchronous motor (5);

control means (4A) for generating an opening signal (a1, a2) based on a malfunction signal (P) of said inverter or an operating instruction when one of said plurality of sensors detects zero voltage across one of said semiconductor devices while said permanent magnet synchronous motor (5) continues to rotate; and

switch means (6a, 6b) connected to receive said opening signal (a2) from said control means (4a) for opening the connection between said inverter (3) and said permanent magnet synchronous motor (5) so as to cut off a short-circuit current generated from said permanent magnet synchronous motor (5) by operation of said electric vehicle."

Claims 2 to 6 are dependent on claim 1.

IV. Oral proceedings were held on 9 November 2005.

V. The arguments of the appellant opponent can be summarized as follows:

The control system according to claim 1 of the granted patent lacked an inventive step in view of document D1 alone. D1 disclosed a control system which comprised a sensor for detecting a short-circuit occurring in the DC current power supply of an inverter driving a permanent magnet motor. A switch connected between the inverter and the DC power supply was controlled to be opened if a short-circuit was detected during operation of the motor in a generator mode. It was obvious to dispose such a switch between the inverter and the motor to protect the system from a short-circuit current generated by the motor. The subject-matter of claim 1 would also be obvious in view of the combination of D1 with document D3, which disclosed a short-circuit detector and a switch for every phase unit of an inverter driving a motor, or with document D4, which showed a switch disposed between an inverter and a synchronous motor.

VI. The arguments of the respondent proprietor can be summarized as follows:

The subject-matter of claim 1 as granted involved an inventive step. None of the cited documents mentioned the problem of a "generator effect" and a short-circuit current caused by a motor continuing to be rotated because of the movement of a vehicle. There was no suggestion of specific means for opening a connection between a motor and an inverter so as to cut off such a short-circuit current. D1 corresponded to the prior art acknowledged in the contested patent and was concerned with detecting faults in a DC current supply for an AC inverter. There was no mention in D1 of means for

detecting a fault in the semiconductor devices of the inverter, or for isolating the motor driven by the inverter in the event of such a fault. In the arrangement described in document D2, the voltage of each phase of an inverter was monitored for controlling the phases of the motor under normal conditions. According to D3, the operation of a motor was allowed to continue with the "remaining sound phases" even though one inverter unit of a multiple inverter might be shut down. D4 did not show a switch for disconnecting an inverter from a motor and avoiding a short-circuit current. The switch was disposed between a PWM modulator and an inverter for restarting the inverter when synchronisation had been completed after restoration of a lost power supply.

VII. The appellant (opponent) requested that the decision under appeal be set aside and that the European patent No. 0 718 143 be revoked.

VIII. The respondent (patentee) requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. Lack of novelty, although formally mentioned in the notice of opposition, was not substantiated in the course of the proceedings.

3. Claim 1 of the granted patent relates to a control system for controlling an electric vehicle. This system

comprises *inter alia* an AC permanent magnet synchronous motor (5) which receives AC power from an inverter for driving said electric vehicle, and a switch that is controlled for opening the connection between the inverter and the AC motor when a zero voltage is detected across one of the semiconductor devices of the inverter (for instance because of a malfunction of the inverter) while the motor continues to rotate. The system according to claim 1 is not to be considered as being obviously derivable from any, or any combination, of the documents D1 to D4 cited by the opponent.

3.1 None of these documents relates to a control system for an electric vehicle. Nor is there any disclosure of an AC permanent magnet motor which could continue to be rotated so as to operate in a generator mode while a zero voltage across one of the semiconductor devices of an inverter driving the motor is detected. Reading these documents, the skilled person would not be aware that a situation might arise in which a short-circuit current generated from an AC permanent magnet motor could burn out the motor if it continued to rotate while the voltage across one of the semiconductor devices of an inverter driving the motor had a zero value. Hence, the skilled person would not find in these pieces of prior art, even if the use in a vehicle of the motors described there was considered, any hint of means for cutting off a short-circuit current generated from the motor, and more specifically for disconnecting it from the inverter, as recited in claim 1. More specifically:

3.2 D1 (figure 1; column 2, lines 5 to 39) discloses means (EW) for detecting a short-circuit occurring in a DC

current power supply which is connected via an inverter (UR) to a motor (M), which can also operate as a generator. Means (HS) are provided for isolating the inverter from such a defective power supply when the motor is operating as a generator. But D1 does not disclose that the motor (M) is a permanent magnet motor, nor does it disclose any switch means connected between the inverter and the motor. Furthermore, no means for detecting a zero voltage across a semiconductor device of the inverter and disconnecting the inverter from the motor during operation of a vehicle are disclosed in D1.

3.3 D2 relates to a device in which a voltage corresponding to each phase of an inverter is monitored for preventing a short-circuit between the controllable switching elements of an inverter driving an AC motor (figures 21 and 22; column 1, lines 3 to 9; columns 2 and 3, bridging paragraph). The sensor shown in figure 22 (see, also column 3, lines 19 to 37) does not detect a zero voltage across one of these elements. A switch responsive to a sensor for opening the connection between the motor and the inverter during operation of a vehicle is not disclosed in D2.

3.4 D3 discloses a multiple inverter for driving an AC motor wherein each phase inverter unit is provided with a short-circuit detector and a switch. The purpose of D3 is to avoid having to switch off a three-phase motor when an overcurrent occurs in one phase of an inverter unit driving the motor. If such a fault occurs, the motor is allowed to continue operating with the remaining sound phases.

3.5 D4 relates to an apparatus for restarting an inverter (20) which drives a synchronous motor when power supply is restored after momentary interruption (column 1, lines 3 to 11). A switch (500) controlled to start or stop supplying power to the motor (figure 1; column 3, lines 31 to 39) is disposed between a PMW modulator (18) and the inverter in order to control the switching operations in the inverter (figure 2; column 4, lines 4 to 9). This switch does not disconnect the inverter from the motor so as to cut off a short-circuit current from the motor.

4. As may be seen from the foregoing, neither a sensor which detects a zero voltage across each semiconductor device of an inverter, nor a switch for opening the connection between said inverter and a permanent magnet motor, is disclosed or suggested in any of the documents D1 to D4.

5. For the foregoing reasons, in the Board's judgement the subject-matter of the claims of the patent in suit as granted is considered to involve an inventive step within the meaning of Article 56 EPC. The grounds for opposition mentioned in Article 100 EPC thus do not prejudice the maintenance of patent in suit unamended (Article 102(2) EPC).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

U. Bultmann W. J. L. Wheeler