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B3B B20DY B20F

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US 5056963 A US 4808045 A US 4711146 A
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WPI Abstract Accession No. 86-166591/25 & JP 610100302 A

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(54) Abstract Title
A cutting insert

(57) A polygonal cutting insert comprises radiused comers 28, 30, 32 and 34, at least one pair of cutting edges comprising a lead cutting edge 20 and a finish cutting edge 22 which share a common radiused corner 28. A land 50 begins on the lead cutting edge 20 either at a point corresponding to the depth of cut of the insert when in use, or to the approximate mid-point of the lead cutting edge 20. The land 50 extends substantially parallel to the lead cutting edge 20 and optionally may intersect the finish cutting edge 22 in the area of the tangent point of the radiussed corner. The cutting edges 20 and 22 may be comprised of cemented carbide, ceramic, cubic boron nitride or a PCD diamond wafer. The insert may further be coated with a wear resistant material.

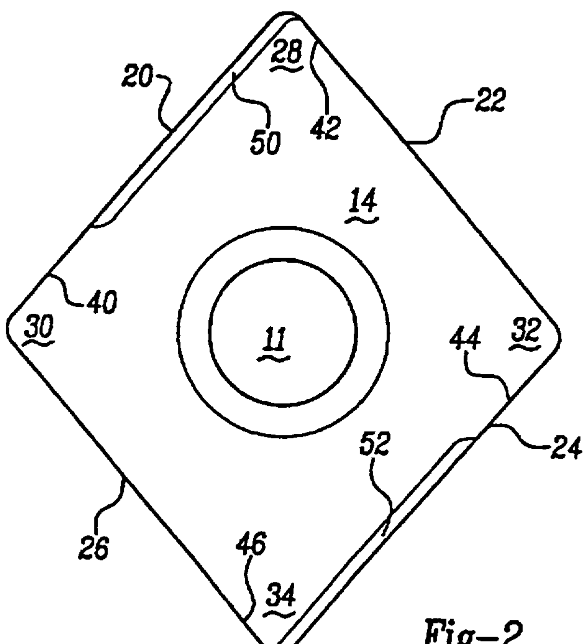

Fig-2

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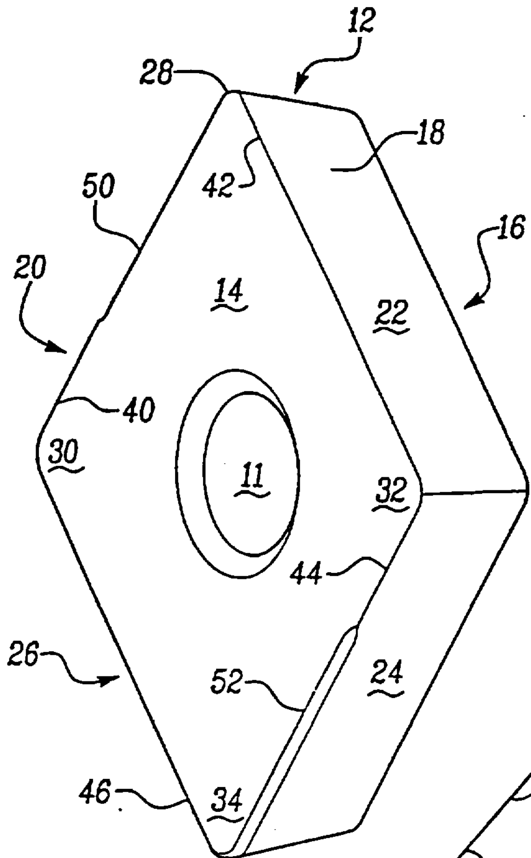
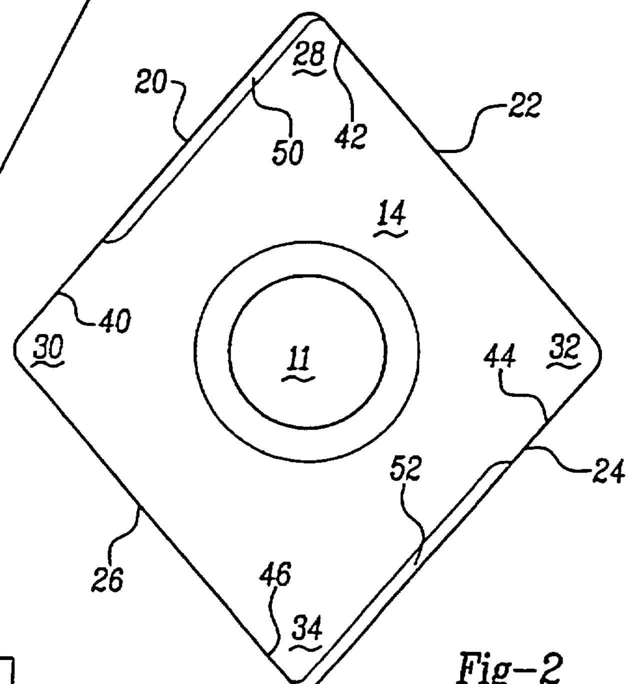
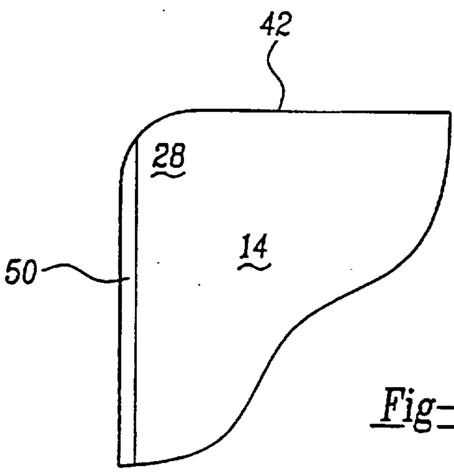


Fig–1



Fig–2



Fig–3

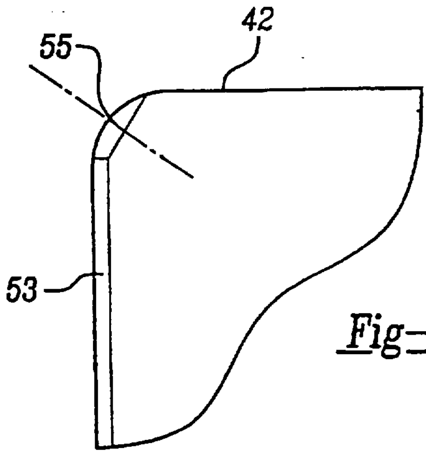


Fig-4

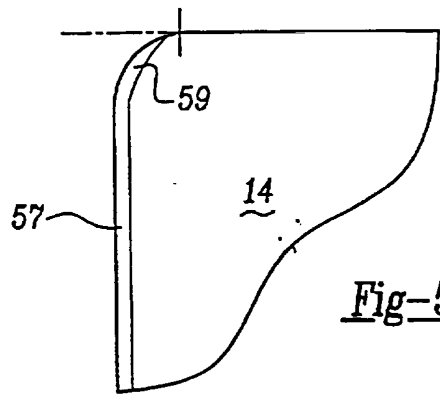


Fig-5

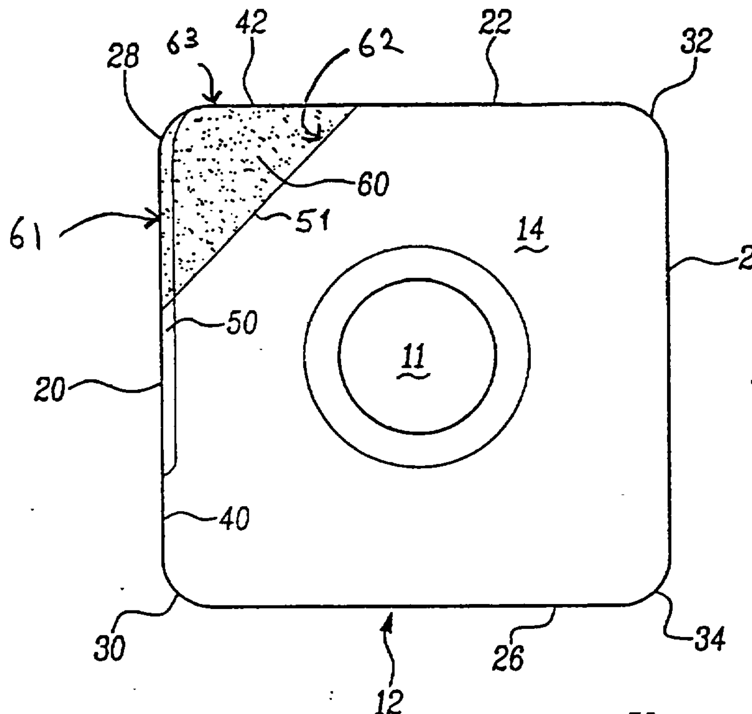


Fig-6

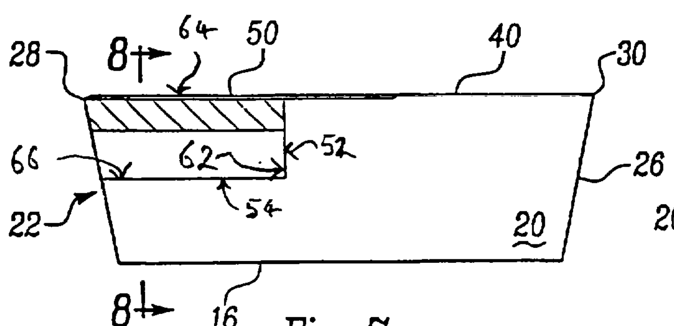


Fig-7

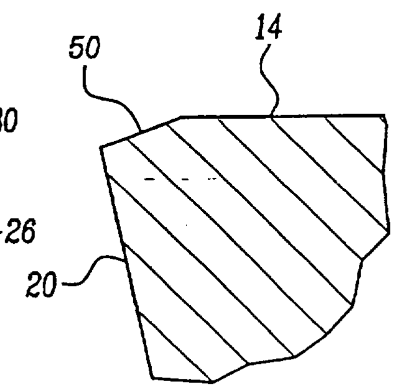
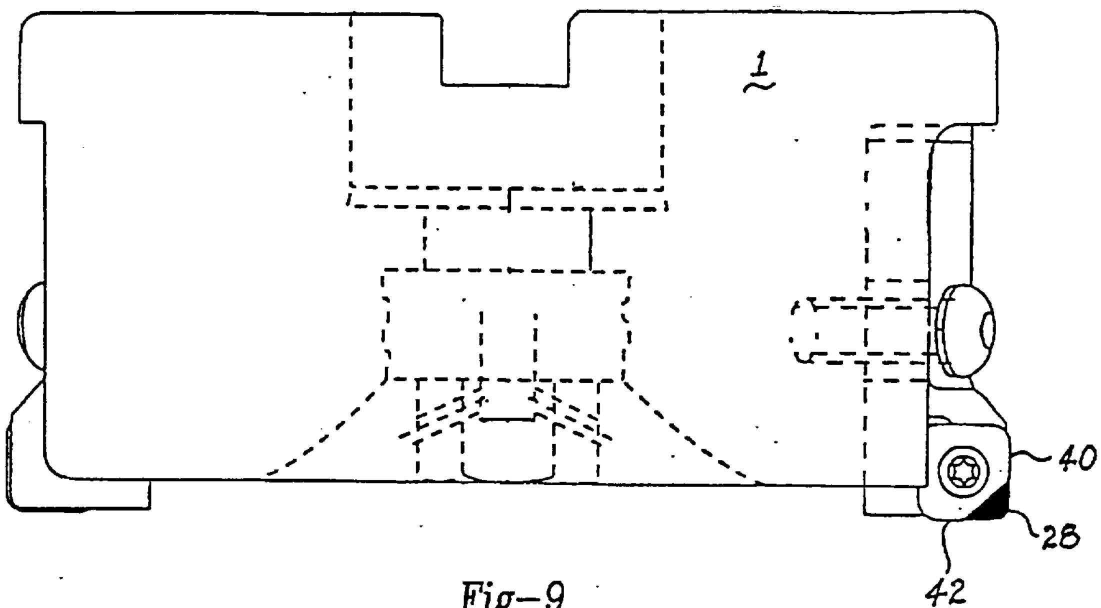
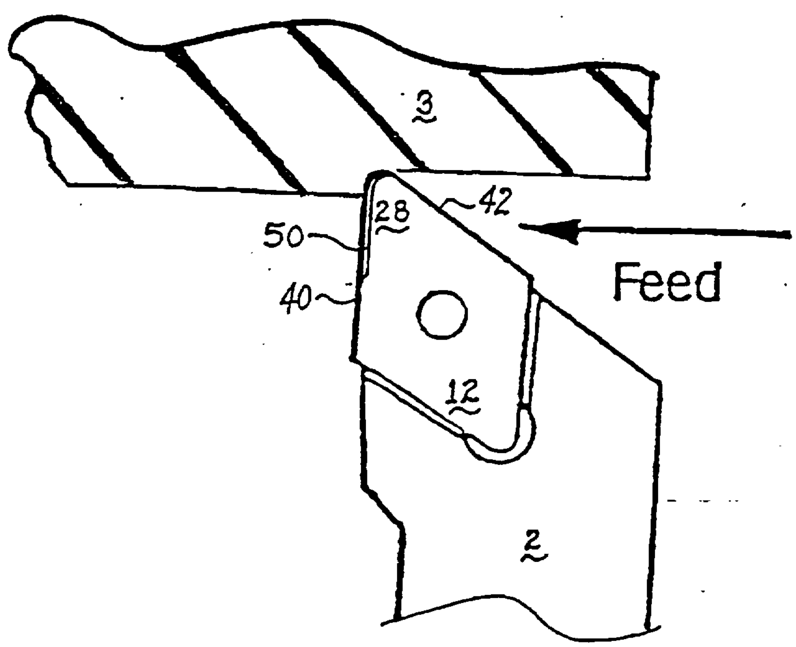


Fig-8



Fig–9



Fig–10

IMPROVEMENTS IN AND RELATING TO CUTTING TOOLS

The present invention relates to cutting tools of hard wear resistant material. In particular, the invention relates to a new cutting edge geometry for cutting inserts which combines landed and upsharp cutting edge features to provide a cutting tool having excellent finish generating properties with extended tool life.

Problem areas of excessive wear are known in the art to include the flanks and cutting edge of the insert. Areas causing particular difficulty are the nose of the insert and the cutting edge at or near the depth of the cut line. The depth of cut line is understood in the cutting tool industry as the area of the cutting edge of a cutting or insert tool where the original uncut surface of the workpiece contacts the cutting edge. The depth of cut line is generally no more than half way long the length of the cutting edge, as measured from the active cutting corner of the insert. The area of the depth of cut line is readily located empirically as the highest point along the cutting edge bearing wear marks from contact with the workpiece.

The above areas on inserts are subject to notching caused by the higher forces exerted thereon. Contact with the surface of the workpiece at the depth of cut line is particularly damaging to cutting tools during machining of age or work hardened workpieces. Notching of the insert can cause premature failure and may require replacement of the insert before the tool life of the insert has been fully utilized. Premature failure of the cutting tool can also damage the workpiece being machined, causing increased costs.

Some manufacturers have attempted to alleviate these problems by applying a T-land around the entire cutting edge of inserts. However, T-landed inserts have the disadvantage of lacking an up-sharp cutting edge. "Up-sharp" cutting edges formed by the intersection of the top face and flank of an insert, generally lack a cutting land, but may exhibit a height hone. The up-sharp cutting edge is one of the features which create improved surface finish. Adding a T-land destroys the up-sharp edge and results in loss of the finishing properties that are most desirable in certain inserts. Diamond inserts are a particular problem for insert manufacturers in this area. The prior art insert manufacturers have been forced to balance surface finish against tool life in attempts to achieve a satisfactory diamond insert. Applicants have surprisingly discovered a new cutting insert geometry that provides excellent surface finish generation without sacrificing tool life, which geometry is applicable to diamond and other similar materials.

It is, therefore, an object of this invention to provide an insert design which provides excellent finishing properties and extra long tool life. A more particular object of the invention is to provide the same advantages in diamond and other extremely hard but somewhat brittle materials used in the metal cutting industry, e.g. ceramics, cubic boron, nitride, cemented carbide, ceramic.

The invention provides a cutting insert as defined in any one of Claims 1, 9 or 13.

Further preferred features and advantages of the invention will become apparent from the following description and the dependent claims.

The invention is illustrated by way of example in the drawings, in which:

Figure 1 is a perspective view of one embodiment of an indexable cutting insert according to the present invention.

Figure 2 is a plan view of the cutting insert shown in Figure 1.

Figure 3 is a fragmentary plan view of an insert according to the present invention showing a corner exhibiting one embodiment of the T-land geometry.

Figure 4 is a view similar to that of Fig. 3 of another embodiment of the invention, showing a corner exhibiting a preferred embodiment of the T-land geometry.

Figure 5 is another view similar to that of Fig. 3, showing a corner exhibiting another preferred embodiment of the T-land geometry.

Figure 6 is a plan view of a further embodiment of an indexable cutting insert according to the present invention.

Figure 7 is a side view of the cutting insert shown in Figure 6.

Figure 8 is a fragmentary cross-sectional view of the cutting insert of Figure 7 viewed along a line shown by arrows 8-8 in Figure 7.

Figure 9 is a side view of a milling cutter shown with an insert of Figure 6 in place therein, and

Figure 10 is a diagrammatic plan view showing an insert of the invention in use in a turning tool.

In accordance with the present invention a hard wear resistant insert, generally polygonal or parallelpipedal in shape, having a selected cutting edge geometry at the corner thereof is provided. The present invention is directed to a land, preferably a T-land, applied to the cutting edges which meet at the active cutting corner of an inset of the invention. As is known in the industry, generally during use a selected one of an insert's corners acts as the active cutting corner. To more particularly identify the active cutting corner in relation to its location in the cutting tool and to the workpiece reference is made to Figures 9 and 10. Figure 9 shows an embodiment of the present invention located for use in a milling cutter. Figure 10 shows an embodiment of the present invention in use in a turning operation. In both Figures, the active cutting corner 28 can be identified as the corner having both cutting edges adjacent thereto available for contacting the workpiece. Figure 9 shows the orientation of the insert body 12 of the present invention in a toolholder 2 in relation to a workpiece 3. As can be seen from the figure, lead cutting edge 40 contacts the uncut surface of the workpiece while finish cutting edge 42 trails behind and is the last portion of the insert to contact the finished workpiece. Those skilled in the art will recognise that inserts having more than one corner provided with the cutting edge geometry of the present invention may be positioned, by indexing, to use each corner in turn as the active cutting corner.

A preferred embodiment of the present invention is shown in Figure 1. The generally polygonal indexable cutting insert 10 has a body 12 of wear resistant material, such as cemented carbide or ceramic. The body 12 may be coated with a hard water resistant material, as are known in the industry. Preferred coatings are such as diamond, boron nitride or ceramic. It is particularly preferred that the coating include an adherent, wear resistant diamond layer. Optionally, the body 12 has a central aperture 11 for accepting known holding means. The body includes a top surface 14 and a bottom surface 16, that are substantially parallel to each other and connected by a peripheral wall 18 extending therebetween. Optionally, the top and bottom surfaces may be non parallel. The peripheral wall 18 is comprised of flanks 20, 22, 24 and 26. At least two adjacent flanks form cutting edges at the intersection of said flanks with at least one of the top and bottom surfaces. Corners 28, 30, 32 and 34 are formed at the intersection of respective pairs of said flanks. In the preferred embodiment, the corners are radiused, however flatted and non radiused corners may be used.

Further description of the cutting edge geometry of the present invention will be made with reference to corner 28 in Figure 2 as the active cutting corner, as defined herein or depicted in Figures 9 and 10. A lead cutting edge 40 is formed at the intersection of top surface 14 and flank 20 and extends between corners 28 and 30. Immediately adjacent lead cutting 40 is finish cutting edge 42, formed at the intersection of top surface 14 and flank 22, and extending from corner 28 to corner 32. The cutting edges may optionally be comprised of subsidiary cutting edge portions such as wiper flats and the like.

Lead cutting edge 40 possesses a land 50 along a selected portion of its length. The land width is selected based upon parameters known in the industry, generally being selected in the range of 0.003 to 0.020 inches (0.008mm to 0.05mm). In a preferred embodiment, the land width is in the range of 0.0035 to 0.010 (0.009mm to 0.025mm) and in the most preferred embodiment, the land width ranges from 0.004 to 0.006 (0.01mm to 0.015mm).

The land 50 begins at or near the midpoint of the lead cutting edge 40 and extends around corner 28 to the finish cutting edge 42. Preferably, the land beginning point along flank 20 toward corner 30 encompasses the area on the lead cutting edge 40 that intersects the depth of cut line. Land 50 ends in the area of the tangent point of the nose radius on finish cutting edge 42, preferably before said tangent point. In the most preferred embodiment, a land extends from before the depth of cut line on the lead cutting edge around the active cutting corner and ends in the area of the finish cutting edge where the workpiece finish is generated. The area of the finish cutting edge which generates the workpiece finish is considered to be the last section of the finish edge which contains the workpiece.

Figure 3 depicts an embodiment of the invention showing one of Applicant's first developments in solving the problem of poor tool life on up sharp edges for diamond. The land 50 is substantially parallel to flank 20 and extends only along the lead cutting edge to corner 28. Addition of this geometry to the insert provide the benefit of decreasing notching at the depth of cut area, while maintaining the up sharp finish cutting edge 42. However, during testing of this geometry, portions of the corner 28 which did not have a land exhibited notching type failure.

The embodiments of Figure 4 and 5 solve the problem of notching at the nose of the insert. Figure 4 shows a detailed view of corner 28 having a preferred embodiment of the land 50 of the present invention. In this preferred embodiment, land 50 has two portions 53 and 55. First portion 53 extends substantially parallel to flank 20. Second portion 55 extends across corner 28, past the nose bisector line, at an oblique angle to flank 20. The cutting finish edge 42 is intersected by second portion 55 in the area of the tangent point to the nose radius, preferably before said tangent point. It is preferred that the angle of second portion 55 is selected to control the width of the land 50 at the corner 28 such that the cutting forces are not unnecessarily increased. Figure 5 shows a detailed view of the most preferred embodiment of the present invention. In this embodiment, land 50 is comprised of portions 57 and 59 which form a land that curves around corner 28 to end in the area of the tangent point of the nose radius, preferably before said tangent point. First portion 57 extends substantially parallel to flank 20 blending into second portion 59 in the area of corner 28. Preferably, first portion 57 maintains a constant width and angular relation to top surface 14. Second portion 59 comprises a curved land portion, preferably of diminishing width which approaches a minimum width as the land 50 approaches the tangency point of the nose radius on finish cutting edge 42. The embodiments of Figures 4 and 5 may be applied to non-radiused corners with the land 50 intersecting the finish cutting edge 42 in the area of edge designed to create the finish on the workpiece.

Figure 6 shows a second embodiment of the present invention wherein a diamond wafer 60 is brazed into a pocket of the insert body 12 to form the cutting insert 10. The body 12 has a slot 51 for positioning a diamond wafer 60 therein. The wafer 60 has an upper wafer surface 64 and a lower wafer surface 66, connected by a wafer flank 68 extending therebetween. The wafer flank 68 is comprised of flank sections 61, 62 and 63, that form wafer corners at the intersections of two flank sections. Slot 51 has abutting surfaces 52 and 54 that support wafer 60. The wafer 60 is positioned in the slot such that flank section 62 abuts surface 52 and lower wafer surface 66 abuts surface 54. Wafer 60 is secured to slot 51 by known means, such as brazing and the like, securing the abutting surfaces 52, 54, 62 and 66. Flank section 61 of the wafer forms a portion of flank 20; such coplanar relation may be achieved by known means, including grinding. Flank section 63, likewise forms a portion of flank 22 of the insert 10. Flanks 20 and 22 intersect to form corner 28. As seen in Figure 7, the upper wafer surface 64 forms part of top surface 14.

In the embodiment shown in Figure 6, the cutting insert 10 having a diamond wafer 60 secured thereto exhibits a land 50 similar to that shown in Figure 5. This land begins on insert body 12 and continues along the lead cutting edge 40 onto the diamond wafer 60 extending around radiused corner 28 to the finish cutting edge 42. Preferably, land 50 has a constant width along lead cutting edge 40 and a diminishing curved width as it approaches the tangent point of the nose radius. The land 50 ends in the area of the tangent point of the nose radius, preferably before said tangent point.

Figure 8 is a cross-sectional view of the cutting insert of Figure 7 showing the angular relation between the top surface 14 and the land 50 which in this embodiment is a T-land. The angle created by the intersection of the land 50 with the plane in which top surface 14 lies is used to describe the land angle. Preferred land angles range from approximately 5° - 40°, preferably in the range of 10° - 30°. For diamond inserts, the most preferred range is approximately 15° - 25°.

Substrates which can be provided with the selected cutting edge geometry include cemented carbide, ceramic, cubic boron nitride, diamond and other wear resistant materials used in the metal cutting industry. Diamond includes PCD and other hard wear resistant forms of diamond. Preferred substrates are those materials generally used for cutting tools having up-sharp cutting edges, as are known in the industry. Particularly preferred are cutting tools for finishing or single pass rough and finish tools that must remove material and leave an excellent surface finish.

The excellent compressive strength of diamond, enables diamond cutting tools to provide some of the tightest tolerances and smoothest surface finishes of available materials in the industry. These tight tolerances and smooth surface generation on the workpiece often make diamond inserts the tool of choice for finishing operations. Diamond also performs well in high speed machining, which is becoming more prevalent in the industry with the advent of newer machines that can be run at higher revolutions per minute. Disadvantages of prior art diamond inserts include poor tool life in certain machining applications. Diamond tooling is often used in machining applications requiring extremely hard and sharp edges. A drawback of prior art diamond inserts has been that up-sharp cutting edges are very fragile and subject to notching. In the most preferred embodiments of the present invention, the selected cutting edge geometry is applied to a tool, blade or insert having a diamond coating or a diamond wafer adhered to a substrate or a tool, blade or insert. However, any extremely hard material that is subject to brittle failure such as chipping and notching may benefit from the present invention.

The present invention will become more clear upon consideration of the following examples which are intended to be only illustrative of the present invention.

Examples

The properties of a selected cutting edge geometry according to the present invention were compared to conventional up-sharp and T-landed inserts. Applicants evaluated the tool life and flank wear in the following Examples.

Example 1

Square positive inserts of commercially available grade cemented carbide having a diamond wafer brazed thereon (designated SPMW 32.52) were selected. A comparison test was run between commercially available SPMW 32.52 prior art inserts and the present invention. Inserts of the present invention were prepared by applying a 0.004 in. (0.01mm) blended 20° T-land to SPMW 32.52 standard grade inserts using a known diamond wheel grind method. The two sets of inserts were tested in machining Cast Aluminum 380, low Silicon, having some surface scale. It will be noted from the following table that the sets of inserts formed the respective teeth of a milling cutter.

	INVENTION INSERTS	PRIOR ART INSERTS
Parts Generated per Edge	9046.00	600.00
Number of Inserts Used	90.00	1398
Cutter Diameter (in.) Cutter Diameter (mm)	4.000 10.16	4.000 10.16
Number of Teeth	6	6
Number of Edges per Insert	1	1
Feed (IPM) Feed (CM/min)	184.000 467.36	184.000 467.36
Feed per Tooth (in.) Feed per Tooth (mm)	0.0040 0.01	0.0040 0.01
Spindle Speed (RPM)	7700	7700
Cycle Time (sec.)	15	15
Width of Cut(in.) Width of Cut(mm)	4.000 10.16	4.000 10.16
Depth of Cut(in.) Depth of Cut(mm)	0.080 0.20	0.080 0.20
Surface Footage (SFM) Surface Metrage (SM/min)	8036 747	8036 747

The results of testing showed that inserts of the present invention generated more parts by a factor of ten than prior art inserts. This significant increase in production over the previously known art did not adversely affect the work piece finish generated.

Example 3

A tool life duration test of inserts of the present invention was performed under test parameters of Example 2, with the following changes:

Feed (IPM) cm/min	140.000 355.6
Feed per Tooth (in.)	0.0030 0.008
Spindle Speed (RPM)	7700
Depth of Cut (in.) (mm)	0.100-0.125 0.25 - 0.32
Surface Footage (SFM) (SM/Min)	8000 743

Under the above conditions, inserts of the present invention averaged 10,000 pieces per edge. This surprising increase in tool life over the previously known art did not adversely affect the work piece finish generated.

It is intended that the specification and examples be considered as exemplary only. The land of the present invention preferably begins at or near the depth of cut line of the lead cutting edge of the insert, and extends along said cutting edge at least as far as the active cutting corner of the insert. However, the land may extend the full length of the lead cutting edge provided it does not interfere with utilization of other corners of the insert for cutting. In a preferred embodiment, the land is applied only to the area of the depth of cut line where notching occurs. In another preferred embodiment, the land extends along the lead cutting edge past the bisector of the insert corner and ends in the area of the tangent point of the nose radius, preferably before said point. In another preferred embodiment, a T-land extends along the lead cutting edge to the insert corner and ends in the area of the point on the finish cutting edge at which the finish surface of the workpiece to be cut is generated, preferably before that point.

Other embodiments of the invention, within the scope and spirit of the following claims will be apparent to those of skill in the art from practice of the invention disclosed herein and consideration of this specification. All documents referred to herein are incorporated by reference hereby.

CLAIMS

1. A cutting insert of hard, wear resistant material comprising a body having a substantially polygonal top surface, a substantially planar bottom surface, flanks extending therebetween, respective pairs of said flanks intersecting to form corners, at least one pair of cutting edges comprising a lead cutting edge and a finish cutting edge sharing a common corner being formed by intersection of one of said top and bottom surfaces with one of said respective pairs of flanks, and a land beginning approximately in an area of the lead cutting edge that is intersected by the depth of cut line and extending along said lead cutting edge at least to said common corner, wherein a portion of said finish cutting edge remains unlanded.

2. The cutting insert of Claim 1, wherein said land comprises a first portion and a second portion, said first portion being substantially parallel to said lead cutting edge and said second portion, immediately adjoining said first portion, being curved at said common corner and intersecting said finish cutting edge in an area of said finish cutting edge designed to perform final cutting actions on a workpiece.

3. The cutting insert of Claim 2, wherein said second portion has a selected width that diminishes as said second portion extends around said common corner said width approaching minimum value at the intersection of the second portion with the finish cutting edge.

4. The cutting insert of Claim 6, wherein said land comprises a first linear portion and second linear portion, said first linear portion being substantially parallel to said lead cutting edge and said second linear portion extending across said common corner at an oblique angle to said lead cutting edge and intersecting said finish cutting edge in an area of said finish cutting edge designed to perform final cutting actions on a workpiece.

5. The cutting insert of Claim 1 wherein the common corner of the insert is radiused and said land comprises a first portion and second portion, said first portion being substantially parallel to said lead cutting edge and said second portion, immediately adjoining said first portion, being curved at said common corner and intersecting said finish cutting edge in an area of the tangent point of said radiused

corner on said finish cutting edge.

6. The cutting tool of any one of Claims 1 - 5, wherein at least one of said cutting edges is comprised of two or more subsidiary cutting edges.

7. The cutting insert of any one of Claims 1 - 6, wherein the said land comprises a T-land and said lead cutting edge and the finish cutting edge are comprised of cemented carbide, ceramic, cubic boron nitride, diamond or a combination thereof.

8. The cutting tool of any one of Claims 1 - 7 further comprising an adherent coating of hard wear resistant material.

9. A cutting insert of hard, wear resistant material comprising a body having a substantially polygonal top surface, a substantially planar bottom surface, flanks extending between said surfaces, respective pairs of said flanks intersecting to form radiused corners, at least one pair of cutting edges comprising a lead cutting edge and a finish cutting edge sharing a common corner being formed by intersection of one of said top and bottom surfaces with one of said respective pairs of flanks, and a land comprising a first portion and a second portion, said first portion beginning in an area corresponding to an approximate midpoint along the lead cutting edge between corners of the insert and extending from said midpoint area toward said common corner substantially parallel to said lead cutting edge and said second portion, immediately adjoining said first portion, being curved at said common corner and intersecting said finish cutting edge in an area of the tangent point of said radiused corner on said finish cutting edge.

10. The cutting insert of Claim 9, wherein said second portion has a diminishing width that extends around said common corner and approaches its minimum value at the intersection of the second portion with the finish cutting edge.

11. The cutting insert of Claim 9 or 10, wherein the land comprises a T-land and said lead cutting edge and the finish cutting edge are comprised of cemented carbide, ceramic, cubic boron nitride, diamond or a combination thereof.

12. The cutting tool of any one of Claims 9 - 11 further comprising an adherent coating of hard wear resistant material.

13. A polygonal cutting insert of hard, wear resistant material comprising a body having a top surface, a bottom surface and flanks extending therebetween, respective

pairs of said flanks intersecting to form corners, at least one pair of cutting edges comprising a lead cutting edge and a finish cutting edge sharing a common corner being formed by intersection of one of said top and bottom surfaces with one of said respective pairs of flanks, and a T-land beginning approximately in an area of the lead cutting edge that is intersected by a depth of cut line and extending toward said common corner along the lead cutting edge wherein at least said common corner and a portion of said body and said cutting edges is comprised of a PCD diamond wafer.

14. The cutting insert of Claim 13, wherein said land comprises a first portion and a second portion, said first portion being substantially parallel to said lead cutting edge and said second portion, immediately adjoining said first portion, being curved at said common corner and intersecting said finish cutting edge in an area of said finish cutting edge designed to perform final cutting actions on a workpiece.

15. The cutting insert of Claim 14, wherein said second portion has a selected width that diminishes as said second portion extends around said common corner said width approaching minimum value at the intersection of the second portion with the finish cutting edge.

16. The cutting insert of Claim 13, wherein said land comprises a first linear portion and a second linear portion, said first linear portion being substantially parallel to said lead cutting edge and said second linear portion extending across said common corner at an oblique angle to said lead cutting edge and intersecting said finish cutting edge in an area of said finish cutting edge designed to perform final cutting actions on a workpiece.

17. The cutting insert of Claim 13, wherein the common corner of the insert is radiused and said land comprises a first portion and a second portion, said first portion being substantially parallel to said lead cutting edge and said second portion, immediately adjoining said first portion, being curved at said common corner and intersecting said finish cutting edge in an area of the tangent point of said radiused corner on said finish cutting edge.

18. A cutting tool of any one of Claims 13 - 17, wherein at least one of the said cutting edges is comprised of two or more subsidiary cutting edges.

19. A cutting tool substantially as described herein with reference to the accompanying drawings.

The Patent Office

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INVESTOR IN PEOPLE

Application No:	GB 9828716.2	**Examiner:**	Matthew Lawson
Claims searched:	1-8 and in part 19	**Date of search:**	12 March 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): B3B; B5E (ECA, ECX)

Int Cl (Ed.6): B23B 27/14, 27/16, 27/18, 27/20

Other: Online: PAJ, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 1527091	(ZAPP) area 18 in figures 4-6.	1 at least
X	GB 888628	(NORTON) figures 1 & 2.	1 at least
X	EP 0029764 A1	(SNECMA) see WPI Abstract Accession No. 81-F4327D/24 and figures 1 & 4.	1 at least
X	US 5056963	(KAMENO) figures 1B & 5.	1 at least
X	US 4808045	(TSUJIMURA) figure 12.	1 at least
X	US 4711146	(LUNG) column 7 lines 14-48 and figures 8-16.	1 at least
X	US 4465650	(OHNO) column 7 lines 43-65 and figures 8A & 8B.	1 & 13 at least
X	WPI Abstract Accession No. 86-166591/25 & JP 610100302 A (NIPPON OILS) - see WPI & PAJ abstracts.		1 & 13 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		