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(54) Title: COATED CUTTING INSERT AND METHOD OF MAKING IT

(57) Abstract

The present invention discloses a coated cutting tool insert particularly useful for dry and wet machining in low and medium alloyed steels, stainless steels, with or without raw surface zones under severe conditions such as vibrations, long overhang and recutting of chips. The insert is characterized by a WC-Co cemented carbide with a low content of cubic carbides and a rather low W-alloyed binder phase and a coating including an innermost layer of $TiC_xN_yO_z$ with columnar grains and a top layer of TiN and an inner layer of κ-Al_2O_3. The layers are deposited by using CVD-methods.

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COATED CUTTING INSERT AND METHOD OF MAKING IT

The present invention relates to a coated cutting tool (cemented carbide insert) particularly useful for toughness demanding wet and dry machining, preferably milling, of low and medium alloyed steels and stainless steels, with raw surfaces such as cast skin, forged skin, hot or cold rolled skin or pre-machined surfaces under unstable conditions.

When machining low and medium alloyed steels and stainless steels with cemented carbide tools the cutting edge is worn according to different wear mechanisms, such as chemical wear, abrasive wear, adhesive wear and by edge chipping caused by cracks formed along the cutting edge, the so called comb cracks. In bad conditions problems with bulk and edge line breakages occur commonly.

Different cutting conditions require different properties of the cutting insert. For example, when cutting in steels with raw surface zones or cutting under difficult conditions a coated cemented carbide insert must consist of a tough carbide and have very good coating adhesion. When machining in low alloyed steels and stainless steels the adhesive wear is generally the dominating wear type. Here generally 1-3 µm CVD- or PVD-coatings have to be used.

Measures can be taken to improve the cutting performance with respect to a specific wear type. However, very often such action will have a negative effect on other wear properties.

The influence of some possible measures is given below:

1.) Comb crack formation can be reduced by lowering the binder phase content. However, such action will lower the toughness properties of the cutting inserts which is not desirable.

2.) Improved abrasive wear can be obtained by increasing the coating thickness. However, thick coatings increase the risk for flaking and will lower the resistance to adhesive wear.

3.) Machining at high cutting speeds and at high cutting edge temperatures requires a cemented carbide with a rather high amount of cubic carbides (solid solution of WC-TiC-TaC-NbC). Such carbides will more easily develop comb cracks.

4.) Improved toughness can be obtained by increasing the Co-content. However, high Co-content will decrease the plastic deformation resistance.

So far it has been very difficult to improve all tool properties simultaneously. Commercial cemented carbide grades have therefore been optimized with respect to one or few of these wear types and hence to specific application areas.

Swedish patent application 9504304-8 discloses a coated cutting insert particularly useful for milling in low and medium alloyed steel with or without raw surface zones during wet or dry conditions. The insert is characterized by WC-Co cemented carbide with a low content of cubic carbides and a highly W-alloyed binder phase and a coating including an innermost layer of $TiC_xN_yO_z$ with columnar grains and a top layer of TiN and an inner layer of κ-Al_2O_3.

Swedish patent application 9501286-0 discloses a coated cutting insert particularly useful for dry milling of grey cast iron. The insert is characterized by a straight WC-Co cemented carbide grade and a coating including a layer of $TiC_xN_yO_z$ with columnar grains and a top layer of fine grained textured α-Al_2O_3.

Swedish patent application 9502640-7 discloses a coated turning insert particularly useful for intermittent turning in low alloyed steel. The insert is characterized by a WC-Co cemented carbide body having a highly W-alloyed Co-binder phase and a coating including a layer of $TiC_xN_yO_z$ with columnar grains and a top layer of a fine grained, textured α-Al_2O_3.

Swedish patent application 9503056-5 discloses a coated turning cutting tool particularly useful for cutting in hot and cold forged low alloyed steel. The insert is characterized by a WC-Co cemented carbide body having a highly W-alloyed Co-binder phase and a coating including a layer of $TiC_xN_yO_z$ with columnar grains and a top layer of a fine-grained, α-Al_2O_3.

Swedish patent application 9602413-8 discloses a coated turning insert particularly useful for turning in stainless steel. The insert is characterised by WC-Co-based cemented carbide substrate having a highly W-alloyed Co-binder phase and a coating including an innermost layer of $TiC_xN_yO_z$ with columnar grains and a top layer of TiN and an inner layer of fine grained κ-Al_2O_3.

It has now surprisingly been found that by combining many different features a cutting tool, preferably for milling, can be obtained with excellent cutting performance in low and medium alloyed steel, with or without raw surface zones preferably under unstable conditions such as vibrations, long overhang, chip-hammering or recutting of chips or in generally toughness demanding operations both in wet and dry conditions. It has also been found that this specific cutting tool also works in stainless steel. The cutting tool according to the invention shows improved properties with respect to many of the wear types earlier mentioned.

The cutting tool insert according to the invention consists of: a cemented carbide body with a rather low

W-alloyed binder phase and with a well balanced chemical composition and grain size of the WC, a columnar $TiC_xN_yO_z$-layer, a κ-Al_2O_3-layer, a TiN-layer and optionally followed by smoothening the cutting edges by brushing the edges with e.g. a SiC based brush.

According to the present invention a coated cutting tool insert is provided consisting of a cemented carbide body with a composition of 10.9-13 wt% Co, preferably 11.0-12.0 wt% Co, most preferably 11.1-11.7 wt% Co, 0.2-1.8 wt% cubic carbides, preferably 0.4-1.8 wt% cubic carbides, most preferably 0.5-1.7 wt% cubic carbides of the metals Ta, Nb and Ti and balance WC. The cemented carbide may also contain other carbides from elements from group IVb, Vb or VIb of the periodic table. The content of Ti is preferably on a level corresponding to a technical impurity. The average grain size of the WC is in the range of about 1.5-2.5 µm, preferably about 1.7 µm.

The cobalt binder phase is rather low alloyed with W. The content of W in the binder phase can be expressed as the CW-ratio= M_S / (wt% Co · 0.0161), where M_S is the measured saturation magnetization of the cemented carbide body in kA/m and wt% Co is the weight percentage of Co in the cemented carbide. The CW-value is a function of the W content in the Co binder phase. A high CW-value corresponds to a low W-content in the binder phase.

It has now been found according to the present invention that improved cutting performance is achieved if the cemented carbide body has a CW-ratio of 0.87-0.99, preferably 0.88-0.97, and most preferably 0.90-0.95. The cemented carbide may contain small amounts, <1 volume %, of η-phase (M_6C), without any detrimental effect. From the CW-value it follows that no free graphite is allowed in the cemented carbide body according to the present invention.

The coating comprises

- a first (innermost) layer of $TiC_xN_yO_z$ with $x+y+z=1$, preferably $y>x$ and $z<0.2$, most preferably $y>0.8$ and $z=0$, with equiaxed grains with size <0.5 µm and a total thickness <1.5 µm preferably >0.1 µm.

- a layer of $TiC_xN_yO_z$ with $x+y+z=1$, µm preferably with $z=0$, $x>0.3$ and $y>0.3$, most preferably $x>0.5$, with a thickness of 1-8 µm, preferably 2-7 µm, most preferably <6 µm, with columnar grains and with an average diameter of <5 µm, preferably 0.1-2 µm

- a layer of a smooth, fine-grained (grain size about 0.5-2 µm) Al_2O_3 consisting essentially of the κ-phase. However, the layer may contain small amounts, 1-3 vol-%, of the θ- or the α-phases as determined by XRD-measurement. The Al_2O_3-layer has a thickness of 0.5-5 µm, preferably 0.5-2 µm, and most preferably 0.5-1.5 µm. Preferably, this Al_2O_3-layer is followed by a further layer (<1 µm, preferably 0.1-0.5 µm thick) of $TiC_xN_yO_z$ with $x+y+z=1$, preferably with $y>x$ and $z<0.3$, most preferable $y>0.8$, but the Al_2O_3 layer can be the outermost layer. This outermost layer, Al_2O_3 or $TiC_xN_yO_z$, has a surface roughness $R_{max} \leq 0.4$ µm over a length of 10 µm. The $TiC_xN_yO_z$-layer, if present, is preferably removed along the cutting edge. Alternatively, the $TiC_xN_yO_z$ layer is removed and the underlying alumina layer is partly or completely removed along the cutting edge.

The present invention also relates to a method of making a coated cutting tool insert consisting of a cemented carbide body with a composition of 10.9-13 wt% Co, preferably 11.0-12.0 wt% Co, most preferably 11.1-11.7 wt% Co, 0.2-1.8 wt% cubic carbides, preferably 0.4-1.8 wt% cubic carbides, most preferably 0.5-1.7 wt% cubic carbides of the metals Ta, Nb and Ti and balance

WC. The cemented carbide may also contain other carbides from elements from group IVb, Vb or VIb of the periodic table. The content of Ti is preferably on a level corresponding to a technical impurity. The average grain size of the WC is in the range of about 1.5-2.5 µm, preferably about 1.7 µm. Onto the cemented carbide body is deposited

- a first (innermost) layer of $TiC_xN_yO_z$ with $x+y+z=1$, preferably $y>x$ and $z<0.2$, most preferably $y>0.8$ and $z=0$, with equiaxed grains with size <0.5 µm and a total thickness <1.5 µm, preferably >0.1 µm, using known CVD-methods.

- a layer of $TiC_xN_yO_z$ with $x+y+z=1$, preferably with $z=0$, $x>0.3$ and $y>0.3$, most preferably $x>0.5$, with a thickness of 1-8 µm, preferably 2-7 µm, most preferably <6 µm, with columnar grains and with an average diameter of about <5 µm, preferably 0.1-2 µm, using preferably MTCVD-technique (using acetonitrile as the carbon and nitrogen source for forming the layer in the temperature range of 700-900 ^oC). The exact conditions, however, depend to a certain extent on the design of the equipment used.

- a smooth Al_2O_3-layer essentially consisting of κ-Al_2O_3 is deposited under conditions disclosed in e.g. EP-A-523 021. The Al_2O_3 layer has a thickness of 0.5-5 µm, preferably 0.5-2 µm, and most preferably 0.5-1.5 µm. Preferably, a further layer (<1 µm, preferably 0.1-0.5 µm thick) of $TiC_xN_yO_z$ is deposited, but the Al_2O_3-layer can be the outermost layer. This outermost layer, Al_2O_3 or $TiC_xN_yO_z$, has a surface roughness $R_{max}\leq0.4$ µm over a length of 10 µm. The smooth coating surface can be obtained by a gentle wet-blasting the coating surface with fine grained (400-150 mesh) alumina powder or by brushing (preferably used when $TiC_xN_yO_z$ top coating is present) the edges with brushes based on e.g. SiC as disclosed e.g. in Swedish patent application 9402543-4. The $TiC_xN_yO_z$-layer, if present, is preferably removed along the cutting edge. Alternatively, the $TiC_xN_yO_z$ layer is removed and the underlying alumina layer is partly or completely removed along the cutting edge.

Example 1.

A. A cemented carbide milling tool in accordance with the invention with the composition 11.5 wt-% Co, 1.25 wt-% TaC, 0.30 wt-% NbC and balance WC, with a binder phase alloyed with W corresponding to a CW-ratio of 0.93 were coated with a 0.5 µm equiaxed $TiC_{0.05}N_{0.95}$-layer (with a high nitrogen content corresponding to an estimated C/N-ratio of 0.05) followed by a 4 µm thick $TiC_{0.54}N_{0.46}$-layer, with columnar grains by using MTCVD-technique (temperature 885-850 °C and CH_3CN as the carbon/nitrogen source). In subsequent steps during the same coating cycle, a 1.0 µm thick layer of Al_2O_3 was deposited using a temperature 970 °C and a concentration of H_2S dopant of 0.4 % as disclosed in EP-A-523 021. A thin (0.3 µm) layer of TiN was deposited on top according to known CVD-technique. XRD-measurement showed that the Al_2O_3-layer consisted of 100 % κ-phase. The cemented carbide body had a WC grain size in average of 1.7 µm. The coated inserts were brushed by a nylon straw brush containing SiC grains. Examination of the brushed inserts in a light microscope showed that the thin TiN-layer and some of the Al_2O_3-layer had been brushed away only along the cutting edge leaving there a smooth Al_2O_3-surface. Coating thickness measurements on cross sectioned brushed samples showed that the outer TiN-layer and roughly half of the Al_2O_3-layer was removed along the edge line.

B. A cemented carbide milling tool in accordance with the invention with the composition 11.1 wt-% Co, 1.25 wt-% TaC, 0.30 wt-% NbC and balance WC, with a binder phase alloyed with W corresponding to a CW-ratio of 0.93 were coated with a 0.5 µm equiaxed $TiC_{0.05}N_{0.95}$-layer followed by a 4 µm thick $TiC_{0.54}N_{0.46}$-layer, with columnar grains by using MTCVD-technique (temperature 885-850 ^{O}C and CH_3CN as the carbon/nitrogen source). In subsequent steps during the same coating cycle, a 1.0 µm thick layer of Al_2O_3 was deposited using a temperature 970 °C and a concentration of H_2S dopant of 0.4 % as disclosed in EP-A-523 021. A thin (0.3 µm) layer of TiN was deposited on top according to known CVD-technique. XRD-measurement showed that the Al_2O_3-layer consisted of 100 % κ-phase. The cemented carbide body had a WC grain size in average of 1.8 µm. The coated inserts were brushed by a nylon straw brush containing SiC grains. Examination of the brushed inserts in a light microscope showed that the thin TiN-layer and some of the Al_2O_3-layer had been brushed away only along the cutting edge leaving there a smooth Al_2O_3-surface. Coating thickness measurements on cross sectioned brushed samples showed that the outer TiN-layer and roughly half of the Al_2O_3-layer was removed along the edge line.

C. A strongly competitive cemented carbide grade from an external leading carbide producer was selected for comparison in a milling test. The carbide had a composition of 11.4 wt-% Co, 0.1 wt-% TiC, 1.9 wt-% TaC, 0.4 wt% NbC balance WC and a CW-ratio of 0.90. The WC-grain size was 1.4 µm. The insert had a PVD-coating consisting of total 5 µm of TiN/TiC/TiC,N/TiC layers.

D. A strongly competitive cemented carbide grade from an external leading carbide producer was selected for comparison in a milling test. The carbide had a composition of 11.5 wt-% Co, 0.2 wt-% TiC, 1.4 wt-% TaC, balance WC and a CW-ratio of 0.97. The WC-grain size was 1.5 µm. The insert had a conventional CVD-coating consisting of total 4.8 µm of TiN/TiC,N/TiC layers.

Operation: Face milling-roughing, cutter diameter. 160 mm
Work-piece: Connecting rod for ship
Material: 6S42CrMo4V-cast skin, 260HB
Cutting speed: 151 m/min
Feed rate/tooth: 0.15 mm/rev.
Depth of cut: 2-3 mm
Insert-style: TPKN 2204 PDR
Note: 10 inserts, dry, overhang, some vibrations

Results:	Tool-life, min:
Grade A:	26
Grade B:	39
Competitor C (prior art):	1.3
Competitor D (prior art):	13

Tool-life criteria were chipping of the edge line and breakages.

Example 2.

E. A cemented cutting tool with the composition of 8.0 wt-% Co, 0.1 wt-% TiC, balance WC and CW-ratio of 0.88. The WC-grain size was 3.2 µm. The insert had a conventional CVD-coating consisting of total 2.5 µm TiC/TiC,N/TiN.

Inserts from A, B, C and E were tested in a face milling operation.

Operation:	Face milling, R260.22-250
Work-piece:	Bar, 200x250 mm with holes
Material:	SS2541
Cutting speed:	100 m/min
Feed rate/tooth:	0,4 mm/rev.
Depth of cut:	2 mm
Insert-style:	SEKN 1204
Note:	offset 20 mm, single tooth, dry, different exit angles due to the holes, some vibrations

Results:	Tool-life, min
Grade A:	132
Grade B:	19
Competitor C (prior art):	13
Competitor E (prior art):	7

Tool-life criteria were edge-line chipping and bulk breakages.

Example 3.

F. A cemented cutting tool identical to the one mentioned in example A except that the coating was not brushed.

G. A cemented cutting tool identical to the one mentioned in example B except that the coating is brushed differently. Examination of the brushed inserts in a light microscope showed that the thin TiN-layer had been brushed away only along the cutting edge leaving there a smooth Al_2O_3-layer surface. Coating thickness measurements on cross sectioned brushed samples showed no reduction of the coating along the edge line except for the outer TiN-layer that was removed.

H. A strongly competitive cemented carbide grade from an external leading carbide producer was selected for comparison in a milling test. The carbide had a composition of 9.5 wt-% Co, 6.6 wt-% TiC, 12.7 wt-% TaC, 1.4 wt-% NbC, balance WC and a CW-ratio of 0.83. The insert was uncoated.

Inserts from A, B and F were tested in a face milling operation.

Operation:	Face milling-roughing, R282.2-200-30
Work-piece:	Plate, 800x4200 mm
Material:	Fe, forging skin, sand inclusions, 150-250 HB
Cutting speed:	100 m/min
Feed rate/tooth:	0,19 mm/rev.
Depth of cut:	6-8 mm
Insert-style:	TPKN 2204 PDR
Note:	dry, 11 teeth, heavy vibrations

Results:	Tool-life, min:
Grade F:	26
Grade G:	26
Competitor H (prior art):	7

Tool-life criterion was chipping of the edge.

Example 4.

I. A cemented cutting tool with the composition of 9.1 wt-% Co, 1.2 wt-% TaC, 0.3 wt-% NbC, balance WC and CW-ratio of 0.89. The WC-grain size was 1.7 µm. The insert had the same coating as mentioned in example A.

Inserts from A, B, E and G were tested in a square-shoulder test.

Operation:	Full slot, widening, 0 exit angle, R290.90-063Q22-12M
Work-piece:	Bar, 200x600 mm
Material:	SS1672, rusty surface, 150 HB
Cutting speed:	181 m/min
Feed rate/tooth:	0,17 mm/rev.
Depth of cut:	3-5 mm
Insert-style:	R290.90-12T308PPM-WM
Note:	dry, 5 teeth, recutting of chips

Results:	Tool-life, min:
Grade A:	63
Grade B:	46
Competitor E (prior art):	25
Competitor I (prior art):	5

Tool-life criterion was chipping in the edge line due to plastic deformation.

Example 5.

J. A cemented cutting tool identical to the one mentioned in example A, but the brushing was different. Examination of the brushed inserts in a light microscope showed that the thin TiN-layer and the Al_2O_3-layer had been brushed away only along the cutting edge leaving there a smooth $TiC_{0.54}N_{0.46}$-surface. Coating thickness measurements on cross sectioned brushed samples showed no reduction of the $TiC_{0.54}N_{0.46}$-layer, but the outer TiN-layer and the Al_2O_3-layer were removed along the edge line.

Inserts from C, D, E, I and J were tested in a face milling operation. Two parallel bars each of a thickness of 35 mm were central positioned relatively the cutter body, and the bars were placed with an airgap of 10 mm in between.

Operation:	Face milling,
Work-piece:	2 bars, 35x600 mm
Material:	SS1672, rusty surface, 150 HB
Cutting speed:	230 m/min
Feed rate/tooth:	0,28 mm/rev.
Depth of cut:	3 mm
Insert-style:	SPKN 1203 EDR
Note:	wet, one tooth

Results:	Tool-life, min:
Grade J:	27
Competitor C (prior art):	18
Competitor D (prior art):	22
Competitor E (prior art):	15
Competitor I (prior art):	22

Tool-life criterion was chipping due to comb crack formation.

Example 6.

Inserts from A and E were tested in a turning test.

Operation:	Facing
Work-piece:	Cylinder, 180 mm
Material:	SS2541, 300 HB
Cutting speed:	220 m/min
Feed rate:	0,3 mm/rev.
Depth of cut:	2 mm
Insert-style:	CNMG 120408-PM
Note:	dry

Results:	Tool-life, min:
Grade A:	5
Competitor E (prior art):	4

Tool-life criterion was plastic deformation.

Example 7.

Inserts from A and E were tested in a turning operation in stainless steel.

Operation:	Facing and longitudinal turning
Work-piece:	Cylinder, 96 mm
Material:	Sanmac 304L
Cutting speed:	200 m/min
Feed rate:	0,3 mm/rev.
Depth of cut:	2 mm
Insert-style:	CNMG 120408-PM
Note:	wet

Results:	Tool-life, min:
Grade A:	4
Competitor E (prior art):	3

Tool-life criterion was flank wear due to plastic deformation.

Example 8.

Inserts from A and E were tested in a turning operation in low alloyed steel.

Operation:	Facing, edge-line flaking test
Work-piece:	Pre-machined cylinder, 150 mm
Material:	SS 2172
Cutting speed:	130 m/min
Feed rate:	0,2 mm/rev.
Depth of cut:	2 mm
Insert-style:	CNMG 120408-PM
Note:	dry, five inserts per variant were tested

Results:	Edge-line flaking, %
Grade A:	5
Competitor E (prior art):	21

The result is given as a mean-value after one cut. Five inserts per variant were tested.

Claims

1. A cutting tool insert particularly useful for wet or dry machining of low and medium alloyed steels, stainless steels, with or without raw surfaces comprising a cemented carbide body and a coating c h a r a c t e r i z e d in that said cemented carbide body consists of WC with an average grain size of 1.5-2.5 µm, preferably about 1.7 µm, 10.9-13, preferably 11-12 wt-% Co and 0.2-1.8 wt-% TaC+NbC, and a low W-alloyed binder phase with a CW-ratio of 0.87-0.99 and in that said coating consist of

- a first (innermost) layer of $TiC_xN_yO_z$ with x+y+z=1, preferably y>x and z<0.2, with a thickness of 0.1-1.5 µm, and with equiaxed grains with size <0.5 µm

- a layer of $TiC_xN_yO_z$ with x+y+z=1, preferably z=0, x>0.3 and y>0.3, with a thickness of 1-8 µm with columnar grains with a diameter of about <5 µm

- a layer of a smooth, fine-grained (0.5-2 µm) κ-Al_2O_3 with a thickness of 0.5-5 µm and

- preferably an outermost layer of $TiC_xN_yO_z$, preferably TiN, with a thickness of <1 µm.

2. Cutting insert according to claim 1 c h a r a c t e r i z e d in that the cemented carbide has the composition 11.1-11.7 wt-% Co and 0.5-1.7 wt% TaC+NbC.

3. Cutting insert according to any of the preceding claims c h a r a c t e r i z e d in a CW-ratio of 0.90-0.95.

4. Cutting insert according to any of the preceding claims c h a r a c t e r i z e d in that the outermost $TiC_xN_yO_z$-layer, if present, has been removed along the cutting edge.

5. Cutting insert according to any of the preceding claims c h a r a c t e r i z e d in that the κ-Al_2O_3-layer has been removed along the cutting edge.

6. Method of making a cutting insert comprising a cemented carbide body and a coating c h a r a c t e r i z e d in that the WC-Co-based cemented carbide body consisting of WC with an average grain size of 1.5-2.5 µm, preferably about 1.7 µm, 10.9-13, preferably 11-12 wt-% Co and 0.4-1.8 wt-% TaC+NbC, and a low W-alloyed binder phase with a CW-ratio of 0.87-0.99 is coated with

- a first (innermost) layer of $TiC_xN_yO_z$ with x+y+z=1, preferably y>x and z<0.2, with a thickness of 0.1-1.5 µm, with equiaxed grains with size <0.5 µm using known CVD-methods

- a layer of $TiC_xN_yO_z$ with x+y+z=1, preferably with z=0 and x>0.3 and y>0.3, with a thickness of 1-8 µm with columnar grains with a diameter of about <5 µm deposited by MTCVD-technique, using acetonitrile as the carbon and nitrogen source for forming the layer in a preferred temperature range of 850-900 ^{O}C.

- a layer of a smooth κ-Al_2O_3 with a thickness of 0.5-5 µm using known CVD-methods and

- preferably a layer of TiN with a thickness of <1 µm.

7. Method according to the previous claim characteri z ed in that said cemented carbide body has the composition 11.1-11.7 wt-% Co and 0.5-1.7 wt% TaC+NbC.

8. Method according to any of the claims 6 and 7 c h a r a c t e r i z e d in a CW-ratio of 0.90-0.95.

9. Method according to any of the claims 6, 7 and 8 c h a r a c t e r i z e d in that the outermost $TiC_xN_yO_z$ layer, if present, is removed along the cutting edge.

10. Method according to any of the claims 6, 7 and 8 c h a r a c t e r i z e d in that the Al_2O_3-layer is removed along the cutting edge.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01579

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C23C 16/30, C23C 16/40, C23C 30/00, B23B 27/14
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)

IPC6: 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)

JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0685572 A2 (MITSUBISHI MATERIALS CORPORATION), 6 December 1995 (06.12.95), page 3, line 21 - page 4, line 39; page 5, line 38 - line 41; page 17, claims 1,8,12 --	1-10
Y	EP 0709484 A1 (MITSUBISHI MATERIALS CORPORATION), 1 May 1996 (01.05.96), page 2, line 30 - line 52; page 4; page 6 --	1-10
Y	EP 0686707 A1 (MITSUBISHI MATERIALS CORPORATION), 13 December 1995 (13.12.95), page 2, line 1 - line 18; page 4, line 9 - line 12, claim 1 --	1-10

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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"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	Date of mailing of the international search report
18 February 1997	01-03-1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ingrid Grundfelt Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01579

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0653499 A1 (SUMITOMO ELECTRIC INDUSTRIES, LTD.), 17 May 1995 (17.05.95), page 13, line 1 - line 41	1-10
	--	
Y,P	EP 0693574 A1 (SANDVIK AKTIEBOLAG), 24 January 1996 (24.01.96), claims 5,6	4,5,9,10
	--	
Y	US 4643620 A (HIROSHI FUJII ET AL), 17 February 1987 (17.02.87), column 2, line 8 - line 30; column 3, line 42 - line 44; column 3, line 59 - line 66, figure 5C, abstract	4,5,9,10
	--	

INTERNATIONAL SEARCH REPORT

Information on patent family members

03/02/97

International application No.

PCT/SE 96/01579

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP-A2-	0685572	06/12/95	CN-A-	1121537	01/05/96
			JP-A-	7331443	19/12/95
			JP-A-	7328808	19/12/95
			JP-A-	7328809	19/12/95
			JP-A-	7328810	19/12/95
			JP-A-	8001408	09/01/96
			JP-A-	8001409	09/01/96
			JP-A-	8001410	09/01/96
			JP-A-	8001411	09/01/96
			JP-A-	8090311	09/04/96
EP-A1-	0709484	01/05/96	JP-A-	8118105	14/05/96
			JP-A-	8118108	14/05/96
			JP-A-	8187605	23/07/96
			JP-A-	8187606	23/07/96
EP-A1-	0686707	13/12/95	JP-A-	6190605	12/07/94
EP-A1-	0653499	17/05/95	JP-C-	1441045	30/05/88
			JP-A-	58031118	23/02/83
			JP-B-	62050570	26/10/87
			JP-A-	7100701	18/04/95
			WO-A-	9428191	08/12/94
			JP-A-	7285001	31/10/95
EP-A1-	0693574	24/01/96	BR-A-	9503375	12/03/96
			CN-A-	1116571	14/02/96
			IL-D-	114674	00/00/00
			JP-A-	8052603	27/02/96
			SE-A-	9402543	21/01/96
US-A-	4643620	17/02/87	AU-B-	581847	09/03/89
			AU-A-	2855984	29/11/84
			EP-A,B-	0127416	05/12/84
			SE-T3-	0127416	
			JP-A-	59219122	10/12/84
			US-A-	4755399	05/07/88