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(54) Title: PICK TOOL FOR ROAD MILLING

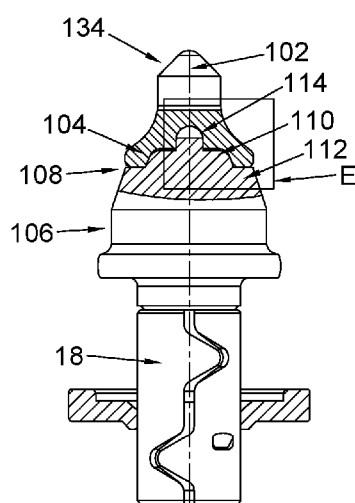


Fig. 6

(57) Abstract: This disclosure relates to a pick tool suitable for road milling. The pick tool comprises a central axis, an impact tip and a support body, and the impact tip is joined to the support body at a non-planar interface. The non-planar interface comprises two co-axial and annular interface surfaces.



## PICK TOOL FOR ROAD MILLING

FIELD OF THE INVENTION

5 The invention relates to a wear resistant pick tool for use in mining, milling and excavation. Particularly but not exclusively, the pick tools may include tips comprising cemented metal carbide.

BACKGROUND ART

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Pick tools are commonly used for breaking, boring into or otherwise degrading hard or abrasive bodies, such as rock, asphalt, coal or concrete and may be used in applications such as road reconditioning, mining, trenching and construction.

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Pick tools can experience extreme wear and failure in a number of ways due to the environment in which they operate and must be frequently replaced. For example, in road reconditioning operations, a plurality of pick tools may be mounted on a rotatable drum and caused to break up road asphalt as the drum is rotated. A similar approach may be used to break up rock formations such as in coal mining.

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Some pick tools comprise a working tip comprising synthetic diamond material, which is likely to have better abrasion resistance than working tips formed of cemented tungsten carbide material. However, synthetic and natural diamond material tends to be more brittle and less resistant to fracture than cemented metal carbide material and this tends to reduce its potential  
25 usefulness in pick operations.

There is a need to provide a pick tool having longer working life.

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In particular, there is a need to provide a pick tool with a cemented metal carbide impact tip that helps to protect the steel support body at no additional cost.

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US 2009/0051212 A1 to Sandvik Intellectual Property discloses a cemented carbide cutting bit comprising a cutting tip and a head which meet at a non-planar interface. Welding, brazing, soldering or adhesive bonding occurs along a portion of the mating interface to fix the cutting  
tip to the head.

The problem with such an arrangement is that it is challenging in production to consistently ensure a join along the entire non-planar interface and not just a portion of it.

It is another aim of this disclosure to provide a more secure join along the non-planar interface.

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### SUMMARY OF THE INVENTION

According to the invention, there is provided a pick tool comprising a central axis, an impact tip and a support body, the impact tip joined to the support body at a non-planar interface, the non-planar interface comprising two co-axial and annular interface surfaces, the width of an outer interface surface being the same or less than the width of an inner interface surface.

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This configuration provides a large brazing surface, which increases the compressive stresses after brazing. This leads to a higher shear strength.

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When the width of the outer interface surface is the same or less than the width of the inner interface surface, braze material is encouraged to flow radially inwardly during the brazing process, which again contributes to achieving the higher shear strength post-braze.

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Furthermore, the wear resistance of the pick tool as a whole is significantly improved. This avoids the situation where the pick tool fails because of wear of the steel support body despite the carbide tip having useful life remaining. With this configuration, the investment made into the carbide impact tip is realised because full lifetime usage is achieved.

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Additionally, the brazing process is more flexible in terms of manufacturing tolerance because of the large brazing surface area. The arrangement also yields a more reliable brazing process.

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Finally, the quality checking of the pick tools is much easier because no preparation of the sample is required before sectioning the sample to inspect the weld quality.

These effects may be further enhanced. The impact tip has a free distal end, remote from the non-planar interface. Axially, the inner annular interface surface is intermediate the outer annular interface surface and the distal free end. In other words, the outer interface surface is further away from the distal free end than the inner annular interface surface. As with the different widths of annular interface surfaces, this helps draw braze material radially inwardly

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during brazing, thereby contributing to a strong connection along most, if not all, of the non-planar interface.

Preferable and/or optional features of the invention are provided in dependent claims 2 to 15.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

A non-limiting example arrangement of a pick tool will be described with reference to the accompanying drawings, in which:

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Figure 1 shows an underside of a typical road-milling machine, incorporating prior art pick tools;

Figure 2 shows a front perspective view of a prior art pick tool;

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Figure 3 shows a front perspective view of the prior art pick tool of Figure 2 with partial cross-section of the interface between the impact tip and the support body;

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Figure 4 shows an example of a worn prior art pick tool before (left) and after (right) the impact tip has broken off;

Figure 5 shows a front perspective view of a pick tool in one embodiment of the invention;

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Figure 6 shows a cross-sectional view of the pick tool of Figure 5;

Figure 7 shows an enlarged view of part of square E in Figure 5; and also in outline a cross-section of the prior art pick of Figure 2;

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Figure 8 shows a perspective view of the impact tip of Figure 5;

Figure 9 shows a bottom view of the impact tip of Figure 5; and

Figure 10 shows a side view of the impact view of Figure 5.

35 The same reference numbers refer to the same general features in all drawings.

DESCRIPTION OF EMBODIMENTS

Figure 1 shows an underside of a typical road-milling machine 10. The milling machine may be an asphalt or pavement planer used to degrade formations such as pavement 12 prior to placement of a new layer of pavement. A plurality of pick tools 14 are attached to a rotatable drum 16. The drum 16 brings the pick tools 14 into engagement with the formation 12. A base holder 18 is securely attached to the drum 16 and, by virtue of an intermediate tool holder (not shown), may hold the pick tool 14 at an angle offset from the direction of rotation such that the pick tool 14 engages the formation 12 at a preferential angle. In some embodiments, a shank (not shown) of the pick tool 14 is rotatably disposed within the tool holder, though this is not necessary for pick tools 14 comprising super-hard impact tips.

Figures 2 and 3 show a prior art pick tool 14. The pick tool 14 comprises a generally bell shaped impact tip 20 and a steel support body 22. The support body comprises a body portion 24 and a shank 26 extending centrally from the body portion 24. The impact tip 20 sits within a circular recess 27 provided in one end of the support body 22. This means that an edge of the steel support body 22 always surrounds the metal carbide impact tip 20. Braze material (not shown), typically provided as a thin circular disc, positioned within the circular recess 27 securely joins the impact tip 20 to the support body 22. The pick tool 14 is attachable to a drive mechanism, for example, of a road-milling machine, by virtue of the shank 26 and a spring sleeve 28 surrounding the shank 26 in a known manner. The spring sleeve 28 enables relative rotation between the pick tool 14 and the tool holder.

In use, as evidenced in Figure 4, the steel support body 22 erodes at a faster rate than the carbide impact tip 20, particularly near the braze. The volume of steel in this area gradually decreases in use due to abrasion. Eventually, the support body 22 can no longer sufficiently support the impact tip 20 and the impact tip 20 breaks off, prematurely terminating the useful life of the impact tip 20.

Turning now to Figures 5 to 10, a pick tool in accordance with the invention is indicated generally at 100. The pick tool 100 comprises a central axis 102, an impact tip 104 and a support body 106. The pick tool 100 is symmetrical about its central axis 102. As best seen in Figure 6, the impact tip 104 is joined to the support body 106 at a non-planar interface 108. Significantly, the interface 108 comprises two co-axial and annular interface surfaces 110, 112.

The support body 106 comprises a central protrusion or pin 114, which is surrounded by and extends radially outwardly into a first annular joining surface 116 (see Figure 7). In this embodiment, the central protrusion 114 is a boss and comprises a cylindrical body portion 114a. However, other shapes and profiles of central protrusion 114 are envisaged, such as a conical protrusion or a truncated conical protrusion, or a hemispherical protrusion. A diameter  $\varnothing_P$  of the cylindrical body portion 114a is preferably around 5mm but may be in the range of 3mm to 10mm. A height H1 of the cylindrical portion 114a is preferably around 2.5mm but may be in the range of 1mm to 5mm. The central protrusion 114 may be undercut by an arcuate notch 118. The notch provides an additional volume into which braze material can flow, and helps contribute to the large brazing area.

The first annular joining surface 116 is connected to a radially outer second annular joining surface 120 by means of shoulder 122. In Figure 7, the shoulder 122 is initially arcuate and then rectilinear. It is positioned intermediate the first and second annular joining surfaces 116, 120. Whereas the first and second annular joining surfaces 116, 120 are arranged perpendicularly to the central axis 102, the shoulder 122 is arranged at an acute angle  $\Theta$  to the central axis 102, as shown in Figure 7. The angle  $\Theta$  is between 10 and 30 degrees, and is preferably about 20 degrees.

The first and second annular joining surfaces 116, 120 are separated axially, i.e. stepped, such that the first annular joining surface 116 is axially intermediate the central protrusion 114 and the second annular joining surface 120. It is feasible that the second annular joining surface 120 could be axially intermediate the central protrusion 114 and the first annular joining surface 116 instead, but this is not a preferred arrangement because it likely requires more (not less) carbide material in the impact tip 104.

As shown in Figure 8, the impact tip 104 comprising a central recess 124 at one end for receiving the central protrusion 114 of the support body 106. The internal configuration of the recess 124 is hemispherical but other shapes are possible. The role of the central protrusion 114 and recess 124 is to ensure good relative location of the impact tip 104 and the support body 106 in the initial assembly, during the early stages of production. They also assist during pressing to improve the density of the green body, at the pre-sintering stage. However, they are not essential to the invention in that they do not directly contribute to an increased weld strength and, as such, they may be omitted. Whether or not the protrusion 114 and recess 124 are included in the impact tip, it is important that the first and second annular interface surfaces 110, 112 are spaced apart axially to some extent.

The impact tip 104 further comprises a third annular joining surface 126 surrounding and extending radially outwardly from the central recess 124. The impact tip 104 also comprises a radially outer fourth annular joining surface 128 connected to the third annular joining surface 126.

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As best seen in Figures 8 and 9, a plurality of dimples 129 protrude from the fourth annular joining surface 128. The dimples 129 are equi-angularly arranged about the central longitudinal axis 102. In this embodiment, the angular spacing  $\phi$  between adjacent dimples is 60 degrees since there are 6 dimples. Any number of dimples may be arranged on the fourth annular joining surface 128. The dimples help to create a small gap  $G_1$  of around 0.3mm between the impact tip 104 and the support body 106. The dimples further increase the surface area of the impact tip 104 against which the braze bonds, yet further enhancing the shear strength of the join.

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Similar to the support body 106, a second said shoulder 130 connects the third and fourth annular joining surfaces 126, 128 of the impact tip 104.

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In this embodiment, the first and second shoulders, 122, 130 are planar. However, they need not necessarily be so. It is important that the structural link between the first and second annular interface surfaces 110, 112 extends the length of the interface between the impact tip 104 and the support body 106 but how this is achieved is not necessarily significant. For example, the structural link may simply be a chamfer on one of the annular interface surfaces 110, 112 or alternatively, a fillet.

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The third annular joining surface 126 of the impact tip 104 and the first annular joining surface 116 of the support body 106 face each other but, aside from any dimples 129 which are optional, they do not abut one another. Additionally, the fourth annular joining surface 128 of the impact tip 104 and the second annular joining surface 120 of the support body 106 face each other but again, aside from any dimples 129, they do not abut one another. The impact tip 104 and the support body 106 are separated by a gap  $G_2$  of approximately 0.2mm measured at the first and second shoulders 122, 130. Gap  $G_2$  provides space for braze material (not shown) to sit between the impact tip 104 and the support body 106. Similarly, Gap  $G_3$  also provides space for additional braze material (not shown) to sit between the impact tip 104 and the support body 106. For assembly, the braze is supplied as a ring or annulus, such that two rings in gaps  $G_1$  and  $G_3$  are needed for this invention. However, once heated, the braze becomes molten and flows. Braze from the outer braze ring at  $G_1$  wicks up the gap

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G<sub>2</sub>, towards the inner braze ring at G<sub>3</sub>, to further increase the length of the braze join. This significantly increases the strength of the join. Feasibly, more than two annular interface surfaces may be provided.

5 The impact tip 104 comprises a protective skirt portion 132. In this embodiment, the skirt portion 132 encompasses the central recess 124, the third annular joining surface 126 and second shoulder 130. When joined to the support body 106, the skirt portion 132 also encompasses the protrusion 114, the first annular joining surface 116 and first shoulder 122. The skirt portion 132 peripherally terminates broadly in line with the support body 106, at the  
10 meeting of the second and fourth annular joining surfaces 120, 128. The skirt portion 132 has a diameter  $\varnothing_s$  (see Figure 10) of at least 25 mm. Preferably, diameter  $\varnothing_s$  is between 25mm and 40mm inclusively. This general arrangement is important since it means that for the same volume of carbide material in the impact tip 104, greater protection for the steel support body 106 is afforded. The volume of carbide material is simply redistributed to where it is needed  
15 most, with no additional cost. Notably, when diameter  $\varnothing_s$  is at the upper end of the range, the impact tip 104 protrudes radially outwardly over the support body 106, thereby providing more side protection against abrasion for the pick tool 100.

In this embodiment, the two co-axial and annular interface surfaces 110, 112 have different  
20 widths, measured radially. However, it is envisaged that the interface surfaces 110, 112 may alternatively have the same width. It is preferable that the radial outer annular interface surface 112 is lesser in width than the radial inner annular interface surface 110 as this encourages the flow of braze material radially inwardly, thereby promoting an improved joint strength. The radial inner annular interface surface 110 has an outer diameter of approximately 15mm and  
25 a width of approximately 5mm. The radial outer annular interface surface 112 has an outer diameter of approximately 25mm and a width of approximately 3mm.

For clarity, the radial inner annular interface surface 110 comprises the first and third annular joining surfaces 116, 126. The radial outer annular interface surface 112 comprises the second  
30 and fourth annular joining surfaces 120, 128.

At an opposing end to the central recess 124, the impact tip 104 has a working surface 134 with a rounded geometry that may be conical, hemispherical, domed, truncated or a combination thereof. Other forms of tip are envisaged within the scope of the invention, such  
35 as those that are hexagonal, quadrangular and octagonal in lateral cross-section.



As best seen in Figure 10, the impact tip 104, as a whole, is generally bell-shaped. The working surface 134 extends into and is co-linear with a cylindrical first body surface 136 of the impact tip 104. The first body surface 136, in turn, extends into and is co-linear with a curved second body surface 138 of the impact tip 104. Both the first and second body surface 136, 138 are continuous and uninterrupted, without any external grooves recessed therein. Similarly, the support body 106 has no external grooves of any kind.

In this embodiment, the impact tip 104 consists of cemented metal carbide material. In some embodiments, the support body 106 comprises a cemented metal carbide material having fracture toughness of at most about 17 MPa.m<sup>1/2</sup>, at most about 13 MPa.m<sup>1/2</sup>, at most about 11 MPa.m<sup>1/2</sup> or even at most about 10 MPa.m<sup>1/2</sup>. In some embodiments, the support body 106 comprises a cemented metal carbide material having fracture toughness of at least about 8 MPa.m<sup>1/2</sup> or at least about 9 MPa.m<sup>1/2</sup>. In some embodiments, the support body 106 comprises a cemented metal carbide material having transverse rupture strength of at least about 2,100 MPa, at least about 2,300 MPa, at least about 2,700 MPa or even at least about 3,000 MPa.

In some embodiments, the support body 106 comprises a cemented carbide material comprising grains of metal carbide having a mean size of at most 8 microns or at most 3 microns. In one embodiment, the support body 106 comprises a cemented carbide material comprising grains of metal carbide having a mean size of at least 0.1 microns.

In some embodiments, the support body 106 comprises a cemented metal carbide material comprising at most 13 weight percent, at most about 10 weight percent, at most 7 weight percent, at most about 6 weight percent or even at most 3 weight percent of metal binder material, such as cobalt (Co). In some embodiments, the support body 106 comprises a cemented metal carbide material comprising at least 1 weight percent, at least 3 weight percent or at least 6 weight percent of metal binder.

The combination of the two annular interface surfaces 110, 112 providing improved weld strength, and the protective skirt portion 132 providing improved protection of the support tool 106 together result in vastly superior pick tool 100 performance in use. Notably, the useful working lifetime (which may be measured in terms of time, metres cut or planed, number of operations etc) of the impact tool 100 is extended. When the central protrusion 114 and recess 134 arrangement is also included, this superior performance is obtainable with a redistribution of carbide material and little additional cost.

CLAIMS

1. A pick tool comprising a central axis, an impact tip and a support body, the impact tip joined to the support body at a non-planar interface, the non-planar interface comprising two co-axial and annular interface surfaces, the width of an outer interface surface being the same or less than the width of an inner interface surface.
2. A pick tool as claimed in claim 1, in which the two co-axial and annular interface surfaces extend radially outwardly, perpendicular to the central axis.
3. A pick tool as claimed in claim 1 or 2, in which the two interface surfaces are non-concentric, being spaced apart axially.
4. A pick tool as claimed in any one of the preceding claims, in which the two co-axial and annular interface surfaces have different widths.
5. A pick tool as claimed in any one of the preceding claims, in which the support body comprises a central protrusion, and the impact tip comprises a correspondingly shaped central recess for receiving the central protrusion.
6. A pick tool as claimed in claim 5, in which the central protrusion is undercut by a notch.
7. A pick tool as claimed in claim 5 or 6, in which the central protrusion comprises a cylindrical body portion.
8. A pick tool as claimed in claim 5, 6, or 7 the support body comprising a first annular joining surface surrounding and extending from the central protrusion, the first annular joining surface connected to a radially outer second annular joining surface, the impact tip comprising a third annular joining surface surrounding and extending from the central recess, the impact tip further comprising a radially outer fourth annular joining surface connected to the third annular joining surface, wherein the third annular joining surface of the impact tip and the first annular joining surface of the support body face each other, and the fourth annular joining surfaces of the impact tip and the second annular joining surface of the support body face each other.

9. A pick tool as claimed in claim 8, in which the first annular joining surface of the support body is connected to the second annular joining surface of the support body at a shoulder, the shoulder being arranged at an angle to the central axis.
- 5 10. A pick tool as claimed in claim 9, in which the angle is between 10 and 30 degrees, and is preferably about 20 degrees.
11. A pick tool as claimed in claim 9 or 10, in which the impact tip and support body are separated by a gap of at least 0.2 mm measured along the shoulder.
- 10 12. A pick tool as claimed in any one of the preceding claims, in which the impact tip comprises a protective skirt portion.
13. A pick tool as claimed in claim 12, in which the skirt portion has a diameter of between  
15 25 mm and 40mm.
14. A pick tool as claimed in any one of claims, in which the impact tip comprises dimples.
15. A pick tool as claimed in any one of the preceding claims, in which the pick tool is a  
20 road milling tool.

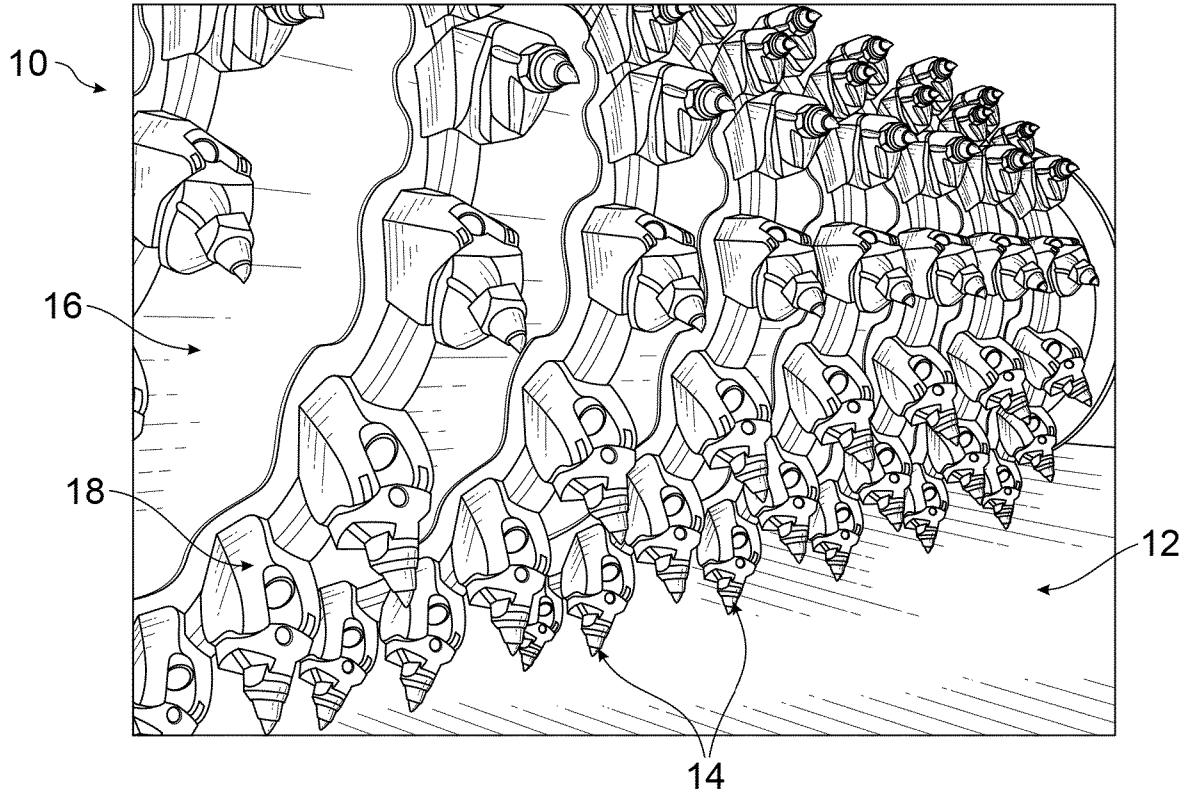


Fig. 1

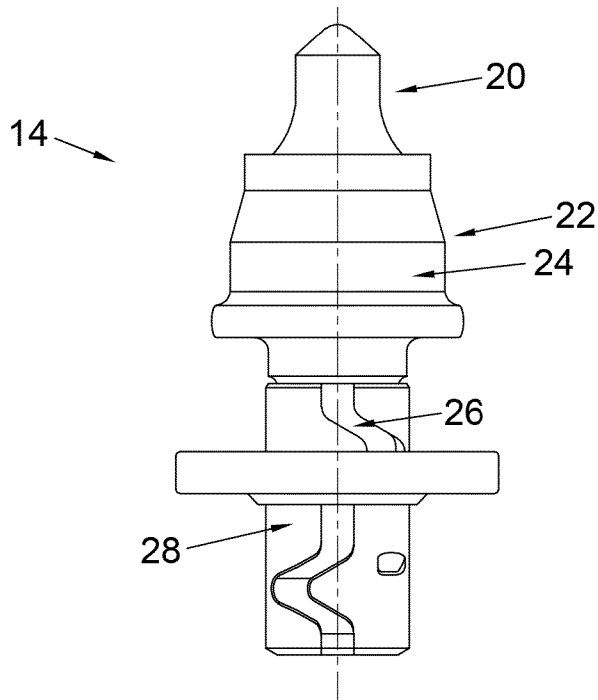
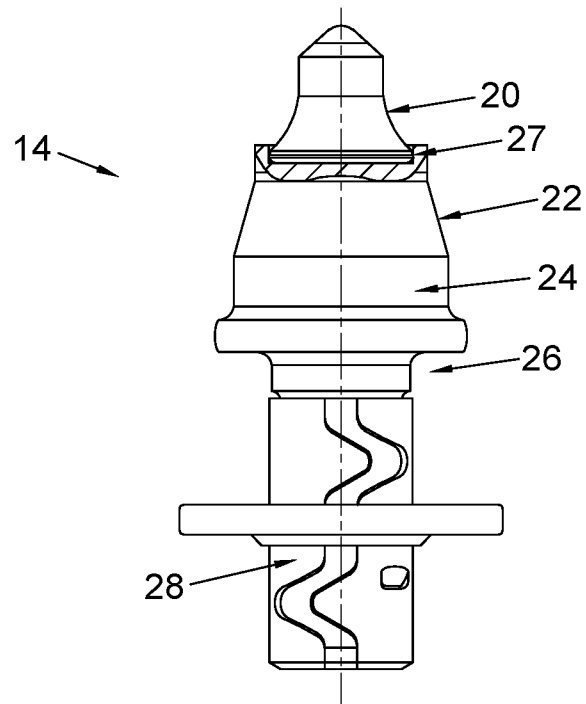
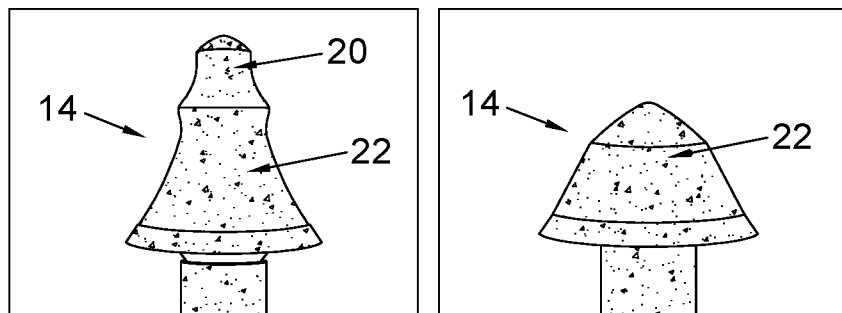


Fig. 2  
(Prior Art)



**Fig. 3**  
(Prior Art)



**Fig. 4**  
(Prior Art)

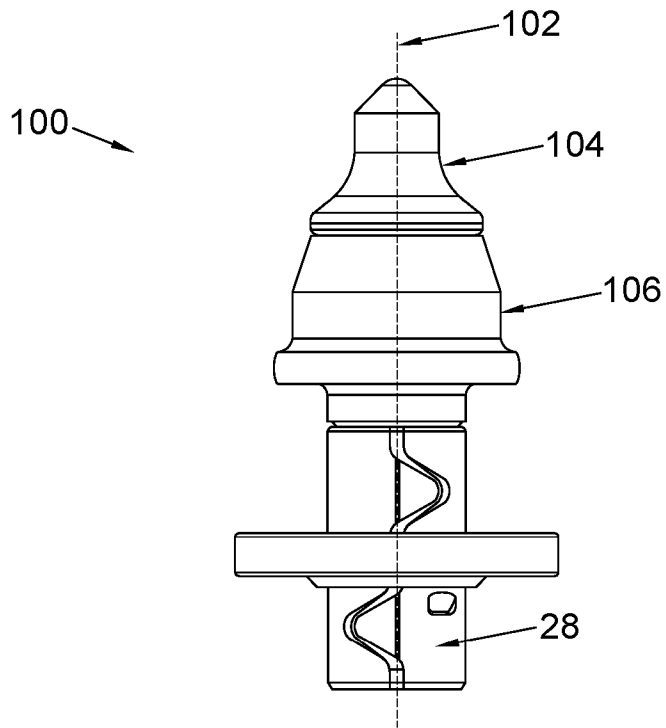


Fig. 5

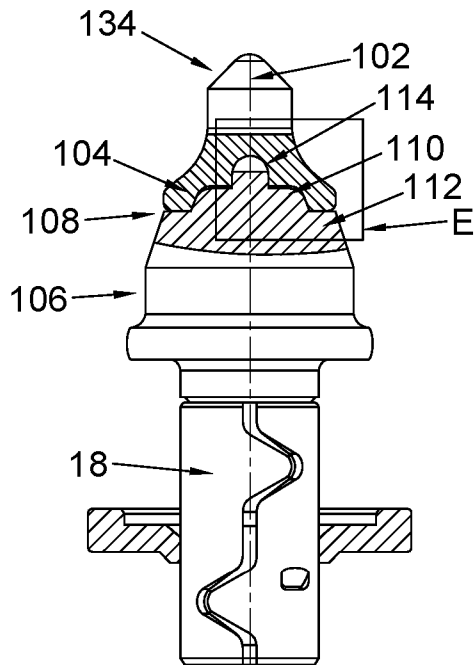


Fig. 6

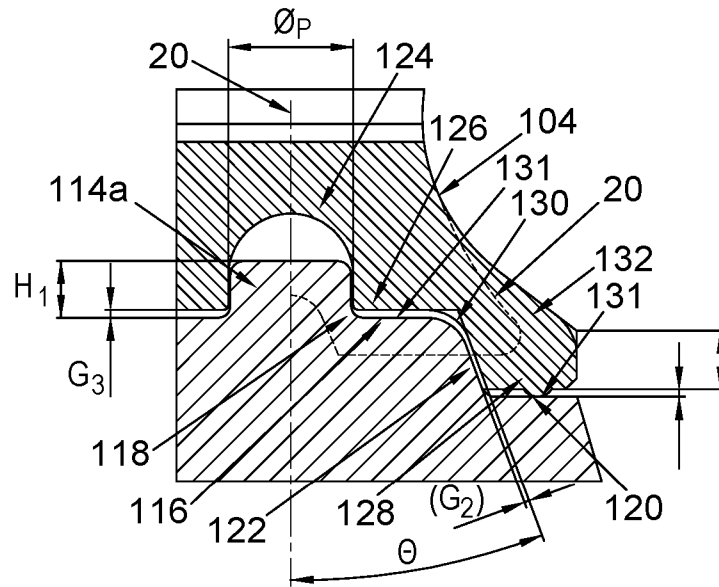


Fig. 7

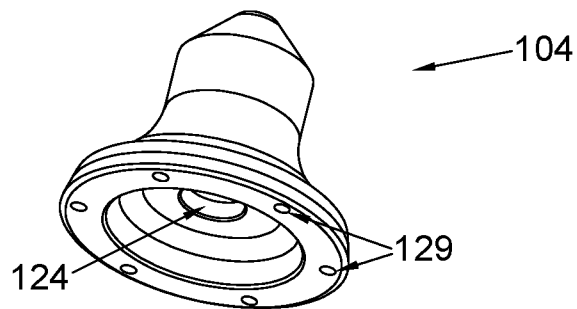


Fig. 8

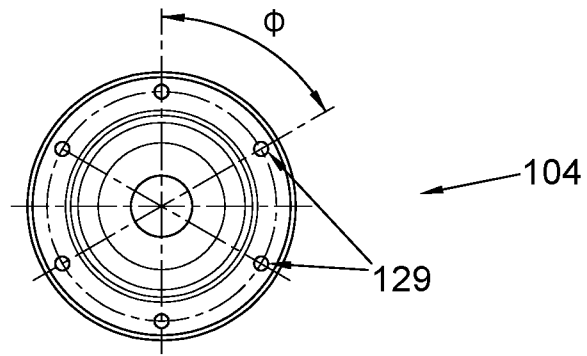


Fig. 9

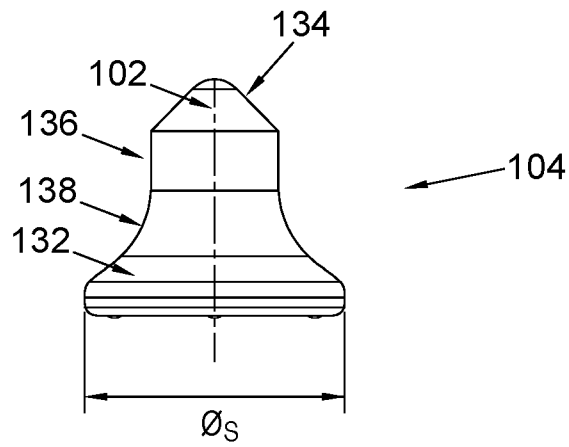


Fig. 10



INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2019/082369

A. CLASSIFICATION OF SUBJECT MATTER  
INV. E21C35/183 E01C23/088 E21C35/18  
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)  
E21C E01C E21B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/002004 A1 (GREENSPAN GREGORY [US] ET AL) 3 January 2013 (2013-01-03) paragraph [0050]; figure 14 -----	1-10,12
X	US 4 941 711 A (STIFFLER STEPHEN P [US]) 17 July 1990 (1990-07-17) column 3, line 24 - line 43; figures -----	1,3-5,7-15
X	US 2009/066149 A1 (HALL DAVID R [US] ET AL) 12 March 2009 (2009-03-12) paragraph [0001] paragraph [0005] paragraph [0019] - paragraph [0020] paragraph [0027] figures 3a, 6 paragraph [0027] ----- -/--	1,3-8,12,15

Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search  4 February 2020	Date of mailing of the international search report  12/02/2020
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Pieper, Fabian
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## INTERNATIONAL SEARCH REPORT

International application No  
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/309146 A1 (HALL DAVID R [US] ET AL) 18 December 2008 (2008-12-18)  paragraph [0018] - paragraph [0019]; figures  -----	1,3-5, 7-10,12, 13,15
X	US 2015/076894 A1 (VOITIC HANNES [AT] ET AL) 19 March 2015 (2015-03-19)  paragraph [0003]; figures  -----	1,3, 5-10,12, 15
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Information on patent family members

International application No PCT/EP2019/082369
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