



(51) International Patent Classification:
E21C 35/18 (2006.01) *E21C 35/183* (2006.01)

(21) International Application Number:
PCT/SE2011/050547

(22) International Filing Date:
2 May 2011 (02.05.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2010206065 30 July 2010 (30.07.2010) AU

(71) Applicant (for all designated States except US): **SANDVIK INTELLECTUAL PROPERTY AB** [SE/SE]; ., ., SE-811 81 Sandviken (SE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **BELL, Andy** [GB/GB]; Torrington Avenue, c/o Sandvik Hard Materials, Coventry West Midlands CV4 (GB).

(74) Agent: **CARLSSON, Lars-Åke**; ., Sandvik Intellectual Property AB, S-811 81 Sandviken (SE).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: METAL MATRIX COMPOSITE MINING PICK AND METHOD OF MAKING

(57) Abstract: A mining pick (10) is disclosed. The pick (10) has a body (12), at least part of the body (12) being formed of a metal matrix composite comprising particles dispersed in a metal, a cutting element (14) mounted to body (12), a shank (16) extending from the body (12), the at least part of the body (12) formed of the metal matrix composite being configured to provide a barrier (20) during an excavation operation.

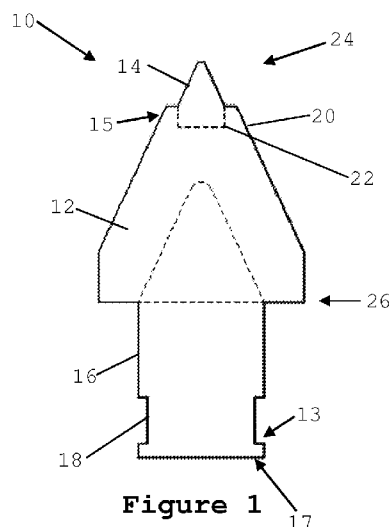


Figure 1

Metal matrix composite mining pick and method of making

Field of the Invention

5 The present invention relates to mining picks used for mining and excavation purposes, and particularly but not exclusively to a mining pick that has a relatively low propensity to ignite a flammable substance adjacent the pick when used.

10

Background of the Invention

 Various different forms of equipment and machinery can be employed for mining and excavation operations, such as long wall miners. The present invention is principally concerned with underground coal mining and one of the major safety difficulties in that type of mining relates to fires or explosions within the mine. These can occur due to the generation during mining of methane gas and coal dust (commonly known as mine dust), which can be trapped within the mine and is readily ignitable. Disadvantageously, the equipment used in coal mining can generate heat and/or incendive sparks that may initiate a fire or explosion, especially from frictional contact with coarse grained quartz containing lithologies. Therefore, it is important that all appropriate steps be taken to minimize or eliminate the risk of ignition.

 Equipment used to mine or excavate in hard earth can include rotary cutters, in which a rotating drum that carries a plurality of projecting cutting bits or picks, is brought into engagement with an earth face. The picks bite into the earth face as they rotate with the drum, to impact against and to dislodge or fragment earth from the face. This highly aggressive engagement between the picks and the earth face can generate heat and/or sparks.

- 2 -

Prior art picks employed for the above purpose generally have a hard cemented tungsten carbide tip that is fixed, usually by brazing, to a steel shank. Sparks can be produced between the tungsten carbide tip and the earth face and also between the steel shank and the earth face, although there typically is greater likelihood of spark production between the shank and the earth face.

Summary of Invention

10

Some embodiments of the present invention may be used in underground coal mining. It will therefore be convenient to describe the invention in relation to that use although it will be readily appreciated that the invention could be employed for any mining or excavation operation to which its function is suitable.

According to a first aspect of the invention there is provided a mining pick, the pick comprising:

20

a body;

at least part of the body being formed of a metal matrix composite comprising particles dispersed in a metal;

a cutting element mounted to the body;

25

a shank extending from the body;

the at least part of the body formed of the metal matrix composite being configured to provide a barrier during an excavation operation.

30

In an embodiment, the at least part of the body formed of the metal matrix composite is configured to provide a barrier disposed adjacent to a distal end of the body, the barrier protecting at least a portion of the mining pick disposed between the barrier and a proximal end of the shank. The barrier may protect the shank.

35

In an embodiment, the at least part of the body

- 3 -

formed of the metal matrix composite is configured to provide a barrier after the cutting element fails.

5 In an embodiment, the at least part of the body formed of the metal matrix composite forms an exterior surface of the body adjacent the cutting element. The exterior surface may encircle the cutting element.

10 In an embodiment, the metal matrix composite has a lower propensity to cause ignition of a flammable substance adjacent the body during excavation than a material of the shank. The material of the shank may comprise a steel, or any other suitable material

15 In an embodiment, the metal matrix composite has less propensity to cause ignition of a flammable substance adjacent the body during excavation than a material of the cutting element.

20 In an embodiment, the metal matrix composite has less propensity to cause ignition of a flammable substance adjacent the body during excavation than cemented carbide.

25 In an embodiment, the particles have a hardness greater than 1000 Hardness Vickers and a modulus greater than around 200 Gigapascals. The particles may have a thermal conductivity lower than around 100 W/m/C).

30 In an embodiment, the metal has a hardness and a modulus less than the particles. The metal may have a thermal conductivity greater than around 100 W/m/C).

In an embodiment, the particles constitute between 20% and 90% by volume of the metal matrix composite.

35

In an embodiment, the metal constitutes between 10% and 80% by volume of the metal matrix composite.

- 4 -

In an embodiment, the particles in the metal matrix composite are tungsten carbide. The tungsten carbide particles may constitute around 60% by volume of the metal matrix composite.

In an embodiment, the particles comprise steel.

In an embodiment, the metal comprises copper, silver and zinc. The metal may comprise 65% to 75% by volume copper, 5% to 15% by volume silver and 15% to 25% by volume zinc.

In an embodiment, the metal is copper.

In an embodiment, the metal matrix composite comprises at least one of tungsten carbide, vanadium, chromium, silicon, boron, a carbide forming element, a metal carbide, copper, zinc, manganese, tin, iron, and silver.

In an embodiment, the metal matrix composite constitutes the body. The shank may have an end embedded in the metal matrix composite. Alternatively, the metal matrix composite constitutes both the body and the shank. The shank may be integral with the body.

In an embodiment, the cutting element is mechanically attached to the metal matrix composite. At least one transverse dimension of at least some of the cutting element may increase in a direction inward of the body. The at least some of the cutting element may be embedded in the metal matrix composite.

In an embodiment, the cutting element is metallurgically attached to the metal matrix composite. The cutting element may be attached to the metal matrix

- 5 -

composite by a metallurgical high temperature braze.

In an embodiment, the cutting element is attached to the metal matrix composite by a sintered bond.

5

In an embodiment, a portion of the cutting element is embedded in the metal matrix composite.

In an embodiment, the cutting element comprises thermally stable silicon carbide diamond composite (SCDC). The cutting element may have a surface bonded to a product of a reaction of a metal with the SCDC. The product may be bonded to the metal matrix composite.

In an embodiment, the body comprises a plurality of monoliths. The monoliths may comprise at least one of diamond, cermet, ceramic, and cemented carbide. The plurality of monoliths may be embedded in a plurality of carbide containing pellets which are imbedded in the metal matrix compound. The plurality of monoliths may be disposed adjacent the exterior surface of the body near the cutting element.

In an embodiment, the body comprises at least two portions, each portion having a respective metal matrix composite, one of the metal matrix composites having a composition that is different to that of the other metal matrix composite. One of the portions may be disposed at a distal end of the body. Another of the at least two portions may be disposed at a proximal end of the body. One of the portions may be disposed in a pocket formed in another of the at least two portions. The pocket may have the cutting element disposed therein.

In an embodiment, the body comprises a ring of material encircling the cutting element, the ring having an equal or lesser hardness than that of the cutting

- 6 -

element and greater than that of the metal matrix composite.

5 In an embodiment, the body has a portion disposed at a distal end comprising a metal matrix composite and another portion disposed at a proximal end comprising a steel. The portion comprising a steel may be integral with the shank.

10 In an embodiment, the mining pick is configured as a point attack pick.

In an embodiment, the mining pick is configured as a radial attack pick.

15

In an embodiment, the mining pick is configured to couple to a mining apparatus by a pair of cooperating elements that engage when the mining pick and the mining apparatus are so coupled, each of the pair of elements
20 being disposed on one of the shank and apparatus respectively.

According to a second aspect of the invention there is provided a method of making a mining pick, the method
25 comprising the steps of:

disposing a powder used in the manufacture of a metal matrix composite in a mould of complementary shape to at least a portion of a body of a mining pick;

30 heating the powder to a temperature for a period of time to form the metal matrix composite that has the shape of the at least the portion of the body.

Brief description of the Figures

35 Features and advantages of the present invention will become apparent from the following description of embodiments thereof, by way of example only, with

- 7 -

reference to the accompanying drawings, in which:

Figure 1 shows a side elevation view of an embodiment of a mining pick in accordance to an aspect of the invention;

5 Figure 2 shows a cross section through a cutting element bonded to a metal matrix composite body via a product of a reaction, in accordance with an embodiment of an aspect of the invention;

10 Figure 3 shows a cross section through an example of a cutting element that is mechanically attached to a respective body in accordance with an embodiment of an aspect of the invention;

15 Figure 4 shows a cross section through a cutting element and respective body wherein the body comprises a plurality of very hard monoliths in accordance with an embodiment of an aspect of the invention;

20 Figure 5 shows a cross section through a cutting element and a respective body having a continuous ring of very hard material, such as cemented carbide, encircling the cutting element in accordance with an embodiment of an aspect of the invention;

25 Figure 6 shows a side elevation view of an embodiment of a mining pick having a body comprising first and second portions, each portion having a respective metal matrix composite in accordance with an embodiment of an aspect of the invention;

30 Figure 7 shows a side elevation view of an another embodiment of a mining pick having a body comprising first and second portions, each portion having a respective metal matrix composite in accordance with an embodiment of an aspect of the invention;

35 Figure 8 shows a side elevation view of another embodiment of a mining pick have a body comprising steel and metal matrix composite in accordance with an aspect of the invention; and

Figure 9 is a graph showing probability curves of two embodiments of a mining pick having respective metal

- 8 -

matrix body portions causing ignition in comparison to a prior art mining pick, over the respective lives of the picks.

5 Detailed Description of embodiments of the invention

Figure 1 shows a side elevation view of an embodiment of a mining pick generally indicated by the numeral 10. This embodiment is symmetric around a central axis. The pick has a body 12. In this embodiment the body 12 is formed of a metal matrix composite comprising particles dispersed in a metal. In some other embodiments, however, only a part of the body is formed of the metal matrix composite.

15

The pick 10 of this embodiment has at a distal end thereof 22 a cutting element 14 configured to cut, fracture, wear, plough or otherwise remove material from a formation in use. Examples of formations include geological formations such as a body of coal, and man made structures. The cutting element 14 is in the form of an insert or tip having a ballistic shape. It will be appreciated that any suitable cutting element may be used. In this embodiment, a portion of the insert is disposed in a pocket 22 formed at a distal end 15 of the pick body 12. The pocket is indicated by dashing. The insert 14 is attached to the side and/or bottom walls of the pocket.

The pick has at a proximal end 13 a shank 16 extending from a proximal end 26 of the body 12. The shank is one of by a pair of cooperating elements that engage when the pick and the rotary drum of the mining machine are coupled. The other of the pair of elements is disposed on the rotary drum. The shank includes a recess 18. A clip engages the shoulders of the recess to retain the pick at the drum. A portion of the shank is embedded in the metal matrix composite body and this portion is

- 9 -

indicated by dashing. In this embodiment the shank comprises an air hardening steel and is joined to the metal matrix composite by a high temperature braze, although the shank may be formed of any suitable material.

5 In another embodiment, the metal matrix composite constitutes both the body and the shank, and the shank is integral with the body (as would be represented by figure 1 if the dashed triangle with a round apex, in that figure, was deleted). A pick embodiment having a body and
10 a shank made from a contiguous metal matrix composite may have less steps during its manufacture than that of a pick embodiment having a body and shank separately formed and subsequently joined.

15 The mining pick 10 is configured as a point attack mining pick, however it will be appreciated that alternative embodiments may be configured as a radial attack mining pick.

20 In the embodiment of Figure 1, the cutting element 14 is formed of a cemented carbide comprising tungsten carbide particles dispersed in metallic cobalt (alternatively metallic nickel or metallic iron, for example), and the body 12 is formed from a metal matrix
25 composite comprising around 60% by volume tungsten carbide particles dispersed in a metal. The metal of this embodiment comprises around 70% by volume copper, 10% by volume silver and 20% by volume zinc. Five other examples of compositions of a metal for use in forming a matrix
30 composite are listed in Table 1, although it will be appreciated that there are many other compositions not listed in the table.

Table 1. Some alternative metal compositions by volume %.

	Cu	Zn	Mn	Ni	Ag	Sn	Pb
1	60-95	40-5				(<10)	(<10)
2	60-95				40-5	(<10)	(<10)
3	60-95	30-5		10-0		(<10)	(<10)
4	60-95	20-5	10-0	10-0		(<10)	(<10)
5	60-95	35-5				(<10)	(<10)

5 The applicant has unexpectedly found that the body
12, comprising the metal matrix composite, did not produce
a spark on contact with a workshop grinder wheel rotating
at high speed. The wheel comprises resin bonded ceramic.
The wheel simulates an environment that is more severe
10 than that typically experienced by the pick 10 during
excavation. Contact between the cemented carbide cutting
tip 14 and the wheel, however, produced sparks. Contact
between the steel shank 16 with the wheel produced a
proliferation of sparks. The applicant has also found
15 that a metal matrix composite body comprising steel
particles dispersed in cooper also has a low propensity to
spark. This was very much unexpected especially in light
of the fact that steel generally has a propensity to
spark.

20

 The reason for the particularly low propensity of the
metal matrix composite body to produce a spark is not
known by the applicant definitively, however the applicant
is of the opinion that the metal within the metal matrix
25 composite may act as a contiguous path for the flow of
heat away from the point of contact and so prevent the
build up of heat and sparking.

- 11 -

In use, the tip 14 engages the formation. Fragments cut from the formation may contact the metal matrix composite exterior surface 20 disposed at a distal end 15 of the body adjacent the cutting element 14. The exterior surface 20 encircles the cutting element 14. The metal matrix composite surface 20 acts as a barrier against the fragments, protecting at least a portion of the mining pick disposed between the barrier 20 and a proximal end 17 of the shank 16. Even if some of the surface 20 is worn away a barrier is still provided by the exposed metal matrix composite. If the cutting element penetrates the formation deeply and the body is dragged across the formation the surface 20 will provide a barrier against the formation.

15

As described, the metal matrix composite barrier has a relatively lower propensity to spark and contact of the fragments with the exterior surface 20 is unlikely to produce a spark. Typically the barrier 20 greatly reduces the chance of a fragment striking the shank 16, or any other component of the pick that may present an ignition risk, for example.

20

The distal end 26 of the body is wider than the shank 16, and thus the barrier provides a region protected from fragments that encompass more than the shank. In the embodiment of Figure 1 the protected region is around 1.3 times the width of the shank. Other embodiments have a protected area width of 3 times the width of the shank.

30

By way of contrast, prior art mining picks, particularly those having a body formed of steel, may heat up and/or spark during excavation. Hot and/or sparking picks have been known to ignite methane and/or coal dust in mines. Thus, use of the pick embodiment of figure 1 instead of a prior art pick may greatly reduce the incidence of friction induced ignition during excavation

35

- 12 -

which is very dangerous in a mine, for example.

It is not uncommon during excavation for a cutting element to fail. For example, the element 14 may shear
5 off adjacent the surface 20 or become dislodged from the pocket 22. In this case, the surface 20, which now may extend to include the surface of the pocket 22, provides a wear resistant barrier with a low propensity to ignite a flammable material. Even if the body is subsequently
10 dragged across the formation it is unlikely that this would cause ignition.

In prior art devices, the fragments may wear the body or shank so that the pick becomes unusable before the tip
15 wears out. The barrier, being much harder than steel, for example, may protect the shank and/or other parts of the pick 10 from fragments which may otherwise cause the pick to reach the end of its working life prematurely. In contrast, the use of a super or ultra hard insert within a
20 metal matrix body provides extended tool life and productivity.

It will be appreciated that in an embodiment, the shank and body may both be formed of a metal matrix
25 composite.

Some properties of metal matrix composites that may form at least part of a pick having a low propensity to cause ignition will now be described. The particles may
30 have hardness greater than 1000 Hardness Vickers and a modulus greater than around 200 Gigapascals. The thermal conductivity of the particles may be less than 100 W/m/C. The metal may have a hardness and a modulus less than the particles. In some but not all embodiments, the thermal
35 conductivity of the metal may be greater than 100 W/m/C, although metals having a higher thermal conductivity such as cooper (around 400 W/m/C) may be preferable in some

- 13 -

circumstances, especially if heat needs to leave the point of contact more rapidly because of aggressive excavation. The metal matrix composite may comprise at least one of tungsten carbide, vanadium, chromium, silicon, boron, a
5 carbide forming element, a metal carbide, copper, zinc, manganese, tin, iron, and silver. The particles may constitute between 20% and 90% by volume of the metal matrix composite, and the metal constitutes between 10% and 80% by volume of the metal matrix composite.

10

Various techniques may be employed to mount a cutting element such as 14 to a body such as 20. In the embodiment of figure 1, the cemented carbide cutting element 14 is attached to the metal matrix composite 12 by
15 a metallurgical high temperature braze. In making the pick 10, a powder containing the particles to be included in the metal matrix composite is disposed in a mould of complementary shape to at least a portion of a body, and the cutting part is disposed in the mould and in contact
20 with the powder. A metal, such as copper, typically in the form of pellets, is disposed over the powder. Subsequently heating the mould in a furnace for a period of time causes the metal to melt and infiltrated and bind the powder to form the metal matrix composite which
25 permanently adopts the shape of the body on cooling, and simultaneously forms the braze. The temperature of the furnace is typically in the range of 900 to 1200 degrees centigrade, and the mould is typically in the furnace for between 5 and 90 minutes. In the case of the manufacture
30 of a metal matrix composite made using silver-zinc-copper metal together with a tungsten carbide powder, the furnace temperature is around 1050 centigrade and the mould is typically in the furnace for 45 minutes.

35 Alternatively, a cutting element may be attached to the metal matrix composite by a sintered bond. In making picks of this embodiment, the powder and cutting element

- 14 -

are disposed in a mould, and mechanical pressure is applied to the powder while being heated in a furnace and a low pressure atmosphere. The powder may comprise at least one of cobalt, iron and carbides. A metal may be optionally disposed in the mould during heating to form a metal binder.

In an embodiment, the cutting element comprises polycrystalline diamond compact (PDC) which degrades in air at temperatures above around 750 degrees centigrade. In this case, during the making of the pick at least one pocket forming element may be disposed in a mould and the powder disposed around the at least one element. The at least one element may be removed after the powder is caused to adopt the shape of at least a portion of the body providing a pocket in the body into which the PDC cutting element may be disposed. The PDC cutting element may then be brazed using conventional silver soldering techniques, for example. The pocket forming element may comprise, for example, graphite or sand.

An embodiment of a mining pick has a cutting element comprising thermally stable silicon carbide diamond composite (SCDC). The cutting element has a surface coated by a product of a reaction of a metal with the SCDC, and the product is bonded to both the metal matrix composite and the cutting element. In this case, during the making of the pick, elements that form carbides and/or take carbon into solution may be disposed in the mould. The SCDC cutting element is prior coated with a metal such as titanium, silicon, and tungsten using, for example, deposited using a chemical or physical vapour deposition process. During heating the chemical bond between the SCDC, metal coating, and metal matrix composite is formed. In some circumstances a plating (another coating) may be applied to the metal coating, such as a nickel, iron or copper plating. The additional plating may prevent

- 15 -

oxidation during processing. Figure 2 shows a cross section through an example of a SCDC cutting element 30 bonded to a metal matrix composite body 32 via a product of the reaction, which in this case is a metal carbide 34.

5 Other methods of chemical retention of the SCDC insert include the addition of carbide and/or solution forming elements of diamond/carbon. Such elements include but are not restricted to chromium, titanium and tungsten. During the making of the pick, these elements may be dispersed in

10 the powder, or more desirably locally around the SCDC insert. During liquid metal infiltration transport of these elements bond to the diamond through the formation of carbides and/or by taking the diamond surface into solution. Other approaches include the use of a high

15 manganese containing binder or the local insertion of active braze metals at or around the SCDC prior to infiltration

Figure 3 shows a cross section through an example of

20 a cutting element 40 that is mechanically attached to a respective body 42. At least one transverse dimension of at least some of the portion embedded in the metal matrix composite increases in a direction 44 inward of the body 42. The portion embedded in the metal matrix composite

25 mechanically interferes with a complementarily shaped pocket providing resistance to separation of the cutting element 40 from the body 42. Generally, any tapered, cap, or dove tail geometry may be used. The bottom of the cutting element 40, which is embedded in the metal matrix

30 composite, gently transitions to the side rather than having an abrupt transition marked by a corner, for example. Avoiding corners reduces stress concentration which assists in reducing the probability of fracture of the metal matrix composite during excavation, especially

35 in the case of the end of the cutting element being embedded in t a metal matrix composite which may have a relatively low fracture toughness compared with other

- 16 -

materials such as a steel.

Figure 4 shows a cross section through an example of a cutting element 50 and respective body 52 wherein the body comprises a plurality of very hard monoliths such as 54. This may improve wear resistance of the body. Each monolith may comprise, for example, diamond 56, a cermet 58, a ceramic 60, and a cemented carbide 62. The plurality of monoliths 54 to 62, in this but not necessarily all 10 embodiments, are embedded in a plurality of carbide containing pellets which are in turn imbedded in the metal matrix composite 52. The plurality of monoliths are disposed adjacent a surface of the body. The monolith may be arranged in a ring around the cutting element.

15

In another embodiment, diamond or other ceramic particles can be dispersed throughout the metal matrix composite or added to the surface locations occupied by monoliths shown in Figure 4. These diamond and/or ceramic 20 particles can be also incorporated within a carbide containing pellet.

Figure 5 shows a cross section through an example of a cutting element 70 and a respective body 72 having a continuous ring 74 of very hard material, such as cemented 25 carbide, encircling the cutting element. The ring 74 may be bonded to the metal matrix composite 76 by a high temperature braze. The ring 74 would typically have an equal or lesser hardness than that of the cutting element and greater than the metal matrix composite 76. Benefits 30 of the ring include intimate and improved wear resistance compared with a metal matrix composite without additions. The maximum width D1 of the cutting part is greater than an inner circumference D2 of the ring 74. While it may be 35 advantageous in view of wear resistance to form the entire pick from cemented carbide, this is typically prohibitively expensive. The pick embodiment of Figure 5,

- 17 -

however, provides better wear resistance than the pick embodiment of Figure 1 and may still be economical. When a SCDC cutting element is used there may not be a bond between the cutting element and the metal matrix composite. Mechanical retention is thus assisted by the ring 74, which has an inner circumference D2 less than the maximum outer circumference D1 of the cutting element.

Figure 6 shows a side elevation view of an embodiment of a mining pick 80 having a body 82 comprising first 84 and second 86 portions, each portion having a respective metal matrix composite. The first portion 84 is adjacent a proximal end of the body and may comprise a material that is softer, cheaper and/or easier to make, than that of the second portion 86. The second portion 86 is located adjacent a distal end of the body and adjacent to the tip 88 and so is more wear resistant than the first portion 84. This approach may reduce the cost of the pick 80 compared with a pick having the entire body comprising a hard metal matrix composite.

Figure 7 shows a side elevation view of another embodiment of a mining pick 90 having a body 92 comprising first 94 and second 96 portions, each portion having a respective metal matrix composite. The metal matrix 96 is more ductile than 94, to increase toughness and fracture resistance adjacent the cutting element 98 which may reduce the likelihood of cracking and failure of the metal matrix composite adjacent the cutting element. This may be achieved by including iron, steel, copper, tungsten, or molybdenum, for example, in portion 96. Metal matrix composite 94 may be harder than metal matrix composite 96 providing improved wear resistance and protection of metal matrix composite 96.

35

Figure 8 shows a side elevation view of another embodiment of a mining pick 100. In this embodiment, the

- 18 -

proximal end 101 of the body has a portion 102 comprising, for example, a steel and another portion 104 at a distal end 106 comprising a metal matrix composite 104. The metal matrix composite portion 104 may be sufficient
5 protection and reduce the propensity of the pick to cause ignition when used. The steel portion 102 and the metal matrix composite portion 104 may be joined by, for example, a pair of cooperating elements such as a thread on each of the portions 102 and 104, shrink fitting,
10 chemical or metallurgical bonding etc. Alternatively, the shank and the steel portion of the body may be formed of the one piece of steel. Some of the relatively expensive metal matrix composite has been substituted in this embodiment for relatively inexpensive steel reducing
15 costs. Also, the configuration of the distal end 106 of the pick may be kept constant across a range of embodiments while the proximal end 108 is adapted to engage machines having various pick coupling configurations.

20

Figure 9 is a graph showing, for two embodiments 120,130 of a mining pick having respective metal matrix body portions, the probability of causing ignition in comparison to a prior art mining pick 110 over their
25 respective lives. One embodiment 120 has a cemented carbide cutting element, and the other 130 has a silicon carbide diamond (SCDC) cutting element. Both embodiments 120, 130 have at least a portion of the body comprising metal matrix composite at a distal end. The probability of
30 ignition when using the embodiments 120,130 is lower than that when using the prior art pick 110.

Prior art pick 110 has a body comprising only steel and a cemented carbide cutting element (insert). Region A
35 corresponds to the period of usage wherein the cutting element is not significantly worn. Region B corresponds to the period of usage where the cutting element exhibits

- 19 -

significant wear. The probability of ignition increases as the cemented carbide blunts and creates more fine particles during cutting. Region C corresponds to a period after the cutting element fails. The cutting
5 element may be lost or broken, for example, or worn down to or near the level of the body and the steel body is exposed. Sparking is very likely and the risk of frictional ignition very high.

10 While in Figure 9 Region B is shown to correspond to periods of identical length in the case of the prior art device 110 and the embodiment 120, in some embodiments the wear resistant metal matrix composite may in fact extend Region B so that it is longer than the corresponding
15 Region B for the prior art device 110.

A SCDC cutting element such as that of embodiment 130 stays sharp for a significantly longer period than an equivalent cemented carbide cutting element and shows no
20 significant propensity for sparking. In the case pick embodiment 130, Region A is about 10 to 100 times longer than that for prior art pick 110. The probability of ignition in Region A is low. If and when the SCDC insert is lost (Region C) and the matrix directly contacts the
25 formation the probability of ignition is significantly lower than that of either the prior art pick or the embodiment of the pick having a metal matrix body portion with the cemented carbide cutting element in place. Thus, it may be desirable to use in some circumstances a pick
30 embodiment having a SCDC cutting element and a body with at least a portion comprising a metal matrix composite, in view of the prolonged tool life and productivity and the low probability of ignition.

35 It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part

- 20 -

of the common general knowledge in the art, in Australia or any other country.

In the claims which follow and in the preceding
5 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
10 not to preclude the presence or addition of further features in various embodiments of the invention.

It will be understood to persons skilled in the art of the invention that many modifications may be made
15 without departing from the spirit and scope of the invention. For example, the cutting element may comprise a rotary cutter.

Claims

1. A mining pick, the pick comprising:
 - a body;
 - 5 at least part of the body being formed of a metal matrix composite comprising particles dispersed in a metal;
 - a cutting element mounted to the body;
 - a shank extending from the body;
 - 10 the at least part of the body formed of the metal matrix composite being configured to provide a barrier during an excavation operation.
2. A mining pick defined by claim 1 wherein the at least
15 part of the body formed of the metal matrix composite is configured to provide a barrier disposed adjacent to a distal end of the body, the barrier protecting at least a portion of the mining pick disposed between the barrier and a proximal end of the shank.
- 20 3. A mining pick defined by either one of the claims 1 and 2 wherein the at least part of the body formed of the metal matrix composite forms an exterior surface of the body adjacent the cutting element.
- 25 4. A mining pick defined by claim 3 wherein the exterior surface encircles the cutting element.
5. A mining pick defined by any one of the previous
30 claims wherein the metal matrix composite has less propensity to cause ignition of a flammable substance adjacent the body during the excavation operation than at least one of cemented carbide, a material of the shank, and a material of the cutting element.
- 35 6. A mining pick defined by any one of the previous claims wherein the at least part of the body formed

- 22 -

of the metal matrix composite is configured to provide a barrier after the cutting element fails.

- 5 7. A mining pick defined by any one of the previous claims wherein the particles have a hardness greater than 1000 Hardness Vickers and a modulus greater than around 200 Gigapascals.
- 10 8. A mining pick defined by any one of the previous claims wherein the metal has a hardness and a modulus less than the particles, and a thermal conductivity greater than around 100 W/m/C).
- 15 9. A mining pick defined by any one of the previous claims wherein the particles constitute between 20% and 90% by volume of the metal matrix composite.
- 20 10. A mining pick defined by any one of the previous claims wherein the metal constitutes between 10% and 80% by volume of the metal matrix composite.
- 25 11. A mining pick defined by any one of the previous claims wherein the particles are tungsten carbide and constitute around 60% by volume of the metal matrix composite.
- 30 12. A mining pick defined by any one of the previous claims wherein the particles comprise steel.
- 30 13. A mining pick defined by any one of the previous claims wherein the metal comprises 65% to 75% by volume copper, 5% to 15% by volume silver and 15% to 25% by volume zinc.
- 35 14. A mining pick defined by any one of the claims 1 to 12 wherein the metal is copper.

- 23 -

15. A mining pick defined by any one of the preceding claims wherein the metal matrix composite constitutes the body and the shank has an end embedded in the metal matrix composite.
- 5
16. A mining pick defined by any one of the previous claims wherein the cutting element is mechanically attached to the metal matrix composite.
- 10
17. A mining pick defined by the preceding claim wherein at least one transverse dimension of at least some of the portion embedded in the metal matrix composite increases in a direction inward of the body.
- 15
18. A mining pick defined by any one of the previous claims wherein the cutting element is metallurgically attached to the metal matrix composite.
19. A mining pick defined by the preceding claim wherein the cutting element is attached to the metal matrix composite by a metallurgical high temperature braze.
- 20
20. A mining pick defined by any one of the preceding claims wherein the cutting element is attached to the metal matrix composite by a sintered bond.
- 25
21. A mining pick defined by any one of the preceding claims wherein a portion of the cutting element is embedded in the metal matrix composite.
- 30
22. A mining pick defined by any one of the preceding claims wherein the cutting element comprises thermally stable silicon carbide diamond composite (SCDC), the cutting element has a surface bonded to a product of a reaction of a metal with the SCDC, and the product is bonded to the metal matrix composite.
- 35

- 24 -

23. A mining pick defined by any one of the preceding claims wherein the body comprises a plurality of monoliths.
- 5 24. A mining pick defined by the preceding claim wherein the monoliths comprise at least one of diamond, cermet, ceramic, and cemented carbide.
- 10 25. A mining pick defined by claim 23 wherein the plurality of monoliths are embedded in a plurality of carbide containing pellets which are imbedded in the metal matrix compound.
- 15 26. A mining pick defined by claims 23 wherein the plurality of monoliths are disposed adjacent a surface of the body.
- 20 27. A mining pick defined by any one of the preceding claims wherein the body comprises at least two portions, each portion having a respective metal matrix composite, one of the metal matrix composites having a composition that is different to that of the other metal matrix composite.
- 25 28. A mining pick defined by claim 27 wherein one of the portions is disposed at a distal end of the body, and another of the portions is disposed at a proximal end of the body.
- 30 29. A mining pick defined by claim 27 wherein one of the portions is disposed in a pocket formed in another of the portions.
- 35 30. A mining pick defined by any one of the preceding claims wherein the body comprises a ring of material encircling the cutting element, the ring having an equal or lesser hardness than that of the cutting

- 25 -

element and greater than the metal matrix composite.

31. A mining pick defined by any one of the preceding
claims wherein the body has a portion disposed at a
5 distal end comprising a metal matrix composite and
another portion disposed at a proximal end comprising
a steel.
32. A method of making a mining pick, the method
10 comprising the steps of:
 disposing a powder used in the manufacture of a
metal matrix composite in a mould of complementary
shape to at least a portion of a body of a mining
pick;
15 heating the powder to a temperature for a period
of time to form the metal matrix composite that has
the shape of the at least the portion of the body.

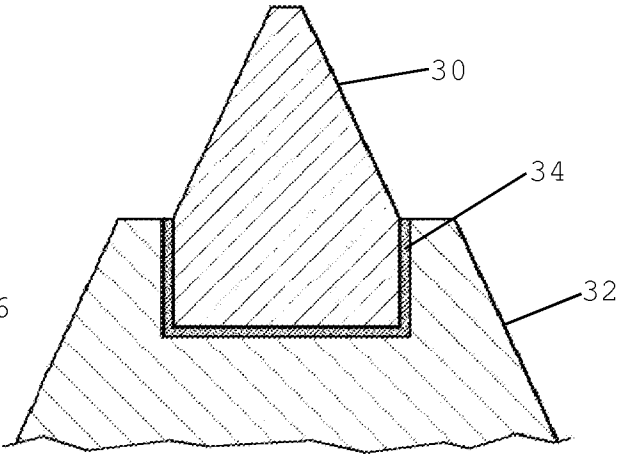
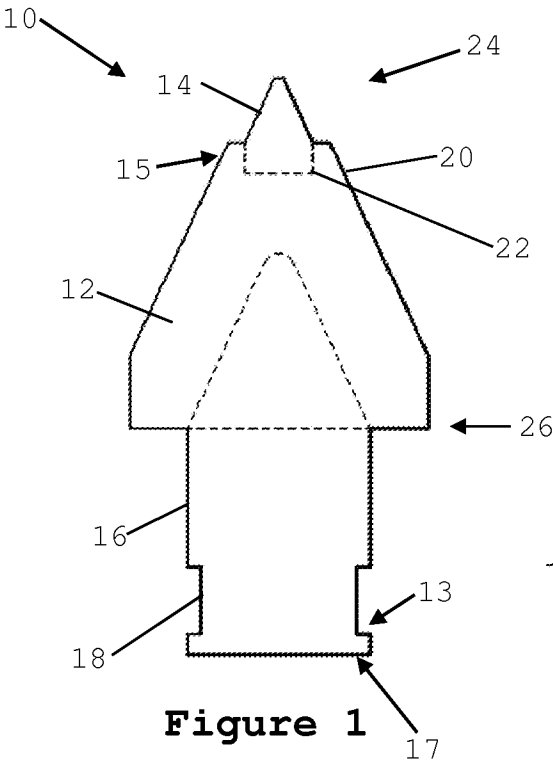


Figure 2

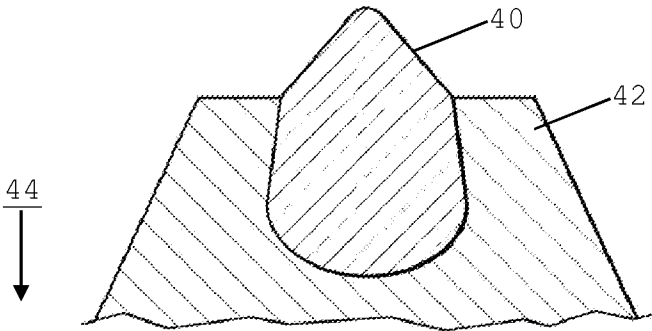


Figure 3

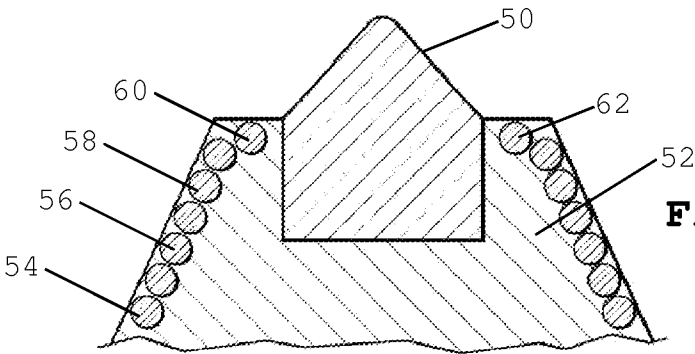


Figure 4

2/3

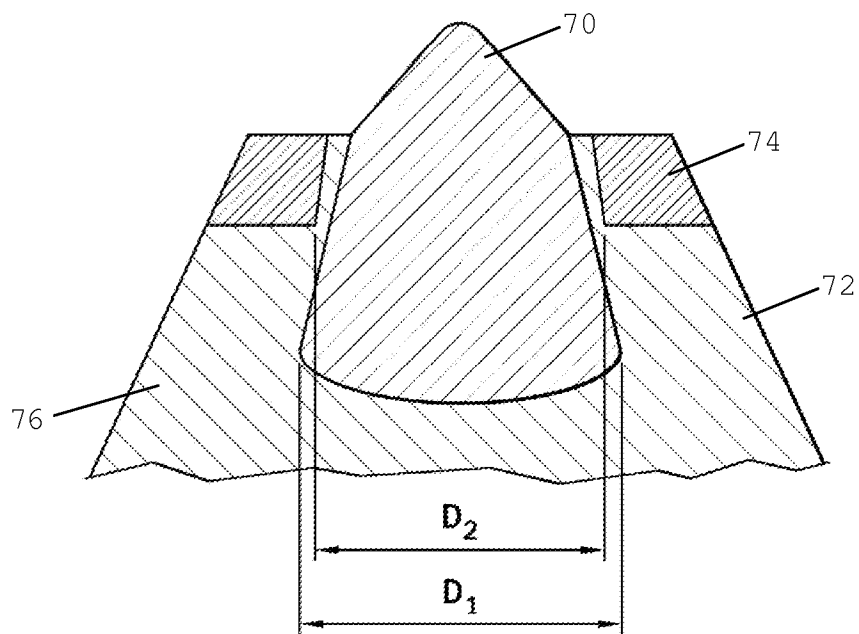


Figure 5

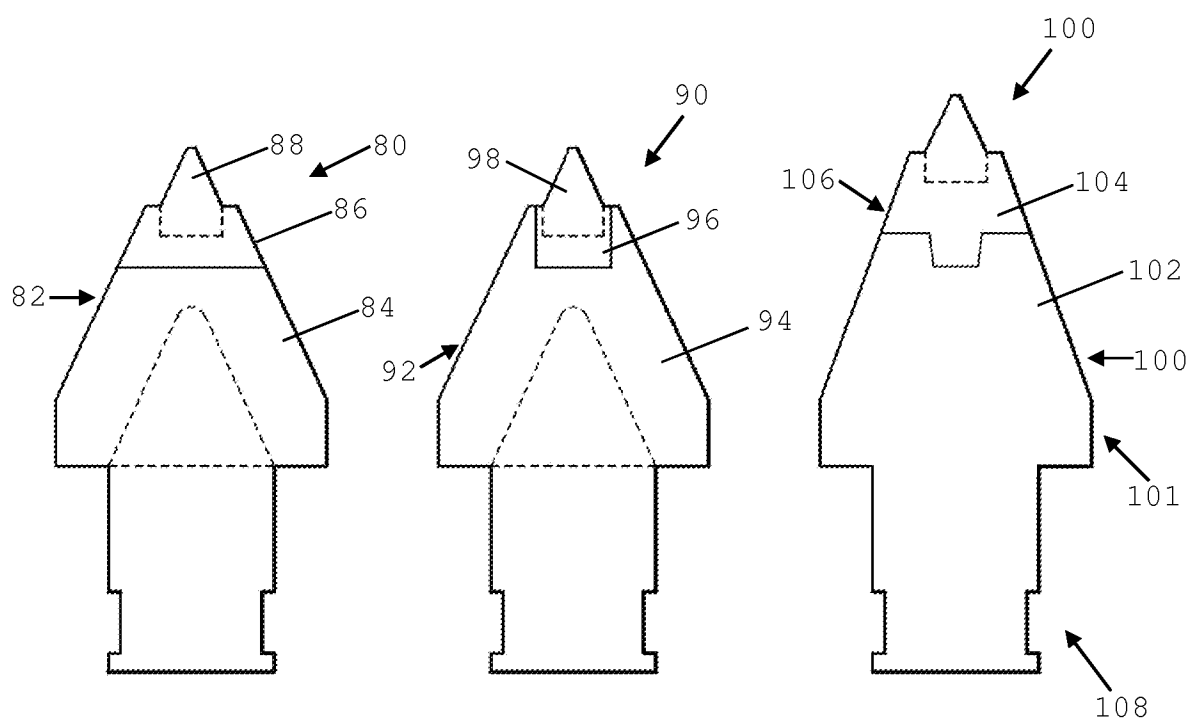
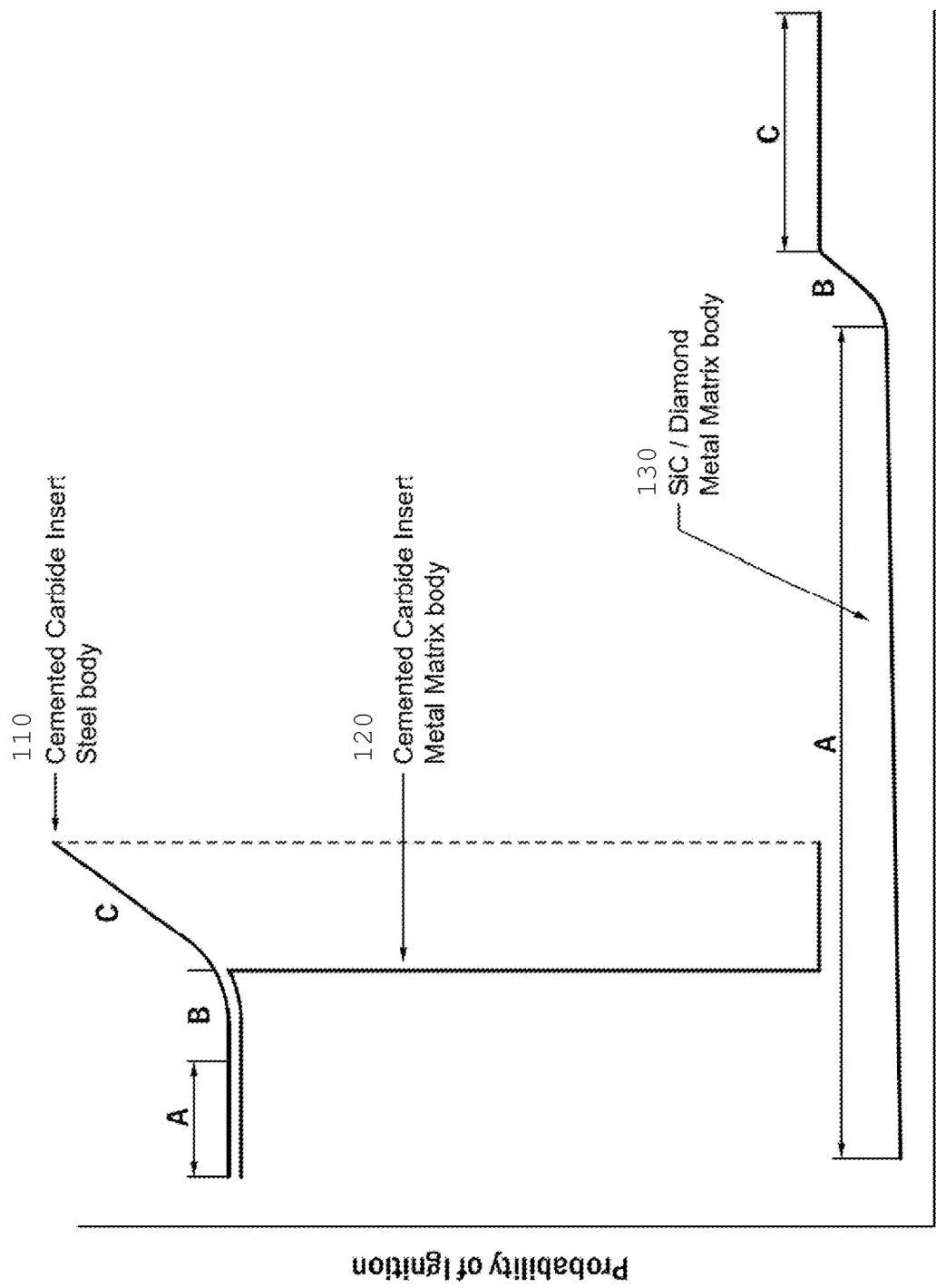


Figure 6

Figure 7

Figure 8



Pick Usage
Figure 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2011/050547

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: E21C

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

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, 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 20050212345 A1 (SLEEP KEITH ET AL), 29 September 2005 (2005-09-29); whole document --	1-32
X	US 20070040442 A1 (WEAVER STEVEN), 22 February 2007 (2007-02-22); whole document --	1-32
A	US 20080164747 A1 (WEAVER STEVEN LEE ET AL), 10 July 2008 (2008-07-10); whole document --	1-32
A	US 20030209366 A1 (MCALVAIN BRUCE WILLIAM), 13 November 2003 (2003-11-13); whole document --	1-32

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

☒ See patent family annex.

* Special categories of cited documents:

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

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

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

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

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

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

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

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

“&” document member of the same patent family

Date of the actual completion of the international search

10-11-2011

Date of mailing of the international search report

14-11-2011

Name and mailing address of the ISA/SE

Patent- och registreringsverket

Box 5055

S-102 42 STOCKHOLM

Facsimile No. + 46 8 666 02 86

Authorized officer

Christer Bäcknert

Telephone No. + 46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2011/050547

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2005093214 A1 (SANDVIK INTELLECTUAL PROPERTY ET AL), 6 October 2005 (2005-10-06); whole document --	1-32
A	US 20040065484 A1 (MCALVAIN BRUCE WILLIAM), 8 April 2004 (2004-04-08); whole document --	1-32
A	US 20040026983 A1 (MCALVAIN BRUCE WILLIAM), 12 February 2004 (2004-02-12); whole document --	1-32
A	DE 3112459 A1 (GEWERK EISENHUETTE WESTFALIA), 7 October 1982 (1982-10-07); whole document -- -----	1-32

Continuation of: second sheet

International Patent Classification (IPC)

E21C 35/18 (2006.01)

E21C 35/183 (2006.01)

Download your patent documents at www.prv.se

The cited patent documents can be downloaded:

- From "Cited documents" found under our online services at www.prv.se
(English version)
- From "Anförda dokument" found under "e-tjänster" at www.prv.se
(Swedish version)

Use the application number as username. The password is **ZPQWLEUQAZ**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SE2011/050547

US	20050212345 A1	29/09/2005	AT	414213 T	15/11/2008
			AU	2009200664 A1	12/03/2009
			AU	2004201284 B2	18/12/2008
			CN	101684730 A	31/03/2010
			DE	602005010987 D1	24/12/2008
			RU	2006137711 A	10/05/2008
			RU	2363847 C2	10/08/2009
			US	7172256 B2	06/02/2007
			ZA	200606866 A	28/05/2008
US	20070040442 A1	22/02/2007	AU	2008207512 A1	18/09/2008
			AU	2005203762 B2	02/12/2010
			CN	101248251 A	20/08/2008
			CN	101413391 A	22/04/2009
			US	20090026829 A1	29/01/2009
			US	7717523 B2	18/05/2010
			US	7837277 B2	23/11/2010
			WO	2007024171 A1	01/03/2007
US	20080164747 A1	10/07/2008	AU	2006252152 B2	10/12/2009
			CN	101205807 A	25/06/2008
			DE	102007061709 A1	28/08/2008
			US	7963616 B2	21/06/2011
US	20030209366 A1	13/11/2003	NONE		
WO	2005093214 A1	06/10/2005	CA	2554654 A1	06/10/2005
			CN	1930370 B	17/08/2011
			EP	1733120 A1	20/12/2006
US	20040065484 A1	08/04/2004	NONE		
US	20040026983 A1	12/02/2004	NONE		
DE	3112459 A1	07/10/1982	NONE		