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(54) Title: INDEXABLE CENTRAL DRILL INSERT AND CUTTING TOOL THEREWITH

(57) Abstract: A central drill insert (100) has a bottom surface, a top surface, and a peripheral surface extending therebetween. At least three lead drill portions (108) protrude outwards from the peripheral surface, each having a drill axis (H) and a plurality of drill cutting edges (110). A secondary cutting edge (112) is adjacent each lead drill portion (108), extending along the intersection of the top surface and the peripheral surface, transversely to the respective drill axis (H). Each secondary cutting edge (112) is spaced apart from the associated drill cutting edges (110) along the drill axis (H). A dovetail abutment flank is formed on the peripheral surface along the intersection of the top surface and the peripheral surface, extending from each one of the lead drill portions towards the secondary cutting edge associated with another lead drill portion. A cutting tool (120) has an insert pocket for retaining the central drill insert (100) with the operative drill axis (H) aligned with the tool axis (R).

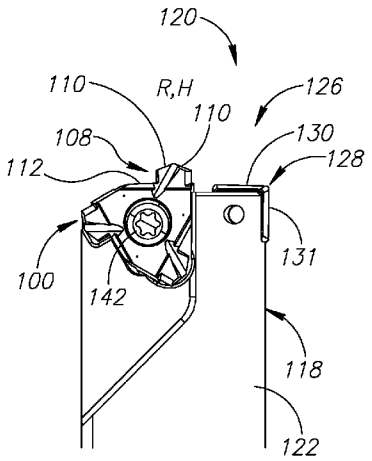

FIG.4

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

INDEXABLE CENTRAL DRILL INSERT AND CUTTING TOOL THEREWITH

FIELD OF THE INVENTION

The present invention relates to indexable cutting inserts and cutting tools therefor, in general, and to an indexable central drill insert and a cutting tool therefor, in particular.

BACKGROUND OF THE INVENTION

Metal cutting tools such as spot drills or pilot drills have a spot drill insert retained at the front of the drill, and possibly additional cutting inserts positioned alongside the spot drill insert. The spot drill insert may have multiple cutting areas, and it may be indexable for using a different cutting area when a used cutting area is worn or damaged.

The drill body has respective insert pockets adapted for receiving the spot drill insert and the additional cutting inserts, and retaining these inserts during machining operations. Cutting inserts and cutting tools as described above are shown, for example, in the following patent publications: DE19710996, EP1080812, US4100983, US5259707, US5688083, US5505569, US5954459, US7108460, US2004/124016, US2011/305534 and US2012/189393.

It is an object of the present invention to provide a novel indexable central drill insert with a plurality of lead drill portions and respective secondary cutting edges, and a tool holder with a central drill insert pocket suitable for receiving and firmly retaining the central drill insert.

SUMMARY OF THE INVENTION

In accordance with the subject matter of the present application, there is provided a central drill insert having rotational symmetry about a central insert axis, the central drill insert comprising:

a bottom surface having a bottom plane, a top surface, and a peripheral surface extending therebetween;

at least three lead drill portions protruding outwards from the peripheral surface, each lead drill portion having a drill axis and a plurality of drill cutting edges converging towards the drill axis;

at least three secondary cutting edges, each adjacent an associated lead drill portion, extending along the intersection of the top surface and the peripheral surface transversely to the respective drill axis, each secondary cutting edge being axially spaced apart from the drill cutting edges of the respective lead drill portion along the respective drill axis;

at least three abutment undercuts, each formed on the peripheral surface along the intersection of the bottom surface and the peripheral surface and extending opposite one of the secondary cutting edges; and

at least three abutment flanks formed on the peripheral surface along the intersection of the top surface and the peripheral surface, each extending from one of the lead drill portions towards the secondary cutting edge associated with another lead drill portion, each abutment flank forming a dovetail angle with the bottom plane.

In accordance with the subject matter of another embodiment of the present application, there is provided a cutting tool having a tool holder with a shank and a central rotation axis, the cutting tool comprising:

a first insert pocket formed at a front end of the tool holder, and a side cutting insert retained therein, the side cutting insert having a first cutting edge transverse to the rotation axis;

a second insert pocket formed at the front end of the tool holder rotationally opposite of the first insert pocket, and a central drill insert retained therein, the central drill insert having rotational symmetry about a central insert axis, the central drill insert comprising:

a bottom surface, a top surface, a peripheral surface extending therebetween, and at least three lead drill portions protruding outwards from the peripheral surface, each lead drill portion having a drill axis and a plurality drill cutting edges converging towards the drill axis, one of the drill axes coincides with the rotation axis of the tool holder;

at least three secondary cutting edges, each adjacent an associated lead drill portion, extending along the intersection of the top surface and the peripheral surface transversely to the respective drill axis, each secondary cutting edge being

axially spaced apart from the drill cutting edges of the respective lead drill portion along the respective drill axis.

In accordance with the subject matter of some embodiments of the present application, there is provided the cutting tool as described above, wherein:

at least three abutment undercuts formed on the peripheral surface along the intersection of the bottom surface and the peripheral surface, each extending opposite one of the secondary cutting edges; and

at least three abutment flanks formed on the peripheral surface along the intersection of the top surface and the peripheral surface, each extending from one of the lead drill portions towards the secondary cutting edge associated with another lead drill portion; and

the second insert pocket has:

a support surface with a support plane, extending parallel to the rotation axis, for abutting the bottom surface of the central drill insert;

a dovetail clamping surface forming a dovetail angle with the support plane, for abutting one of the abutment flanks of the central drill insert;

a clamping ledge located across from the dovetail clamping surface, for abutting one of the abutment undercuts of the central drill insert.

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 wfhich:

Fig. 1 is a perspective view of a cutting tool according to an embodiment of the present invention;

Fig. 2 is another perspective view of the cutting tool of Figure 1;

Fig. 3 is a perspective view of the cutting tool of Figure 1, partially disassembled;

Fig. 4 is a first side view of the cutting tool of Figure 1;

Fig. 5 is another side view of the cutting tool of Figure 1;

Fig. 6 is a front view of the cutting tool of Figure 1;

Fig. 7 is a front view of the tool holder of the cutting tool of Figure 1;

Fig. 8 is a top plan view of the cutting insert of according to an embodiment of the present invention;

Fig. 9 is a bottom plan view of the cutting insert of Figure 8;

Fig. 10 is a top perspective view of the cutting insert of Figure 8; and

Fig. 11 is a bottom perspective view of the cutting insert of Figure 8.

It will be appreciated that for simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity, or several physical components may be included in one functional block or element. Further, where considered appropriate, reference numerals may be repeated among the figures to indicate corresponding or analogous elements.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, various aspects of the present invention will be described. For purposes of explanation, specific configurations and details are set forth in order to provide a thorough understanding of the present invention. However, it will also be apparent to one skilled in the art that the present invention may be practiced without the specific details presented herein. Furthermore, well-known features may be omitted or simplified in order not to obscure the present invention.

Reference is made to Figures 1-7, depicting a cutting tool **120** according to an embodiment of the present invention. The cutting tool **120** is a drilling tool, having a tool holder **118** with a cylindrical shank **122** and a longitudinal rotation axis **R**. A first insert pocket **124** and a second insert pocket **132** are formed at a front end **126** of the tool holder **118**. The first and second insert pockets **124**, **132** are rotationally opposite one another about the rotation axis **R** (i.e., facing in different directions when rotating about the rotation axis **R**).

A side cutting insert **128** is retained in the first insert pocket **124**. The side cutting insert **128** has a first cutting edge **130** extending transverse to the rotation axis **R**. The side cutting insert **128** may also have a second cutting edge **131**, angled relative to the first cutting edge **130**. In particular embodiments, the second cutting edge **131** is perpendicular to the first

cutting edge **130**. As seen in the figures, the second cutting edge **131** extends along the rotation axis **R**.

It is noted that the second cutting edge **131** is employed when the side cutting insert **128** is indexed, e.g., when the first cutting edge **130** is worn or damaged (i.e., the second cutting edge **131** is not operative when the first cutting edge **130** is in an operative position at the front of the cutting tool **120**). In addition to the second cutting edge **131**, the side cutting insert **128** may have additional indexing cutting edges (e.g., a total of four cutting edges, as in the square side cutting insert **128** shown in the drawings of the present application).

A central drill insert **100**, in accordance with an embodiment of the present invention, is retained in the second insert pocket **132**. Reference is further made to Figures 8-11, depicting various views of the central drill insert **100**. The central drill insert **100** has a central insert axis **I**, about which the central insert **100** has 120^{o} rotational symmetry (i.e., three-fold rotational symmetry). The central insert **100** comprises a bottom surface **102**, a top surface **104**, and a peripheral surface **106** extending therebetween. The bottom surface **102** defines a bottom plane **P,** as seen in Figure 6. An insert clamping hole **117** passes along the central insert axis **I**, and opens out to the bottom and top surfaces **102**, **104**. It is noted that in the present application, the terms "central insert", "central cutting insert" and "central drill insert", are used interchangeably. It would be appreciated that the side cutting insert **128** and the central drill insert **100** are the only cutting inserts at the tool front end **126**.

The central insert **100** has at least three lead drill portions **108** protruding outwards from the peripheral surface **106**. Each lead drill portion **108** has a drill axis **H** and a plurality of front drill cutting edges **110** converging towards the drill axis **H**. Each drill cutting edge **110** is spaced away from the peripheral surface **106** by at least one drill flank **111**. The lead drill portions **108** are arranged symmetrically about the central axis **I**, such that the angle between one drill axis **H** to another is 120^{o}, as noted in Figure 8. The central insert **100** is indexable, such that a different lead drill portion **108** may be employed, if one of the lead drill portions **108** is worn or damaged.

The central insert **100** depicted in the attached drawings has three lead drill portions **108**. However, it is noted that the central insert **100** may have more than three lead drill portions **108**, in which case the central insert **100** would have an **n**-fold rotational symmetry about the central axis **I** (where **n** is the number of lead drill portions **108**). In some embodiments of the cutting tool **150**, the central insert **100** may have at least two lead drill portions **108**.

A secondary cutting edge **112** is located adjacent each lead drill portion **108**, and extends along the intersection of the top surface **104** and the peripheral surface **106**, transversely to the respective drill axis **H**. In some embodiments, each secondary cutting edge **112** may be substantially perpendicular to the respective drill axis **H**. Each secondary cutting edge **112** is axially spaced apart from the drill cutting edges **110** of the respective lead drill portion **108** along the respective drill axis **H**. In other words, the secondary cutting edge **112** is located rearwards of the drill cutting edges **110,** spaced therefrom by the at least one drill flank **111**. Thus, it would be appreciated that the drill cutting edges **110** and the secondary cutting edge **112** are axially non-continuous cutting edges.

An abutment undercut **114** is recessed in the peripheral surface **106** and extends along the intersection of the bottom surface **102** and the peripheral surface **106** opposite each one of the secondary cutting edges **112**. An abutment flank **116** is formed on the peripheral surface **106** along the intersection of the top surface **104** and the peripheral surface **106**, and extends from each one of the lead drill portions **108** towards the secondary cutting edge **112** associated with another adjacent lead drill portion **108**. Each abutment flank **116** forms a dovetail angle α with the bottom plane **P**, as noted in Figure 6.

In the cutting tool **120**, the second insert pocket **132** has a support surface **134** defining a support plane **S** (as noted in Figure 7), extending parallel to the rotation axis **R**. A pocket clamping hole **140** passes through the tool holder **118**, having an internal threaded surface, and opening out to the support surface **134**. A dovetail clamping surface **136** extends away from the support surface **134**, forming a dovetail angle α with the support plane **S**, as noted in Figure 7. A clamping ledge **138** is formed extending away from the support surface **134**, and located across from the dovetail clamping surface **136**.

The central insert **100** is retained in the second insert pocket **132** with a clamping screw **142** that passes through the insert clamping hole **117** and threadingly engages the pocket clamping hole **140**. The bottom surface **102** of the central insert **100** abuts the support surface **134**. One of the abutment undercuts **114** of the central insert **100** abuts the clamping ledge **138**. One of the abutment flanks **116** of the central insert **100** abuts the dovetail clamping surface **136**. The dovetail angle formed between the dovetail clamping surface **136** and the support plane **S** may be slightly smaller than the dovetail α, in order to ensure clamping between the dovetail clamping surface **136** and one of the abutment flanks **116**.

The dovetail clamping between the abutment flank **116** and the dovetail clamping surface **136** applies a force component perpendicular to the support plane **S**, for preventing the central insert **100** from being pulled out of the second insert pocket **132** in the direction perpendicular to the support plane **S**. In addition, each abutment undercut **114** is spaced apart from the opposite secondary cutting edge **112**. Thus, upon clamping of the central cutting insert **100**, no direct forces are applied on that secondary cutting edge **112**, thereby avoiding damage due to clamping forces to that secondary cutting edge **112**.

The central insert **100** is retained in the second insert pocket **132**, such that one of the lead drill portions **108** of the central insert **100** is operative, and protrudes outwards and forwards of the front end **126** of the tool holder **118**. The secondary cutting edge **112** associated with the operative lead drill portion **108** is referred to as the operative secondary cutting edge **112**. The drill axis **H** of the operative lead drill portion **108** coincides with the rotation axis **R** of the tool holder **118**. In this manner, the drill cutting edges **110** of the operative lead drill portion **108** are the forwardmost edges of the cutting tool **120**, and are the first to contact the work piece being machined by the cutting tool **120**. As the cutting tool **120** is advanced along the rotation axis **R** further into the work piece, the secondary cutting edge **112** and the first cutting edge **130** of the side cutting insert **128**, contact the work piece. Because the operative lead drill portion **108** first contacts the work piece, the cutting tool **120** is stabilized and led steadily along the rotation axis **R**, with reduced vibrations and deviation from the rotation axis **R**.

Particular reference is made to Figure 6, depicting a front view of the cutting tool **120**. This view shows that the first cutting edge **130** of the side cutting insert **128** has a first edge length **L1**. The operative secondary cutting edge **112** and the adjacent operative drill cutting edge **110** have a combined second edge length **L2** (i.e., the extent of the operative secondary cutting edge **112** from the rotation axis **R**). The sum length of the first edge length **L1** and the second edge length **L2** is larger than the radius **r** of the cylindrical shank **122**, providing radial edge continuity for the cutting tool **120**. In other words, the operative secondary cutting edge **112** radially overlaps with the first cutting edge **130** of the side cutting insert **128**. In this manner, the cutting tool **120** may cut a radially continuous circular drill hole in the work piece. It would be appreciated that the laterally extending secondary cutting edge **112** may thus alleviate the need of having two side cutting inserts, on both sides of the central cutting

insert **100**, and as such, the side cutting insert **128** and the central drill insert **100** are the only cutting inserts at the tool front end **126**.

While the present invention has been described with reference to one or more specific embodiments, the description is intended to be illustrative as a whole and is not to be construed as limiting the invention to the embodiments shown. It is appreciated that various modifications may occur to those skilled in the art that, while not specifically shown herein, are nevertheless within the scope of the invention.

CLAIMS

1. A central drill insert (100) having rotational symmetry about a central insert axis (I), the central drill insert (100) comprising:

a bottom surface (102) having a bottom plane (P), a top surface (104), and a peripheral surface (106) extending therebetween;

at least three lead drill portions (108) protruding outwards from the peripheral surface (106), each lead drill portion (108) having a drill axis (H) and a plurality of drill cutting edges (110) converging towards the drill axis (H);

at least three secondary cutting edges (112), each adjacent an associated lead drill portion (108), extending along the intersection of the top surface (104) and the peripheral surface (106) transversely to the respective drill axis (H), each secondary cutting edge (112) being axially spaced apart from the drill cutting edges (110) of the respective lead drill portion (108) along the respective drill axis (H);

at least three abutment undercuts (114), each formed on the peripheral surface (106) along the intersection of the bottom surface (102) and the peripheral surface (106) and extending opposite one of the secondary cutting edges (112); and

at least three abutment flanks (116) formed on the peripheral surface (106) along the intersection of the top surface (104) and the peripheral surface (106), each extending from one of the lead drill portions (108) towards the secondary cutting edge (112) associated with another lead drill portion (108), each abutment flank (116) forming a dovetail angle (α) with the bottom plane (P).

2. The drill central drill insert (100) according to claim 1, wherein the rotational symmetry about the central insert axis (I) is 120^{o} rotational symmetry.

3. A cutting tool (120) having a tool holder (118) with a shank (122) and a central rotation axis (R), the cutting tool (120) comprising:

a first insert pocket (124) formed at a front end (126) of the tool holder (118), and a side cutting insert (128) retained therein, the side cutting insert (128) having a first cutting edge (130) transverse to the rotation axis (R);

a second insert pocket (132) formed at the front end (126) of the tool holder (118) rotationally opposite of the first insert pocket (124) about the rotation axis (R),

and a central drill insert (100) retained therein, the central drill insert (100) having rotational symmetry about a central insert axis (I), the central drill insert (100) comprising:

a bottom surface (102), a top surface (104), a peripheral surface (106) extending therebetween, and at least three lead drill portions (108) protruding outwards from the peripheral surface (106), each lead drill portion (108) having a drill axis (H) and a plurality drill cutting edges (110) converging towards the drill axis (H), one of the drill axes (H) coincides with the rotation axis (R) of the tool holder (118);

at least three secondary cutting edges (112), each adjacent an associated lead drill portion (108), extending along the intersection of the top surface (104) and the peripheral surface (106) transversely to the respective drill axis (H), each secondary cutting edge (112) being axially spaced apart from the drill cutting edges (110) of the respective lead drill portion (108) along the respective drill axis (H).

4. The cutting tool (120) according to claim 3, wherein:

the central drill insert (100) further comprises:

at least three abutment undercuts (114) formed on the peripheral surface (106) along the intersection of the bottom surface (102) and the peripheral surface (106), each extending opposite one of the secondary cutting edges (112); and

at least three abutment flanks (116) formed on the peripheral surface (106) along the intersection of the top surface (104) and the peripheral surface (106), each extending from one of the lead drill portions (108) towards the secondary cutting edge (112) associated with another lead drill portion (108); and

the second insert pocket (132) has

a support surface (134) with a support plane (S), extending parallel to the rotation axis (R), for abutting the bottom surface (102) of the central drill insert (100);

a dovetail clamping surface (136) forming a dovetail angle (α) with the support plane (S), for abutting one of the abutment flanks (116) of the central drill insert (100);

a clamping ledge (138) located across from the dovetail clamping surface (136), for abutting one of the abutment undercuts (114) of the central drill insert (100).

5. The cutting tool (120) according to claim 4, wherein the bottom surface (102) has a bottom plane (P) forming a dovetail angle (α) with each of the abutment flanks (116).

6. The cutting tool (120) according to any one of claims 3 to 5, wherein the rotational symmetry of the central drill insert (100) is 120^{o} rotational symmetry about the central insert axis (I).

7. The cutting tool (120) according to any one of claims 3 to 6, wherein one of the lead drill portions (108) is operative and protrudes outwards of the front end (126) of the tool holder (118), with the drill cutting edges (110) being the forwardmost edges of the cutting tool (120).

8. The cutting tool (120) according to any one of claims 3 to 7, wherein one of the secondary cutting edges (112) is operative, and radially overlaps with the first cutting edge (130) of the side cutting insert (128).

9. The cutting tool (120) according to any one of claims 3 to 8, wherein the first cutting edge (130) of the side cutting insert (128) has a first edge length (L1), and an operative secondary cutting edge (112) and an adjacent operative drill cutting edge (110) have a combined second edge length (L2), and

the sum length of the first edge length (L1) and the second edge length (L2) is larger than a radius (r) of the cylindrical shank (122).

10. The cutting tool (120) according to any one of claims 3 to 9, wherein the side cutting insert (128) and the central drill insert (100) are the only cutting inserts at the tool front end (126).

11. The cutting tool (120) according to any one of claims 3 to 10, wherein the first and second insert pockets (124, 132) are rotationally opposite one another about the central rotation axis (R).

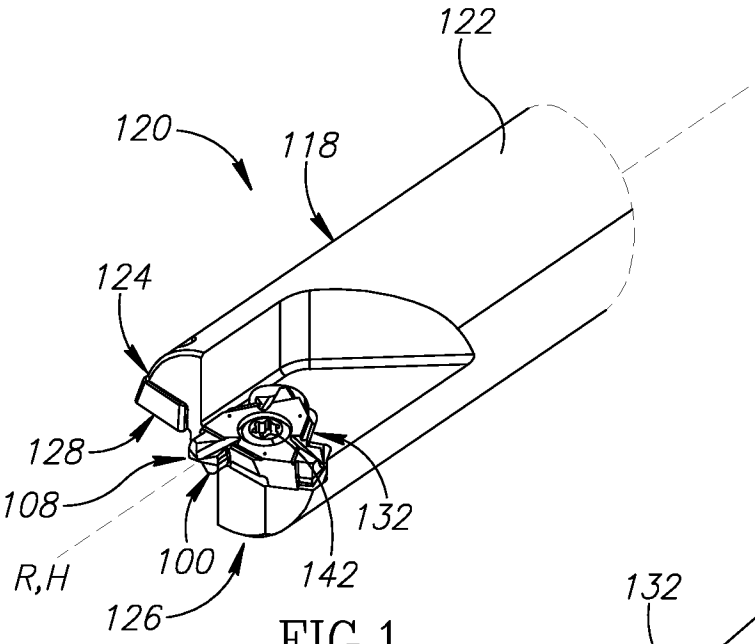

FIG.1

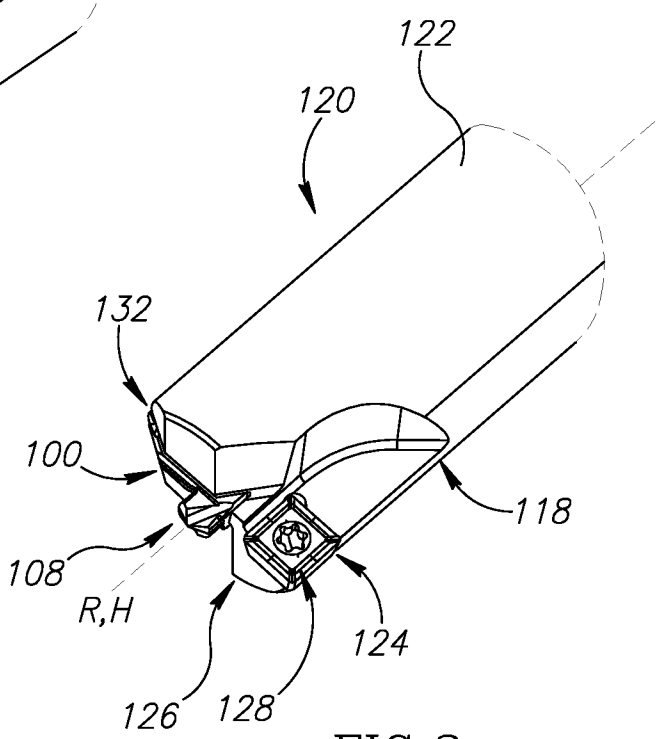

FIG.2

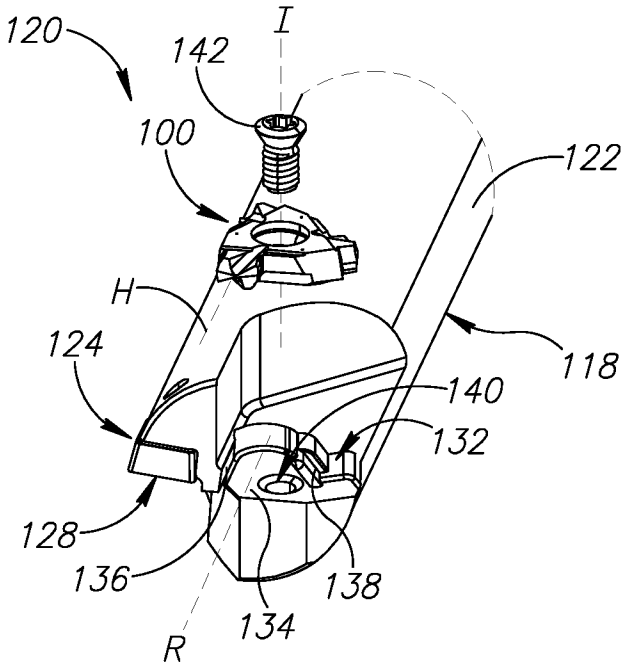

FIG.3

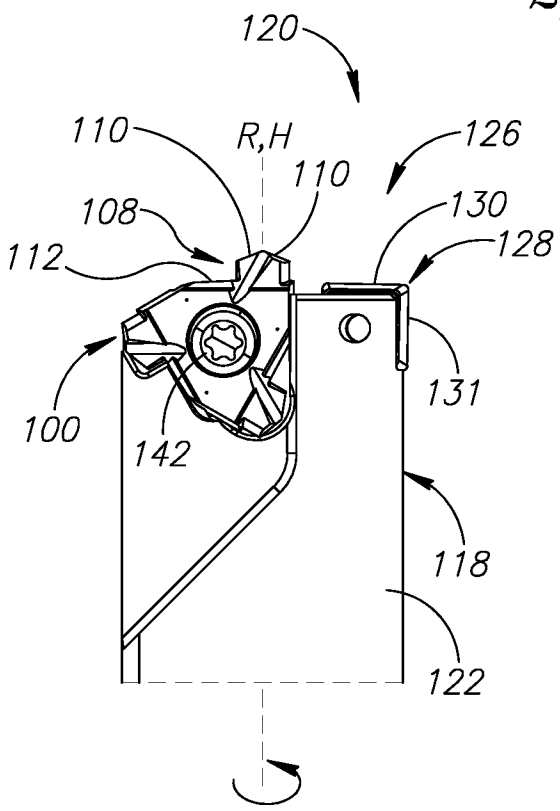

FIG.4

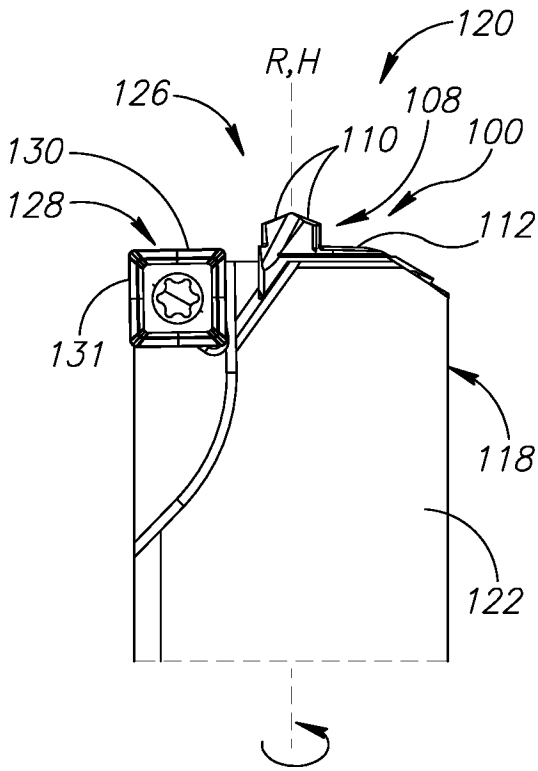

FIG.5

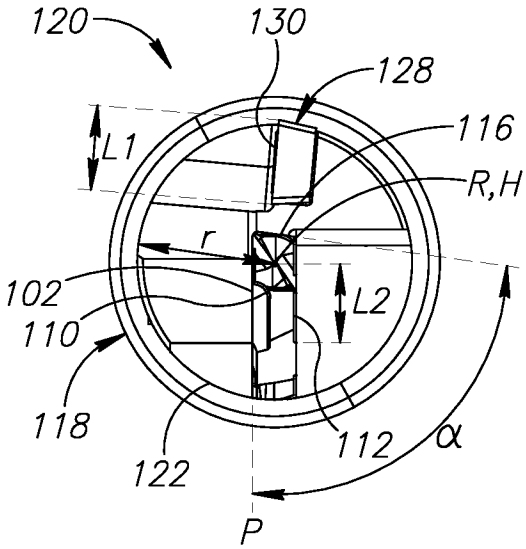

FIG.6

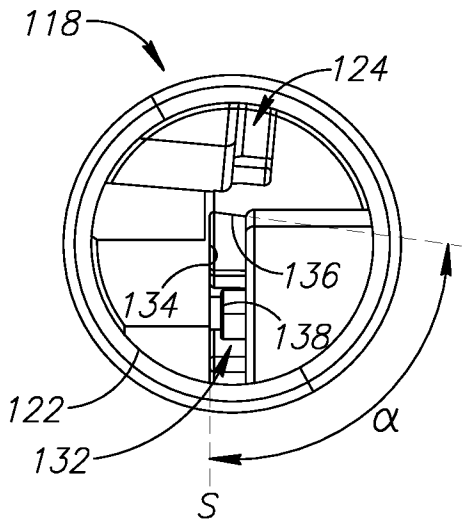

FIG.7

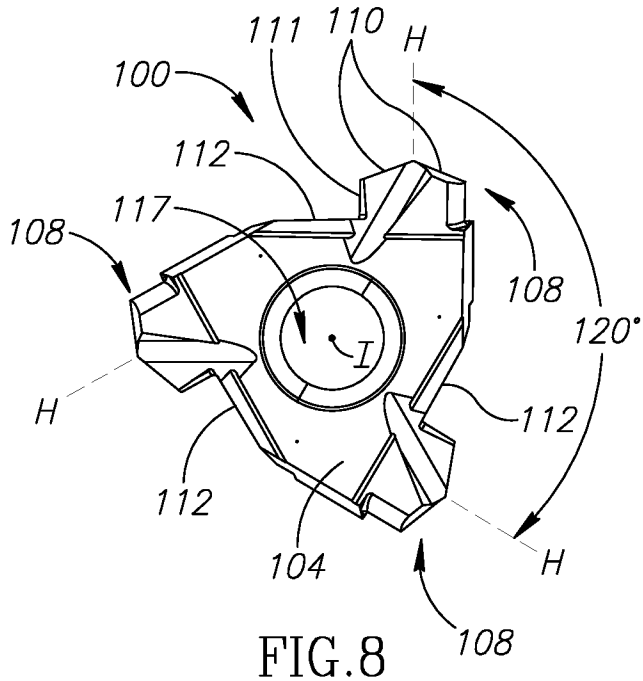

FIG.8

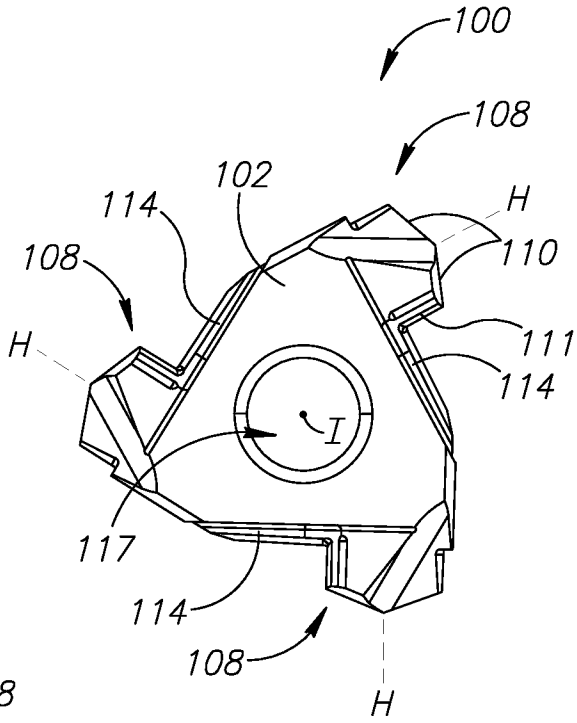

FIG.9

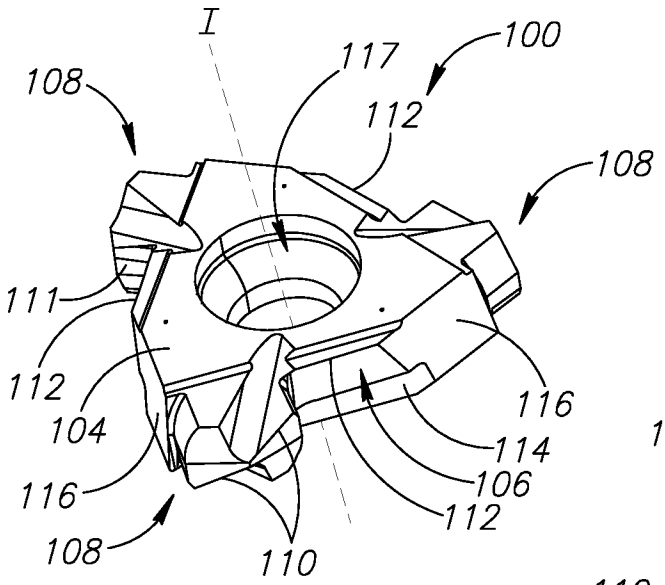

FIG.10

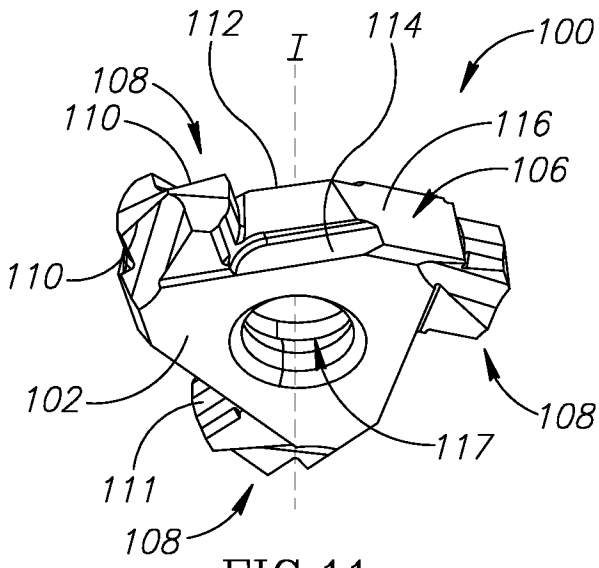

FIG.11

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2014/051095

A. CLASSIFICATION OF SUBJECT MATTER
INV. B23B51/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B23B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 688 083 A (BOIANJIU GIDEON [IL]) 18 November 1997 (1997-11-18) cited in the application column 4, line 40 - column 6, line 64; figures 1-6	1,2,5-11
A	EP 2 532 461 A1 (SECO TOOLS AB [SE]) 12 December 2012 (2012-12-12) paragraphs [0015] - [0027]; figures 1-8	1,2,5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 March 2015	03/06/2015

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2014/051095

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1, 2(completely); 5-11(partially)

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1, 2(completely); 5-11(partially)

   Central drill insert and cutting tool therewith

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2. claims: 3, 4(completely); 5-11(partially)

   Cutting tool

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IL2014/051095

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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