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Datasheet for the decision of 22 May 2007

Case Number: T 1002/05 - 3.2.01

Application Number: 97924355.7

Publication Number: 0844412

IPC: F16D 3/20

Language of the proceedings: EN

Title of invention:
Sliding type constant-speed universal joint

Patentee:
NTN CORPORATION

Opponent:
GKN Automotive

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 1002/05 **-** 3.2.01

D E C I S I O N
of the Technical Board of Appeal 3.2.01
of 22 May 2007

Appellant: (Patent Proprietor)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 3 June 2005 revoking European patent No. 0844412 pursuant to Article 102(1) EPC.**

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 3 June 2005 revoking European patent No. 0 844 412.

II. The following evidence played a role during the appeal procedure:

D1: GB-A-1 523 170

D11: J.W. Macielinski, "Propeller Shafts and Universal Joints - Characteristics and Methods of Selection", Proc Inst Mech Engrs 184(31), 1969-70, 516-543

D22: JP-A-03 255 226

D25: Publicity brochure "The New Generation of GKN-Halfshafts. A Global Approach", GKN Automotive Driveline Division

D26: US-A-1 916 442

E1: Technical drawing "Doppel-Offset-Gelenkwelle", No. 0 252 30 02 02 001

E3: Technical drawing "Doppel-Offset-Gelenkwelle 252.35", No. 0 252 355 02 72 001

E5: Technical drawing "Doppel-Offset-Gelenkwelle 252.30", No. 0 252 65 01 38 002

III. During oral proceedings held on 22 May 2007 the appellant requested that the decision under appeal be set aside and the patent maintained in amended form on

the basis of respective sets of claims according to a main request and an auxiliary request filed as first and third auxiliary requests with a letter without date received by fax on 20 April 2007. The respondent requested that the appeal be dismissed.

IV. Claim 1 according to the appellant's main request reads as follows:

"A power transmission mechanism of an automobile that transmits power of an engine between a differential and a wheel, comprising a plunging type constant velocity joint connected to one end of a drive shaft, and a fixed type constant velocity joint connected to the other end of the drive shaft, the plunging type constant velocity joint comprising:
an outer joint member (1) having a plurality of straight guide grooves (ib) formed on an inner cylindrical surface (Ia) thereof and extending in an axial direction of the outer joint member (1);
an inner joint member (2) having a plurality of straight guide grooves (2b) formed on an outer spherical surface (2a) thereof and extending in an axial direction of the inner joint member (2);
a plurality of ball tracks defined between the guide grooves (Ib) of the outer joint member (1) and the guide grooves (2b) of the inner joint member (2);
a plurality of torque transmitting balls (3) each disposed in each of the ball tracks; and
a cage (4) having a plurality of pockets (4c) for retaining the torque transmitting balls (3), an outer spherical surface (4b) brought into contact with the inner cylindrical surface (la) of the outer joint member (1) to be guided thereby, and an inner spherical

surface (4a) brought into contact with the outer spherical surface (2a) of the inner joint member (2) to be guided thereby, wherein the spherical center (B) of the outer spherical surface (4b) of the cage (4) is offset to one side in an axial direction of the cage (4) with respect to the centers of the pockets (4c), and the spherical center (A) of the inner spherical surface (4a) of the cage (4) is offset to the other side in an axial direction of the cage (4) with respect to the centers of the pockets (4c),
characterized in that, the number of the ball tracks and the number of the torque transmitting balls (3) are respectively eight,
the ratio r1 ($=PCD_{BALL}/D_{BALL}$)of the pitch circle diameter (PCD_{BALL}) to the diameter (D_{BALL}) of the torque transmitting balls (3) is in the range of $2.9 \leq r1 \leq 4.5$; and
the ratio r2 ($=D_{OUTER}/PCD_{SERR}$) of the outer joint member (1) to the pitch circle diameter (PCD_{SERR})of serrations (2c) formed on an inner surface of the inner joint member (2) for connection to the shaft is in the range of $2.5 \leq r2 \leq 3.5$."

Claim 1 according to the auxiliary request differs from that of the main request by the addition of the following features:

"a pocket clearance ($=L_C-D_{BALL}$) in the axial direction is defined between each of the pockets (4c) of the cage (4) and each of the torque transmitting balls (3), where L_C is an axial dimension of the pocket (4c) of the cage (4), and D_{BALL} is the diameter of the torque transmitting ball (3), and

an axial clearance (S) is defined between the inner spherical surface (4a) of the cage (4) and the outer spherical surface (2a) of the inner joint member (2)."

V. The submissions of the appellant may be summarised as follows:

The claims according to both requests have been amended to specify a power transmission mechanism of an automobile that transmits power of an engine between a differential and a wheel, comprising an eight-ball plunging type constant velocity ('CV') joint connected to one end of a drive shaft, and a fixed type constant velocity joint connected to the other end of the drive shaft. This amendment clearly establishes novelty of the claimed subject-matter.

As regards inventive step it is accepted that a power transmission mechanism according to the preamble of both claims 1 is known, typically comprising a six-ball plunging joint as disclosed in D1, and is conventional in light vehicles such as passenger cars. Within the mass production, cost sensitive area of automobiles the six-ball joint has established itself as the standard. The problem addressed by the subject-matter of claim 1 according to the main request is to provide a joint which for the same capacity and durability as a conventional six-ball one is smaller and lighter. D25 is evidence that the skilled person seeking a solution to this problem would not consider changing the number of balls. Plunging CV joints may comprise eight balls in order to provide increased capacity. However, the specified ratio r2 in both claims 1 excludes a larger joint fitted on the known shaft and the ratio r1

indicates that the balls are of relatively small size. Moreover, within the technical field of automobiles the capacity of the conventional six-ball joint is sufficient and the skilled person would have no incentive to increase the number of balls. The joints of E1, E3 and E5 are for specific applications involving large shafts, small degrees of plunge and only small angular deviations. The ratio r2 derivable from those drawings is in respect of the diameter of a propeller shaft for a railway vehicle, not the half shaft of an automobile. Moreover, those joints were developed to replace Hooke's joints, not six-ball CV joints.

As regards the additional features of claim 1 of the auxiliary request, the pocket clearance provides for the working angles necessary for automobile use and the joints of E1, E3 and E5 therefore are not relevant. D1 again represents the closest state of the art and relates to an arrangement for restricting movement of the cage. Although it is accepted that the additional features *per se* are known, according to D22 these features create free play between the balls and the cage. The teachings according to D1 and D22 therefore are incompatible and the skilled person would not attempt to combine them. A reduced tendency of the balls to slide which results from the improved lubrication associated with the eight-ball arrangement is further enhanced by a reduction in friction resulting from the feature of the pocket clearance. The feature of axial clearance has the effect of permitting small axial movements between the cage and the outer member whilst the pocket clearance and the reduction in size of the balls associated with their increased

number improves their rolling action. These features combine to reduce the transmission of axial vibration.

VI. The respondent countered essentially as follows:

It is accepted that the subject-matter of the respective claims 1 is novel and that no formal objections arise from the amendments.

However, the subject-matter of claim 1 according to the main request does not involve an inventive step. The closest prior art joint is known from D1 and the skilled person's knowledge is not restricted to the automotive field but extends to the whole field of transmission technology. The trend in the automobile area is to increasing levels of power and torque. Eight-ball CV joints have been known since the first Rzeppa patent in 1929 (D26) and their adoption is an obvious reaction to the trend. The same trend exists in the technical field of railways where E1, E3 and E5 show the resulting eight-ball joints. The ratios r1, r2 are known from each of E1, E3, E5 and merely represent the conventional arrangement of an eight-ball joint. Indeed, the patent specification states that the claimed range of the ratio r2 merely represents what is usable. The establishment of the six-ball joint as the industry standard for light self-propelled vehicles is in part the result of commercial considerations. However, the term "automobile" covers all self-propelled land vehicles and not all CV joints for all such vehicles are produced in large volumes.

As regards the additional features of claim 1 according to the auxiliary request these relate to a different problem and there is no functional combination with the novel features of claim 1 according to the main request. The closest state of the art for this claim 1 is D22 which already discloses the additional features according to this request and consideration of inventive step therefore is the same as for the main request.

Reasons for the Decision

1. Claim 1 of the patent on which the contested decision was based specified a plunging-type constant velocity ('CV') joint for use in a power transmission mechanism of an automobile and the opposition division found that this was not new with respect to a CV joint for use in a railway vehicle (E1). During the appeal procedure the appellant amended claim 1 which now specifies a power transmission mechanism of an automobile, comprising a plunging-type CV joint. By this amendment, which *per se* leads to no objections, the matter of novelty is resolved and it remains only to consider inventive step. In agreement with both parties the board has exercised its discretion in accordance with Article 111(1), second sentence, EPC and continued prosecution of the case.

Main request

2. Although the subject-matter of the claim is now a power transmission mechanism the matter of inventive step concerns modifications only to the plunging joint. A

typical plunging double-offset joint, which conventionally comprises six balls, is known from D1 and it is accepted by the appellant that half shafts as set out in the preamble of claim 1 are known. D1 may be considered as representative of that state of the art.

2.1 Whilst the six-ball joint is conventional and, indeed, is the standard in mass-produced vehicles such as passenger cars, the idea of an eight-ball joint is known from D26 which states that "The number and size of the grooves and the balls therein are basically unrestricted … . Said number may be taken between 3 and 8 for practical purposes. However, 6 is recommended as the best practice for the average construction." D11 considers the factors affecting the capacity of a CV joint to transmit torque, one of which is "the number of balls (n), which is normally four or six, but on larger size joints eight or more balls may have to be employed." It follows that the skilled person wishing to provide a half shaft comprising the joint of D1 would consider increasing the number of balls to eight if the required torque capacity were sufficiently high.

2.2 Claim 1 specifies that the CV joint is comprised in a power transmission mechanism of an "automobile". In the appellant's view this term restricts the subject-matter of the claim to the high volume, cost sensitive category of motor vehicles characterised by passenger cars and light commercial vehicles for which the skilled person would not consider an eight-ball joint because the required torque capacity is not sufficiently high. The term "automobile" has a broad and somewhat vague meaning, as may be judged from the definitions of "self-propelled road vehicle designed to

carry passengers" (Collins English Dictionary) and "self-propelled vehicle" (Oxford English Dictionary). The patent specification states that the CV joint described in the embodiment "can be widely utilized as a power transmission element in automobile, industrial machines, etc., and especially the same is preferable as a joint for a power transmission mechanism of automobile, for example, for connection of a drive shaft and a propeller shaft of automobile … ." It follows that neither the general meaning of the term nor the patent specification lends support to the appellant's view.

2.3 According to the appellant and as set out in the patent specification the problem solved by the subject-matter of claim 1 is to reduce the size of the joint whilst maintaining strength, load capacity and durability equivalent to the conventional six-ball joint. In other words, the problem was not to increase the capacity of the joint in accordance with the teachings of D11 and D26 but to provide a smaller joint having the same capacity. The appellant argues that the small joint size is reflected in claim 1 by the ratios r1 and r2.

2.3.1 As regards r1, however, the eight-ball CV joints of E1, E3 and E5 which are for use in railway vehicles all have values of r1 which fall within the claimed range. Indeed, the largest joint of the three, which is shown in E5, has a housing diameter of 315mm and a value of r1 of about 3.3. It follows that the ratio r1 cannot serve to distinguish the joint in claim 1 from one for which the skilled person would have adopted an eight-ball construction for the purpose of increasing capacity.

2.3.2 As regards r2 the description states the following:

"… it is better that the ratio r2 (=D_{OUTER}/PCD_{SERR}) of the outer diameter (D_{OUTER}) of the outer joint member to the pitch circle diameter (PCD_{SERR}) of serrations formed on an inner surface of the inner joint member is established to be $2.5 \leq r2 \leq 3.5$."

It continues:

"The reason why $2.5 \leq r2 \leq 3.5$ is established resides in that the pitch circle diameter (PCD_{SERR}) of the serrations of the inner joint member can not be greatly changed in view of the strength of a shaft connecting thereto. Therefore, the figure of r2 depends mainly on the outer diameter (D_{OUTER}) of the outer joint member. If $r2<2.5$ is established (mainly in a case where the outer diameter D_{OUTER} is smaller), the thickness of the respective components (outer joint member, inner joint member, etc.) is made too thin, a worry arises in view of the strength. On the other hand, if $r2>3.5$ is established (mainly in a case where the outer diameter D_{OUTER} is larger), a problem arises in use in view of the dimensional aspect, and the object of making compact can not be achieved. By establishing $2.5 \leq r2 \leq 3.5$, the strength of the outer joint member, etc., and durability of the joints equivalent to or exceeding those of the comparative article (a plunging type constant velocity joint having six balls) can be obtained, and various requirements in use can be satisfied. Especially, by establishing $2.5 \leq r2 < 3.1$, there is an advantage with which the outer diameter thereof can be made compact with respect to the

comparative article (a plunging type constant velocity joint having six balls) having the same nominal type. Based on the above description, it is better that r2 is set to be 2.5 ≤ r2 ≤ 3.5, preferably 2.5 ≤ r2 < 3.1."

2.3.3 The teaching of the description therefore is that the joint is "compact with respect to the comparative article (a plunging type constant velocity joint having six balls) having the same nominal type" if r2 has a value of less than 3.1. In other words, the eight-ball joint is smaller than the six-ball joint if the ratio r2 is less than 3.1. However, the claimed range of r2 extends to 3.5. Moreover, the ratio r2 for every one of the joints of E1, E3 and E5 falls within the claimed range of 2.5 to 3.5. The appellant argues that the ratio r2 in each of E1, E3 and E5 is based on the size of the associated drive shafts and therefore cannot be compared with the claimed range based on a half shaft for an automobile. However, the size of the shaft is not specified in claim 1 and the term "automobile" fails to limit it to a certain range (see 2.2 above). It follows that also r2 cannot serve to characterise the joint in claim 1 as being smaller than one for which the skilled person would have adopted an eight-ball construction for the purpose of increasing capacity.

2.4 D25 is a publicity brochure issued by companies associated with the respondent and relating to development of a "new generation" of half shafts which are lighter and smaller than their forerunners. A chart indicates that the improved performance permits smaller joints to replace larger, earlier ones and the largest earlier size indicated is 97 mm housing diameter. The

appellant argues that the fact that these half shafts still employed six-ball CV joints is evidence that the skilled person attempting to improve half shafts of up to this size would limit himself to developing the standard six-ball joint. However, as already set out above, the subject-matter of present claim 1 is not restricted to half shafts comprising CV joints of the size to which D25 relates. Moreover, D25 indicates that one of the development tasks was cost reduction. It is inevitable that cost will have played a certain role in the establishment of the six-ball joint as the industry standard and it cannot be excluded that it also will have influenced the decision to further develop the six-ball joint for the "new generation" of half shafts announced in D25. D25 therefore cannot serve as an indicator of the actions of the skilled person when unfettered by commercial limitations.

3. On the basis of the foregoing the board finds that the subject-matter of claim 1 does not involve an inventive step (Article 56 EPC) and the present request must be refused.

Auxiliary request

4. Claim 1 according to this request contains the additional features relating to the clearance between the balls and their pockets in the cage and the axial clearance between the inner spherical surface of the cage and the outer spherical surface of the inner joint member. D22 discloses a CV joint which, analogously to D1 in respect of the main request (see point 2 above), may be considered as representative of a half shaft as defined in the preamble of the claim but which, as

accepted by the appellant, furthermore comprises the additional features of present claim 1. D22 thereby discloses state of the art which is closer than D1 to the subject-matter of present claim 1 and which forms the closest state of the art for consideration of inventive step.

4.1 Since the additional features according to this request are already known from the closest state of the art D22 the subject-matter of present claim 1 differs therefrom by the same features as for claim 1 of the main request in comparison with its closest state of the art D1. Since the additional features according to this request are already known from the closest state of the art it need not be considered whether or not they combine or are merely juxtaposed with those of the characterising portion of claim 1 according to the main request. It suffices to establish that the additional features do not serve any better than those already considered in respect of the main request to define the subject-matter of the claim as being limited to a particular range of capacity. The matter of inventive step therefore comes down to essentially the same considerations as for the main request, namely whether it would be obvious for the skilled person starting from a power transmission mechanism of an automobile incorporating a CV joint in accordance with D22 to modify it in such a way as to provide eight balls and arrive at the defined ratios r1 and r2. For the same reasons as are set out in respect of the main request this would be an obvious act.

5. The conclusion is therefore the same as for the main request, that the subject-matter of the claim does not involve an inventive step (Article 56 EPC).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

A. Counillon S. Crane