(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 January 2014 (09.01.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/006609 A1

(51) International Patent Classification:
B23C 5/22 (2006.01)

(21) International Application Number:
PCT/IL2013/050492

(22) International Filing Date:
9 June 2013 (09.06.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13/542,846 6 July 2012 (06.07.2012) US

(71) Applicant: **ISCAR LTD.** [IL/IL]; P.O. Box 11, 24959 Tefen (IL).

(72) Inventors: **SMILOVICI, Carol**; 31/17 Hashaked Street, 22358 Nahariya (IL). **ATAR, Osama**; First Street, No. 100, 24967 Yarka (IL).

(74) Agent: **ISCAR LTD.**; Patent Department, P.O. Box 11, 24959 Tefen (IL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

WO 2014/006609 A1

(54) Title: ROTARY CUTTING TOOL AND REVERSIBLE CUTTING INSERT THEREFOR

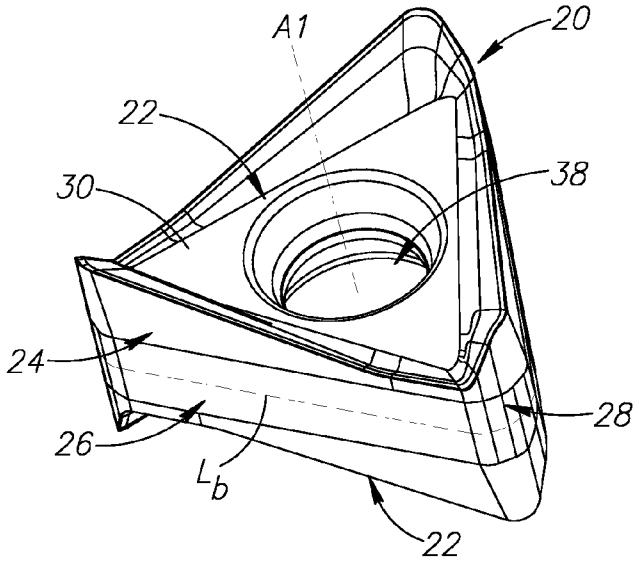

FIG.1

(57) Abstract: In a rotary cutting tool (58) used for milling operations, a reversible indexable cutting insert (20) is removably secured in a cutting body (60). The cutting insert (20) has two opposing end surfaces (22) interconnected by a continuous peripheral surface (24), including three side surfaces (26) alternating with three corner surfaces (28). The side (26) and corner (28) surfaces intersect with both end surfaces (22) at side (40) and corner (42) edges, respectively, with each side (40) edge having a major cutting edge (44), and each corner edge (42) having a corner (46) and minor (48) cutting edge. Each major (44) and minor (48) cutting edge slopes away from first (E1) and second (E2) end points, respectively, of its mutually associated corner cutting edge (46), towards a median plane (M). A first imaginary straight line (LI) extending perpendicular to the median plane (M) and intersecting any one of the corner cutting edges (46) at any point along its length except the second end point, passes through the median plane (M) inside an insert boundary line (Lb).

ROTARY CUTTING TOOL AND REVERSIBLE CUTTING INSERT THEREFOR

FIELD OF THE INVENTION

The present invention relates to cutting inserts and cutting tools for use in metal cutting processes, in general, and to rotary cutting tools having reversible cutting inserts for milling operations, in particular.

BACKGROUND OF THE INVENTION

Within the field of rotary cutting tools used in milling operations, there are many examples of reversible cutting inserts being removably secured in a cutting body. In some instances, these cutting tools are configured to perform square shoulder milling operations.

US 7,241,082 discloses a generally rectangular shaped double-sided indexable cutting insert having two major and two minor side surfaces connected to two opposing end surfaces, and a total of four major cutting edges. A primary 'reversed' relief surface adjacent each major cutting edge is inclined to a median plane of the cutting insert at an acute interior angle. The cutting insert is retained in the insert pocket of a milling cutter and configured to perform milling operations with a positive axial rake angle.

US 7,455,483 discloses a trigon-shaped double-sided indexable cutting insert of 'negative' geometry having six edge surfaces connected to two opposing sides, and a total of six main cutting edges. The cutting insert is seated in the insert pocket of a milling tool and configured to cut perpendicular corners in a workpiece with a positive rake angle.

US 7,604,441 discloses a square double-ended indexable cutting insert of 'negative' geometry having four side surfaces connected to two opposing end surfaces, and a total of eight primary cutting edges. The cutting insert is seated in the insert pocket of a milling cutter and configured to cut a true 90° shoulder in a workpiece with a positive axial rake angle. However, the depth of the shoulder is limited by the size of the insert and dependent on the length of the primary cutting edge.

It is an object of the present invention to provide an improved cutting insert and cutting tool.

It is also an object of the present invention to provide an improved cutting insert having two major cutting edges per side surface.

It is a further object of the present invention to provide an improved cutting insert having robust cutting edges.

It is yet a further object of the present invention to provide an improved cutting tool capable of performing square shoulder milling operations.

It is still yet a further object of the present invention to provide an improved cutting tool capable of performing ramping operations.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention, there is provided a reversible indexable cutting insert, comprising:

opposing first and second end surfaces interconnected by a continuous peripheral surface, with a median plane located between the first and second end surfaces and intersecting the peripheral surface to form an insert boundary line, and an insert axis perpendicular to the median plane about which the cutting insert is indexable,

the peripheral surface including at least three side surfaces alternating with at least three corner surfaces, with each corner surface having a corner bisector plane containing the insert axis, and

the side and corner surfaces intersecting with both the first and second end surfaces at side and corner edges, respectively, with each side edge having a major cutting edge, and each corner edge having a corner and minor cutting edge,

wherein, in a side view of the cutting insert, each major and minor cutting edge slopes away from first and second end points, respectively, of its mutually associated corner cutting edge, towards the median plane, and

wherein a first imaginary straight line extending perpendicular to the median plane and intersecting any one of the corner cutting edges at any point along its length except the second end point, passes through the median plane inside the insert boundary line.

In accordance with another aspect of the invention, there is provided a cutting tool rotatable about a tool axis, comprising a cutting body having an insert receiving pocket, and at

least one reversible indexable cutting insert of the sort described above removably secured in the insert receiving pocket.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding, the invention will now be described, by way of example only, with reference to the accompanying drawings in which chain-dash lines represent cut-off boundaries for partial views of a member and in which:

Fig. 1 is a perspective view of a cutting insert in accordance with some embodiments of the present invention;

Fig. 2a is an end view of the cutting insert shown in Fig. 1;

Fig. 2b is a detailed end view of the cutting insert shown in Fig. 1;

Fig. 3 is a side view of the cutting insert shown in Fig. 2a, viewed along a corner bisector plane **Pc**;

Fig. 4 is a side view of the cutting insert shown in Fig. 2a, viewed along a side bisector plane **Ps**;

Fig. 5 is a partial cross-sectional view of the cutting insert shown in Fig. 3, taken along the line V-V;

Fig. 6 is a partial cross-sectional view of the cutting insert shown in Fig. 4, taken along the line VI-VI;

Fig. 7 is a perspective view of a cutting tool in accordance with some embodiments of the present invention;

Fig. 8 is side view of the cutting tool shown in Fig. 7;

Fig. 9 is an end view of the cutting tool shown in Fig. 7; and

Fig. 10 is a diagrammatical representation of the contour lines inscribed by the operative cutting edges of the cutting tool shown in Fig. 9, in a radial plane **Pr.**

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a reversible indexable cutting insert **20** having opposing first and second end surfaces **22** interconnected by a continuous peripheral surface **24**, the

peripheral surface **24** at least three side surfaces **26** alternating with at least three corner surfaces **28**.

In some embodiments of the present invention, the at least three side surfaces **26** may be identical, and the at least three corner surfaces **28** may be identical.

As shown in Figs. 1 and 2a, the cutting insert **20** may have the basic shape of a regular polygon.

In some embodiments of the present invention, the cutting insert **20** may preferably be manufactured by form pressing and sintering a cemented carbide, such as tungsten carbide, and may be coated or uncoated.

As shown in Figs. 3 and 4, the cutting insert **20** has a median plane **M** located between the first and second end surfaces **22** and intersecting the peripheral surface **24** to form an insert boundary line **Lb**.

In some embodiments of the present invention, the first and second end surfaces **22** may be identical, each having a support surface **30** substantially parallel to the median plane **M**.

Also, in some embodiments of the present invention, the two support surfaces **30** may be equidistant from the median plane **M**.

As shown in Figs. 3 and 4, the at least three side and corner surfaces **26**, **28** may have side and corner median regions **32**, **34**, respectively, forming a continuous peripheral median region **36** extending perpendicular to the median plane **M**.

Throughout the description, it should be appreciated that the perpendicularity of the peripheral median region **36** with respect to the median plane **M** has a manufacturing tolerance of 0.5°.

In some embodiments of the present invention, the peripheral median region **36** may exhibit mirror symmetry about the median plane **M**.

Also, in some embodiments of the present invention, each side median region **32** may be planar.

As shown in Figs. 1 and 2a, the cutting insert **20** has an insert axis **A1** perpendicular to the median plane **M** about which the cutting insert **20** is indexable.

In some embodiments of the present invention, the peripheral surface **24** may have exactly three side surfaces **26** alternating with exactly three corner surfaces **28**, and the cutting insert **20** may exhibit three-fold rotational symmetry about the insert axis **A1**.

Also in some embodiments of the present invention, a through bore **38** coaxial with the insert axis **A1** may extend between and open out at both the first and second end surfaces **22**.

As shown in Figs. 1 and 2a, the cutting insert **20** may have the basic shape of an equilateral triangle.

In some embodiments of the present invention, the cutting insert **20** may be manufactured by direct pressing along the direction of the insert axis **A1**.

Also, in some embodiments of the present invention, the cutting insert **20** may be pressed into its final shape, and the peripheral surface **24** may be unground.

According to the present invention, the side and corner surfaces **26**, **28** intersect with both the first and second end surfaces **22** at side and corner edges **40**, **42**, respectively, with each side edge **40** having a major cutting edge **44**, and each corner edge **42** having a corner and minor cutting edge **46**, **48**.

Thus, the cutting insert **20** is advantageously configured with two major cutting edges **44** per side surface **26**, and two corner and minor cutting edges **46**, **48** per corner surface **28**, and thus for embodiments exhibiting three-fold rotational symmetry about the insert axis **A1**, the cutting insert **20** has a total of six major, corner and minor cutting edges **44**, **46**, **48**

In an end view of the cutting insert **20**, as shown in Fig. 2b, each corner cutting edge **46** may be curved while the minor and major cutting edges **44**, **48** may be straight. Each curved corner cutting edge **46** extends between a first end point **E1**, where it merges with a substantially straight portion of its associated major cutting edge **44**, and a second end point **E2**, where it merges with substantially straight portion of its associated minor cutting edge **48**.

In a corner side view of the cutting insert **20**, as shown in Fig. 3, each corner cutting edge **46** may again be curved while the minor and major cutting edges **44**, **48** may again be straight.

As shown in Fig. 4, a side axis **A2** may extend transversely to each side surface **26**, and each side surface **26** may exhibit two-fold rotational symmetry about its associated side axis **A2**.

In some embodiments of the present invention, each major cutting edge **44** may intersect a side bisector plane **Ps** containing the insert axis **A1** and its associated side axis **A2**. For these embodiments, it can be understood that each major cutting edge **44** extends along greater than half the peripheral length of its associated side surface **26**.

According to the present invention, as shown in the corner side view of Fig. 3, each major and minor cutting edge **44**, **48** slopes away from the first and second end points **E1**, **E2**, respectively, of its mutually associated corner cutting edge **46**, towards the median plane **M**.

In some embodiments of the present invention, each major and minor cutting edge **44**, **48** may slope away from its mutually associated corner cutting edge **46** towards the median plane **M** along its entire length.

Also, in some embodiments of the present invention, as shown in Figs. 3 and 5, each corner cutting edge **46** may be entirely located further from the median plane **M** than each of the support surfaces **30**.

Further, in some embodiments of the present invention, as shown in Fig. 6, each end surface **22** may include a rake surface **50** adjacent each major cutting edge **44**, with each rake surface **50** inclined towards the median plane **M** and merging with its associated support surface **30**.

As shown in Figs. 2b and 5, a first imaginary straight line **L1** extending perpendicular to the median plane **M** and intersecting any one of the corner cutting edges **46** at any point along its length except the second end point **E2**, passes through the median plane **M** inside the insert boundary line **Lb**.

It should be appreciated that the first imaginary straight line **L1** appears as a point in an end view of the cutting insert **20**, as shown in Fig. 2b.

In a similar vein, as can be surmised from Figs. 1, 2a and 2b, in an end view projection of the minor cutting edges **48** onto the median plane **M**, (projection not shown) each minor cutting edge **48** may be coincident with the insert boundary line **Lb**.

In some embodiments of the present invention, as shown in Fig. 3, each corner surface **28** may include two partially conical shaped corner relief surfaces **52** extending from the same corner median region **34** in opposite axial directions to their respective corner cutting edges **46**. As seen in the corner side view of Fig. 3, the two partially conical shaped corner relief surfaces **52** may overlap in the axial direction of the cutting insert **20**.

It should be appreciated that with respect to the insert boundary line **Lb**, each partially conical shaped corner relief surface **52**, also known as a 'reversed' relief surface, generally extends inwardly (i.e., in a direction of the insert axis **A1**) from its associated corner median

region **34** towards its respective corner cutting edge **46**, so that each corner cutting edge **46** is beneficially supported and advantageously robust.

In some embodiments of the present invention, as shown in Fig. 3, each corner surface **28** may include two planar minor relief surfaces **54** extending from the same corner median region **34** in opposite axial directions to their respective minor cutting edges **48**. As seen in the corner side view of Fig. 3, the two planar minor relief surfaces **54** may not overlap in the axial direction of the cutting insert **20**.

Also, in some embodiments of the present invention, each minor relief surface **54** may be perpendicular to the median plane **M**.

Further, in some embodiments of the present invention, each minor relief surface **54** may be spaced apart from its adjacent side surface **26** by a non-planar joining surface **68**.

According to the present invention, as shown in Fig. 2a, each corner surface **28** has a corner bisector plane **Pc** containing the insert axis **A1**.

In some embodiments of the present invention, each corner cutting edge **46** may intersect its associated corner bisector plane **Pc**, and its first and second end points **E1**, **E2** may be located on opposite sides of the corner bisector plane **Pc**. However, as seen in the corner side view of Fig. 3, the corner bisector plane **Pc** may not pass through the highest point of the corner cutting edge **46**. Also, as seen in the enlarged end view of Fig. 2b, the corner bisector plane **Pc** may not bisect the corner cutting edge **46** (i.e., need not pass mid-way between its first and second end points **E1**, **E2**.)

Also, in some embodiments of the present invention, as shown in Fig. 3, each corner median region **34** may exhibit mirror symmetry about its associated corner bisector plane **Pc**.

Further, for embodiments of the present invention having planar side median regions **32** perpendicular to the median plane **M**, each side median region **32** may form a first bisector angle **α1** with the corner bisector plane **Pc** of an adjacent corner surface **28**, having a value of 30°.

Yet further, for embodiments of the present invention having planar minor relief surfaces **54** perpendicular to the median plane **M**, each minor relief surface **54** may form a second bisector angle **α2** with its associated corner bisector plane **Pc**, having a value of between 60° and 80°.

As shown in Fig. 6, a second imaginary straight line **L2** extending perpendicular to the median plane **M** and intersecting any one of the major cutting edges **44** at any point along its length, may pass through the median plane **M** inside the insert boundary line **Lb**.

In some embodiments of the present invention, as shown in Fig. 4, each side surface **26** may include two major relief surfaces **56** extending from the same side median region **32** to their respective major cutting edges **44**.

Further, in some embodiments of the present invention, each major cutting edge **44** may be substantially straight along its entire length, and each major relief surface **56** may be substantially planar.

It should be appreciated that with respect to the insert boundary line **Lb**, each major relief surface **56**, also known as a 'reversed' relief surface, generally extends inwardly (i.e., in a direction of the insert axis **A1**) from its associated side median region **32** towards its respective major cutting edge **44**, so that each major cutting edge **44** is beneficially supported and advantageously robust.

As shown in Figs. 7 to 10, the present invention also relates to a cutting tool **58** rotatable about a tool axis **A3**, in a direction of rotation **Z**, having a cutting body **60** and at least one of the aforementioned reversible indexable cutting inserts **20**. Each cutting insert **20** is removably secured in an insert receiving pocket **62** of the cutting body **60**.

In some embodiments of the present invention, each cutting insert **20** may be removably secured in the insert receiving pocket **62** by means of a clamping screw **64** passing through its through bore **38**, and threadingly engaging a screw bore (not shown) in a seating surface (not shown) of the insert receiving pocket **62**.

As shown in Fig. 10, each cutting insert **20** may be configured within the cutting tool **58** so that during rotation of the cutting tool **58** about its tool axis **A3**, the operative corner cutting edge **46** inscribes an arc-shaped first contour line **C1** in a radial plane **Pr** containing the tool axis **A3**, with the first contour line **C1** having a constant radius of curvature **R** subtending a corner cutting angle **δ** of 90°.

Also, as shown in Fig. 10, each cutting insert **20** may be configured within the cutting tool **58** so that during rotation of the cutting tool **58** about its tool axis **A3**, the operative major and minor cutting edges **44**, **48** inscribe straight second and third contour lines **C2**, **C3**,

respectively, in the radial plane **Pr**, with the second contour line **C2** substantially parallel to the tool axis **A3** and the third contour line **C3** substantially perpendicular to the tool axis **A3**.

Throughout the description, it should be appreciated that the parallelity and perpendicularity of the second and third contour lines **C2**, **C3**, respectively, with respect to the tool axis **A3** have an accuracy tolerance of 0.5°.

In some embodiments of the present invention, the rotary cutting tool **58** may be used for milling operations.

It should be appreciated that during a milling operation, the operative corner cutting edge **46** cuts a corner in a workpiece (not shown) having a constant radius of curvature **R** subtending a corner cutting angle **δ** of 90°, advantageously resulting in reduced stress concentrations at the corner, and thus minimizing its risk of fracture.

It should also be appreciated that during a milling operation, the operative minor cutting edge **48**, which can also be referred to as a wiper, is parallel to the surface of the workpiece, promoting an even and smooth surface finish.

It should be further appreciated that during a milling operation, the major 'reversed' relief surfaces **56** beneficially provide the trailing non-operative major cutting edges **44** of each reversible cutting insert **20** with greater clearance from the workpiece, thus advantageously enabling their arrangement on relatively smaller diameter cutting tools **58**.

In some embodiments of the present invention, as can be readily understood from Fig. 10, each cutting insert **20** may be configured within the cutting tool **58**, so that the operative major, corner and minor cutting edges **44**, **46**, **48** perform a square, or 90°, shoulder milling operation in the workpiece.

It should be appreciated that during a square, or 90°, shoulder milling operation, the height of the machined shoulder is not limited by the cutting insert **20**.

In some embodiments of the present invention, as shown in Figs. 8 and 9, each cutting insert **20** may be configured within the cutting tool **58**, so that the operative major cutting edge **44** has a positive axial rake angle **β**, and the operative minor cutting edge **48** has a positive radial rake angle **θ**.

It should be appreciated that by providing the operative major and minor cutting edges **44**, **48** with positive axial and radial rake angles **β**, **θ**, respectively, lower cutting forces are generated, the machine spindle requires less operating power, and the workpiece undergoes a

smoother cutting action. Also the cutting chips produced are advantageously evacuated way from the operative cutting edges.

In some embodiments of the present invention, each side edge **40** may include an auxiliary cutting edge **66** extending from its associated major cutting edge **44** towards an adjacent minor cutting edge **48** belonging to an adjacent corner edge **42**.

Each cutting insert **20** may be configured within the cutting tool **58**, so that the auxiliary cutting edge **66** adjacent the operative minor cutting edge **48** is operative during ramping operations.

Each cutting insert **20** may also be configured within the cutting tool **58**, so that the auxiliary cutting edge **66** extending from the operative major cutting edge **44** is operative during shoulder milling operations, thus increasing the insert's depth of cut.

As seen in the side views of Figs. 3 and 4, the auxiliary cutting edge **66** may be sloped to a lesser extent than its associated major cutting edge **44**. In some embodiments, the auxiliary cutting edge **66** may be parallel to the median plane **M**.

Also, in some embodiments of the present invention, each auxiliary cutting edge **66** may be substantially coplanar with its associated support surface **30**.

Further, in some embodiments of the present invention, each end surface **22** may include an auxiliary rake groove (not shown) longitudinally extending adjacent each auxiliary cutting edge **66** to provide efficient chip evacuation during ramping operations.

Although the present invention has been described to a certain degree of particularity, it should be understood that various alterations and modifications could be made without departing from the spirit or scope of the invention as hereinafter claimed.

CLAIMS

What is claimed is:

1. A reversible indexable cutting insert (20), comprising:

opposing first and second end surfaces (22) interconnected by a continuous peripheral surface (24), with a median plane (M) located between the first and second end surfaces (22) and intersecting the peripheral surface (24) to form an insert boundary line (Lb), and an insert axis (A1) perpendicular to the median plane (M) about which the cutting insert (20) is indexable,

the peripheral surface (24) including at least three side surfaces (26) alternating with at least three corner surfaces (28), with each corner surface (28) having a corner bisector plane (Pc) containing the insert axis (A1), and

the side and corner surfaces (26, 28) intersecting with both the first and second end surfaces (22) at side and corner edges (40, 42), respectively, with each side edge (40) having a major cutting edge (44), and each corner edge (42) having a corner and minor cutting edge (46, 48),

wherein, in a side view of the cutting insert (20), each major and minor cutting edge (44, 48) slopes away from first and second end points (E1, E2), respectively, of its mutually associated corner cutting edge (46), towards the median plane (M), and

wherein a first imaginary straight line (L1) extending perpendicular to the median plane (M) and intersecting any one of the corner cutting edges (46) at any point along its length except the second end point (E2), passes through the median plane (M) inside the insert boundary line (Lb).

2. The cutting insert (20) according to claim 1, wherein the at least three side and corner surfaces (26, 28) have side and corner median regions (32, 34), respectively, and

wherein the side and corner median regions (32, 34) form a continuous peripheral median region (36) extending perpendicular to the median plane (M).

3. The cutting insert (20) according to claim 2, wherein the peripheral median region (36) exhibits mirror symmetry about the median plane (M).

4. The cutting insert (20) according to claim 2 or 3, wherein each side median region (32) is planar.

5. The cutting insert (20) according to claim 4, wherein each side median region (32) forms a first bisector angle ($\alpha 1$) with the corner bisector plane (Pc) of an adjacent corner surface (28), and

wherein the first bisector angle ($\alpha 1$) is 30°.

6. The cutting insert (20) according to any one of claims 2 to 5, wherein each corner median region (34) exhibits mirror symmetry about its associated corner bisector plane (Pc).

7. The cutting insert (20) according to any one of claims 2 to 6, wherein each corner surface (28) includes two partially conical shaped corner relief surfaces (52) extending from the same corner median region (34) in opposite axial directions to their respective corner cutting edges (46).

8. The cutting insert (20) according to any one of claims 2 to 7, wherein each corner surface (28) includes two planar minor relief surfaces (54) extending from the same corner median region (34) in opposite axial directions to their respective minor cutting edges (48).

9. The cutting insert (20) according to claim 8, wherein each minor relief surface (54) is spaced apart from its adjacent side surface (26) by a non-planar joining surface (68).

10. The cutting insert (20) according to claim 8 or 9, wherein each minor relief surface (54) is perpendicular to the median plane (M).

11. The cutting insert (20) according to claim 10, wherein each minor relief surface (54) forms a second bisector angle ($\alpha 2$) with its associated corner bisector plane (Pc), and

wherein the second bisector angle ($\alpha 2$) is between 60° and 80°.

12. The cutting insert (20) according to any one of the preceding claims, wherein, in a side view of the cutting insert (20), each major and minor cutting edge (44, 48) slopes away from its mutually associated corner cutting edge (46) towards the median plane (M) along its entire length.

13. The cutting insert (20) according to any one of the preceding claims, wherein the at least three side surfaces (26) are identical, and the at least three corner surfaces (28) are identical.

14. The cutting insert (20) according to any one of the preceding claims, wherein each corner cutting edge (46) intersects its associated corner bisector plane (Pc), and

wherein its first and second end points (E1, E2) are located on opposite sides of the corner bisector plane (Pc).

15. The cutting insert (20) according to any one of the preceding claims, wherein in an end view of the cutting insert (20), each corner cutting edge (46) is curved and each minor cutting edge (48) is straight.

16. The cutting insert (20) according to any one of the preceding claims, wherein the first and second end surfaces (22) are identical, each having a support surface (30) substantially parallel to the median plane (M).

17. The cutting insert (20) according to claim 16, wherein the two support surfaces (30) are equidistant from the median plane (M).

18. The cutting insert (20) according to claim 16 or 17, wherein each corner cutting edge (46) is entirely located further from the median plane (M) than each of the support surfaces (30).

19. The cutting insert (20) according to any one of the preceding claims, wherein a second imaginary straight line (L2) extending perpendicular to the median plane (M) and intersecting

any one of the major cutting edges (44) at any point along its length, passes through the median plane (M) inside the insert boundary line (Lb).

20. The cutting insert (20) according to any one of the preceding claims, wherein in an end view projection of the minor cutting edges (48) onto the median plane (M), each minor cutting edge (48) is coincident with the insert boundary line (Lb).

21. The cutting insert (20) according to any one of the preceding claims, wherein the peripheral surface (24) has exactly three side surfaces (26) alternating with exactly three corner surfaces (28), and

wherein the cutting insert (20) exhibits three-fold rotational symmetry about the insert axis (A1).

22. The cutting insert (20) according to any one of the preceding claims, wherein a side axis (A2) extends transversely to each side surface (26), and

wherein each side surface (26) exhibits two-fold rotational symmetry about its associated side axis (A2).

23. The cutting insert (20) according to claim 22, wherein each major cutting edge (44) intersects a side bisector plane (Ps) containing the insert axis (A1) and its associated side axis (A2).

24. The cutting insert (20) according to any one of the preceding claims, wherein in an end view of the cutting insert (20), the cutting insert (20) has the basic shape of a regular polygon.

25. The cutting insert (20) according to any one of the preceding claims, wherein in an end view of the cutting insert (20), the cutting insert (20) has the basic shape of an equilateral triangle.

26. The cutting insert (20) according to any one of the preceding claims, wherein a through bore (38) coaxial with the insert axis (A1) extends between and opens out at both the first and second end surfaces (22).

27. The cutting insert (20) according to any one of the preceding claims, wherein the cutting insert (20) is manufactured by direct pressing along the direction of the insert axis (A1).

28. The cutting insert (20) according to any one of the preceding claims, wherein the peripheral surface (24) is unground.

29. A cutting tool (58) rotatable about a tool axis (A3), comprising a cutting body (60) and at least one reversible indexable cutting insert (20), each cutting insert (20) removably secured in an insert receiving pocket (62) of the cutting body (60), and each cutting insert (20) comprising:

opposing first and second end surfaces (22) interconnected by a continuous peripheral surface (24), with a median plane (M) located between the first and second end surfaces (22) and intersecting the peripheral surface (24) to form an insert boundary line (Lb), and an insert axis (A1) perpendicular to the median plane (M) about which the cutting insert (20) is indexable,

the peripheral surface (24) including at least three side surfaces (26) alternating with at least three corner surfaces (28), with each corner surface (28) having a corner bisector plane (Pc) containing the insert axis (A1), and

the side and corner surfaces (26, 28) intersecting with both the first and second end surfaces (22) at side and corner edges (40, 42), respectively, with each side edge (40) having a major cutting edge (44), and each corner edge (42) having a corner and minor cutting edge (46, 48),

wherein, in a side view of the cutting insert (20), each major and minor cutting edge (44, 48) slopes away from first and second end points (E1, E2), respectively, of its mutually associated corner cutting edge (46), towards the median plane (M), and

wherein a first imaginary straight line (L1) extending perpendicular to the median plane (M) and intersecting any one of the corner cutting edges (46) at any point along its length except the second end point (E2), passes through the median plane (M) inside the insert boundary line (Lb).

30. The cutting tool (58) according to claim 29, wherein each cutting insert (20) is configured so that the operative major, corner and minor cutting edges (44, 46, 48) are capable of performing a square shoulder milling operation in a workpiece.

31. The cutting tool (58) according to claim 29 or 30, wherein each side edge (40) includes an auxiliary cutting edge (66) extending from its associated major cutting edge (44) towards an adjacent minor cutting edge (48) belonging to an adjacent corner edge (42), and

wherein each cutting insert (20) is configured so that the auxiliary cutting edge (66) adjacent the operative minor cutting edge (48) is operative during ramping operations.

32. The cutting tool (58) according to any one of claims 29 to 31, wherein each cutting insert (20) is configured so that the operative major cutting edge (44) has a positive axial rake angle (β), and the operative minor cutting edge (48) has a positive radial rake angle (θ).

33. The cutting tool (58) according to any one of claims 29 to 32, wherein each cutting insert (20) is configured so that during rotation of the cutting tool (58) about its tool axis (A3), the operative corner cutting edge (46) inscribes an arc-shaped first contour line (C1) in a radial plane (Pr) containing the tool axis (A3), and

wherein the first contour line (C1) has a constant radius of curvature (R) subtending a corner cutting angle (δ) of 90°.

34. The cutting tool (58) according to claim 33, wherein each cutting insert (20) is configured so that during rotation of the cutting tool (58) about its tool axis (A3), the operative major and minor cutting edges (44, 48) inscribe straight second and third contour lines (C2, C3), respectively, in the radial plane (Pr), and

wherein the second contour line (C2) is substantially parallel to the tool axis (A3), and

wherein the third contour line (C3) is substantially perpendicular to the tool axis (A3).

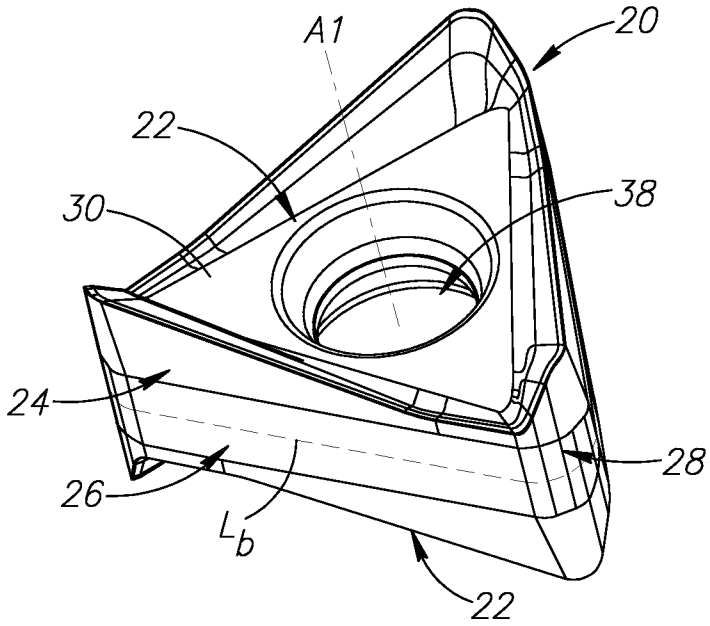
A1
20
22
30
38
24
28
26
L_b
22

FIG.1

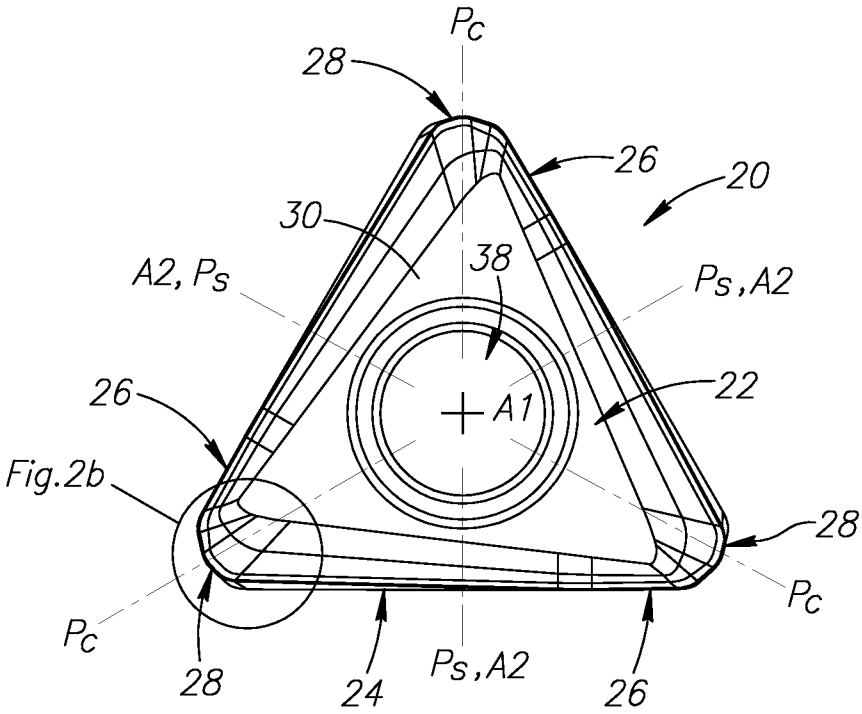
P_c
28
26
20
30
38
A2, P_s
P_s, A2
26
A1
22
Fig.2b
28
P_c
P_c
28
24
P_s, A2
26

FIG.2a

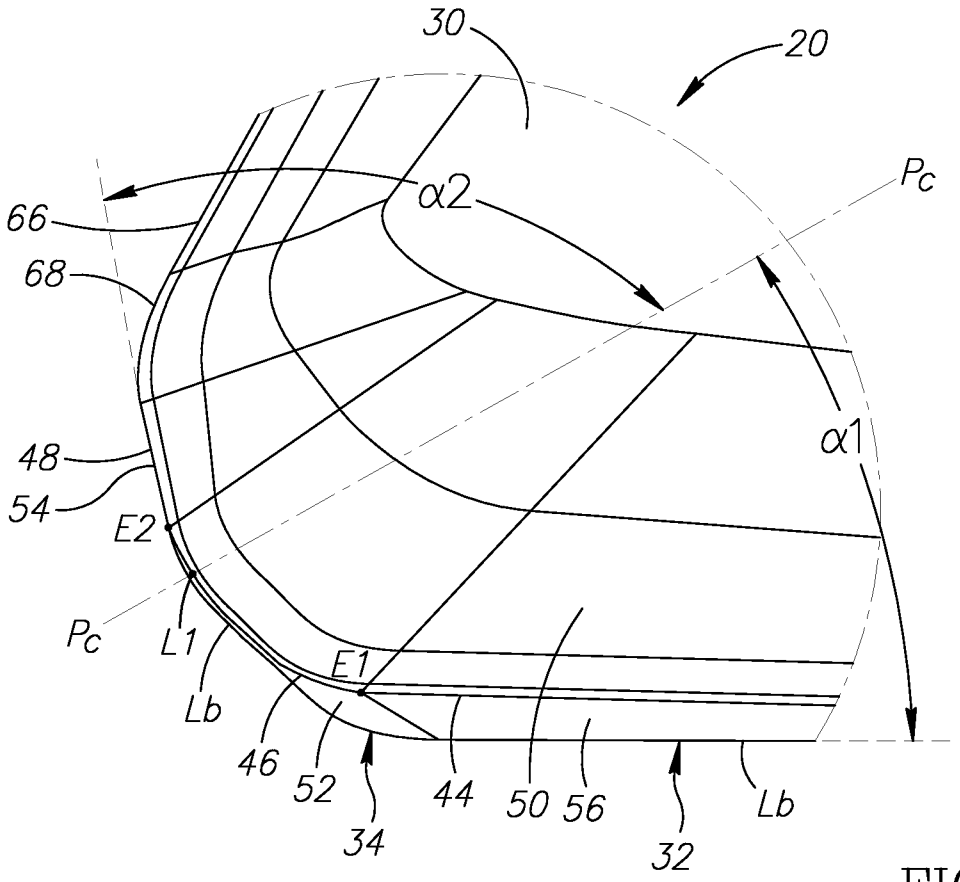
30
20
Pc
α2
66
68
48
54
E2
α1
Pc
L1
E1
Lb
46
52
44
50
56
Lb
34
32

FIG.2b

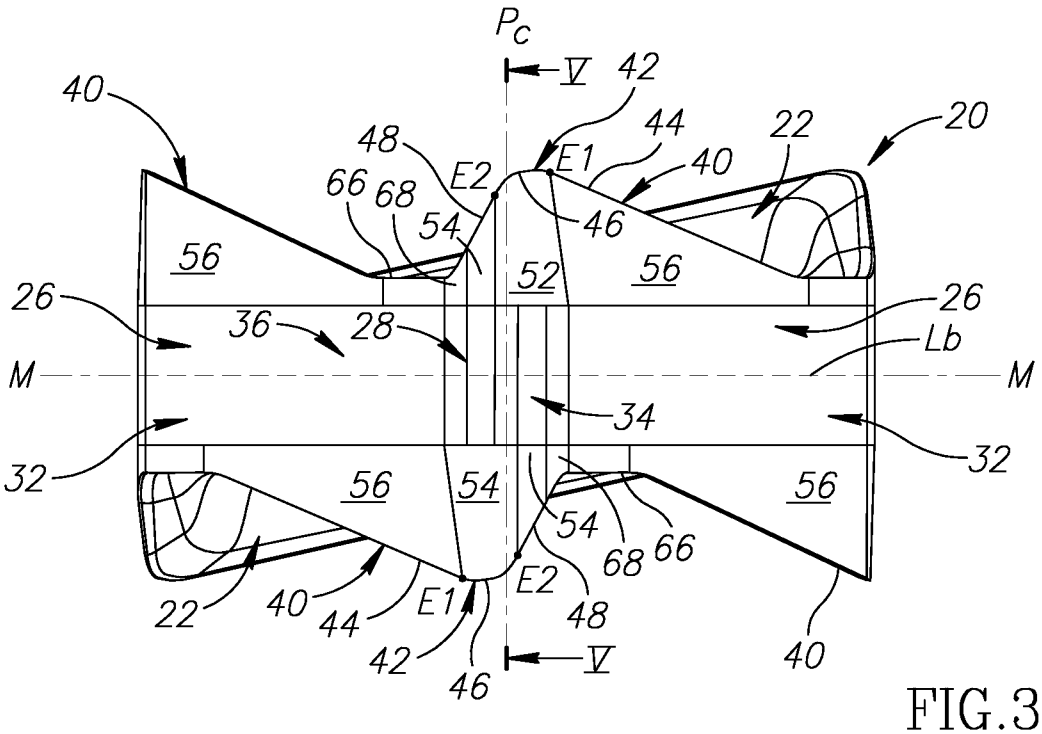
Pc
V
42
40
44
22
20
48
E2
E1
40
66
68
54
46
56
52
56
26
26
36
28
Lb
M
M
34
32
32
56
54
56
54
68
66
E2
48
22
40
44
E1
42
46
V
40

FIG.3

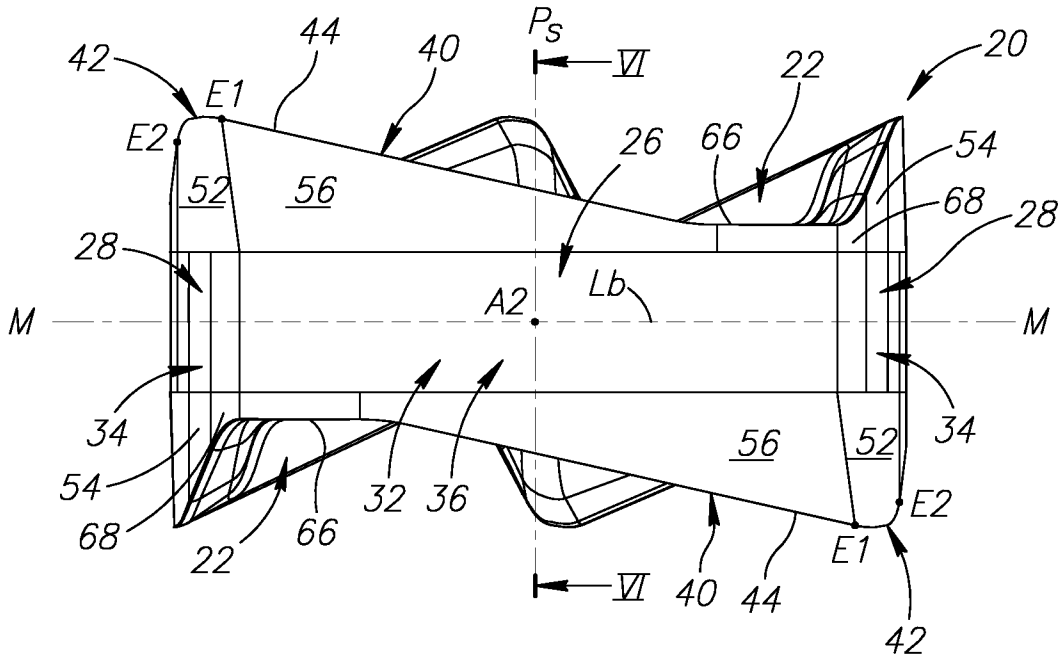

FIG.4

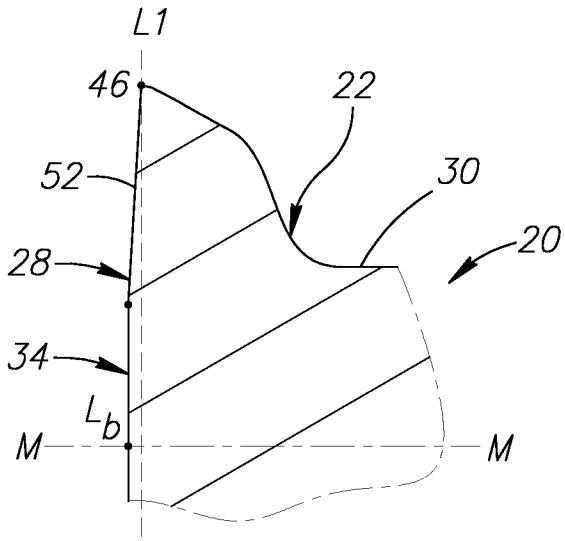

FIG.5

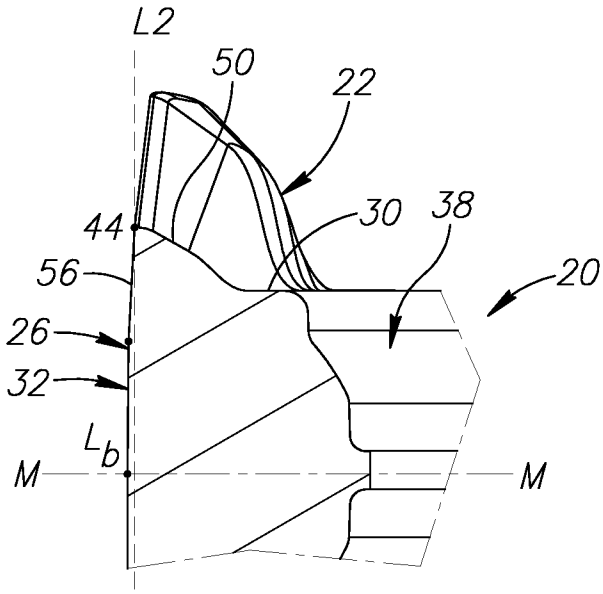

FIG.6

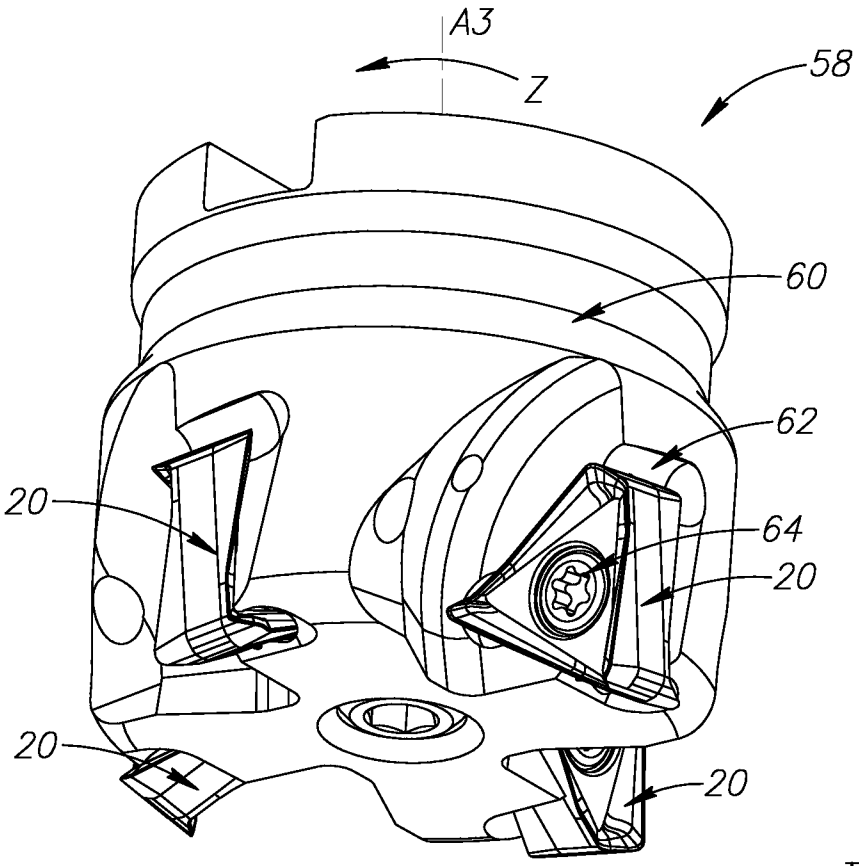

FIG.7

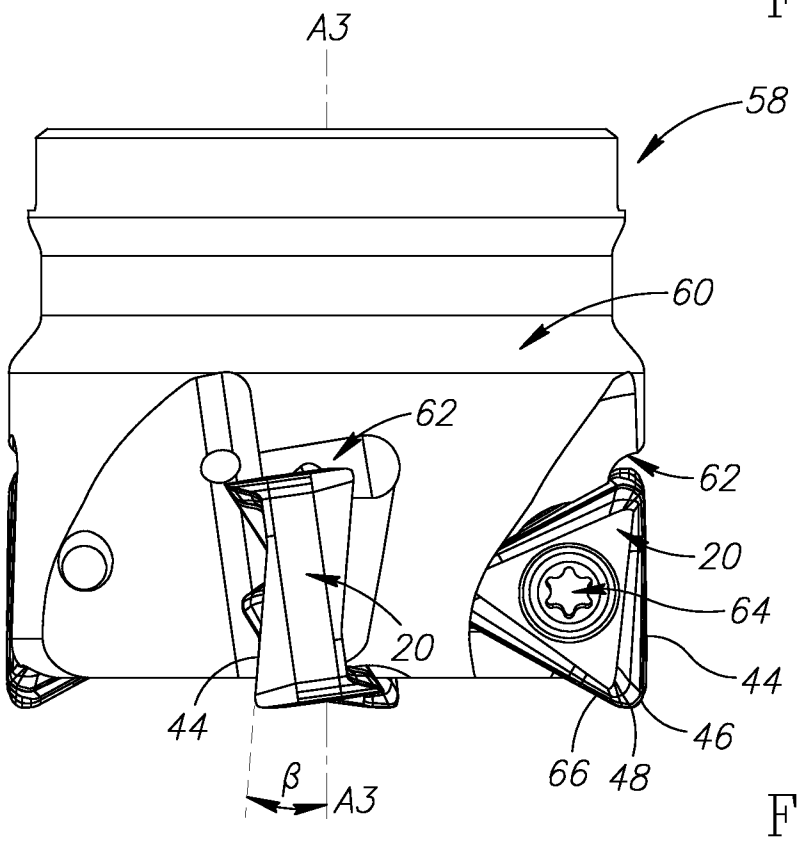

FIG.8

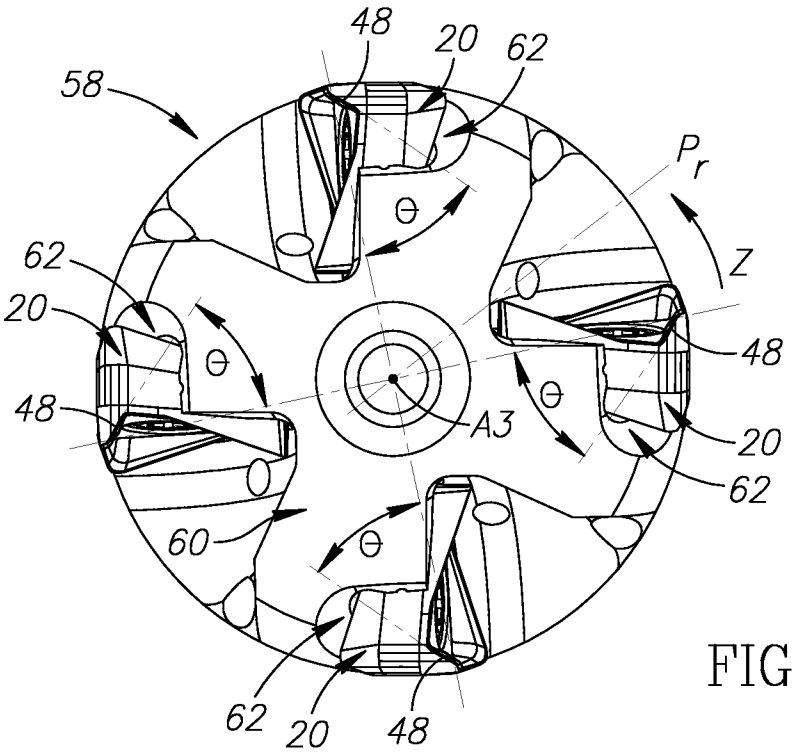
48
20
62
58
P_r
Θ
Z
62
20
48
A3
20
62
60
62
20
48

FIG.9

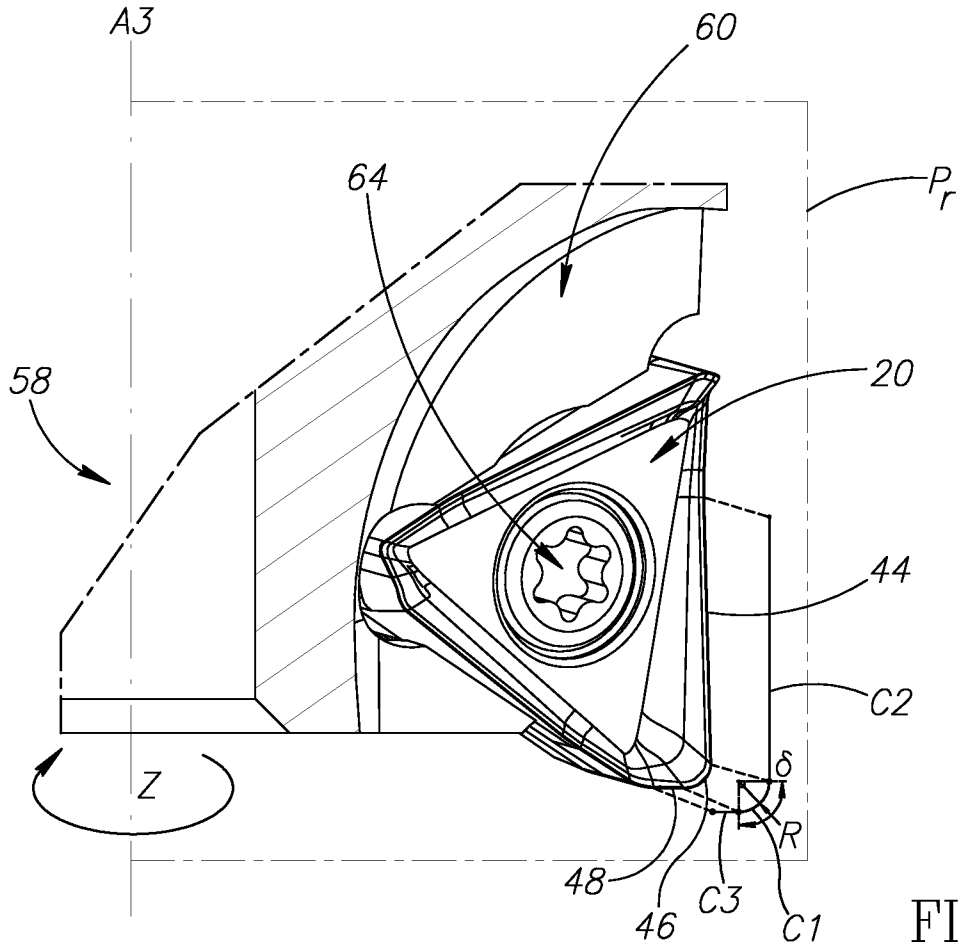
A3
60
64
P_r
58
20
44
C2
Z
δ
R
48
46
C3
C1

FIG.10

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2013/050492

A. CLASSIFICATION OF SUBJECT MATTER
INV. B23C5/22
ADD.

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)
B23C B23B

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/202839 A1 (FANG X DANIEL [US] ET AL) 12 August 2010 (2010-08-12)	1-4,6, 12,13, 15-18, 20,22, 24, 26-29, 31,32,34
A	paragraph [0042] paragraph [0031] paragraph [0039]	8-11,33

A	US 2007/003384 A1 (SMILOVICI CAROL [IL] ET AL) 4 January 2007 (2007-01-04) paragraph [0051]; figures paragraph [0046]	1

A,P	US 2013/004251 A1 (HAUSMANN MARTIN [DE] ET AL) 3 January 2013 (2013-01-03) figures	1-34

☐ 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	Date of mailing of the international search report
30 September 2013	08/10/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rabolini, Marco

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IL2013/050492

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010202839 A1	12-08-2010	CA 2749711 A1	19-08-2010
		CN 102361719 A	22-02-2012
		EP 2396133 A1	21-12-2011
		TW 201043365 A	16-12-2010
		US 2010202839 A1	12-08-2010
		WO 2010093488 A1	19-08-2010
US 2007003384 A1	04-01-2007	AT 464143 T	15-04-2010
		AU 2006264382 A1	11-01-2007
		BR PI0612116 A2	04-09-2012
		CA 2613661 A1	11-01-2007
		CN 101213045 A	02-07-2008
		EP 1899100 A1	19-03-2008
		ES 2340198 T3	31-05-2010
		IL 169491 A	15-06-2009
		JP 2008544872 A	11-12-2008
		KR 20080019248 A	03-03-2008
		NZ 563997 A	30-04-2010
		US 2007003384 A1	04-01-2007
		US 2007224006 A1	27-09-2007
		WO 2007004206 A1	11-01-2007
		ZA 200711127 A	30-09-2009
US 2013004251 A1	03-01-2013	CN 102848001 A	02-01-2013
		DE 102011105978 A1	03-01-2013
		US 2013004251 A1	03-01-2013