

Description

This invention relates to metal cutting tools for use in parting, grooving and turning operations and, in particular, to metal cutting inserts for use with such cutting tools.

BACKGROUND OF THE INVENTION

Known cutting inserts for use with such metal cutting tools are formed with top and bottom faces and front and side relief flanks, with a cutting edge defined between the intersection of the front relief flank and the top face, the top face including a rake surface and chip forming means for suitably shaping and diverting the chips formed during the cutting operation so as to facilitate the breakage and removal thereof without damage to the workpiece and cutting tool and without danger to the tool operator.

The chip forming means are generally designed to narrow the chip, so as to ensure that in grooving or parting operations the chip flows smoothly through the cutting region and also, to some extent, to rigidize the chip so as to facilitate its subsequent deflection and compacting in spiral form and eventual breakage.

It will be realised that the entire process of chip forming, shaping and deflection, involving as it does the continuing abutment in movement of the chip with the chip forming means, is accompanied by forces which tend to resist the movement of the chip and, in order to overcome these forces, the cutting operations are accompanied by increased power requirements. There is, therefore, in consequence a relatively increased generation of heat during the cutting operation which leads to an increased heating, on the one hand, of the cutting insert and cutting tool and, on the other hand, of the workpiece.

Whilst such increased heating of the cutting insert may itself lead to increasing wear of the cutting insert and necessitate its frequent replacement, the increased heating of the workpiece can be particularly undesirable in the case of workpieces made of stress hardening materials, i.e. materials wherein excessive heating leads to the generation of undesirable stresses and these stresses, in their turn, lead to an undesirable hardening of the material. Thus, with such stress hardening materials (examples of which include stainless steel and so-called space alloys), the hardening of the material as a result of heat-induced stresses generated during an initial cutting operation, results in the hardening of the material, rendering the subsequent cutting operation more difficult, with a greater power requirement.

Thus, with such stress hardening materials, efforts should be directed in the design of the cutting tool to ensure that the cutting operation is accompanied by a minimum amount of heat and, in this connection, the heat generated during the chip forming should be reduced to a minimum.

It is known, in this connection, that the more highly positive is the cutting edge, the less heat is generated. It is, however, not possible to render the cutting edge unduly highly positive, seeing that this inevitably results in an undesirable weakening of the cutting edge and requiring its frequent replacement. The use of low feed rates, on the other hand, results in the formation of relatively thin chips and it is known that with such relatively thin chips special chip forming means have to be provided in order to ensure the effective shaping and disposal of these thin chips.

It is an object of the present invention to provide a new and improved cutting insert for use in a metal cutting tool, wherein the above-referred-to disadvantages are substantially reduced.

In US-A-4,776,733 there is disclosed a metal cutting insert having top and bottom faces and front and side relief flanks; an arcuately shaped cutting edge defined at the intersection of said front relief flank and said top face; said top face comprising a rake surface extending inwardly from said cutting edge, and a chip forming means located inwardly of said rake face; said cutting edge being concave with respect to the top face and formed with a rake angle which varies along the length of the cutting edge being more positive at its central portion than at its terminal portions; said chip forming means comprising a pair of curved deflector surfaces constituting deflector ridges, each of said deflector surfaces sloping uniformly and smoothly away from said rake surface towards a deflector peak; each deflector ridge having a front deflector surface concavely curved in an axial direction, an outer axially directed side portion which merges with an adjacent side relief flank and an inner side axially directed surface which slopes towards the bottom face while extending towards said peak; said inner side surfaces of both ridges defining between them an angle and constituting a central axially directed valley portion which extends in an axial direction along said top face between said ridges.

According to the present invention, there is provided a metal cutting insert having top and bottom faces and front and side relief flanks; an arcuately shaped cutting edge defined at the intersection of said front relief flank and said top face; said top face comprising a rake surface extending inwardly from said cutting edge; and a chip forming means located inwardly of said rake face; said cutting edge being concave with respect to the top

face and formed with a rake angle which varies along the length of the cutting edge being more positive at its central portion than at its terminal portions; said chip forming means comprising a pair of curved deflector surfaces constituting deflector ridges; each of said deflector surfaces sloping uniformly and smoothly away from said rake surface towards a deflector peak; each deflector ridge having a front deflector surface concavely curved in an axial direction, an outer axially directed side portion which forms a relief surface and merges with an adjacent side relief flank and an inner side axially directed surface which slopes towards the bottom face while extending towards said peak; said inner side surfaces of both ridges defining between them an angle and constituting a central axially directed valley portion which extends in an axial direction along said top face between said ridges; characterized in that each front deflector surface is convexly curved in a lateral direction and merges continuously via smoothly curved corners with said inner side surface of said valley portion; said angle defined by said inner surfaces increases uniformly along the axial direction in a direction away from said cutting edge; said front deflector surfaces of said ridges diminishing uniformly from a maximum area, adjacent said rake face, to a minimum area, adjacent the corresponding deflector peak.

With such a cutting insert, the chip which has been generated at the cutting edge is already provided with a relatively narrowed lateral extent owing to the concave shape of the cutting edge, and then proceeds, under the influence of the cutting forces, over the rake surface and onto the curved chip deflector surfaces, passing from the rake surface to the chip deflector surface in a smooth, continuous movement. Owing to the particular curved nature of the chip deflector surface, it is ensured that the chip contacts these surfaces over their entire length in a tangential form of contact, being supported by the chip deflector surfaces at its side and being forced downwardly into the valley portion under the influence of the cutting forces. In this way, the central axial portion of the chip becomes suitably deformed but the entire deformation, shaping and deflection of the chip is achieved with a minimum exertion of forces and therefore with a minimum heating of the cutting tool and the workpiece.

In this way, the cutting tool is effective in cutting operations on stress hardening workpieces, particularly at low feed rates.

BRIEF SUMMARY OF THE DRAWINGS

One embodiment of a cutting insert in accordance with the present invention will now be de-

scribed by way of example and with reference to the accompanying drawings, in which:

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

Fig. 2 is a side elevation of the insert shown mounted in an insert holder;

Fig. 3 is a plan view from above of the insert;

Fig. 4 is a front elevation of the insert;

Fig. 5 is a cross-sectional view of the insert shown in

Fig. 3 taken along the line V-V; and

Fig. 6 is a cross-sectional view of the insert shown in Fig. 3 taken along the line VI-VI.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

As seen in the drawings, a cutting insert 1 is formed with top and bottom faces 2 and 3, a front relief flank 4, side relief flanks 5 and 6 and a rear face 7.

The insert 1 is formed with a rear, wedge-shaped body portion facilitating its wedge clamping in an appropriately wedge-shaped recess formed in an insert holder 8 (seen in Fig. 2), the wedge-shaped body portion being formed with upper and lower V-shaped clamping grooves 9 and 10 in which are fitted V-shaped ribs of holder clamping jaws 11 and 12. The insert is provided with an abutting shoulder 13 designed to abut the front end of the clamping jaw 11, thereby limiting the degree of insertion of the insert into the holder 8.

A cutting edge 14 is defined at the intersection of the front relief flank 4 and the top face 2 and is of generally arcuate shape, being concave with respect to the top face 2 and comprising two side portions 14a and 14b which slope respectively downwardly towards the bottom face 3 at an angle θ (see Fig. 4) with respect to a plane parallel to the bottom face 3, the two side portions 14a and 14b merging via a central curved portion 14c.

A rake face 15 extends from the cutting edge 14. Extending out of the top face 2 is a pair of deflector ridges 16. Each deflector ridge 16 comprises a curved chip deflector surface 16a which extends from and merges smoothly and continuously with the rake face 15, an outer, axially directed side surface 16b which merges with an adjacent side relief flank and an inner, axially directed side surface 16c which slopes towards said bottom face 3. As can be clearly seen in Fig. 1 of the drawings, the chip deflector surfaces 16a are concavely curved in an axial direction and, as can be seen in Figs. 5 and 6 of the drawings, are convexly curved in a lateral direction. The chip deflector surfaces 16a slope uniformly and smoothly away from the rake surface 15 in a direction away from the bottom face 3 towards respective deflector surface peaks 17.

The axially directed side surfaces 16c define between them a valley portion 18, the side surfaces 16 defining an angle α between them. The side surfaces 16c merge smoothly with the chip deflector surfaces 16a at respectively smoothly curved corners. As can be clearly seen in Figs. 5 and 6 of the drawings, the angle α steadily increases along the length of the valley portion extending from the cutting edge from a value α_1 (see Fig. 5) close to the cutting edge to a larger value α_2 (see Fig. 6) remote from the cutting edge. This steady increase in the angle α subtended by the side surfaces 16c carries with it the consequence that the actual lateral extent of the chip deflector ridges 16 diminishes uniformly from a maximum adjacent the rake surface 15 to a minimum adjacent the respective peaks 17.

As can be seen in Fig. 2 of the drawings, the cutting edge 14 is formed with a rake angle ϕ which varies along the length of the cutting edge from a relatively high positive value at the central portion 14c of the cutting edge (for example, 20°), to a lesser positive, or even slightly negative value, at the respective corners of the cutting edge (for example, 10° positive or negative). Fig. 5 shows the angle α_3 subtended by the respective side portions of the rake surface adjacent the cutting edge. This relatively large angle reflects the fact that the rake angle changes from a highly positive value in the central portion of the rake surface to a much less positive or even negative value adjacent the corners.

When used in a metal cutting operation such as, for example, parting or grooving, the chip which is formed at the cutting edge is immediately given an arcuate cross-sectional shape owing to the arcuate shape of the cutting edge and smoothly passes over the rake surface 15 onto the chip deflector surfaces 16a, contacting the latter substantially tangentially. Whilst the side portions of the chip are respectively supported by the chip deflector surfaces 16a, the central portion thereof which moves over the valley portion 18 is deformed downwardly under the cutting forces so as to acquire an appropriately deformed central depression. In this way, the chip is effectively narrowed and rigidized and curls into a required disposition, whereupon it breaks either as a result of impacting the workpiece or as a result of the internal stresses present consequent upon the curving.

It will be appreciated that by virtue of the particular construction of the chip forming means and the fact that the chip passes into contact with the chip deflector surfaces 16a over very smoothly sloping surfaces, the tangential contacting of the chip with these surfaces introduces minimal stresses and therefore results in relatively low heat generation. The cutting insert is therefore particularly

useful when cutting stress hardening materials, seeing that minimal stresses are introduced into the materials as a result of the cutting operation. Furthermore, and particularly when using stress hardening materials where low feed rates are indicated, the particular construction just described is effective in the shaping of relatively thin chips produced with such low feed rates and thereby effectively contributes to the control and removal of such chips.

Furthermore, the fact that the cutting edge is provided at its central portion with a highly positive rake angle, whilst at its sensitive corner portions the rake angle is very much less positive or even negative, contributes, on the one hand, to the effective cutting operations with minimal introduction of stresses and, on the other hand, lessens the wear and damage to the cutting edge which would occur when the cutting edge is uniformly negative along its entire extent.

Claims

1. A metal cutting insert (1) having top and bottom faces (2,3); and front and side relief flanks (4,5,6); an arcuately shaped cutting edge (14) defined at an intersection of said front relief flank (4) and said top face (2); said top face (2) comprising a rake surface (15) extending inwardly from said cutting edge (14), and a chip forming means located inwardly of said rake face (15); said cutting edge (14) being concave with respect to the top face (2) and formed with a rake angle which varies along the length of the cutting edge (14) being more positive at its central portion (14c) than at its terminal portions (14a, 14b); said chip forming means comprising a pair of curved deflector surfaces constituting deflector ridges (16); each of said deflector surfaces sloping uniformly and smoothly away from said rake surface (15) towards a deflector peak (17); each deflector ridge having a front deflector surface (16a) concavely curved in an axial direction, an outer axially directed side portion (16b) which forms a relief surface and merges with an adjacent side relief flank (5,6) and an inner side axially directed surface (16c) which slopes towards the bottom face (3) while extending towards said peak (17); said inner side (16c) surfaces of both ridges (16) defining between them an angle (α) and constituting a central axially directed valley portion (18) which extends in an axial direction along said top face (2) between said ridges (16); characterized in that each front deflector surface (16a) is convexly curved in a lateral direction and merges continuously via smoothly curved corners with said inner



The axially directed side surfaces 16c define between them a valley portion 18, the side surfaces 16 defining an angle α between them. The side surfaces 16c merge smoothly with the chip deflector surfaces 16a at respectively smoothly curved corners. As can be clearly seen in Figs. 5 and 6 of the drawings, the angle α steadily increases along the length of the valley portion extending from the cutting edge from a value α_1 (see Fig. 5) close to the cutting edge to a larger value α_2 (see Fig. 6) remote from the cutting edge. This steady increase in the angle α subtended by the side surfaces 16c carries with it the consequence that the actual lateral extent of the chip deflector ridges 16 diminishes uniformly from a maximum adjacent the rake surface 15 to a minimum adjacent the respective peaks 17.

As can be seen in Fig. 2 of the drawings, the cutting edge 14 is formed with a rake angle ϕ which varies along the length of the cutting edge from a relatively high positive value at the central portion 14c of the cutting edge (for example, 20°), to a lesser positive, or even slightly negative value, at the respective corners of the cutting edge (for example, 10° positive or negative). Fig. 5 shows the angle α_3 subtended by the respective side portions of the rake surface adjacent the cutting edge. This relatively large angle reflects the fact that the rake angle changes from a highly positive value in the central portion of the rake surface to a much less positive or even negative value adjacent the corners.

When used in a metal cutting operation such as, for example, parting or grooving, the chip which is formed at the cutting edge is immediately given an arcuate cross-sectional shape owing to the arcuate shape of the cutting edge and smoothly passes over the rake surface 15 onto the chip deflector surfaces 16a, contacting the latter substantially tangentially. Whilst the side portions of the chip are respectively supported by the chip deflector surfaces 16a, the central portion thereof which moves over the valley portion 18 is deformed downwardly under the cutting forces so as to acquire an appropriately deformed central depression. In this way, the chip is effectively narrowed and rigidized and curls into a required disposition, whereupon it breaks either as a result of impacting the workpiece or as a result of the internal stresses present consequent upon the curving.

It will be appreciated that by virtue of the particular construction of the chip forming means and the fact that the chip passes into contact with the chip deflector surfaces 16a over very smoothly sloping surfaces, the tangential contacting of the chip with these surfaces introduces minimal stresses and therefore results in relatively low heat generation. The cutting insert is therefore particularly

useful when cutting stress hardening materials, seeing that minimal stresses are introduced into the materials as a result of the cutting operation. Furthermore, and particularly when using stress hardening materials where low feed rates are indicated, the particular construction just described is effective in the shaping of relatively thin chips produced with such low feed rates and thereby effectively contributes to the control and removal of such chips.

Furthermore, the fact that the cutting edge is provided at its central portion with a highly positive rake angle, whilst at its sensitive corner portions the rake angle is very much less positive or even negative, contributes, on the one hand, to the effective cutting operations with minimal introduction of stresses and, on the other hand, lessens the wear and damage to the cutting edge which would occur when the cutting edge is uniformly negative along its entire extent.

Claims

1. A metal cutting insert (1) having top and bottom faces (2,3); and front and side relief flanks (4,5,6); an arcuately shaped cutting edge (14) defined at an intersection of said front relief flank (4) and said top face (2); said top face (2) comprising a rake surface (15) extending inwardly from said cutting edge (14), and a chip forming means located inwardly of said rake face (15); said cutting edge (14) being concave with respect to the top face (2) and formed with a rake angle which varies along the length of the cutting edge (14) being more positive at its central portion (14c) than at its terminal portions (14a, 14b); said chip forming means comprising a pair of curved deflector surfaces constituting deflector ridges (16); each of said deflector surfaces sloping uniformly and smoothly away from said rake surface (15) towards a deflector peak (17); each deflector ridge having a front deflector surface (16a) concavely curved in an axial direction, an outer axially directed side portion (16b) which forms a relief surface and merges with an adjacent side relief flank (5,6) and an inner side axially directed surface (16c) which slopes towards the bottom face (3) while extending towards said peak (17); said inner side (16c) surfaces of both ridges (16) defining between them an angle (α) and constituting a central axially directed valley portion (18) which extends in an axial direction along said top face (2) between said ridges (16); characterized in that each front deflector surface (16a) is convexly curved in a lateral direction and merges continuously via smoothly curved corners with said inner



side surface (16c) of said valley portion (18); said angle (α) defined by said inner surfaces (16c) increases uniformly along the axial direction in a direction away from said cutting edge (14); said front deflector surfaces (16a) of said ridges (16) diminishing uniformly from a maximum area, adjacent said rake face (15), to a minimum area, adjacent the corresponding deflector peak (17).

2. A metal cutting insert according to claim 1 characterised in that said cutting edge (14) is substantially negative at its terminal portions (14a, 14b).

Patentansprüche

1. Metallschneideinsatz (1) mit einer Ober- und Unterseite (2, 3) sowie Vorder- und Seitenfreiflanken (4, 5, 6), einer gebogen geformten Schneidkante (14), die an einem Übergang der Vorderfreiflanke (4) und der Oberseite (2) gebildet wird, wobei die Oberseite (2) eine einwärts von der Schneidkante (14) verlaufende Spanfläche (15) und eine einwärts von der Spanfläche (15) befindliche Spanbildungseinrichtung aufweist, die Schneidkante (14) gegenüber der Oberseite (2) konkav und mit einem Spanwinkel ausgebildet ist, der sich über die Länge der Schneidkante (14) ändert und an ihrem Mittelabschnitt (14c) positiver als an ihren Endabschnitten (14a, 14b) ist, die Spanbildungseinrichtung ein Paar gekrümmte Ablenkflächen aufweist, die Ablenkstege (16) bilden, jede der Ablenkflächen gleichmäßig und glatt von der Spanfläche (15) zu einer Ablenkspitze (17) geneigt sind, jeder Ablenksteg eine Vorderablenkfläche (16a), die in eine Axialrichtung konkav gekrümmt ist, einen axial gerichteten Außenseitenabschnitt (16b), der eine Freifläche ausbildet und sich mit einer benachbarten Seitenfreiflanke (5, 6) vereinigt, und eine axial gerichtete Innenseitenfläche (16c) hat, die zur Unterseite (3) geneigt ist und gleichzeitig zu der Spitze (17) verläuft, die Innenseitenflächen (16c) beider Stege (16) zwischen sich einen Winkel (α) bilden und einen axial gerichteten Mittelkehlenabschnitt (18) bilden, der in eine Axialrichtung entlang der Oberseite (2) zwischen den Stegen (16) verläuft, dadurch gekennzeichnet, daß jede Vorderablenkfläche (16a) in eine Seitenrichtung konvex gekrümmt ist und sich kontinuierlich über glatt gekrümmte Ecken mit der Innenseitenfläche (16c) des Kehlenabschnitts (18) vereinigt, der durch die Innenflächen (16c) gebildete Winkel (α) sich gleichmäßig entlang der Axialrichtung in eine von der Schneidkante (14) wegführende Rich-

tung erhöht, wobei sich die Vorderablenkflächen (16a) der Stege (16) gleichmäßig von einer an die Spanfläche (15) angrenzenden Maximalfläche zu einer an die entsprechende Ablenkspitze (17) angrenzenden Minimalfläche verkleinern.

2. Metallschneideinsatz nach Anspruch 1, dadurch gekennzeichnet, daß die Schneidkante (14) an ihren Endabschnitten (14a, 14b) im wesentlichen negativ ist.

Revendications

1. Element rapporté (1) de coupe de métal avant des faces supérieure et inférieure (2, 3), et des flancs avant et latéraux (4, 5, 6) de dépouille, un bord de coupe (14) de forme courbe délimité a une intersection du flanc avant (4) de dépouille et de la face supérieure (2), la face supérieure (2) avant une surface de dégagement (15) dirigée vers l'intérieur depuis le bord de coupe (14), et un dispositif formateur de copeau place a l'intérieur de la face de dégagement (15), le bord de coupe (14) étant concave par rapport à la face supérieure (2) et avant un angle de dégagement qui varie sur la longueur du bord de coupe (14) et qui est plus positif dans la partie centrale (14c) que dans les parties terminales (14a, 14b), le dispositif formateur de copeau comprenant deux surfaces défectrices courbes constituant des nervures défectrices (16), chacune des surfaces défectrices étant inclinée uniformément et progressivement depuis la surface de dégagement (15) vers un pic défecteur (17), chaque nervure défectrice ayant une surface défectrice avant (16a) courbée de manière concave dans la direction axiale, une partie laterale externe (16b) dirigée axialement qui forme une surface de dépouille et qui se raccorde à un flanc latéral adjacent (5, 6) de dépouille et une surface latérale interne (16c) dirigée axialement et qui est inclinée vers la face inférieure (3) tout en étant dirigée vers le pic (17), les surfaces laterales internes (16c) des deux nervures (16) délimitant entre elles un angle (α) et constituant une partie centrale (18) de creux qui est dirigée axialement, qui s'étend dans une direction axiale le long de la face supérieure (2) entre les nervures (16), caractérisé en ce que chaque surface défectrice avant (16a) a une courbure convexe en direction laterale et se raccorde de façon continue par des coins à courbure progressive à la surface latérale interne (16c) de la partie de creux (18), l'angle (α) délimité par les surfaces internes (16c) augmente uniformément dans la direction



axiale a partir du bord de coupe (14), les surfaces défectrices avant (16a) des nervures (16) diminuant uniformément d'une surface maximale, près de la face de dégagement (15), à une surface minimale près du pic défecteur correspondant (17).

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2. Element rapporté de coupe de métal selon la revendication 1, caractérisé en ce que le bord de coupe (14) est pratiquement négatif dans ses parties terminales (14a, 14b).

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