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**Datasheet for the decision
of 5 July 2011**

Case Number: T 0484/10 - 3.2.07

Application Number: 01950844.9

Publication Number: 1307605

IPC: C23C 16/00

Language of the proceedings: EN

Title of invention:

Chromium-containing cemented tungsten carbide coated cutting insert

Applicant:

KENNAMETAL INC.

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 56

Relevant legal provisions (EPC 1973):

-

Keyword:

"Inventive step (all requests - no)"

Decisions cited:

-

Catchword:

-



Case Number: T 0484/10 - 3.2.07

D E C I S I O N
of the Technical Board of Appeal 3.2.07
of 5 July 2011

Appellant: KENNAMETAL INC.
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 16 September 2009
refusing European patent application
No. 01950844.9 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman: H.-P. Felgenhauer
Members: H. Hahn
I. Beckedorf

Summary of Facts and Submissions

I. The applicant lodged an appeal against the decision of the Examining Division to refuse the European patent application No. 01 950 844.9.

II. In this decision the following documents are mentioned:

D2: US-A-5 750 247

D3: US-A-5 188 489

D5: Santhanam and Tierney, "Cemented Carbides", Reprint from Metals Handbook, Vol. 16, 9th Edition, ASM International, Metals Park, OH, 1989, pages 71 to 89

D6: Ullmann's Encyclopedia of Industrial Chemistry, 6th edition, 2003, Volume 34, pages 70 and 71

D7: Marwanga, Voigt and Cohen: "Influence of Graphite Morphology and Matrix Structure on Chip Formation During Machining of Continuously Cast Ductile Irons", American Foundry Society Transactions (2003), pages 651 to 661

D8: Voigt, Marwanga and Cohen: "Machinability of gray iron - Mechanics of chip formation", International Journal of Cast Metals Research, 1999, vol. 11, pages 567 to 572

D9: Declaration of Peter Leicht, dated 13 April 2011

Annex 1: Comparative milling test of Class 40 gray cast iron with the tools SP7779 and SP3979

- III. The Examining Division held that the subject-matter of product claim 1 of the single request as filed during the oral proceedings of 25 March 2009 lacked inventive step starting from D2 as closest prior art and further considering D3.

- IV. With its grounds of appeal the appellant requested to set aside the impugned decision and to grant a patent on the basis of the claims 1-6 of the single request filed together with the notice of appeal dated 17 November 2009. As an auxiliary request oral proceedings were requested.

- V. With a communication dated 3 March 2011 annexed to the summons to oral proceedings the Board gave its preliminary and non-binding opinion with respect to the claims of the single request.

Amongst others the Board considered D5 and D6 to be relevant. With respect to the issue of inventive step the Board indicated that it seemed that the skilled person would arrive at the subject-matter of claim 1 in an obvious manner starting from the two CVD layer embodiment of the closest prior art D2 by simply applying common general knowledge (as represented by e.g. D5 and D6) in providing a further outermost alumina coating. This conclusion was based on the fact that it had not been proven that an effect can be attributed to the feature of a coercive force of 195 to 245 oersteds of the tungsten carbide substrate so that this feature could not be considered in the assessment

of inventive step. In particular it was indicated that it is not apparent from Annex 1 that there would be a notable change in properties when reducing the coercive force from 250 Oe (the lower value of D2) to 245 Oe (the upper value of claim 1).

The appellant was invited to submit corresponding evidence in order that the alleged effect could be acknowledged.

VI. With letter dated 18 April 2011 the appellant submitted, as a response to the summons to oral proceedings, claims of a slightly amended main request and new claims of first to fourth auxiliary requests, being supported by explanations of the amendments carried out therein. Furthermore, the appellant submitted arguments concerning inventive step of the subject-matter claimed in claims 1 of these five requests together with the new documents D7, D8 and the declaration D9 concerning further details of the comparative experiments according to Annex 1.

VII. Oral proceedings were held on 5 July 2011. To start, it was discussed whether D2 can be considered as prior art. Thereafter inventive step of the subject-matter of claim 1 of all requests was discussed in the light of D2 as closest prior art and the common general knowledge of the person skilled in the art.

The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of one of the sets of claims filed as main request and as first to fourth auxiliary requests with letter dated 18 April 2011.

At the end of the oral proceedings the Board announced its decision.

VIII. Independent claim 1 of the main request reads as follows:

"1. A coated cutting insert for milling of gray cast iron alloys, comprising:

a tungsten carbide-based substrate having a rake surface and a flank surface, the rake surface and the flank surface intersect to form a substrate cutting edge;

the substrate consisting of 5.9 weight percent to 6.1 weight percent cobalt, and 0.4 weight percent to 0.6 weight percent chromium, the remainder being tungsten and carbon, apart from impurities; and

a coating on the substrate characterized in that the substrate has a coercive force (H_c) of 195 to 245 oersteds, and

the coating consists of one of the following:

(i) a base layer of titanium carbonitride applied by chemical vapor deposition to the substrate, a mediate layer of titanium carbide applied to the base layer by chemical vapor deposition, and an outer layer of alumina applied to the mediate layer by chemical vapor deposition, or

(ii) a base layer of titanium nitride applied to the substrate by chemical vapor deposition, a mediate layer of titanium carbonitride applied to the base layer by moderate temperature chemical vapor deposition, and an outer layer of alumina applied to the mediate layer by chemical vapor deposition."

- IX. Claim 1 of the first auxiliary request differs from that of the main request in that the composition of the substrate is defined as "the substrate consisting of **between** 5.9 weight percent **and** 6.1 weight percent cobalt, and **between** 0.3 weight percent **and** 0.7 weight percent chromium, the **[remainder] balance** being tungsten and carbon, apart from impurities" (amendments compared to claim 1 of the main request are in bold with deletions in brackets, emphasis added by the Board).
- X. Claim 1 of the second auxiliary request differs from that of the main request in that the substrate is defined as "the substrate consisting of 5.9 **[weight percent]** to 6.1 weight percent cobalt, and 0.4 **[weight percent]** to 0.6 weight percent chromium, the **[remainder] balance** being tungsten and carbon, apart from impurities; **wherein the substrate has a hardness of between 91.7 and 92.6 Rockwell A, a magnetic saturation of between 133 and 149 gauss cubic centimeter per gram cobalt**" (amendments compared to claim 1 of the main request are in bold with deletions in brackets, emphasis added by the Board).
- XI. Claim 1 of the third auxiliary request reads as follows:
- "1. **Use of** a coated cutting insert for milling gray cast iron alloys, **the cutting insert** comprising:
- a tungsten carbide-based substrate having a rake surface and a flank surface, the rake surface and the flank surface intersect to form a substrate cutting edge;
- the substrate consisting of between 5.9 weight percent and 6.1 weight percent cobalt, and between 0.3

weight percent and 0.7 weight percent chromium, the [remainder] balance being tungsten and carbon, apart from impurities; and

a coating on the substrate

wherein the substrate has a coercive force (H_c) of 195 to 245 oersteds, and

the coating consists of one of the following:

(i) a base layer of titanium carbonitride applied by chemical vapor deposition to the substrate, a mediate layer of titanium carbide applied to the base layer by chemical vapor deposition, and an outer layer of alumina applied to the mediate layer by chemical vapor deposition, or

(ii) a base layer of titanium nitride applied to the substrate by chemical vapor deposition, a mediate layer of titanium carbonitride applied to the base layer by moderate temperature chemical vapor deposition, and an outer layer of alumina applied to the mediate layer by chemical vapor deposition" (amendments compared to claim 1 of the main request are in bold with deletions in brackets, emphasis added by the Board).

XII. Use claim 1 according to the fourth auxiliary request differs from that of the third auxiliary request in that substrate features concerning a more restricted chromium content range, the substrate hardness and its magnetic saturation ranges have been added and the coercive force range has been united with these substrate features by shifting it so that the substrate is defined therein as "the substrate consisting of [between] 5.9 [weight percent and] to 6.1 weight percent cobalt, and [between] 0.4 [weight percent and] to 0.6 weight percent chromium, the balance being tungsten and carbon, apart from impurities; **wherein the**

substrate has a hardness of between 91.7 and 92.6 Rockwell A, a magnetic saturation of between 133 and 149 gauss cubic centimetre per gram cobalt and a coercive force (H_c) of 195 to 245 oersteds" (amendments compared to claim 1 of the third auxiliary request are in bold with deletions in brackets, emphasis added by the Board).

XIII. The appellant argued essentially as follows:

The Board's view expressed in the annex to the summons to oral proceedings, that D2 represents the closest prior art, is disagreed with. Firstly, the disclosure in D6 and D5 does not justify this position and secondly, reliable technical evidence supports the position that the machining characteristics of ductile cast iron are fundamentally different from those of gray cast iron. Therefore a cutting insert useful for milling ductile cast iron is not conclusively suitable for milling gray cast iron. D6 is silent about the machinability of ductile cast iron which is termed "Spheroidal Graphite (SG) Cast Iron" (see page 71, the paragraph bridging the left- and the right-hand column) while with respect to gray cast iron it reveals only "its good machining properties" (see page 71, left-hand column, 2nd full paragraph). D5 does also not support the Board's position since it mentions "Alloyed tungsten carbide grades (letter M, yellow color, generally with less TiC than the corresponding P series) for multipurpose use, such as steels, nickel-base superalloys, and ductile cast irons" and "Straight tungsten carbide grades (letter K, red color) for cutting gray cast iron, nonferrous metals, and non-metallic materials" (see page 75) so that ductile cast

iron uses one grade of cutting inserts while gray cast iron uses another grade. Consequently, D5 does not teach or suggest that one cutting insert is suitable for machining both types of materials. The same conclusion is valid with respect to the passage under the heading "Machining Applications" at page 86 of D5 only mentioning gray cast iron and the use of uncoated straight WC-Co grades. There is no common technical knowledge that WC grades used for milling ductile cast irons are suitable for milling gray cast irons, too. Furthermore, D7 and D8 prove that the mechanism of chip formation in the machining of these two types of materials having different graphite morphologies is fundamentally different (see D7, page 655) so that ductile cast iron is easier to machine (see D7, page 660; see D8, pages 568 and 572). Accordingly, although D2 is also concerned with milling operations, the person skilled in the art would not take D2 as a springboard when aiming at improved cutting tools for the milling of gray cast iron. In this context it is admitted that the problem underlying D2 with respect to the thermal and mechanical shocks of the cutting inserts is similar to that of the present application. However, the present application relates to gray cast iron and all examples were made with gray cast iron (see page 1, lines 23 to 26 and the examples given on pages 6 to 12).

The distinguishing features of the cutting inserts based on composition 1 of D2 have been correctly mentioned in the annex. But even if the skilled person would apply the steps referred to by the Board with respect to the common general knowledge he would not arrive at the improved cutting insert according to

claim 1 of the main request but only at an inferior one, as proven by the test results according to Annex 1.

Concerning the coercive force feature of claims 1 of all requests it is confirmed by the declaration D9 that the coatings on the cutting inserts SP7779 and SP3979 used in the milling tests according to Annex 1 have been applied to the respective substrates using the same coating receipt (i.e. coating time, gas pressure, flow rate and gas concentration) to the same specification, i.e. the same layer thicknesses.

Accordingly, the comparative tests of Annex 1 were made in accordance with the established case law of the Boards of Appeal. In this context it is noted that the insert SP3979 does not constitute a true prior art insert since the combination of substrate and coating scheme has never been disclosed in the prior art, but is a modification of the cutting inserts shown in D2 taking into account selected elements from the present invention. The comparative tests show that the inventive substrate SP7779 having a magnetic coercive force of 208 oersteds outperforms the other one having a coercive force of 288 oersteds. It is admitted that no further tests with respect to a comparison of coercive force values of 245 and 250 oersteds have been made since the applicant has only a commercial plant for coating these cutting inserts and it is difficult to produce samples at the borders of the coercive force range given in claim 1. Concerning the coercive force it is admitted that the application - except from the statement on page 3, lines 21 to 31 according to which "a coercive force (H_c) of about 195-245 oersteds (Oe)" is provided - is silent with respect to said coercive force range. It needs, however, to be considered that

the inventive cutting inserts outperform those of the prior art and the applicants produce these cutting inserts within the coercive force ranges defined in claims 1 of all requests.

Furthermore, it needs to be considered that the person skilled in the art will select a particular coating scheme in view of the desired application and the nature of the substrate to be coated. Therefore, although D5 seems to disclose that an alumina outer coating may have some advantages over a TiC outer coating, it is clear for the skilled person that these advantages do not come into play for each and any cutting application and/or substrate. D5 appears to teach that alumina has a higher hardness at about 1000°C than TiC which does not necessarily mean that the coating is suitable to withstand thermal and mechanical shocks. D5 also shows that alumina has a higher coefficient of thermal expansion than TiC (see page 81, table 8) which would also cause a higher thermal expansion mismatch between the substrate and the alumina coating. Accordingly, D5 does also not support any common general knowledge that overlying a TiC layer with an alumina outer coating would result in an improved tool life for each and any machining operation, in particular in the milling of gray cast iron. The skilled person has no reasonable expectation of success, nor any other motivation to modify the teaching of D2 being directed to the milling of ductile cast iron, by using a different substrate and different coating scheme to adapt it for the machining of workpieces of different material. Therefore the subject-matter of claim 1 of the main request involves inventive step.

Claims 1 according to the first and second auxiliary request were only submitted in order to overcome Article 123(2) EPC objections raised by the Board and their subject-matter does not comprise additional features which contribute to inventive step.

With respect to use claims 1 of the third and fourth auxiliary requests it is argued that skilled person starting from D2 would not arrive at the milling of gray cast iron taking account of the fundamentally different machining characteristics of ductile cast iron. Therefore the subject-matter of claims 1 of the third and fourth auxiliary request meets the requirements of Article 56 EPC.

Reasons for the Decision

1. Allowability of amendments (Articles 84 and 123(2) EPC)

Since the Board comes to the conclusion that the subject-matter claimed in claim 1 of all requests lacks inventive step (see points 4 to 6.2 below) there is no need to verify whether or not the claims of these requests or the amendments made therein comply with Articles 84 and 123(2) EPC.

2. Consideration of D2 as prior art

2.1 The Board considers that D2 represents the closest prior art and thus the most promising springboard towards the invention.

2.2 The appellant's arguments to the contrary cannot hold for the following reasons.

2.2.1 It is correct that D2 relates to cutting inserts for milling of **ductile** iron alloys, a material which is different from gray cast iron. However, D2 mentions the micro-chipping problems associated with mechanical and thermal shock, particularly in high speed milling operation between about 600 and about 800 surface feet per minute (see column 1, lines 13 to 67) in exactly the same way as the present application (according to its examples cutting speeds of about 900 and 1200 surface feet per minute were applied; see WO-A-02 14578, page 8, lines 9 and 37; page 9, line 19; page 10, line 11; page 11, line 5) wherein it is generally mentioned that thermal shocks and mechanical shocks of the milling operation result in micro-chipping of the cutting edge of the cutting tool (see the published WO-A-02 14578 corresponding the application as originally filed, page 1, lines 11 to 17). Thus the problems mentioned above are considered to be the same for both materials. This finding has not been objected to by the appellant at the oral proceedings.

D2 further discloses that the ability of the cutting tools referred to to withstand the mechanical and thermal stresses make them ideal candidates for the milling of ductile irons (see column 7, lines 31 to 34).

Moreover, the application as originally filed was not restricted to the milling of gray cast iron but mentioned this specific machining operation and this type of material only as examples, while in general it related to metal cutting applications

(see WO-A-02 14578, page 1, lines 6 to 9 and lines 23 to 26). This view is also supported by the subject-matter of claim 1 as originally filed which does not specify that gray cast iron is intended to be milled. This holds true irrespective the appellant's statement that the present application relates to gray cast iron and that all milling tests of the application were made with gray cast iron (see page 6, lines 21 to 28).

2.2.2 The fact that the machining characteristics of gray cast iron are different from those of ductile cast iron, due to the different carbon morphology, as proven by documents D7 (see e.g. page 655, left-hand column, sixth paragraph; page 660, left-hand column, fifth paragraph) and D8 (see e.g. page 567, abstract; page 572, point 5) does, however, **not** imply that cutting inserts used for milling ductile iron are not suitable for milling gray cast iron and that the person skilled in the art would not consider D2 in an attempt to devise a coated cutting insert for milling of gray cast iron.

First of all, the experiments underlying the documents D7 and D8 were made using an identical cutting tool for machining the ductile cast iron and the gray cast iron, since in both documents it is stated that "the only independent variable is the material under study (see D7, page 653, left-hand column, first paragraph; see D8, page 568, left-hand column, first paragraph). Hence the used cutting tool must have been once considered as **suitable** for machining both types of cast iron although it is admitted that the used tool will not be the optimum one for either of them (e.g. with respect to the tool life and the surface quality of the machined workpiece).

Furthermore, it is clear from D7 that the amount of ferrite in a pearlitic/ferritic matrix largely influences the machining properties of the cast iron (see page 659, right-hand column, first and second paragraph) so that the machining properties of a ductile iron workpiece can be similar to that of a gray cast iron one.

2.2.3 D5 is an excerpt of a text book and concerns cemented carbides in general. D5 discloses the ISO R513 classification of carbides according to their use for machining by chip removal (see page 75, table 4). It mentions in the text "Alloyed tungsten carbide grades (**letter M**, yellow color, generally with less TiC than the corresponding P series) for multipurpose use, such as steels, nickel-base superalloys, and **ductile cast iron**" (see page 75, left-hand column, second and third full paragraph), i.e. the M-series is suitable for machining ductile cast iron, while it discloses with respect to grades **M 10, M 20 and M 30** in said table 4 **gray cast iron** among the materials to be machined and **milling** as one use of these alloyed WC-based carbide substrate materials (see page 75, table 4). Hence the appellant's argument that ductile cast iron uses one grade of cutting insert while gray cast iron uses another grade cannot hold.

2.2.4 Moreover, the tungsten carbide based compositions no. 1 to 7 according to D2 being alloyed with e.g. Ta, Nb, Ti and/or Cr (compare table 1) represent compositions which are covered by said ISO R513 grade M.

2.2.5 Therefore and since the Board is also not aware of any prejudice which would prevent the person skilled in the art from using the coated tungsten carbide based cutting inserts according to D2 for milling gray cast iron, these cutting inserts are - particularly taking account of the aforementioned disclosure of D5 with respect to the cemented carbide grade M - considered to be suitable for milling gray cast iron.

3. *Disclosure of D2*

Document D2 discloses a coated cutting tool for the milling of ductile iron comprising a rake face and a flank face, a cutting edge at the juncture of the rake and flank face and a coating on the substrate; the substrate comprising a WC based cemented carbide having a bulk composition of no more than 7 wt.% Ta, no more than 3 wt.% Nb, no more than 5 wt.% Ti, no more than 1 wt.% Cr, between about 5 and about 13 wt.% Co and the balance WC; the coating comprising an innermost coating scheme including at least one layer adjacent to the substrate, and the coating further including an outermost layer comprising TiC applied by CVD (see column 4, lines 14 to 38 and claim 1). According to claims 4 and 5 - both referring to claim 1 - the innermost coating scheme comprises a single innermost TiCN layer applied at a temperature between about 900 and about 1050°C and the CVD layer of TiC is adjacent to the CVD layer of TiCN; this two-layer embodiment corresponds to that of figure 2.

The substrates of D2 are cemented tungsten carbide-based compositions wherein the binder metal is cobalt (see column 6, lines 50 to 53). Among the disclosed

suitable specific substrates is composition No. 1 comprising (in wt.%) 0.3-0.5 Cr, 5.7-6.3 Co, WC balance, hardness (Rockwell A) 92.6-93.4, magnetic coercive force (H_c) 250-320 oersteds, magnetic saturation 83-95 % (see table 1).

4. *Inventive step (Article 56 EPC)*

Taking account of the arguments presented by the appellant the Board considers that it has not been shown that the Examining Division's conclusion was wrong in concluding that the subject-matter claimed in the patent in suit lacks an inventive step. The reasons are as follows:

Main request

4.1 The subject-matter of product claim 1 of the main request differs from the coated cutting insert of D2 having a substrate consisting (apart from incidental impurities) of Co, Cr, and WC (i.e. substrate No. 1 shown in table 1), having a magnetic coercive force of 250-320 oersteds, and being coated with the disclosed two-layer coating scheme with an innermost CVD layer of TiCN and an outermost CVD TiC layer according to claims 4 or 5 in that:

- i) the cutting insert is intended for milling gray cast iron,
- ii) the substrate has a coercive force of 195 to 245 oersteds, and
- iii) the coating scheme comprises an (additional) outermost layer of alumina applied by CVD.

4.1.1 With respect to feature i) the Board considers that, particularly in view of D5 as explained in points 2.2.3 to 2.2.5 above, in general the alloyed tungsten carbide grades M, which can be used for milling ductile cast irons, are suitable for milling gray cast iron. This fact implies that feature i) need not be considered as a distinguishing feature having a particular effect.

4.1.2 With respect to feature ii) the Board remarks that any effect of this (different) coercive force range of the substrate is neither described in the present application (the only disclosures in the WO-A-02 14578 of this range are to be found at page 3, lines 21 to 31 and in claim 1 as originally filed; also the examples are silent in this respect) nor is an effect over the whole range claimed proven by the comparative test according to Annex 1.

Even when assuming that the latter has been made in accordance with the established Case Law (see Case Law of the Boards of Appeal of the European Patent Office, 6th edition 2010, chapter I.D.9.9) - namely such that the coercive force of the substrate is the **only** distinguishing feature between the two cutting tools compared and considering the statement of Mr Leicht in his declaration D9 (although he specifies in point 6 of D9 a "magnetic coercive force (Hc) of 250 to 325 Oersteds" for the SP3979 sample which range is inconsistent with the range of "Hc 250-320 Oersteds" for this comparative sample specified in ANNEX 1), namely that the thickness and process conditions for the CVD deposition of the three coating layers of the two samples SP7779 and SP3979 were identical and that the coercive force value of sample SP7779 was measured

to be 208 oersteds while that of SP3979 was measured to be 288 oersteds - then there exist **no** comparative values provided at, or close to the end points of the coercive force range defined in claim 1.

At the oral proceedings the appellant admitted, that it failed to submit evidence which would prove an effect over the entire range of coercive force as defined in the claims 1 of all requests, although the Board in its communication annexed to the summons to oral proceedings had invited to submit evidence that there exists a notable change in properties, when reducing the coercive force from the lower value of D2 of 250 oersteds to the upper value claimed in claim 1 of the main request of 245 oersteds.

Consequently, since an effect has **not** been proven over the entire coercive force range said feature ii) cannot be considered as having a particular effect to be considered in defining the objective technical problem.

- 4.1.3 With respect to feature iii) the Board remarks that it belongs to the common general knowledge that an (additional) outermost alumina layer provides an improved tool life at higher cutting speeds as compared to an outermost TiC layer, due to a better temperature stability and hardness (abrasion resistance) of the alumina coating (see D5, page 81, left hand column, second paragraph to middle column, second paragraph and figures 19 and 20b). By overlying the TiC layer with an alumina layer the latter prevents the oxidation of the TiC layer at high temperatures of about 1000°C which are easily reached at high cutting speeds.

4.2 The objective technical problem starting from D2 is therefore considered as the provision of a cutting tool for the milling of gray cast iron at higher cutting speeds.

4.3 This problem is solved by the product as defined in claim 1 of the main request.

4.4 The subject-matter of product claim 1 of the main request is obvious for the following reasons:

4.4.1 As already mentioned, it belongs to the common general knowledge of the person skilled in the art that an alumina coating has a higher hardness than TiC at a temperature of 1000°C - which is easily reached at the rake face of the tool during high-speed machining - and provides a better abrasion resistance at higher cutting speeds and thereby provides an improved tool life, e.g. when turning gray cast iron (see D5, page 81, left-hand column, first full paragraph to middle column, second full paragraph; and figures 19 and 20). Such an improved tool life is also due to the fact that an outermost alumina layer prevents or suppresses the oxidation of the underlying TiC layer at such high temperatures of about 1000°C.

At the oral proceedings the appellant admitted that the alumina layer improves the oxidation stability.

4.4.2 Therefore the Board is of the opinion that the person skilled in the art, when aiming to improve the described cutting tool of D2 having the substrate composition No. 1 and being CVD coated with the innermost TiCN layer and the outermost TiC layer so

that it can be used for milling at higher cutting speeds, taking account of the said advantages to be expected would apply an additional outermost alumina layer to said cutting tool by a CVD process.

The application of the alumina layer by a CVD method is obvious due to the fact that the use of only CVD steps for all the three coating layers simplifies the implied method for producing the coated cutting inserts since in such a case a single CVD apparatus is needed.

Taking the approach outlined above the person skilled in the art would arrive at the subject-matter of claim 1 of the main request without inventive skills.

4.4.3 In view of figure 20(b) of D5, which shows at high cutting speeds a superior tool life of a WC-Co substrate cutting insert having an outermost alumina coating when machining gray cast iron when compared to an identical cutting insert having an outermost TiC coating, the appellant's argument that an outermost alumina coating applied to the two-layer coating scheme of D2 does not automatically result in an improvement of the properties of the cutting insert cannot hold. To the contrary it is evident from figure 20(b) of D5 that the outermost alumina layer can outperform the outermost TiC layer.

4.4.4 The appellant's argument based on the fact that the alumina layer has a higher thermal expansion coefficient than the TiC layer (see D5, page 81, table 8) which would prevent the person skilled in the art from applying the alumina layer on a cutting insert used for milling of gray cast iron since he would

expect problems due to the higher mismatch and the repeated thermal shocks occurring during the machining operation cannot hold, either.

According to D5 the high temperatures employed for CVD coating generally ensure good bonding between the substrate and the coating but the coating adhesion can be adversely affected by stresses caused by the thermal mismatch between the substrate and the coating. The thermal expansion mismatch between the WC-Co substrate based on the values according to table 8 of D5 (these thermal expansion coefficients in [$\mu\text{m}/\text{m}\cdot\text{K}$] are: WC-Co 5-6; TiC 7.7; TiN 9.4; Al_2O_3 (alumina) 8.4) is lowest for TiC and highest for TiN (see page 5, right-hand column, third full paragraph to page 82, left-hand column, first paragraph; table 8). Concerning this argument of the appellant it needs to be considered that the alumina layer is **not** directly applied to the WC-Co substrate but only to the intermediate TiC layer. But even if this argument were true then any innermost layer of TiN or TiCN (which thermal expansion coefficient should be in the middle between TiN and TiC) directly applied to the substrate - claim 1 of the main request defines both alternatives in its features (i) and (ii) - should be expected to cause more (severe) problems than any alumina layer applied to an underlying (intermediate) TiC layer since the mismatch between these two layers ($8.4-7.7 = 0.7$) is much smaller than that with respect to the WC-Co substrate (for alumina: $(5-6)-8.4 = 2.4-3.4$; for TiN: $(5-6)-9.4 = 3.4-4.4$).

- 4.5 For the reasons given above the subject-matter of claim 1 of the main request lacks inventive step

(Article 56 EPC). The main request is therefore not allowable.

First and second auxiliary request

5. The Board holds in this context that the chromium concentration range of "between 0.3 weight percent and 0.7 weight percent" according to product claim 1 of the first auxiliary request is broader than that of the main request while the other amendments principally do not change the teaching of this claim 1 (see point IX above) so that the conclusion of above point 4.5 applies *mutatis mutandis* to the subject-matter of claim 1 of the first auxiliary request.

5.1 With respect to the additional features of claim 1 of the second auxiliary request defining properties of the substrate (see point X above) the Board remarks that these properties are inherent to the substrate composition concerned (with respect to the hardness range see e.g. D5, page 73, table 2, "94WC-6Co") or known from the prior art D2 (the magnetic saturation range of the substrate composition No. 1 of D2 of 83-95% based on a 100% magnetic saturation equalling 160 gauss cubic centimeter per gram cobalt corresponds to **133-152** gauss cubic centimetres per gram cobalt, the hardness of composition No. 1 [Rockwell A] is **92.6-93.4**; for both see table 1). Therefore - as admitted by the appellant at the oral proceedings - claims 1 of the first and second auxiliary request were mainly amended in order to overcome Article 123(2) EPC objections raised by the Board in its annex. Their subject-matter does not comprise any additional features which render these claims inventive.

5.2 The subject-matter of claims 1 of the first and second auxiliary requests therefore does not involve inventive step (Article 56 EPC). The first and second auxiliary requests are therefore not allowable.

Third and fourth auxiliary request

6. Claims 1 of the third and fourth auxiliary requests define the use of the coated cutting inserts - which correspond to the products defined in product claims 1 of the first and second auxiliary request, respectively - for milling gray cast iron (see points XI and XII above).

6.1 Taking account of the considerations with respect to the closest prior art D2 (see points 2.1 to 2.2.5 above) it is clear that the person skilled in the art would at least try to use the CVD alumina layer modified cutting insert comprising the substrate composition No. 1 of D2 for milling of gray cast iron since, in general, as derivable from ISO R513 classification in D5, the alloyed tungsten carbide based substrates (M series) **are suitable** for this purpose. Thereby for the reasons given with respect to claim 1 according to the main request the person skilled in the art arrives at the subject-matter of the use claims 1 of the third and fourth auxiliary requests without inventive skill.

Consequently, the appellant's arguments to the contrary based on the different machining mechanism and characteristics of gray cast iron cannot hold.

6.2 The subject-matter of claims 1 of the third and fourth auxiliary requests therefore does not involve inventive step (Article 56 EPC). The third and fourth auxiliary requests are therefore not allowable, either.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

G. Nachtigall

H.-P. Felgenhauer