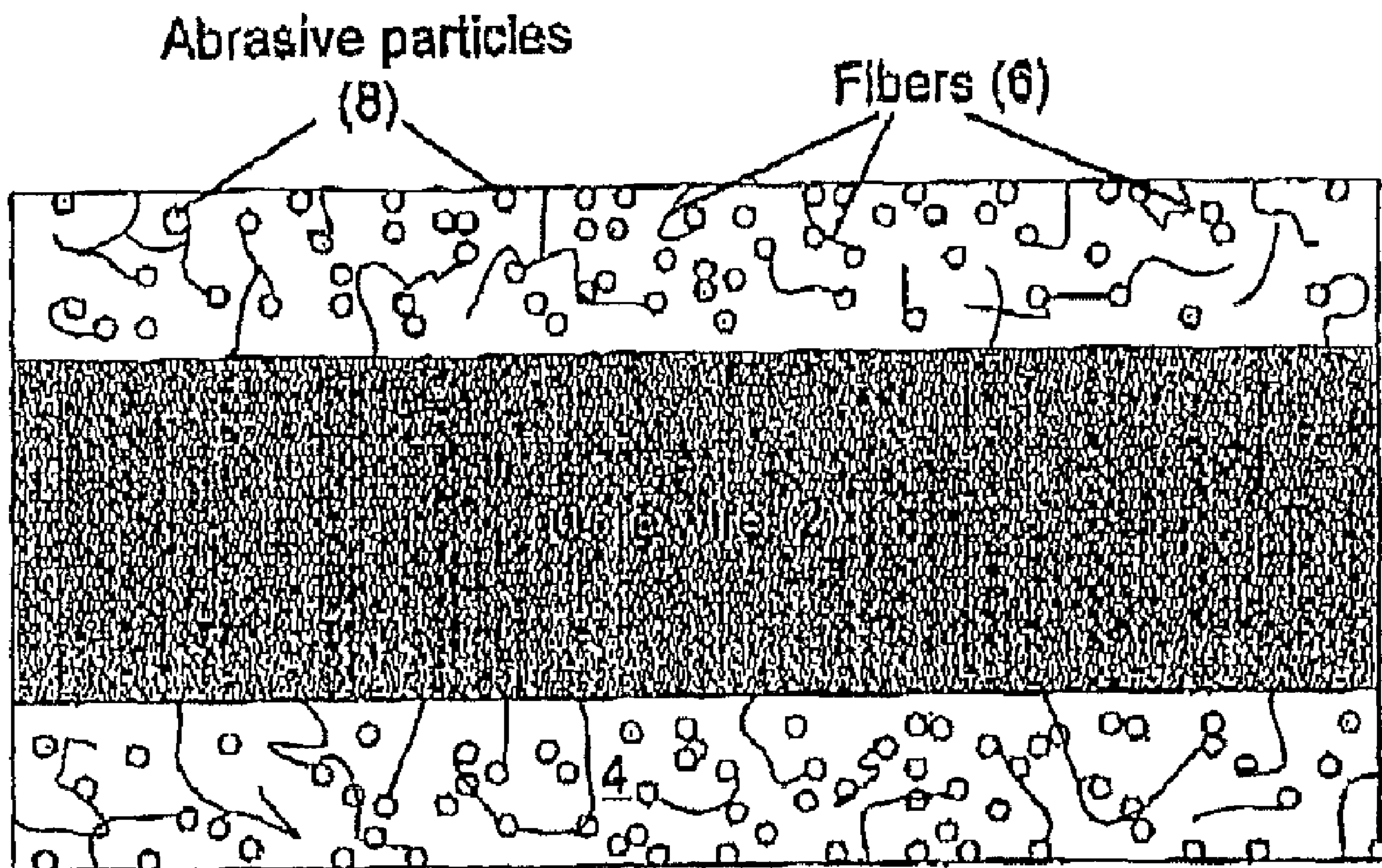




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(57) Abrégé/Abstract:

Fibers for diamond-impregnated cutting tools and their associated methods for manufacture and use are described. The cutting tools contain a diamond-impregnated cutting portion that contains fibers made from carbon, glass, ceramic, polymer, and the like. The fibers can be in any form, including chopped and milled fibers. The fibers may also be coated with metal, ceramic, or other performance-enhancing coatings. The fibers may be used to both control the tensile strength control the erosion rate of the matrix

(57) **Abrégé(suite)/Abstract(continued):**

to optimize the cutting performance of the tools. Additionally, the fibers may also weaken the structure and allow higher modulus binders to be used for the cutting tools at a lower cost, allowing the amount of fibers to be tailored to retain the diamonds in the cutting portion for the desired amount. And as the cutting portion erodes, the fibers may also increase the lubricity at the face of the cutting portion. Using the fibers allows the cutting tools to last longer and make them safer and more economical because they need to be replaced less often.

## ABSTRACT

Fibers for diamond-impregnated cutting tools and their associated methods for manufacture and use are described. The cutting tools contain a diamond-impregnated cutting portion that contains fibers made from carbon, glass, ceramic, polymer, and the like. The fibers can be in any form, including chopped and milled fibers. The fibers may also be coated with metal, ceramic, or other performance-enhancing coatings. The fibers may be used to both control the tensile strength control the erosion rate of the matrix to optimize the cutting performance of the tools. Additionally, the fibers may also weaken the structure and allow higher modulus binders to be used for the cutting tools at a lower cost, allowing the amount of fibers to be tailored to retain the diamonds in the cutting portion for the desired amount. And as the cutting portion erodes, the fibers may also increase the lubricity at the face of the cutting portion. Using the fibers allows the cutting tools to last longer and make them safer and more economical because they need to be replaced less often.

**FIBER-CONTAINING DIAMOND-IMPREGNATED CUTTING TOOLS**

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**BACKGROUND****1. Field**

This application relates generally to cutting tools and their methods of use. In particular, this application relates to diamond-impregnated cutting tools that may contain fibers.

15 **2. Background**

Cutting tools can be impregnated with diamonds so that they can be used to grind, polish, or otherwise cut a variety of materials that normal cutting tools cannot. The part of these tools that performs the cutting action (or the cutting portion of the tool) is generally formed of a matrix that contains a powdered metal or a hard  
20 particulate material, such as tungsten carbide. This material is sometimes infiltrated with a binder, such as a copper alloy. Finally, the cutting portion of these tools is impregnated with diamond crystals or some other form of abrasive cutting media. As the tool grinds and cuts the desired materials, the cutting portion of the tool erodes and exposes new layers of the diamond crystal (or other cutting media) so that a sharp  
25 surface is always available for the cutting process. Any diamond-impregnated cutting tool may continue to cut efficiently until the diamond impregnated portion of the tool is completely consumed. At that point, the tool becomes dull and must be replaced with another one.

In some cases, diamond-impregnated cutting tools may be expensive and their  
30 replacement may be time consuming, costly, as well as dangerous. For example, the replacement of a diamond-impregnated core sampling drill bit requires removing (or tripping out) the entire drill string out of the hole that has been drilled (the borehole). Each section of the drill rod must be sequentially removed from the borehole. Once the drill bit is replaced, the entire drill string must be assembled section by section and

then tripped back into the borehole. Depending on the depth of the hole and the characteristics of the materials being drilled, this process may need to be repeated multiple times for a single borehole.

As well, conventional diamond-impregnated cutting tools often have several characteristics that can add to the consumption rate of the cutting portion and, therefore, increase the operating costs associated with hose cutting tools. First, the binder materials in the tools may be relatively soft in comparison to the cutting media. Accordingly, the cutting portion may erode and allow diamonds or other abrasive cutting materials to slough off prematurely. Second, the erosion rate of the cutting portion can be increased by insufficient lubrication to and around the cutting face of the tool, or the interface between the cutting portion of the tool and the material being cut. Third, conventional impregnated cutting tools may also be too wear resistant to expose and renew layers of the cutting portion.

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### SUMMARY

This application describes diamond-impregnated cutting tools and their associated methods for manufacture and use. The cutting tools contain a diamond-impregnated cutting portion that may contain fibers made from carbon, glass, ceramic, polymer, and the like. The fibers can be in any form, including chopped and milled fibers. The fibers may also be coated with metal, ceramic, or other performance-enhancing coatings. The fibers may be used to both control the tensile strength control the erosion rate of the matrix in the cutting portion to optimize the cutting performance of the tools. Additionally, the fibers may also weaken the structure and allow higher modulus binders to be used for the cutting tools at a lower cost, allowing the amount of fibers to be tailored to retain the diamonds in the cutting portion for the desired amount of time. And as the cutting portion erodes, the fibers may also increase the lubricity at the face of the cutting portion. Using the fibers allows the cutting tools to last longer and make them safer and more economical because they need to be replaced less often.

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### BRIEF DESCRIPTION OF THE DRAWINGS

The following description can be better understood in light of the Figures, in which:

Figure 1 contains an exemplary view of a core sampling drill bit;

Figure 2 contains an exemplary view of a cross section of a diamond wire;

Figure 3 contains an exemplary view of a cross section of another diamond wire; and

Figure 4 contains an exemplary view of a cross section of an individual diamond wire bead.

5 Together with the following description, the Figures may help demonstrate and explain the principles of the invention and methods for using the invention. In the Figures, the thickness and configuration of components may be exaggerated for clarity. The same reference numerals in different Figures represent the same component.

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### DETAILED DESCRIPTION

The following description supplies specific details in order to provide a thorough understanding. Nevertheless, the skilled artisan would understand that the apparatus and associated methods of making and using the apparatus can be  
15 implemented and used without employing these specific details. Indeed, the apparatus and associated methods can be used in conjunction with any systems, components, and/or techniques conventionally used in the industry. For example, while the description below focuses on using fibers in diamond-impregnated cutting tools, this invention may be implemented in many other cutting tool applications, such  
20 as in cutting tools that are impregnated with any cutting media like super-abrasive materials (e.g., polycrystalline diamond), aluminum oxide, silicon carbide, silicon nitride, tungsten carbide, cubic boron nitride, alumina, seeded or unseeded sol-gel alumina, etc., and combinations thereof.

The cutting tools described herein can be used to cut stone, subterranean  
25 mineral formations, ceramics, asphalt, concrete, and other hard materials. These cutting tools may include core sampling drill bits, drag-type drill bits, roller cone drill bits, diamond wire, grinding cups, diamond blades, tuck pointers, crack chasers, and the like. For example, the cutting tools may be any type of earth drill bit (i.e., core sampling drill bit, drag drill bit, roller cone bit, navi-drill, full hole drill, hole saw,  
30 hole opener, etc.), diamond saw blade (e.g., laser welded blade, concave diamond blade, segmented blade, continuous rim blade, wavy core blade, ventilated core blade, etc.), grinding cup (e.g., single row cup, double row cup, grinding cup with T-shaped segments, etc.), tuck pointer (e.g., triple row, etc.), crack chaser, polishing disk, and

so forth. In some embodiments, though, the cutting tools are core sampling drill bits and diamond wire.

The part of the cutting tools that performs the cutting action (or the cutting portion of the tool) contains a matrix with a powdered metal or a hard particulate material, such as tungsten carbide or any other super-abrasive material. This material can sometimes be infiltrated with a binder, such as a copper alloy or a substantial equivalent, and can be sintered to form a segment. The cutting portion of these tools can also be impregnated with diamonds, or some other form of abrasive cutting media, and mixed (and, in some embodiments, reinforced) with fibrous materials (or fibers) as described in detail in the embodiments where the cutting tool is a core sampling drill bit and a diamond wire.

Figure 1 illustrates one example of a fiber-containing cutting tool, a fiber-containing (and, in some embodiments, fiber-reinforced) core sampling drill bit. As shown in Figure 1, the drill bit 20 contains a first section 21 that connects to the rest of the drill string. The drill bit 20 also contains a second section 22 that is used to cut the desired materials during the drilling process. The body of the drill bit 20 has an outer surface and an inner surface containing a hollow portion therein. With this configuration, pieces of the material being drilled can pass through the hollow portion, up into a drill string to which the drill bit is connected, and then be collected.

The drill bit 20 may be any size, and may therefore be used to collect core samples of any size. While the drill bit may have any circumference and may be used to remove and collect core samples with any desired diameter, the diameter generally ranges from about 1 to about 12 inches. As well, while the kerf of the drill bit (the radius of the outer surface minus the radius of the inner surface) may be any width, it generally ranges from about ½ of an inch to about 6 inches.

The first section 21 of the drill bit may be made of any suitable material known in the art. In some embodiments, the first section may be made of steel or a matrix casting of a hard particulate material in a binder. In some embodiments, the first section 21 may contain a chuck end, sometimes called a blank, bit body, or shank, that may be used for any purpose, including connecting the drill bit to the nearest part of the drill string. Thus, the chuck end can be configured as known in the art to connect the drill bit 20 to any desired part of the drill string.

The second section 22 of the core sampling drill bit 20 contains a cutting portion with cutting elements 12 having a cutting face 14. The cutting elements 12

have a space 16 between them so that, as known in the art, a drilling fluid following the path shown by the arrow may be used during drilling. The cutting portion of the core sampling drill bit, often called the crown, may be constructed of any material(s) known in the art. This type of drill bit (a core sampling bit) is generally formed of steel or a matrix of powdered metal, which is a hard particulate material, such as tungsten carbide, tungsten, iron, cobalt, and/or molybdenum. This material may then be infiltrated with a binder, such as a copper alloy, zinc, silver, molybdenum, nickel, cobalt, or a substantial equivalent, and/or may be sintered. The cutting portion of the drill bit may also be impregnated with any form or combination of forms of cutting media, such as diamond crystals.

The cutting media used in the drill bit may have any desired characteristic or combination of characteristics. For instance, the cutting media may be of any size, shape, grain, quality, grit, concentration, etc. In some embodiments, the cutting media may be very small and substantially round in order to leave a smooth finish on the material being cut by the core sampling drill bit. In other embodiments, the cutting media may be larger to cut aggressively into the material being cut.

The cutting media may be contained homogeneously or heterogeneously in the drill bit. As well, the cutting media may be aligned in a particular manner so that the cutting properties of the media are presented in an advantageous position with respect to the cutting portion of the drill bit. Similarly, the cutting media may be contained in the drill bit in a variety of densities as desired for a particular use. For example, large abrasive particles spaced further apart may cut material more quickly than small abrasive particles packed tightly together. But the size, density, and shape of the abrasive particles may be provided in a variety of combinations depending on desired cost and performance of the drill bit.

In some instances, the cutting portion of the drill bit may be made of one or more layers. For example, the cutting portion may contain two layers: a matrix layer that performs the cutting operation and a backing layer, which connects the matrix layer to the first section of the drill bit. In these embodiments, the matrix layer contains the actual cutting media that abrades and erodes the material being drilled. The portion of the matrix layer that comes in contact with the material being cut is known as the cutting face.

Another embodiment of a cutting tool comprises a fiber-containing (and, in some embodiments, a fiber-reinforced) diamond wire segments or beads. Diamond



wire may be used to cut a variety of hard materials. For example, a relatively large diamond wire may be used to cut large blocks of granite out of a granite formation in a quarry for further processing. However, in other uses, a relatively small diamond wire may be used in a laboratory to cut a sample of a hard material for testing.

5 One example a diamond wire is shown in Figure 2. In Figure 2, the diamond wires contain a core wire 2 made of any suitable strong material, such as steel, that may be coated with a cutting material coating 4. The coating 4 in such wires may act as the cutting portion of the diamond wire. The coating 4 may contain a binder (e.g., a copper alloy, iron, silicon carbide, etc.) and a base material that may be formed from  
10 steel or a matrix of powdered metal/hard particulate material (e.g., tungsten carbide, tungsten, iron, cobalt, molybdenum, etc.). The coating 4 may also be impregnated with any cutting media 8, such as diamond crystals. The cutting media 8 in the coating 4 may have any desired characteristic, including any size, shape, alignment, grain, quality, grit, concentration, disbursement, and so forth.

15 In some instances, the coating 4 of the diamond wire may be made of one or more layers. In such embodiments, each layer may be made of any desired material. For example, the backing layer may contain an iron alloy and the bond between the matrix and backing layer is usually achieved with a copper alloy or braze alloy.

Figure 3 illustrates another example of a fiber-containing diamond wire. As  
20 shown in Figure 3, the diamond wires may have abrasive beads that are applied to a core cable 28 (or core wire) to create a continuous string of abrasive beads that act as cutting portions on the diamond wire. The abrasive beads may be formed from any suitable material. For example, the abrasive beads may have a diamond matrix 27 formed of a base material, like powdered metal or a hard particulate material (e.g., tungsten carbide, tungsten, cobalt, molybdenum, etc.). The base material may be  
25 infiltrated with a binding material (e.g., a copper alloy). And the abrasive beads may be impregnated with any cutting media (e.g., diamond crystals) having any desired characteristic, including any size, shape, alignment, grain, quality, grit, concentration, disbursement, and the like.

30 Figure 4 illustrates an individual diamond wire bead 26 that is used with the diamond wire shown in Figure 3. The bead 26 may be of any shape and size known in the art and may be applied to the core wire in any manner known in the art. The diamond wire in Figure 3, for example, may be made by manufacturing the bead 26 to contain a coating 34 with abrasive particles 38 and fibers 36 and a channel 32. In this

example, the bead 26 may then be attached to a steel ferrule, which may be threaded onto the core wire. Therefore, the beads 26 on the diamond wire may be manufactured separately from the core wire and then strung on the core wire with other beads to create the diamond wire. An encapsulant, usually a rubber 25 or some other polymeric material, can be coated on the core wire between the beads as known in the art to create the diamond wire.

The diamond wires may also be any size and may therefore be used in any known process using diamond wire. For example, the diamond wire in Figure 3 may range in length from about 5 meters to more than 100 meters and have beads 26 with a diameter of from about 4 millimeters to about 12 millimeters. And for the diamond wire in Figure 2, the length can be about 10 centimeters long and the diameter of the core wire and cutting material coating can be about a few microns. Nevertheless, the diamond wire can be longer or shorter than the lengths in the previous examples and may also have beads and a cable of any desired diameter.

In addition to these features, the diamond-impregnated cutting tools—including the core sampling drill bits or diamond wires—may have any additional feature known in the art. For example, a core sampling drill bit may have additional gauge protection, hard-strip deposits, various bit profiles, and combinations thereof. Protector gauges on or in a drill bit may be included to reduce the damage to the drill bit and well casing as the drill bit is lowered into the casing. Additionally, the core sampling drill bit may have hard-metal strips applied that may prevent the premature erosion of the cutting portion of the drill bit.

The cutting portion(s) of the diamond-impregnated cutting tools contain fibers. Any known fiber, or combination of fibers, may be added to the cutting tool. In some embodiments, the cutting portion of a diamond-impregnated cutting tool may include fibers such as carbon fibers, metal fibers (e.g., fibers made of tungsten, tungsten carbide, iron, molybdenum, cobalt, or combinations thereof), glass fibers, polymeric fibers (e.g., fibers made of Kevlar), ceramic fibers (e.g., fibers made of silicon carbide), coated fibers, and/or the like.

In some embodiments, the cutting portion of a diamond-impregnated cutting tool may contain any carbon fibers. Any known type of carbon fiber may be included in the cutting portion of a diamond-impregnated cutting tool.

In some embodiments, the fibers may optionally be coated with one or more additional material(s) before being included in the cutting tool. Such coatings may be

used for any performance-enhancing purpose. For example, a fiber coating may be used to help retain fibers in the cutting tool. In another example, a fiber coating may be used to increase lubricity near the cutting face of a cutting tool as the fiber coating erodes away and forms a fine particulate material that acts to reduce friction. In yet  
5 another example, a fiber coating may act as an abrasive material and thereby be used to aid in the cutting process.

Any known material may be used to coat the type of fiber(s) that is used in the cutting tool. For example, any desired metal, ceramic, polymer, glass, sizing, wetting agent, flux, or other substance could be used to coat a desired type of fiber(s) that may  
10 be included in a cutting tool. In one example, carbon fibers could be coated with a metal, such as iron, titanium, nickel, copper, molybdenum, lead, tungsten, aluminum, chromium, or combinations thereof. In another example, carbon fibers may be coated with a ceramic material, such as SiC, SiO, SiO<sub>2</sub>, or the like.

Where fibers are coated with one or more coatings, the coating material may  
15 cover any portion of the fibers and may be of any desired thickness. Accordingly, a coating material may be applied to the fibers in any manner known in the art. For example, the coating may be applied to fibers through spraying, brushing, electroplating, immersion, vapor deposition, or chemical vapor deposition.

The fibers in the cutting portion of a diamond-impregnated cutting tool, such  
20 as a core sampling drill bit, may be of any size or combination of sizes, including mixtures of different sizes. For instance, fibers may be of any length and have any desired diameter. In some embodiments, the fibers may be approximately 10 to about 25,000 microns long and may have a diameter of approximately 1 to about 500 microns. In other embodiments, the fibers may be approximately 150 microns in  
25 length and may have a diameter of approximately 7 microns.

The fibers may be of any shape or combination of shapes. The fibers may be ribbon-like, cylindrical, polygonal, elliptical, straight, curved, curly, coiled, bent at angles, etc.... For instance, Figure 2 illustrates that in some embodiments, the majority of the fibers 6 may be curved. In other embodiments, such as when the  
30 cutting tool comprises a core sampling drill bit, the fibers have a substantially cylindrical shape.

Additionally, the fibers may also be of any type or combination of types. Examples of the types of fibers include chopped, milled, braided, woven, grouped and wound, or tows. In some embodiments, such as when the cutting tool comprises a

core sampling drill bit, the fibers can contain a mixture of chopped and milled fibers. In some embodiments, a diamond-impregnated cutting tool contains one type of fiber. In other embodiments, though, the cutting tool may contain multiple types of fibers. In such instances, where a cutting tool contains more than one type of fiber, any  
5 combination of fiber type, quality, size, shape, grade, coating, and/or fiber with any other characteristic may be used.

The fibers may be found in any desired concentration in the cutting tool. For instance, the cutting portion of a cutting tool may have a very high concentration of fibers, a very low concentration of fibers, or any concentration in between. In some  
10 embodiments, the cutting tool may contain fibers ranging from about 0.1 to about 70 vol%. In other embodiments, the cutting tool may contain fibers ranging from about 0.1 to about 30 vol%. A first portion of the cutting tool may have a first concentration of a particular type of reinforcing fiber and another portion may have a different concentration (either lower or higher) of the same or another type of reinforcing fiber.

15 In some embodiments, fibers may be homogeneously dispersed throughout the cutting portion of a cutting tool. In other embodiments, though, the concentration of fibers may vary throughout any desired portion of a cutting tool, as desired. Indeed, any desired variation of the concentration of fibers may be implemented in a cutting tool. For example, where the cutting tool comprises a core sampling drill bit, it may  
20 contain a gradient of fibers. In this example, the portion of the matrix layer that is closest to the cutting face of the drill bit may contain a first concentration of fibers and the concentration of fibers could gradually decrease or increase towards the backing layer. Such a drill bit may be used to drill a formation that begins with a soft, abrasive, unconsolidated formation, which gradually shifts to a hard, non-consolidated  
25 formation. Thus, the dispersal of the fibers in the drill bit can be customized to the desired earth formation through which it will be drilling.

The fiber concentration may also vary in any desired manner in the cutting tool. In other words, a cutting tool may comprise sections, strips, spots, rings, or any other formation that contains a different concentration or mixture of fiber  
30 reinforcements than other parts of the cutting tool. For example, the cutting portion of a drill bit may comprise multiple layers, rings, or segments of matrix layer containing fibers. Each ring, layer, or segment of the drill bit may have a roughly homogeneous (or heterogeneous) concentration of fibers throughout the entire ring, layer or segment. Yet the concentration of fibers may vary from ring to ring (or from segment

to segment, etc...). And the various rings of differing fiber gradients may be arranged in any order, may contain different fibers or combinations of fibers, and may be of any desired thickness. In another example, the outer and inner surfaces of a drill bit could be provided with a different concentration of fibers than the inner parts of the  
5 drill bit.

The fibers may be located in the cutting portion of a cutting tool in any desired orientation or alignment. In some embodiments, the fibers may run roughly parallel to each other in any desired direction. However, Figures 2 and 4 illustrate that, in other embodiments, the fibers may be randomly configured and may thereby be  
10 oriented in practically any and/or every direction.

The diamond-impregnated cutting tools with fibers can be made using any known method that provides them with the features described above. For example, the drill bit described above can be made in the following exemplary manner. In this example, the first section of the drill bit can be made with any known method. The  
15 fibers can be incorporated into the drill bit using any method that provides the desired fibers in the desired location with the desired concentration. For instance, the fibers may be mixed in with the powdered metal that is used to make the crown of the drill bit. This mixture may then be sintered and/or infiltrated with a binder. In other embodiments, though, the fibers may be incorporated by just placing them into the  
20 mold that is used to make the crown of the drill bit. The first section of the drill bit can then be connected to the second section using any method known in the art. For example, the first section may be present in the mold that is used to form the second section of the drill bit and the two ends of the body may be fused together. Alternatively, the first and second sections can be mated in a secondary process such  
25 as by brazing, welding, or adhesive bonding.

The diamond-impregnated cutting tools with fibers may be used for any purpose known in the art, which depends on the type of cutting tool. For example, a diamond-impregnated core sampling drill bit may be attached to the end of a drill string, which is in turn connected to a drilling rig. As the drill string and therefore the  
30 drill bit is rotated and pushed by the drill bit, it grinds away the materials in the subterranean formations that are being drilled. The core samples that are drilled away are withdrawn from the drill string. The cutting portion of the drill bit will erode over time because of the grinding action. This process may continue until the cutting

portion of a drill bit has been consumed and the drilling string need be tripped out of the borehole and the drill bit replaced.

The described fibers give diamond-impregnated cutting tools several added advantages when compared to conventional cutting tools that lack fibers. First, the addition of the fibers can control the tensile strength and the erosion rate of the cutting tool, whether to strengthen or weaken these properties. Without being restricted to this understanding, it is believed that the presence of the fibers can be use to modify the amount of voids in the cutting portion of the tools. And since the tensile strength and erosion rate depend on the amount of voids, modifying the amount of the fibers can be used to tailor the tensile strength and the erosion rate to the amount needed for the particular end use of the cutting tool. This increased tensile strength can also increase the life of a cutting tool, allowing the cutting portion of the tools to wear at a desired pace and improving the rate at which the tool cuts.

Second, the addition of fibers may also weaken the structure of the cutting portion and allow higher modulus binders to be used for the cutting tools, but at a lower cost. Thus, the amount of fibers in the cutting portion can be tailored to retain the diamonds in the cutting portion for the desired length of time.

A third advantage is that the fibers may also act as abrasive cutting media that aid in the cutting process. A fourth advantage is that as the fibers in the cutting portion erode away, their fine particulate matter can reduce friction and increase the lubrication at the interface between the cutting portion and the surface being cut, allowing easier cutting and better flushing. This increased lubrication may also reduce the amount of cutting lubricants (such as drilling muds, polymers, bentonites, etc...) that are needed, reducing the costs as well as the environmental impact that can be associated with using diamond-impregnated cutting tools.

#### EXAMPLE

In one example of a comparison between a conventional diamond-impregnated cutting tool (one lacking fibers) and a fiber-containing diamond-impregnated cutting tool, two sets of substantially similar drill bits were manufactured. In this comparison, the first set of drill bits contained no fibers and the second set was reinforced with carbon fibers. Each drill bit was then tested and the following properties were measured.

Penetration Rate: The average penetration rates of the first set of drill bits ranged from about 30 to about 40 meters per shift. Nevertheless, with the second set of fiber-reinforced bits, the drillers consistently achieved about 50 meters per shift. This equates to an increase in penetration rate of about 25% to about 67%.

5        Bit life: The average bit life of the first set of drill bits was 64 meters. Conversely, the average bit life of the second set of drill bits was about 104 meters. This equates to an increase in bit life of about 60%.

10        In addition to any previously indicated modification, numerous other variations and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the above description, and appended  
15        claims are intended to cover such modifications and arrangements. Thus, while the information described above with particularity and detail in connection with what is presently deemed to be the most practical and exemplary embodiments, it will be apparent to those of ordinary skill in the art that numerous modifications, including, but not limited to, form, function, manner of operation and use may be made without departing from the principles and concepts set forth herein. Also, as used herein, examples and embodiments are meant to be illustrative only and should not be construed as limiting in any manner.

**CLAIMS**

1. A cutting tool including a cutting section comprising:  
a matrix of hard particulate material infiltrated with a binder including one or more of copper, zinc, silver, molybdenum, nickel, cobalt, or alloys thereof;  
a plurality of cutting media dispersed within said matrix; and  
a plurality of fibers dispersed within said matrix, wherein said plurality of fibers comprise carbon fibers having a diameter of between about 1 micron and about 500 microns.
2. The cutting tool of claim 1, wherein said plurality of fibers is unorganized within said matrix.
3. The cutting tool of claim 1, wherein the cutting tool comprises a drill bit.
4. The cutting tool of claim 1, wherein the cutting tool comprises a diamond wire.
5. The cutting tool of claim 1, wherein the plurality of fibers are coated with metal, glass, ceramic, or combinations thereof.
6. The cutting tool of claim 3, wherein the cutting tool comprises a core sampling drill bit.
7. The cutting tool of claim 1, wherein the plurality of fibers comprise chopped or milled fibers.
8. The cutting tool of claim 1, wherein the plurality of cutting media comprises diamond crystals.
9. The cutting tool of claim 1, wherein the plurality of fibers are about 10 to about 25,000 microns long.



10. The cutting tool of claim 1, wherein the concentration of the fibers ranges from about 0.1 to about 70 vol%.

11. The cutting tool of claim 11, wherein the concentration of the fibers ranges from about 0.1 to about 30 vol%.

12. A method for making a drill bit, comprising:  
providing a section for attaching to a drill string; and  
providing a cutting portion configured to be operably coupled to the section, and  
wherein the cutting portion comprises:

a matrix of hard particulate material infiltrated with a binder including one or more of copper, zinc, silver, molybdenum, nickel, cobalt, or alloys thereof;

a plurality of cutting media dispersed within said matrix; and

a plurality of fibers dispersed within said matrix, wherein said plurality of fibers comprise carbon fibers having a diameter of between about 1 micron and about 500 microns.

13. The method of claim 12, wherein the plurality of fibers is unorganized within said matrix.

14. The method of claim 13, wherein the drill bit comprises a core sampling drill bit.

15. The method of claim 14, wherein the carbon fibers comprise chopped or milled carbon fibers.

16. The method of claim 12, wherein the plurality of fibers are coated with metal, glass, ceramic, or combinations thereof.

17. A method for using a drill bit, comprising:  
providing a section for attaching to a drill string; and

providing a cutting portion, configured to be operably coupled to the section, and wherein the cutting portion comprises:

a matrix of hard particulate material infiltrated with a binder including one or more of copper, zinc, silver, molybdenum, nickel, cobalt, or alloys thereof;

a plurality of cutting media dispersed within said matrix; and

a plurality of fibers dispersed within said matrix, wherein said plurality of fibers comprise carbon fibers having a diameter of between about 1 micron and about 500 microns; and

using the drill bit to cut a material.

18. The method of claim 17, wherein the plurality of fibers is unorganized within said matrix.

19. The method of claim 17, wherein the plurality of fibers are coated with metal, glass, ceramic, or combinations thereof.

20. The method of claim 19, wherein the drill bit comprises a core sampling drill bit.

21. A system for drilling, comprising:

a drill string; and

a drill bit configured to be coupled to the drill string and comprising the cutting tool of any one of claims 1-5 and 7-9.

22. The system of claim 21, wherein the drill bit comprises a core sampling drill bit.

23. The cutting tool of claim 4, further comprising a core wire, and wherein the cutting section takes the form of a coating disposed on the core wire.

24. The cutting tool of claim 4, further comprising a core wire, and wherein the cutting section takes the form of one or more abrasive beads disposed on the core wire.

25. The cutting tool of claim 1, wherein the cutting tool comprises one of a saw blade, grinding cup, tuck pointer, crack chaser, or polishing disk.

26. The cutting tool of any one of claims 3 or 6, wherein the drill bit contains a gradient of fibers such that the relative concentration of fibers varies within the drill bit.

27. The cutting tool of any one of claims 3 or 6, wherein the plurality of fibers are homogeneously dispersed within the drill bit.

28. The cutting tool of any one of claims 1-10, wherein the matrix comprises a sintered matrix.

29. A cutting tool including a cutting section comprising:  
a matrix of hard particulate material infiltrated with a binder including one or more of copper, zinc, silver, molybdenum, nickel, cobalt, or alloys thereof;  
a plurality of cutting media dispersed within said matrix; and  
a plurality of fibers dispersed within said matrix, wherein said plurality of fibers are coated with one or more of carbon, metal, glass, ceramic, or combinations thereof and wherein each fiber of said plurality of fibers has a diameter of between about 1 micron and about 500 microns.

30. The cutting tool of claim 29, wherein the cutting tool comprises a core sampling drill bit.

31. The cutting tool of claim 29, wherein said plurality of fibers comprise chopped or milled fibers.

32. The cutting tool of claim 29, wherein said plurality of fibers are about 10 microns to about 25,000 microns long.

33. The cutting tool of claim 29, wherein the concentration of said plurality of fibers ranges from about 0.1 to about 70 vol %.

34. The cutting tool of claim 29, wherein said plurality of fibers comprise carbon fibers, glass fibers, metal fibers, ceramic fibers, or combinations thereof.

35. A system for drilling, comprising:

a drill string; and

the cutting tool of any one of claims 29 to 32, the cutting tool comprising a drill bit and configured to be coupled to the drill string.

36. A cutting tool including a cutting section comprising: a matrix of hard particulate material infiltrated with a binder including one or more of copper, zinc, silver, molybdenum, nickel, cobalt, or alloys thereof; a plurality of cutting media dispersed within said matrix; and a plurality of fibers having a diameter of between about 1 micron and about 500 microns dispersed within said matrix; wherein said cutting tool comprises a diamond wire.

37. The cutting tool of claim 36, wherein said plurality of fibers comprise carbon fibers, glass fibers, metal fibers, ceramic fibers, or combinations thereof.

38. The cutting tool of claim 36, wherein said plurality of fibers are coated with carbon, metal, glass, ceramic, or combinations thereof.

39. A method of forming an infiltrated drill bit including a cutting section including a matrix having a plurality of abrasive cutting media therein, wherein said matrix is configured to erode and continually expose new abrasive cutting media during drilling operations, the method comprising:

mixing a matrix of hard particulate material and a plurality of abrasive cutting media, to form a cutting segment, wherein said matrix of hard particulate material comprises one or more of tungsten carbide, tungsten, iron, cobalt, molybdenum, or mixtures thereof;

creating voids or at least partially preventing the consolidation of voids in said matrix by mixing a plurality of fibers in said matrix, said voids decreasing the strength of

said cutting segment and thereby allowing said matrix to more easily erode during drilling operations; and

infiltrating said cutting segment with a binder including one or more of copper, zinc, silver, molybdenum, nickel, cobalt, or alloys thereof.

40. The method of claim 39, further comprising securing said cutting segment to a shank configured to be secured to a drill string component.

41. The method of claim 39, wherein fibers of said plurality of fibers comprise carbon fibers.

42. The method of claim 39, wherein said plurality of fibers comprises one of chopped fibers and milled fibers.

43. The method of claim 39, further comprising applying a coating material to said plurality of fibers, wherein said coating material comprises one or more of a glass, a polymer, a ceramic, and a metal.

44. The method of claim 43, wherein applying a coating material comprises one of spraying, brushing, electroplating, immersion, vapor deposition, or chemical vapor deposition.

45. The method of claim 39, wherein said plurality of fibers comprise fibers with a length of approximately 150 microns and a diameter of approximately 7 microns.

46. The method of claim 39, further comprising:

forming said matrix with a first concentration of fibers;

forming a second matrix with a second concentration of fibers, the second concentration of fibers differing from the first concentration of fibers; and

securing said first matrix and said second matrix together to form the cutting section.

47. The method of claim 39, wherein said hard particulate material comprises a powdered metal.

48. The method of claim 39, further comprising forming said cutting section into an annular crown for use on a core-sampling drill bit.

49. The method of claim 39, further comprising varying the concentration of fibers in said matrix to control the tensile strength of said cutting section.

50. The method of claim 39, further comprising varying the concentration fibers in said matrix to control the erosion rate of said cutting section.

51. The method of claim 39, wherein said plurality of abrasive cutting media comprises polycrystalline diamonds.

52. The method of claim 39 further comprising dispersing said plurality of fibers substantially homogeneously throughout said matrix.

53. The method of claim 39, wherein said fibers have a diameter of between about 1 micron and about 500 microns.

54. A method of forming an infiltrated drill bit including a cutting section including a matrix having a plurality of abrasive cutting media therein, wherein said matrix is configured to erode and continually expose new abrasive cutting media during drilling operations, the method comprising:

mixing a plurality of abrasive cutting media within a matrix of hard material particles to form a cutting section, wherein said matrix includes one or more of tungsten carbide, tungsten, iron, cobalt, molybdenum, or mixtures thereof;

creating voids or at least partially preventing the consolidation of voids in said matrix by mixing a plurality of fibers in said matrix in an amount to constitute from about 0.1% to about 30% volume of said cutting section, said voids decreasing the strength of said cutting segment and thereby allowing said matrix to more easily erode during drilling operations; and

securing said cutting section to a shank, said shank being configured to be attached to a drill string component.

55. The method of claim 54, wherein said plurality of abrasive cutting media comprises natural or synthetic diamonds.

56. The method of claim 54, wherein adding a plurality of fibers to said matrix comprises adding a plurality of carbon fibers to said matrix.

57. The method of claim 54, wherein adding a plurality of fibers to said matrix comprises adding fibers having a length of about 10 microns to about 25,000 microns and a diameter from about 1 micron to about 500 microns.

58. The method of claim 54, further comprising infiltrating said matrix with a binder including one or more of copper, zinc, silver, molybdenum, nickel, cobalt, or alloys thereof.

59. The method of claim 54, further comprising sintering said matrix.

60. An infiltrated drill bit produced by the method of any of claims 39-59.

61. A cutting tool including a cutting section comprising:

a matrix of one or more of tungsten carbide, tungsten, iron, cobalt, or molybdenum;

a plurality of cutting media dispersed within said matrix; and

a plurality of fibers dispersed within said matrix, wherein fibers of said plurality of fibers are about 10 to about 25,000 microns long and have a diameter ranging from about 1 to about 500 microns.

62. The cutting tool of claim 61, wherein said plurality of fibers is unorganized within said matrix.

63. The cutting tool of claim 61, wherein said plurality of fibers comprises carbon fibers.

64. The cutting tool of claim 61, wherein the cutting tool comprises a drill bit.
65. The cutting tool of claim 64, wherein the cutting tool comprises a core sampling drill bit.
66. The cutting tool of claim 61, wherein said plurality of fibers is coated with carbon, metal, glass, ceramic, or combinations thereof.
67. The cutting tool of claim 61, wherein said plurality of fibers comprises chopped or milled fibers.
68. The cutting tool of claim 61, wherein said plurality of cutting media comprises diamond crystals.
69. The cutting tool of claim 61, wherein said matrix is sintered.
70. The cutting tool of claim 61, wherein the concentration of said plurality of fibers in said cutting tool ranges from about 0.1 volume % to about 70 volume %.
71. The cutting tool claim 70, wherein the concentration of said plurality of fibers in said cutting tool ranges from about 0.1 volume % to about 30 volume %.
72. A core drill bit, comprising:
- a shank portion having a first end for attaching to a drill string component, an opposing second end, and a central axis therethrough, said shank portion defining an interior space about said central axis for receiving a core sample; and
  - an annular cutting portion having a first end and an opposing second end, said first end of said annular cutting portion being secured to and extending away from said second end of said shank portion, said second end of said annular cutting portion comprising a cutting face,
- wherein said annular cutting portion comprises a matrix including a plurality of fibers and a hard particulate material, wherein said hard particulate material includes one or more of tungsten carbide, tungsten, iron, cobalt, or molybdenum, and



wherein said plurality of fibers comprises fibers having a length to diameter ratio between about 10 to 1 and about 50 to 1 and a diameter between about 1 micron and about 500 microns.

73. The core drill bit of claim 72, wherein said plurality of fibers has an unorganized arrangement within said matrix.

74. The core drill bit of claim 72, wherein said plurality of fibers comprises carbon fiber.

75. The core drill bit of claim 72, wherein said annular cutting portion comprises:

a first cutting section defined by said cutting face and extending toward said shank portion a first distance, said first cutting section containing a first concentration of fibers dispersed throughout said matrix thereby providing said first cutting section with a first erosion rate; and

a second cutting section extending from said first distance toward said shank portion, said second cutting section containing a second concentration of fibers dispersed throughout said matrix thereby providing said second cutting section with a second erosion rate that is different from said first erosion rate.

76. The core drill bit of claim 72, wherein said matrix is sintered.

77. A drill bit, comprising:

a shank adapted to be secured to a drill string; and

a cutting section having a cutting face, said cutting section extending from said shank, wherein said cutting section comprises:

a matrix of one or more of tungsten carbide, tungsten, iron, cobalt, or molybdenum, and

a plurality of unorganized fibers dispersed within said matrix,

wherein said plurality of fibers comprises from about 0.1% to about 30% volume of said cutting section so as to weaken said cutting segment and thereby increase the erosion rate of said matrix.

78. The drill bit of claim 77, wherein said plurality of fibers is adapted to increase the lubricity at said cutting face as said matrix erodes.

79. The drill bit of claim 77, further comprising a plurality of diamond cutting media impregnated within said matrix.

80. The drill bit of claim 77, wherein said cutting portion further comprises:

a first portion containing a first concentration of fibers thereby providing said first portion with a first erosion rate; and

a second portion containing a second concentration of fibers thereby providing said second portion with a second erosion rate that is different from said first erosion rate.

81. The drill bit of claim 77, wherein said matrix is sintered.

82. A drill bit, comprising:

a shank adapted to be secured to a drill string; and

a cutting section having a cutting face, said cutting section extending from said shank, wherein said cutting section comprises:

a matrix of hard particulate material comprising one or more of tungsten carbide, tungsten, iron, cobalt, or molybdenum, and

a plurality of unorganized fibers dispersed within said matrix,

wherein said plurality of fibers comprises fibers having a length to diameter ratio between about 10 to 1 and about 50 to 1 to weaken said cutting section thereby increasing the erosion rate of said cutting section.

83. The drill bit as recited in claim 82, wherein said plurality of fibers comprise carbon fibers.

84. The drill bit as recited in claim 83, wherein fibers of said plurality of fibers have a length of about 10 microns to about 25,000 microns and a diameter from about 1 micron to about 500 microns.

85. The drill bit of claim 82, wherein fibers of said plurality of fibers have a length of about 10 microns to about 25,000 microns and a diameter from about 1 micron to about 500 microns.

86. The core drill bit of claim 82, wherein said matrix is sintered.

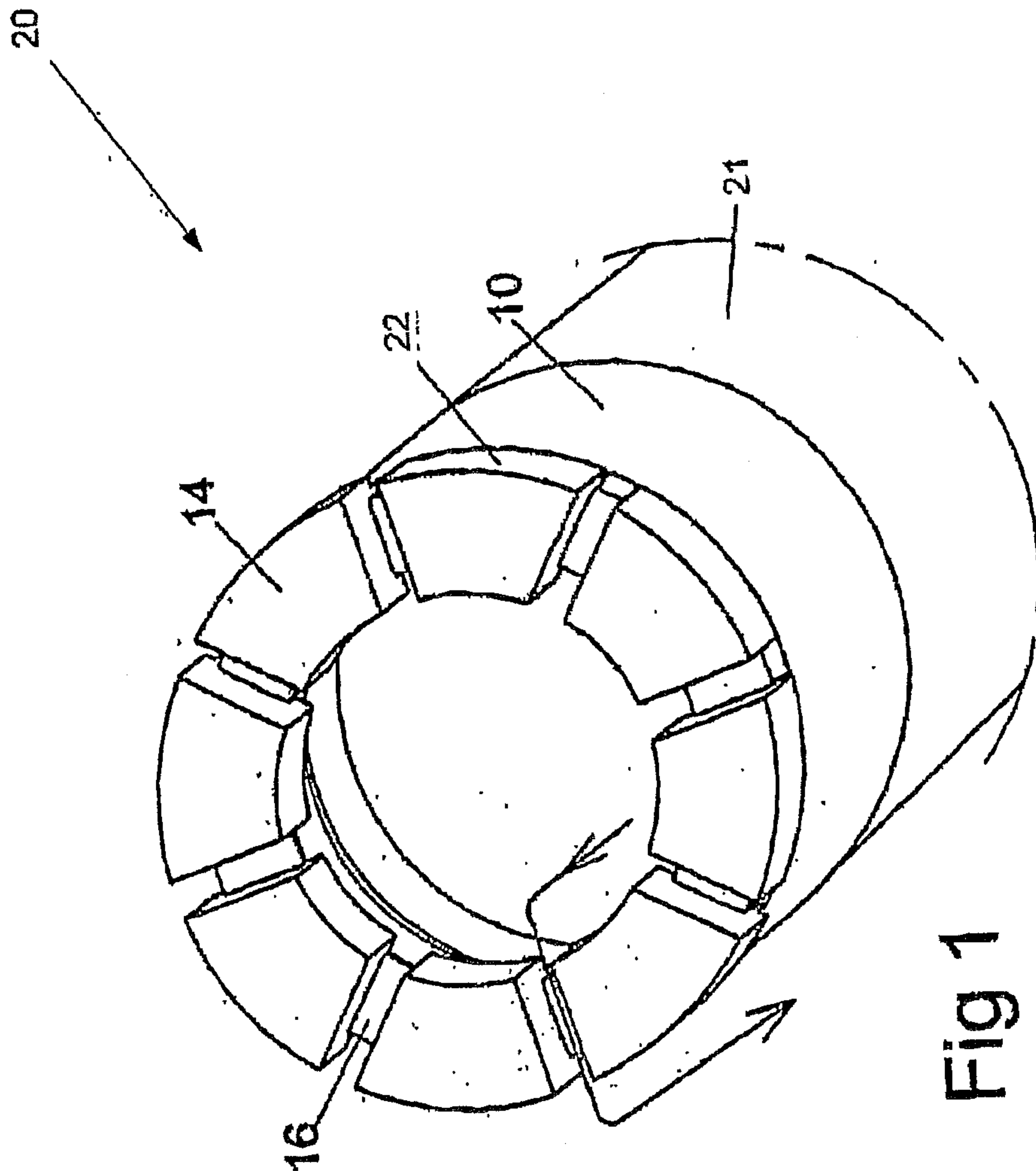


Fig 1

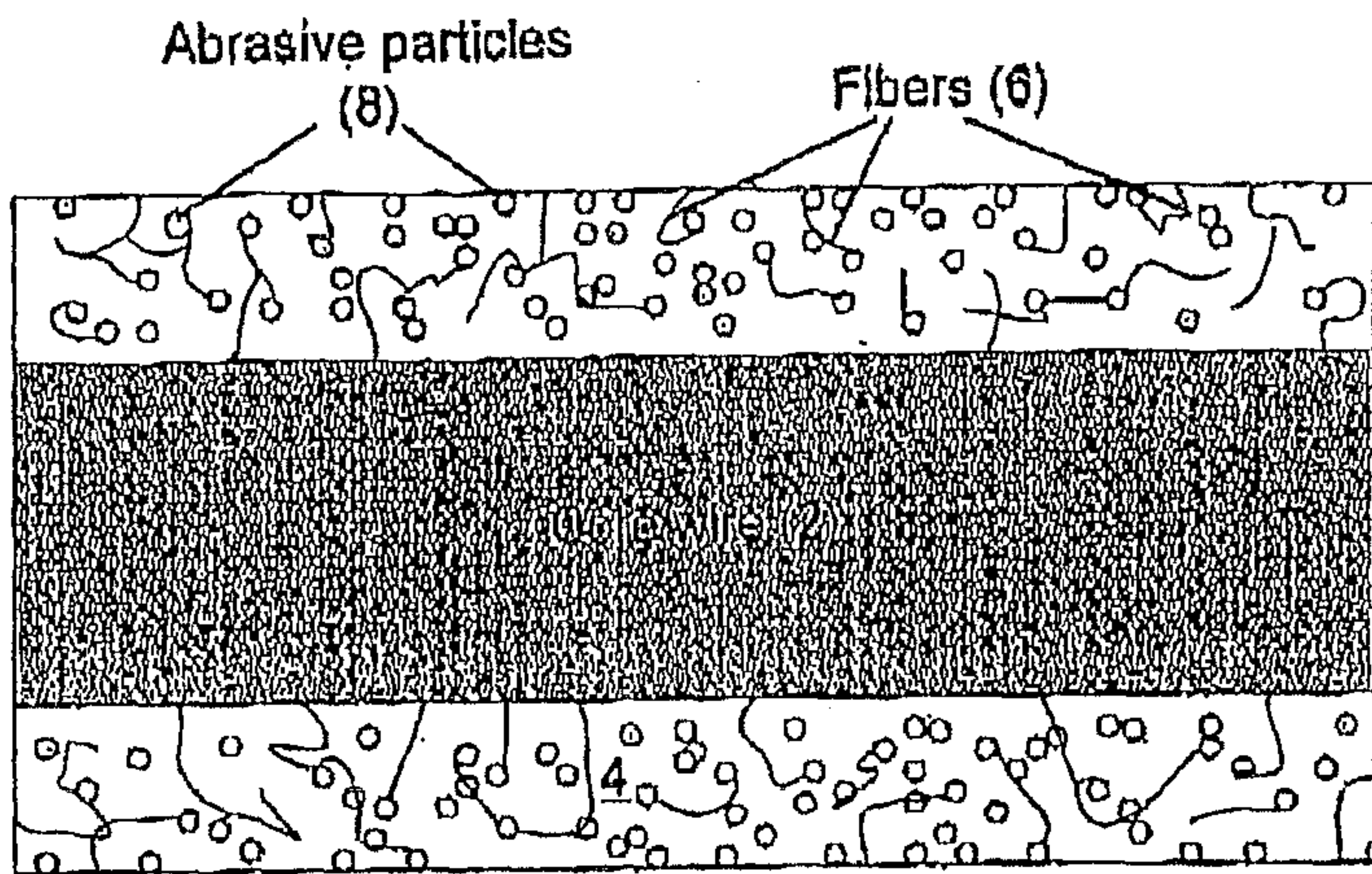


FIG. 2

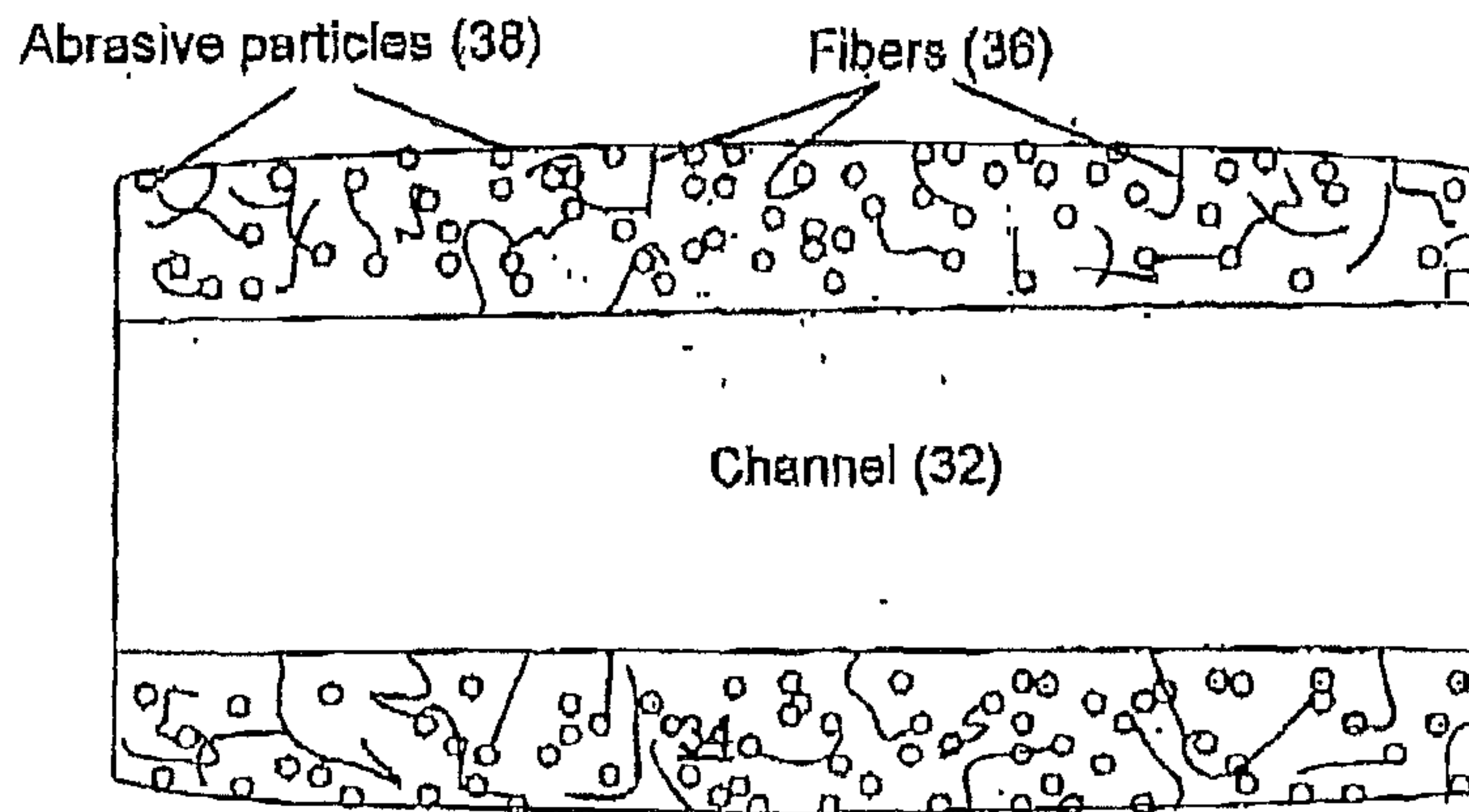


FIG. 4

26

SUBSTITUTE SHEET (RULE 26)

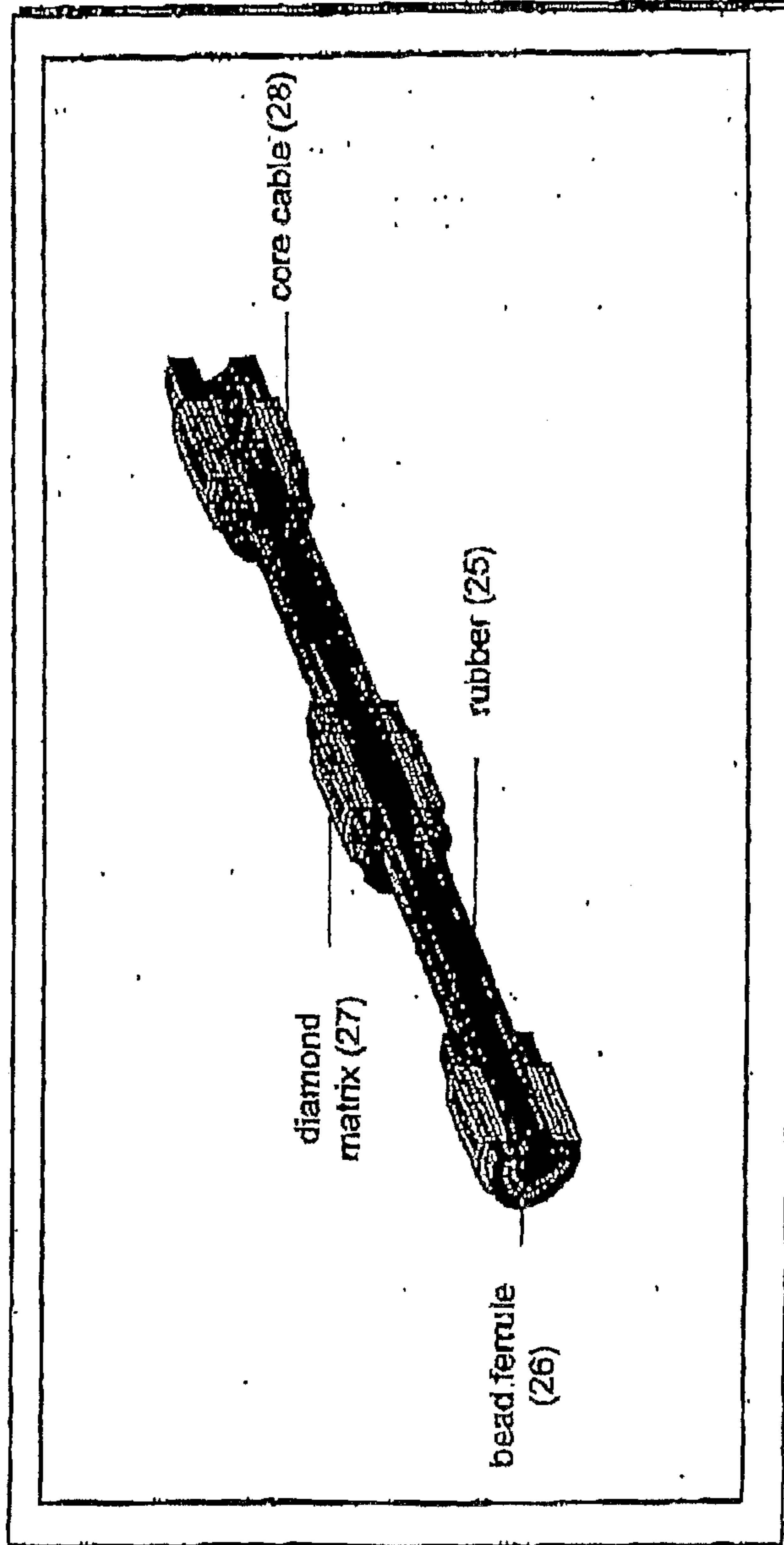


FIG. 3

Abrasive particles

Fibers (6)

(8)

