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(54) **TOOL INSERT**

WERKZEUGEINSATZ

PIECE RAPPORTEE D'OUTIL

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US-A- 5 979 571
US-A1- 2001 035 302
US-A1- 2002 074 168

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Description

BACKGROUND OF THE INVENTION

[0001] THIS invention relates to tool inserts and more particularly tool inserts which can be used as cutting elements in rotary drilling bits intended for subterranean rock drilling.

[0002] The use of diamond compacts, also known as PCD, as cutters in drilling operations is well known due to the high abrasion resistant properties of diamond cutters. It is also well established that diamond cutters cannot be used satisfactorily for milling or drilling through ferrous substrates such as steel. Therein lies a problem in the use of diamond cutters in certain down the hole drilling operations, particularly with regard to subterranean directional drilling, such as drilling horizontally into a rockbed from an underground location in a vertical borehole or shaft.

[0003] In order to drill horizontally into a rockbed from an underground location, it is necessary to change the direction of movement of the drill bit from a vertical direction to a horizontal direction. To do so, a steel casing is typically positioned down the vertical borehole or shaft, creating a lining therefor in the region requiring horizontal drilling. Located within the steel casing is a deflector which is positioned adjacent the position where horizontal drilling is to be carried out. The function of the deflector, which is generally wedge-shaped, is to cause the drill to change direction and begin milling through the steel casing to create a window to the bedrock.

[0004] As PCD is not suitable for drilling through the steel casing due to reactions with the ferrous materials, an alternative drill bit insert is required. Accordingly, tungsten carbide cutters are typically used in the drill bit to mill through the steel casing. Once through the casing, the tungsten carbide inserts have to be replaced with abrasive resistant cutters such as diamond cutters in order to drill into the bedrock. This means that the drill bit has to be removed and replaced with an appropriate bit. As the drill strings that have to be removed are very long, this is a time consuming exercise that results in costly downtime.

[0005] US-A-5 979 571, which is considered the closest prior art, discloses a combination metal milling and earth drilling tool, for use in performing a single trip kickoff from a casing in a well bore. The combination milling and drilling tool has a first, relatively more durable cutting structure, such as tungsten carbide, and a second, relatively harder cutting structure, such as polycrystalline diamond. The more durable first cutting structure is better suited for milling metal casing, while the harder second cutting structure is better suited for drilling through a subterranean formation, especially a rock formation. The first cutting structure is positioned outwardly relative to the second cutting structure, so that the first cutting structure will mill through the metal casing while shielding the second cutting structure from contact with the casing. The first cutting structure can wear away while milling through the casing and upon initial contact with the rock formation, thereby exposing the second cutting structure to contact with the rock formation. The second cutting structure can then be used to drill through the rock formation.

[0006] US-A-2001/0035302 discloses a dual function drag bit that is used in a method for both milling well casing or liner and subsequently drilling rock formation without the sequential removal of a milling assembly and replacement with a drilling assembly. The method employs a cutting tool that is capable of both milling steel pipe casing in a well bore and subsequently drilling rock formation outside the well bore after passing through the casing. In one embodiment an insert embedded into the surface of the cutting tool comprises at least an outer layer, such as cemented tungsten carbide, capable of milling steel casing, and at least a second layer, such as polycrystalline diamond, capable of drilling formation, the two layers being bonded together and to a carbide substrate. In another embodiment, inserts with a polycrystalline diamond cutting face for drilling rock formation are in parallel with cemented tungsten carbide cutters for milling steel casing.

SUMMARY OF THE INVENTION

[0007] According to one aspect of the invention, a tool insert comprises:

a substrate;

a layer of ultra-hard abrasive material bonded to the substrate, the layer of ultra-hard abrasive material having a side surface and a top surface, a portion of the periphery of the top surface of the ultra-hard abrasive material providing a primary cutting edge for the tool insert; and

a protective layer, a surface of the protective layer being bonded to the top surface and/or the side surface of the ultra-hard abrasive material so as to protect the primary cutting edge thereof, a periphery of the protective layer providing a secondary cutting edge for the tool insert, the depth of the protective layer being selected so as to be sufficient to protect the primary cutting edge whilst cutting, milling or drilling a window through a first substance, such as a casing or lining of a borehole or shaft, but to expose the primary cutting edge upon encountering a second substance, such as a rockbed, wherein the protective layer forms a segment which is bonded to the substrate adjacent the layer of ultra-hard abrasive material.

[0008] According to another aspect of the invention, a tool insert comprises:

a substrate;

a layer of ultra-hard abrasive material bonded to the substrate, the layer of ultra-hard abrasive material having a side surface and a top surface, a portion of the periphery of the top surface of the ultra-hard abrasive material providing a primary cutting edge for the tool insert; and

a protective layer, a surface of the protective layer being bonded to the top surface and/or the side surface of the ultra-hard abrasive material so as to protect the primary cutting edge thereof, a periphery of the protective layer providing a secondary cutting edge for the tool insert, the depth of the protective layer being selected so as to be sufficient to protect the primary cutting edge whilst cutting, milling or drilling a window through a first substance but to expose the primary cutting edge upon encountering a second substance, wherein a plurality of alternating ultra-hard abrasive material strips and protective layer strips are located on the substrate, the successive strips of ultra-hard abrasive material providing a series of primary cutting edges and the successive protective layer strips providing a series of secondary cutting edges.

[0009] According to a further aspect of the invention, a method of drilling a horizontal or angled hole in a subterranean rock formation includes the steps of:

1) preparing the site for horizontal or angled drilling by a) using an existing borehole or, if not available, drilling a borehole into a subterranean rock formation to an appropriate depth and b) lining the borehole, at least in the region where horizontal or angled drilling is to take place, with a casing or lining having a passage and a deflector means mounted in the passage;

2) providing a drill bit with at least one cutting tool insert according to any preceding aspect of the invention, the or each cutting tool insert comprising a substrate, a layer of ultra-hard abrasive material bonded to the substrate, the ultra-hard abrasive material providing a primary cutting edge for the tool insert, and a protective layer for protecting the primary cutting edge and for providing a secondary cutting edge;

3) guiding the drill bit down the borehole until it contacts the deflector and is deflected towards the casing or lining;

4) milling a window through the casing or lining to the subterranean rock formation; and

5) drilling a hole in the subterranean rock formation, wherein the depth of the protective layer is such as to protect the primary cutting edge whilst milling through the casing or lining and to expose the primary cutting edge upon encountering the subterranean rock formation.

[0010] The above method can also be used for the drilling of multiple directional holes from a central vertical borehole.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic sectional side view of a rotary drill bit in a subterranean rock drilling operation;

Figure 2 is a sectional side view of a tool insert for explaining the present invention;

Figure 3 is a plan view of the tool insert of figure 2;

Figure 4 is a sectional side view of a first embodiment of a tool insert of the invention;

Figure 5 is a plan view of the tool insert of Figure 4;

Figure 6 is a sectional side view of a second embodiment of a tool insert of the invention;

Figure 7 is a plan view of the tool insert of Figure 6;

DESCRIPTION OF EMBODIMENTS

[0012] Referring to figure 1 a drill assembly 10 consists of a rotary drill string 12 and a rotary drill bit 14, of the drag bit kind in this case.

[0013] The drill bit 14 is directed down a passage 16 within a steel tubular casing 18. The steel casing 18 is anchored in a borehole or shaft 20 drilled into a subterranean bedrock or rock formation 22.

[0014] In order for the rotary drill bit 14 to drill a horizontal or angled hole in the bedrock 22 in the region indicated by an 'X', it is necessary for the drill bit 14 to be redirected from a vertical direction of movement to a horizontal or angled direction of movement, along the arrow 24. A deflector 26, which is attached to the casing 18 and which has previously been positioned adjacent the region 'X', causes the bit 14 to change direction in this manner. The deflector 26 is supported by an anchor 28.

[0015] As mentioned previously, in order to drill through the casing 18, typically cemented tungsten carbide cutters have traditionally been used. Once a window 30 has been milled through the casing 18, the drill bit 14 is withdrawn and replaced with a drill bit having abrasion resistant cutters such as PCD cutters. This time consuming operation is obviated by using tool inserts or cutters

of the invention.

[0016] The layer of ultra-hard abrasive material will generally be a layer of PCD, although under appropriate conditions PCBN may also be used. The layer may also be a layer of diamond produced by chemical vapour deposition, called CVD diamond.

[0017] The substrate of the tool insert will generally be a cemented carbide substrate. Such substrates are well known in the art and are generally cemented tungsten carbide substrates.

[0018] The protective layer, which may be an extension of the substrate or a separate layer, will also generally be of cemented tungsten carbide, although it may be of a different grade to that of the substrate. In certain instances, the protective layer may be formed of tool steel or other appropriate material suited to milling through steel or other material used for the casing or lining.

[0019] Referring to figures 2 and 3, a first embodiment of a tool insert outside the scope of the invention is illustrated. A cemented carbide substrate 40 has a planar base surface 42 and an upper surface 44. A centrally located recess 46 is formed in the upper surface 44. The recess 46 is surrounded by an annular region 48 and has a surface 50. Although the recess 46 is centrally located in this embodiment, it could also be positioned off centre.

[0020] The recess 46 is filled with diamond particles. Thereafter, the diamond-filled substrate 40 is placed in a reaction capsule and the reaction capsule placed in the reaction zone of a conventional high pressure/high temperature apparatus. The capsule is exposed to conditions of high pressure and temperature suitable to produce a diamond abrasive compact (PCD) 52. Under these conditions the PCD 52 will form and bond to the cemented carbide substrate over the entire surface which defines the recess 46. A cutting edge 54, the primary cutting edge of the tool insert, is defined by the periphery of the PCD 52.

[0021] The cemented carbide / PCD body is then removed from the reaction capsule using known techniques. As such the cemented carbide / PCD body forms a precursor of a tool insert.

[0022] The annular region 48 of the substrate 40 is ground or otherwise removed so as to leave a predetermined depth, indicated by the numeral 56, of tungsten carbide material. This depth of material 56 is selected so as to correspond to the amount of tungsten carbide material required to mill through the wall of a steel casing or lining of a borehole, as described above. To this end, the depth of tungsten carbide 56 provides a protective layer for the primary cutting edge 54 of the PCD 52, and also a secondary cutting edge 58 for milling through the steel casing. Once a window has been milled through the steel casing, ideally the layer 56 should be almost expended so as to expose the cutting edge 54 for drilling into the rockbed.

[0023] In some applications, the tungsten carbide substrate 40, whilst having the desired properties for forming the PCD layer 52, may not have the desired properties for milling through a steel casing or lining. In view thereof, the annular protective layer 48 may be replaced by tungsten carbide of a different grade or by another suitable material, such as tool steel, for example. The annular region 48 in such a case could be formed as a ring in situ or, alternatively, could be formed as a separate ring component which is attached to the tool insert. The ring 48 may be attached to the tool insert, which has been machined to accept the ring, by for example brazing, press fitting, shrink fitting or any other convenient method.

[0024] A first embodiment of a tool insert of the invention is illustrated in figures 4 and 5 of the accompanying drawings. The tool insert consists of a cemented carbide substrate 80, a PCD layer 82, having a cutting edge 84, and a tungsten carbide protective segment 86, having a cutting edge 88, bonded to the substrate 80. The tungsten carbide segment 86 could be an extension of the substrate 80. Alternatively, if the grade of the tungsten carbide substrate 80 is not appropriate for the cutting of a particular grade of steel, the tungsten carbide segment 86 could be formed of a tungsten carbide material of a different grade that is adapted to the particular substrate to be milled. The depth of the tungsten carbide segment 86 is once again selected so as to protect the cutting edge 84 whilst drilling through a steel casing, but to expose the cutting edge 84 soon after encountering the subterranean bedrock.

[0025] Referring to figures 6 and 7, which illustrate a second embodiment of a tool insert of the invention, a tungsten carbide substrate 90 includes a number of parallel recesses 92 in which parallel PCD segments or strips 94 are formed. The PCD segments 94 are protected by respective tungsten carbide segments or strips 96. In this arrangement, the cutting edges 98 of respective PCD segments 94 are protected by the tungsten carbide segments 96, which in turn have cutting edges 100. This arrangement allows the tool insert to be used for cutting through successive layers of steel and subterranean bedrock and can therefore be used multiple times.

[0026] As should be evident from the above, a number of different configurations of the tool insert of the invention are possible in order to achieve the desired purpose of protecting the primary cutting edge of a PCD or PCBN layer whilst milling a window through the steel casing or lining of a borehole in a subterranean bedrock, and exposing the PCD or PCBN cutting edge once through the steel casing.

Claims

1. A tool insert comprising:

a substrate (80);

a layer of ultra-hard abrasive material (82) bonded to the substrate, the layer of ultra-hard abrasive material having a side surface and a top surface, a portion of the periphery of the top sur-

face of the ultra-hard abrasive material providing a primary cutting edge (84) for the tool insert; and a protective layer (86), a surface of the protective layer being bonded to the top surface and/or the side surface of the ultra-hard abrasive material so as to protect the primary cutting edge thereof, a periphery of the protective layer providing a secondary cutting edge (88) for the tool insert, the depth of the protective layer being selected so as to be sufficient to protect the primary cutting edge whilst cutting, milling or drilling a window through a first substance (18) but to expose the primary cutting edge upon encountering a second substance (22), **characterised in that** the protective layer forms a segment which is bonded to the substrate adjacent the layer of ultra-hard abrasive material.

2. A tool insert according to claim 1, wherein the substrate (80) is a tungsten carbide substrate.

3. A tool insert according to claim 1 or claim 2, wherein the protective layer (86) is integrally formed with the substrate and is formed of the same material as the substrate.

4. A tool insert according to claim 1 or claim 2, wherein the protective layer (86)is formed as a separate component *in situ.*

5. A tool insert according to claim 1 or claim 2, wherein the protective layer (86) is formed as a separate component which is bonded to the top surface and/or the side surface of the ultra-hard abrasive material (82).

6. A tool insert according to any one of claims 1 to 5, wherein a plurality of alternating ultra-hard abrasive material strips (94) and protective layer strips (96) are located on the substrate, wherein one of the protective layer strips (96) forms a segment adjacent one of the ultra-hard abrasive strips (94) and wherein successive strips of ultra-hard abrasive material provides a series of primary cutting edges and successive protective layer strips provides a series of secondary cutting edges.

7. A tool insert according to any one of the preceding claims, wherein the protective layer (86, 96) is formed of the same type of material as the substrate (80, 90) but of a different grade to that of the substrate, or of tool steel or of another suitable material dependent on the first substance.

8. A tool insert according to any one of the preceding claims, wherein the first substance is a casing (18) or lining of a borehole or shaft in a bedrock and the second substance is the bedrock (22).

9. A method of drilling a horizontal or angled hole in a subterranean rock formation includes the steps of:

1) preparing the site for horizontal or angled drilling by a) using an existing borehole or, if not available, drilling a borehole into a subterranean rock formation to an appropriate depth and b) lining the borehole, at least in the region where horizontal or angled drilling is to take place, with a casing or lining having a passage and a deflector means mounted in the passage;
2) providing a drill bit with at least one cutting tool insert according to any preceding claim, the or each cutting tool insert comprising a substrate, a layer of ultra-hard abrasive material bonded to the substrate, the ultra-hard abrasive material providing a primary cutting edge for the tool insert, and a protective layer for protecting the primary cutting edge and for providing a secondary cutting edge;
3) guiding the drill bit down the borehole until it contacts the deflector and is deflected towards the casing or lining;
4) milling a window through the casing or lining to the subterranean rock formation; and
5) drilling a hole in the subterranean rock formation,

wherein the depth of the protective layer is such as to protect the primary cutting edge whilst milling through the casing or lining and to expose the primary cutting edge upon encountering the subterranean rock formation.

10. A method according to claim 9, which is used for the drilling of multiple directional holes from a central vertical borehole.

Patentansprüche

1. Werkzeug-Einsatz Umfassend:

ein Substrat (80);
eins Schicht aus ultrahartem abrasiven Material (82), das mit dem Substrat verbunden ist, wobei die Schicht aus ultrahartem abrasiven Material eine Seitenfläche und eine obere Oberfläche aufweist, wobei ein Abschnitt des Randgablets der oberen Oberfläche des ultraharten abrasiven Materials einen primären Schneidrand (84) für den Warkzeug-Einsatz schafft; und
eine Schutzschicht (86), wobei eine Oberfläche der Schutzschicht mit der oberen Oberfläche und/oder der Seitenfläche des ultraharten abrasiven Materials verbunden ist, um den primären Schneidrand desselben zu schürtzen, wobei ein Randgebiet der Schutzschicht einen sekundä-

ren Schneldrand (88) für den Werkzeug-Einsatz schaft, wobei die Stärke der Schutzschicht so ausgewählt wird, dass sie ausreicht, um den primären Schneidrand beim Schneiden, Fräsen oder Bohren eines Fensters durch eine erste Substanz (18) zu schützen, den primären Schneidrand beim Auftreifen auf eine zweite Substanz (22) jedoch freizulegen **dadurch gekennzeichnet, dass** die Schutzschicht eine Segment bildet, welches benachbart zu der Schicht aus ultrahartem abrasiven Material mit dem Substrat verbunden ist.

2. Werkzeug-Einsatz nach Anspruch 1, wobei das Substrat (80) ein Wolframkarbid-Substrat ist.

3. Werkzeug-Einsatz nach Anspruch 1 oder Anspruch 2, wobei die Schutzschicht (86) einteilig mit dem Substrat ausgebildet ist und aus demselben Material wie das Substrat besteht.

4. Werkzeug-Einsatz nach Anspruch 1 oder Anspruch 2, wobei die Schutzschicht (86) in situ als eine separate Komponente ausgebildet ist.

5. Werkzug-Einsatz nach Anspruch 1 oder Anspruch 2, wobei die Schutzschicht (86) als eine separate Komponente ausgebildet ist, welche mit dar oberen Oberfläche und/oder der Seitanfläche des ultraharten abrasiven Materials (82) verbunden ist.

6. Werkzeug-Einsatz nach einem der Ansprüche 1 bis 5, wobei eine Vietzahl Von Streifen aus ultrahartem abrasiven Material (94) und Schutzschicht-Streifen (96) abwechseind auf dem Substrat angeordnet ist, wobei einer der Schutzschicht-Streifen (96) ein Segment bildet, welches benachbart einem der Streifen aus ultrahartem abrasiven Material (94) ist und wobei aufeinander folgende Streifen aus ultrahartem abrasiven Material eine Reihe von primären Schneklrädern schaffen und aufeinander folgende Schutzchicht-Streifen eine Reihe von sekundären Schneidrändem schaffen.

7. Werkzeug-Einsatz nach einem dar vorhergehenden Ansprüche, wobei die Schutzschicht (86, 96) aus demseiben Materialtyp wie das Substrat (80, 90), jedoch mit einer vorn Substrat untereschiedlichen Qualität, oder aus Werkzeugstahl oder aus einem anderen geeigneten Material, abhängig von der ersten Substanz, ausgeblidet ist.

8. Werkzeug-Einsatz nach einem der vorhergehenden Ansprüche, wobei die erste Substanz eine Ausfülterung (18) oder eine Auskleidung eines Bohrlochs oder Schachts in einem Grundgestein ist, und die zweite Substanz das Grundgestein (22) ist.

9. Verfahren zum Bohren eines horizontalen oder abgewinkelten Lochs in einer unterirdischen Gesteinsformation, wobei das Verfahren die Schritte umfasst, dass:

1) die Stelle für die horizontale oder abgewinkelte Bohrung vorbereitet wird, indem a) ein bestehendes Bohrloch verwendet wird, oder, falls keines verfügbar ist, ein Bohrloch bis auf eine geeignete Tiefe in eine unterirdische Gesteinsformation gebehrt wird, und b) das Bohrloch zumindest in dem Bereich, in dem die horizontale oder abgewinkelte Bohrung vorgenommen werden soll, mit einer Ausfütterung oder einer Auskleidung die einen Durchgang und ein in dem Durchgang befestigtes Umlenkmittel aufweist, ausgekleidet wird;
2) ein Bohreinsatz mit zumindest einem Schneidwerkzeug-Einsatz nach einem der vorbergahenden Ansprüche wird, wobei der bzw. jeder Schneidwerkzeug-Einsatz ein Substrat, eine Schicht aus ultrahartern abrasiven Material, das mit dem Substrat verbunden ist, wobei das ultraharte abrasive Material einem primären Schneidrand für den Werkzeug-Einsatz schallt, sowie eine Schutzschicht zum Schutz des primären Schneidrandes und zur Schalfung eines sekundären Schneidrandes umfasst;
3) der Bohreinsatz durch des Bohrloch nach unten geführt wird, bis er mit dem Umlenkelement in Kontakt gelangt, und zu der Ausfütterung oder der Auskleidung hin umgelenkt wird.
4) ein Fenster durch die Ausfülterung oder die Auskleidung zu der unterirdischen Gesteinsformation gefräst wird; und
5) ein Loch in die unterirdische Gesteinzsformation gebohrt wird,

wobei die Stärke der Schutzschicht derart ausgestaltet ist, dass der primäre Schneidrand beim Fräsen durch die Ausfütterung oder die Auskleldung geschützt wird und der primäre Schneidrand beim Auftreffen auf die unterindische Gesteinformation freigelegt wird.

10. Verfahren nach Anspruch 9, welches zum Bohren von Löchern in mehrere Richtungen von einem zentralen vertikalen Bohrloch aus verwendet wird.

Revendications

1. Pièce rapportée d'outil comprenant:

un substrat (82);
une couche de matériau abrasif ultra-dur (82) collée au substrat, la couche de matériau abrasif ultra-dur ayant une surface latérale et une sur-

face supérieure, une partie de la périphérie de la surface supérieure du matériau abrasif ultra-dur assurant un premier bord d'attaque (84) pour la pièce rapportée d'outil; et
une couche protectrice (86), une surface de la couche protectrice étant collée à la surface latérale et/ou à la surface supérieure du matériau abrasif ultra-dur protégeant ainsi le premier bord d'attaque, une périphérie de la couche protectrice assurant un second bord d'attaque (88) pour la pièce rapportée d'outil, la profondeur de la couche protectrice étant choisit de sortie à être suffisante pour protéger le premier bord d'attaque lors du découpage, fraisage ou forage d'une fenêtre à travers une première substance (18) mais exposant le premier bord d'attaque à une second substance (22), **caractérisé en ce que** la couche protectrice forme un segment collé au substance adjacent à la couche de matériau abrasif ultra-dur

2. Pièce rapportée d'outil selon la revendication 1, dans laquelle le substrat (80) est un substrat en carbure de tungstène.

3. Pièce rapprotée d'outil selon la revendication 1 ou la revendication 2, dans laquelle la couche protectrice (86) fait partie intégrants du substance et est composée du même matériau que le substrat.

4. Pièce rapportée d'outil selon la revendication 1 ou la revendication 2, dans laquelle la couche protectrice (86) est formée comme un composant distinct *in situ*.

5. Pièce rapportée d'outil selon la revendication 1 ou la revendication 2, dans laquelle la couche protectrice (86) est formée comme un composant distinct collé à la surface supérieure et/ou à la surface latérale du matériau abrasif ultra-dur (82).

6. Pièce rapportée d'outil selon l'une quelconque des revendication 1 à 5, dans laquelle une alternance de plusieurs bandes de matériau abrasif ultra-dur (94) et de bandes de couche protectrice (96) est localisée dans la substrat, dans laquelle l'une des bandes de couche protectrice (96) forme un segment adjacent à l'une des bandes abrasive ultra dur (94) et dans laquelle les bandes sucessives de matériau abrasif ultra-dur forment une série de premiers bords d'attaque et les bandes successives de couche protectrice forment une série de seconds bords d'attaque.

7. Pièce rapportée d'outil selon l'une quelconque des revendications précédentes, dans laquelle la couche protectrice (86, 96) est constituée du même type de matériau que le substrat (80, 90) mais l'une qualité différente de celui composant le substrat, ou d'un acier à outils ou d'un autre matériau approprié à la première substance.

8. Pièce rapportée d'outil selon l'une quelconque des revendications précédentes, dans laquelle la première substance est un coffrage (18) ou un gainage d'un trou de forage ou d'un puits dans un substratum rocheux et la seconde substance est le substratum rocheux (22).

9. Méthode de forage de trou horizontal ou selon un angle dans une formation rocheuse souterraine incluant les étapes de:

1) préparation du site de forage horizontal ou selon un angle en a) utilisant un trou de forage existant ou, s'il n'existe pas, es forant un trou de forage dans une formation rocheuse souterraines selon une profondeur appropriée et b) en gainant le trou de forage, au moins dans la partie où le forage horizontal ou selon un angle doit avoir Lieu, avec un coffrage ou un gainage comportant un conduit et des moyens de déflection montée dans le conduit;
2) fourniture d'un trépan avec un moins une pièce rapportée d'outil coupante selon l'une quelconque des revendications précédentes, la ou chaque pièce rapportée d'outil coupante comprenant un substrat, une couche de matériau abrasif ultra-dur collée au substrat, le matériau abrasif ultra-dur formant un premier bord d'attaque à la pièce rapportée d'outil, et une couche protectrice protégeant le premier bord d'attaque et formant un second bord d'attaque;
3) guidage du trépan dans le trou de forage jusqu'à ce qu'il entre en contact avec le déflecteur et soit dévié vers le coffrage ou le gainage;
4) fraisage d'une fenêtre à travers le coffrage ou le gainage en direction de la formation rocheuse souterraine; et
5) forage d'un trou dans la formation rocheuse souterraine

dans laquelle la profondeur de la couche protectrice est telle qu'elle protège le premier bord d'attaque lors du fraisage à travers le coffrage ou le gainage et qu'elle expose le premier bord d'attaque lors de la rencontre avec la formation rocheuse souterraine.

10. Méthode, selon la revendication 9, utilisée pour le forage de trous dans de directions multiples à partie d'un trou forage vertical central.

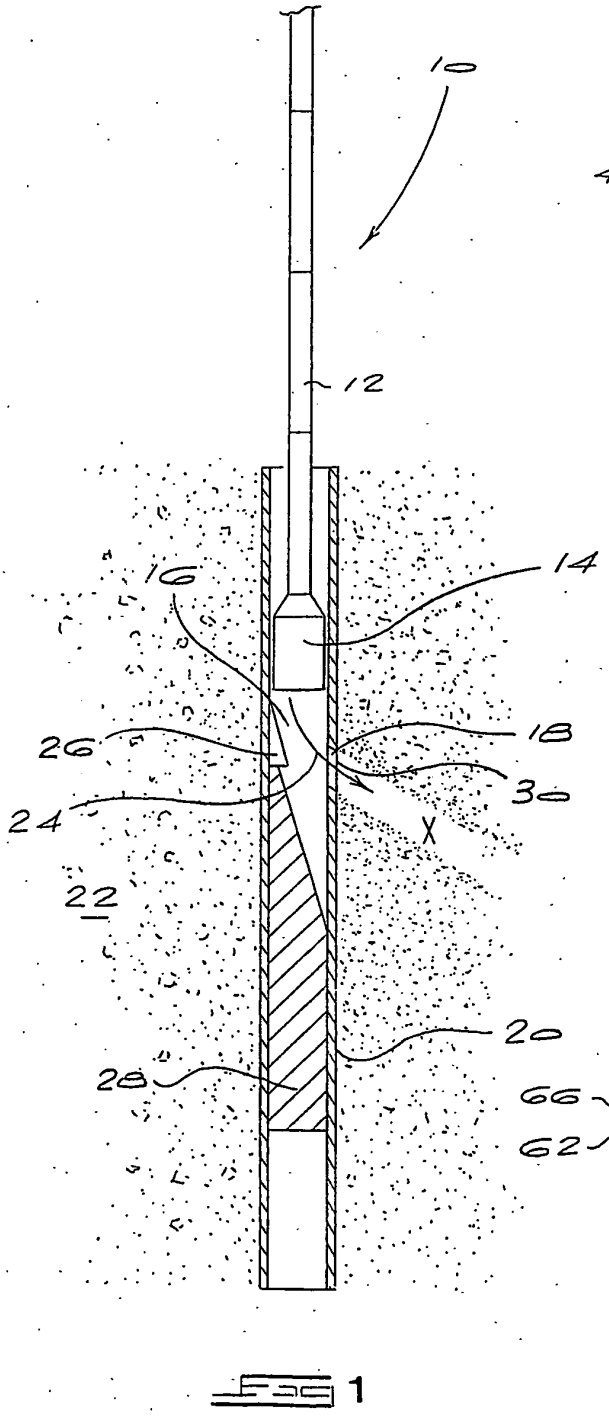


Fig 1

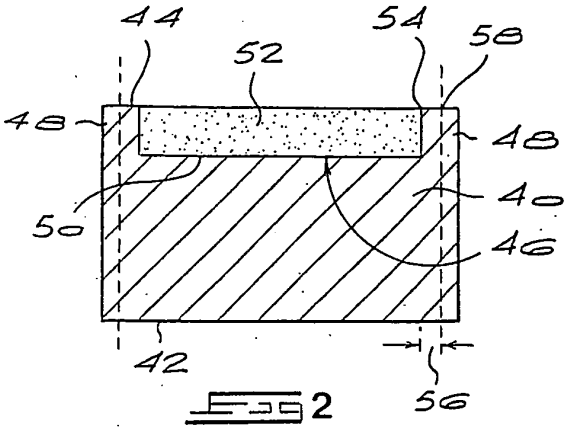


Fig 2

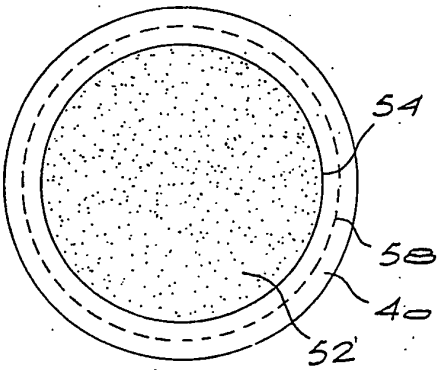


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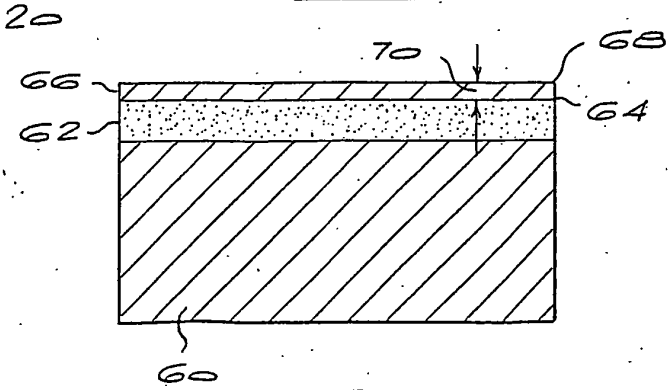


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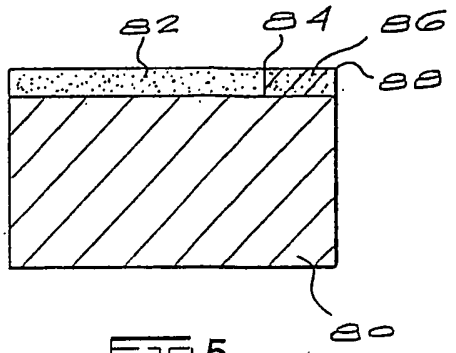


Fig 5

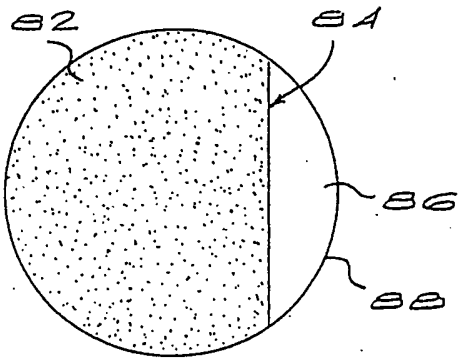


Fig 6

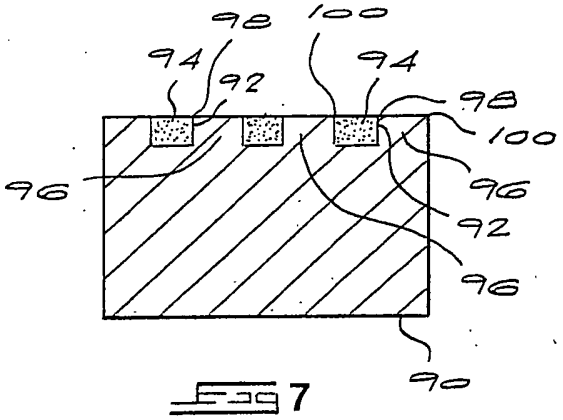


Fig 7

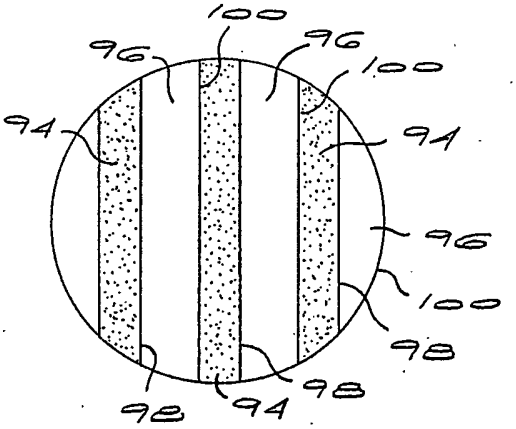


Fig 8

Fig 9

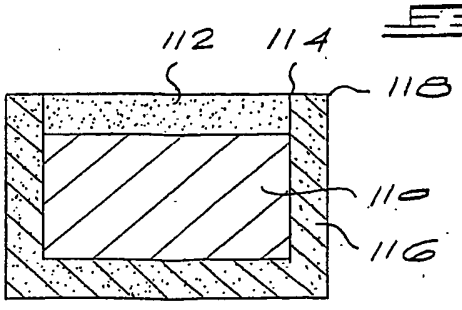
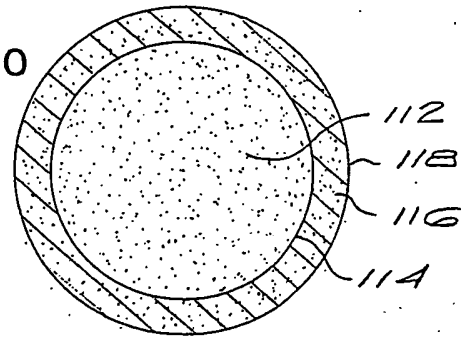


Fig 10



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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