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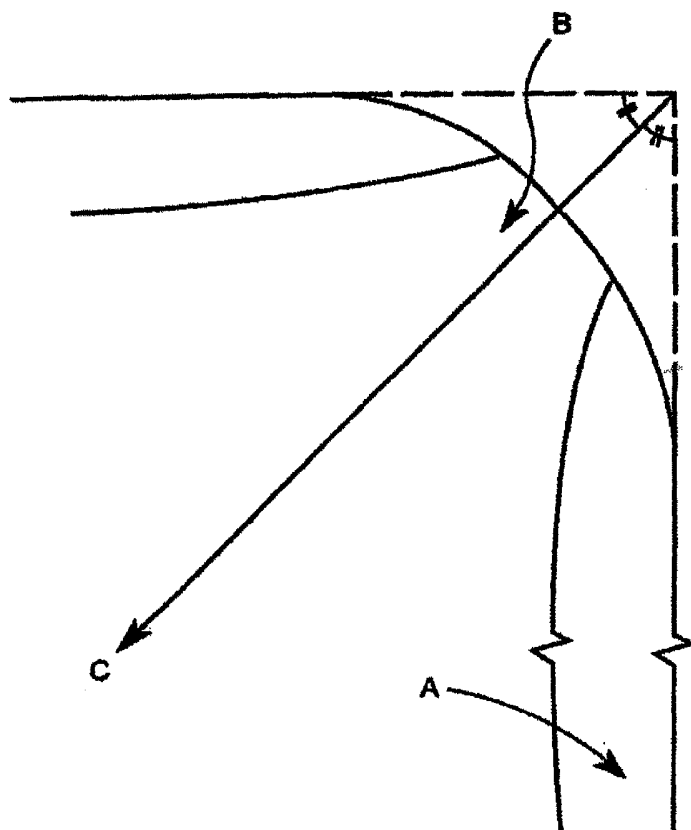
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(54) Title: CEMENTED CARBIDE INSERT FOR WEAR RESISTANCE DEMANDING SHORT HOLE DRILLING OPERATIONS



(57) Abstract: The present invention relates to a coated cemented carbide insert particularly useful for short hole drilling in steel at high speed and moderate feed. The insert has a binder phase enriched and essentially cubic carbide free surface zone A of a thickness of <20 µm and along a line C, essentially bisecting the edge, in the direction from the edge to the centre of the insert, a binder phase content increases essentially monotonously until it reaches the bulk composition. The binder phase content at the edge in vol-% is 0.65-0.75 times the binder phase content of the bulk and the depth of the binder phase depletion is 100-300 µm. The insert is coated with - a first, innermost, layer of TiC_xNyO₂ with equiaxed or columnar grains, with size <0.5 µm - a next layer of TiC_xNyO_z with columnar grains and with a diameter of about <5 µm - a next layer of TiC_xNyO₂, with equiaxed or needlelike grains with size ≤0.5 µm, and - an outer layer of a smooth, textured, fine-grained, CX-Al₂O₃ layer with a surface roughness (Ra) of less than 0.3 mm over a measured length of 0.25 mm.



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Cemented carbide insert for wear resistance demanding
short hole drilling operations

The present invention relates to a coated cutting tool
5 insert particularly useful for short hole drilling in steel at
high speed and moderate feed.

Drilling in metals is divided generally in two types: long
hole drilling and short hole drilling. By short hole drilling
is meant generally drilling to a depth of up to 3-5 times the
10 drill diameter.

Long hole drilling puts large demands on good chip
formation, lubrication, cooling and chip transport. This is
achieved through specially developed drilling systems with
specially designed drilling heads fastened to a drill rod and
15 fulfilling the above mentioned demands.

In short hole drilling, the demands are not as great,
enabling the use of simple helix drills formed either of solid
cemented carbide or of solid tool steel or of tool steel
provided with a number of cutting inserts of cemented carbide
20 placed in such a way that they together form the necessary
cutting edge. In the center of the head an insert of tough
grade is used and on the periphery a more wear resistant one.
The cutting inserts are brazed or mechanically clamped.

The objective of the invention is to provide a coated
25 cutting tool insert with ability to perform at higher speeds,
maintaining a good balance, regarding tool life, between
periphery and center inserts.

US 5,786,069 and US 5,863,640 disclose coated cutting tool
inserts with a binder phase enriched surface zone and a highly
30 W-alloyed binder phase.

Figure 1 is a schematic drawing of a cross section of an
edge of an insert gradient sintered according to the present
invention where

A = binder phase enriched surface zone

B = cutting edge near zone

C = a line essentially bisecting the edge.

Significant improvements with respect to resistance to
plastic deformation and toughness behaviour can simultaneously

be obtained for a cemented carbide insert if a number of features are combined. The improvement in cutting performance of the cemented carbide inserts can be obtained if the cobalt binder phase is highly alloyed with W, if the essentially cubic carbide free and binder phase enriched surface zone A has a certain thickness and composition, if the cubic carbide composition near the cutting edge B is optimised and if the insert is coated with a 3-12 μm columnar $\text{Ti}(\text{C},\text{N})$ -layer followed by a 2-12 μm thick Al_2O_3 -layer e.g. produced according to any of the patents US 5,766,782, US 5,654,035, US 5,674,564 or US 5,702,808 possibly with an outermost layer of 0.5-4 μm TiN . The Al_2O_3 -layer will serve as an effective thermal barrier during cutting and thereby improve not only the resistance to plastic deformation which is a heat influenced property but also increase the crater wear resistance of the cemented carbide insert. In addition, if the coating along the cutting edge is smoothed by an appropriate technique like by brushing with a SiC -based nylon brush or by a gentle blasting with Al_2O_3 grains the cutting performance can be enhanced further, in particular with respect to flaking resistance of the coating (see US 5,861,210).

According to the present invention there is now provided a coated cemented carbide insert with a $<20 \mu\text{m}$, preferably 5-15 μm , thick essentially cubic carbide free and binder phase enriched surface zone A (Fig.1) with an average binder phase content (by volume) of 1.2-3.0 times the bulk binder phase content. In order to obtain high resistance to plastic deformation but simultaneously avoid a brittle cutting edge the chemical composition is optimised in zone B (Fig.1). Along line C (Fig.1), in the direction from edge to the centre of the insert, the binder phase content increases essentially monotonously until it reaches the bulk composition. At the edge the binder phase content in vol-% is 0.65-0.75, preferably about 0.7 times the binder phase content of the bulk. In a similar way, the cubic carbide phase content decreases along line C from about 1.3 times the content of the bulk. The depth of the binder phase depletion and cubic

carbide enrichment along line C is 100-300 μm , preferably 150-250 μm .

The binder phase is highly W-alloyed. The content of W in the binder phase can be expressed as a

5 $\text{CW-ratio} = M_{\text{S}} / (\text{wt-\% Co} \cdot 0.0161)$ where

M_{S} is the saturation magnetisation of the cemented carbide body in hAm^2/kg and wt-% Co is the weight percentage of Co in the cemented carbide. The CW-ratio takes a value ≤ 1 and the lower the CW-ratio is the higher is the W-content in the
10 binder phase. It has now been found according to the invention that an improved cutting performance is achieved if the CW-ratio is 0.75-0.90, preferably 0.80-0.85.

The present invention is applicable to cemented carbides
15 with a composition of 4-7 weight percent of binder phase consisting of Co, and 7-10 weight percent cubic carbides of the metals from groups IVa, Va or VIa of the periodic table, preferably >1 wt% of each of Ti, Ta and Nb and as balance WC. The WC has an average grain size of 1.0 to 4.0 μm , preferably
20 2.0 to 3.0 μm . The cemented carbide body may contain small amounts, <1 volume-%, of η -phase (M_6C).

The coating comprises

- a first, innermost, layer of $\text{TiC}_x\text{N}_y\text{O}_z$ with $x+y+z=1$, preferably $z < 0.5$, with a thickness of 0.1-2 μm , and with equiaxed
25 or columnar grains with size $< 0.5 \mu\text{m}$

- a next layer of $\text{TiC}_x\text{N}_y\text{O}_z$ $x+y+z=1$, preferably with $z=0$ and $x > 0.3$ and $y > 0.3$, with a thickness of 4-7 μm with columnar grains and with a diameter of about $< 5 \mu\text{m}$, preferably $< 2 \mu\text{m}$

30 - a next layer of $\text{TiC}_x\text{N}_y\text{O}_z$, $x+y+z=1$ with $z \leq 0.5$, preferably $z > 0.1$, with a thickness of 0.1-2 μm and with equiaxed or needle-like grains with size $\leq 0.5 \mu\text{m}$, this layer being the same as or different from the innermost layer,

- an outer layer of a smooth, textured, fine-grained
35 (grain size about 1 μm) $\alpha\text{-Al}_2\text{O}_3$ layer with a thickness of 3-6 μm and a surface roughness (R_a) of less than 0.3 mm over a measured length of 0.25 mm, and

- possibly an outermost layer of 0.5-4 μm TiN.

In addition, the α -Al₂O₃ layer has a preferred crystal growth orientation in either the (012)-, (104)- or (110)-direction, preferably in the (012)-direction, as determined by X-ray Diffraction (XRD) measurements. A Texture Coefficient, TC, is defined as:

$$TC(hkl) = \frac{I(hkl)}{I_0(hkl)} \left\{ \frac{1}{n} \sum \frac{I(hkl)}{I_0(hkl)} \right\}^{-1}$$

where

I(hkl) = measured intensity of the (hkl) reflection

I₀(hkl) = standard intensity of the ASTM standard powder pattern diffraction data

n = number of reflections used in the calculation, (hkl) reflections used are: (012), (104), (110), (113), (024), (116)

According to the invention TC for the set of (012), (104) or (110) crystal planes is larger than 1.3, preferably larger than 1.5.

The invention also relates to a method of making cutting inserts comprising a cemented carbide substrate consisting of a binder phase of Co, WC and a cubic carbonitride phase with a binder phase enriched surface zone essentially free of cubic phase and a coating. The powder mixture contains 2-10, preferably 4-7, weight percent of binder phase consisting of Co, and 4-12, preferably 7-10, weight percent cubic carbides of the metals from groups IVa, Va or VIa of the periodic table, preferably >1 wt% of each Ti, Ta and Nb and a balance WC with an average grain size of 1.0-4.0 μ m, preferably 2.0-3.0 μ m. Well-controlled amounts of nitrogen have to be added either through the powder as carbonitrides or/and added during the sintering process via the sintering gas atmosphere. The amount of added nitrogen will determine the rate of dissolution of the cubic phases during the sintering process and hence determine the overall distribution of the elements in the cemented carbide after solidification. The optimum amount of nitrogen to be added depends on the composition of the cemented carbide and

in particular on the amount of cubic phases and varies between 0.9 and 1.7%, preferably about 1.1-1.4%, of the weight of the elements from groups IVa and Va of the periodic table. The exact conditions depend to a certain extent on the design of the sintering equipment being used. It is within the purview of the skilled artisan to determine whether the requisite surface zones A and B of cemented carbide have been obtained and to modify the nitrogen addition and the sintering process in accordance with the present specification in order to obtain the desired result.

The raw materials are mixed with pressing agent and possibly W such that the desired CW-ratio is obtained and the mixture is milled and spray dried to obtain a powder material with the desired properties. Next, the powder material is compacted and sintered. Sintering is performed at a temperature of 1300-1500°C, in a controlled atmosphere of about 5 kPa followed by cooling. After conventional post sintering treatments including edge rounding a hard, wear resistant coating according to above is applied by CVD- or MT-CVD- technique.

According to method of the invention a WC-Co-based substrate is coated with

- a first, innermost, layer of $\text{TiC}_x\text{N}_y\text{O}_z$ with $x+y+z=1$, preferably $z<0.5$, with a thickness of 0.1-2 μm , and with equiaxed or columnar grains with size $<0.5 \mu\text{m}$ using known CVD-methods.

- a next layer of $\text{TiC}_x\text{N}_y\text{O}_z$ $x+y+z=1$, preferably with $z=0$ and $x>0.3$ and $y>0.3$, with a thickness of 2-10 μm , preferably 4-7 μm , with columnar grains and with a diameter of about $<5 \mu\text{m}$, preferably $<2 \mu\text{m}$, deposited either by MTCVD-technique (using acetonitrile as the carbon and nitrogen source for forming the layer in the temperature range of 700-900 °C) or by high temperature CVD-technique (1000-1100 °C), the process conditions being selected to grow layers with columnar grains, that is generally high process pressure (0.3-1 bar). However, the exact conditions depend to a certain extent on the design of the equipment used.

- a next layer of $\text{TiC}_x\text{N}_y\text{O}_z$, $x+y+z=1$ with $z \leq 0.5$, preferably $z > 0.1$, with a thickness of $0.1\text{--}2\text{ }\mu\text{m}$ and with equiaxed or needlelike grains with size $\leq 0.5\text{ }\mu\text{m}$, using known CVD-methods this layer being the same as or different from the innermost layer.

- an outer layer of a smooth textured $\alpha\text{-Al}_2\text{O}_3$ layer with a thickness of $2\text{--}10\text{ }\mu\text{m}$, preferably $3\text{--}6\text{ }\mu\text{m}$, and a surface roughness (R_a) of less than $0.3\text{ }\mu\text{m}$ over a measured length of 0.25 mm according to US 5,487,625, US 5,851,687 or US 5,766,782.

When a $\text{TiC}_x\text{N}_y\text{O}_z$ -layer with $z > 0$ is desired, CO_2 and/or CO is added to the reaction gas mixture.

Example 1

A.) Cemented carbide drilling inserts of the style CoroDrill880, US0807P-GM, with the composition 5.5 wt% Co, 3.5 wt% TaC, 2.3 wt% NbC, 2.1 wt% TiC and 0.4 wt% TiN and balance WC with an average grain size of $2.5\text{ }\mu\text{m}$ were produced according to the invention. The nitrogen was added to the carbide powder as Ti(C,N) . Sintering was done at $1450\text{ }^\circ\text{C}$ in a controlled atmosphere consisting of Ar, CO and some N_2 at a total pressure of about 5 kPa.

Metallographic investigation showed that the produced cemented carbide inserts had a cubic-carbide-free zone A with a thickness of $10\text{ }\mu\text{m}$. Image analysis technique was used to determine the phase composition at zone B and the area along line C (Fig.1). The measurements were done on polished cross sections of the inserts over an area of about $40 \times 40\text{ }\mu\text{m}$ gradually moving along the line C. The phase composition was determined as volume fractions. The analysis showed that the cobalt content in zone B was 0.7 times the bulk cobalt content and the cubic carbide content 1.3 times the bulk cubic carbide content. The measurements of the bulk content were also done by image analysis technique. The Co-content was gradually increasing and the cubic carbide content gradually decreasing along line C in the direction from the edge to the centre of the insert.

Magnetic saturation values were recorded and used for calculating CW-values. An average CW-value of 0.84 was obtained.

The inserts were coated with a 0.5 μm equiaxed Ti(C,N)-
5 layer followed by a 5 μm thick Ti(C,N) layer with columnar grains by using MTCVD-technique (process temperature 850 $^{\circ}\text{C}$). In subsequent process steps during the same coating cycle, a 1 μm thick layer with equiaxed grains of $\text{TiC}_x\text{N}_y\text{O}_z$ (approx. $x=0.6$, $y=0.2$ and $z=0.2$) was deposited followed by a 4 μm thick layer
10 of (012)-textured $\alpha\text{-Al}_2\text{O}_3$ deposited according to conditions given in US 5,487,625. XRD-measurement showed a texture coefficient TC(012) of 1.5. After coating the inserts were smoothed by wet blasting.

15 Example 2

Inserts from Example 1 were tested and compared with inserts from Sandvik commercial grade 3040 with respect to wear resistance in a short hole drilling operation. The tested inserts were mechanically clamped on the periphery of the
20 drill head. In the center, an insert of tough grade was used according to Example 1 of Swedish Patent Application No SE 0500234-0. Tool life criteria: flank wear, crater wear or chipping >0.25 mm.

25 Material: Low alloy steel SS2541-03, 285 HB.
Emulsion: Blasocut BC25, 7%.
Operation: Through hole, 48 mm.
Cutting speed: 260 m/min
Feed: 0.10 mm/r
30 Drill: Diameter 24 mm, 3XD
Insert style: CoroDrill 880, US0807P-GM

Results. Drilled length at tool life:
Inserts according to the invention >15 meters
35 Reference inserts 5 meters

Example 3

Inserts from Example 1 were tested and compared with inserts from Sandvik commercial grade 3040 with respect to wear resistance in a short hole drilling operation. The tested inserts were mechanically clamped on the periphery of the drill head. In the center, an insert of tough grade was used according to Example 1 of Swedish Patent Application No SE 0500234-0. Tool life criteria: flank wear, crater wear or chipping >0.25 mm.

Material: Low alloy steel SS2541-03, 285 HB.

Emulsion: Blasocut BC25, 7%.

Operation: Through hole, 48 mm.

Cutting speed: 230 m/min

Feed: 0.20 mm/r

Drill: Diameter 24 mm, 3XD

Insert style: CoroDrill 880, US0807P-GM

Results. Drilled length at tool life:

Inserts according to the invention	6 meters
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Reference inserts	8.4 meters
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Example 4

Inserts from Example 1 were tested and compared with inserts from Sandvik commercial grade 3040 with respect to wear resistance in a short hole drilling operation. The tested inserts were mechanically clamped on the periphery of the drill head. In the center, an insert of tough grade was used according to Example 1 of Swedish Patent Application No SE 0500234-0. Tool life criteria: flank wear, crater wear or chipping >0.25 mm.

Material: Low alloy steel SS2541-03, 330-340 HB.

Emulsion: Blasocut BC25, 7%.

Operation: Through hole, 48 mm.

Cutting speed: 260 m/min

Feed: 0.10 mm/r

Drill: Diameter 23 mm, 3XD

Insert style: CoroDrill 880, US0807P-GM

Results. Drilled length at tool life:

5	Inserts according to the invention	15.4 meters
	Reference inserts	7 meters

Example 5

10 Inserts from Example 1 were tested and compared with
inserts from Sandvik commercial grade 4025 with respect to
wear resistance in a short hole drilling operation. The tested
inserts were mechanically clamped on the periphery of the
drill head. In the center, an insert of tough grade was used
according to Example 1 of Swedish Patent Application No SE
15 0500234-0. Tool life criteria: flank wear, crater wear or
chipping >0.25 mm.

Material: Low alloy steel SS2541-03, 400 HB.

Coolant: Cooledge 5, 50 bar.

20 Operation: Through hole, 30 mm.

Cutting speed: 300 m/min

Feed: 0.10 mm/r

Drill: Diameter 24 mm, 2XD

Insert style: CoroDrill 880, US0807P-GM

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Results. Drilled length at tool life:

Inserts according to the invention	8.5 meters
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Reference inserts	5.3 meters
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30 Example 6

Inserts from Example 1 were tested and compared with
inserts from Sandvik commercial grade 3040 with respect to
wear resistance in a short hole drilling operation. The tested
inserts were mechanically clamped on the periphery of the
35 drill head. In the center, an insert of tough grade was used
according to Example 1 of Swedish Patent Application No SE
0500234-0. Tool life criteria: flank wear, crater wear or
chipping >0.25 mm.

Material: Low alloy steel SS2541-03, 285 HB.

Emulsion: Syntilo XPS, 7%.

Operation: Through hole, 40 mm.

5 Cutting speed: 350 m/min

Feed: 0.12 mm/r

Drill: Diameter 16.5 mm, 3XD

Insert style: CoroDrill 880, US0602P-GM

10 Results. Drilled length at tool life:

Inserts invention 7.5 meters

Inserts reference 3.5 meters

Claims

1. A cutting tool insert particularly useful for short hole drilling in steel at high speed and moderate feed comprising a cemented carbide body and a coating characterised in that

5 - the cemented carbide body consists of WC with an average grain size of 1.0-4.0 μm , 4-7 wt-% Co and 7-10 wt-% of cubic carbides of metals from groups IVa, Va or VIa of the periodic table whereby N is added in an amount of 1.1-1.4 % of the weight of the elements from groups IVa and Va

10 - the Co-binder phase is highly alloyed with W with a CW-ratio of 0.75-0.90

- the cemented carbide body has a binder phase enriched and cubic carbide free surface zone A of a thickness of 5-15 μm

15 - the cemented carbide body has along a line C, bisecting the edge, in the direction from edge to the centre of the insert, a binder phase content increasing monotonously until it reaches the bulk composition from a binder phase content in vol-% at the edge of 0.65-0.75 times the binder phase content of the bulk whereby the depth of the binder phase depletion is 20 100-300 μm whereby the coating comprises

- a first, innermost, layer of $\text{TiC}_x\text{N}_y\text{O}_z$ with $x+y+z=1$, preferably $z<0.5$, with a thickness of 0.1-2 μm , and with equiaxed or columnar grains with size $<0.5 \mu\text{m}$

25 - a next layer of $\text{TiC}_x\text{N}_y\text{O}_z$ $x+y+z=1$, preferably with $z=0$ and $x>0.3$ and $y>0.3$, with a thickness of 4-7 μm with columnar grains and with a diameter of about $<5 \mu\text{m}$, preferably $<2 \mu\text{m}$

- a next layer of $\text{TiC}_x\text{N}_y\text{O}_z$, $x+y+z=1$ with $z\leq 0.5$, preferably $z>0.1$, with a thickness of 0.1-2 μm and with equiaxed or 30 needlelike grains with size $\leq 0.5 \mu\text{m}$, this layer being the same as or different from the innermost layer, and

- an outer layer of a smooth, textured, fine-grained, grain size about 1 μm , $\alpha\text{-Al}_2\text{O}_3$ layer with a thickness of 3-6 μm and a surface roughness (R_a) of less than 0.3 μm over a 35 measured length of 0.25 mm.

2. A cutting tool insert according to claim 1 characterised in that the $\alpha\text{-Al}_2\text{O}_3$ layer has a preferred crystal growth orientation in either the (012)-,

(104)- or (110)-direction, preferably in the (012)-direction, as determined by X-ray Diffraction (XRD) measurements whereby TC for the set of (012), (104) or (110) crystal planes is larger than 1.3, preferably larger than 1.5 TC being defined as:

$$TC(hkl) = \frac{I(hkl)}{I_O(hkl)} \left\{ \frac{1}{n} \sum \frac{I(hkl)}{I_O(hkl)} \right\}^{-1}$$

where

$I(hkl)$ = measured intensity of the (hkl) reflection

$I_O(hkl)$ = standard intensity of the ASTM standard powder pattern diffraction data

n = number of reflections used in the calculation, (hkl) reflections used are: (012), (104), (110), (113), (024), (116).

3. A cutting tool insert according to any of the previous claims characterised in an outermost layer of 0.5-4 μm TiN.

4. A cutting tool insert according to any of the previous claims characterised in that the cutting edge is smoothed by brushing or by blasting.

5. A cutting tool insert according to any of the previous claims characterised in that the average WC-grain size is 2.0-3.0 μm .

6. A cutting tool insert according to any of the previous claims characterised in containing >1% of each Ti, Ta and Nb.

7. A cutting tool insert according to any of the previous claims characterised in a binder phase content in vol-% at the edge of 0.7 times the binder phase content of the bulk.

8. A cutting tool insert according to any of the previous claims characterised in a depth of the binder phase depletion of 150-250 μm .

9. Method of making a cutting insert comprising a cemented carbide substrate with a binder phase enriched surface zone and a coating, said substrate consisting of a binder phase of Co, WC and a cubic carbonitride phase, said

binder phase enriched surface zone being free of said cubic carbonitride phase and with an constant thickness around the insert characterised in forming a powder mixture containing WC, 4-7 weight percent Co and 7-10 weight percent cubic carbides of the metals from groups IVa, Va or VIa of the periodic table whereby N is added in an amount of between 1.1 and 1.4 of the weight of the elements from groups IVa and Va

mixing said powders with pressing agent and possibly W such that the desired CW-ratio of 0.75-0.90 is obtained

milling and spray drying the mixture to a powder material with the desired properties

compacting and sintering the powder material at a temperature of 1300-1500°C, in a controlled atmosphere of about 5 kPa followed by cooling

applying conventional post sintering treatments including edge rounding and

applying a hard, wear resistant coating comprising

- a first, innermost, layer of $\text{TiC}_x\text{N}_y\text{O}_z$ with $x+y+z=1$, preferably $z<0.5$, with a thickness of 0.1-2 μm , and with equiaxed or columnar grains with size $<0.5 \mu\text{m}$ using known CVD-methods.

- a next layer of $\text{TiC}_x\text{N}_y\text{O}_z$ $x+y+z=1$, preferably with $z=0$ and $x>0.3$ and $y>0.3$, with a thickness of 2-10 μm , preferably 4-7 μm , with columnar grains and with a diameter of $<5 \mu\text{m}$, preferably $<2 \mu\text{m}$, deposited either by MTCVD-technique (using acetonitrile as the carbon and nitrogen source for forming the layer in the temperature range of 700-900 °C) or by high temperature CVD-technique (1000-1100 °C), the process conditions being selected to grow layers with columnar grains, that is generally high process pressure, 0.3-1 bar

- a next layer of $\text{TiC}_x\text{N}_y\text{O}_z$, $x+y+z=1$ with $z\leq 0.5$, preferably $z>0.1$, with a thickness of 0.1-2 μm and with equiaxed or needlelike grains with size $\leq 0.5 \mu\text{m}$, using known CVD-methods this layer being the same as or different from the innermost layer.

- an outer layer of a smooth textured $\alpha\text{-Al}_2\text{O}_3$ layer with a thickness of 2-10 μm , preferably 3-6 μm , and a surface roughness (R_a) of less than 0.3 μm over a measured length of 0.25 mm.

10. Method according to claim 9 characterised in containing >1% of each Ti, Ta and Nb.

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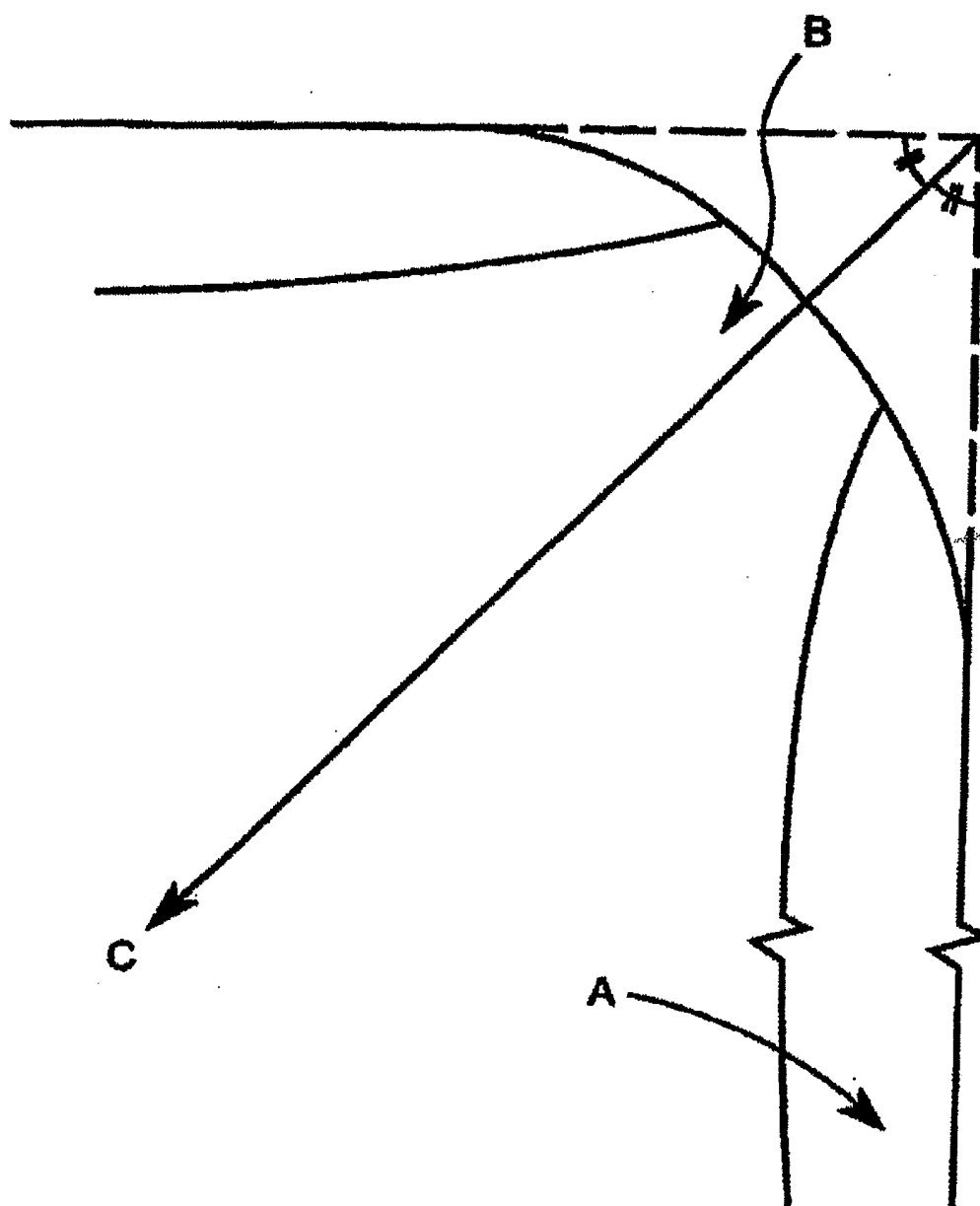


FIG. 1

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference MF 12086 WO	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/SE2006/000118	International filing date (day/month/year) 26 January 2006	(Earliest) Priority Date (day/month/year) 31 January 2005
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This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 5 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the language, the international search was carried out on the basis of:

- ☒ the international application in the language in which it was filed
☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, see Box No. I.

2. ☐ Certain claims were found unsearchable (see Box No. II)

3. ☐ Unity of invention is lacking (see Box No. III)

4. With regard to the title,

- ☒ the text is approved as submitted by the applicant.
☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

- ☐ the text is approved as submitted by the applicant.
☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,

- a. the figure of the drawings to be published with the abstract is Figure No. 1
☐ as suggested by the applicant.
☒ as selected by this Authority, because the applicant failed to suggest a figure.
☐ as selected by this Authority, because this figure better characterizes the invention.
- b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/000118

Box No. IV Text of the abstract (Continuation of item 5 of the first sheet)

The present invention relates to a coated cemented carbide insert particularly useful for short hole drilling in steel at high speed and moderate feed. The insert has a binder phase enriched and essentially cubic carbide free surface zone A of a thickness of $<20\text{ }\mu\text{m}$ and along a line C, essentially bisecting the edge, in the direction from the edge to the centre of the insert, a binder phase content increases essentially monotonously until it reaches the bulk composition. The binder phase content at the edge in vol-% is 0.65-0.75 times the binder phase content of the bulk and the depth of the binder phase depletion is 100-300 μm . The insert is coated with

- a first, innermost, layer of $\text{TiC}_x\text{N}_y\text{O}_z$ with equiaxed or columnar grains with size $<0.5\text{ }\mu\text{m}$
- a next layer of $\text{TiC}_x\text{N}_y\text{O}_z$ with columnar grains and with a diameter of about $<5\text{ }\mu\text{m}$
- a next layer of $\text{TiC}_x\text{N}_y\text{O}_z$, with equiaxed or needlelike grains with size $\leq 0.5\text{ }\mu\text{m}$, and
- an outer layer of a smooth, textured, fine-grained, $\alpha\text{-Al}_2\text{O}_3$ layer with a surface roughness (R_a) of less than 0.3 μm over a measured length of 0.25 mm.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2006/000118

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: C23C, B23B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20020051871 A1 (PALMQVIST, LISA ET AL), 2 May 2002 (02.05.2002), figure 1, abstract, paragraphs (0001)-(0002), (0012), (0017)-(0032) --	1-10
A	US 5863640 A (LJUNGBERG, BJÖRN ET AL), 26 January 1999 (26.01.1999), column 2, line 8 - column 3, line 31, abstract ---	1-10
A	EP 1348779 A1 (SANDVIK AKTIEBOLAG), 1 October 2003 (01.10.2003), claim 11, abstract, paragraphs (0018)-(0027) --	1-10

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

24 April 2006

Date of mailing of the international search report

05-05-2006

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2006/000118

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1469101 A2 (SECO TOOLS AB), 20 October 2004 (20.10.2004), claims 1-9, abstract, paragraphs (0001), (0015)-(0023) -- -----	1-10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/000118

International patent classification (IPC)

C23C 30/00 (2006.01)

C23C 16/30 (2006.01)

C23C 16/40 (2006.01)

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Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT
Information on patent family members

04/03/2006

International application No.

PCT/SE2006/000118

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