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(54) A pick body

(57) A pick body comprising a shank, a substrate (101) and an impact resistant tip (103) bonded to the substrate (101) and exposed to perform a cutting action in a forward direction in use, the impact resistant tip having an exposed layer of superhard material selected from PCD, PCBN, single crystal diamond and cBN composite materials, wherein the impact resistant tip is of conical, frustoconical, ballistic, hemispherical, chisel or wedge shaped including a rounded top and wherein a thickness of the layer of superhard material is from about 0.05mm to about 2.3mm from an apex of the tip of the conical, frustoconical, ballistic, hemispherical, chisel or wedge shape to the substrate.

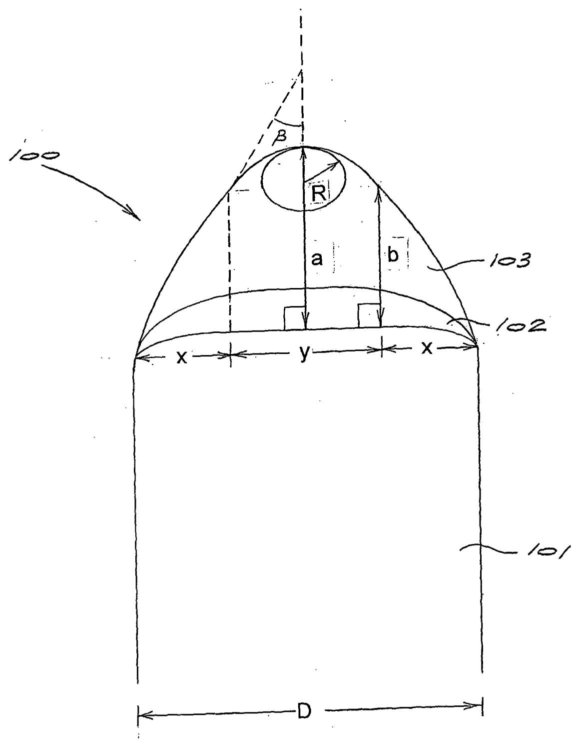

FIGURE 1

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Description

INTRODUCTION

[0001] The present invention relates to picks comprising a shank, a substrate and an impact resistant tip bonded to the substrate and exposed to perform a cutting action in a forward direction in use. The invention further relates to high impact resistant tools including such picks, and to use of such tools in methods of formation degradation.

BACKGROUND OF THE INVENTION

[0002] Picks are used as cutting tools in machinery for formation degradation applications such as the mining of coal, the tunneling through of rock, surface mining and in road surfacing, road milling and trenching. The term "pick" typically means a pointed or chisel shaped rock cutting tool which cuts rock by penetrating and scraping along the surface of the rock, asphalt or concrete. Picks typically consist of a steel shank with a tapered front end with a pointed tungsten carbide-cobalt tool forming the cutting tip.

[0003] An array of picks is typically mounted onto a rotating barrel or drum or mining machine which engages the picks with the material to be removed. Picks are generally axi-symmetric and mounted such that they themselves can rotate around their own axis. Pick rotation is typically facilitated by mounting the pick into a cylindrical aperture of a mounting block which in turn is permanently attached to the drum or mining machine. Load is transmitted onto the tool via an annular flange which mates with the planar front surface of the mounting block.

[0004] As the picks engage the working surface of the material to be removed they are subject to a range of wear modes which include severe impact and loading in various directions often resulting in bending moments, as well as severe abrasive and thermal wear due to the removed material being hard, inhomogeneous and abrasive and scraping continuously along the tip and body of the pick.

[0005] The severe and rapid wear of the carbide tip and pick body is the prime reason for introducing rotating picks. The rotational action allows the tip and pick body to wear symmetrically around the axis and a degree of self sharpening is induced. As a result undermining and one-sided wear are avoided. This increases the overall lifetime of the pick avoiding premature failure through breakage or bluntening of the tip to a point where no further cutting action is achieved.

[0006] Whilst being significantly more wear resistant than hard metals, polycrystalline diamond (PCD), also known as a diamond abrasive compact, tends to be brittle. In use such materials are frequently bonded to a cemented carbide substrate to afford support. Such supported abrasive compacts are known in the art as composite diamond abrasive compacts. Composite diamond abrasive compacts may be used as such in a working surface of an abrasive tool.

[0007] Polycrystalline cubic boron nitride (PCBN), also known as a cubic boron nitride abrasive compact, is another superhard abrasive material which can, in use, be bonded to a substrate such as a cemented carbide substrate.

[0008] Abrasive compacts bonded to a cemented carbide substrate made at HPHT conditions are brought into or close to an equilibrium state at those conditions. Bringing the compacts to conditions of normal temperature and normal pressure induces large stresses in the abrasive compact due to the different thermal and mechanical/elastic properties of the abrasive layer and the substrate. The combined effect is to place the abrasive layer in a highly stressed state. Finite element analysis shows that the abrasive layer may be in tension in some regions whilst being in compression elsewhere. The nature of the stresses is a complex interaction of the conditions of manufacture, the nature of the materials of the abrasive layer and the substrate, and the nature of the interface between the abrasive layer and the substrate, amongst others. In service, such a stressed abrasive compact is predisposed to premature failure by spalling, delamination and other mechanisms. That is to say, the abrasive compact fails prematurely due to separation and loss of all or part of the abrasive layer from the cutting surface of the abrasive compact, and the higher the residual stresses, the greater is the probability of premature failure.

[0009] This problem is well recognised in the industry and there have been a number of techniques applied in an attempt to solve it.

[0010] Various abrasive compact structures have been proposed in which the interface between the abrasive layer and the supporting substrate contains a number of ridges, grooves, indentations or asperities of one type or another aimed at reducing the susceptibility of the interface to mechanical and thermal stresses. Such structures are taught, for example, in U.S. Pat. Nos. 4,784,203, 5,011,515, 5,486,137, 5,564,511, 5,906,246 and 6,148,937. In effect, these patents focus on distributing the residual stresses over the largest possible area. Further examples of composite abrasive compacts which have non-planar interfaces can be found described in US Pat. Nos. 5,154,245, 5,248,006, 5,743,346, 5,758,733, 5,848,657, 5,871,060, 5,890,552, 6,098,730, 6,102,143 and 6,105,694.

[0011] Another method applied in attempting to solve the problem of a highly stressed composite abrasive compact is to provide one or more interlayers of a different material with properties, particularly thermal and mechanical/elastic properties, intermediate between the properties of the substrate and the abrasive layer. The purpose of such interlayers is to accommodate some of the stresses in the interlayers and thereby reduce the residual stresses in the abrasive layer.

[0012] This method is exemplified by U.S. Pat. No. 5,510,913 which provides for an interlayer of sintered polycrystalline cubic boron nitride. Another example is U.S. Pat. No. 5,037,704 which allows the interlayer to comprise cubic boron nitride with aluminium or silicon and at least one other component selected from the group comprising the carbides, nitrides and carbonitrides of the elements of Groups 4A, 5A and 6A of the Periodic Table of the Elements. A further example, U.S. Pat. No. 4,959,929, teaches that the interlayer may comprise 40% to 60% by volume cubic boron nitride together with tungsten carbide and cobalt.

[0013] In yet another approach, U.S. Pat. No. 5,469,927 teaches that the combination of a non-planar interface and transition layers may be used. In particular, this patent describes the use of a transition layer of milled polycrystalline diamond with tungsten carbide in the form of both particles of tungsten carbide alone and precemented tungsten carbide particles. Furthermore, there is provision for tungsten metal to be mixed into the transition layer to enable excess metal to react to form tungsten carbide *in situ.*

[0014] Further examples of composite diamond abrasive compacts having one or more interlayers can be found described in US Pat. Nos. 3,745,623, 4,403,015, 4,604,106, 4,694,918, 4,729,440, 4,807,402, 5,370,195, 5,469,927, 6,258,139 and 6,315,065 and US patent publication no. 2006/0166615 A1.

[0015] Finally, improvements in impact resistance have been demonstrated by employing a solid self-supporting PCD layer where the yield strength of the layer is at least as high as the yield strength of the hard metal substrate (US Pat. No. 5,890,552).

[0016] The prior art on improving impact resistance has been established primarily in the context of shear bit drilling, roller cone drilling and to a lesser degree for percussive hard rock drill bits. Little is known as to what is the optimum design for PCD cutters for pick applications.

[0017] The following patents and patent applications describe picks with composite diamond compact tips: US 4,944,559, US 6,051,079, US 6,733,087,US 2003/0209366, US 2004/0026983, US 2004/0065484. The picks described in these documents are all of the rotatably mounted type. The PCD tips are not described in great detail.

[0018] An alternative concept of a non-rotating plough-type pick with a planar cylindrical PCD cutter as cutting element has been disclosed in US Pat Nos. US 4,733,987, US 4,902,073, US 5,722,733 and US 6,283,844. In this arrangement the shank is mounted non-rotatably in the mounting block.

[0019] Whilst there is a strong need to extend the lifetime of picks in application, all the published PCD pick solutions have significant drawbacks:-

- The moving parts associated with rotating picks become the weak link once the lifetime of the pick is extended by using a PCD tip. Significant wear and ultimately failure is seen through the actions of shank moving against and within the mounting block aperture together with sleeve and washer. Fragments of rock or asphalt cause significant erosion and failure of joints well before the PCD tip is worn out. At the same time, the dramatically increased wear resistance of PCD over carbide results in a tip that does not blunt appreciably over the lifetime of the pick and eliminates the need to generate a symmetrical wear pattern in the tip through rotation.
- The only PCD-tipped non-rotating pick reported in the prior art uses a planar cutter with a PCD layer having a planar or stepped planar interface. This solution is very susceptible to impact damage. Particular weaknesses are firstly the brittle sharp corner presented as the cutting edge to the rock, and secondly the high directional dependence of impact resistance. Good impact resistance is only seen if the impact is normal to the top PCD surface. Any side impact is likely to cause the PCD table to shear off from the substrate due to lack of carbide support and the residual stresses between substrate and PCD layer.

[0020] There is therefore a need for optimized wear and impact resistant pick bodies for mining and road working applications.

SUMMARY OF THE INVENTION

[0021] According to a first aspect to the present invention there is provided a pick body comprising a shank, a substrate and an impact resistant tip bonded to the substrate and exposed to perform a cutting action in a forward direction in use, the impact resistant tip having an exposed layer of superhard material selected from PCD, PCBN, single crystal diamond and cBN composite materials, wherein the impact resistant tip is of conical, frustoconical, ballistic, hemispherical, chisel or wedge shaped including a rounded top and wherein a thickness of the layer of superhard material is from about 0.05mm to about 2.3mm from an apex of the tip of the conical, frustoconical, ballistic, hemispherical, chisel or wedge shape to the substrate.

[0022] The superhard material may be selected from polycrystalline diamond (PCD), vapour deposited diamond, natural diamond, cubic boron nitride, infiltrated diamond, layered diamond, diamond impregnated carbide, diamond impregnated matrix, silicon bonded diamond or combinations thereof.

[0023] The shank of the pick body is preferably adapted to be received non-rotatably in use in a tool holder or mounting block. As such, the pick body may include a base with the shank extending from the base wherein the shank is threaded to engage with corresponding threading in a mounting block or tool holder bore. Alternatively or in conjunction with the above, the shank may be eccentric with respect to the base, preferably in the forward direction. The pick body is receivable in the tool holder or mounting block by brazing, press fit, adhesive or other means of attachment known in the art.

[0024] Preferably the superhard material is PCD.

[0025] The PCD may comprise an impact resistant grade of diamond with an average grain size range greater than 10 um. The grain size is preferably less than 30 um.

[0026] The superhard layer preferably includes an average cobalt content greater than 15 % by weight. The cobalt content is preferably less than 20 wt.%. Other material which may be included in the superhard layer and/or substrate include iron, nickel, ruthenium, rhodium, palladium, chromium, manganese, tantalum or combinations thereof.

[0027] The superhard layer may be constructed from multimodal diamond.

[0028] In a preferred embodiment the pick body includes a front end located between the tip and the shank, the front end having a wear resistant surface comprising high quality steel, hardened steel and/or hard metal. The front end may be coated with or include a hard-facing, or other abrasion resistant coated or treated portion.

[0029] Preferably the rounded top of the superhard layer has a radius greater than 0.5 mm. The top of the superhard layer is preferably conical or ballistic shaped with the half cone angle not exceeding 60 degrees.

[0030] Preferably the superhard layer is at least 1 mm thick in all working directions over a central working surface comprising the inner ½ of the working surface diameter of the substrate.

[0031] In a preferred embodiment of this aspect to the present invention, the layer over the central working surface is PCD, is between 1 and 2.3 mm thick in all working directions and tapers off towards the outer diameter of the tip.

[0032] The substrate is preferably a cemented carbide substrate such as cemented tungsten carbide, cemented tantalum carbide, cemented titanium carbide, cemented molybdenum carbide or a mixture thereof. The cemented carbide substrate may contain particles of a grain inhibiting agent such as titanium carbide, tantalum carbide, vanadium carbide or a mixture thereof. The binder metal for such cemented carbide may be any known in the art such as nickel, cobalt, iron or an alloy containing one or more of these metals. Typically the binder will be present in an amount of 6 to 20% by mass. Some of the binder metal may infiltrate the abrasive compact during High Pressure High Temperature (HPHT) treatment. A shim or layer of binder may be used for this purpose.

[0033] To improve the service life of the tip, it is preferable to reduce the residual stresses induced in the tip, inter alia, as a result of the HPHT treatment. The residual stresses due to the thermal expansion differences between the abrasive layer and the substrate may be minimised providing a graduated change in thermal expansion from the substrate to the outer or working region of the abrasive compact layer (tip).

[0034] More particularly this may be achieved by the introduction of a number of intermediate regions or layers between the outer abrasive region or layer and the substrate, each region or layer having a thermal expansion such that there is a graduated change in thermal expansion from the outer region or layer to the substrate. The control of thermal expansion may be achieved by admixing one or more types of refractory particles of low thermal expansion with superhard abrasive particles, and adjusting the relative proportions of superhard abrasive particles and refractory particles to achieve the desired thermal expansion. A metal or alloy may be present in each or some of the regions.

[0035] When such a metal or alloy is present, the amount relative to the amount of superhard abrasive particle and refractory particle may be adjusted to achieve the desired graduated thermal expansion. Examples of suitable refractory particles with low thermal expansion are carbides, oxides and nitrides of silicon, hafnium, titanium, zirconium, vanadium and niobium, an oxide and nitride of aluminium, cubic boron nitride, and carbides of tungsten, tantalum and molybdenum. Tungsten carbide is a particularly suitable refractory particle. Examples of suitable metals and alloys are nickel, cobalt, iron or an alloy containing one or more of these metals.

[0036] Preferably, the metal or alloy is the same as the metal or alloy present in the cemented carbide substrate.

[0037] The proportion of superhard abrasive particles is generally in the range 20 to 80 volume per cent of the region and the proportion of refractory particles is generally in the range 80 to 70 volume per cent of the region. The metal binder, when used, is generally present in the amount of about 8 to 12 volume per cent of the total volume of the particles. In one embodiment of the present invention, the proportion of superhard particles is about 25 volume per cent, the proportion of refractory particles is about 75 volume per cent, and the metal binder about 10 volume per cent. It will be appreciated, however, that if there is only a single interlayer, a 50/50 mix of carbide and diamond by volume may be selected. In the event there are three interlayers present, the first interlayer, closest to the substrate, preferably contains 25 vol% diamond and the two subsequent interlayers 50 and 75 vol. % respectively.

[0038] In the tip the superhard abrasive particles are generally in the particle size range 5 to 100 microns, and preferably in the size range 15 to 30 microns.

[0039] The superhard particles are characterised by containing at least three, and preferably four, different particle sizes. The proportion of metal binder is about 2 per cent of the volume of superhard abrasive particles. In the case of a mixture comprising three particle sizes, an example of the composition by average particle size is :

Average particle size	Per cent by mass
greater than 10 microns	at least 20
between 5 and 10 microns	at least 15

(continued)

Average particle size	Per cent by mass
less than 5 microns	at least 15

[0040] The term "average particle size" as used above and hereinafter means that a major amount of the particles by mass will be close to the specified size although there will be some particles larger and some particles smaller than the specified size. Thus, for example, if the average particle size is stated as 20 microns, there will be some particles that are larger and some particles that are smaller than 20 microns, but the major amount of the particles will be at approximately 20 microns in size and a peak in the size distribution by mass of particles will be at 20 microns.

[0041] The term "percent by mass" as used above and hereinafter means that the percentages are the percentages by mass of the entire abrasive particle mass.

[0042] A specific particle size composition containing three particle sizes which is useful for the superhard layer is:

Average particle size	Per cent by mass
12 microns	25
8 microns	25
4 microns	50

[0043] In the case of a mixture comprising four diamond particle sizes, an example of the composition by average particle size is:

Average particle size	Per cent by mass
25 to 50 microns	25 to 70
15 to 24 microns	15 to 30
8 to 14 microns	5 to 45
less than 8 microns	minimum 5

[0044] A specific particle size composition containing four particle sizes which is useful for the superhard layer is:

Average particle size	Per cent by mass
30 microns	65
22 microns	20
12 microns	10
4 microns	5

[0045] A specific composition containing five particle sizes which is useful for the superhard layer is:

Average particle size	Per cent by mass
22 microns	28
12 microns	44
6 microns	7

(continued)

Average particle size	Per cent by mass
4 microns	16
2 microns	5

[0046] In all regions, the binder metal powder, when present, will generally have a particle size of less than 10 microns, and preferably will be about 3 microns.

[0047] Preferably the substrate has a hardness of at least 1000 Hv, preferably at least 1100Hv, more preferably at least 1200Hv, most preferably at least 1300Hv. The hardness is preferably less than 2500Hv, more preferably less than 2400Hv, more preferably less than 2300Hv, most preferably less than 2200Hv.

[0048] In a preferred embodiment of the present invention the pick contains 8% Co, 2-3 um average grain size, 1400-1500 Hv

[0049] In one embodiment of the invention the pick body includes at least one interlayer between the superhard layer and the substrate which interlayer has a thermal expansion coefficient and Young's modulus between those of the superhard layer and the substrate. The effect of this is to reduce peak mismatch stress between the superhard layer and the substrate.

[0050] A pick body may therefore include one or more composite interlayers of intermediate thermo-mechanical properties as hereinbefore described. In this regard reference is made to WO03/064806, the contents of which are incorporated herein by reference.

[0051] As such the superhard layer may be PCD and the substrate of high compressive strength and matched thermo-elastic properties to the PCD layer.

[0052] The term 'high compressive strength" is defined to include compressive strengths of greater than 2000 N/mm^2, preferably greater than 2200 N/mm^2, more preferably greater than 2400 N/mm^2, more preferably greater than 2600 N/mm^2, more preferably greater than 2800 N/mm^2, most preferably greater than 3000 N/mm^2 and less than 6000 N/mm^2, preferably less than 58000 N/mm^2, more preferably less than 5600 N/mm^2, more preferably less than 5400 N/mm^2, more preferably less than 5200 N/mm^2, most preferably less than 5000 N/mm^2.

[0053] Examples of preferred compressive strength are between 4500 ± 200 N/mm^2 and 3600 ± 200 N/mm^2.

[0054] The substrate is preferably a carbide, most preferably a metal carbide substrate. The substrate may comprise 6 - 10 % by weight cobalt. The carbide substrate may further comprise tungsten, titanium, tantalum, molybdenum, niobum, cobalt and/or combinations thereof, as hereinbefore described.

[0055] Preferably the superhard layer is bonded to the substrate via a non-planar interface.

[0056] The interlayer(s) may be bonded to the substrate via a planar or non-planar interface.

[0057] According to a second aspect to the present invention there is provided a high impact resistant tool comprising a pick body as hereinbefore described, preferably non-rotatably mounted in a tool holder or mounting block.

[0058] The high impact resistant tool may be mounted on a rotatable drum or barrel.

[0059] According to a third aspect to the present invention there is provided a method of formation degradation including the step of engaging a pick body as hereinbefore described with the formation to degrade the formation.

[0060] According to a fourth aspect to the present invention there is provided the use of a pick body as hereinbefore described in a method of formation degradation.

[0061] It is expected that a 'thick' PCD layer would be essential to achieve a significant increase over conventional shaped cutters (thin layers < 1 mm, less aggressive geometry) in impact resistance as measured by perpendicular drop testing. The applicant has confirmed this trend. However, a significant increase in impact resistance with a non-optimal interface design at a thickness of 2.2 mm has been observed. For impact resistance both PCD thickness and pointed geometry are important but the cutters taught in the prior art are over designed. See in this regard USSN 11/673,634, Hall et al.

[0062] The benefits of the present invention of 'thin' layers of superhard material are:-

- reduced costs;
- less processing;
- easier to sinter;
- reduced residual stresses; and
- better shape control.

[0063] In one embodiment of the pick tools of the present invention, a more abrasion resistant grade of PCD is included as the superhard layer. As such, overall wear resistance is the same but with reduced thickness. Preferably this is matched with a WC substrate of slightly higher cobalt (Co) content achieving a new local optimum in minimising residual stresses between substrate and more wear resistant, thinner PCD layer.

[0064] The prior art suggests a thicker tip is required (2.5 - 3.2mm) and that furthermore, with a fixed pick one would expect more wear on the working surface as it does not have the benefit of rotation. However, the applicants have surprisingly found that a thinner tip than would be expected still provides sufficient pick performance and lifetime. Fixed picks are needed in preference to rotational ones to help prevent the pick body from wearing out before the tip, the wear on the body being exacerbated by the rotational movement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0065] The invention will now be described with reference to the following illustrations in which:

Figure 1 shows a schematic cross section through a pick body according to the invention;

Figure 2 shows tips including interlayers according to the present invention;

Figures 3 A - F show a non-rotating pick with a PCD layered tip engaged in a tool holder which is engaged in a mounting block;

Figures 4 A - E show a non-rotating pick with a PCD layered tip engaged in a mounting block; and

Figures 5 A - D show a non-rotating pick with a PCD layered tip screw threadingly engaged in a mounting block;

SPECIFIC DESCRIPTION OF THE INVENTION

[0066] In Figure 1 a tip 100 of a pick body includes a carbide substrate 101, an interlayer 102 and a layer of superhard material 103 in a ballistic shape including a rounded top. A thickness (a) of the layer of superhard material 103 is from 0.05mm to 2.3mm from an apex of the tip of the ballistic shape to the substrate 101.

[0067] The rounded top of the superhard layer 103 has a radius R greater than 0.5 mm.

[0068] The top of the superhard layer 103 has a half cone angle (β) not exceeding 60 degrees.

[0069] The superhard layer 103 over a central working surface comprising the inner ½ (y) of the working surface diameter (y + 2x (where 2x = y)) of the tip, is at least 1 mm thick (b) in all working directions being 45 degrees off the central axis of the ballistic.

[0070] The central working surface tapers off towards the outer diameter of the tip.

[0071] Figure 2 illustrates impact and abrasion resistant tips including at least one interlayer according to the present invention.

[0072] The details of the tips shown are as follows

Tips 200A, 200B and 200C

[0073]

Name	Value	Unit
Crest thickness (a)	2.2	mm
Crest radius (R)	2	mm
Rim thickness (z)	1	mm
Cone Angle (β)	50	deg

Tips 201A and 201 B

[0074]

Name	Value	Unit
Crest thickness (a)	2.2	mm
Crest radius (R)	2	mm
Rim thickness (z)	1	mm
Cone Angle (β)	42	deg

[0075] In Figures 3 A - F a pick assembly 300 is shown including a pick body 301 according to the present invention, a tool holder 302 and a mounting block 303. The pick body 301 includes a tip 304 including a layer of superhard material exposed to perform a cutting action in a forward direction in use (not shown). The tool holder includes a base 302A and a shank 302B extending from the base 302A, the shank 302B being eccentric with respect to the base 302A in the forward direction.

[0076] In this arrangement, the pick body 301 and tool holder 302 are fixedly held in the mounting block 303 such that rotation of the pick body 301 and/or tool holder 302 is not permitted in use.

[0077] The pick assembly 300 is adapted to be attached to a rotating drum or barrel (not shown).

[0078] In Figures 4 A - E a pick assembly 400 is shown including a pick body 401 according to the present invention and a mounting block 402. The pick body 401 includes a tip 403 including a layer of superhard material exposed to perform a cutting action in a forward direction in use (not shown). The pick body includes a base 401A and a shank 401 B extending from the base 401A, the shank 401 B being eccentric with respect to the base 401A in the forward direction. The pick body 401 is retained in the mounting block 402 by means of a retaining means (not shown). In this arrangement, the pick body 401 is fixedly held in the mounting block 402 such that rotation of the pick body 401 is not permitted in use.

[0079] The pick assembly 400 is adapted to be attached to a rotating drum or barrel (not shown).

[0080] In Figures 5 A - D a pick assembly 500 is shown including a pick body 501 according to the present invention and a mounting block 502. The pick body 501 includes a tip 504 including a layer of superhard material exposed to perform a cutting action in a forward direction in use (not shown). The pick body 501 includes a collar 501A and a threaded shank 501 B extending from the collar 501A, the shank 501 B being concentric with respect to the collar 501A. The pick body 501 is retained in the mounting block 502 by means of the threaded shank 501 B engaging with complementary threading in the mounting block (not shown). A retaining means 505 is accommodated within a mounting block bore. In this arrangement, the pick body 501 is fixedly held in the mounting block 502 such that rotation of the pick body 501 is not permitted in use.

[0081] The pick assembly 500 is adapted to be attached to a rotating drum or barrel (not shown).

Claims

1. A pick body comprising a shank, a substrate and an impact resistant tip bonded to the substrate and exposed to perform a cutting action in a forward direction in use, the impact resistant tip having an exposed layer of superhard material selected from PCD, PCBN, single crystal diamond and cBN composite materials, wherein the impact resistant tip is of conical, frustoconical, ballistic, hemispherical, chisel or wedge shaped including a rounded top and wherein a thickness of the layer of superhard material is from about 0.05mm to about 2.3mm from an apex of the tip of the conical, frustoconical, ballistic, hemispherical, chisel or wedge shape to the substrate.

2. A pick body according to claim 1 wherein the shank of the pick body is adapted to be received non-rotatably in use in a tool holder or mounting block.

3. A pick body according to claim 2 including a base with the shank extending from the base wherein the shank is threaded to engage with corresponding threading in a mounting block or tool holder bore.

4. A pick body according to claim 2 including a base with the shank extending from the base, the shank being eccentric with respect to the base.

5. A pick body according to any previous claim wherein the superhard material is PCD.

6. A pick body according to claim 5 wherein the PCD comprises an impact resistant grade of diamond with an average grain size range between 10 and 30 um.

7. A pick body according to any previous claims wherein the superhard layer includes an average cobalt content between 15 and 20 wt.%.

8. A pick body according to any one of claims 5, 6 and 7 wherein the superhard layer is constructed from multimodal diamond.

9. A pick body as claimed in any preceding claim wherein the pick body includes a front end located between the tip and the shank, the front end having a wear resistant surface comprising high quality steel, hardened steel and/or hard metal.

10. A pick body as claimed in claim 9 wherein the front end is coated with or includes a hard-facing, or other abrasion resistant coated or treated portion.

11. A pick body according to any preceding claim wherein the rounded top of the superhard layer has a radius greater than 0.5 mm.

12. A pick body according to any preceding claim wherein the top of the superhard layer is conical or ballistic shaped with the half cone angle not exceeding 60 degrees.

13. A pick body according to any preceding claim wherein the superhard layer over a central working surface comprising the inner ½ of the working surface diameter of the substrate, is at least 1 mm thick in all working directions.

14. A pick body according to claim 13 wherein the layer over the central working surface is PCD and is between 2.3 and 1 mm thick in all working directions and tapers off towards the outer diameter of the tip.

15. A pick body according to any preceding claim wherein the substrate has a hardness of at least 1000 Hv.

16. A pick body according to any preceding claim including at least one interlayer between the superhard layer and the substrate, the interlayer having a thermal expansion coefficient and Young's modulus between those of the superhard layer and the substrate to reduce peak mismatch stress between the superhard layer and the substrate.

17. A pick body according to any preceding claim wherein the superhard layer is PCD and the substrate is of high compressive strength and matched thermoelastic properties to the PCD layer.

18. A pick body according to any preceding claim wherein the substrate comprises 6 - 10 % by weight cobalt.

19. A pick body according to any preceding claim wherein the superhard layer is bonded to the substrate via a non-planar interface.

20. A pick body according to any preceding claim wherein the pick includes one or more composite interlayers of intermediate thermo-mechanical properties.

21. A pick body according to any preceding claim wherein the interlayer(s) are bonded to the substrate via a planar or non-planar interface.

22. A high impact resistant tool comprising a pick body according to any one of claims 1 to 21 non-rotatably mounted in a tool holder or mounting block.

23. A high impact resistant tool according to claim 22 mounted on a rotatable drum or barrel.

24. A method of formation degradation including the step of engaging a pick body according to any one of claims 1 to 21 with the formation to degrade the formation.

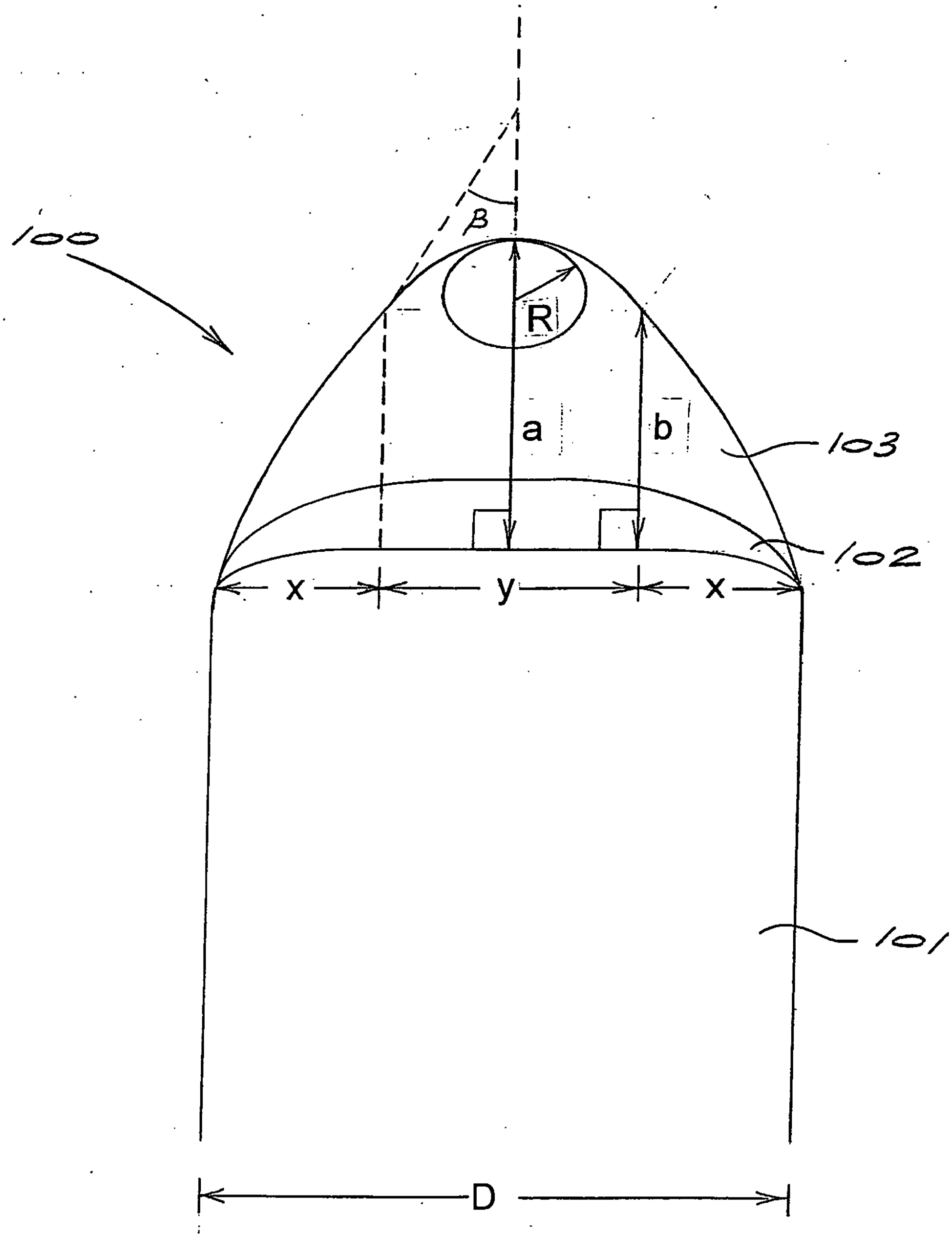

FIGURE 1

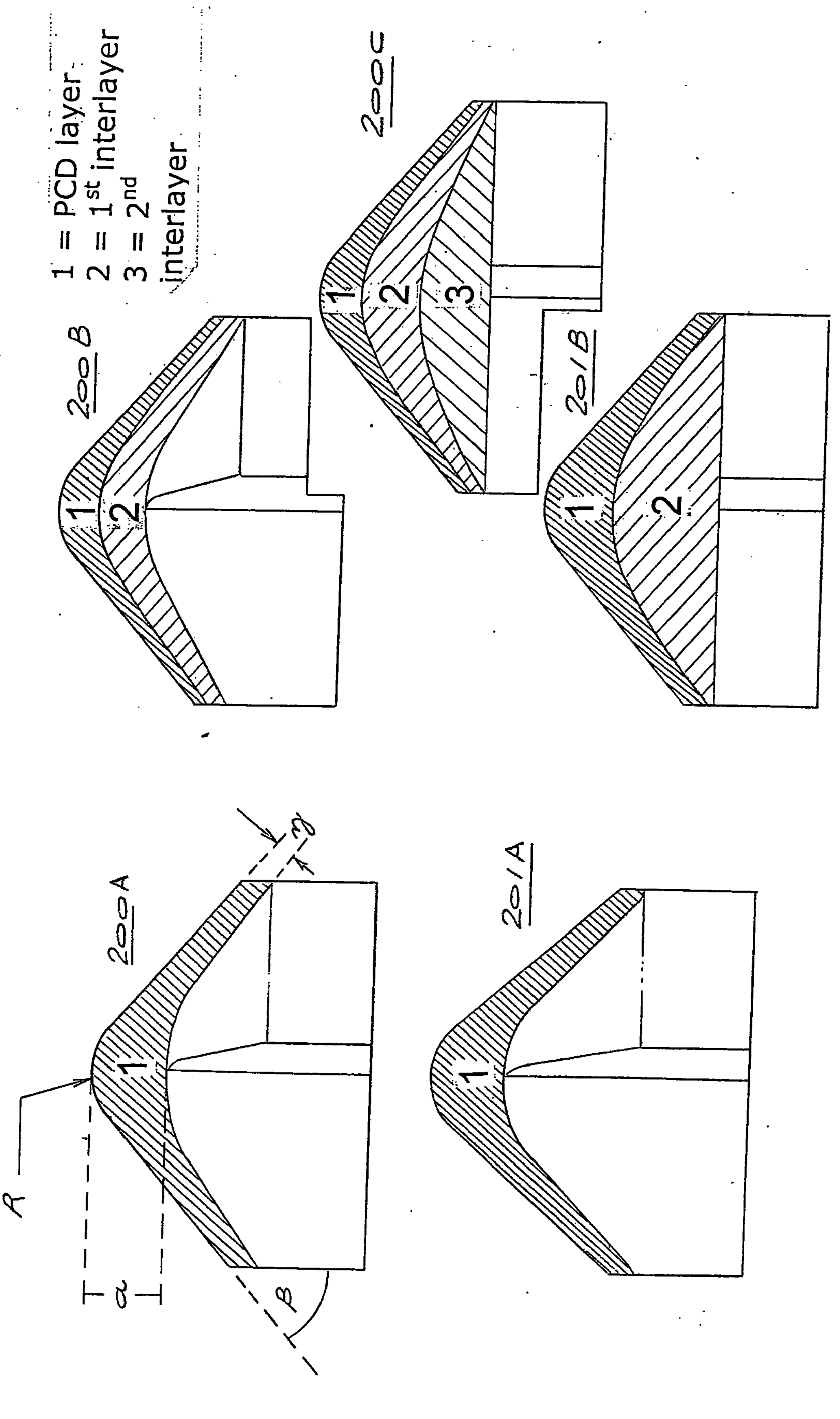
1 = PCD layer
2 = 1st interlayer
3 = 2nd interlayer
200A
200B
200C
201A
201B
1
2
3
R
α
β
γ

FIGURE 2

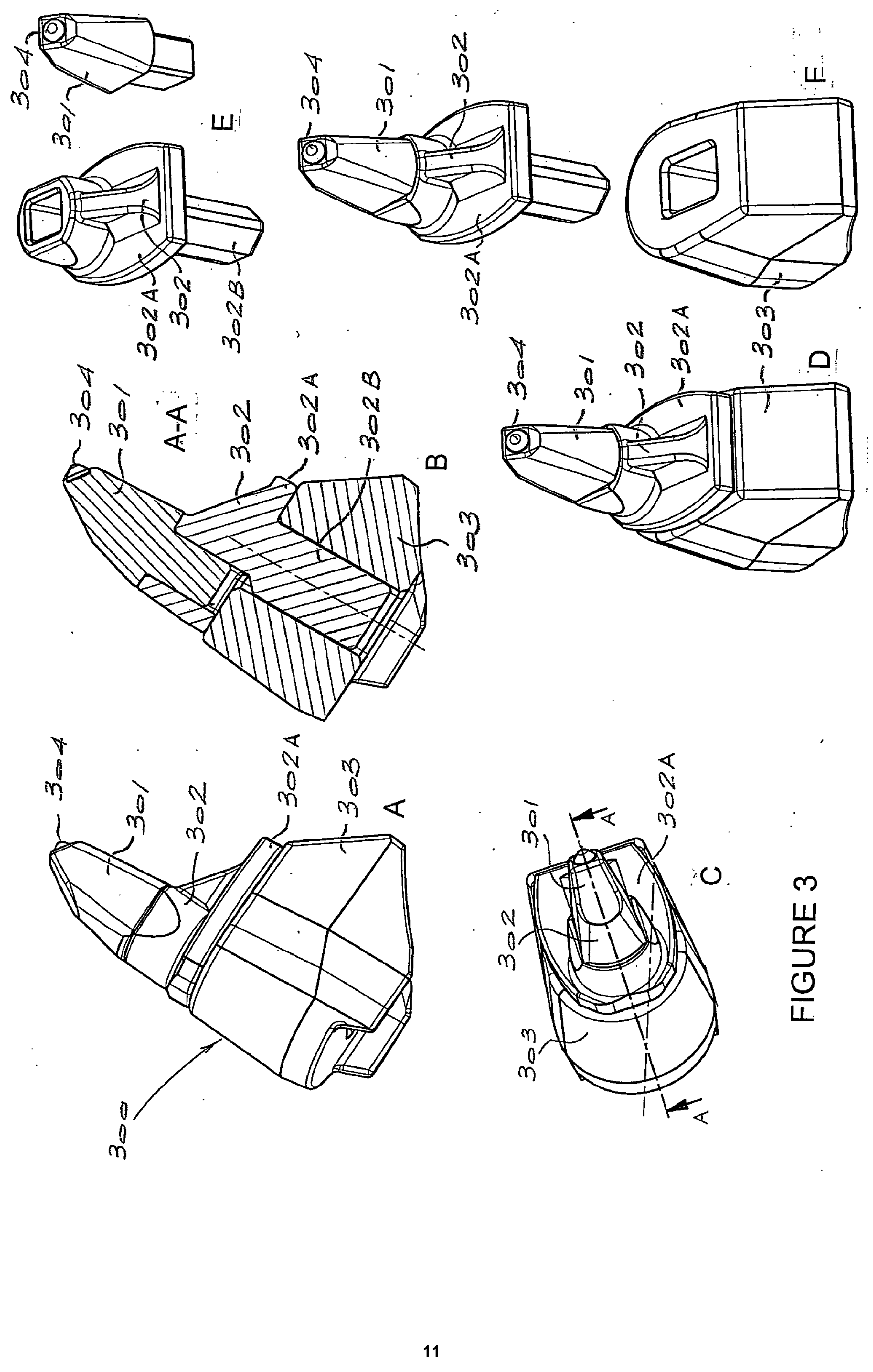

FIGURE 3

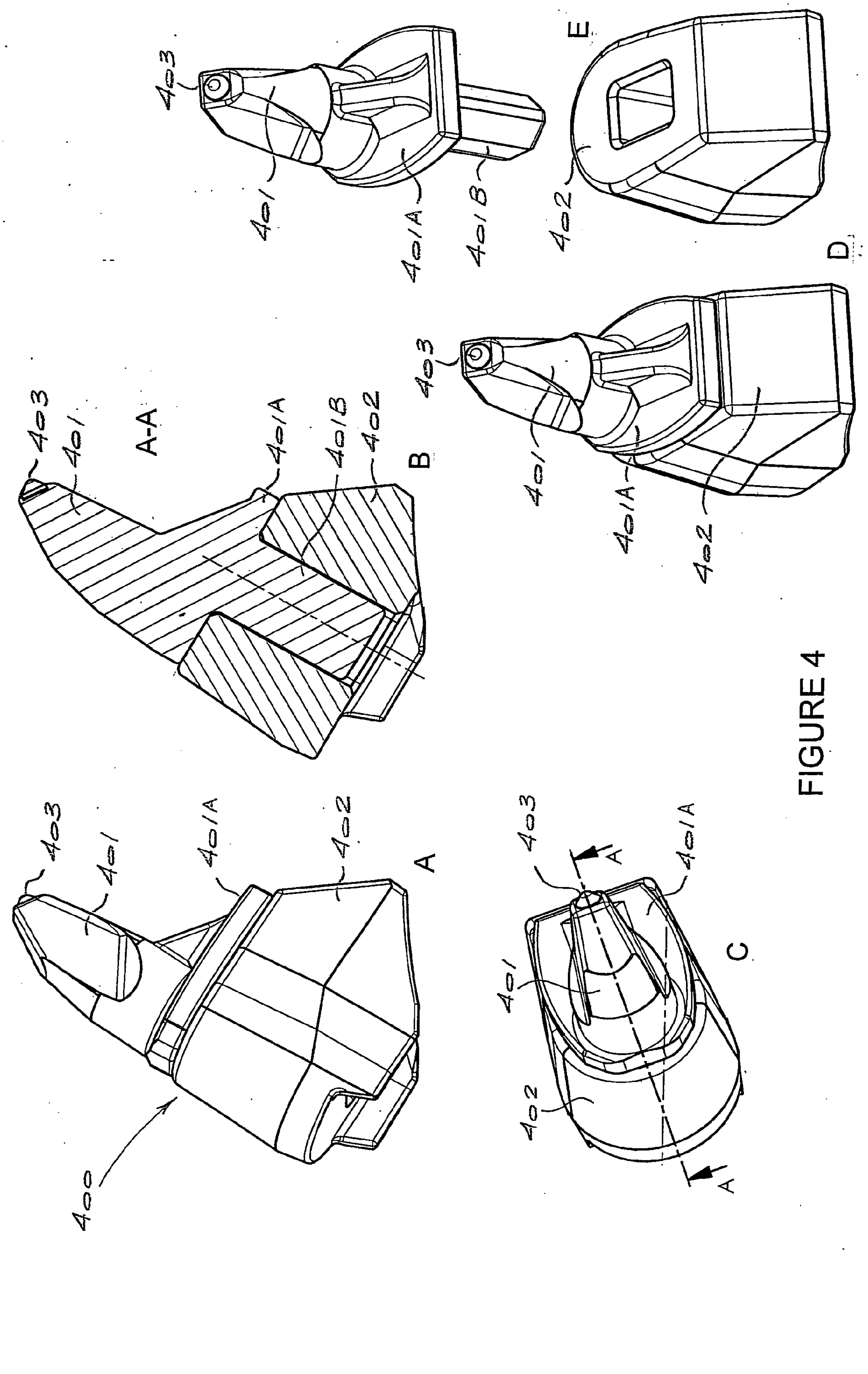

FIGURE 4

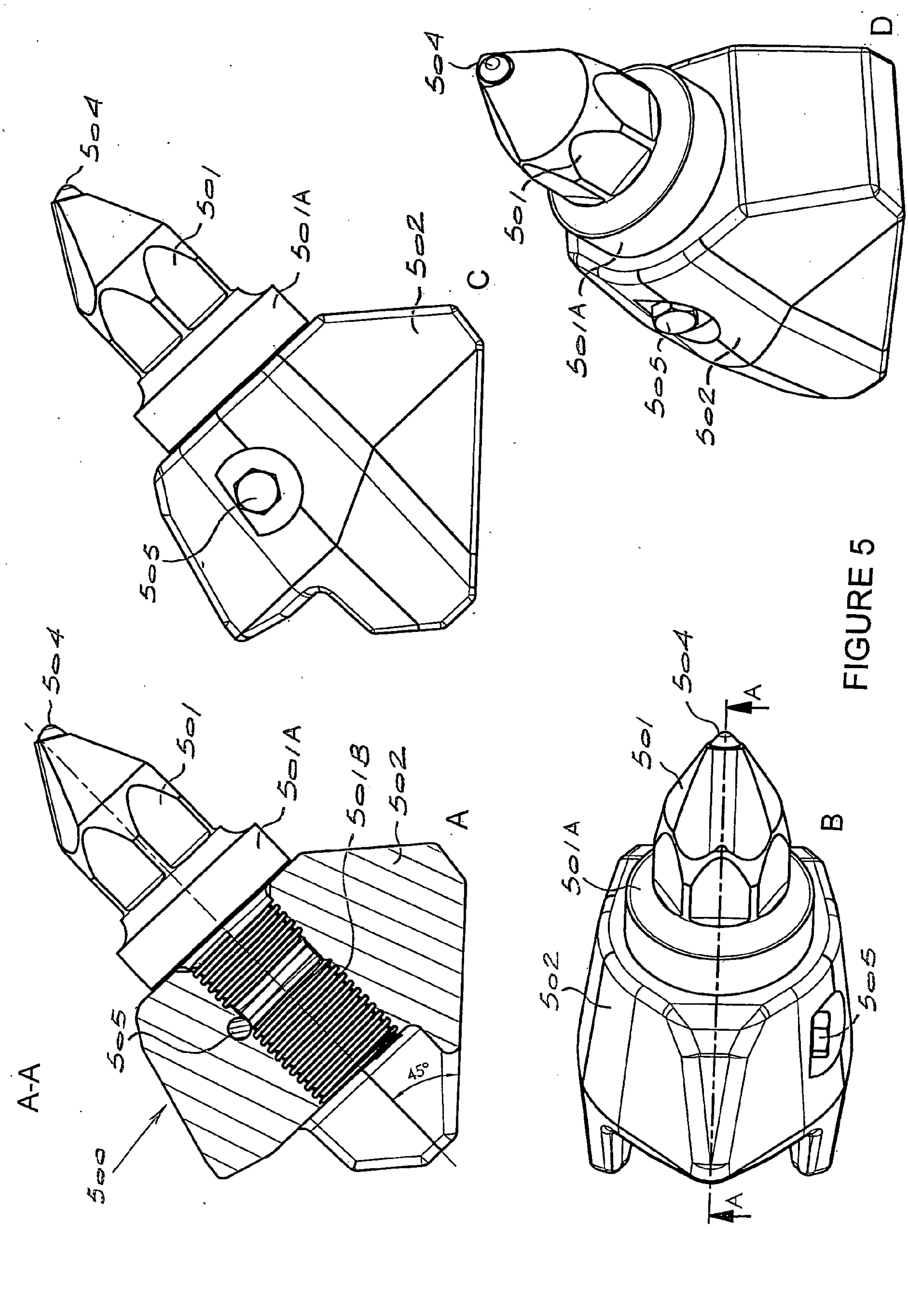

FIGURE 5

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EUROPEAN SEARCH REPORT

Application Number
EP 07 25 4182

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 161 627 A (BURKETT KENNETH H [US]) 10 November 1992 (1992-11-10) * column 5, lines 49-56 * -----	1,5-19, 24	INV. E21C35/183
X	WO 97/28353 A (SANDVIK AB [SE]; SMITH INTERNATIONAL [US]) 7 August 1997 (1997-08-07) * page 6, lines 1-9 * -----	1,5-12, 15-21,24	
D,A	WO 03/064806 A (ELEMENT SIX PTY LTD [ZA]; TANK KLAUS [ZA]; JONKER CORNELIS ROELOF [ZA]) 7 August 2003 (2003-08-07) * page 13, paragraph 4 - page 14, paragraph 1 * -----	1-24	
D,A	US 4 944 559 A (SIONNET JEAN [FR] ET AL) 31 July 1990 (1990-07-31) * column 5, lines 12-17 * -----	1-24	
D,A	US 4 403 015 A (NAKAI TETSUO [JP] ET AL) 6 September 1983 (1983-09-06) * column 6, lines 45-48 * -----	1-24	TECHNICAL FIELDS SEARCHED (IPC)
E	US 2007/290547 A1 (HALL DAVID R [US] ET AL) 20 December 2007 (2007-12-20) * paragraph [0033] * -----	1	E21C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	6 June 2008	Garrido Garcia, M

CATEGORY OF CITED DOCUMENTS

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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06-06-2008

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5161627 A	10-11-1992	NONE	
WO 9728353 A	07-08-1997	AU 704833 B2	06-05-1999
		AU 1561597 A	22-08-1997
		BR 9707297 A	20-07-1999
		CA 2243712 A1	07-08-1997
		DE 69707836 D1	06-12-2001
		DE 69707836 T2	29-05-2002
		EP 0877855 A1	18-11-1998
		JP 2000504382 T	11-04-2000
		ZA 9700497 A	01-08-1997
WO 03064806 A	07-08-2003	CN 1625640 A	08-06-2005
		EP 1470315 A1	27-10-2004
		JP 2005516139 T	02-06-2005
		RU 2303688 C2	27-07-2007
		UA 80420 C2	25-09-2007
		US 2006166615 A1	27-07-2006
		US 2007186483 A1	16-08-2007
US 4944559 A	31-07-1990	EP 0345114 A1	06-12-1989
		FR 2632353 A1	08-12-1989
US 4403015 A	06-09-1983	NONE	
US 2007290547 A1	20-12-2007	US 2007290545 A1	20-12-2007

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4784203 A **[0010]**
- US 5011515 A **[0010]**
- US 5486137 A **[0010]**
- US 5564511 A **[0010]**
- US 5906246 A **[0010]**
- US 6148937 A **[0010]**
- US 5154245 A **[0010]**
- US 5248006 A **[0010]**
- US 5743346 A **[0010]**
- US 5758733 A **[0010]**
- US 5848657 A **[0010]**
- US 5871060 A **[0010]**
- US 5890552 A **[0010] [0015]**
- US 6098730 A **[0010]**
- US 6102143 A **[0010]**
- US 6105694 A **[0010]**
- US 5510913 A **[0012]**
- US 5037704 A **[0012]**
- US 4959929 A **[0012]**
- US 5469927 A **[0013] [0014]**
- US 3745623 A **[0014]**
- US 4403015 A **[0014]**
- US 4604106 A **[0014]**
- US 4694918 A **[0014]**
- US 4729440 A **[0014]**
- US 4807402 A **[0014]**
- US 5370195 A **[0014]**
- US 6258139 B **[0014]**
- US 6315065 B **[0014]**
- US 20060166615 A1 **[0014]**
- US 4944559 A **[0017]**
- US 6051079 A **[0017]**
- US 6733087 B **[0017]**
- US 20030209366 A **[0017]**
- US 20040026983 A **[0017]**
- US 20040065484 A **[0017]**
- US 4733987 A **[0018]**
- US 4902073 A **[0018]**
- US 5722733 A **[0018]**
- US 6283844 B **[0018]**
- WO 03064806 A **[0050]**
- US SN11673634 A, Hall **[0061]**