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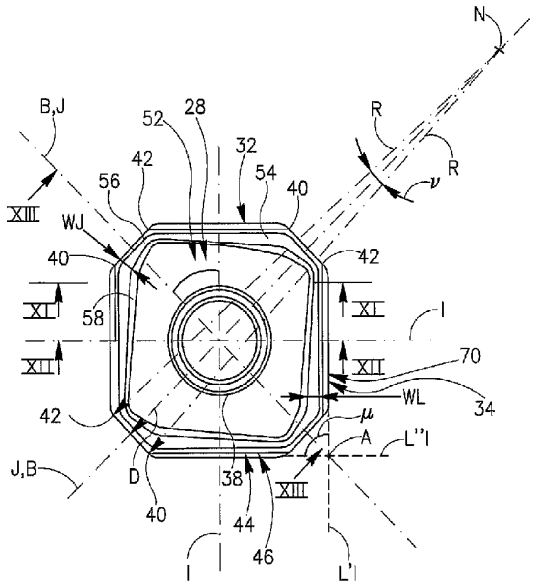

(57) Abstract: A double-sided reversible and indexable cutting insert comprises identical opposing first and second end faces (28) and a peripheral side surface (32) extending therebetween and a clamping through-bore (38) extending between, and opening out to, the first and second end faces, the cutting insert having a median plane extending between the first and second end faces, a through-bore axis extending perpendicularly through the median plane, and an Y-fold rotational symmetry about the through-bore axis; the peripheral side surface comprising Y major side surfaces (34) and Y minor side surfaces, each minor side surfaces interconnecting two adjacent major side surfaces (34); each minor side surface is a section of a single cylindrical surface having a given radius (R), the given radius (R) is greater than a minor side surface distance (D) of each minor side surface from the through-bore axis.

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CUTTING INSERT

FIELD OF THE INVENTION

The present invention relates to a double-sided, indexable and reversible cutting insert.

BACKGROUND OF THE INVENTION

Such cutting inserts are generally provided with curved corners. US 6,196,771 discloses a cutting insert having first and second side faces. Each side face includes a pair of minor cutting edges at each corner of the insert. The two minor cutting edges are located on two opposing sides of a 10 corner bisector **B**, together forming an obtuse inner angle of about 1700, and are mirror-imaged about the bisector **B**. Two major cutting edges intersect respective ones of the minor cutting edges whereby each major cutting edge and its associated minor cutting edge together form a cooperating pair of cutting edges. There are two such cooperating pairs at each corner of each side 15 face, whereby the insert has at least sixteen cooperating pairs. During a milling operation the insert is oriented so that only one cutting corner engages a work-piece, and only one of the cooperating pairs of cutting edges of that cutting corner is operative. Only half of the major cutting edge of each cooperating pair is effective. The minor cutting edge of the operative cooperating pair of cutting edges constitutes a wiper edge, by being arranged parallel to the surface of the work-piece, that is perpendicularly to an axis of rotation of a milling tool in which the cutting insert is mounted.

A drawback of these known inserts is that the minor cutting edge of each cooperating pair has a constant setting angle during the machining of the work-piece. Positioning deviation of the cutting insert relative to a cutter body of a milling cutter in which the cutting inserts are mounted, or axial bending of the milling cutter (which may occur under demanding machining conditions) may result in either a wiper corner adjacent the main cutting edge, or a wiper corner distal the main cutting edge of the cooperating pair cutting into the work-piece face, and thereby marring the face of a

work-piece being milled.

US 5,032,049 discloses an indexable cutting insert for face milling of engine blocks of cast iron. The insert has two opposing, substantially identical, generally square-shaped upper and lower surfaces which are perpendicularly connected by four side surfaces. Two adjacent side surfaces connect to each other via a smoothly rounded corner. The radius of the corner R is 1/4 to 1/8 of a length X of the insert, and therefore the setting angle gets close to zero degrees during machining of the engine block when the insert gets close to the border line of the work piece. The corner of the cutting insert serves in machining the shoulder of a work-piece, as well as in finishing the face of the work-piece during the last pass of the milling cutter.

It is desired therefore to provide an improved cutting insert. Such a cutting insert may be used for metal cutting operations, in general, and for 450 shoulder face-milling operations, in particular.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided a double-sided reversible and indexable cutting insert comprising identical opposing first and second end faces and a peripheral side surface extending therebetween. A clamping through-bore extends between, and opens out to, the first and second end faces. The cutting insert has a median plane extending between the first and second end faces and a through-bore axis extending perpendicularly through the median plane. The cutting insert has a Y-fold rotational symmetry about the through-bore axis. The peripheral side surface comprises Y major side surfaces and Y minor side surfaces, each minor side surfaces interconnecting two adjacent major side surfaces. Each minor side surface is a section of a single cylindrical surface having a given radius; the given radius is greater than a minor side surface distance of each minor side surface from the through-bore axis.

Preferably, each minor side surface has an associated minor surface axis extending parallel to the through-bore axis.

Further preferably, in an end view of the cutting insert, the minor side surface subtends a minor central angle of less than 15°.

Yet further preferably, the minor central angle is less than 5°.

Generally, the peripheral side surface meets the first and second end faces each at a continuous peripheral edge. Each peripheral edge comprises Y major edges and Y minor edges. Each major edge is formed at an intersection of an associated major side surface and a respective one of the first and second end faces. Each minor edge is formed at an intersection of an associated minor side surface and a respective one of the first and second end faces, and interconnects two adjacent major edges.

If desired, each minor edge extends between a raised corner, formed at a meeting of the minor edge with a preceding major edge, and a lowered

corner, formed at a meeting of the minor edge with a following major edge. The raised corner is disposed farther from the median plane M than the lowered corner.

If further desired, the through-hole axis and the minor side surface axis define a bisector plane bisecting the minor side surface. The bisector plane and the median plane define a minor axis about which the minor side surface has 180° rotational symmetry.

generally, two adjacent major median lines formed at intersections of the median plane with each of two adjacent major side surfaces, respectively, meet at an apex located on the minor axis of the minor side surface interconnecting the two adjacent major side surfaces.

Typically, the median plane intersects each minor side surface at a minor median line.

Preferably, each major median line is a straight line.

Further preferably, the minor axis bisects an internal major angle defined by the two adjacent major median lines.

If desired, each major side surface comprises a median surface extending transversely away from a major median line formed at an intersection of the median plane with the major surface, towards the first and second major edges.

If further desired, each major side surfaces comprises first and second support surfaces extending from the median surface towards the respective one of the first and second end faces.

If yet further desired, each major side surfaces comprises first and second primary relief surface extending transversely the major edge adjacent the respective one of the first and second end faces towards the support surface.

Preferably, the first and second support surfaces form each an acute internal support angle with the median plane, the first and second relief surface

form each an acute internal relief angle with the median plane, and the internal support angle is equal to, or greater than, the internal relief angle.

Further preferably, the internal relief angle is largest adjacent the lower corner and smallest adjacent the raised corner of the major edge.

Generally, the minor side surface is perpendicular to the median plane.

If desired, in a major side view of the cutting insert, a major side line parallel to the major median line and passing through the lowered corner is longer than the major median line.

If further desired, in a minor side view of the cutting insert, a minor side line parallel to the minor median line and passing through the lowered corner is shorter than the minor median line.

The present invention provides the following preferred advantages:

because the entire length of each minor edge constitutes a wiper edge, positional deviation of the cutting insert in the insert pocket may not lead to reduced cutting performances, so that the wiper edge may be able to continue machining the work-piece face, substantially without compromising the smoothness of the work-piece face and to the quality of the finished product;

peripheral surfaces of cutting inserts are often ground to reduce positioning deviation and to achieve a high quality finished product; however, the cutting insert of the present invention is capable of reducing the effects of positional deviation without necessitating grinding of the peripheral side surface.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention and to show how the same may be carried out in practice, reference will now be made to the accompanying drawings, in which:

Fig. 1 is a perspective view of a milling cutter having a cutting insert in accordance with the present invention mounted therein;

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

Fig. 3 is a top view of the cutting insert shown in Fig. 2;

Fig. 4 is a major side view of the cutting insert shown in Fig. 2;

Fig. 5 is a minor side view of the cutting insert shown in Fig. 2;

Fig. 6 is a section view of the cutting insert, taken along the line **XI - XI** in Fig. 2;

Fig. 7 is a section view of the cutting insert, taken along the line **XII - XII** in Fig. 2;

Fig. 8 is a section view of the cutting insert, taken along the line **XIII - XIII** in Fig. 2;

Fig. 9 is a perspective view of an insert pocket of the milling cutter shown in Fig. 1;

Fig. 10 is a front view of the of the milling cutter shown in Fig. 1;

Fig. 11 is a front view of the of the milling cutter shown in Fig. 1;

Fig. 12 is a radial side view of the of the milling cutter shown in Fig. 1, taken perpendicularly to the radial plane **P** in Fig. 10;

Fig. 13 is a detail view showing a wiper edge of the cutting insert mounted in a correct position in the insert pocket of the cutter tool shown in Fig. 11;

Fig. 14 is a detail view of the wiper edge of the cutting insert shown in Fig. 13, mounted in a deviated position.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Attention is first drawn to Fig. 1. A cutting insert **20** in accordance with the present invention is secured to a cutter body **22** of a rotary milling cutter **24** by a clamping screw **26**. The cutting insert **20** is of a double-sided, indexable and reversible type, and is generally adapted to perform face- and 45° shoulder-milling a work-piece (not shown).

Attention is now drawn to Figs. 2 to 5. The cutting insert **20** has identical and opposing first and second end faces **28, 30**. In an end view of the cutting insert **20**, best shown in Fig. 4, each of the identical first and second end faces **28, 30** is of a general form of a square having curved corners. A peripheral side surface **32** extends between the opposing first and second end faces **28, 30**. The cutting insert is of a negative type and therefore the peripheral side surface **32** is generally perpendicular to both end faces **28, 30**. The peripheral end surface **32** has four identical major side surfaces **34** of a generally parallelogrammatic shape, and four identical minor side surfaces **36**, also of a general parallelogrammatic shape. Each minor side surface **36** interconnects two adjacent major side surfaces **34**.

A given major side surface **34** has 180° rotational symmetry about given major axis **I** associated therewith and extending generally perpendicularly therethrough. Similarly, a given minor side surfaces **36** has 180° rotational symmetry about given minor axis **J** associated therewith and passing generally perpendicularly therethrough. The major and minor axes **I, J** are co-planar and intersect at an insert center **C** to define an insert median plane **M**. A given major axis **I** defines an axis angle α of 45° with a given minor axes **J**.

The cutting insert **20** is provided with a clamping through-bore **38** extending between, and opening out to, the first and second end faces **28, 30**.

The clamping through-bore **38** is adapted for receiving the clamping screw **26**. The clamping through-bore **38** has a through-bore axis **T** extending perpendicularly to the median plane **M** through the insert center **C**, so that the first and second end faces **28, 30** each have 90° rotational symmetry about the through-bore axis **T**.

The first and second end faces **28, 30** have each four raised corners **40** and four lowered corners **42**. The raised corners **40** of each of the first and second end faces **28, 30** lie in a first and second end planes E_F, E_S, respectively. The median plane **M** is parallel to, and lies midway between, the first and second end planes E_F, E_S. The lowered corners **42** are closer to the median plane **M** than the raised corners **40**.

The major and minor side surfaces **34, 38** are each intersected by the median plane **M** to form major and minor median lines L_I, L_J, respectively. As best shown in Fig. 4, a major side lines S_I lying on the major side surface **34** and extending from the lowered corner **42** parallel to the major median line L_I is longer than the major median line L_I. As best shown in Fig. 5, a minor side lines S_J lying on the minor side surface and extending from the lowered corners **42** parallel to the minor median line L_J is shorter than the minor median line L_J.

As is best shown in Fig. 3, imaginary extensions of the major median lines L_I', L_I'' of two adjacent major side surfaces **34** meet at an apex **A** to define an internal corner angle **μ**. The apex **A** lies on the minor axis **J** associated with the minor side surface **36** extending between the adjacent major side surfaces **34**. In a particular embodiment, the corner angle **μ** is a right angle. A bisector plane **B** passes through the through-bore axis **T** and the respective minor axis **J** extending perpendicularly to the median plane **M** to bisect the corner angle **μ**.

Each minor side surfaces **36** is a section of a single cylindrical surface extending transversely to the median plane **M**. Each minor side surface **36** has a minor surface radius **R** extending thereto from an associated minor surface axis **N** lying in the associated bisector plane **B** parallel to the through-bore axis **T**. The minor side surface **36** intersects the associated minor axis **J** at a minor surface distance **D** from the insert center **C**. Generally, the minor surface radius **R** is two to twelve times greater than the minor surface distance **D**. In the particular embodiment, the minor surface radius **R** is approximately four times greater than the minor surface distance **D**. The minor side surfaces do not all conform to the same cylindrical surface. The minor side surface **36** subtends an acute minor central angle **v**, preferably of less than 15°. In a non-binding example, the minor central angle **v** is approximately 4° 30'.

The first and second end faces **28**, **30** each intersect the peripheral side surface **32** at a peripheral edge **44**. The peripheral edges **44** have each four major edges 46 associated with the adjacent major side surface **34**, and four minor edges **48** associated with the adjacent minor side surface. In the particular embodiment, a given major edge **46** extends between given lowered corner **42** and given raised corner **40**, and a given minor edge extends between given raised corner **40** and given lowered corner **42**. Each of the major and minor edges **46**, **48** may constitute major and minor cutting edges, respectively. The particular embodiment has four major cutting edges and four minor cutting edges associated with each of the first and second end faces **28**, **30**, for a total of eight major and eight minor cutting edges.

The first and second end faces **28**, **30** have each a peripheral rake surface **50** extending in an inward direction of the cutting insert from the respective peripheral edge **44** towards an end abutment surface **52**. The end abutment surfaces **52** may be generally flat, and substantially parallel to each

other and to the median plane **M**. In the end view of the cutting insert, the end abutment surfaces **52** has a general form of a square having beveled corners, which is rotated relatively to the respective end face **28**, **30**. The peripheral rake surfaces **50** comprise each four major rake surfaces **54** associated with the major edges **46** and four minor rake surfaces **56** associated with the minor edges **48**. The major and minor rake surfaces **54**, **56** have major and minor rake widths W_I, W_J, respectively, defined in directions transverse to the associated major and minor edges **46**, **48**, respectively. The major rake width W_I increases from a minimal major rake width adjacent the lowered corner **42** to a maximal major rake width adjacent the raised corner **40** of the respective major edge **46**, while the minor rake width W_J decreases from a maximal minor rake width adjacent the raised corner **40** to a minimal minor rake width adjacent the lowered corner **42** of the respective minor edge **48**.

Peripheral rake steps **58** are formed between the peripheral rake surfaces **50** and the respective end abutment surface **52**. The rake step **58** extends from the end abutment surface **52** transversely to the median plane **M** to a step height H_S. The step height H_S increases gradually from a minimal step height adjacent the lowered corner **42** to a maximal step height adjacent the raised corner **40**. In the particular embodiment, the minimal step height is zero.

The major side surfaces **34** comprise each first and second primary relief surfaces **62**, **64** adjacent each of the first and second end surfaces **28**, **30**, respectively. Each of the first and second primary relief surfaces **62**, **64** extends from the adjacent major edge **46** towards the major median line L_I. First and second side abutment surfaces **66**, **68** extend along each major side surface **34** away from the first and second primary relief surfaces **62**, **64**, respectively, towards a substantially planar side median surface **70** extending therebetween generally perpendicularly to the median plane **M**.

Attention is now drawn to Figs. 6 and 7. In each major cross section of the cutting insert, taken in a plane generally perpendicular to a given major side surface **34**, the first and second primary relief surfaces **62, 64** may be straight, or they may be convexly curved. The major rake surfaces **54** may be straight, or they may be concavely curved. First and second primary relief lines $\mathbf{F_F}$, $\mathbf{F_S}$ tangent to the first and second primary relief surfaces **62, 64**, respectively, at the respective major edge **46** form each an acute interior relief angle φ with the median plane **M**. The relief angle φ may be constant or may vary along the major edge. The variation of the relief angle φ may be in accordance to any desired definition. The first and second side abutment surfaces **66, 68** form each an acute side abutment angle σ with the median plane **M**. The side abutment angle σ may be generally constant along the major side surface **34**, and is generally equal to, or greater than, the relief angle φ. In the particular embodiment, the primary relief angle φ is equal to the side abutment angle σ adjacent the lower corner **42**, and decreases along the major edge **46** towards the raised corner **40** in such a way so as to define a helically twisting primary relief surface **62, 64**. As is best shown in Fig. 8, in each minor cross section of the cutting insert **20**, taken in a plane generally perpendicular to a given minor side surface **36**, the minor side surface 36 is perpendicular to the median plane **M**.

Attention is now drawn to Figs. 9 to 12. The milling cutter **24** is rotatable about an axis of rotation **X** defining a front-to-rear direction and a direction of rotation **Z**, and has four cutting inserts **20** in accordance with the present invention mounted each in an insert pocket **72** provided at a cutter front end **74** of the cutter body **22**. It should be noted that directional terms appearing throughout the specification and claims, e.g. “front”, "rear", etc., (and derivatives thereof) are for illustrative purposes only, and are not intended to limit the scope of the appended claims. The insert pocket **72** comprises

adjacent inner and outer walls **76**, **78**, generally transverse to a pocket base **80**. The outer wall **78** is provided with an outer location surface **82** and the inner wall **76** is provided with front and rear location surfaces **84**, **86** located on either side of a central recessed region **88** of the inner wall **76**. The pocket base **80** is provided with a threaded bore **90** for receiving the clamping screw **26** in order to secure the cutting insert **20** in the insert pocket **72**.

When the cutting insert **20** is secured in the insert pocket **72**, one of the first and second end faces **28**, **30**, e.g., the first end face **28**, is positioned to face generally tangentially forwardly in the direction of rotation **Z** of the milling cutter, and constitutes an operative end face **92**. The second end face **30** constitutes a supporting end face (not shown), and is positioned with the respective end abutting surface **52** abutting the pocket base **80**. A front outer major edge **96** of the operative end face **92** constitutes an operative major cutting edge **98**, while a front minor edge **100** of the operative end face **92** constitutes an operative minor cutting edge **102** associated with the operative major cutting edge **98**. The first side abutment surface **66** of an inner rear major side surface (not shown), located adjacent the operative end face **92** and opposite the operative major cutting edge **98**, abuts the front and rear location surfaces **84**, **86**. The first side abutment surface **66** of an outer rear major side surface (not shown) adjacent the operative end face **92** and located adjacent the operative major cutting edge **98** abuts the outer location surface **82** of the insert pocket **72**.

The cutting insert **20** and the milling cutter **24** shown in the figures may be used to face-mill a work-piece (not shown), machining a 45° shoulder on the work-piece face, and therefore the cutting insert **20** is located in the insert pocket **72** so that, when the milling cutter **24** is rotated about the axis of rotation **X**, the operative major cutting edge **98** describes a frustoconical envelope having a generator line **G** forming a generator angle **η** of generally

45° with the axis of rotation **X**. In order to provide a high-quality work-piece face relatively free from machining marks or blemishes, the operative minor cutting edge **102** functions as a wiper edge **106** adapted to machine a flat face on the work-piece at 90° to the axis of rotation **X** of the milling cutter **24**. The operative major cutting edge **98** forms a positive major axial rake angle γ_A with a radial plane **P** passing through a raised corner **40** thereof and through the axis of rotation **X** of the milling cutter **24** (best shown in Fig. 12).

The cutting insert **20** shown in the figures may be indexed in the insert pocket **72** about its through-hole axis **T** in four steps of 90°, each indexing step positioning a fresh major edge **46** as the operative major cutting edge **98**. The cutting insert **20** may additionally be reversed so that the first end face **28** may become the supportive end face (not shown) and the second end face **30** may become the operative end face **92**, providing four additional fresh major edges **46** which can be indexed to the position of the operative major cutting edge **98**. Generally, each of the major and minor edges **46**, **48** constitutes "full effective" cutting edges, i.e., the entire extent of each of the major and minor edges is capable of performing machining operations in a given position of the cutting insert **20**.

The cutting insert **20** in accordance with the present invention is preferably manufactured by form-pressing or injection molding and sintering of metallurgical, ceramic or cermet powders. The peripheral side surface **32** of the cutting insert **20** may be ground to increase positioning accuracy thereof in the insert pocket **72**, which may be desirable in milling a smooth, high-quality face of the work-piece. However, in accordance with the present invention, it may not be necessary to grind the peripheral side surfaces **32** while maintaining desired smoothness and quality of the milled face of the work-piece.

Attention is directed to Figs. 13 and 14, showing the cutting insert in accordance with the present invention machining the work-piece face **108**

while being secured in the milling cutter in a correct position (Fig. 13) and in a deviated position (Fig. 14). In the correct position (Fig. 13), the wiper edge **106** of the cutting insert machines the work-piece face **108** at a first wiping region $\mathbf{K}_1$ located on a first wiper portion **110** extending between the bisector plane **B** and the associated operative major cutting edge **98**. However, even when mounted in the deviated position (Fig. 14), the wiper edge **106** still machines the work-piece face **108**, albeit at a second wiping region $\mathbf{K}_2$ located on a second wiper portion **112** extending from the bisector plane **B** away from the operative major cutting edge **98**.

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.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

CLAIMS:

1. A double-sided reversible and indexable cutting insert comprising identical opposing first and second end faces, a peripheral side surface extending therebetween and a clamping through-bore extending between, and opening out to, the first and second end faces, the cutting insert having a median plane M extending between the first and second end faces, a through-bore axis T extending perpendicularly through the median plane, and an Y-fold rotational symmetry about the through-bore axis;

the peripheral side surface comprising Y major side surfaces and Y minor side surfaces, each minor side surfaces interconnecting two adjacent major side surfaces; wherein

each minor side surface is a section of a single cylindrical surface having a given radius R, the given radius is greater than a minor side surface distance D of each minor side surface from the through-bore axis.

2. The cutting insert of claim 1, wherein each minor side surface has an associated minor surface axis N extending parallel to the through-bore axis.

3. The cutting insert of claim 1, wherein in an end view of the cutting insert, the minor side surface subtends a minor central angle of less than 15°.

4. The cutting insert of claim 3, wherein the minor central angle is less than 5°.

5. The cutting insert of claim 1, wherein the peripheral side surface meets the first and second end faces each at a continuous peripheral edge, each peripheral edge comprises Y major edges and Y minor edges, each major edge being formed at an intersection of an associated major side surface and a respective one of the first and second end faces;

each minor edge being formed at an intersection of an associated minor side surface and a respective one of the first and second end faces, and interconnects two adjacent major edges.

6. The cutting insert of claim 5, wherein each minor edge extends between a raised corner, formed at a meeting of the minor edge with a preceding major edge, and a lowered corner, formed at a meeting of the minor edge with a following major edge, the raised corner is disposed farther from the median plane M than the lowered corner.

7. The cutting insert of claim 1, wherein the through-hole axis and the minor side surface axis define a bisector plane B bisecting the minor side surface, the bisector plane and the median plane define a minor axis J about which the minor side surface has 180° rotational symmetry.

8. The cutting insert of claim 7, wherein two adjacent major median lines formed at intersections of the median plane with each of two adjacent major side surfaces, respectively, meet at an apex located on the minor axis of the minor side surface interconnecting the two adjacent major side surfaces.

9. The cutting insert of claim 7, wherein the median plane intersects each minor side surface at a minor median line.

10. The cutting insert of claim 8, wherein each major median line is a straight line.

11. The cutting insert of claim 10, wherein the minor axis bisects an internal major angle defined by the two adjacent major median lines.

12. The cutting insert of claim 1, wherein each major side surface comprises a median surface extending transversely away from a major median line formed at an intersection of the median plane with the major surface, towards the first and second major edges.

13. The cutting insert of claim 12, wherein each major side surfaces comprises first and second support surfaces extending from the median surface towards the respective one of the first and second end faces.

14. The cutting insert of claim 13, wherein each major side surfaces comprises first and second primary relief surface extending transversely the

major edge adjacent the respective one of the first and second end faces towards the support surface.

15. The cutting insert of claim 14, wherein the first and second support surfaces form each an acute internal support angle with the median plane, the first and second relief surface form each an acute internal relief angle with the median plane, and the internal support angle is equal to, or greater than, the internal relief angle.

16. The cutting insert of claim 15, wherein the internal relief angle is largest adjacent the lower corner and smallest adjacent the raised corner of the major edge.

17. The cutting insert of claim 1, wherein the minor side surface is perpendicular to the median plane.

18. The cutting insert of claim 8, wherein in a major side view of the cutting insert, a major side line parallel to the major median line and passing through the lowered corner is longer than the major median line.

19. The cutting insert of claim 9, wherein in a minor side view of the cutting insert, a minor side line parallel to the minor median line and passing through the lowered corner is shorter than the minor median line.

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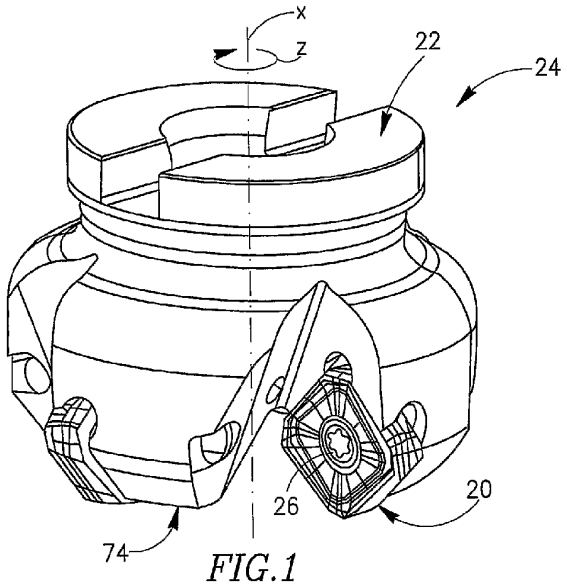
X
Z
22
24
26
20
74

FIG.1

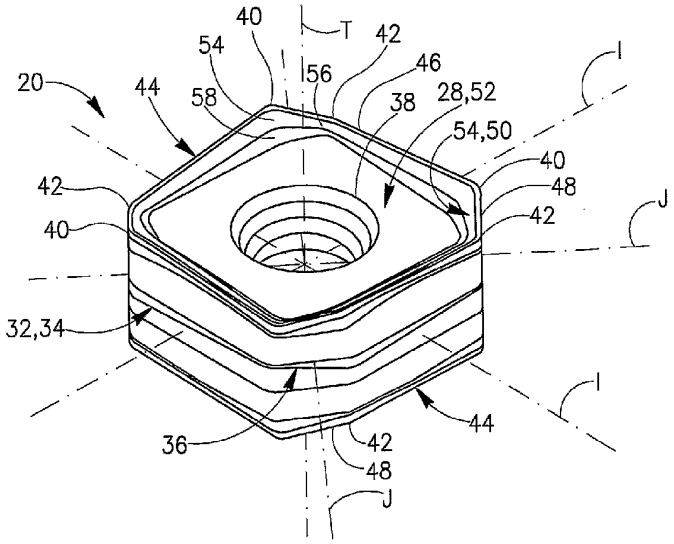
40
T
42
54
56
46
20
44
58
38
28,52
54,50
I
40
48
42
J
42
40
32,34
I
44
36
42
48
J

FIG.2

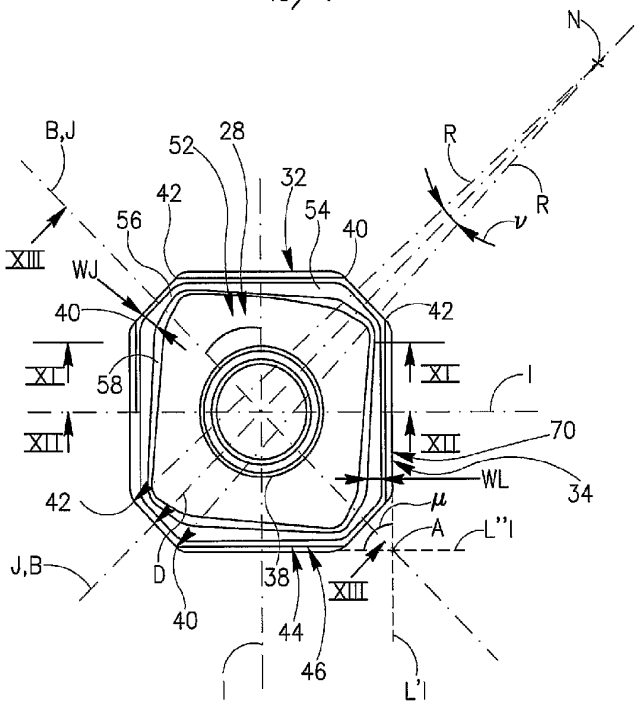
N
B,J
52
28
R
32
42
54
R
56
40
ν
XIII
WJ
40
42
XI
58
XI
I
XII
70
XII
WL
34
42
μ
A
L''I
J,B
D
38
XIII
40
44
46
L'I

FIG.3

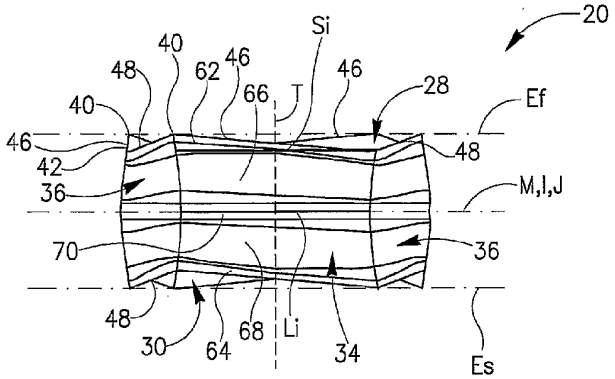
20
Si
40
48
62
46
66
T
46
28
Ef
40
46
48
42
36
M,I,J
70
36
48
30
64
68
Li
34
Es

FIG.4

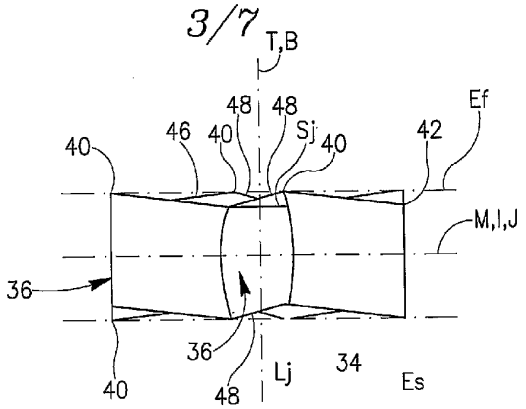
T,B
48
48
Ef
46
40
Sj
40
42
40
M,I,J
36
36
Lj
34
Es
40
48

FIG.5

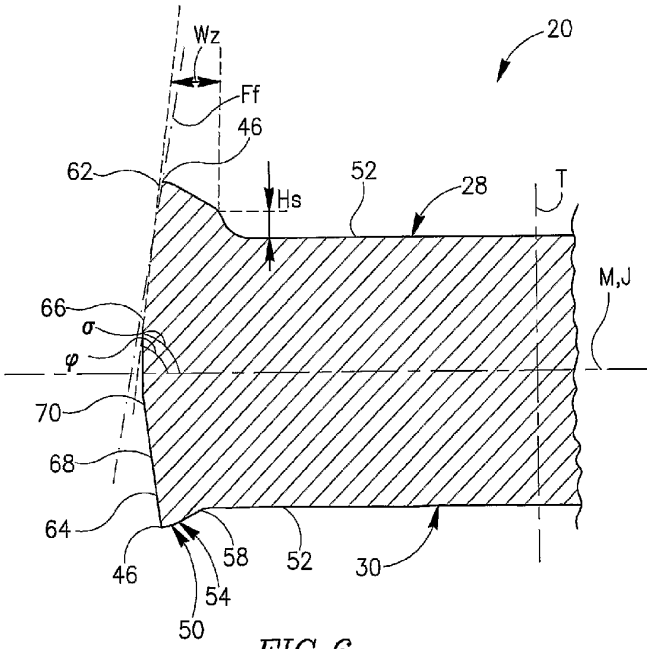
Wz
20
Ff
46
62
52
28
T
Hs
M,J
66
σ
φ
70
68
64
46
58
52
30
54
50

FIG.6

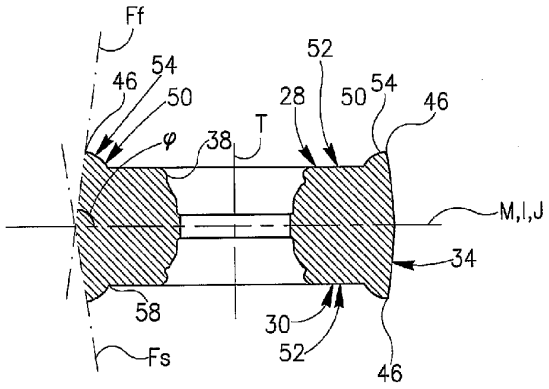
Ff
54
46
50
φ
38
T
52
28
50
54
46
M,I,J
34
58
30
52
Fs
46

FIG. 7

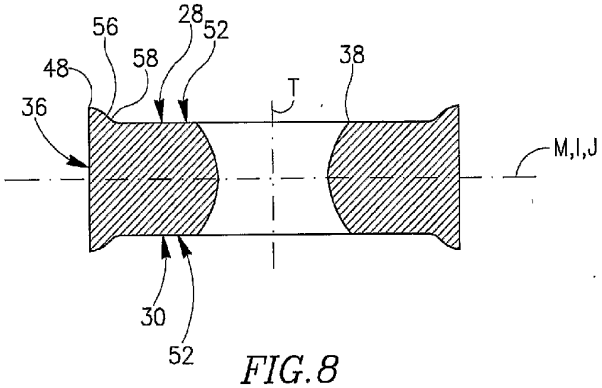
56
28
52
58
48
36
38
T
M,I,J
30
52

FIG.8

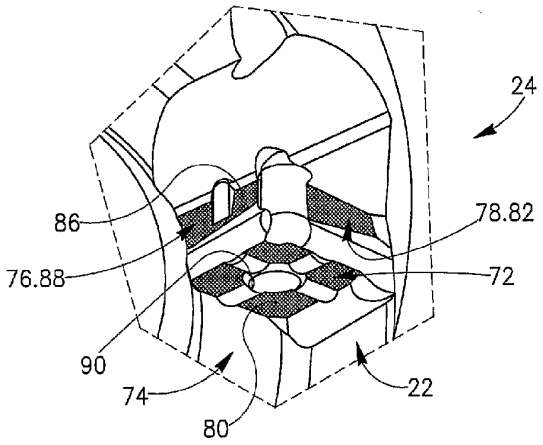
24
86
78.82
76.88
72
90
74
22
80

FIG.9

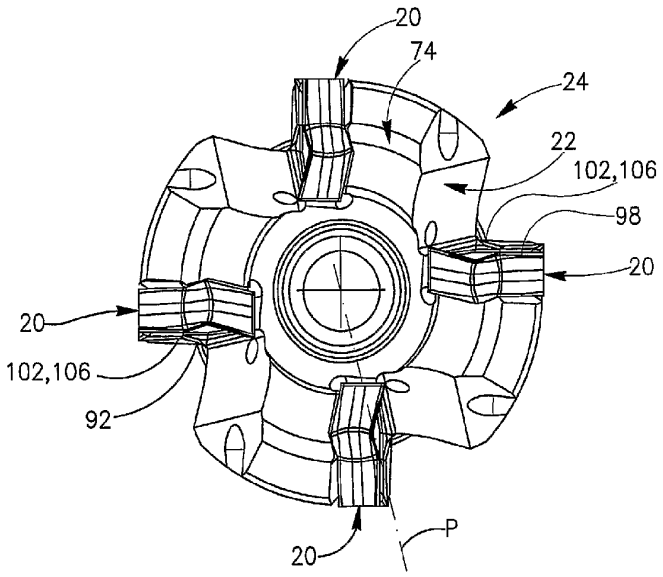
20
74
24
22
102,106
98
20
20
102,106
92
20
P

FIG.10

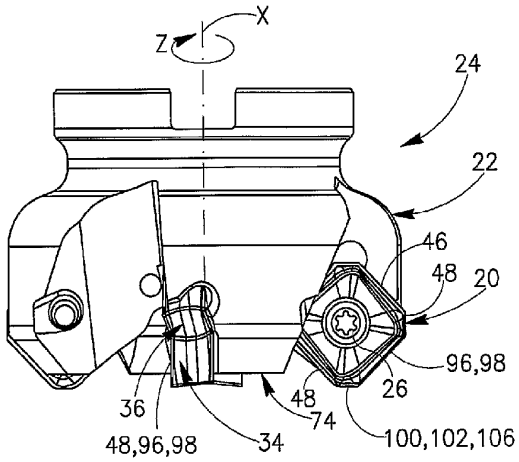
X
Z
24
22
46
48
20
96,98
26
48
74
100,102,106
36
48,96,98
34

FIG.11

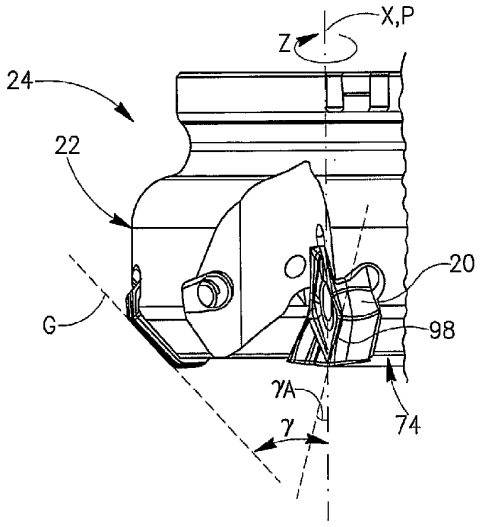
X,P
Z
24
22
20
98
G
γA
γ
74

FIG.12

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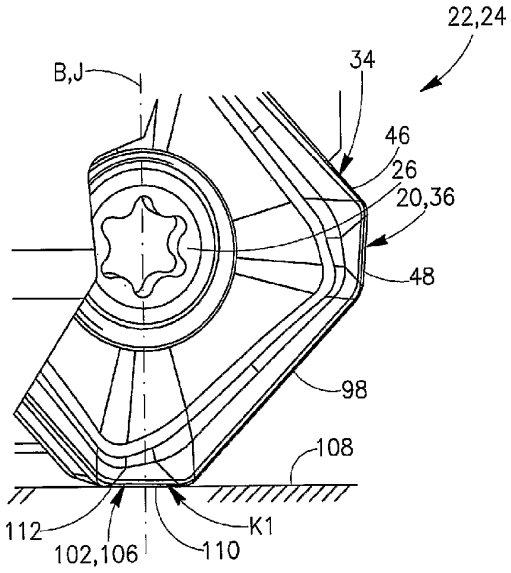

FIG.13

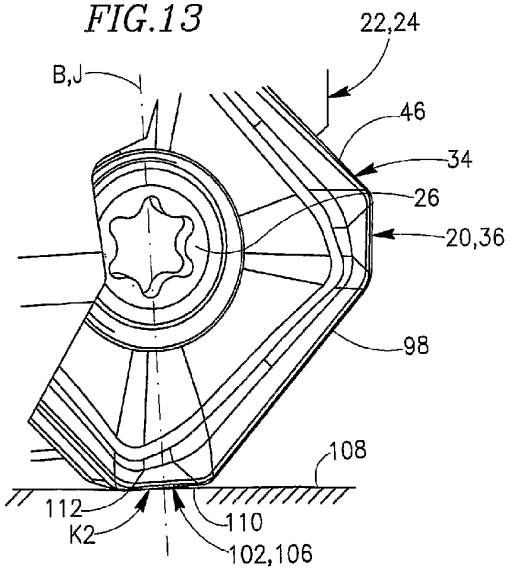

FIG.14