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Datasheet for the decision of 15 May 2009

Case Number: T 1020/06 - 3.2.01

Application Number: 96942575.0

Publication Number: 0802341

IPC: F16D 3/20

Language of the proceedings: EN

Title of invention:
Constant velocity universal coupling

Patentee:
NTN Corporation

Opponent:
GKN Automotive GmbH
Volkswagen AG

Headword:
-

Relevant legal provisions:
RPBA Art. 13

Relevant legal provisions (EPC 1973):
EPC Art. 56

Keyword:
"Amendment to a party's case (no)"
"Inventive step - non-obvious combination of known features"

Decisions cited:
T 1002/05

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1020/06 **-** 3.2.01

D E C I S I O N
of the Technical Board of Appeal 3.2.01
of 15 May 2009

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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 20 April 2006 revoking European patent No. 0802341 pursuant to Article 102(1) EPC 1973.

Composition of the Board:

Chairman: S. Crane
Members: J. Osborne
S. Hoffmann

Summary of Facts and Submissions

I. The appeal is directed against the decision posted 20 April 2006 revoking European patent No. 0 802 341 due to a lack of inventive step of the subject-matter of the claim 1 on file at that time.

II. With its statement of grounds of appeal the appellant requested maintenance of the patent on the basis of *inter alia* a claim 1 identical to that on which opposition division based its decision. With a letter dated 7 March 2008 the appellant replaced all previous requests with a second set including fifteen auxiliary requests. With a letter dated 15 April 2009 the appellant replaced the second set of requests with a third set including five auxiliary requests. During the oral proceedings the appellant replaced all of its earlier requests by a single request.

III. The following evidence played a role during the appeal proceedings:

D1 US-A-5 221 233;

D9 J.W. Macielinski, "Propeller Shafts and Universal Joints - Characteristics and Methods of Selection", Proc Instn Mech Engrs 184(31), 1969-70, 516 - 543;

D16 GB-A-1 336 129;

D21 US-A-1 916 442;

D23 F. Schmelz *et al* "Universal Joints and Driveshafts", Berlin: Springer Verlag, 1992, VII-XV, 117-126;

D26 Technical paper "Universal Joint and Driveshaft Design Manual AE-7", Society of Automotive Engineers, Inc., 1979, 145-150;

E1 US-A-5 129 752;

E2 DE-C-38 00 031;

E3 US-A-4 726 796;

E5 Sales brochure "Con-Vel® Constant Velocity Joints", Dana Corporation, Michigan;

E6 DE-B-1 183 318.

IV. At oral proceedings held on 15 May 2009 the appellant requested that the decision under appeal be set aside and the patent be maintained on the basis of the following documents:

- claims 1 to 10 submitted during the oral proceedings;
- pages 2 to 10 of the description submitted during the oral proceedings; and
- figures as granted.

The respondents requested that the appeal be dismissed.

V. Claim 1 according to the appellant's request reads:

"A fixed type constant velocity joint for use in a drive shaft of an automobile, comprising:
an outer joint member (1) having a plurality of axially extending curved guide grooves (1b) formed in the spherical inner surface (1a) thereof;
an inner joint member (2) having a plurality of axially extending curved guide grooves (2b) formed in the spherical outer surface (2a) thereof;
the respective centers of said guide grooves (1b,2b) of the outer and inner joint members (1,2) are offset with respect to the respective spherical centers of said inner and outer surfaces (1a,2a) axially by an equal distance (F) in opposite directions;
a plurality of ball tracks defined between said guide grooves (1b) of said outer joint member (1) and said guide grooves (2b) of said inner joint member (2) corresponding thereto;
a torque transmitting ball (3) disposed in each of said plurality of ball tracks;
a cage (4) having a plurality of pockets (4c) for storing each of said torque transmitting balls (3), said cage (4) being guided by the spherical inner surface (1a) of said outer joint member (1) and the spherical outer surface (2a) of said inner joint member (2), wherein
said ball tracks are each enlarged in wedge form in the same axial direction toward an open side of the joint;
characterized in that the number of said ball tracks, the number of said torque transmitting balls (3), and the number of said pockets (4c) of said cage (4) are respectively eight;
said torque transmitting balls (3) are each arranged in

respective ball tracks and retained in each of said pockets (4c) of said cage (4), so that an input rotation torque is transmitted with said eight torque transmitting balls (3) in a direction of rotation of the input rotation torque;
the ratio r1 (= PCD_{BALL}/ D_{BALL}) of the pitch circle diameter (PCD_{BALL}) of said torque transmitting balls (3) to the diameter (D_{BALL}) of said torque transmitting balls (3) is within the range $3.3 \leq r1 \leq 5.0$, and the ratio r2 (= D_{OUTER}/ PCD_{SERR}) of the outer diameter (D_{OUTER}) of said outer joint member (1) to the pitch circle diameter (PCD_{SERR}) of a tooth profile formed in an inner surface of said inner joint member (2) is within the range $2.5 \leq r2 \leq 3.5$; and
the ratio R1 (= F/PCR) of said offset (F) to the length (PCR) of a line segment connecting the center of said guide grooves (1b, 2b) of said outer or inner joint member (1,2) and the centers of said torque transmitting balls (3) is within the range of $0.069 \leq R1 \leq 0.121$."

Claims 2 to 10 specify features additional to those of claim 1.

VI. The appellant's submissions as far as relevant to this decision may be summarised as follows:

As regards admissibility of the present request, the claims do not differ in content from the claims according to the main request as filed with the statement of grounds of appeal and the fifth auxiliary request of the second set of claims filed with a letter of 7 March 2008. Claim 1 is no broader than that

defended upon entry into the appeal procedure and has been the subject of a request throughout the procedure.

As regards inventive step, the closest state of the art is a six-ball joint having equally offset centres of curvature of the respective grooves in the outer and inner joint members, as acknowledged in the patent specification and shown in figure 23. Despite the constant search for improvement and weight reduction that joint has remained virtually unchanged for 40 years. The problem is as set out in the patent specification, namely to make the joint more compact and secure whilst retaining strength, load capacity and durability. The problem is solved by a combination of features. Firstly, the number of balls is increased to eight. Although D21, which is the original Rzeppa patent for this type of joint and which was published over 70 years ago, states that eight balls may be used it recommends six and it is that number which has become the industry standard for a joint for an automotive drive shaft. D9 suggests using eight balls for a larger joint having increased torque capacity but in the 40 years since its publication it has not motivated the skilled person to move away from six balls in a joint for an automotive drive shaft. Secondly, the offset ratio R1 which is limited by conflicting requirements is conventionally about 0.14, corresponding to a groove wedge angle of 15°-17° which is necessary to ensure smooth ball movement under all conditions, see D26. However, in accordance with the invention the increased number of balls permits a reduction in the value of R1, leading in turn to a reduced physical size of the joint, as explained with reference to attachment A to the letter of 7 March 2008.

The reduction in size goes beyond that possible by merely employing eight smaller balls in place of six. The reduced offset decreases the radial movement of the balls so that the cage can be thinner and the joint members correspondingly thicker, thereby in turn permitting a further reduction in the diameter of the balls. The remaining claimed parameters r1 and r2 serve to specify the joint. The physical size of the joint is primarily represented by the relationship r2 between the outer diameter of the outer joint member and the size of the splines, the latter being essentially fixed for a given joint capacity. Similarly, the relationship r1 between the pitch circle diameter of the balls and the ball diameter reflects the ball diameter since the pitch circle diameter is also essentially invariable for a given capacity. Other attempts at reducing the size of the conventional six-ball joint have concentrated on improvements such as in lubrication and design efficiency. Nowhere is there any suggestion that the problem could be solved by increasing the number of balls and choosing a different range of R1. The respondents attempt to show that E5 would render the subject-matter of claim 1 obvious but it is not permissible to derive dimensions from the drawing in the manner that they do.

VII. The respondents replied essentially as follows:

The request should not be admitted because although it corresponds to the main request as filed with the statement of grounds, that was explicitly withdrawn and replaced by requests filed with a letter of 7 March 2008.

As regards inventive step, beginning from the state of the art acknowledged in the patent specification the only novel features relate to the number of balls and the parameters R1, r1, r2. The corresponding problem is to be seen as increasing the torque capacity of the joint, for which the move from six to eight balls is obvious, as may be seen from D9. Since the ball size is determined by the Hertz contact stress it follows that using eight balls rather than six allows them to be smaller, leading in turn to a more compact joint. The eight-ball joint has been known since 1926 and offset to provide a wedge-shaped groove was introduced soon afterwards to ensure smooth running. The industry may have standardised on six-ball joints but D9, D21, E1, E2 and E6 all suggest other numbers of balls. E3 describes a joint in the catalogue E5 as "small" and the corresponding value of r2 is within the presently claimed range. Moreover, consideration of the fundamental geometry of the joint illustrates that the claimed range is no technical limitation. In making the change to eight balls the skilled person will examine and optimise all related parameters, as indeed is acknowledged in the patent specification and as was recognised also in decision T1002/05. The appellant is attempting to patent an eight-ball joint merely by specifying parameters which are normal in the art. Also D9 discloses not just the number of balls as being relevant to torque capacity but also their diameter and pitch circle radius so the skilled person would be motivated to investigate all of these. The claimed features are merely aggregated as no synergy results from their combination. Moreover, contrary to the appellant's assertions, the claimed range for R1 is not lower than otherwise known in the art. D16, for

instance, relates to an eight-ball joint having a crossing angle of 10° which corresponds to a value of R1 within the claimed range. Values of R1 within the claimed range are also derivable from E5. Similarly, D1 discloses in respect of an eight-ball joint that the crossing angle must be greater than the self-inhibition angle and preferably greater than 7°. Indeed, the skilled person would naturally arrive at the values of the parameters as claimed when adopting an eight-ball joint. The appellant argues that the state of the art does not motivate the skilled person to employ an increased number of balls in order to reduce physical size whilst maintaining capacity. However, for the skilled person it is merely a corollary of increasing the capacity, which is addressed by the state of the art, without increasing physical size.

Reasons for the Decision

Admissibility of the request

1. The subject-matter of claim 1 as granted was essentially a conventional fixed-type Rzeppa joint having the single characterising feature of eight torque-transmitting balls and tracks. The claim was amended during the opposition procedure to include parameters r1, r2 and R1 and remained in that form in the main request filed with the statement of grounds of appeal. Although in the letter of 7 March 2008 the appellant stated that all previous requests were replaced, the claims of the previous main request were contained in the new fifth auxiliary request. Similarly, they were contained in the second auxiliary request

filed with the letter of 15 April 2009 and were amended during the oral proceedings only in the presentation of claim 1 in the two-part form. It follows that the content of claim 1 as requested during the oral proceedings had been the subject of a request at all times since filing the appeal. In so far the appellant has not amended its case within the meaning of Article 13 RPBA and the request is admissible.

Inventive step

2. The patent relates to a fixed-type constant velocity joint for use in a drive shaft of an automobile. Such a joint for rotationally connecting two shafts was originally patented (D21, issued in 1933) in a form in which the curvatures of the grooves in the inner and outer joint members were based on the centre of the joint. In a subsequent improvement the centres of curvature of the respective grooves were spaced from each other along the centre-line to be offset from the joint centre. The resultant wedge form of the ball tracks ensures more accurate guidance of the balls. The relationship between the offset of each groove centre of curvature (F) and the pitch circle radius of the balls (PCR) is designated in present claim 1 as R1=F/PCR. The parameter r1 represents the relationship between the pitch circle diameter of the balls (PCD_{BALL}) and the diameter of each ball (D_{BALL}) whereby $r1=PCD_{BALL}/D_{BALL}$. The parameter r2 represents the relationship between the outer diameter of the outer joint member (D_{OUTER}) and the pitch circle diameter of serrations on the inner diameter of the inner joint member (PCD_{SERR}) whereby $r2=D_{OUTER}/PCD_{SERR}$.

3. The board and the parties are in agreement that the closest state of the art is a joint having six tracks and balls such as acknowledged in the patent specification (paragraphs [0003] to [0005] and figure 23) and correctly reflected in the preamble of present claim 1. The subject-matter of claim 1 differs from that closest state of the art by the following features:

– that the number of tracks, balls and pockets is
– eight;

– $0.069 \leq R1 \leq 0.121$;

– $3.3 \leq r1 \leq 5.0$; and

– $2.5 \leq r2 \leq 3.5$.

3.1 One factor in determining the load capacity of a constant velocity joint is the number of tracks and balls; D9, page 531 states that the torque which can be transmitted depends on ***inter alia*** the number of balls "which is normally four or six, but on larger size joints eight or more balls may have to be employed". Claim 1 in its form as granted did not contain the relationships R1, r1 and r2 and the single novel feature at that time, namely eight tracks and balls, was obvious in the light of the teaching of D9 for solving the problem of increasing the capacity of the joint. The respondents still base their chains of argumentation on the assertion that increasing the number of tracks and balls to eight would be obvious ***per se*** in order to increase the capacity and that the ranges for R1, r1 and r2 merely result from subsequent optimisation. The problem to be solved as set out in

the patent specification is to make the constant velocity joint "more compact and secure" whilst the strength, load capacity and durability remain at least equal to those of a comparable six-ball joint. In accordance with established case law (see "Case Law of the Boards of Appeal", 5th edition 2006, I.D.8.2.1), if any of R1, r1 and r2 acts in combination with the increase in the number of tracks and balls to solve the problem set out in the patent specification then at least that feature must be considered together with that of the eight tracks, balls and pockets.

3.2 With the letter of 7 March 2008 the appellant filed reasoning and evidence in support of its assertion that the claimed range of parameter R1 is different from that conventionally chosen for six ball joints and contributed in combination with the higher number of tracks and balls to a reduction in physical size of the joint. The evidence, which the board finds convincing *per se*, relates to single values of R1 lying within and outside of the claimed range. In reaction to that evidence the burden of proof rested with the respondents to challenge its probative value. However, in over twelve months subsequent to the evidence being filed they failed to do so. Although progress of the present appeal case was delayed by procedural considerations during that period the respondents nevertheless were free to make submissions. Under these circumstances the respondents' definition of the problem as being one solved by the increase in the number of tracks, balls and pockets alone whereby the remaining differentiating features would merely follow as the result of subsequent optimisation is not correct. On the contrary, inventive step is to be considered on

the basis of whether the skilled person would reasonably believe in the light of the available state of the art that the known joint could be made more compact by increasing the number of tracks, balls and pockets to eight and by selecting a value of R1 within the claimed range. In this respect this case differs from that which led to the decision T 1002/05 (not published in OJ EPO) to which the respondents refer since that related to a plunging joint in which the grooves of the inner and outer joint members are straight and the parameter R1 therefore does not exist.

4. The respondents assert that it is evident from fundamental considerations of the capacity of individual balls and of their size that increasing their number will result in a physically smaller joint. However, no evidence has been provided that this belonged to the general knowledge of the skilled person and the board takes the view that the assertions arise from *ex post* considerations.

5. The respondents refer to D16 and argue that it discloses an eight-ball joint in which the tracks diverge at an angle of 10° which corresponds to a value of R1 within the presently claimed range. However, whereas present claim 1 specifies a constant velocity joint for use in a drive shaft of an automobile, D16 relates to one for an automotive propeller shaft which is not necessarily suited for the larger operation angles encountered in a drive shaft. As regards the number of tracks, balls and pockets, whilst figure 2 does illustrate eight, there is no further disclosure in this respect. More importantly, there is no offset of the centres of curvature of the grooves because

curved grooves are explicitly rejected in favour of straight ones in order to solve the problem of reducing manufacturing costs, see page 1, lines 48 to 64. As a result, there is no teaching relevant to R1.

6. D1 shows a joint having eight tracks and balls but in which the wedge forms of circumferentially adjacent tracks enlarge in axially opposing directions. It states that the wedge angle of the grooves should exceed the self-inhibition angle, and preferably exceed 7°. However, the problem to be solved relates to use at high operating angles and non-chip forming manufacture. D1 addresses neither the parameter R1 nor any influence of either it or the number of balls in the context of the physical size of the joint. Moreover, as disclosed in D26 one factor in the choice of the wedge angle is the joint's operating angle, whereby operation around 0° requires a higher wedge angle than fixed, high operating angles. Since the disclosure of D1 is directed particularly to a joint for large operating angles its teaching relating to the wedge angle is not directly applicable to a joint for an automotive drive shaft which must be capable of operating through a range of angles.

7. E5 also provides no support for the respondents' case. It is a catalogue for constant velocity joints and the respondents argue that it is derivable by measurement from the drawing on page 20 that R1 would fall within the presently claimed range and in respect of a joint which is described in E3 as "small". However, the drawing represents a range of joints of different sizes listed in the table on the same page and whilst it must be considered to be representative of the general

construction the skilled person would have no reason to believe that it conveys any information beyond what is relevant to the content of the catalogue. Even if the drawing were representative of a particular joint, the derivation of any value of R1 from it, which would involve the construction of tangents prior to measuring, would be inherently inaccurate. Moreover, any value of R1 derived from the drawing would be disclosed neither in combination with a joint having eight tracks, balls and pockets nor in respect of any possible reduction in physical size achievable thereby. The term "small" used in E3 in respect of a joint listed in E5 evidently refers primarily to the capacity of the joint rather than any aspect of its physical size.

8. Whilst the appellant submits that constant velocity joints for automotive drive shafts conventionally employ six tracks and balls the respondents refer to documents which suggest using other numbers. However, the matter at issue is not whether other numbers of balls may be employed but whether the skilled person wishing to reduce the physical size of the known six-ball joint would have been motivated by any of these documents to modify the joint in the way presently claimed. That would not be so in respect of E1 firstly because it uses six balls out of preference and secondly, whilst it suggests that other numbers may be used, it is silent as regards both R1 and any influence on physical size. E2 also would provide no motivation because it discloses a machine employing pistons and incorporating a constant velocity joint wherein the number of tracks and balls is equal to the number of pistons and evidently has no teaching of relevance to the present case. E6 addresses the problem of reduction

of vibrations in conventional constant velocity joints having six tracks and balls. It suggests that five or seven would provide improved refinement and there is nothing to motivate the skilled person to arrive at the subject-matter presently claimed. Indeed, it states that six already offered the best compromise between the physical size and the torque capacity of the joint, thereby teaching away from the concept underlying the present patent. Similarly, D9 suggests using more than six balls only on larger capacity joints and whilst D21 discloses using up to eight balls, it states that six is "recommended as the best practice for the average construction".

9. On the basis of the foregoing the board concludes that the subject-matter of present claim 1 involves an inventive step (Article 56 EPC 1973). Since claims 2 to 10 contain all features of claim 1 the same conclusion is applicable to them also.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to maintain the patent on the basis of the following documents:

   – claims 1 to 10 and pages 2 to 10 of the description submitted during the oral proceedings;

   – figures as granted.

The Registrar: The Chairman:

A. Vottner S. Crane