(51) International Patent Classification: E21C 35/19 (2006.01)

(21) International Application Number: PCT/EP2010/059991

(22) International Filing Date: 12 July 2010 (12.07.2010)

(25) Filing Language: English

(43) International Publication Date
13 January 2011 (13.01.2011)

(41) Application Number
GB/09/02211 (GB), GB/09/02211 (GB)

(21) International Application Number: PCT/EP2010/059991

(22) International Filing Date: 12 July 2010 (12.07.2010)

(25) Filing Language: English


Declarations under Rule 4.17:
— as to applicant’s entitlement to apply for and be granted a patent (Rule 4.17(h))
Published:
— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: ATTACK TOOL ASSEMBLY

Abstract: An attack tool assembly (10) comprising an attack tool having a shank (23) extending therefrom, the shank (23) having a longitudinal axis; and a holder having a holder body (31) and a bore for receiving the shank (23) of the attack tool (10); the holder being adapted to receive the shank (23) in a configuration in which it prevents the shank (23) from rotating relative to the bore when the holder is in an engaged condition, and in which it allows the shank (23) to be rotatable relative to the bore when the holder is in a disengaged condition, so as to enable the shank (23) to be selectively secureable to the holder in a required orientation about the longitudinal axis. The attack tool assembly (10) is particularly but not exclusively for use in the degradation of rock or asphalt bodies for formations, such as in soft rock mining and asphalt milling.

![Fig. 5](image-url)
ATTACK TOOL ASSEMBLY

FIELD

This invention relates to an attack tool assembly, and more particularly, but not exclusively, to an attack tool assembly having a superhard working tip for use in the degradation of rock and asphalt bodies or formations, such as in soft rock mining and asphalt milling.

BACKGROUND

In this specification an attack tool assembly shall be interpreted to mean a high impact resistant and high wear resistant tool that may be used in milling, mining, degradation and excavation applications. As used herein, a pick tool is an attack tool assembly in assembled form. The attack tool assembly may comprise an attack tool and holder, the attack tool comprising a working tip at one end and a shank at an opposite end, the holder being adapted to receive the shank of the attack tool and to hold it by mechanical means. In some applications, for example road reconditioning, a plurality of pick tools may be mounted on a rotatable drum and driven against the body to be degraded as the drum is rotated against the body.

In some pick tools, the attack tools are capable of rotating about their own axis in use ("rotating" tools), and in other pick tools ("non-rotating" or "fixed" tools) they are held in a fixed orientation relative to their holders. The non-rotating tool design is the more widely used design used in conjunction with hard-metal tips.

The entire pick tool including the working tip may be made from a hard metal, such as cemented tungsten carbide, or the working tip may comprise a superhard material. Superhard materials have Vickers hardness of greater than about 25 GPa and include composite materials that incorporate diamond or cubic boron nitride. In polycrystalline diamond (PCD) material is an example of a superhard material. PCD
Material comprises a mass of substantially inter-grown diamond grains forming a skeletal mass defining interstices between the diamond grains. PCD material may comprise at least about 80 volume % diamond and may be made by subjecting an aggregated mass of diamond grains to an ultra-high pressure of greater than about 5 GPa, for example, and a temperature of at least about 1,200 degrees centigrade, for example. While PCD is much more abrasion resistant than hard-metals, its strength and impact resistance are generally much lower. Since rock degradation may be a high impact process, PCD has not yet become commercially significant in mining or asphalt processing applications, although recent advances in PCD tool design have shown potential to extend substantially the working life of PCD tips in high impact operations. These developments may increase the use of PCD in attack tool applications. The life of pick tools comprising a PCD working tip may become determined by the rate of wear of the other attack tool components and the support base in particular. For this reason, rotatable tools may be preferred when using PCD working tips since this allows the tool to wear more evenly around its central axis, enabling its working life to be maximised. However, rotating tools may introduce problems such as jamming, where the rotation becomes prevented or restricted by fouling of the interface between the tool and holder, or mechanical distortion. Another serious problem may be the wear of the shaft and bore surfaces arising from the rotation of the shaft. United States patent number 7,320,505 discloses the use of highly wear resistant surfaces on the shank and bore to address this problem.

United States patent application publication number 2008035383 discloses a high impact resistant tool having a superhard material bonded to a cemented metal carbide substrate, the cemented metal carbide substrate being bonded to a front end of a cemented metal carbide segment, which has a stem formed in the base end, the stem being press fit into a bore of a steel body.

United States patent application publication number 2008169698 discloses a high impact resistant attack tool comprising a superhard material bonded to a cemented metal carbide substrate at a non-planar interface and a stem formed in a base end of a carbide segment, the carbide stem being press fitted into a bore of a steel body.
United States patent number 7,396,086 discloses a pick comprising a shank attached to a base of a steel body, a cemented metal carbide core press fit into the steel body opposite the shank, and an impact tip bonded to a first end of the core opposite the shank. The press fit may comprise an interference of between 1 and 5 thousandths of an inch proximate the second end of the core.

United States patent number 7,401,863 discloses a pick comprising a shank attached to a base of a steel body, a cemented metal carbide core press fit into the steel body opposite the shank, and an impact tip bonded to a first end of the core opposite the shank. The impact tip comprises a superhard material. Also disclosed is a method of reusing a carbide core, the method including removing the used carbide core from the worn steel body by cutting or grinding away portions of the steel body of the provided pick, and then press fitting the used carbide core into a cavity substantially opposite a shank of a substantially unused steel body of a pick.

United States patent number 7,568,770 discloses a pick comprising a steel body comprising a formed shank attached to a first end of the body and generally extending along a central axis of the body. An impact tip is secured to a second end of the steel body and comprises a carbide substrate attached to the second end of the steel body which is bonded to a superhard material. The impact tip may be brazed to a carbide bolster which is press fit into a bore formed in the steel body.

There is a need to provide a superhard attack tool assembly having enhanced working life.

SUMMARY

According to a first aspect of the invention there is provided an attack tool assembly comprising an attack tool having a shank extending therefrom, the shank having a longitudinal axis; and a holder having a bore for receiving the shank of the attack tool; the holder being adapted to receive the shank in a configuration in which it prevents the shank from rotating relative to the bore when the holder is in an engaged condition, and in which it allows the shank to be rotatable relative to the
bore when the holder is in a disengaged condition, so as to enable the shank to be
selectively securable to the holder in a required orientation about the longitudinal
axis.

In one embodiment of the invention, the holder may include engagement means for
securing the shank relative to the holder, the engagement means engaging the
shank when the holder is in an engaged condition, and being spaced apart from the
shank when the holder is in a disengaged condition.

In one embodiment of the invention, the engagement means may be in the form of a
protrusion that protrudes into the bore, the protrusion being displaceable between an
engaged position in which an end of the protrusion abuts the shank, and a retracted
position, in which the end of the protrusion is spaced apart from the shank.

In one embodiment of the invention, the protrusion may be in the form of a threaded
rod extending through a threaded aperture provided in the holder. The threaded rod
may be a screw.

In one embodiment of the invention, the shank may include an engagement zone that
is not cylindrically rotationally symmetric. In use, the engagement zone may be at
least partially aligned with the threaded aperture in the holder. In one embodiment of
the invention, the engagement zone may include a plurality of substantially planar
surfaces arranged on a periphery of the shank, to permit the protrusion in use to abut
a selected planar surface when in the engaged position.

In one embodiment of the invention, at least part of the shank, or substantially the
entire shank may be substantially cylindrical or frustoconical in shape.

In one embodiment of the invention, the attack tool assembly may comprise an attack
tool and a holder configured such that the attack tool is continuously indexable within
the holder. In one embodiment, the attack tool may be infinitely indexable, not being
limited to a predetermined number of orientations.
In one embodiment of the invention, the bore may engage the shank when the attack tool assembly is in the engaged condition, and the disengaged condition may be achievable by heating the holder, alternatively by cooling the shank.

In one embodiment of the invention, the attack tool of the attack tool assembly may include a superhard tip joined to a cemented carbide support body, and in one embodiment, the superhard tip may comprise a polycrystalline diamond structure bonded to a cemented carbide substrate.

According to an aspect of the invention there is provided a method of putting the holder in the disengaged condition, the method including heating the steel holder to expand the bore.

An aspect of the invention provides a method of using an embodiment of an attack tool assembly according to the invention, the method including using the attack tool assembly to degrade a body, putting the holder into the disengaged condition to release the attack tool, reorienting the attack tool within the holder; putting the holder into the engaged condition; and further using the attack tool assembly to degrade a body.

DRAWINGS

Non-limiting embodiments will now be described with reference to the accompanying drawings, of which:

Fig. 1 is a perspective view of an embodiment of an attack tool assembly in accordance with the invention;

Fig. 2 is a side view of the attack tool assembly of Fig. 1;

Fig. 3 is a perspective view of an attack tool of the attack tool assembly of Fig. 1;

Fig. 4 is a perspective view of an embodiment of a holder of the attack tool assembly of Fig. 1;
Fig. 5 is a partial cross-sectional side view of a part of the attack tool assembly of Fig. 1;

Fig. 6 is a partial cross-sectional side view of the attack tool of Fig. 3;

Fig. 7(a) shows a schematic partially cut-away side view of an embodiment of a pick tool;

Fig. 7(b) shows a schematic side view of the embodiment of an attack tool; and

Fig. 7(c) shows a partially cut-away perspective view side view of an embodiment of a steel holder.

DETAILED DESCRIPTION OF EMBODIMENTS

As used herein, "superhard" means a Vickers hardness of at least 25 GPa.

As used herein, a superhard tool, insert or component means a tool, insert or component comprising a superhard material.

Referring to Fig. 1 to Fig. 6, in which like numerals indicate like features, a non-limiting example of an embodiment of an attack tool assembly 10 comprises an attack tool 20, which is secured to a holder 30 that may be connected to a rotatable drum (not shown) of an excavation, milling, degradation or mining machine (not shown). The attack tool 20 comprises a base 22 having at one end a working tip 21 made from or comprising a superhard material, and a shank 23 extending from the base at an opposite end. The shank 23 is an integral part of the attack tool and is bonded to the support base 22 directly or indirectly via an intermediate portion. The working tip 21 comprises a superhard material such as PCD, having extremely high abrasive wear resistance. The working tip 21 may be mounted onto a supporting base 22 made of a wear-resistant hard metal such as cemented tungsten carbide or hard steel, or a ceramic material. The working tip 21 may be attached to the base 22
by brazing, for example, or other methods known in the art. While the material of the base 22 may be as wear-resistant as possible, it would be significantly less wear resistant than the superhard material of the tip 21. For this reason, the base 22 may tend to wear away in use much more rapidly than the superhard working tip 21 and may limit the working life of the attack tool 20. The working tip 21 may have a pointed, domed or chisel shape, and it may be desirable for the integrity of the working edge or tip to maintain sharpness in order to cut rock efficiently.

An article may be defined as having cylindrical rotational symmetry if there is an axis passing through it such that the article appears substantially identical from any given perspective as it is rotated through 360 degrees about that axis. An article has less than cylindrical rotational symmetry if this condition cannot be met. With reference to Fig. 2, a principal, central or longitudinal axis of the attack tool 20 may be defined as the line B-B passing through a central point on the tip 21 and the centre of mass of the attack tool 20. As used herein, the term “shank” is meant to be construed broadly as being the part of the attack tool 20 adapted to be connectable to the holder 30 directly or via an intermediate sleeve (not shown), which is adapted to accommodate the shank 23 and to be capable of holding it. With reference to Fig. 1 to Fig. 6, an embodiment of an attack tool assembly may comprise an attack tool 20 and holder 30 adapted so that the tool 20 cannot rotate about its principle axis in use, but it is capable of being detached from the holder 30 and re-attached at a different orientation about this axis. Throughout the working life of the tool 20, it may be possible to re-orientate it manually within the holder 30 in order to distribute the wear more evenly than would be possible in conventional non-rotating tool assemblies. The principal benefit is prolonged working life of the tool while avoiding problems associated with wear and jamming at the shank-bore interface.

With reference to Fig. 2, Fig. 3 and Fig. 4, an embodiment of a holder 30 comprises a body 31 in which is provided a bore 32 suitable for receiving the shank 23 of the attack tool 20. The shank 23 of the attack tool 20 may include an engagement zone 24 that has less than cylindrical rotational symmetry about the principal axis B-B. The reduced symmetry may enable the attack tool 20 to be securely held by the holder 30 so that it cannot rotate about its central axis. The holder 30 may further
comprise a threaded aperture 33 that extends through the body 31 of the holder 30 into the bore 32. The aperture 33 may be substantially perpendicular to the bore 32 and to the principal axis B-B of the tool 20. The threaded aperture 33 may permit an engagement means (not shown), for example in the form of a threaded screw, to abut a surface 25 of the shank 23 to effect a clamping action once the shank 23 is inserted into the holder bore 32, and so to exert a clamping force on the shank 23 in order to hold it secure in use. The screw (not shown) may be selectively disengaged from contact (i.e. by unscrewing it) so as to permit the attack tool shank 23 to be withdrawn from the holder bore 32, thereby allowing the attack tool 20 to be re-orientated and re-installed.

With reference to Fig. 5 and Fig. 6, the engagement zone 24 may comprise a finite, integer number of substantially planar surfaces 25 that meet at angles of about 90 degrees or greater. The engagement zone 24 may have four-fold symmetry about the central tool axis, with a portion of the shank 23 having four substantially planar outer surface regions 25. The four planar surfaces 25 are distinct, have substantially the same surface areas and are positioned intermediate the extreme ends of the shank 23, approximately equidistant either end. The planar surfaces 25 are furthermore substantially parallel to the central axis and meet at four right angles.

Many variations of shank configuration and shape may be used to facilitate the prevention of its rotation within the holder, while permitting the attack tool to be released from the holder and re-inserted at a limited number of different orientations about the principal axis. For example, the shank may comprise substantially planar surface regions that do not meet at right angles, having arcuate surface portions between them, for example. They may be positioned at substantially the same or different axial distances from either end of the tool. It is also not essential that there be any substantially planar outer surface regions on the shank at all. In a further embodiment that may be understood as being the inverse of the embodiment described above, the shank may include a bore, or cavity that is open at one end and the holder may include a protruding member, the shank bore being adapted to receive the protruding member of the holder.
In general, the greater the number of different orientations in which it is possible for the tool to be held by the holder, the more evenly it may be possible for wear to be distributed on the body of the tool, but the more difficult it may be for the tool to be held without rotation in use. The optimum balance between these factors may depend on the operating conditions, the wear resistance of the tool components and the base in particular, and the type of rock or stone formation being worked, since these may affect the nature, rate and degree of tool wear. The optimum may be determined by straightforward trial and error.

In use, the working tip may engage a rock (e.g. coal, potash or other rock), stone, or asphalt material for example by repeatedly impacting that material with force in order to degrade it. It may be desirable that the working tip should retain its structural integrity as much as possible and for as long as possible, and that it wears away or fractures as little as possible in order to prolong the working life of the tool.

With reference to Fig. 7(a), Fig. 7(b) and Fig. 7(c), an embodiment of a pick tool 100 comprises an attack tool 110 and a steel holder 120, in which the attack tool 110 may be infinitely indexable, the configuration not being limited to a predetermined number of orientations.

With reference to Fig. 7(b), an embodiment of an attack tool 110 comprises a superhard tip 112 joined to a cemented carbide support body 114 at an end 119 of the support body 114, the support body 114 comprising a shank 116. The superhard tip 112 comprises a superhard structure 112a bonded to a cemented carbide substrate 112b. The shank 116 has a substantially cylindrical form and a diameter d that is substantially invariant along its entire length. The support body 114 includes a tapering portion 115 having a substantially frustoconical form and an end 119 to which the superhard tip 112 is brazed. In one embodiment, the superhard structure 112a comprises PCD and may have a rounded or spherically blunted conical form having an apex, the longitudinal thickness of the PCD structure 112a at the apex being in the range from about 5.5 mm to 6 mm.
With reference to Fig. 7(c), an embodiment of a steel holder 120 has a bore 126 configured to accommodate the shank of a support body of a superhard attack tool, such as that described above with reference to Fig. 7(b), and a shaft 124 for mounting the holder onto a tool carrier (not shown). The shank of the superhard attack tool or pick insert is secured within the bore 126 of the steel holder 120 in a manner in which the bore abuts and engages at least part of the shank when the attack tool assembly is in an engaged condition. The bore 126 extends through the holder 120, providing a through-hole having a pair of open ends 128a and 128b. A disengaged condition may then be achieved by heating the holder, thus allowing the bore to expand and the shank to be released. The shank can then be re-orientated inside the holder.

Embodiments of the invention, particularly embodiments in which the working tip comprises a superhard material such as PCD, may have the advantage of having extended working life. Embodiments may have the advantage that the volume of superhard material is reduced or even minimised, thereby reducing or minimising the cost of the attack tool.
CLAIMS

1. An attack tool assembly comprising an attack tool having a shank extending therefrom, the shank having a longitudinal axis; and a holder having a bore for receiving the shank of the attack tool; the holder being adapted to receive the shank in a configuration in which it prevents the shank from rotating relative to the bore when the holder is in an engaged condition, and in which it allows the shank to be rotatable relative to the bore when the holder is in a disengaged condition, so as to enable the shank to be selectively securable to the holder in a required orientation about the longitudinal axis.

2. The attack tool assembly according to claim 1, in which the holder includes engagement means for securing the shank relative to the holder, the engagement means engaging the shank when the holder is in an engaged condition, and being spaced apart from the shank when the holder is in a disengaged condition.

3. The attack tool assembly according to claim 1 or claim 2, in which the bore engages the shank when the attack tool assembly is in the engaged condition, and wherein the disengaged condition is achievable by heating the holder.

4. The attack tool assembly as claimed in any one of the preceding claims, in which at least part of the shank is cylindrical or frustoconical in shape.

5. The attack tool assembly of any one of the preceding claims, in which the attack tool comprises a superhard tip joined to a cemented carbide support body.

6. The attack tool assembly as claimed in any one of the preceding claims, in which the attack tool comprises a polycrystalline diamond structure bonded to a cemented carbide substrate.
7. The attack tool assembly as claimed in any one of the preceding claims, in which the engagement means is in the form of a protrusion that protrudes into the bore, the protrusion being displaceable between an engaged position in which an end of the protrusion abuts the shank, and a retracted position, in which the end of the protrusion is spaced apart from the shank.

8. The attack tool assembly according to claim 7 wherein the protrusion is in the form of a threaded rod extending through a threaded aperture provided in the holder.

9. The attack tool assembly according to any one of the preceding claims, in which the shank includes an engagement zone that is not cylindrically rotationally symmetric, the engagement zone in use being at least partially aligned with the threaded aperture in the holder.

10. The attack tool assembly according to claim 9, in which the engagement zone includes a plurality of substantially planar surfaces located about a periphery of the shank, in order for the protrusion in use to abut a selected planar surface when in the engaged position.

11. The attack tool assembly as claimed in any one of claims 1 to 8, comprising an attack tool and a holder configured such that the attack tool is continuously indexable within the holder.

12. A method of releasing an attack tool from a steel holder of an attack tool assembly the method including the step of heating the steel holder to expand the bore.

13. A method of using an attack tool assembly as claimed in any of claims 1 to 11, the method including using the attack tool assembly to degrade a body, putting the holder into the disengaged condition to release the attack tool, reorienting the attack tool within the holder; putting the holder into the engaged condition; and further using the attack tool assembly to degrade a body.
Fig. 7(b)