

CUTTING ELEMENT, TOOL AND METHOD OF CUTTING WITHIN A BOREHOLE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Application No. 13/530,942, filed on June 22, 2012, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Cutting tools, such as mills used in downhole applications, for example, can be made with a plurality of cutting elements that are adhered to a surface of a tool. The cutting elements can be randomly shaped particles made by fracturing larger pieces. Alternately, cutting elements can be precisely formed into repeatable shapes using processes such as machining and molding, for example. Regardless of the process employed to make the individual cutting elements the elements are typically adhered to the mill with random orientations. These random orientations create disparities in maximum heights relative to a surface of the mill. Furthermore, angles of cutting surfaces relative to the target material are randomized and consequently few are near preferred angles that facilitate efficient cutting. In addition to uniformity, greater tool life than can be achieved with a single layer of cutting elements is often desired. When even precisely formed elements with advantageous angles with respect to the target are stacked in multiple layers, the second layer typically has random orientation. A precisely formed element capable of being stacked in a controlled advantageous orientation would be well received in the industry.

BRIEF DESCRIPTION

[0003] Disclosed herein is a cutting element. The cutting elements includes a body having two planes, each of the two planes defining a plurality of edges, and a support extending from a first of the two planes. The support and the body are configured such that when the cutting element is resting against a planar surface such that at least one of the plurality of edges and the support are in contact with the planar surface, edges of the plurality of edges on a second of the two planes form cutting edges and the second of the two planes forms an acute angle with the planar surface. The second of the two planes of the cutting element has a recess formed therein sized and positioned to be receptive to a support of a second cutting element similar to the cutting element when the first of the two planes of the second cutting element is butted against the second of the two planes of the cutting element.

[0004] Further disclosed herein is an elongated cutting element. The elongated cutting element includes two of the cutting elements described above that are stacked and attached together such that the support of a first of the two of the cutting elements engages in a recess of a second of the two of the cutting elements.

[0005] Further disclosed herein is a cutting tool. The cutting tool includes a trunk with a surface, and a plurality of the elongated cutting elements described above that are attached to the surface, a plurality of the plurality of elongated cutting elements are oriented such that a first support and at least one cutting edge is in contact with the surface.

[0006] Further disclosed herein is a method of cutting within a borehole. The method include rotating the cutting tool described above within a borehole, contacting a target in the borehole with one or more of the plurality of elongated cutting elements, and cutting the target.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

[0008] FIG. 1 depicts a side view of a cutting element disclosed herein;

[0009] FIG. 2 depicts a top view of the cutting element of FIG. 1;

[0010] FIG. 3 depicts a perspective view of a three cutting elements disclosed herein each having two of the cutting elements of Figures 1 and 2 stacked together;

[0011] FIG. 4 depicts a side view of one of the cutting elements of FIG. 3; and

[0012] FIG. 5 depicts a perspective view of a portion of a cutting tool disclosed herein.

DETAILED DESCRIPTION

[0013] A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

[0014] Referring to Figures 1 and 2, an embodiment of a cutting element disclosed herein is illustrated at 12. The cutting element 12 includes a body 16 and a support 28. The body 16 has a first plane 20A defining a plurality of edges 24A and a second plane 20B defining a plurality of edges 24B. The support 28 extends beyond the first plane 20A such that the cutting element 12 is restable upon a planar surface 32 with at least one of the edges 24A and the support 28 being simultaneously in contact with the planar surface 32. The

planar surface 32 may be on a cutting tool 36 to which the cutting element 12 is attachable. It should be noted that a tool may have a surface that is not planar to which the cutting elements 12, 48 (see Figures 3-5) are attachable as well. With the cutting element 12 resting on the planar surface 32 the second plane 20B forms an acute angle 40 with the planar surface 32, and the edges 24B on the second plane 20B are cutting edges.

[0015] Additionally referring to Figures 3 and 4, the second plane 20B has a recess 44 therein configured and sized to be receptive to the support 28 of another of the cutting elements 12 such that the second plane 20B of the other of the cutting elements 12 butts against the first plane 20A thereof. Two or more of the cutting elements 12 can be positioned relative to one another in this manner such that they are stacked and attached together to form an elongated cutting element 48. In embodiments wherein the cutting elements 12 that combined make one of the elongated cutting elements 48 are substantially the same size and shape the supports 28 and the recesses 44 can be configured to orient the cutting elements 12 together such that the second plane 20B of both of the cutting elements 12 form the same acute angle 40 with the planar surface 32. Although in the embodiment illustrated the recess 44 and the support 28 appear to allow one of the cutting elements 12 to be rotated relative to the other of the cutting elements 12 prior to them being attached together, embodiments wherein the recess 44 and the support 28 rotationally fix the cutting elements 12 to one another is an option. The fit of the support 28 within the recess 44 can also be used to provide alignment between the two cutting elements 12 prior to them being attached to one another.

[0016] Additionally, the planes 20A and 20B of the illustrated embodiment are geometrically similar to one another and are of the same size thereby resulting in the body 16 being a regular solid. Alternate embodiments are possible wherein the planes 20A and 20B are not geometrically similar to one another nor are they of the same size. A perimeter of each of the planes 20A, 20B that defines the edges 24A, 24B can have various shapes including, polygons, as well as shapes that approximate a polygon with deviations such as rounded corners 49 and grooves 50 shown in the Figures. Inclusion of the grooves 50 has the added feature of disrupting propagation of cracks in the cutting element 12 when such cracks intersect with the grooves 50. Also, formation of chips removed from a target 52 may be smaller than had the grooves 50 not been present since the grooves 50 in essence separate one of the cutting edges 24B into two or more such cutting edges 24B. Additionally, the planes 20A, 20B though shown as being parallel to one another in the embodiment of the Figures could instead be skewed relative to one another. By rotating one such configured element

relative to another similarly configured element prior to attachment together such planes can be made to form selected acute angles relative to the planar surface 32.

[0017] The first plane 20A and the support 28 of the cutting element 12 can be configured such that the acute angle 40 has specific values. Experience shows that when the acute angle 40 is between 10 and 30 degrees the cutting edges 24B are effective at cutting the target 52 or work piece that the cutting element 12 moves relative to. And setting the acute angle 40 at about 20 degrees shows particularly effective cutting therewith. Experience further shows effective cutting when the cutting edges 24B are defined by 90 degree angles between the second plane 20B and a face 56 of the body 16. Further orienting the cutting elements 12 on the planar surface 32 of the cutting tool 36 such that movement of the cutting elements 12 in a direction along arrow 60 relative to the target 52 (the target 52 being stationary) results in a leading angle 64 between the face 56 and the target 52 and a trailing angle 62 between the second plane 20B and the target 52 that is quite effective for cutting the target 52.

[0018] Orienting the cutting elements 12 such that the face 56 forms the leading angle 64 with the target 52 also distributes loads imparted on the cutting elements 12, 48 in a direction of arrow 68 through a dimension 72 of the body 16. Such an orientation can enhance durability of the cutting elements 12, due to less fracturing of the element 12, particularly when the dimension 72 is set to be greater than a dimension 76 of the body 16.

[0019] Although a planar land 80 exists on the plane 20B between the edges 24B and the recess 44 in the illustrated embodiments, other embodiments without the planar land 80 are contemplated. Without the planar land 80 an alternate recess (not shown) could extend all the way to a cutting edge as could walls of an alternate support that would be complementary to such a recess.

[0020] Figure 5 depicts a perspective view of a portion of the cutting tool 36 disclosed herein. The tool 36 includes a trunk 84 that rotates about an axis 88 in a direction according to arrow 92. A plurality of the cutting elements 48 are attached to the surface 32 of the tool 36 such that they move relative to the target 52 as shown in Figures 1 and 4. Alternately, a combination of the cutting elements 48 and the cutting elements 12 can be attached to a surface of a single tool. The elements 48 can be oriented along radial spokes on the surface 32 either with or without the elements 12 positioned on the surface 32 in the spaces between the radial spokes.

[0021] The cutting tool 36 disclosed herein is well suited for cutting the target 52. In downhole applications for example wherein removal of the target 52 from an earth formation

borehole is desired, the target 52 may consist of stone, earth, metal, ceramic, polymers, monomers and combinations of the foregoing. Fabricating the cutting elements 12, 48 of hard materials such as steel, tungsten carbide, tungsten carbide matrix, polycrystalline diamond, ceramics and combinations thereof, for example, allow for good cutting performance while also providing longevity of the tool 36 and the cutting elements 12, 48.

[0022] While the invention has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

CLAIMS

What is claimed:

1. A cutting element comprising:
a body having two planes, each of the two planes defining a plurality of edges; and
a support extending from a first of the two planes, the support and the body being configured such that when the cutting element is resting against a planar surface such that at least one of the plurality of edges and the support are in contact with the planar surface, edges of the plurality of edges on a second of the two planes form cutting edges and the second of the two planes forms an acute angle with the planar surface, the second of the two planes of the cutting element having a recess formed therein sized and positioned to be receptive to a support of a second cutting element similar to the cutting element when the first of the two planes of the second cutting element is butted against the second of the two planes of the cutting element.
2. The cutting element of claim 1, wherein the recess and the support are configured to positionally orient the two cutting elements such that the second of the two planes of the second cutting element forms substantially the same acute angle with the planar surface.
3. The cutting element of claim 1, wherein the acute angle is between about 10 and 30 degrees.
4. The cutting element of claim 1, wherein the acute angle is about 20 degrees.
5. The cutting element of claim 1, wherein the second of the two planes and a face of the body defining the cutting edges form a substantially 90 degree angle.
6. The cutting element of claim 1, wherein a planar land exists between the cutting edges and the recess.
7. The cutting element of claim 1, wherein the first of the two planes is substantially parallel to the second of the two planes.
8. The cutting element of claim 1, wherein a shape of the first of the two planes is substantially the same as a shape of the second of the two planes.
9. An elongated cutting element comprising at least two of the cutting elements of claim 1 being stacked and attached together such that the support of a first of the at least two of the cutting elements engages in a recess of a second of the at least two of the cutting elements.
10. The elongated cutting element of claim 9, wherein each of the at least two of the cutting elements have substantially the same size and shape.

11. The elongated cutting element of claim 9, wherein an acute angle between a second of the two planes of the first of the at least two of the cutting elements and the planar surface is substantially the same as an acute angle between the second of the two planes of the second of the at least two of the cutting elements and the planar surface.

12. A cutting tool comprising:

a trunk with at least one surface; and

a plurality of the elongated cutting elements of claim 9 being attached to the at least one surface, a plurality of the plurality of elongated cutting elements being oriented such that a first support and at least one cutting edge is in contact with the at least one surface.

13. The cutting tool of claim 12, wherein the at least one surface is a planar surface.

14. The cutting tool of claim 12, further comprising a plurality of the cutting elements of claim 1 being attached to the at least one surface, a plurality of the plurality of cutting elements being oriented such that the first support and at least one cutting edge is in contact with the at least one surface.

15. The cutting tool of claim 14, wherein the plurality of elongated cutting elements are positioned in groups on the at least one surface separate from the cutting elements.

16. The cutting tool of claim 15, wherein the groups of elongated cutting elements are positioned along radially oriented spokes on the at least one surface.

17. A method of cutting within a borehole comprising:

rotating the cutting tool of claim 12 within a borehole;

contacting a target in the borehole with one or more of the plurality of elongated cutting elements; and

cutting the target.