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D E C I S I O N
of 9 November 1995

Case Number: T 0568/93 - 3.4.1

Application Number: 89311321.7

Publication Number: 0367595

IPC: G01R 33/18

Language of the proceedings: EN

Title of invention:
Torque detecting device

Applicant:
DAIDO TOKUSHUKO KABUSHIKI KAISHA, et al

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56, 83 and 123(2)

Keyword:
"Inventive step (yes - after amendments)

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0568/93 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 9 November 1995

Appellant 01: DAIDO TOKUSHUKO KABUSHIKI KAISHA
11-18, Nishiki 1-chome
Naka-ku
Nagoya-city
Aichi-prefecture (JP)

Appellant 02: Nissan Motor Company Limited
2, Takara-cho
Kanagawa-ku
Yokohama-shi
Kanagawa-ken 221 (JP)

Representative: Jenkins, Peter David
PAGE WHITE & FARRER
54 Doughty Street
London WC1N 2LS (GB)

Decision under appeal: **Decision of the Examining Division of the European Patent Office dated 4 February 1993 refusing European patent application No. 89 311 321.7 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: G. D. Paterson
Members: U. G. O. Himmler
Y. J. F. Van Henden

Summary of Facts and Submissions

I. European patent application No. 89 311 321.7 was refused by a decision of the Examining Division, which was based on claims 1 to 14 as filed with the letter of 4 December 1992. The reason given for the refusal was that the subject-matter of the independent claim 1 lacked an inventive step having regard to the state of the art disclosed in document D1 = EP-A-0 261 980.

Further, the decision to refuse the application also referred to the documents D2 = EP-A-0 270 122 and D3 = EP-A-0 162 957 with respect to the patentability of dependent claims 10, 12, 13 and 14.

II. The Appellant filed an appeal against the decision, and requested in the Statement of Grounds of Appeal that the appeal is based on these claims 1 to 8 filed therewith.

III. In the Statement of Grounds of Appeal the Appellant requested also reimbursement of the appeal fee without giving any reasons for this request.

IV. Following a communication accompanying a summons to oral proceedings the Appellant filed with letter of 20 October 1995 a new set of claims 1 to 8. Independent claim 1 of this new set of claims had been further limited by additional features. During oral proceedings on 9 November 1995 the Appellant further specified the composition of the steel in this claim 1 which reads as follows:

"1. A torque detecting device having a measuring shaft (2), excitation means (5a,5b) for forming a magnetic circuit wherein said measuring shaft (2) is a part of said magnetic circuit, and detection means (15,16) for

detecting a magnetostrictive force passing through said measuring shaft (2), said measuring shaft being formed, at least in a portion in which the magnetostrictive force is detected, from a steel, characterised in that:

the steel includes specific amounts of the following elements, in by weight percentage;- not more than 1.5% of C, not more than 4.0% of Si, not more than 3.0% of Mn, one or both of not more than 5.0% of Ni and not more than 5.0% of Cr, and not more than 5.0% Co; the steel optionally further comprising at least one element selected from not more than 1.0% of Cu, not more than 1.0% of Mo, not more than 0.05% of B, not more than 0.5% of W, not more than 0.5% of V, not more than 0.5% of Ti, not more than 0.5% of Nb, not more han 0.5% of Ta, not more than 0.5% of Zr, not more than 0.5% of Hf and not more than 0.1% of N; the steel also optionally further comprising not more than 3.0% of Al; and the steel additionally optionally further comprising at least one element selected from not more than 0.5% of Pb, not more than 0.5% of Bi, not more than 0.5% of S, not more than 0.3% of P, not more than 0.5% of Te, not more than 0.5% of Se and not more than 0.05% of Ca; with the remainder being Fe and impurities, and

in that the steel has the following electromagnetic characteristics at least in the portion thereof in which said magnetostrictive force is detected: specific resistance ρ_{RT} of not less than 30 μΩ -cm at room temperature;

temperature coefficient $\alpha\rho$ of specific resistance of not more than 0.25 x 10^{-2}/°C at temperature of -50 to 150°C; and

temperature coefficient α_L of inductance L of not more than 0.07 x 10^{-2}/°C at temperature of -50 to 150°C.

V. In support of this request the Appellant argued essentially as follows:

The essential idea of the present invention for solving a specific problem is the selection of particular parameters, i.e. the specific resistance of the used steel, the temperature coefficient of the specific resistance of the used steel and the temperature coefficient of the inductance of the device. In combination with the particular composition of the steel there are specific effects which cannot be deduced from the state of the art.In the state of the art there is no indication that the steel composition would have the decisive influence on the specific resistance , the temperature coefficient of the specific resistance and the temperature coefficient of the inductance of the device. These parameters essentially contribute to solving of the underlying problem of avoidance of a drift of the zero point. This specific problem of the present invention as disclosed on page 3, l. 23 to 26 of the original document, i.e. the avoidance of a drift of the zero point of the torque detecting device, neither can be derived from the state of the art.

In particular, this combination of values cannot be derived from document D1 which discloses a different steel composition and the specific resistance is there discussed only very shortly in connection with a two phase iron-aluminium alloy which is different from the present steel composition. There does not exist any hint - neither in document D1 nor in documents D2 or D3 - to the solution found by the inventors which is a specific combination of measures: the cooperation of the composition of the shaft of the device in combination with three particular parameters ρ , α_ρ and α_L. There is no example for the interrelation of these values with the steel composition.

Further, the Appellant pointed out that the steel composition of the shaft in document D1 does not include the element Co which considerably improves the drift behaviour of ρ and α_ρ. This is a completely unexpected technical effect on the basis of Co which is a mandatory part of the steel composition of the invention.

Further the Appellant asserted that there had been a lot of other possibilities which the inventors could have used when trying to compensate the drift of the zero point; e.g. there could have been tried an electronic compensation of such a drift. However, the inventors had chosen a specific composition of the shaft material which gives full compensation and yet has the necessary mechanical properties.

There is no hint in document D1 or any other prior document that the specific electrical resistance ρ of the shaft steel has any significance to the temperature changes or any influence on a temperature gradient along the shaft.

VI. At the end of the oral proceedings the decision was announced that the decision of the Examining Division is set aside and the case is remitted to the first instance with an order to grant a patent on the basis of the claims 1 to 5 as filed during the oral proceedings, with description to be adapted to such claims.

Reasons for the Decision

1. *Admissibility of the amendments*

Claim 1 as filed during oral proceedings differs from the originally filed claim 1 in that the composition of the steel forming the measuring shaft necessarily includes:

- "specific amounts of the following elements, in by weight percentage:

- not more than 1.5% of C, not more than 4.0% of Si, not more than 3.0% of Mn, one or both of not more than 5.0% of Ni and not more than 5.0% of Cr, and not more than 5.0% Co".

The content of the individual elements C, Si, Mn, Ni, Cr and Co is disclosed in the originally filed claims 5 and 7 and on page 4, lines 35 to 39 of the originally filed description.

The inclusion of at least small specific amounts of the specified elements is derivable from the whole content of the originally filed documents, in particular from the embodiment described on page 4, line 49 to page 6, line 33.

The optional elements of the shaft material as claimed were disclosed in the originally filed claims 6, 7, and 8 and in the description on page 4, lines 35 to 48.

2. *Novelty*

None of the cited documents

D1= EP-A-0 261 980,
D2= EP-A-0 270 122,
D3= EP-A-0 162 957,
D4= US-A-3 861 206 and
D5= EP-A-0 338 227 (a document published in the priority interval and further being state of the art according to Article 54(3) EPC),

discloses all the features of the subject-matter defined in claim 1. The novelty of the subject-matter of claim 1 was not contested by the Examining Division, and the Board agrees with the Examining Division on this point.

3. *Inventive step*

3.1 In the Board's view the closest prior art is document D1, which is mainly concerned with the increase of the output sensitivity and the decrease of the hysteresis of a torque detecting device; cf. page 5, lines 4 to 5, 23 to 24, 52 and Figures 2, 3, 9, 10, 13, 15, 16 and the related parts of the description.

Document D1 describes for the solution of the above stated problem, a torque detecting device having a measuring shaft, excitation means for forming a magnetic circuit wherein said measuring shaft is a part of said magnetic circuit, and detection means for detecting a magnetostrictive force passing through said measuring shaft, said measuring shaft being formed, at least in a portion in which the magnetostrictive force is detected, from a steel, the steel includes specific amounts of the following elements, in by weight percentage:not more than 1.5% of C, not more than 2.0% of Si, not more than

2.0% of Mn, not more than 5.0% of Ni and not more than 5.0% of Cr.

Consequently, the steel composition of the measuring shaft of this known torque detecting device is distinguished from the steel composition of the present application in the content of Si and Mn, as well as that Co is not included in the known steel composition.

3.2 Starting from the state of the art according to document D1, the objective problem of the application is the avoidance of any drift of the zero point of the torque detecting device, even if there is a temperature gradient along the axial direction of the measuring shaft; cf. page 3, lines 23 to 26 of the application.

This technical problem was not identified in the state of the art and it is more specific than just "keeping the influence of temperature on the results of the torque measurements within acceptable limits" as mentioned in paragraph 5 of the contested decision.

3.3 The solution of this unknown problem is the new steel composition of the measuring shaft in combination with the requirement of keeping the three parameters of the specific resistance ρ_{RT}, the temperature coefficient α_ρ of the specific resistance and the temperature coefficient α_L of the inductance of the device within certain limits.

3.4 Document D1 does not give any incentive to look for such a solution composed of different parameters for the above specified problem:

The examples described in document D1 can be divided into two different embodiments:

- the first embodiment having a similar steel composition (even if Co is lacking in this state of the art) of the measuring shaft as the shaft of the torque detecting device of claim 1; cf. description of D1 page 4. line 40 to page 5, line 28. In the context of this steel composition there is no hint to the fact that one or several of the other parameters of claim 1, i.e. the specific resistance ρ_{RT}, the temperature coefficient α_ρ of the specific resistance and the temperature coefficient α_L of the inductance of the device, would have any influence on the accuracy of the torque detecting device, and in particular no hint that the drift of the zero point of the torque detecting device could be influenced.

- the second embodiment is concerned with a measuring shaft made from an Fe-Al alloy which is composed of the disordered phase or mixed phase comprising at least two phases of Fe_3Al type ordered phase of which order parameter is not more than 0.9 FeAl type ordered phase. Exclusively in the context of this Fe-AL alloy measuring shaft it is mentioned in document D1 that it is desirable that the electric resistivity is not less than 75 μΩ-cm in order to get a low hysteresis; cf. page 6, lines 5 to 14 of document D1.

  The Board is of the opinion that this second embodiment of document D1 is of no relevance to the subject-matter of claim 1 as an Fe-Al alloy cannot be compared with the steel of the present application and the electric resistivity is mentioned only with regard to a low hysteresis.

Consequently, there is no suggestion or motivation to derive the subject-matter of claim 1 in an obvious manner from document D1.

3.5 Documents D2, D3 and D4 are more remote from the subject-matter of the present application than document D1.

Document D2 is also concerned with a torque detecting device having a measuring shaft according to the preamble of claim 1. However, the steel composition of this measuring shaft does not comprise Si and there are no upper limits indicated for the amounts of Mn, Ni, Cr and Co. Therefore the steel composition is different from that of claim 1. However, none of the other three parameters of claim 1 are mentioned in this document. Therefore, in the Board's view this document is of no significance to the subject-matter of claim 1, whether considered alone or in combination with any other document.

Document D3 describes a torque detecting device where the material of the shaft is not selected with respect to the measuring properties of the shaft but only with respect to the high quality requirements of a force transmitting device. The torque measuring device is made from a sleeve, the surface of which is coated with a magnetostrictive material. The sleeve having the same inner diameter as the shaft's outer diameter is fastened on the shaft. In the Board's opinion the principles applied in this document are fundamentally so different from the subject-matter of the present application that this state of the art cannot contribute to the solution as defined in claim 1.

Similar considerations apply to document D4 wherein the shaft is coated with a double film structure. The first film directly applied on the surface of the shaft is of a non-magnetic material. The second film coated over the first film is of a magnetorestrictive material. The measurement of the torque is based on the change of the permeability of the second film layer on the surface of the shaft exclusively. Also this document does not give any hints in the direction of the claimed invention.

3.6 For the above reasons, in the Board's judgement, the cited prior art documents would not lead the person skilled in the art to the claimed invention, and the subject-matter of independent claim 1 involves an inventive step within the meaning of Article 56 EPC.

Claims 2 to 5 are dependent claims and therefore also fulfil the requirement of inventive step.

4. During the oral proceedings doubts were expressed as to whether claim 1 can be carried out, because the inductance L is not a property of a material but of an electromagnetic circuit; consequently also the temperature coefficient α_L of inductance L is a property of a circuit.

However, the Appellant satisfied the Board that the original disclosure is sufficiently clear and complete for determining this temperature coefficient α_L of inductance L. The inductance L is by definition the ratio between the magnetic flux and the generating current of an electromagnetic circuit. As the measuring shaft of the torque detecting device forms part of the electromagnetic circuit built by the flux generating coils, the yoke, the air gap and the measuring shaft, the permeability of the shaft which is influenced by its composition takes effect on the inductance of the

device. Consequently the temperature coefficient α_L of inductance L, i.e. the change of the inductance caused by a change of the temperature of the shaft per °C, can be determined. How this determination has to be carried out for a certain torque detecting device has clearly been disclosed in the original description on page 6, line 56, to page 7, line 2 and page 7, lines 7 to 9. Thus in the Board's judgment the application satisfies the requirements of Article 83 EPC.

5. As certain examples of the description do not now fall within the scope of the amended claim 1, the description has to be adapted to this amended claim.

Therefore the Board remits the case to the first instance in order to complete examination with respect to the adaptation of the description.

6. There is no basis for reimbursement of the appeal fee under Rule 67 EPC.

Order

For these reasons it is decided that:

1. The decision of the Examining Division is set aside.

2. The case is remitted to the first instance with the order to grant a patent on the basis of the claims as filed during the oral proceedings, with description to be adapted to such claims.

The Registrar: The Chairman:

M. Beer G. D. Paterson