(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 487 355 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number : **91310787.6**

(51) Int. Cl.[5] : **E21B 10/48**

(22) Date of filing : **22.11.91**

(30) Priority : **23.11.90 ZA 909441**

(43) Date of publication of application : **27.05.92 Bulletin 92/22**

(84) Designated Contracting States : **AT BE CH DE FR GB IT LI NL SE**

(71) Applicant : **Stewart, Aulette**
45 Arend Avenue
Randburg, Transvaal (ZA)

(72) Inventor : **Stewart, Aulette**
45 Arend Avenue
Randburg, Transvaal (ZA)

(74) Representative : **Jones, Alan John et al**
CARPMAELS & RANSFORD 43 Bloomsbury Square
London, WC1A 2RA (GB)

(54) **Drill bit.**

(57) A rotatable crown for a rotary drill bit comprises a working end (20) which presents a working face (26) for the crown and an opposite end (12) for engagement with a drill rod, stringer or adaptor coupling. The working end (20) comprises a mass of discrete abrasive particles (29) uniformly distributed through a bonding matrix, and a plurality of elongate abrasive elements (30) so arranged in the matrix that ends (30-A) thereof are located in the working face (26). The working face (26) has a serrated profile with alternating peaks (28) and troughs (28A). The ends (30A) of the elongate elements are located in peaks (28).

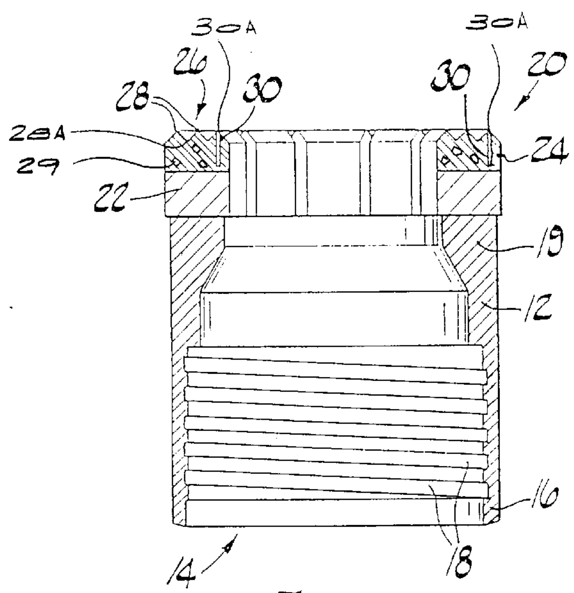

FIG 2

Jouve, 18, rue Saint-Denis, 75001 PARIS

BACKGROUND OF THE INVENTION

This invention relates to a drill bit.

Rotary drills comprise a rotatable crown having one end threaded for engagement with a drill rod, stringer or adapted coupling, and a working portion which presents a working or cutting face at the other end. The working portion comprises a plurality of cutting elements firmly held in a suitable bonding matrix. The bonding matrix may contain an alloy such as bronze cementing together hard particles such as tungsten carbide, tungsten, iron or cobalt.

The cutting elements may be made of a variety of hard material such as diamond, cubic boron nitride, cemented carbide and abrasive compact.

Abrasive compacts, as is known in the art, consist essentially of a mass of abrasive particles present in an amount of at least 70 percent, preferably 80 to 90 percent by volume of the compact bonded into a hard conglomerate. Compacts are polycrystalline masses containing a substantial amount of direct particle-to-particle bonding. The abrasive particles of the compacts are invariably ultra-hard abrasives such as diamond and cubic boron nitride. Diamond compacts are also known in the art as polycrystalline diamond or PCD.

Diamond compacts which are thermally stable at temperatures above 700°C are known in the art and are used, for example, as the cutting elements in rotary drills. Examples of such compacts are described in United States Patent Specifications Nos. 4,534,773, 4,793,828 and 4,224,380.

European Patent Publication No. 0 156 235 describes and claims a diamond cutter insert for use in a drill bit which comprises a plurality of thermally stable polycrystalline diamond cutting elements each characterised by a longitudinal axis and held in a matrix material in such manner that the longitudinal axes of the elements are generally mutually parallel. The cutter insert may be mounted on the end of a stud for insertion into a drill bit body. Alternatively, the cutter insert may be bonded directly into the cutting face of the drill bit. The individual polycrystalline diamond cutting elements are said to be capable of having a length of up to 10mm.

United States Patent No. 4,190,126 describes a rotary abrasive drilling bit comprising a plurality of cutting elements held in a bonding matrix in a working face of the bit, each element comprising a stick-like body of cemented tungsten carbide which presents a curved cutting edge.

European Patent Publication No. 0 391 683 describes a rotatable crown for a rotary drill comprising a working end and an opposite end for engagement in a drill rod, stringer or adapted coupling. The wording end has a cutting face and a plurality of discrete, spaced, elongate cutting elements located in the cutting face. The cutting elements are of square or rectangular cross section, each presents a cutting point which is defined by corner of the element and each has a longitudinal axis which extends behind the cutting face. The elements are each made of thermally stable abrasive compact.

SUMMARY OF THE INVENTION

According to the present invention, a rotatable crown for a rotary drill bit comprises a working end which presents a working face for the crown and an opposite end for engagement with a drill rod, stringer or adaptor coupling, the working end comprising a mass of abrasive particles uniformly distributed through a bonding matrix, and a plurality of elongate abrasive elements so arranged in the matrix that ends thereof are located in the wording face.

DESCRIPTION OF THE DRAWINGS

Figure 1 shows a three-dimensional view of a a bit in accordance with the invention;

Figure 2 shows a longitudinal sectional view through II-II of Figure 1;

Figure 3 shows an enlarged view of part of Figure 2;

Figure 4 shows a plan view of the drill bit of Figure 1, illustrating the arrangement of the elongate abrasive elements in the working face; and

Figure 5 shows three-dimensional views of two forms of elongate abrasive elements for use in the drill bit of Figure 1.

DESCRIPTION OF EMBODIMENTS

The abrasive particles will generally have a size of less than 1000 microns. These particles are typically diamond or cubic boron nitride, with diamond being preferred. The particles may also be particles of thermally stable diamond compact. Such particles may be produced by crushing a thermally stable diamond compact.

The abrasive particle concentration in the working face will typically be in the range 20 to 75 concentration.

The elongate abrasive elements may be made of thermally stable diamond compact, cemented carbide such as cemented tungsten carbide or other suitable abrasive material. They are preferably made of thermally stable diamond compact such as that sold under the trade name Syndax 3.

The elongate abrasive elements will be located in the working end such that the longitudinal axis thereof extends behind the working face and an end thereof is located in the working face. The longitudinal axis may extend perpendicular to the wording face or at an angle which will not exceed 45° thereto.

The elongate abrasive elements may have rectangular, square or circular cross section and will preferably have a high aspect ratio. By way of example, the cross sectional area of the elements may be in the range 1 to 4mm^2, while the lengths of the elements may be in the range 3 to 8mm.

The working face preferably has a serrated profile with alternating peaks and troughs. With such a working face, the ends of the elongate elements will preferably be located in peaks.

An embodiment of the invention will now be described with reference to the drawings. In the drawings, reference numeral 10 generally indicates the drill bit.

The drill bit 10 includes a cylindrical steel bit body 12, having a central passageway 14. Towards one end 16 of the body 12 is provided an internal box screw thread 18 so that the body can be screwed onto a core barrel or drill string (not shown). At the other end 19 of the body 12, is provided a working or cutting portion, generally indicated by reference numeral 20.

The wording portion 20 comprises an annular component 22 moulded to the end 19 of the body 12, as well as a further annular component 24 moulded integrally with the component 22 and having a serrated profile wording face 26 which comprises a plurality of annular ridges or peaks 28, and alternating troughs 28A.

The component 24 comprises a bonding matrix having a mass of diamond particles 29 uniformly distributed therethrough. The component 24 also has a plurality of elongate abrasive elements 30, with the elements 30 extending perpendicularly to the working face 26, as indicated in Figure 2 and 3. The elements 30 are spaced circumferentially about the ridges 28, and the ends 30A of the elements 30 extend into the ridges 28. The elements 30 are located perpendicular to the working face 26 and extend close to the full depth of the component 24. The elements 30 of adjacent ridges are staggered circumferentially, as shown in Figure 4. Other patterns or arrangements of the elements may be used.

The elements 30 may be square or circular in cross section, as shown in Figure 5, and their length is typically between 3 and 8mm. Their cross sectional area is typically between 1 and 4mm^2. They are thus of high aspect ratio.

The elements 30 are of thermally stable diamond compact. Such diamond compacts are known in the art, and do not signicantly graphitise when subjected to temperatures of the order of 1200°C in a vacuum, reducing or inert atmosphere. Typically, the compact material from which the elements 30 is formed can be that described in U.S. Patents Nos. 4,224,380, 4, 534,773 or 4,793,828 with the last-mentioned being preferred. The thermally stable diamond compact of U.S. 4,793,828 is known by the trade mark Syndax 3.

Diamond compacts are manufactured in the form of discs of varying diameter and thickness, and the elements 30 can then be cut from such discs using laser cutting machines.

The working portion 20 is formed by moulding it to the body 12. The moulding is effected by locating the elements 30 in position in a graphite mould and surrounding it with an abrasive particle impregnated matrix.

The working portion can be formed by the so-called infiltration process. This process comprises loading the mould with powdered metal such as tungsten/tungsten carbide, nickel, iron, cobalt, transition metals selected from Group IV of the Periodic Table of Elements, or combinations thereof. Thereafter, a bonding alloy which has a comparatively low melting point, is introduced into the matrix powder by melting the bond alloy and allowing it to be drawn into the matrix powder by capillary action. Pressure can be employed subsequent to the infiltration process, if desired.

A hot press technique can also be used. In this technique, metals similar to those described with respect to the infiltration process are used. The metals may also be used in the form of alloys with one another. This technique comprises simultaneous application of heat and pressure to compact the composition, and force the bonding metal to flow uniformally between the more refractory metal particles and to eliminate all or nearly all internal porosity. This process utilises self bonding powder, i.e. powders which already contain the bonding alloy before they are placed in the mould.

In both these processes, the result is that the abrasive particles are bonded uniformly and randomly throughout the matrix of the working portion 24.

The number of elongate elements 30 spaced circumferentially around each of the peaks or ridges 28, will vary according to the degree of reinforcing abrasiveness required. This will depend largely on the abrasiveness of the rock to be drilled with the bit 10, and will be selected bearing in mind that it is desired to reduce the wear rate of the peaks sufficiently to match the wear rate of the adjacent grooves or troughs in the working portion so that the original face profile of the bit is retained for as long as possible during drilling continuing beyond the original height of the grooves and into the lower part of the working portion 24.

In use, when drilling rock with the bit 10, continuous and regular attrition of the surface of the rock by the numerous small diamond cutting points exposed on the working portion 20 takes place. As wear of the working portion takes place, fresh diamond cutting points are continually exposed. Ideally, the working portion continues its abrading action on the rock until the entire diamond bearing matrix has been exhausted. Hitherto, it has been found that the peaks 28 wear down more rapidly than the adjacent grooves so that the original serrated profile of the working face is not maintained. By using the elements 30, the original face profile is maintained for significantly longer periods than is the case with bits without the reinforcing while the life of the bit is also prolonged thereby.

While the use of the elements 30 will find particular use in working faces having circle or serrated face profiles, they can in principle also be used on other shapes such as semi-flat, flat, full or stepped face profiles.

An advantage of the serrated profile is that, in use, high pressure is generated on the rock surface at the peaks. This enables rock, and in particular hard rock, to be fractured more readily, resulting in more efficient breakout of rock between the peaks. Another advantage of this profile is that the surface of the rock being drilled initially reflects a similar serrated profile to that of the working face profile. This particular feature, in which the two matching profiles of the wording face and rock face become almost locked together, is advantageous in maintaining radial bit stability while drilling. Thus, there will be a lower tendency for radial vibrations to occur while drilling, resulting in improved hole size integrity and directional stability. In certain rock formations, it is believed that improved penetration rates will be observed.

Traditionally, with unreinforced bits, a limitation of the serrated profile is that the grooves or ridges generally occupy only a small proportion of the overall depth of the impregnated matrix. Due to the increased pressure at the ridges, these areas are subjected to a faster rate of wear than the valleys or grooves, as mentioned hereinbefore. Consequently, during use, the peaks are worn down to the same level as the grooves or troughs, so that the bit thereafter essentially takes a bat face profile configuration. While the face of the crown, by virtue of the remaining diamond impregnated matrix, still continues to drill rock, the initial advantages of the serrated profile are lost.

A drill bit as described above has been found to provide excellent drilling in quartzite with chert bands and formations which contain lava and sticky shale.

The invention will be illustrated by the following examples in which the coring bits had a shape and serrated working face as illustrated in the drawings.

EXAMPLE 1

A PNQ type diamond impregnated coring bit (122mm OD x 48mm ID), containing 300 - 420 micron diamond grit at 50 concentration, was manufactured incorporating elongate Syndax 3 abrasive elements (1.5mm square by 8mm long). The elongate elements were positioned on alternate peaks (ridges) of each of 12 segments around the periphery of the crown. The bit was used in the drilling of dolerite and chert formations. An average drilling rate of 11 metres per 12 hour shift was obtained. After 137 metres of drilling, the bit was withdrawn for examination. Although the kerf height had been reduced by approximately 5mm by abrasive wear, the original serrated profile of the bit was still evident. This bit continued to drill for a further 24 metres. In comparison, a similar, unreinforced impregnated bit using the same diamond and at the same concentration, resulted in a drilling rate of 7 metres per 12 hour shift and a total life span of 92 metres.

EXAMPLE 2

Seven diamond impregnated coring bits - designated 76-CHD size (76mm OD x 44mm ID) - each containing (420 - 600 microns) diamond grit at 40 concentration, were manufactured incorporating elongate Syndax 3 abrasive elements (1,5mm square by 5mm long). The elongate elements were again positioned on alternate peaks (ridges) of each of 10 peripheral segments. The bits were used in the drilling of sandstone and shale formations. An average bit life of 107 metres was obtained at a drilling rate of 57 metres per 12 hour shift. In comparison, unreinforced impregnated bits in the same formation achieved an average life of 61 metres at a drilling production rate of 35 metres per how. Additionally, the reinforced bits displayed excellent drilling stability and resulted in far less hole deviation relative to the unreinforced bits used in the same formation.

Claims

1. A rotatable crown for a rotary drill bit comprises a working end (20) which presents a working face (26) for the crown and an opposite end (12) for engagement with a drill rod, stringer or adaptor coupling, the working end (20) comprising a mass of discrete abrasive particles (29) uniformly distributed through a bonding matrix, and a plurality of elongate abrasive elements (30) so arranged in the matrix that ends (30A) thereof are located in the working face (26).

2. A crown according to claim 1 wherein the abrasive particles (29) have a size of less than 1000 microns.

3. A rotatable crown according to claim 1 or claim 2 wherein the abrasive particles (29) are diamond or cubic boron nitride particles.

4. A crown according to claim 1 or claim 2 wherein the particles (29) are particles of thermally stable diamond compact.

5. A crown according to any one of the preceding claims wherein the elongate elements (30) are thermally stable diamond compact elements.

6. A crown according to any one of claims 1 to 4 wherein the elongate elements (30) are cemented carbide elements.

7. A crown according to any one of the preceding claims wherein the working face (26) has a serrated profile with alternating peaks (28) and troughs (28A).

8. A crown according to claim 7 wherein an end (30A) of each elongate element (30) is located in a peak (28).

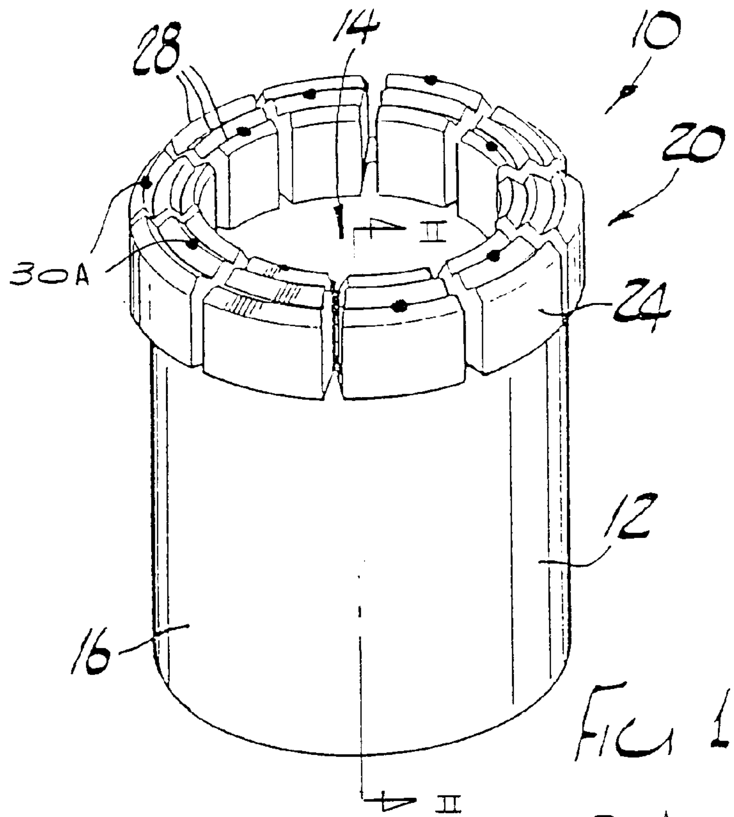
28
14
10
20
30A
24
12
16
II
II

Fig 1

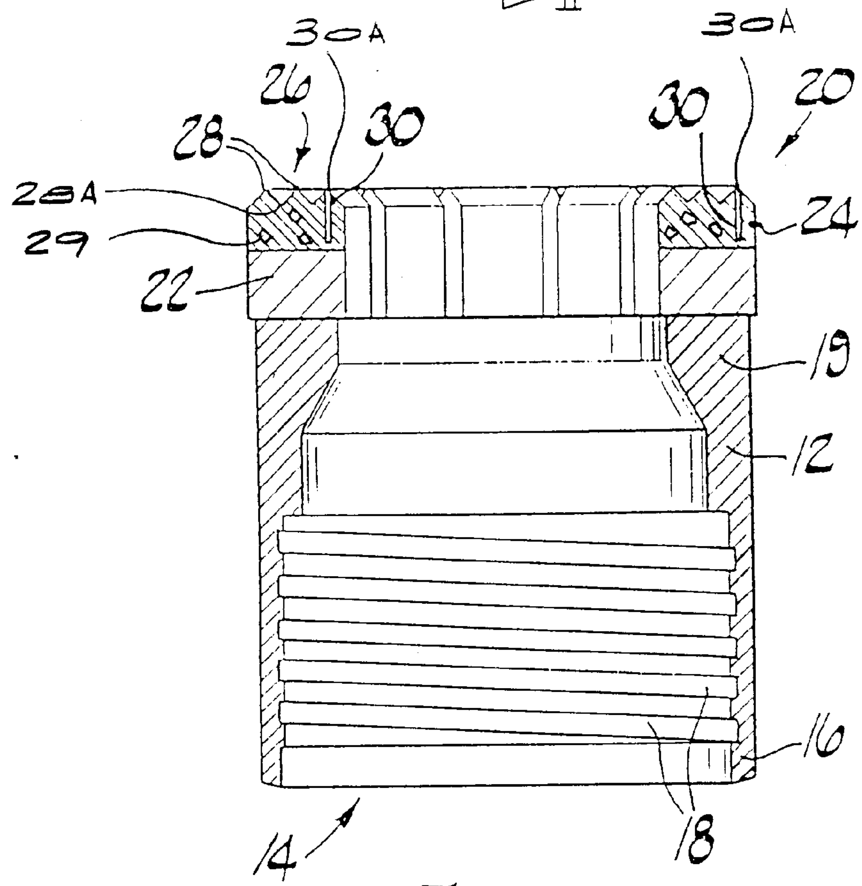
30A
30A
26
30
30
20
28
28A
24
29
22
19
12
16
14
18

Fig 2

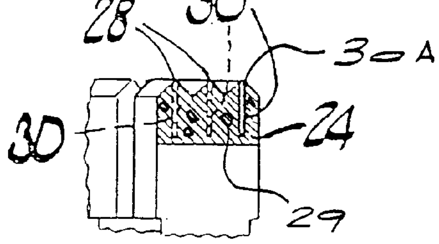

FIG 3

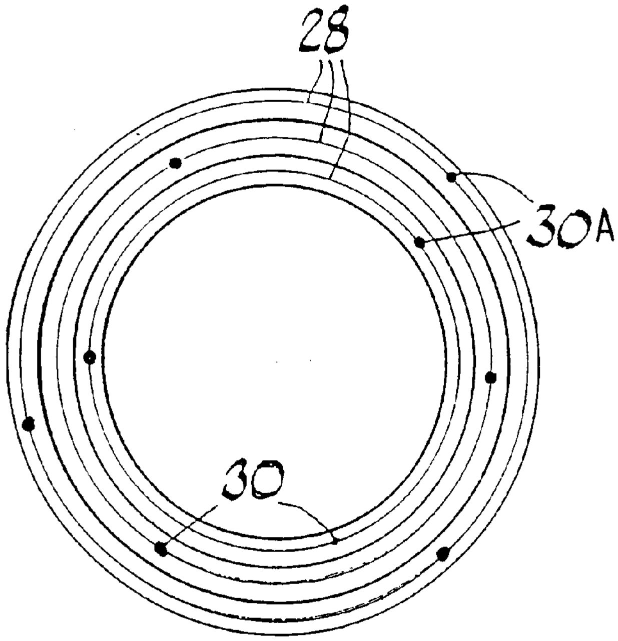

FIG 4

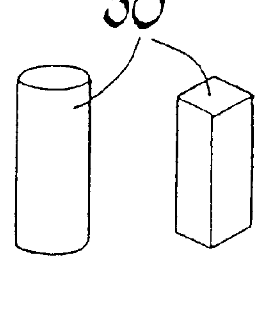

FIG 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 31 0787

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-3 537 538 (GENEROUX) * column 2, line 43 - column 4, line 30; figures 1-3 *	1,3,5,7, 8	E21B10/48
D,X	EP-A-0 391 683 (MORRISON) * the whole document *	1-5	
D,Y	US-A-4 190 126 (KABASHIMA) * column 7, line 40 - column 8, line 32; figure 2 *	1-4,6	
D,Y	US-A-4 793 828 (BURNAND) * column 4, line 65 - column 5, line 43; figures 2,4 *	1-4,6	
A	US-A-4 128 136 (GENEROUX) * column 3, line 10 - line 32; figures 1,8 *	1,7,8	
A	EP-A-0 149 530 (ECER) * page 9, line 8 - page 11, line 13; figure 5 *	1,7,8	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	US-A-2 729 427 (DAVIS) * the whole document *	1,7	E21B
A	US-A-2 495 400 (WILLIAMS) * column 3, line 5 - line 20; figures 1-3 *	1,8	
A	US-A-2 818 233 (WILLIAMS) * the whole document *	1,8	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 MARCH 1992	FONSECA Y FERNANDEZ

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)