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(54) Title: CUTTING TIP AND TOOL

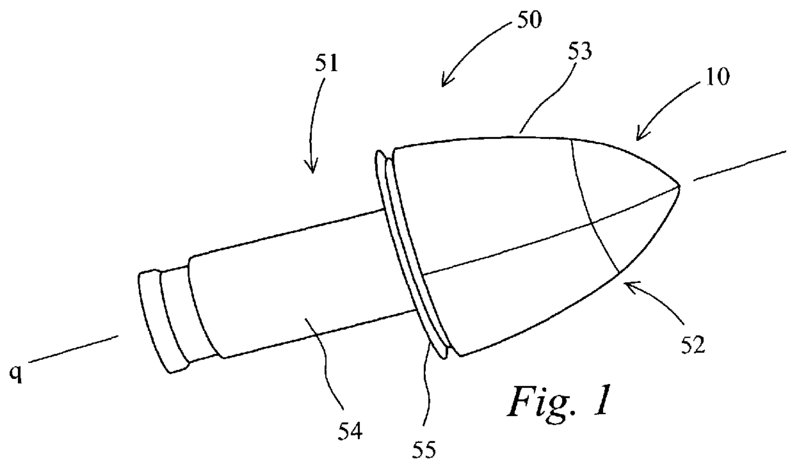

Fig. 1

(57) Abstract: A cutting tip (10) for a mechanical excavator comprises a tip body (11) having a generally pointed distal end (12), a proximal end (13) spaced from the distal end, and a wall (14) that diverges outwardly from the distal end towards the proximal end. The wall (14) is profiled to induce a non-uniform stress profile on the material impacted by the cutting tip to facilitate radial cracking in that material. In one form, the wall (14) is profiled to include a plurality of ridges (15) and intermediate regions (16), with the ridges (15) being arranged to induce a higher stress concentration in the impacted material than the intermediate regions (16).

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CUTTING TIP AND TOOL

Technical Field

The present invention relates generally to mechanical excavation processes and equipment, and more particularly to cutting tools (commonly referred to as cutting picks) for the use in such excavation processes. The invention has been developed especially for mechanical excavators used in the mining industry and the invention is herein described in that context. However, it is to be appreciated that the invention has a broader application and is not limited to that use.

Background

Mechanical excavators that incorporate cutting picks are extensively used in the removal of rock and coal in the mining industry. Such machinery includes roadheaders, continuous miners and longwall shearers. One of the most widely used cutting picks is the "point attack" pick (otherwise known as the conical pick). The tip of these picks, which actually engages in cutting, has a conical geometry and is made of hard material such as tungsten carbide. These picks are popular particularly as they have a relatively long service life.

Despite the popularity of the point attack picks, they are known to generate large amounts of dust due to the indentation action of the conical tip which crushes a considerable volume of coal/rock at the point of impact. The excessive dust has been a major issue, particularly in underground coal mining due to the adverse health effects such as black lung (pneumoconiosis) which has been the biggest killer of underground workers. The usual practices to mitigate the problem of excessive dust, such as blowing large quantities of air at high speed, water spray and installation of dust scrubbers are expensive and only partially effective. In addition to the dust, the point attack pick is known to consume excessive energy and generate excessive noise (which can result in significant hearing loss to those working in the mine) and excess coal fines which are more difficult and hence more costly to process at the coal preparation plant.

Summary of Invention

According to a first aspect, there is provided a cutting tip for a mechanical excavator comprising a tip body having a generally pointed distal end, a proximal end spaced from the distal end, and a wall that diverges outwardly from the distal end towards the proximal end, the wall being profiled to induce a non-uniform stress profile on the material impacted by the cutting tip to facilitate radial cracking in that material.

Accordingly, a modified cutting tip is disclosed which is applicable for point attack picks (having a pointed distal end). The cutting tip of the invention is specifically profiled to induce a non-uniform stress profile so as to facilitate radial cracking in the impacted material. In this way the cutting tip differs from the traditional conical tip which induces a uniform stress profile on the impacted material.

A traditional conical tip has a tendency to compress the impacted material at its point of contact with the indentation action of the pick inducing a large number of circular cracks and this cracking behaviour in turn generates a large volume of small particles in a brittle material such as coal and rock. In contrast, a cutting tip according to the above aspect of the invention is arranged to induce a different cracking behaviour where there is a higher probability of radial cracking. This in turn promotes the removal of larger fragments of material and also less dust due to the reduction of circular cracking. As this process crushes less material it further results in lower energy consumption, less noise and less pick/tip wear.

In one form, the cutting tip has a tip axis and the distal and proximal ends are spaced apart along that axis. Further, the wall of the tip body is profiled to include a plurality of axially extending ridges, and intermediate regions located between those ridges. The ridges are arranged to induce a higher stress concentration in the impacted material than the intermediate regions thereby providing the non-uniform stress profile.

The profiling of the tip body wall to incorporate the ridges may take various forms. In particular the ridges may extend to the proximal end of the tip body, or may terminate prior to the proximal end. Furthermore in a preferred form the ridges extend to the distal end, however, in another form at least some of the ridges may terminate prior to the distal end. Each ridge may be continuous or alternatively some or all may be formed from a plurality of aligned shorter lengths which form collectively the axially extending ridge. Further the individual ridges may extend purely in the direction of the tip axis or alternatively may extend both axially and radially to that axis so that those ridges form a part helix on the tip body wall.

In one form, at least some of the adjacent immediate regions are mutually inclined. In this arrangement the ridges are disposed between respective ones of those mutually inclined intermediate regions and form edges in the tip body. In another form, adjacent intermediate regions may be aligned so that the ridge effectively forms an interruption in the plane of those aligned adjacent intermediate regions.

In one form, the intermediate regions may function as a cutting surface of the tip. In that arrangement, at least one of the intermediate regions may be substantially planar across at least a portion of the region. However, the intermediate regions may be other than planar and may have an arcuate profile at least across a portion of their length. In that arrangement, each ridge has a radius of curvature which is substantially smaller than the respective radius of curvature of the arcuate intermediate region. An intermediate region that incorporates an arcuate potion may be convex, concave or may be of more complex shape including any combination of a planar, concave or convex section.

In one form, the tip body includes at least three ridges.

In a particular form, the cutting tip body has a proximal end that is polygonal. Further, in a particular form, the ridges extend from corners of the proximal end so that the number of ridges corresponds to the number of sides of the polygon.

The dimensions of the cutting tip may vary depending on the tool in which that tip is used. In one form, the ridges typically have a radius of curvature in the range of 0.1mm to 20mm. Further, the wall of the tip body or the ridges diverges outwardly towards the proximal end at a pitch angle of between 30° to 170°. In one form, the angle is such that in use the cutting tip forms a negative rake angle on impact. The pitch angle of the tip body that will cause a negative rake angle is a function of the attack angle at which the cutting tool is presented to the material surface. However, typically an pitch angle of between 100° and 140° may be sufficient to produce the negative rake angle. The advantage of a negative rake angle is that it can increase the compressive stress applied to the material thereby facilitating cracking.

In one form, the distal end has a tip radius of between 0.2mm to 5mm.

Typically the cutting tip is arranged to be mounted on a cutting tool bit. In one form, a coupling is disposed at the proximal end of the tip body to allow for this mounting. In one form, the coupling is in the form of a projection that is arranged to be received in a corresponding recess in the tool bit. In an alternative arrangement, the coupling is in the form of a recess with the tool bit incorporates the corresponding projection. Typically the cutting tip is securely mounted to the tool bit by any suitable means such as by a welding or by a mechanical fastening arrangement.

The tips are made from a hard material such as sintered tungsten carbide. However, other hard materials such as diamond, polycrystalline diamond (PCD), cubic born nitride (CBN) and polycrystalline cubic born nitride (PCBN) may also be used as the tip material as will be appreciated by those in the art.

In a further aspect, the invention is directed to a cutting tool which comprises a bit body and a cutting tip according to any form described above disposed at a leading end of that bit body. In a particular form, the cutting tool is arranged to be mounted to a tool holding device in a manner that allows rotation of the cutting tool about a central axis which extends through the cutting tip.

An advantage of the cutting bit according to the above form is that it may be installed on conventional excavators which have previously been designed for use with point attack picks having conical tips.

A Brief Description of the Drawings

It is convenient to hereinafter describe embodiments of the present invention with reference to the accompanying drawings. It is to be appreciated that the particularity of the drawings and the related description is to be understood as not superseding the generality of the preceding broad description of the invention.

In the drawings:

Fig 1 is a schematic view of a cutting tool according to an embodiment of the invention;
Fig 2 is a side view of the cutting tip of the tool of Fig 1;
Fig 3 is a top plan view of the tip of Fig 2;
Fig 4 is a bottom plan view of the tip of Fig 2;
Fig 5 is a schematic view of a second embodiment of the a cutting tool according to the invention;
Fig 6 is a schematic view of the position of the cutting tool of Fig 1 when impacting a material surface; and
Fig 7 is a schematic representation of the cracking behaviour of a brittle material impacted by the cutting tip of Fig 2.

Detailed Description of the Invention

Fig 1 illustrates a cutting tool 50 (otherwise known as a cutting pick) for a mechanical excavator. The cutting tool 50 includes two main components, a cutting bit 51 and a hard insert otherwise known as a cutting tip 10 which is disposed at a forward end 52 of the cutting bit 51. The cutting tip 50 is securely mounted to the forward end 52 of the cutting bit 51 so that it can accommodate the significant forces impacted on the cutting pick in use. The cutting tip may be braze welded onto the cutting bit and may also include a projection or recess which is received in a complementary shaped recess or projection in the cutting bit. Other fastening or mounting arrangements including releasable mechanical fastening arrangements may also be used and are within the ambit of the disclosure.

The cutting pick 50 includes a central axis CL and is generally symmetrical about that axis. In use, the cutting pick 50 is mounted to a pick holding device so as to be able to be rotatable about the axis CL which allows for more even wear of the cutting tip 10.

The cutting bit 51 includes an enlarged head portion on which the cutting tip is mounted and a cylindrical shank 54 which extends rearwardly from a proximal end 55 of the bit head 53. This shank 54 which is of conventional form is mounted into a pick holding device of the excavator in a manner that prevents axial movement of the pick 50 but allows it to rotate about the pick axis CL.

In use, a plurality of the picks 50 are typically mounted in respective pick holding devices which are mounted on a rotatable drum of the excavator. The picks 50 extend outwardly from the drum and as the drum rotates it is moved across the rock face in a cutting direction. In this way the picks impact the rock face at an angle (commonly referred to as the attack angle) and a typical orientation of the cutting pick when impacting the rock material is schematically disclosed in Fig 6. With reference to Fig 6, the attack angle α is less than 90° and typically in the order of 55° whereas the rake angle β is a function of the pitch angle σ and the attack angle α. In the illustrated form, as the pitch angle σ of the cutting tip is large, the rake angle β is negative (ie. it extends beyond a line normal to the rock surface). Whilst a negative rake angle is not essential to the invention, it is beneficial as it is considered to improve the effectiveness of the cutting action of the pick.

Figures 2 to 4 illustrate the geometry of the cutting tip

10 in more detail. In general, the cutting tip 10 includes a tip body 11 having a pointed distal point end 12 and a broader proximal end 13. The pointed distal end 12 locates on the centre axis CL of the cutting tip which coincides in use with the central axis CL of the tip cutting pick as illustrated in Fig 1. In one form the distal end 12 is generally hemispherical and has a tip radius r_1 in the order of 0.2mm to 5mm.

The cutting tip 10 further includes a wall 14 that diverges outwardly from the distal end 12 to the proximal end 13. Unlike previous point attack picks which induces a uniform stress profile in the material on impact by the cutting tip, the wall is specifically profiled to produce a non-uniform stress profile that facilitates radial cracking in the material on impact. In the illustrated form as shown in Fig 2, the cutting tip wall 14 is profiled to incorporate a plurality of axially extending ridges 15 that extend from the proximal end to the distal end and a plurality of intermediate regions 16 which are located between these ridges. As best illustrated in Figs 3 and 4 the proximal end 13 of the cutting tip 10 is approximately square (with or without rounded corners) with the ridges 15 extending from the corners of the square end to the pointed distal end 12. As such, the cutting tip includes four ridges 15 and four intermediate regions 16 and has a tip geometry somewhat akin to a square pyramid. The ridge profile may vary as to how sharply defined it is but typically has a radius of curvature r_2 in the range of 0.1mm to 20mm. With this arrangement, the intermediate regions 16 form discrete faces of the tip body 14. These faces are mutually inclined and the ridges 15 form the corners between adjacent faces. Furthermore, whilst these intermediate regions are generally planar they may not be flat but rather are arcuate and bow from the proximal end 13 to the distal tip as best illustrated in profile in Fig 2.

The amount of bowing of the intermediate regions 16 influences the resultant rake angle of the cutting pick as illustrated in Fig 6. In the illustrated form, the intermediate regions are bowed so as to provide a pitch angle σ at the distal end in the order of 120° to 140°. This provides a strong apex to the tip geometry. However the geometry of the cutting tip could be such that the pitch angle σ varies more widely than this range and typically can range between 30° and 170°. Also, the pitch angle of the cutting tip may vary along the intermediate regions towards the proximal end. In the illustrated form, the intermediate regions have a second pitch angle near the proximal end of the tip body that is smaller than the pitch angle at the distal end to provide a relief for the cutting tip and hence minimises wear during cutting.

Whilst the intermediate regions are shown in the illustrated embodiment to be generally convex as they bow towards the distal end, in an alternative embodiment, these regions may be bowed inwardly to be concave in this orientation. Further these concave regions could extend across the width of each region or could apply only to a portion (typically a mid portion) of that region.

Furthermore, the ridges may be arranged to follow the profiling of the intermediate regions and in the illustrated embodiment the ridges 15 follow the convex orientation of the intermediate regions 16 as they bow towards the distal end 12. However, by varying the height of the ridges along their length, the ridges may have a different orientation to intermediate regions and accordingly may extend in a straight line, may be convex or concave irrespective of the configuration of the intermediate regions (i.e. whether those regions are flat, concave or convex). In this way it provides more opportunity to optimise the cutting tip geometry in respect of its ability to enhance cracking, have effective cutting surfaces and good wear performance.

In the illustrated form, the cutting tip 10 further includes a coupling 17 which extends outwardly from the proximal end 13 of the tip body 11 (Fig. 2). In the illustrated form, the coupling is in the form of a stub shank which is cylindrical and which is arranged to locate within a corresponding recess in the leading end 52 of the tool bit body 51. It is to be appreciated that the construction of the coupling can take other forms as will be appreciated by those skilled in the art.

In utilizing the tip geometry that incorporates the ridges 15, the stress profile on the impacted material is non-uniform and more specifically, the ridges are arranged to induce a higher stress concentration in the impacted material than the intermediate regions. This higher stress concentration in turn promotes radial cracking in that material rather than the predominantly circular cracking which occurs with traditional conical tips. The instance of enhanced radial cracking is illustrated in Fig 7 where a tip having the tip geometry of Fig 2 has been impacted onto a brittle material 100 inducing defined radial cracks 101. The advantage of inducing the different cracking behaviour promotes the removal of larger fragments of material and also less dust due to the reduction of circular cracking. Further the tip geometry as illustrated in Fig 2 crushes less material than a traditional conical tip and further results in lower energy consumption, less noise and less pick tip wear.

Whilst the tip geometry shown in Figs 1 to 4 has a generally square base other tip geometries can be provided which have the advantageous cracking behaviour as discussed above. For example, Fig 5 illustrates a variation where a cutting pick 60 includes a cutting tip

10 having a tip geometry including a pentagonal base thereby resulting in five ridges rather than the four in the earlier embodiment.

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

Variations and/or modifications may be made to the parts previously described without departing from the spirit or ambit of the invention.

CLAIMS:

1. A cutting tip for a mechanical excavator comprising a tip body having a generally pointed distal end, a proximal end spaced from the distal end, and a wall that diverges outwardly from the distal end towards the proximal end, the wall being profiled to induce a non-uniform stress profile on the material impacted by the cutting tip to facilitate radial cracking in that material.

2. A cutting tip according to claim 1, wherein the cutting tip has a tip axis and the distal and proximal ends are spaced apart along that axis, and wherein the wall is profiled to include a plurality of axially extending ridges, and intermediate regions located between said ridges, wherein the ridges are arranged to induce a higher stress concentration in the impacted material than the intermediate regions.

3. A cutting tip according to claim 2, wherein the ridges extend to the distal end of the tip body.

4. A cutting tip according to claim 2 or 3, wherein at least some adjacent intermediate regions are mutually inclined and the ridges disposed between respective ones of those mutually inclined intermediate regions form edges of the tip body.

5. A cutting tip according to any one of claims 2 to 4, wherein at least one of the intermediate regions is substantially planar across at least a portion of that region.

6. A cutting tip according to any one of claims 2 to 5, wherein at least one of the intermediate regions is arcuate and the ridges each have a radius of

curvature which is substantially smaller than the respective radius of curvature of the or each arcuate intermediate region.

7. A cutting tip according to any one of claims 2 to 6, wherein the ridges have a radius of curvature in the range of 0.1mm to 20mm.

8. A cutting tip according to claim 6 or 7, wherein the at least one of the intermediate regions is convex across at least a portion of that region.

9. A cutting tip according to any one of claims 6 to 8, wherein at least one of the intermediate regions is concave across at least a portion of that region.

10. A cutting tip according to any one of claims 2 to 9, wherein the tip body includes at least three ridges.

11. A cutting tip according to any one of claims 2 to 10, wherein the proximal end of the tip body is polygonal and the ridges extend from corners of the proximal end.

12. A cutting tip according to any preceding claim, wherein the wall of the tip body diverges outwardly towards the proximal end and having a pitch angle at the distal end of between 30°-170°.

13. A cutting tip according to any preceding claim, wherein the distal end has a tip radius of between 0.2mm to 5mm.

14. A cutting tip according to any preceding claim, further comprising a tip axis about which the cutting tip rotates in use.

15. A cutting tip according to claim 14, wherein the distal end is located on the tip axis.

16. A cutting tip according to any preceding claim, further comprising a coupling disposed at the proximal end of the tip body and being arranged to mount the cutting tip into a cutting tool bit.

17. A cutting tip according to claim 16, wherein the coupling is in the form of a projection that is arranged to be received in a corresponding recess in the tool bit.

18. A cutting tip according to claim 16, wherein the coupling is in the form of a recess that is arranged to be received in a corresponding projection in the tool bit.

19. A cutting tool comprising bit body having a leading end, and a cutting tip according to any preceding claim disposed at the leading end.

20. A cutting tool according to claim 18, wherein the cutting tip is mounted to the bit body and is formed from a harder material than the bit body.

21. A cutting tool according to either claim 18 or 19 wherein the cutting tool is rotatable about a tool axis.

22. A cutting tool according to claim 20 wherein the tool axis extends through the distal end of the cutting tip.

23. A cutting tip substantially as herein described with reference to the accompanying drawings.

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

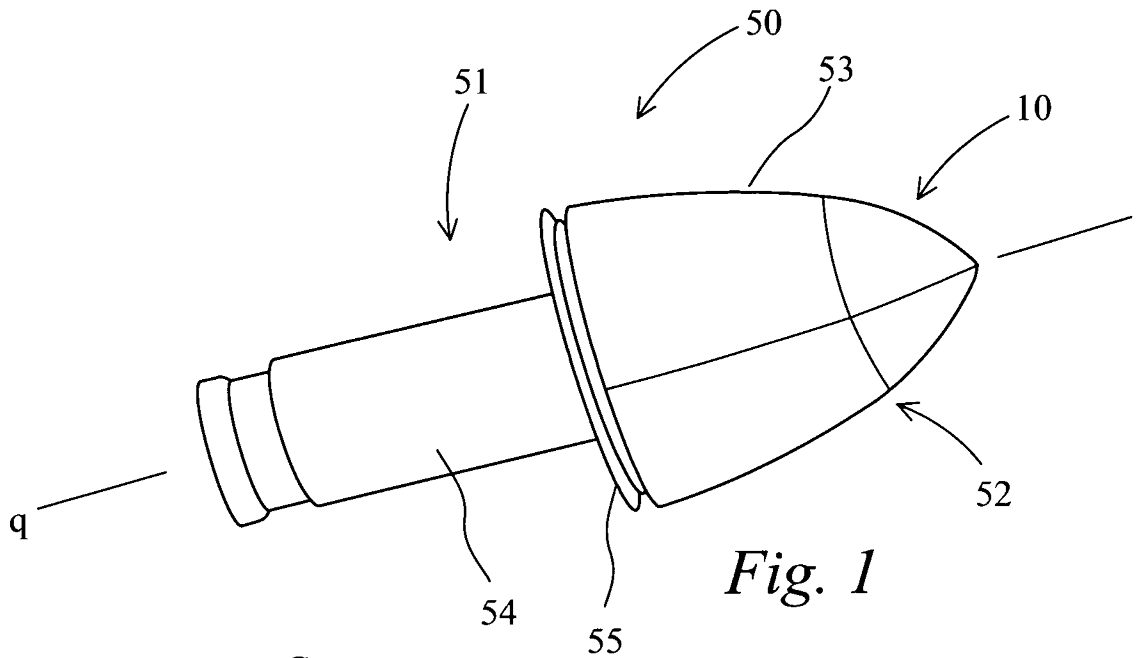

Fig. 1

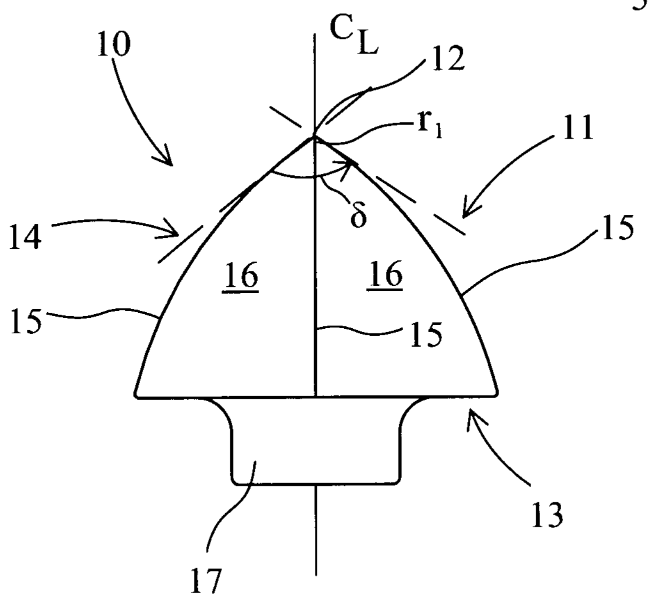

Fig. 2

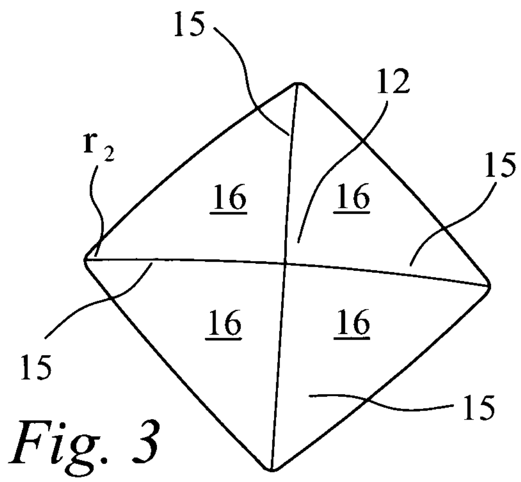

Fig. 3

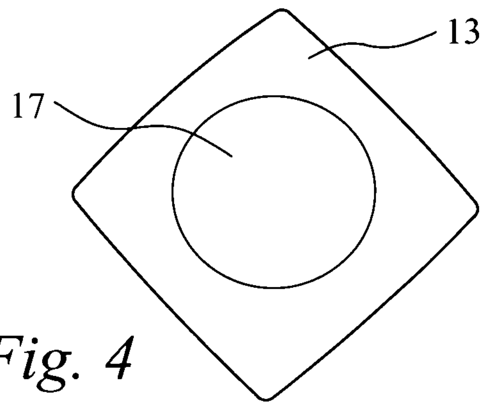

Fig. 4

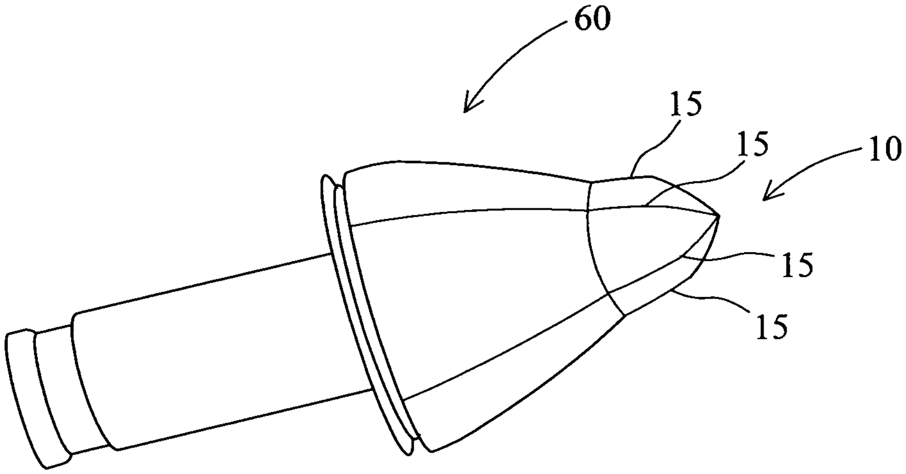

Fig. 5

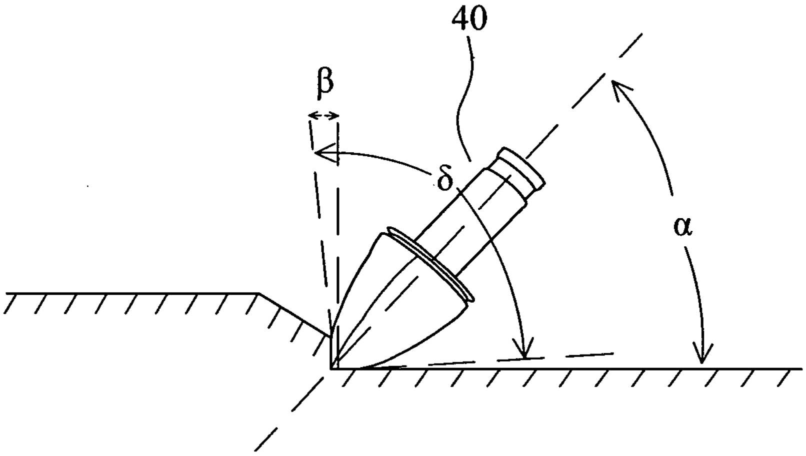

Fig. 6

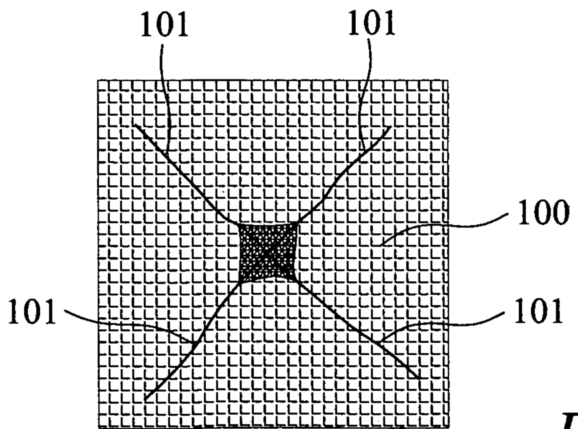

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2008/000969

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

E21C 35/18 (2006.01)

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)

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)

DWPI : IPC as above and Keywords (wall, face, diverg+, taper+, profil+, shape, conical, point+, convex, hemi+, stress)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5551760 A (SOLLAMI) 3 September 1996 See whole document, particularly the drawings	1-18
X	US 5324098 A (MASSA et al) 28 June 1994 See drawings and column 6 line 16 to column 7 line 44	1-18
X	US 2004/0065484 A1 (McALVAIN) 8 April 2004 See figures 4-7	1-18
X	US 5702160 A (LEVANKOVSKII et al) 30 December 1997 See Drawings	1, 12-24

[X] Further documents are listed in the continuation of Box C [X] 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

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"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
08 August 2008	14 AUG 2008

Name and mailing address of the ISA/AU	Authorized officer
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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 4865392 A (PENKUNAS et al) 12 September 1989 See column 2 line 18 to column 3 line 18	1, 12-24
X	EP 259620 A1 (KENNAMETAL INC.) 16 March 1988 See drawings and column 7 lines 10-17	1, 12-24
A	WO 2005/088073 A1 (DIGGA AUSTRALIA PTY LTD) 22 September 2005	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2008/000969

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5551760	US	5484191				
US	5324098	AU	54519/94	BR	9307773	CA	2150246
		EP	0673468	MX	9307066	PL	309389
		WO	9413932	ZA	9309368		
US	2004065484						
US	5702160	EP	0757157	FI	964140	WO	9625585
US	4865392	US	4725099				
EP	0259620	AR	243251	AU	77179/87	BR	8704556
		DK	467587	ES	2005287	JP	63078993
		ZA	8706082				
WO	2005088073	AU	2005222446	EP	1738059	US	2007205652

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX