

**Internal distribution code:**

- (A) [ - ] Publication in OJ
- (B) [ - ] To Chairmen and Members
- (C) [ - ] To Chairmen
- (D) [ X ] No distribution

**Datasheet for the decision  
of 4 March 2016**

**Case Number:** T 0342/13 - 3.2.01

**Application Number:** 04009152.2

**Publication Number:** 1470988

**IPC:** B62D5/04

**Language of the proceedings:** EN

**Title of invention:**

Electric power steering apparatus

**Patent Proprietor:**

JTEKT Corporation

**Opponent:**

ThyssenKrupp Presta AG

**Headword:**

**Relevant legal provisions:**

EPÜ Art. 54(1), 56

**Keyword:**

Novelty (Main Request) NO

Inventive Step (First auxiliary request) YES

**Decisions cited:**

**Catchword:**



**Beschwerdekammern**  
**Boards of Appeal**  
**Chambres de recours**

European Patent  
Office  
D-80298 MUNICH  
GERMANY  
Tel. +49 (0) 89 2399-0  
Fax +49 (0) 89  
2399-4465

Case Number: T 0342/13 - 3.2.01

**D E C I S I O N**  
**of Technical Board of Appeal 3.2.01**  
**of 4 March 2016**

**Appellant:** ThyssenKrupp Presta AG  
(Opponent) Essanestrasse 10  
9492 Eschen (LI)

**Representative:** LENZING GERBER  
Patentanwälte  
Postfach 20 05 09  
40103 Düsseldorf (DE)

**Respondent:** JTEKT Corporation  
(Patent Proprietor) 5-8, Minamisemba 3-chome  
Chuo-ku,  
Osaka-shi  
Osaka 542-8502 (JP)

**Representative:** Hoefer & Partner Patentanwälte mbB  
Pilgersheimer Straße 20  
81543 München (DE)

**Decision under appeal:** **Decision of the Opposition Division of the  
European Patent Office posted on 18 December  
2012 rejecting the opposition filed against  
European patent No. 1470988 pursuant to Article  
101(2) EPC.**

**Composition of the Board:**

**Chairman** G. Pricolo  
**Members:** H. Geuss  
O. Loizou

## Summary of Facts and Submissions

I. The appeal is directed against the decision of the Opposition Division of the European Patent Office posted on 18 December 2012 rejecting the opposition filed against European patent No. 1470988 pursuant to Article 101(2) EPC.

II. The opposition division held that the subject-matter of claim 1 as granted was novel and involved an inventive step in view of, in particular, documents:

JP 2001 - 186790 A (D1),  
EP 382166 A1 (D8)  
EP 1061640 A2 (D13).

III. During oral proceedings held 4 March 2016 the appellant (opponent) requested that the decision under appeal be set aside and that the patent be revoked.

The respondent (patent proprietor) requested that the appeal be dismissed and the patent be maintained as granted (main request), or in the alternative, that a patent be maintained on the basis of claim 1 of the first auxiliary request, as filed during oral proceedings.

IV. Claim 1 as granted reads as follows (emphasis of feature d), which is of particular relevance for the decision, in bold by the Board):

An electric power steering apparatus for giving steering assist force to a steering mechanism of a vehicle by driving an electric motor (6) on the basis of a current target value (It) that is determined in accordance with a manipulation for steering the vehicle, the electric

power steering apparatus comprises  
a rotation speed detecting unit (12) which detects a  
rotation speed ( $\omega_{re}$ ) of the electric motor (6) and is  
further characterized by:

**a compensation current determining unit (118) which  
determines an instruction value ( $\Delta i_q$ ) of a compensation  
current to flow through the electric motor (6) to  
suppress torque ripples due to distortion of an induced  
electromotive force waveform of the electric motor in  
accordance with a load correspondence quantity as a  
physical quantity corresponding to a load of the  
electric motor (6) and the rotation speed ( $\omega_{re}$ ) detected  
by the rotation speed detecting unit (12);**

a correcting unit (122) which corrects the current  
target value ( $I_t$ ) on the basis of the compensation  
current instruction value ( $\Delta i_q$ ) determined by the  
compensation current determining unit (118); and  
a control unit (200) which performs a feedback control  
on the electric motor so that a current having the  
current target value as corrected by the correcting unit  
flows through the electric motor (6), the control unit  
(200) being part of a current control system of the  
electric motor that uses the feedback control.

- V. Claim 1 according to the first auxiliary request reads  
as follows (emphasis in bold by the Board: feature d)  
which is of particular relevance for the decision):

An electric power steering apparatus for giving steering  
assist force to a steering mechanism of a vehicle by  
driving an electric motor (6) on the basis of a current  
target value ( $I_t$ ) that is determined in accordance with  
a manipulation for steering the vehicle, the electric  
power steering apparatus comprises:

- a rotation speed detecting unit (12) which detects a rotation speed ( $\omega_{re}$ ) of the electric motor (6);
  - **a compensation current determining unit (118) which determines an instruction value ( $\Delta i_q$ ) of a compensation current to flow through the electric motor (6) to suppress torque ripples due to distortion of an induced electromotive force waveform of the electric motor in accordance with a load correspondence quantity as a physical quantity corresponding to a load of the electric motor (6) and the rotation speed ( $\omega_{re}$ ) detected by the rotation speed detecting unit (12);**
  - a correcting unit (122) which corrects the current target value ( $I_t$ ) on the basis of the compensation current instruction value ( $\Delta i_q$ ) determined by the compensation current determining unit (118); and
  - a control unit (200) which performs a feedback control on the electric motor so that a current having the current target value as corrected by the correcting unit flows through the electric motor (6), the control unit (200) being part of a current control system of the electric motor that uses the feedback control,
- characterized in that the compensation current determining unit (118) includes:
- an amplitude determining unit (22) which determines an amplitude of the compensation current instruction value so that an amplitude of the compensation current to flow through the electric motor becomes proportional to the load correspondence quantity; and either
  - an amplitude correcting unit (24, 26, 28) which corrects the determined amplitude in accordance with the rotation speed so as to compensate for a gain reduction due to a frequency characteristic of the current control system, or
  - a phase correcting unit (16, 18) which corrects a

phase of the compensation current instruction value in accordance with the rotation speed so as to compensate for a phase delay due to the frequency characteristic of the current control system.

VI. The appellant argues as follows:

The subject-matter of claim 1 as granted is not novel with regard to document D1. D1 (cf. figure 11) discloses all features of the electric power steering apparatus according to claim 1 as granted. In particular figure 11 shows a compensation current determining unit corresponding to feature d) of claim 1 in suit which is represented by part 4k. The wording of the feature d) "in accordance with" is so broad that the implicit consideration of the motor speed in the basic current determining unit (4j and 4b) of D1 (left hand side of figure 11) falls under the definition of granted claim 1.

With respect to the first auxiliary request, document D13 already discloses all features defined in the preamble of claim 1. The skilled person however knows that the torque ripple is proportional to motor load. Hence it would be obvious to provide an amplitude determining unit (22) which determines an amplitude of the compensation current instruction value so that an amplitude of the compensation current to flow through the electric motor becomes proportional to the load correspondence quantity" according to the first feature of the characterizing portion. Since the features of the characterizing part of claim 1 are linked together by an "or"-combination, it is sufficient to question one of these features when assessing inventive step.

Also, document D8 provides a solution for reducing the cogging torque of a brushless electric motor. D8 discloses a dependency between motor load and cogging and a compensation circuit to reduce cogging having regard to torque load.

VII. The respondent's rebuttal was essentially the following:

The subject-matter of claim 1 is novel over document D1. In particular D1 does not disclose feature d) which defines a compensation current determining unit (118) which determines an instruction value ( $\Delta i_q$ ) of a compensation current to flow through the electric motor (6) to suppress torque ripples due to distortion of an induced electromotive force waveform of the electric motor in accordance with a load correspondence quantity as a physical quantity corresponding to a load of the electric motor (6) and the rotation speed ( $\omega_{re}$ ) detected by the rotation speed detecting unit (12).

According to feature d) two values are necessary for determining the instruction value ( $\Delta i_q$ ), namely the motor rotation speed ( $\omega_{re}$ ) and the load of the electric motor. As shown in figure 4 of the opposed patent, both values are processed in the compensation current determining circuit (118) in order to determine the instruction value ( $\Delta i_q$ ). On the contrary, according to D1 (cf. figure 11) the input for part 4k - corresponding to the compensation current determining circuit of the patent - are the motor load (on the left hand side of part 4k), and the angle of the electric current (on the right hand side) which is a value related to the position of the rotor of the electric motor. In fact, the motor rotation speed which is calculated in part 4h does not take part to the determination of the instruction value. In D1, part 4b, which outputs a



signal to part 4k, does not use the rotation speed of the motor for calculation and its output corresponds to a motor load.

The subject-matter of claim 1 of the first auxiliary request is based on inventive step.

Document D13 is not directed to the problem which is addressed by claim 1 of the contested patent.

Document D13 regards a different field of technology, in particular, D13 is directed to an approach for reducing a cogging torque. As described in paragraph [0003] of the opposed patent, two different types of torque ripple occur in brushless electric motors: the so called cogging torque, which is caused by structural factors of the motor, and the electric ripple, caused by deviation of an induced electromotive waveform of the motor from the ideal waveform. As described in document D13, cf. paragraphs [0002] and [0003], cogging is a result of the physical construction of the machine. Document D13 refers only to cogging torque while the opposed patent mentions electric ripple, cf. paragraph [0007]. Also feature d) of claim 1 makes it clear that the compensation current determining circuit determines an instruction value to suppress electric ripple: torque ripple due to distortion of an induced electromotive force is the unambiguous definition of electric ripple. Hence, D13 does not disclose feature d) and the features of the characterizing portion of claim 1 of the first auxiliary request.

In fact, since the subject-matter of claim 1 of the auxiliary request aims at compensating electric ripple, document D13 does not represent an adequate starting point for the assessment of inventive step.

The same line of argument applies for document D8 which is only concerned with reducing cogging torque.

### **Reasons for the Decision**

1. The appeal is admissible.
2. The invention as defined in claim 1 as granted is not new since its subject-matter is disclosed in document D1, Article 54 (1) EPC.

- 2.1 The only issue of dispute in respect of novelty is whether D1 discloses feature d), defining:

a compensation current determining unit (118) which determines an instruction value ( $\Delta i_q$ ) of a compensation current to flow through the electric motor (6) to suppress torque ripples due to distortion of an induced electromotive force waveform of the electric motor in accordance with a load correspondence quantity as a physical quantity corresponding to a load of the electric motor (6) and the rotation speed ( $\omega_{re}$ ) detected by the rotation speed detecting unit (12).

The remaining features of claim 1 are disclosed in D1 beyond dispute.

- 2.2 The respondent argues that the compensation current determining circuit according to the invention is provided with two inputs, the load and the rotational speed of the electric motor. This is clearly defined in feature d) of claim 1 as granted. On the contrary, D1 (cf. figure 11) discloses for the unit 4k (torque ripple

compensation current determining unit), corresponding to the compensation current determining circuit according to the patent, a torque load input (on the left hand side of block 4k) and a rotor position angle (on the right hand side of block 4k), the latter coming from unit 4e.

The Board does not follow the respondent's argument.

According to D1, the rotor position angle value from unit 4e is also input to the motor speed determining unit 4h which is connected to the unit 4i (motor reverse electromotive voltage operation part, cf. par [0017] of the machine translation of D1), which in turn is connected to unit 4j (voltage margin value set part 4j), which is connected to unit 4b (current command value set part), itself connected to the torque ripple compensation current determining unit 4k. Accordingly, the latter unit determines an instruction value of a compensation current for suppressing torque ripples based on, inter alia, the rotation speed of the electric motor.

Notably, the Board considers feature d) of claim 1 as not restricting the compensation current determining circuit (118) to it being provided with two inputs that are specifically the rotation speed and the load of the electric motor as the respondent argues. The wording "a compensation current determining circuit (118) which determines an instruction value ... in accordance with a load correspondence quantity as a physical quantity corresponding to a load of the electric motor and the rotation speed" (cf. feature d), emphasis by the Board) does not necessarily imply that two discrete values - load and speed - are input into the compensation current determining circuit. The wording of claim 1, in

particular due to the presence of the term "in accordance with", merely stands for the fact that motor speed and load are taken into account. Thus also D1 discloses a compensation current determining circuit, which determines an instruction value by taking into account the motor load and the rotation speed.

3. Claim 1 according to the first auxiliary request corresponds to the first auxiliary request filed in opposition proceedings and differs therefrom only in that the claim is drafted in the two-part form (introduction of the term "characterized by"). Claim 1 results from the combination of features of granted claims 1, 2 and 4.

The invention according to claim 1 of the first auxiliary request involves an inventive step, having regard to document D13 (respectively D8) since it is not obvious for a person skilled in the art, Article 56 EPC.

- 3.1 The power steering apparatus of D13 differs from the subject-matter of the claimed invention at least by feature d), which specifies that the compensation current determining circuit determines an instruction value to suppress electric ripple.

The respondent submits that the person skilled in the art would have considered document D13 which is directed to torque irregularities.

The Board notes that D13 only addresses cogging torque irregularities, whereas torque ripple due to distortion of an induced electromotive force waveform of the electric motor referred to in claim 1 is not mentioned at all in this document. Cogging torque is caused by the structural factors of the motor, such as the number of poles and slots of the motor, whereas electric ripple

arises due to distortion of an induced electromotive force waveform of the electric motor from its ideal waveform (cf. [0003] of the patent). Hence, causes and physical effects in D13 and the contested patent are completely different.

For this reason, the Board holds that D13 is not suitable as a starting point for the assessment of inventive step. Moreover, although mentioning electric power steering systems in general (see page 1, line 27), D1 fails to disclose power steering systems for vehicles. Finally, according to the teaching of D13 (cf. [0045], [0048], [0155], [0162], [0191]), there has to be provided a cogging torque rejection feed forward, which reduces the cogging by calculating respective correction currents based on a mathematical representation of the motor, which itself is based on physical motor characteristics. In order to reduce electric ripple, it would be necessary to take into consideration motor frequency characteristics, and this is not disclosed in D13.

- 3.2 The same applies to appellant's line of argument with respect to document D8. D8 as well solves the problem of reducing cogging torque (cf. page 3, lines 37 to 43). Electric ripple, e.g. torque irregularities based on induced electromotive force are not mentioned in D8.

## **Order**

### **For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The case is remitted to the department of first instance with the order to maintain the patent in

amended form on the basis of the following documents:

Claims:

Claim 1 of the first auxiliary request as filed during the oral proceedings;

Description:

Amended pages 2-3 as filed during the oral proceedings and

pages 4-11 of the patent as granted;

Drawings:

Fig. 1-9 of the patent as granted.

The Registrar:

The Chairman:



A. Vottner

G. Pricolo

Decision electronically authenticated