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DECISION
of 5 November 2002

Case Number: T 0898/99 - 3.2.6

Application Number: 87905863.4

Publication Number: 0374139

IPC: B23F 9/00

Language of the proceedings: EN

Title of invention:
Multi-axis bevel and hypoid gear generating machine

Patentee:
THE GLEASON WORKS

Opponents:
Oerlikon Geartec AG
Klingelberg Söhne GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 123(2), (3), 84, 108, 54(2), 83, 56

Keyword:
"Amendments"
"Late-filed ground of appeal (not admitted)"
"Disclosure - enabling"
"Claims - clarity (yes)"
"Remittal for further search/examination (no)"
"Novelty (yes)"
"Inventive step (yes)"
"Substantial procedural violation (no)"

Decisions cited:
G 0009/92, G 0010/91, T 0231/99, T 0337/88, T 0501/92,
T 0190/99

Catchword:
-



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Case Number: T 0898/99 - 3.2.6

D E C I S I O N
of the Technical Board of Appeal 3.2.6
of 5 November 2002

Appellant I:
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Decision under appeal: Interlocutory decision of the Opposition Division
of the European Patent Office posted 23 July 1999
concerning maintenance of European patent
No. 0 374 139 in amended form.

Composition of the Board:

Chairman: P. Alting van Geusau
Members: G. Pricolo
M. J. Vogel
G. C. Kadner
R. T. Menapace

Summary of Facts and Submissions

I. The appeals are from the interlocutory decision of the Opposition Division posted on 23 July 1999 concerning the maintenance in amended form of European patent No. 0 374 139, granted in respect of European patent application No. 87 905 863.4.

In the decision under appeal the Opposition Division considered that the patent as amended according to the second auxiliary request filed during the oral proceedings held on 7 July 1999 met the requirements of the Convention.

II. The appellants I and II (opponents I and II) each lodged an appeal against this decision. Both notices of appeal were received at the EPO on 15 September 1999. The appeal fees were paid simultaneously with the filing of the appeals. The appellants filed a common statement setting out the grounds of appeal, which was received at the EPO on 26 November 1999.

III. The following documents which featured in the opposition procedure played a role in the appeal proceedings:

R4: M.G. Segal: "Ways of Numerical Program Control Utilization in Machine Tools for Machining Round Teeth of Conical and Hypoid Transmissions".
Izvestiya vuzov. Mashinostroenie, 1985, No.6, p 120-124;

R5: SU-A 946 830 with German translation;

R6: Oerlikon Bevel and Hypoid Gears, published in 1989

by Machine Tool Works Oerlikon Bührle Ltd.,
pages 41 to 56;

Moreover, the following evidence filed during appeal proceedings also played a role:

R8: "Gear Handbook"; Darle W. Dudley, Editor,
Copyright 1962 by McGraw-Hill, Inc.; Chapter 20,
pages 20-1 to 20-11;

R20: Original version of R4 in Russian language;

R21: Commented German translation of R20;

R22: Letter of Machine-Tools Design Bureau, Saratov,
USSR, dated 18 February 1991, to The Gleason
Works, USA;

B14: German translation of SU-A-230 614 (the latter
filed as B14a);

B20: Writ of Gleason to the district Court of
Düsseldorf (Landgericht Düsseldorf), dated
23 August 2001, pages 1 and 22;

B21: Letter of reply of Gleason dated 21 June 2002,
pages 1 to 4 and annex K15, filed before the
district Court of Düsseldorf;

B22: Translation in German language of document R4.

IV. Oral proceedings took place on 5 November 2002.

The appellants requested that the decision under appeal
be set aside and that the patent be revoked.

Alternatively, they requested to remit the case to the department of first instance either on the grounds of a procedural violation committed by the Opposition Division for not considering the requirements of Article 84 EPC in its decision, or for carrying out further search and/or examination of the features added to claims 1 and 3, or for carrying out further examination of the patent in respect of the requirements of Article 100(b) EPC.

The respondent (patentee) requested that the appeal be dismissed and the patent be maintained in amended form on the basis of the claims filed during oral proceedings, the description as upheld by the Opposition Division with the replacement pages 2, 5 and 6 filed during oral proceedings, and the drawings as upheld by the Opposition Division.

V. The independent claims read as follows:

"1. A machine for generating longitudinally curved tooth spaces in bevel and hypoid gears using a tool (26) having stock removing surfaces, having: a machine base (10); a tool support (12) mounted on said base; means for rotating said tool in said tool support about a tool axis (T); a work support (14) mounted on said base; means for rotating a work gear (42) in said work support about a work axis (W); means for imparting relative translational movement between said tool support and said work support along three rectilinear axis (X, Y, and Z); and means for imparting relative angular movement between said tool support and said work support about a pivot axis (P); said machine comprising computer controlling means for substantially simultaneously controlling said rotation of the work

gear, said relative translational movements between the tool and work support, and said angular movement between the tool and work axes (T,W) for imparting a predetermined relative rolling motion between said tool and said work gear, said computer controlling means further controlling the rotation of said tool about said tool axis substantially simultaneously with the rotation of said work gear about said work gear axis, a setup parameter of said tool rotation being a predetermined timed relationship with the rotation of said work gear; wherein said predetermined relative rolling motion is as though said work gear were in mesh with a theoretical generating gear rotating about a theoretical generating axis of rotation and having tooth surfaces represented by the stock removing surfaces of said tool, said theoretical generating gear axis varying in angular orientation with respect to said machine base in the course of said predetermined relative rolling motion between said tool and work gear, said computer controlling means further comprising means for adjusting said rotation of said work gear as a function of said varying angular orientation of said theoretical generating gear axis so as to maintain said predetermined relative rolling motion between the tool and the work gear, and said computer controlling means providing means for adjusting one of said rotation of the work gear and said rotation of the tool as a function of said varying angular orientation of said theoretical generating gear axis so as to maintain said predetermined timed relationship between the tool and the work gear in the course of said predetermined relative rolling motion between the tool and work gear."

"3. A method of forming longitudinally curved tooth

spaces in bevel and hypoid gears by a continuous process using a tool (26) having stock removing surfaces, comprising the steps of: mounting a tool (26) in a tool support (12); mounting a work gear (42) in a work gear support (14); rotating said tool about an axis (T) which passes through said tool; rotating said work gear about an axis (W) which passes through said work gear support; relatively moving said tool support with respect to said work support translationally along three orthogonal axes (X, Y, and Z) for initially positioning said work and tool supports (14,12) rectilinearly with respect to each other; relatively pivoting said work support angularly with respect to said tool support about a pivot axis (P) for initially positioning said work and tool supports (14,12) angularly with respect to each other; using a computer to substantially simultaneously control said rotation of the work gear (42), said translational movement between said tool and work supports, and said pivoting between said tool and work supports for imparting a predetermined relative rolling motion between said tool and said work gear, controlling the rotation of said tool about said tool axis substantially simultaneously with the rotation of said work gear about said work gear axis, a setup parameter of said tool rotation being a predetermined timed relationship with the rotation of said work gear, wherein said predetermined relative rolling motion is as though said work gear were in mesh with a theoretical generating gear rotating about a theoretical generating axis of rotation and having tooth surfaces represented by the stock removing surfaces of said tool, said translational movement, said angular movement, and said rotation of said work gear being controlled so as to relatively orient said tool axis inclined to said

generating gear axis and wherein said theoretical generating gear axis varies in angular orientation with respect to said machine base in the course of said predetermined relative rolling motion between said tool and work gear, and said substantially simultaneous controlling further comprises adjusting said rotation of the work gear as a function of said varying angular orientation of said theoretical generating gear axis so as to maintain said predetermined relative rolling motion between the tool and the work gear, and adjusting one of said rotation of the work gear and said rotation of the tool as a function of said varying angular orientation of said theoretical generating gear axis so as to maintain said predetermined timed relationship between the tool and the work gear in the course of said predetermined relative rolling motion between the tool (26) and the work gear (42)."

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

The decision under appeal was deficient in its reasoning because it did not deal with the requirements of Article 84 EPC. Not only objections under Article 84 were explicitly raised by the opponents during the oral proceedings before the Opposition Division, but also, it was a duty of the Division to examine whether the important amendments made by the patentee introduced a lack of clarity. The decision under appeal was therefore affected by a substantial procedural violation which required immediate remittal of the case to the department of first instance.

The claims filed during the oral proceedings before the Board of Appeal did not meet the requirements of

Article 123(2) EPC because the application as filed did not disclose that a predetermined timed relationship with the rotation of the work gear was a setup parameter of the tool rotation. Nor did it disclose that the predetermined rolling motion between the tool and the work gear was maintained if one of the rotation of the work gear and the rotation of the tool were adjusted to maintain a predetermined timed relationship between the tool and work gear.

The amendments also resulted in an extension of the protection conferred by the European patent. Granted claim 5, being the claim corresponding to claim 1 as amended, referred to a further adjustment of one of the rotation of the work gear and the rotation of the tool for imposing corrective modifications upon the predetermined timed relationship between the tool and the work gear in the course of the predetermined rolling motion. In contrast thereto, claim 1 as amended referred to an adjustment of one of the rotation of the work gear and the rotation of the tool only for maintaining the predetermined timed relationship. Therefore, claim 1 was broader in scope than granted claim 5, because it was neither limited to a *further* adjustment, ie one *in addition* to the control of the axes of the machine by the computer controlling means for maintaining the predetermined rolling motion and the predetermined timed relationship as defined in the preamble of granted claim 5, nor to an adjustment for imposing corrective modifications.

The claims as amended did not meet the requirements of Article 84 EPC. The definition that the rotation of the work gear was adjusted to maintain the predetermined relative rolling motion was in contradiction with the

previous definition in claim 1 that the computer controlling means simultaneously controlled the axes of the machine for imparting said predetermined relative rolling motion. As a matter of fact, if the predetermined relative rolling motion was directly obtained by the simultaneous control of the six axes, then an adjustment of the rotation of the work gear would result in that the predetermined relative rolling motion was no longer maintained. Similarly, the definition that one of the rotation of the work gear and the rotation of the tool were adjusted to maintain the predetermined timed relationship was in contradiction with the previous definition in claim 1 that the computer controlling means simultaneously controlled the axes of the machine for imparting the predetermined relative rolling motion, because an adjustment of the rotation of the work gear or the rotation of the tool would result in a rolling motion different from the predetermined one imposed by the computer controlling means. Furthermore, the adjustment for maintaining the predetermined timed relationship was in contradiction with the feature of claim 1 that the predetermined timed relationship was a setup parameter. Indeed, if said predetermined timed relationship was a setup parameter, then no adjustment was necessary to maintain it. Moreover, it was not clear whether claim 1 referred to a machine in which the control of the axes was carried out in successive steps of controlling and then adjusting the axes of the machine or rather to a machine where the adjustment was made during the controlling step. Also, the claims were affected by a redundancy of features which made them unclear. In view of these unclarities and having regard to the principle of legal certainty, according to which the claims should be clear so that a third party could

clearly avoid infringement of the patent, the claims needed complete redrafting. Since this was a task of the department of first instance, the case should be remitted to the Opposition Division for further examination.

Claim 1 referred to a first adjustment, consisting in an adjustment of the rotation of the work gear so as to maintain the predetermined relative rolling motion, and to a second adjustment, consisting in an adjustment of the rotation of the work gear or of the rotation of the tool so as to maintain a predetermined timed relationship between the tool and the work gear. However, neither the claims of the application as filed, nor the claims of the patent as granted, included the combination of said first and second adjustments. Therefore, the claim as amended was directed to subject-matter which was neither searched nor examined. As a consequence, the case should be remitted to the Opposition Division for further search and/or examination.

The amendments could not all be regarded as caused by a ground of opposition, contrary to the requirements of Rule 57a EPC. In particular, the mention in claim 1 of the predetermined timed relationship with the rotation of the work gear being a setup parameter of the tool rotation did not introduce any clear restriction with respect to claim 5 as granted.

The description was amended to acknowledge document R4 in the description, but the relevant art disclosed therein was not discussed in a sufficiently precise manner. Furthermore, the correction made on page 17 (line 19) of the description, consisting in replacing

"a₁" with "a", was not allowable under Rule 88 EPC, because the correction was not immediately evident.

An objection under Article 100(b) EPC was implicitly raised in the opposition proceedings, and also in the appeal proceedings, although after the expiry of the time for filing the grounds of appeal. Since the requirements of Article 100(b) were not considered by the Opposition Division in its decision, remittal of the case was necessary in order for the department of first instance to carry out further examination in this respect. In any case, the amendments were objectionable under Article 83 EPC. In order to carry out the adjustments of the axes so as to maintain a predetermined relative rolling motion and a predetermined timed relationship between the tool and the work gear, it was necessary to measure the position of the axes and also to determine the position of the theoretical generating gear axis. However, the patent did not disclose how these necessary steps were carried out.

Documents B14, B20 to B22 were filed during appeal proceedings. B14 was important in order to show how document R4 should be interpreted, and B20 to B21, which were letters relating to national infringement proceedings, to show what was the respondent's interpretation of certain features. B22 was the German translation of document R4.

Finally, the claimed subject-matter did not involve an inventive step. Considering that it was clear for a skilled person that the numerical control of the machine of R4, which represented the closest prior art, could only be carried out with the help of a computer

performing the necessary calculations either offline, before operating the machine, or online during operation thereof, the subject-matter of claim 1 was distinguished from the machine of R4 essentially only in that one of the rotation of the work gear and the rotation of the tool was adjusted as a function of the varying angular orientation of the theoretical generating gear axis so as to maintain a predetermined timed relationship between the tool and the work gear in the course of the predetermined relative rolling motion between the tool and the work gear. However, it was common general knowledge that in a "continuous indexing" gear making process the work gear was rotated in a predetermined timed relationship with the rotation of the tool in order to form all the tooth spaces in the work gear collectively. Since R5 disclosed that in a continuous indexing gear making process the angle of rotation of the tool about its axis should be coordinated with the movements of the axes of the machine, and since R5 was cited in R4, the skilled person would obviously include the teaching of R5 in the machine of R4, thereby arriving directly at the subject-matter of claim 1. Although it was disclosed in R4 that a large number of movements in the rolling process was a shortcoming, this statement would not deter the skilled person from introducing a further controlled axis in the machine of R4 in accordance with the teaching of R5 in order to achieve a continuous indexing process.

VII. In support of its request the respondent relied essentially on the following submissions:

The opponent did not raise any objections under Article 84 EPC during the oral proceedings before the

Opposition Division, and therefore the latter was not obliged to state in the decision the reasons why the claims were clear. Furthermore, the Division had considered the requirements of Article 84 EPC when allowing the amended claims, as was readily apparent from the text of the impugned decision that the amendments "helped clarifying the claims".

The definition of the new claims was fully supported by the disclosure of the application as filed. In particular, the latter explicitly disclosed that a predetermined timed relationship with the rotation of the work gear was a setup parameter of the tool rotation. The amendments also clearly resulted in a limitation of the extent of protection conferred by the patent. In this respect, and in respect of the requirements of Article 84 EPC as well, the objections of the appellants were based on a formalistic approach rather than on a realistic approach when reading the claims. Indeed a skilled person would read each claim with an attempt to make technical sense out of it and would consider the claim as a whole. In doing so, he would have no difficulties in understanding the claimed subject-matter and therefore the claims were clear in the sense of Article 84 EPC. A remittal to the first instance to redraft the claims to improve their clarity was not justified at this stage of the proceedings, after the patent was granted and then amended in opposition proceedings before the Opposition Division, in view of the risks of introducing defects objectionable under Article 123(2) and (3) EPC when carrying out extensive amendments.

Claim 1 essentially corresponded to claim 5 as granted, which referred to both a first adjustment, consisting

in an adjustment of the rotation of the work gear so as to maintain the predetermined relative rolling motion, and a second adjustment, consisting in an adjustment of the rotation of the work gear or of the rotation of the tool so as to maintain a predetermined timed relationship between the tool and the work gear. Therefore, since the subject-matter of claim 5 as granted was searched and also examined, a remittal of the case to the department of first instance for that purpose was not necessary.

Since the amendments made clearly resulted in a limitation of the extent of protection conferred by the patent, it could not be denied that they were occasioned by the grounds of opposition.

The description was amended to acknowledge document R4 in the description and the relevant art disclosed therein was briefly discussed, therefore the requirements of Rule 27(1)(b) were met. Furthermore, the correction made on page 17 of the description, consisting in replacing "a₁" with "a", was immediately evident and thus allowable pursuant to Rule 88 EPC.

When considering the question of sufficient disclosure, the same level of skill had to be applied as when considering inventive step. However, although in the latter case the skilled person had knowledge of the prior art only, in the second case it had to be assumed that the skilled person had also knowledge of the invention. Since the patent included detailed descriptions of the functioning of the machine and of the various method steps to be performed, the invention was sufficiently disclosed. Moreover, no objections were raised during the whole proceedings before the EPO

in respect of the relevant passages of the description in the patent.

The documents B14, B20 and B21 filed by the appellants during the appeal proceedings should not be allowed into the proceedings in view of their late filing. Indeed B14 was less relevant than the prior art already on file, and B20 and B21 were not prior art documents but letters relating to infringement proceedings which were of no interest for the EPO.

R4 was the English translation of the original Russian document R20, in which equation (3) was incorrect due to an errant term Li . This error was not correctable on the basis of knowledge at the time. Furthermore, R4 required substantial amplification and explanations in order to be understood, as was apparent from document R21, which was an analysis of R4 by Dr. Duschek, however made in hindsight and with the collaboration of the author of R4, Prof. Segal. In summary, the key disclosure of R4 was irreparably incorrect, and no amount of subsequent and hindsight amplification, selection, reverse engineering and explanation could convert R4 into a document that taught a person skilled in the art how to make and use the claimed invention. Furthermore, Prof. Segal himself recognized that his work was only partially public when he wrote a letter (R22) to the patentee. The patent in suit, in contrast to R4, disclosed a machine and a method that could be put in practice, and indeed machines in accordance with the patent were actually manufactured. Even if corrected and amplified, the disclosure of R4 was anyway a mere theoretical one which did not enable the skilled person to provide a machine that functioned in practice. Moreover, there was no mention in R4 of the

varying angular orientation or "wobble" of the generating gear axis, and therefore the skilled person could not realize that a function related to the wobble should be used to adjust the working relationship between the tool and the work gear.

R5 related to a six-axis machine wherein, for carrying out a continuous indexing gear making process, the angle of rotation of the tool about its axis was coordinated with the movements of the other axes of the machine. However, R4 was concerned exclusively with a five-axis machine and therefore the skilled person would not combine it with the teaching of R5 to include a further controlled axis, namely the rotation of the tool. Furthermore, R5 aimed at expanding technical possibilities and easing loading and unloading, but was not concerned with the problem underlying the patent in suit, to provide a functioning six-axis machine and method, which could be simply put in practice by an unskilled operator, using known setup parameters of conventional gear generating machines of the kind provided with a cradle.

Reasons for the Decision

1. The appeals are admissible.
2. *The alleged substantial procedural violation*

The appellants submitted that objections pursuant to Article 84 EPC were raised during the oral proceedings before the Opposition Division. This was however disputed by the respondent, and there is nothing in the minutes of the oral proceedings from which it could be

inferred that these objections were raised. In view of the appellant's allegation it would be expected that in such a situation a request for correction of the minutes of the oral proceedings were submitted to the opposition division after receipt of the minutes (posted together with the decision under appeal on 23 July 1999). However, such a request was never presented (see in this respect T 231/99, points 1.4 and 1.5). Under these circumstances, the Board is of the opinion that the late filed objection cannot be taken into consideration and that thus in the absence of any proof to the contrary the minutes of oral proceedings correctly reflect the essentials of the oral proceedings and the relevant statements made by the parties (Rule 76(1) EPC).

Furthermore, the reference in Article 102(3) EPC to the requirements of the Convention does not have the effect of imposing on the Opposition Division a duty to comment in its decision each and every requirement of the EPC, including Article 84 EPC, regardless of whether or not it had been raised in the opposition itself (see T 337/88, point 3.2). It is true that Article 84 EPC was cited by the opponent during written proceedings before the Opposition Division (see the letter dated 23 November 98, page 4, point II, 2nd paragraph); this was however only in respect of the expression "to impose corrective modifications upon" which was no longer present in the claims of the patent as maintained by the Division. Therefore, since no objections under Article 84 EPC were raised by the opponents in respect of the claims as amended during the oral proceedings, the Board finds that no procedural violation was committed by the Opposition Division in not dealing explicitly with the

requirements of Article 84 in the decision under appeal.

3. *Amendments*

3.1 Article 123(2) EPC

3.1.1 The Board is satisfied that the application as originally filed forms the basis for claiming a machine for generating longitudinally curved tooth spaces in bevel and hypoid gears using a tool having stock removing surfaces, having: a machine base; a tool support mounted on said base; means for rotating said tool in said tool support about a tool axis; a work support mounted on said base; means for rotating a work gear in said work support about a work axis; means for imparting relative translational movement between said tool support and said work support along three rectilinear axis; and means for imparting relative angular movement between said tool support and said work support about a pivot axis; said machine comprising computer controlling means for substantially simultaneously controlling said rotation of the work gear, said relative translational movements between the tool and work support, and said angular movement between the tool and work axes for imparting a predetermined relative rolling motion between said tool and said work gear, said computer controlling means further controlling the rotation of said tool about said tool axis substantially simultaneously with the rotation of said work gear about said work gear axis, wherein said predetermined relative rolling motion is as though said work gear were in mesh with a theoretical generating gear rotating about a theoretical generating axis of rotation and having

tooth surfaces represented by the stock removing surfaces of said tool, said theoretical generating gear axis varying in angular orientation with respect to said machine base in the course of said predetermined relative rolling motion between said tool and work gear. Reference can be made in particular to claims 38, 9, 10 and to the description, page 48, last paragraph to page 49, second paragraph, of the application as filed.

The application as filed further explicitly discloses (see the paragraph bridging pages 38 and 39) that a predetermined timed relationship with the rotation of said work gear is a setup parameter R_c of said tool rotation.

Claim 1 additionally defines that the computer controlling means further comprises means for adjusting said rotation of said work gear as a function of said varying angular orientation of said theoretical generating gear axis so as to maintain said predetermined relative rolling motion between the tool and the work gear. This definition essentially corresponds to the previous definition of claim 1 that the computer controlling means substantially simultaneously controls the axes of the machine such as to obtain a predetermined relative rolling motion which is as though said work gear were in mesh with a theoretical generating gear rotating about a theoretical generating axis of rotation, with the specification that said rolling motion is maintained throughout a generating operation. Indeed, in order for the predetermined rolling motion to be as though the work gear were in mesh with a theoretical generating gear rotating about a theoretical generating axis of

rotation, the computer controlling means must bring together the work gear and the tool in the same spatial position as they would be in the conventional machine (namely the machine where the theoretical generating axis corresponds to the axis of the cradle and is fixed with respect to the machine-base), in the same generating position. This requires, in the machine of the patent in suit where the theoretical generating axis varies in angular orientation, that the rotation of the work gear is controlled, ie adjusted, in function of the varying angular orientation of the theoretical generating gear axis, as disclosed for instance in the paragraph bridging pages 48 and 49 of the application as filed. Since the application as filed also explicitly discloses that said rolling motion is maintained throughout a generating operation (see page 12, last paragraph), it must be concluded that the above-mentioned definition of claim 1 is supported by the disclosure of the application as filed.

Finally, claim 1 defines that the computer controlling means provides means for adjusting one of said rotation of the work gear and said rotation of the tool as a function of the varying angular orientation of said theoretical generating gear axis so as to maintain said predetermined timed relationship between the tool and the work gear in the course of said predetermined relative rolling motion between the tool and work gear. This definition essentially corresponds to the previous definition of claim 1 that the computer controlling means controls the rotation of the tool about the tool axis substantially simultaneously with the rotation of said work gear about said work gear axis, a setup parameter of said tool rotation being a predetermined

timed relationship with the rotation of said work gear, wherein said predetermined relative rolling motion is as though said work gear were in mesh with a theoretical generating gear rotating about a theoretical generating axis of rotation varying in angular orientation with respect to said machine base in the course of said predetermined relative rolling motion between said tool and work gear, with the specification that said predetermined timed relationship is maintained throughout a generating operation. Indeed, if said predetermined timed relationship is a setup parameter and a predetermined relative rolling motion between tool and work gear is to be achieved, then forcibly one of said rotation of the work gear and said rotation of the tool is controlled (ie adjusted) as a function of the varying angular orientation of said theoretical generating gear axis, as disclosed on page 49, second paragraph, of the application as filed. Since the latter also explicitly discloses that said predetermined timed relationship is maintained throughout a generating operation (see page 13, first paragraph), it must be concluded that also the above-mentioned definition of claim 1 is supported by the disclosure of the application as filed.

3.1.2 In the Board's view, the objections raised by the appellants under Article 123(2) are based on a rather formalistic approach in reading the claim. It might be accepted that the literal sense of the claim could be regarded as referring to an adjustment of one of the rotation of the work gear and the rotation of the tool for maintaining a predetermined timed relationship between the tool and the work gear in addition to the control of the axes of the machine for imparting a

predetermined relative rolling motion, whereby the predetermined rolling motion between the tool and the work gear is no longer maintained when the adjustment is made. However, the skilled person, who reads the claim in an attempt to make sense out of it (see T 190/99), would clearly consider such a reading of the claim as erroneous. Indeed, he would realize that the desired result of generating longitudinally curved tooth spaces in bevel and hypoid gears is achieved according to the patent in suit by the provision of a predetermined relative rolling motion between the tool and the work gear which is as though the work gear were in mesh with a theoretical generating gear rotating about a theoretical axis of rotation and having tooth surfaces represented by the stock removing surfaces of the tool, ie of a predetermined relative rolling motion as it would take place in a conventional machine of the kind having a cradle as shown in R8. When the conventional machine is operated for continuous indexing, then the rotational movement of the tool about its axis is controlled in order to treat collectively all of the work gear tooth spaces. Such control (of the timely relationship between work gear and tool) is carried out in the conventional machine whilst the work gear remains in mesh with the theoretical generating gear (this rolling motion implying a control of the relative spacial relationship between the work gear and the theoretical generating gear). Since in the machine according to the patent in suit a predetermined relative rolling motion must take place which is identical to the one that would take place in the conventional machine, the skilled person reading claim 1 would consider that the adjustment in order to maintain the predetermined timed relationship should be carried out simultaneously with the control

of the axes for maintaining the predetermined relative rolling motion between the tool and the work gear such that the work gear remains in mesh with the theoretical generating gear as in the conventional machine, and therefore that the adjustment forms part of said control of the axes of the machine performed by the computer controlling means. Therefore, it cannot be concluded that the adjustment of one of the rotation of the work gear and the rotation of the tool so as to maintain said predetermined timed relationship between the tool and the work gear represents something different from or in addition to the control of the axes of the machine. This view, moreover, is entirely consistent with the description of the patent in suit, see eg page 6, lines 14 to 25 and the paragraph bridging pages 12 and 13.

- 3.1.3 Claim 3 relates to a method of forming longitudinally curved tooth spaces in bevel and hypoid gears by a continuous process. It defines the method steps corresponding to the operation of a machine having all the features of claim 1, which operation is described in detail in the application as filed, in particular on pages 34 to 39.
- 3.1.4 Dependent claim 2 restricts claim 1 to the provision of means for adjusting the rotation of the work gear so as to maintain the predetermined timed relationship between the tool and the work gear. Since this means is already defined in claim 1 as an alternative to the means for adjusting the rotation of the tool, claim 2 meets the requirements of Article 123(2) EPC for the same reasons given in respect of claim 1.
- 3.1.5 The description is amended to be in conformity with the

new claims and to acknowledge document R4.

Furthermore, the correction made on page 17 (line 19) of the description of the patent in suit, consisting in replacing "a₁" with "a", is not objectionable under Article 123(2) EPC because it is a correction of an obvious mistake, which is allowable under Rule 88 EPC since it is immediately evident that nothing else than "a" would have been intended. Indeed, in the description of the patent (see page 9, lines 47 to 49 and page 17, lines 13, 14) there is disclosed that Figure 16 is a partial view of Figure 15 taken along the work gear axis W, showing the rotated position of vector a with respect to the horizontal plane X-Z (this plane is seen in Figure 15 from above). The inclination alpha of vector a with respect to this plane can be calculated by referring to the product $a \cdot u_y$, u_y being the unit vector attached to axis Y, which is perpendicular to plane X-Z. Considering the direction of vector a with respect to axis Y, implying a minus sign in the equation on line 19 of page 17, it is clear that in the latter equation only "a" can be meant, not "a₁", which is the vector identifying the rotational position of the work gear about axis W₁ in the conventional machine (see page 15, lines 33, 34).

3.1.6 It follows that all the amendments made are allowable under Article 123(2) EPC.

3.2 Article 123(3) EPC

3.2.1 Claim 1 is based upon granted claim 5.

Claim 1 defines that the computer controlling means is for controlling "said relative translational movements

between the tool and work support", rather than the rectilinear movements as specified in granted claim 5. However, this amendment does not extend the protection conferred because claim 1 also defines that the translational movements are along three rectilinear axes, ie that they are rectilinear movements.

Granted claim 5 defines that the tool rotation is in a predetermined timed relationship with the rotation of the work gear. Claim 1 is more restricted, since it requires the predetermined timed relationship to be a setup parameter of said tool rotation, ie a parameter which must be set before the machine is operated.

Claim 1 defines that the computer controlling means further comprises means for adjusting the rotation of the work gear as a function of the varying angular orientation of the theoretical generating gear axis so as to maintain a predetermined relative rolling motion between the tool and the work gear. Since, as explained above (see point 3.1.1), this definition corresponds to the previous definition of claim 1 which is present also in granted claim 5, that the computer controlling means substantially simultaneously controls the axes of the machine such as to obtain a predetermined relative rolling motion which is as though said work gear were in mesh with a theoretical generating gear rotating about a theoretical generating axis of rotation, and includes the restricting specification that the rolling motion is maintained, it does not extend the protection conferred.

Claim 1 defines that the computer controlling means provides means for adjusting one of the rotation of the work gear and the rotation of the tool as a function of

the varying angular orientation of the theoretical generating gear axis so as to maintain a predetermined timed relationship between the tool and the work gear in the course of said predetermined relative rolling motion between the tool and work gear. However, claim 5 as granted defines that the computer controlling means provides means for further adjusting one of the rotation of the work gear and the rotation of the tool as a function of the varying angular orientation of the theoretical generating gear axis so as to impose corrective modifications upon said predetermined timed relationship between the tool and the work gear in the course of said predetermined relative rolling motion between the tool and work gear. In the Board's view, the two definitions are identical in substance and therefore no extension of the protection conferred results from the amendment made to claim 1. Indeed, if the control of the axes of the machine is carried out for imparting a predetermined relative rolling motion as though the work gear were in mesh with a theoretical generating gear rotating about a theoretical generating gear axis of rotation, with the tool rotation being in a predetermined timed relationship with the rotation of the work gear, as defined in the preamble of granted claim 5, then there is no further adjustment in addition to the control of the axes of the machine for imparting the predetermined relative rolling motion, but the adjustment forms part of such control, as explained above (see point 3.1.2). Furthermore, the skilled person reading the definition of granted claim 5 would immediately realize that the adjustment of one of the rotation of the work gear and the rotation of the tool cannot have the purpose of imposing corrective modifications upon the predetermined timed relationship between the tool and

the work gear but rather to maintain said predetermined timed relationship, because said purpose is in contradiction with the previous definition of claim 5 that the tool rotation is in a predetermined timed relationship with the rotation of the work gear, and because if the predetermined timed relationship is not maintained no continuous indexing operation can be performed. Again, in the claimed machine the relative rolling motion between the tool and work gear is intended to be identical to the one that would take place in a conventional machine having a cradle, and since in the conventional machine a predetermined timed relationship with the rotation of the work gear is maintained during said relative rolling motion (see eg page 3, lines 7 to 14, of the patent in suit), the skilled person would conclude that claim 5 as granted can only be interpreted to define that said predetermined timed relationship is maintained in the course of said predetermined relative rolling motion between the tool and work gear. Furthermore, this is the only possible interpretation of the claim in the light of the disclosure in the description of the patent in suit (see the last paragraph of page 13), that the ratio of relative rotation between the tool and the work gear for continuous indexing operations is a constant (R_c), since it makes no sense to impose corrective modifications upon a constant.

Therefore, on the basis of the skilled person's interpretation of granted claim 5, claim 1 does not extend the protection conferred by the patent.

3.2.2 Claim 3 is based upon granted claim 8 to which amendments corresponding to those made to claim 1 are introduced. Therefore, for the reasons given above,

also claim 3 does not extend the protection conferred by the patent.

3.2.3 It follows that the requirements of Article 123(3) EPC are met.

3.3 Article 100(b) EPC

3.3.1 With letter dated 24 May 2002, after expiry of the time limit for filing the grounds of appeal, the appellants raised the objection that the ground of opposition under Article 100(b) EPC was not considered by the Opposition Division in its decision and requested remittal of the case to the department of first instance to carry out further examination in this respect.

3.3.2 Considering this issue raised by the appellants, it is observed that the ground of opposition under Article 100(b) EPC was, allegedly, only implicitly raised in the notice of opposition of opponent II. Moreover, it is clear from the file that opponent II did not take up this alleged introduction of the ground of opposition under Article 100(b) EPC and in particular did not submit further arguments in that respect in writing before the Opposition Division or relied on it at the oral proceedings before the Opposition Division. Appellant I was silent about this issue until its letter dated 24 May 2002.

3.3.3 Considering now whether the Article 100(b) EPC objection should nevertheless be considered in appeal proceedings, the following is noted. The statement in the notice of appeal identifying the decision which is impugned and the extent to which amendment or

cancellation of the decision is requested (Article 108 EPC) defines the legal framework of the appeal proceedings (see paragraphs 7 to 12 of decision G 9/92, OJ EPO 1994). The written statement setting out the grounds of appeal defines the legal and factual reasons why the decision under appeal should be set aside and the appeal allowed (see eg decision T 501/92 OJ EPO 1996). In the statement setting out the grounds of appeal no arguments based upon Article 100(b) were submitted nor was it mentioned that the Opposition Division should have dealt with this ground of opposition in the decision. Therefore, the above-mentioned questions in connection with Article 100(b) raised by the appellants for the first time in the letter dated 24 May 2002 do not fall within the legal and factual reasons why the decision under appeal should be set aside. As stated in G 9/92 (*supra*, see point 9) the subject-matter of the appeal proceedings is always the appeal itself, and the appeal may not be regarded simply as a means of recommencing the proceedings.

By failing to make any submissions in respect of Article 100(b) EPC being left out of consideration by the Opposition Division in the grounds of appeal, the appellants put themselves in the situation in which, from an objective point of view, objections based upon Article 100(b) EPC could no longer be expected. Therefore, since it was not filed with the statement setting out the grounds of appeal, the objection of the appellants that the ground of opposition under Article 100(b) EPC was not considered by the Opposition Division in its decision must be regarded in the Board's judgment as a ground of appeal which was not filed in due time and which should therefore be

disregarded pursuant to Article 114(2) EPC.

3.3.4 In accordance with the decision G 10/91 of the Enlarged Board of Appeal a fresh ground of opposition may be considered in appeal proceedings only with the approval of the patentee. Since the respondent did not approve the introduction of a new ground of opposition, also this possibility of introducing the ground of opposition under Article 100(b) fails.

3.3.5 Consequently, remittal of the case to the department of first instance to carry out further examination in this respect is refused.

3.4 Article 83 EPC

3.4.1 Although an objection based under Article 100(b) EPC does not form part of the legal and factual reasons of the appeal, in accordance with Article 102(3) EPC the amendments must still be scrutinised for compliance with the requirements of Article 83 EPC.

3.4.2 In the Board's view, having regard to the disclosure of the patent from page 10 to page 17, the patent includes sufficient details to enable a skilled person to reproduce the invention as claimed.

3.4.3 The appellants submitted that, in order to carry out the adjustments of the axes so as to maintain a predetermined relative rolling motion and a predetermined timed relationship between the tool and the work gear, it was necessary to measure the position of the axes and also to determine the position of the theoretical generating gear axis. However, the patent specifically discloses the use of encoders (see

page 11, lines 49 to 54) for measuring the position of the axes. Anyway, means for measuring the position of the axes of a machine tool are part of the basic common general knowledge of the skilled person. Furthermore, contrary to the opinion of the appellants, there is no necessity of determining the position of the theoretical generating gear axis in order to carry out the invention. Indeed, in the machine of the patent in suit, the theoretical generating gear axis is a virtual axis, which does not correspond to any of the axes of the machine, in contrast to the conventional machine having a cradle where the axis of rotation of the cradle corresponds to the theoretical generating gear axis. The theoretical generating gear axis plays a role in determining the mathematical relations necessary for establishing the exact positions of the axes of the machine according to the patent in suit such that the relative positions of the tool and work gear axes represent the same relative positions of these axes on the conventional machine (see in particular page 17, lines 30 to 52 of the patent in suit). Once these mathematical relations are established, the instantaneous positions of the axes of the machine can be calculated, and the machine controlled such that its axes are brought in the calculated positions (see Figures 6a and 6b). The control of the axes is made on the basis of a servo-position control loop (page 11, lines 49 to 54 of the patent in suit) which only requires determining the position of the axes of the machine, not however the position of the theoretical generating gear axis.

3.5 Article 84 EPC

3.5.1 In the Board's judgment, the correct approach in

assessing the clarity of the claims consists in considering the claim as it would be read by a skilled person, ruling out interpretations which are illogical or which do not make technical sense, trying to arrive at an interpretation of the claim which is technically sensible and takes into account the whole disclosure of the patent (see T 190/99). On the basis of this approach, the Board is satisfied that the claims are sufficiently clear and that the requirements of Article 84 EPC are met.

- 3.5.2 The appellants argued that the definition according to which the rotation of the work gear was adjusted to maintain the predetermined relative rolling motion was in contradiction with the previous definition in claim 1 according to which the computer controlling means simultaneously controlled the axes of the machine for imparting said predetermined relative rolling motion, and that if the predetermined relative rolling motion was directly obtained by the simultaneous control of the six axes, then an adjustment of the rotation of the work gear would have as a result that the predetermined relative rolling motion was no longer maintained.

The Board cannot follow this view, which limits the technical interpretation to a rather formalistic approach in reading the claims. In fact, as explained above (see point 3.1.1), the adjustment of the rotation of the work gear to maintain the predetermined relative rolling motion forms part of, and therefore is not in contradiction with, the simultaneous control of the axes of the machine for imparting said predetermined relative rolling motion. In other words, the predetermined relative rolling motion is based on a

simultaneous control of the six axes which includes the adjustment of the rotation of the work gear, the means for adjusting being part of the means for providing the predetermined relative rolling motion.

- 3.5.3 Furthermore, the appellants argued that the definition that one of the rotation of the work gear and the rotation of the tool were adjusted to maintain the predetermined timed relationship was in contradiction with the previous definition in claim 1 that the computer controlling means simultaneously controlled the axes of the machine for imparting the predetermined relative rolling motion, because an adjustment of the rotation of the work gear or the rotation of the tool would result in a rolling motion different from the predetermined one imposed by the computer controlling means.

As explained above (see point 3.1.1), also the adjustment of one of the rotation of the work gear and the rotation of the tool in order to maintain the predetermined timed relationship forms part of, and therefore is not in contradiction with, the simultaneous control of the six axes for imparting the predetermined relative rolling motion.

- 3.5.4 The appellants further submitted that the adjustment for maintaining the predetermined timed relationship was in contradiction with the feature of claim 1 that the predetermined timed relationship was a setup parameter: if said predetermined timed relationship was a setup parameter, then no adjustment was necessary to maintain it.

However, the Board cannot see any contradictions. A

setup parameter is an input parameter which is assigned before the machine is operated. By defining that the predetermined timed relationship is a setup parameter and that an adjustment is made for maintaining the predetermined timed relationship, the claim makes it clear that the machine is controlled in a manner that the predetermined timed relationship which is maintained during operation corresponds as close as possible to the parameter which is set before the machine is operated. In fact, it is clear that a mere continuous control of the axis of the machine is required, either analog or in small incremental steps, which includes the above-mentioned adjustments to achieve machining of a gear as close as possible in accordance with the setup parameter.

3.5.5 Finally, the appellants objected to the redundancy of features in the independent claims. Although the Board accepts that there is indeed a certain redundancy of features in claims 1 and 3 (some features corresponding to other features in the same claim, as explained above), it takes the view that, since the redundancy does not lead to any inconsistencies or contradictions, it does not cast doubt on the matter for which protection is sought.

Since the claims are sufficiently clear, there is no need to remit the case to the first instance for a complete redrafting thereof. Although the Board accepts that the wording of the claims might be improved by a complete redrafting, there is no basis in the EPC to require that the wording of claims which are already sufficiently clear for the purposes of Article 84 EPC be further improved.

3.6 The request of remittal for further search and/or examination

The appellants submitted that claim 1 was directed to subject-matter which was neither searched nor examined because the combination of the first adjustment (of the rotation of the work gear so as to maintain the predetermined relative rolling motion) and the second adjustment (of the rotation of the work gear or of the rotation of the tool so as to maintain a predetermined timed relationship between the tool and the work gear) was neither present in the claims of the application as filed, nor in the claims of the patent as granted.

However, the Board draws attention to the fact that the second adjustment is clearly present in claim 5 as granted. The first adjustment is also present, since granted claim 5 defines that the computer controlling means substantially simultaneously controls the axes of the machine such as to obtain a predetermined relative rolling motion which is as though said work gear were in mesh with a theoretical generating gear rotating about a theoretical generating axis of rotation, and this definition, as explained above (see point 3.1.1), corresponds to the definition of claim 1 that the computer controlling means further comprises means for performing said first adjustment.

Therefore, there is no basis for remittal either for reasons of further search or examination to be carried out by the Opposition Division.

3.7 Rule 57a EPC

After deletion of claims 1 to 4 and 7 from the set of

claims underlying the appealed decision, whereby the subject-matter of claims 1 to 3 corresponds essentially to the subject-matter of claims 5, 6 and 8 of the patent as granted and as maintained by the Opposition Division, the Board is satisfied that the remaining amendments, with regard to the granted version, comprised by the now operative claims are all occasioned by the grounds of opposition.

The appellants submitted that the mention in claim 1 of the predetermined timed relationship with the rotation of the work gear being a setup parameter of the tool rotation, did not introduce any clear restriction with respect to claim 5 as granted. However, claim 5 as granted states "said tool rotation being in a predetermined timed relationship with the rotation of said work gear". Although this definition implies that the predetermined timed relationship is satisfied during operation of the machine, it does not necessarily imply that the predetermined timed relationship is a setup parameter, ie an input parameter which must be assigned and set before the machine is operated. Therefore, the objected amendment actually introduces a restriction of the scope of the claim.

3.8 The requirements of Rule 27(1)(b) EPC

On page 5, line 29 ff., of the description of the patent in suit there is acknowledged a background art consisting of machines in which there is no cradle as in the conventional machines, it being replaced by controlled axes. This part of the description is amended to cite document R4 as a document reflecting such background art and to state that in R4, as

explicitly disclosed eg on pages 2 and 3 thereof, "no more than five coordinates need to be controlled in a situation where the tool is not tilted". Thus, the requirements of Rule 27(1)(b) EPC are met.

The appellants submitted that the prior art was not discussed in a sufficiently precise manner. However, since the above-mentioned passage referring to the prior art as disclosed by R4 corresponds exactly to the disclosure of R4 on page 3, lines 14 to 16 ("the position and movement of the instrument axis relative to the billet can be determined completely with no more than 5 coordinates"), it must be concluded that it is sufficiently precise for the purposes of Rule 27(1)(b) EPC.

4. *Documents filed during appeal proceedings*

During appeal proceedings documents R8 and R20 to R22 were filed by the respondent and documents B14, B20 to B22 were filed by the appellants. The question arises whether these documents should be introduced into the appeal proceedings.

The appellants did not object to documents R8 and R20 to R22 being introduced into the proceedings. Neither did the respondent have any objection in respect of B22, it being the German translation of document R4 which is already on file. In the Board's view, B22 actually does not constitute late filed evidence insofar the translation of R4 in the German language is correct.

In respect of B14, although the Board agrees with the respondent's opinion that this document is not more

relevant than the prior art already on file, it takes the view that B14 might play a role in assessing the disclosure of R4, since it represents a precedent document from the same author of R4 and thus might prove helpful in understanding the concepts underlying the disclosure of R4. Similarly, although B20 and B21 do not represent prior art documents and are letters filed in the course of separate infringement proceedings, the Board takes the view that they might prove helpful in assessing the breadth of the features referred to in the claims and thus, in assessing novelty and/or inventive step of the claimed subject-matter.

In view of the particular complexity of the technical issues raised in the present case, and of the fact that the introduction of the late-filed documents might provide elements for reducing such complexity (see T 633/97) and for arriving at a clear and complete picture of the situation, the Board considers it appropriate to consider all the above-mentioned late-filed documents pursuant to Article 114(1) EPC.

5. *Novelty*

Novelty of the subject-matter in accordance with claims 1 and 3 follows from the fact that none of the cited documents discloses a machine and a method for generating longitudinally curved tooth spaces in bevel and hypoid gears wherein computer controlling means adjusts the rotation of the work gear as a function of the varying angular orientation of the theoretical generating gear axis so as to maintain a predetermined relative rolling motion between the tool and the work gear, and also adjusts one of the rotation of the work

gear and the rotation of the tool as a function of said varying angular orientation of said theoretical generating gear axis so as to maintain a predetermined timed relationship between the tool and the work gear in the course of said predetermined relative rolling motion between the tool and work gear.

Novelty was in fact not disputed.

6. *Inventive step*

6.1 The technical problem underlying the patent in suit consists in providing a bevel and hypoid gear generating machine which is readily adaptable to computer controls for automatically setting up and operating the machine and which is arranged for controlling the relative positions of the tool axis and work gear axis using a minimum number of movable machine axes (see page 5, lines 46 to 52 of the patent in suit).

6.2 Document R4 was already filed by the respondent (applicant) during examination proceedings. It is the English translation of the original Russian document filed as R20. In the following R20 will be considered with the help of the English translation R4. Therefore when R4 is referred to, this in fact constitutes a reference to the prior art disclosed in R20. R4 represents the closest prior art because it discloses a machine which aims at the same objective (see R4, page 2, first paragraph, and page 8) as and has the most technical features in common with the claimed invention.

R4 discloses (see Figure 1) a machine for generating

longitudinally curved tooth spaces in bevel and hypoid gears using a tool having stock removing surfaces, having: a machine base; a tool support mounted on said base; means for rotating said tool in said tool support about a tool axis; a work support mounted on said base, means for rotating a work gear in said work support about a work axis; means for imparting relative translational movement between said tool support and said work support along three orthogonal axes (the Z axis is shown in Figure 1; with respect to the X and Y axis R4 discloses that the rotations e_n and Q_n can be replaced with vertical and horizontal movements, see page 7, lines 9 to 15); and means for imparting relative angular movement between said tool support and said work support about a pivot axis, said machine comprising controlling means for controlling said rotation of the work gear, said relative translational movements between the tool and work support and said angular movement between the tool and work axes during said generating for imparting a predetermined relative rolling motion between said tool and said work gear (page 3, lines 6 to 9 from the bottom).

The predetermined relative rolling motion according to R4 is as though said work gear were in mesh with a theoretical generating gear rotating about a theoretical generating gear axis of rotation and having tooth surfaces represented by the stock removing surfaces of said tool. In fact, it follows from the paragraphs bridging pages 2 and 3, 4 and 5, 8 and 9, that the relative rolling motion carried out on the machine of Figure 2 is intended to be the same as if it were carried out on a conventional machine with a cradle. Since the machine axes x_n , y_n , z_n are stationary with respect to the machine of R4, the theoretical

generating gear axis will vary in angular orientation with respect to the machine base, ie with respect to the system of coordinates $x_n y_n z_n$. Since in the machine of R4 the same tool movement relative to the billet as on the conventional machine tool (ie with a cradle carrying the tool, designated as "original machine" on page 4, last line, of R4) is intended, the controlling means also provides for adjusting said rotation of the work gear as a function of said varying angular orientation of said theoretical generating gear axis so as to maintain said predetermined relative rolling motion between the tool and work gear.

The disclosure of R4 is essentially based on the same concept of the patent in suit; ie to move the axes of the machine such that the work gear and tool are in the same spatial positions as they would be in the conventional machine (basic generator with a cradle), in the same generating position. In order to arrive at the mathematical equivalence of movements, R4 teaches to carry out a transformation of vector coordinates. A corresponding transformation is disclosed in the patent in suit (see page 14, line 45 to page 17, line 20). In detail, R4 first states that in a conventional machine the angle of rotation of the cradle q is function of the angle \mathbf{n}_s of rotation of the work gear and that the displacement B of the sliding base carrying the work gear is a function of q , these functions being known (see page 4). The expressions of the tool axis vector \mathbf{g} and of the radius vector \mathbf{r} of point O_0 (see annexed sketch) in the reference system $x_j y_j z_j$ (which rotates with the work gear axis) are then calculated. They are functions of \mathbf{n}_s and q (page 4, equations 2 and 3). Then a transformation from the reference system $x_j y_j z_j$ to the stationary reference system of the machine $x_n y_n z_n$ is

carried out, whereby the displacements of the five axis of the machine as function of the parameter \mathbf{n}_s are obtained (page 5, second paragraph - page 6, last paragraph). Although the penultimate paragraph of page 6 refers to the displacements e_n and Q_n (see Figure 1), it is clear that in case the tool moves along y and z axes, then it is simply necessary to refer to the components y_n and z_n of vector r_n (page 6, paragraph above equation (8)).

- 6.3 The respondent submitted that in the original Russian document R20, of which R4 was a translation, equation (3) was incorrect due to an errant term L_i , and that this error was not correctable on the basis of knowledge at the time.

In the Board's view, the person skilled in the art in the technical field of bevel and hypoid gear manufacturing must be presumed to have sufficient knowledge of the basic mathematics which is required to describe a gear generating process in terms of equations and vectorial relationships. This skilled person must also be presumed to have access to the mathematical formulae describing a conventional gear generating process of the kind as shown in R8.

Considering that the basic idea behind the transformation is to "make it possible to obtain the same tool movement relative to the billet on the S5UK (the five axis machine) as on the original machine (the cradle machine) and consequently to machine the same tooth surface" (see R4, last three lines on page 8), this skilled person would have no difficulties in recognizing that the term L_i in equation (3) of R20 is erroneous. This error is immediately apparent from

equation (3) in combination with the text of R4 (and R20) following equation (3), according to which $L_k(\acute{\alpha})$ is the operator of the turning of the coordinate system around the k-th axis by the angle $\acute{\alpha}$, since equation (3) refers to operator L_1, L_2, L_3 and an operator of turning about a further i-th axis would not make sense.

Furthermore, in view of the intended objective the skilled person having knowledge of the mathematics involved in the mathematical description of the gear generating process would have no difficulties in establishing what the correction should be. Indeed, equation (3) gives the expression for the vector \mathbf{g} (giving the position of the axis of the tool relative to the billet as disclosed on page 4 of R4) in the $x_j y_j z_j$ system which is stationary relative to the billet. Even considering that equation (3) is erroneous and R4 does not describe in what consist the operators $L_k(\acute{\alpha})$ in detail, the person skilled in the art would have no difficulties in newly drafting equation (3) and in writing explicitly all the terms contained therein, because a vectorial transformation from one system of coordinates to another which moves relative thereto, merely requires the application of the basic mathematics of which he has sufficient knowledge.

The respondent further submitted that R4 required substantial amplification and explanations in order to be understood. In the Board's opinion, R4 is not only sufficiently clear and complete to allow understanding of the principles involved when developing the idea of describing movements of cradle machines to apply to the five axis machine of R4, but also contains sufficient practical detail as regards the resulting interdependance of the controlled coordinates during

machining (see Figure 3) to give the skilled person sufficient information as to how the numerical control of the machine could be designed in practice. Insofar it is to be noted that also the independent claims under consideration do not specify the control in detail and cannot be considered to be limited to the specific control disclosed in the description of the patent in suit.

Finally, the respondent submitted that there was no mention in R4 of the varying angular orientation or "wobble" of the generating gear axis. However, it is clear for the skilled person acquainted with the mathematical transformations at issue that if the generating gear axis only rotates when seen in a reference system stationary relative to the theoretical conventional generating machine (the original machine in R4), the same axis varies in angular orientation when seen in the stationary reference system $x_n y_n z_n$ (see above point 6.2) of the five axis machine of R4.

6.4 The above mentioned technical problem is solved, in accordance with the definition of claim 1, by the provision of the following features:

- computer controlling means for substantially simultaneously controlling said rotation of the work gear, said relative translational movements between the tool and work support, and said angular movement between the tool and work axes (T,W) for imparting a predetermined relative rolling motion between said tool and said work gear,
- said computer controlling means further

controlling the rotation of said tool about said tool axis substantially simultaneously with the rotation of said work gear about said work gear axis,

- a setup parameter of said tool rotation being a predetermined timed relationship with the rotation of said work gear;
- said computer controlling means further comprising means for adjusting said rotation of said work gear as a function of said varying angular orientation of said theoretical generating gear axis so as to maintain said predetermined relative rolling motion between the tool and the work gear,
- and said computer controlling means providing means for adjusting one of said rotation of the work gear and said rotation of the tool as a function of said varying angular orientation of said theoretical generating gear axis so as to maintain said predetermined timed relationship between the tool and the work gear in the course of said predetermined relative rolling motion between the tool and work gear.

6.5 The appellants submitted that the skilled person would interpret the numerical program control device in R4 as a reference to a computer controlling device. However, the expressions "numerical program control", "numerical control" do not necessarily imply the presence of a computer at the publication date of R20; they only imply that the programs are stored as numerical information (eg in a punched tape) and that means are provided for transforming the numbers into activating

signals for operating the devices of the machine. This is confirmed by the fact that B14, which refers to numerically controlled (NC) machines (see eg page 2, last paragraph), was published in 1969 and hence before the introduction of computer numerical controls (CNC) in machine tools. Neither documents nor convincing arguments have been provided by the appellants why the disclosure of R20 dating from 1985 should be considered to relate to a computer controlled machine.

6.6 It was not disputed that the disclosure of document R4 is limited to the provision of five axes which are controlled during the rolling motion. A sixth controlled axis, necessary for continuous indexing, is not described. R4 further indicates that a shortcoming of the machine is the large number of movements (see page 9, second paragraph), and it is suggested to use an intermediate solution in which only 4 axes are controlled during the rolling motion (see page 9, last paragraph). In this intermediate solution 4 simultaneously controlled movements and 3 adjustment displacements are necessary; however the latter adjustments cannot be seen as a control of three axes in addition to the control of said four axes during the rolling motion, but only as adjustments carried out when setting up the machine. As a consequence, the skilled person reading document R4 would be inclined to conclude that the introduction of a further controlled axis, such as the further axis necessary for continuous indexing operations, would result in serious control complications of the machine. Therefore, the skilled person would be led away from the provision of a further controlled axis in the machine of R4.

Furthermore, in assessing inventive step it must also

be assessed whether the skilled person would have taken the prior art of R4 as a realistic basis for further development. Considering that in the quite complex technical field of bevel and hypoid gears manufacture a great quantity of experimental data and knowledge has been accumulated in respect of the conventional machine having a cradle since the time of its introduction about 100 years ago (see R6, page 51, last paragraph; although this document does not form part of the prior art under Article 54(2) EPC, it is considered valid evidence of the developments in this field of technology), that this experience is significant for the production of gears that meet the requirements of the industry and that this experience is not of immediate application to the machine of R4, the skilled person, who is normally looking for practical rather than academic solutions, would rather refrain from further developing the machine of R4 in the direction of making it even more complicated. Indeed, the skilled person would consider that sufficient experience should be acquired before being able to assess whether any hypothetical modifications of the machine of R4 would be feasible in practice, whereby for the machine of R4 there is no proof of any industrial application.

6.7 Document R5 relates to a method for generating longitudinally curved tooth spaces in bevel and hypoid gears using a tool having stock removing surfaces. No detail of the machine used is explicitly given. However, it is clear from the description of the first and second embodiments (pages 2 and 3; see Figure 2 for the second embodiment) that the tool axis O_4-O_4

- rotates about an axis O_5-O_5 , and at the same time

- translates, whilst remaining parallel to rotation axis O_5-O_5 , such that the composite movement of the tool axis O_4-O_4 corresponds to a rotation about theoretical generating gear axis of rotation O_2-O_2 . It is clear that to provide a rotation of the inclined tool axis O_4-O_4 about the theoretical generating gear axis of rotation O_2-O_2 it is also necessary to adjust the angle of the tool axis O_4-O_4 after it has been rotated about axis O_5-O_5 and then translated. This is done according to R5 by an adjustment of the angle \hat{a} between work gear axis O_1-O_1 and rotation axis O_5-O_5 .

As a consequence, what is described in R5 is essentially a method for generating longitudinally curved tooth spaces which is equivalent to the conventional method (as shown in R8, Figures 20-2 and 20-4) using a cutter which is carried by a cradle (see also page 2, line 3 of R5). The difference consists essentially in that in the method according to R5, the movement imposed by the cradle to the tool axis is obtained by rotating and translating the tool axis *and* by adjusting the angle between work gear axis and rotation axis *and* by translating the work gear axis in the direction of the tool axis (see page 3, from line 15).

Thus, in this prior art the theoretical generating gear axis does not vary in angular orientation with respect to the machine base in the course of the predetermined relative rolling motion between said tool and work gear.

R5 discloses (page 3, last three lines) that in case of continuous indexing the angular position of the tool about its axis must be matched with the other movements

of the machines. However, since R5 discloses essentially a method for generating longitudinally curved tooth spaces which is equivalent to the conventional method which uses a cradle, wherein the theoretical generating gear axis does not vary in angular orientation with respect to the machine base, it cannot suggest to adjust, in the machine of R4, one of the rotation of the work gear and the rotation of the tool as a function of said varying angular orientation of said theoretical generating gear axis so as to maintain a predetermined timed relationship between the tool and the work gear, in accordance with the definition of claim 1 of the patent in suit.

6.8 For the above reasons, and in the absence of any indications in the remaining available prior art to modify the machine of the closest prior art to provide, in particular, computer controlling means for adjusting one of the rotation of the work gear and the rotation of the tool as a function of the varying angular orientation of the theoretical generating gear axis so as to maintain a predetermined timed relationship between the tool and the work gear, the subject-matter of claim 1 is found to involve an inventive step.

6.9 Since claim 3, which relates to a method of forming longitudinally curved tooth spaces in bevel and hypoid gears by a continuous process, defines the method steps corresponding to the operation of a machine having all the features of claim 1, its subject-matter also involves an inventive step.

7. Therefore, independent claims 1 and 3, together with dependent claim 2, filed during oral proceedings of 5 November 2002, the description as upheld by the

Opposition Division with the replacement pages filed during the oral proceedings of 5 November 2002, and the drawings as upheld by the Opposition Division, form a suitable basis for maintenance of the patent in amended form.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The requests of the appellants for remittal to the first instance for further prosecution of the opposition proceedings are rejected.
3. 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 3 filed during the oral proceedings;

description: pages 2, 5 and 6 filed during the oral proceedings;
pages 3, 4 and 7 to 18 as maintained by the Opposition Division;

drawings: Figures 1 to 18 as maintained by the Opposition Division.

The Registrar:

The Chairman:

M. Patin

P. Alting van Geusau