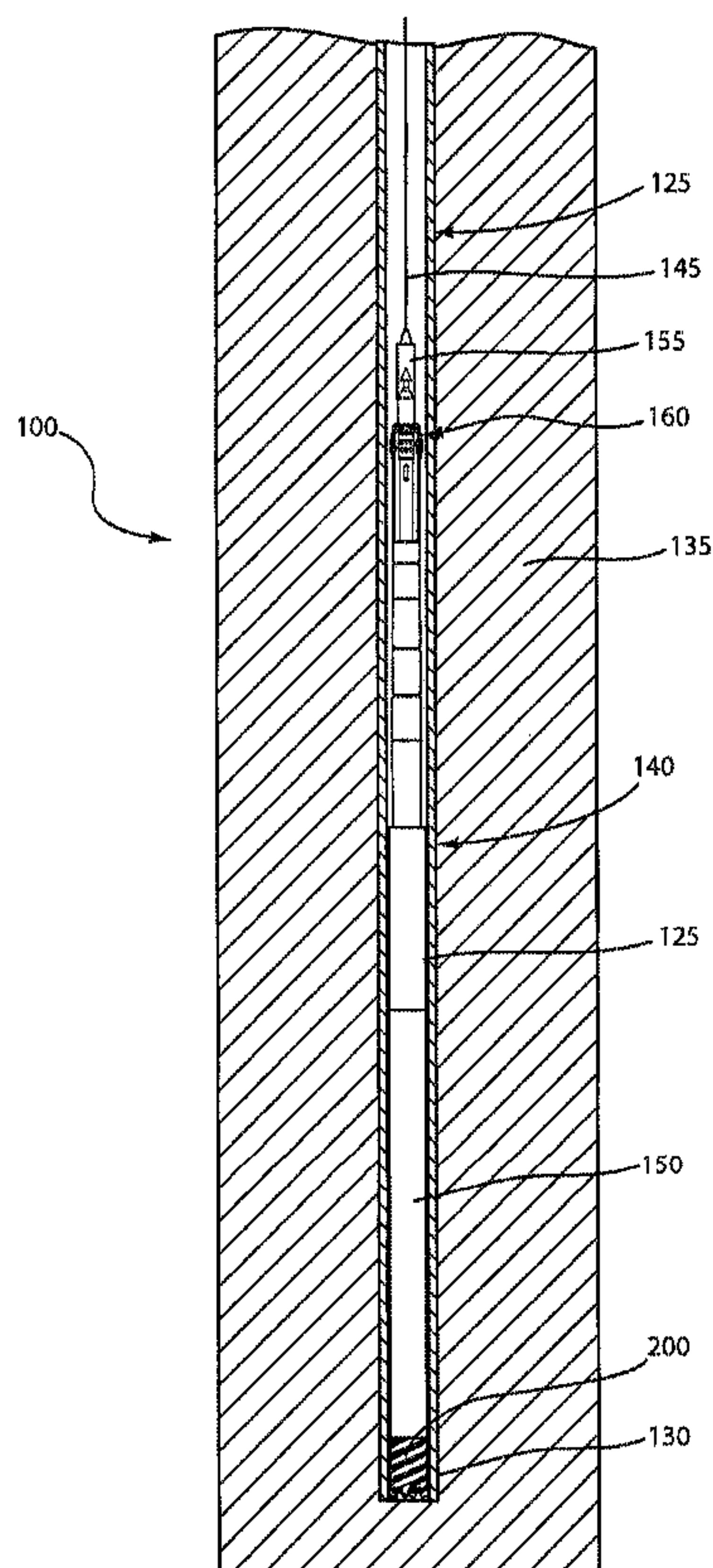




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(54) Titre : TREPAN SONIQUE POUR CAROTTAGE
 (54) Title: SONIC DRILL BIT FOR CORE SAMPLING



(57) Abrégé/Abstract:

A drill bit for core sampling includes a body having a central axis and first end having a tapered outer surface and a radius transverse to the central axis, and an insert having a cutting surface on the first end oriented at an axial angle relative to the radius to move material displaced during drilling away from the first end.

ABSTRACT

A drill bit for core sampling includes a body having a central axis and first end having a tapered outer surface and a radius transverse to the central axis, and an insert having a cutting surface on the first end oriented at an axial angle relative to the radius to move material displaced during drilling away from the first end.

SONIC DRILL BIT FOR CORE SAMPLINGBACKGROUND

1. The Field of the Invention

5 This application relates generally to drill bits and methods of making and using such drill bits. In particular, this application relates to sonic drill bits that are used to collect a core sample, as well as methods for making and using such sonic drill bits.

2. The Relevant Technology

10 Often, drilling processes are used to retrieve a sample of a desired material from below the surface of the earth. In a conventional drilling process, an open-faced drill bit is attached to the bottom or leading edge of a core barrel. The core barrel is attached to a drill string, which is a series of threaded and coupled drill rods that are assembled section by section as the core barrel moves deeper into the formation. The core barrel is rotated and/or pushed into the desired sub-surface formation to obtain a sample of the desired material (often called a core sample).
15 Once the sample is obtained, the core barrel containing the core sample is retrieved. The core sample can then be removed from the core barrel.

An outer casing with a larger diameter than the core barrel can be used to maintain an open borehole. Like the core barrel, the casing can include an open-faced drill bit that is connected to a drill string, but both with a wider diameter than the core barrel.
20 The outer casing is advanced and removed in the same manner as the core barrel by tripping the sections of the drill rod in and out of the borehole.

In a wireline drilling process, a core barrel can be lowered into an outer casing and then locked in place at a desired position. The outer casing can have a drill bit connected to a drill string and is advanced into the formation. Thereafter, the core barrel and the casing advance into the formation, thereby forcing a core sample into the core barrel.
25 When the core sample is obtained, the core barrel is retrieved using a wireline system, the core sample is removed, and the core barrel is lowered back into the casing using the wireline system.

30 As the core barrel advances, the material at and ahead of the bit face is displaced. This displaced material will take the path of the least resistance, which can cause the displaced material to enter the core barrel. The displaced material can cause disturbed, elongated, compacted, and in some cases, heated core samples. In addition, the displaced material is often pushed outward into the formation, which can cause compaction of the

formation and alter the formation's undisturbed state.

Further, the displaced material can also enter the annular space between the outer casing and the borehole wall, causing increased friction and heat as well as causing the casing to bind and become stuck in the borehole. When the casing binds or sticks, the drilling process is slowed, or even stopped, because of the need to pull the casing and ream and clean out the borehole.

As well, bound or stuck casings may also require the use of water, mud or air to remove the excess material and free up the outer casing. The addition of the fluid can also cause sample disturbance and contamination of the borehole.

Additional difficulties can arise when drilling hard and/or dry formations. In particular, while drilling hard and/or dry formations, the displaced material can be difficult to displace. As a result, the material is often re-drilled numerous times creating heat, inefficiencies, and stuck casings.

BRIEF SUMMARY OF THE INVENTION

A drill bit for core sampling includes a body having a central axis and first end having a tapered outer surface and a radius transverse to the central axis and an insert having a cutting surface on the first end oriented at an axial angle relative to the radius to move material displaced during drilling away from the first end. Thus, these drill bits move the displaced material away from the first end and the entrance of the core barrel. This design allows for collection of highly representative, minimally disturbed core samples.

BRIEF DESCRIPTION OF THE DRAWINGS

The following description can be better understood in light of Figures, in which:
Fig. 1A illustrates a surface portion of a drilling system according to one example;
Fig. 1B illustrates a down-hole portion of a drilling system;
Fig. 1C illustrates a down-hole portion of a drilling system according to one example;
Fig. 2A illustrates a lift bit according to one example;
Fig. 2B illustrates a lift bit according to one example;
Fig. 3A illustrates a perspective view of a lift bit according to one example;
Fig. 3B illustrates an elevation view of a lift bit according to one example; and
Fig. 3C illustrates a plan view of a lift bit according to one example.

Together with the following description, the Figures demonstrate and explain the principles of the apparatus and methods for using the drill bits. 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.

5

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 using the apparatus can be implemented and used without
10 employing these specific details. Indeed, the apparatus and associated methods can be placed into practice by modifying the illustrated apparatus and associated methods and can be used in conjunction with any other apparatus and techniques conventionally used in the industry. For example, while the description below focuses on sonic drill bits for obtaining core samples, the apparatus and associated methods could be equally applied in
15 other drilling apparatuses and processes, such as diamond core drill bits and other vibratory and/ or rotary drill systems.

Fig. 1A-1C illustrate a drilling system 100 according to one example. In particular, Fig. 1A illustrates a surface portion of the drilling system 100 while Fig. 1B illustrates a subterranean portion of the drilling system. Accordingly, Fig. 1A illustrates a
20 surface portion of the drilling system 100 that shows a drill head assembly 105. The drill head assembly 105 can be coupled to a mast 110 that in turn is coupled to a drill rig 115. The drill head assembly 105 is configured to have a drill rod 120 coupled thereto.

As illustrated in Figs. 1A and 1B, the drill rod 120 can in turn couple with additional drill rods to form an outer casing 125. The outer casing 125 can be coupled to
25 a first drill bit 130 configured to interface with the material to be drilled, such as a formation 135. The drill head assembly 105 can be configured to rotate the outer casing 125. In particular, the rotational rate of the outer casing 125 can be varied as desired during the drilling process. Further, the drill head assembly 105 can be configured to translate relative to the mast 110 to apply an axial force to the outer casing 125 to urge the
30 drill bit 130 into the formation 135 during a drilling process. The drill head assembly 105 can also generate oscillating forces that are transmitted to the drill rod 120. These forces are transmitted from the drill rod 120 through the outer casing 125 to the drill bit 130.

The drilling system 100 also includes a core-barrel assembly 140 positioned within the outer casing 125. The core-barrel assembly 140 can include a wireline 145, a

core barrel 150, an overshot assembly 155, and a head assembly 160. In the illustrated example, the core barrel 150 can be coupled to the head assembly 160, which in turn can be removably coupled to the overshot assembly 155. When thus assembled, the wireline 145 can be used to lower the core barrel 150, the overshot assembly 155, and the head assembly 160 into position within the outer casing 125.

The head assembly 160 includes a latch mechanism configured to lock the head assembly 160 and consequently the core barrel 150 in position at a desired location within the outer casing 125. In particular, when the core-barrel assembly 140 is lowered to the desired location, the latch mechanism associated with the head assembly 160 can be deployed to lock the head assembly 160 into position relative to the outer casing 125. The overshot assembly 155 can also be actuated to disengage the head assembly 160. Thereafter, the core barrel 150 can rotate with the outer casing 125 due to the coupling of the core barrel 150 to the head assembly 160 and of the head assembly 160 to the outer casing 125.

At some point it may be desirable to trip the core barrel 150 to the surface, such as to retrieve a core sample. To retrieve the core barrel 150, the wireline 145 can be used to lower the overshot assembly 155 into engagement with the head assembly 160. The head assembly 160 may then be disengaged from the drill outer casing 125 by drawing the latches into head assembly 160. Thereafter, the overshot assembly 155, the head assembly 160, and the core barrel 150 can be tripped to the surface.

In at least one example, a second drill bit, such as a sonic axial radial lift bit 200 (hereinafter referred to as lift bit 200) is coupled to the core barrel 150. As discussed above, the core barrel 150 can be secured to the outer casing 125. As a result, the lift bit 200 rotates with the core barrel 150 and the outer casing 125. In such an example, as the core barrel 150 and the outer casing 125 advance into the formation 135, the lift bit 200 sweeps the drilled material into an annular space between the core barrel 150 and the outer casing 125. Removing the material in such a manner can improve the penetration rate of the drilling system by helping reduce the amount of material that is re-drilled as well as reducing friction resulting in the material being compacted at or near the end of the drilling system. Further, such a configuration can help reduce the compaction of the material between the core barrel 150 and the outer casing 125, which in turn may reduce friction and/or reduce contamination of a resulting core sample.

In the illustrated example, the drilling system is a wireline type system in which the core barrel 150 is tipped with a lift bit. In at least one example, as illustrated in Fig.

1C, a lift bit 200 can be coupled to the outer casing 125. Such a configuration can allow the lift bit 200 to sweep drilled material away from the drilling interface and into the annular space between the formation and the outer casing 125. In still other examples, both lift bits can be coupled to each of the outer casing 125 and the core barrel 150 in a
5 wireline system.

While a wireline type system is illustrated in Figs. 1B and 1C, it will be appreciated that a drilling system can include drill rods that are coupled together to form an outer casing and inner drill rods that are coupled together to form an inner drill string. A lift bit 200 can be coupled to the end of the outer casing and/or the inner drill string. In
10 the illustrated example, the lift bit is coupled to the inner drill string and is configured to sweep drilled material into the annular space between the inner drill string and the outer casing. It will be appreciated that the lift bit 200 can be used with any number of drill string configurations.

The lift bits described herein can have any configuration consistent with their
15 operation described herein. Figs. 2A and 2B illustrated a lift bit 200 according to one example. As illustrated in Fig. 2A, the lift bit 200 includes body 202 having a first end 204. The body 202 also includes a back 206 that is located on the opposite end of the body 202 relative to the first end 204. The back 206 is configured to be positioned adjacent to and/or to couple with a core barrel. The body 202 also contains an outer
20 surface 208 and an inner surface 210. While the outer diameter of the outer surface 208 of the lift bit 200 can be varied to obtain any desired core sample size, the diameter typically ranges from about 2 to about 12 inches.

In at least one example, the inner surface 210 of the body 202 has a varied inner diameter through which the core sample can pass from the first end 204 where it is cut, out
25 the back 206 of the lift bit 200, and into a core barrel. While any size and configuration of body 202 can be used, in the illustrated example the body 202 has a substantially cylindrical shape. Further, the lift bit 200 can be configured such that as it coupled to a core barrel, the inner diameter of the body 202 can taper from a smaller inner diameter near the first end 204 to a larger inner diameter. Such a configuration can help retain the
30 core sample.

The first end 204 of the lift bit 200 can have various configurations. In at least one example, the first end 204 has a tapered shape beginning with a narrow portion 214 that transitions to a broader portion 216. The angle of the taper from the narrow portion 214 to the broader portion 216 can vary as desired.

The lift bit 200 can also include inserts 220 coupled to the body 202. The inserts 220 can be used to move or sweep the material displaced during the drilling action away from the first end 204. As well, the inserts 220 can also provide the desired drilling action. Thus, the inserts 220 can be given any configuration desired, such as substantially
5 rectangular, round, parallelogram, triangular shapes and/or combinations thereof.

In the example illustrated in Fig. 2A, the inserts 220 can have a substantially, truncated pyramidal shape that include leading surfaces 221 and cutting surfaces 222. Further, the cutting surfaces 222 of the inserts 220 can be provided as discrete surfaces with a substantially rectangular shape. The configuration of the cutting surfaces 222 as
10 discrete surfaces can serve effectively in the sonic cutting action. It will also be appreciated that the shape of these surfaces can be any that achieves function, rather than rectangular. In other examples, the cutting surface can be substantially continuous. Further, while four of discrete cutting surfaces 222 are depicted in Fig. 2A, it will be appreciated that any number of cutting surfaces may be used, from a single continuous
15 surface, to as many as eight, twelve, or more.

In the example shown in Fig. 2A, the inserts 220 can be substantially planar. As shown in Fig. 2B, a lift bit 200' can having buttons 224 coupled to the inserts 220. The buttons 224 can be embedded or otherwise secured to the cutting surfaces 222. Regardless of the configuration, the inserts 220 can be made of any material known in the
20 drilling art. Examples of some of these materials include hardened tool steels, tungsten carbides, etc.

Referring to both Figs. 2A and 2B, the number of inserts 220 selected can vary and can depend on numerous factors including the material of the formation being drilled. The inserts 220 used in a single drill bit can be shaped the same or can be shaped
25 differently.

The lift bit 200 further includes helical bands 230 coupled to the outer surface 208 of the body 202. As shown in Figs. 2A and 2B, the helical bands 230 can be aligned with the inserts 220 so that the helical bands 230 work in combination with the inserts 220 to move the displaced material away from the first end 204 of the body 202. In other
30 instances, though, the helical bands 230 are not be aligned with the inserts. Further, any number of helical bands 230 can be provided.

For example, Figs. 2A and 2B illustrate that the number of helical bands 230 and the number of inserts 220 can be the same. In other examples, the number of helical bands 230 can be more or less than the number of inserts 220. The number of helical

bands 230 can depend on the diameter of the lift bits 200, 200'. For example, the number of helical bands 230 can range from one to about eight or more, such as a number of between about four and six.

Further, as illustrated in Figs. 2A and 2B, channels 232 can be created between
5 any two adjacent helical bands 230. Since the outer surface of the helical bands is usually proximate the borehole, the channels 232 can be used to contain the displaced material and direct the movement of the material axially up along the body 202 of the lift bits 200, 200'.

The helical bands, and therefore the channels, can be located on the outer surface
10 208 with a variety of configurations of locations, depths, and angles. In some embodiments, the helical bands 230 are located along the side of the lift bit with a distance of about 0.5 to about 6 inches from one point on the helical band to the corresponding location on the next helical band. In other embodiments, this distance can range from about 3 to about 5 inches.

The channels (flutes) 232 can have any width and depth that will move the
15 displaced material along the length of the lift bit. In some embodiments, the channels 232 can have a width ranging from about 1/2 to about 1 1/2 inches and a depth of about 1/8 to about 3/8 inch. In other embodiments, the channels 232 can have a width ranging from about 3/4 to about 1 1/4 inches and a depth of about 3/16 to about 5/16 inch.

The channels 232 can also be oriented at an angle relative to the central axis that
20 also aids in moving the displaced material upwards along the length of the outer casing. In at least one example, the helical bands 230 can be oriented at an angle ranging from about 1 to about 89 degrees, such as at an angle ranging from about 5 to about 60 degrees.

Using the drills bits described above, the material displaced from the formation
25 being drilled can be forced away from the bit face. Initially, the displaced material can be pushed away from the core barrel entrance because of the angles of the carbide cutting teeth and the outer taper on the first end 204. The helical bands 230 and the channels 232 will then push the displaced material further away from the bit face upwards along the length of the outer casing. This movement reduces or prevents the displaced material
30 from being re-drilled which can cause heat. This movement also reduces or prevents the displaced material from being forced out into the formation on the side of the outer casing or core barrel which can compact and alter the natural characteristics of the formations. This movement of the displaced material also reduces or prevents it from accumulating in the annular space between the outer diameter of the core barrel or outer casing and the

borehole wall which can cause heat and stuck casing.

Fig. 3A illustrates a lift bit 300 that includes inserts 320 that have a bladed configuration. In such a configuration, each insert 320 includes a base 330 and a cutting blade 340. In the illustrated example, the cutting blade 340 tapers as it extends away from the base 330. The taper and angle of the cutting blade are illustrated in more detail in Fig. 3B.

Fig. 3B illustrates an elevation view of the lift bit 300. The orientation of the surfaces of the cutting blade 340 can be described relative to a central axis C. The surfaces of the cutting blade 340 include a leading edge 321 and a top or cutting edge 322. As illustrated in Fig. 3B, an angle of attack AT can be described that is taken along the first surface and a line parallel to the central axis C. In the examples illustrated above, an attack angle of the inserts 220 can be measured relative to leading surfaces 222.

Sonic drill bits cut through the formation using various combinations of rotation, pressure, and vibration. In some aspects, the inserts 220, 320 of the lift bits 200, 200', 300 can have an attack angle AT designed to counter or offset the upward axial forces on the insert caused by the resistance of the formation to the vibration and pressure exerted on the bit. The degree of the attack angle AT can be selected to provide desired support for the inserts 220, 320 and the ability to shave off material from the formation and move it in the axial direction. Thus the degree of the attack angle will vary. For example, the attack angle AT can vary between about -60 to about 160 degrees.

In some instances, the inserts 220, 320 can also be inserted into the bit face at an axial angle AX. The axial angle AX can be measured relative to a radius R. The radius R is perpendicular to the center axis C. Such a configuration can reduce the effect of the rotational force applied to the inserts 220, 320. In at least one example, the axial angle AX can be between about 60 degrees and about 150 degrees, such as between about 60 degrees and 120 degrees.

In some instances, the inserts 220, 320 can also be oriented such that a line between the ends of the cutting surface 322 is oriented at a sweep angle S relative to the radius R. The sweep angle S of the insert 320 relative to the lift bit 300 is illustrated in Fig. 3C. The sweep angle S can also help to move or sweep displaced material away from the inserts 320, aiding in obtaining a better sample and reducing the re-drilling of cuttings and thereby increasing the efficiency of the drilling process. The sweep angle S can have any suitable degree. For example, the sweep angle S can be between about one degree and about 89 degrees. In at least one example, the degree of the sweep angle can range

from about 5 to about 35 degrees. In other examples, the sweep angle S can range from about 15 to about 25 degrees. In yet other embodiments, the sweep angle S can be about 20 degrees.

The drill bits mentioned above can be made by any method that provides them with the configurations described above. In one exemplary method, a steel tube with the desired outer diameter is obtained. Next, it is machined conventionally. Then, channels are machined into the steel tube, thereby also creating the helical bands in the same process. The inserts are then created by sintering the tungsten carbide into the desired shape. When tool-steel inserts are used, they can be machined into the desired shape. The inserts are then soldered and/or press fit to the steel tube that has been machined. Where the inserts are tool steel, the drill bit could instead be made by creating a mold for the entire drill bit and then using an investment casting process to form the drill bit. The channels can be produced by machining the outer diameter of the rod, or can be produced by welding or fastening helical bands onto the outer diameter of the rod. The helical bands can be of materials harder or softer than the drill rod.

The drill bits described above can be used as part of a sonic drilling system that can be used to obtain a core sample. The lift bits 200, 200', 300 can be connected to a sonic (or vibratory) casing and/or core barrel. High-frequency, resonant energy is used to advance the core barrel and/or outer casing into the desired formation(s). During drilling, the resonant energy is transferred down the drill string to the core barrel and/or outer casing to the bit face at various sonic frequencies. Typically, the resonant energy generated exceeds the resistance of the formation being encountered to achieve maximum drilling productivity. The material displaced by the sonic drilling action is then moved away from the bit face and towards the drill string by the action of the inserts and the combination of the channels/helical bands.

Such a configuration can result in a lift bit that can help ensure the displaced material at the bit face is effectively and efficiently removed. This removal not only allows for reduced or minimal disturbance, it also allows for much faster more efficient drilling because the displaced material is simply pushed out and then lifted away from the bit face as opposed to the wasted time and energy that can be expended while re-drilling, compacting, and/or otherwise forcing this displaced material either where it should not be (in the core barrel), where it does not want to go (into the formation), or into the annular space where it can cause friction and heat and can cause stuck core barrels and outer casings.

In addition to any previous indicated modification, numerous other variations and alternative arrangements may be devised by those skilled in the art. Thus, while the information has been described above with particularity and detail in connection with what is presently deemed to be the most practical and preferred aspects, 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 are meant to be illustrative only and should not be construed to be limiting in any manner.

Claims:

1. A sonic drill bit for obtaining a core sample, comprising:
 - a body having a central axis, an inner surface, and an outer surface, the body further including a first end and a second end, wherein the first end includes a taper toward the central axis that extends at least the majority of the distance from the outer surface to the inner surface;
 - at least one insert extending upwardly from the first end of the body, each insert having a top portion having a substantially truncated pyramidal cross-sectional shape that defines a substantially planar cutting surface that extends radially outward from the inner surface at a plurality of different angles relative to the central axis of the body;
 - one or more helical channels extending along the outer surface, the one or more helical channels extending from the first end toward the second end of the body; and
 - one or more fluid ports extending between the inner surface and the outer surface, each positioned a distance from the first end.
2. The drill bit as recited in claim 1, wherein the one or more helical channels extend along an entire length of the body from the first end to the second end.
3. The drill bit as recited in claim 1, wherein the one or more fluid ports are positioned within the one or more helical channels.
4. The drill bit as recited in claim 1, further comprising one or more helical bands extending along the outer surface, wherein each helical band is positioned between adjacent helical channels.
5. The drill bit as recited in claim 4, further comprising one or more buttons positioned about the at least one insert, and wherein the one or more buttons are circumferentially aligned with the one or more helical bands.
6. The drill bit as recited in claim 1, wherein the one or more fluid ports are each located the same distance from the first end.
7. A sonic drill bit for obtaining a core sample, comprising:
 - a body having a central axis, an inner surface, and an outer surface, the body further including a first end and a second end, wherein the outer surface at the first end tapers inward toward the central axis until meeting to the inner surface;

at least one insert extending upwardly from the first end of the body, each insert having a top portion having a substantially truncated pyramidal cross-sectional shape that defines a substantially planar cutting surface that extends radially outward from the inner surface at a plurality of different angles relative to the central axis of the body; and

a plurality of helical bands extending along the outer surface, the plurality of helical bands extending from the first end toward the second end of the body.

8. The drill bit as recited in claim 7, wherein the plurality of helical bands extends from the first end to the second end of the body.

9. The drill bit as recited in claim 7, further comprising a plurality of helical channels extending along the outer surface, the helical channels being positioned between adjacent helical bands.

10. The drill bit as recited in claim 7, further comprising a plurality of buttons positioned about the at least one insert.

11. A sonic drilling system for drilling a formation and obtaining a core sample, comprising:

a core drill bit comprising:

an inner surface extending about a central axis,

an outer surface,

a first end,

a second end,

at least one insert extending upwardly from the first end of the body, each insert having a top portion having a substantially truncated pyramidal cross-sectional shape that defines a substantially planar cutting surface that extends radially outward from the inner surface at a plurality of different angles relative to the central axis of the body;

a plurality of helical channels extending from the first end toward the second end, wherein the first end includes a taper toward the central axis that extends from the outer surface inward to the inner surface;

a drill string coupled to the second end of said core drill bit; and

a drill head assembly operatively associated with the drill string, the drill head assembly being adapted to generate and transmit oscillating forces to the core drill bit.

12. The sonic drilling system as recited in claim 11, wherein the outer surface of the core drill bit is adapted to move material of the formation displaced during drilling away from the first end of the core drill bit as the core drill bit oscillates into the formation.

13. The sonic drilling system as recited in claim 11, further comprising a plurality of buttons positioned about the at least one insert.

14. The sonic drilling system as recited in claim 11, wherein the plurality of fluid ports are positioned within the plurality of helical channels.

15. The sonic drilling system as recited in claim 11, wherein the one or more helical channels extend along an entire length of the core drill bit from the first end to the second end.

16. The drill bit as recited in claim 1, further comprising one or more buttons positioned about the at least one insert.

17. The drill bit as recited in claim 16, wherein the one or more buttons are positioned circumferentially between adjacent helical channels.

18. The drill bit as recited in claim 16, wherein:

at least a first button is positioned at a first distance from the second end; and

at least a second button is positioned at a second distance from the second end, the second distance being greater than the first distance.

19. The drill bit as recited in claim 18, wherein the at least a first button is circumferentially offset from the at least a second button.

20. The drill bit as recited in claim 19, wherein the at least a first button and the at least a second button are both positioned circumferentially between a first helical channel and a second adjacent helical channel.

21. The drill bit as recited in claim 1, wherein the plurality of different angles comprises an axial angle and an attack angle.

22. The drill bit as recited in claim 21, wherein the cutting surface extends radially outward from the inner surface at the axial angle relative to a plane extending perpendicular to the central axis.
23. The drill bit as recited in claim 22, wherein the axial angle of the cutting surface is between about 5 degrees and about 35 degrees.
24. The drill bit as recited in claim 22, wherein the attack angle of the cutting surface is between about 10 degrees and about 60 degrees relative to a plane extending coplanar to the central axis.
25. The drill bit as recited in claim 1, wherein the at least one insert includes a leading surface, wherein the leading surface is angled at a sweep angle of between about 10 degrees and about 60 degrees relative to a line extending from the central axis to the leading surface, the line being normal to the central axis.
26. The drill bit as recited in claim 1, wherein the inner surface of the body tapers outwardly away from the central axis as the inner surface moves from first end of the body to the second end of the body.
27. The drill bit as recited in claim 7, further comprising a plurality of fluid ports extending between the inner surface and the outer surface and positioned between adjacent helical bands of the plurality of helical bands.
28. The drill bit as recited in claim 27, wherein the fluid ports are each positioned the same distance from the second end of the body.
29. The drill bit as recited in claim 27, wherein the plurality of fluid ports are positioned a distance from the first end that is at most approximately half the length of the body.
30. The drill bit as recited in claim 7, wherein the plurality of different angles comprises an axial angle and an attack angle, and wherein the cutting surface extends radially outward from the inner surface at the axial angle relative to a plane extending perpendicular to the central axis.
31. The drill bit as recited in claim 30, wherein the axial angle of the cutting surface is between about 5 degrees and about 35 degrees.

32. The drill bit as recited in claim 30, wherein the attack angle of the cutting surface is between about 10 degrees and about 60 degrees relative to a plane extending coplanar to the central axis.

33. The drill bit as recited in claim 7, wherein the at least one insert includes a leading surface, wherein the leading surface is angled at a sweep angle of between about 10 degrees and about 60 degrees relative to a line extending from the central axis to the leading surface, the line being normal to the central axis.

34. The sonic drilling system as recited in claim 11, a plurality of fluid ports positioned in a half of the core drill bit proximate the first end, and wherein a half of the core drill bit proximate the second end is devoid of fluid ports.

35. The sonic drilling system as recited in claim 11, wherein the plurality of different angles comprises an axial angle and an attack angle, and wherein the cutting surface extends radially outward from the inner surface at the axial angle relative to a plane extending perpendicular to the central axis.

36. The sonic drilling system as recited in claim 35, wherein the axial angle of the cutting surface is between about 5 degrees and about 35 degrees.

37. The sonic drilling system as recited in claim 35, wherein the attack angle of the cutting surface is between about 10 degrees and about 60 degrees relative to a plane extending coplanar to the central axis.

38. The sonic drilling system as recited in claim 11, wherein the at least one insert includes a leading surface, wherein the leading surface is angled at a sweep angle of between about 10 degrees and about 60 degrees relative to a line extending from the central axis to the leading surface, the line being normal to the central axis.

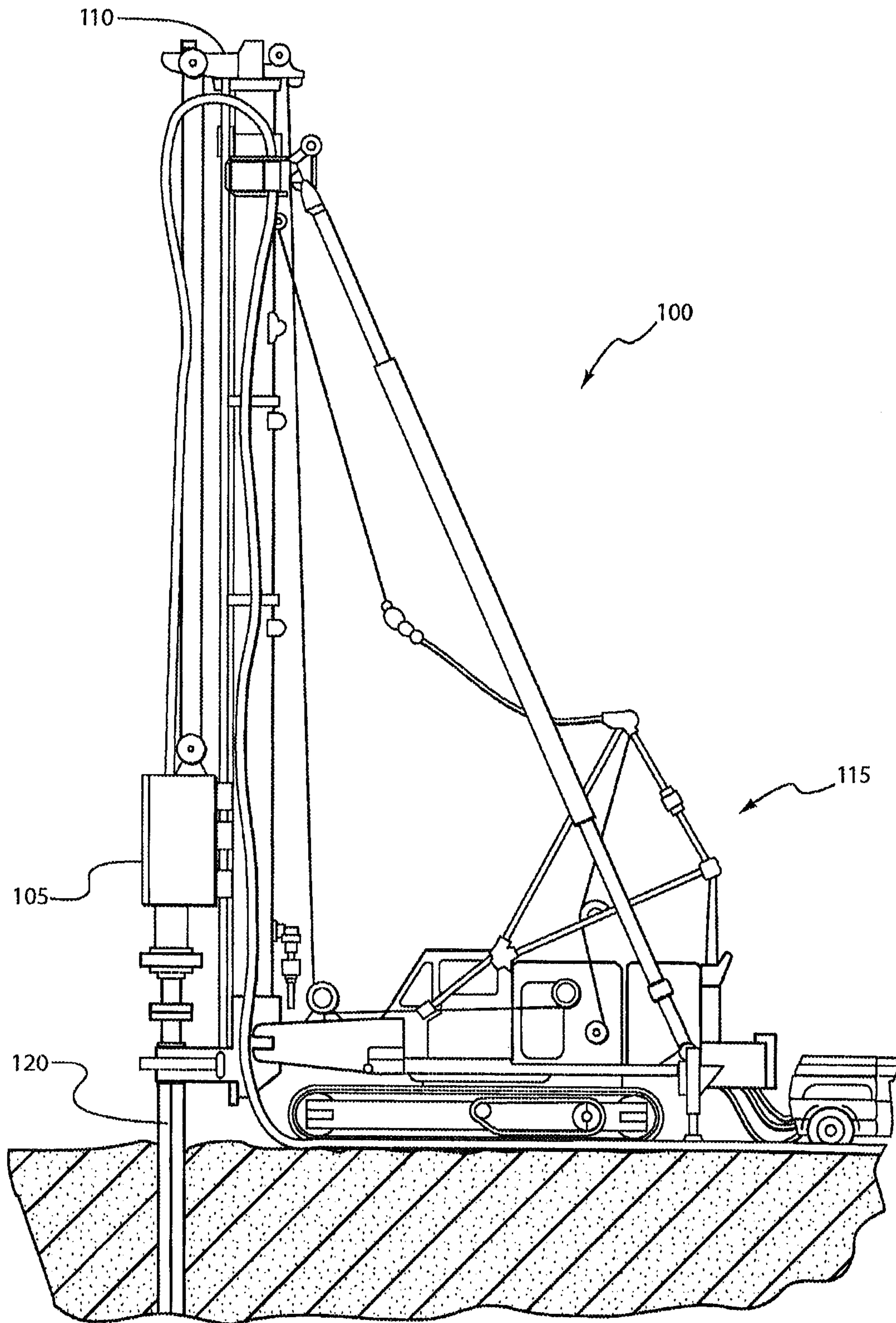


FIG. 1A

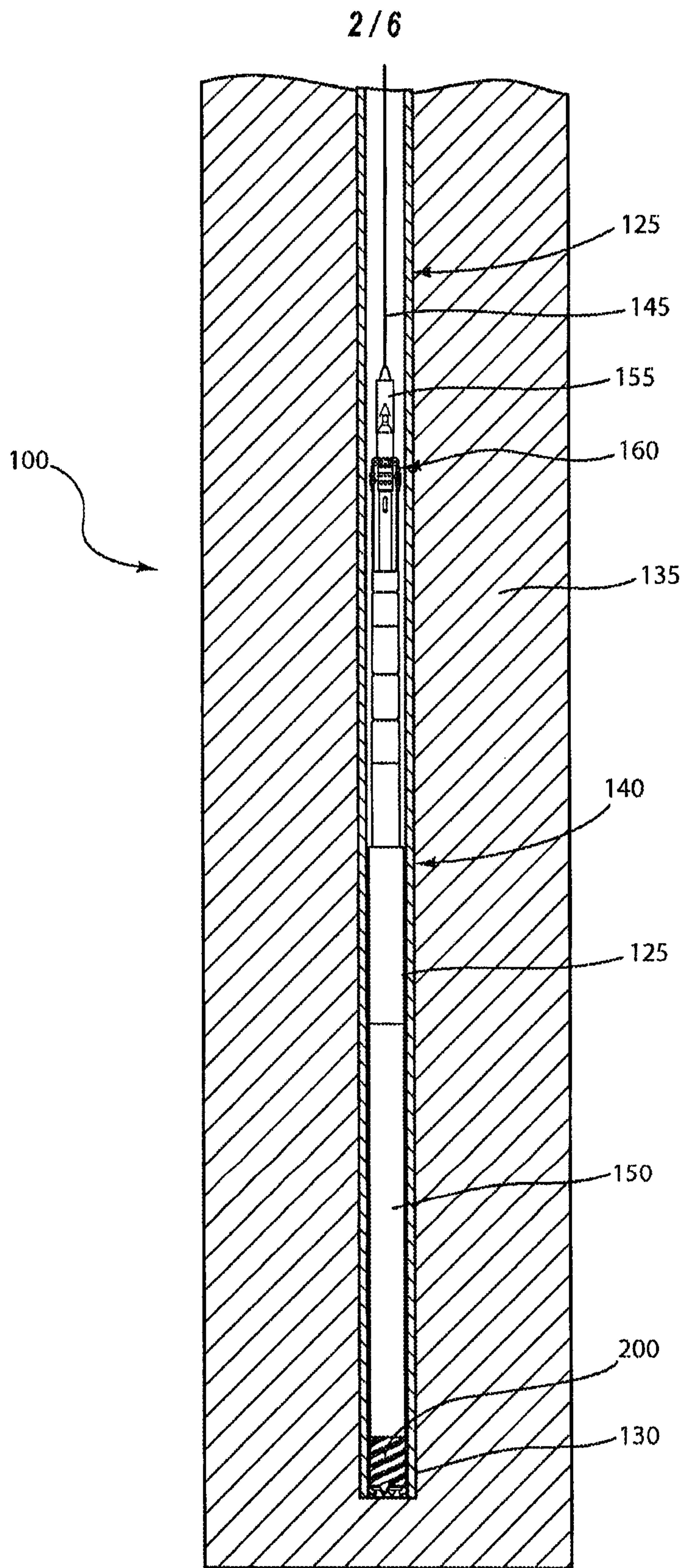


FIG. 1B

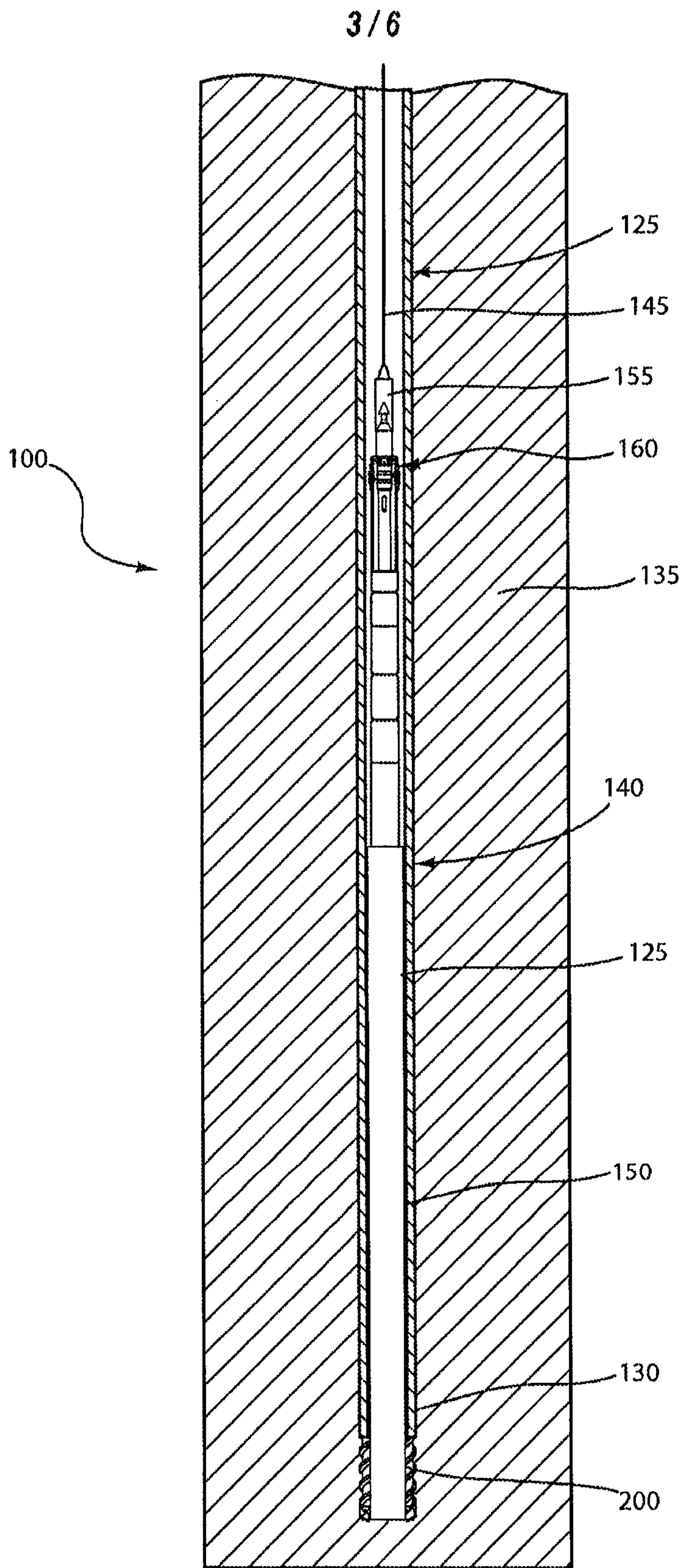


FIG. 1C

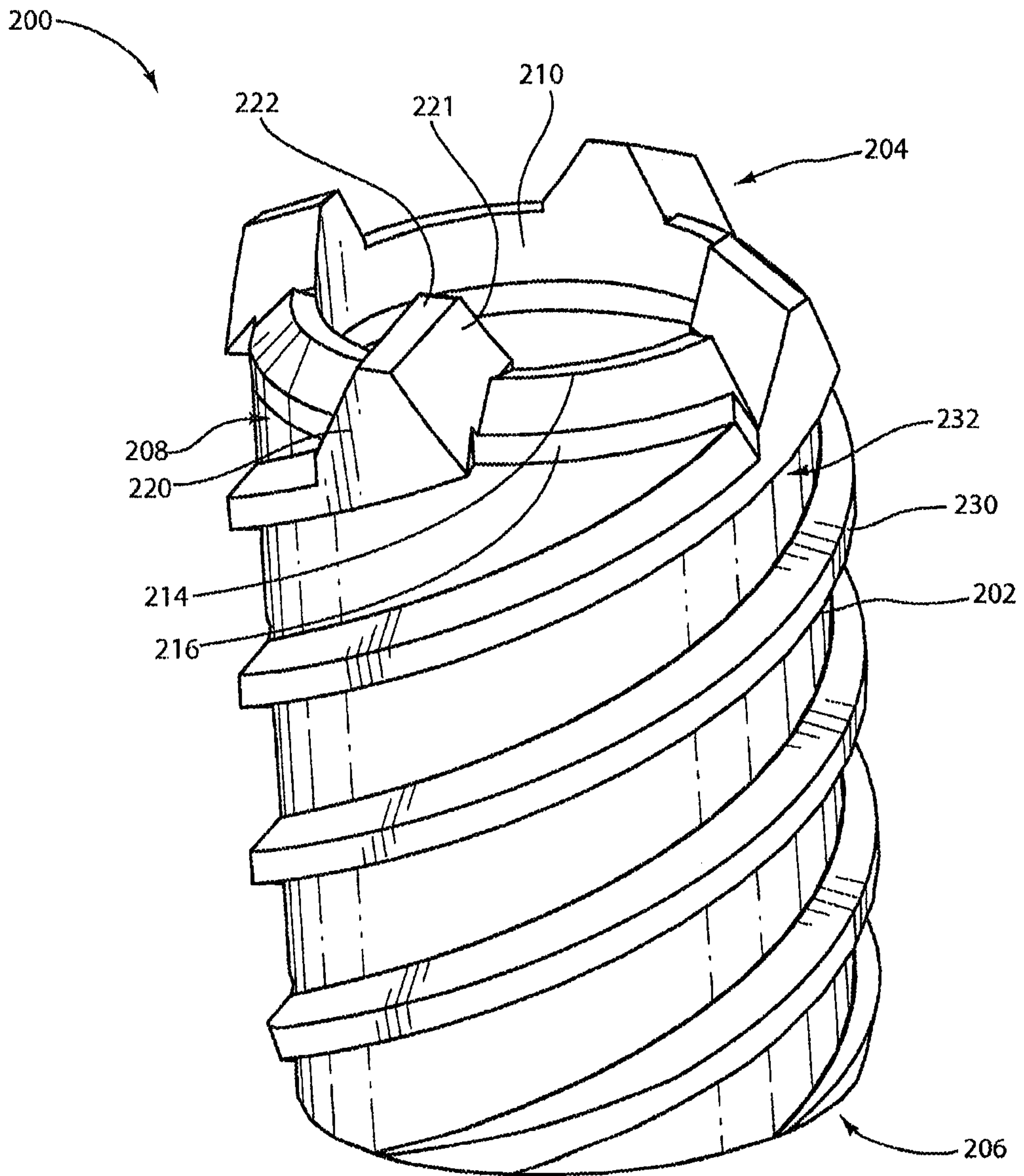


FIG. 2A

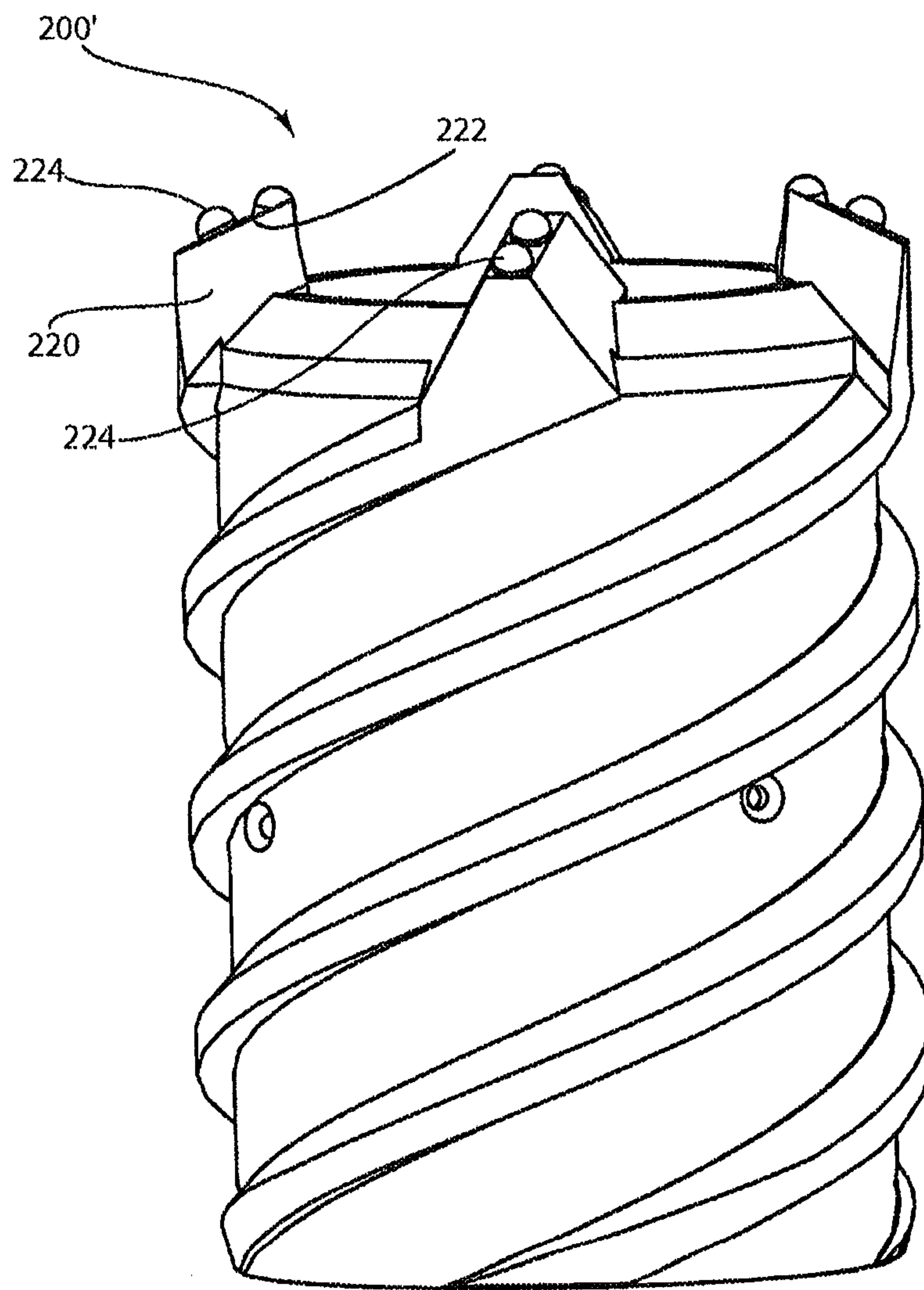


FIG. 2B

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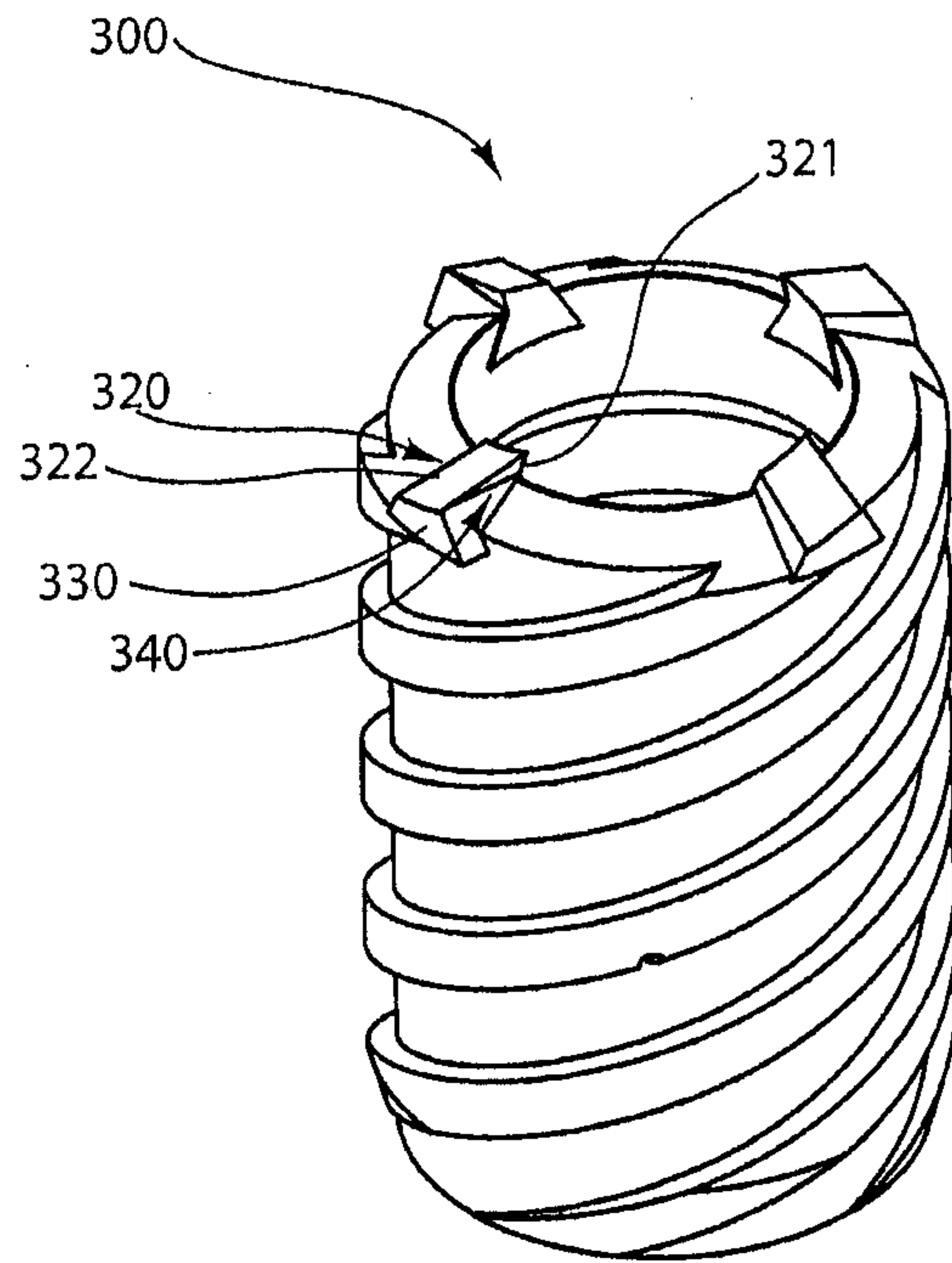


FIG. 3A

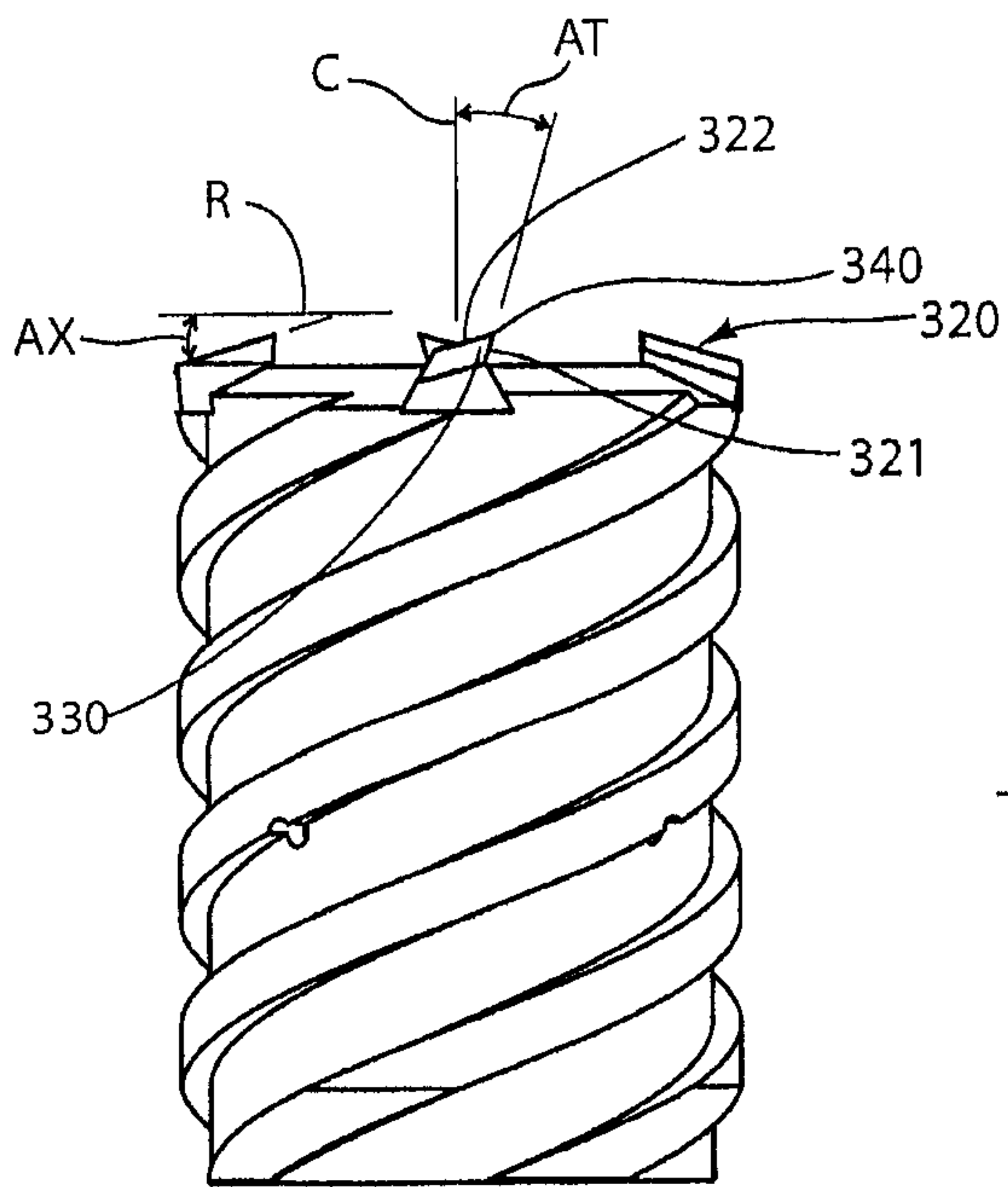


FIG. 3B

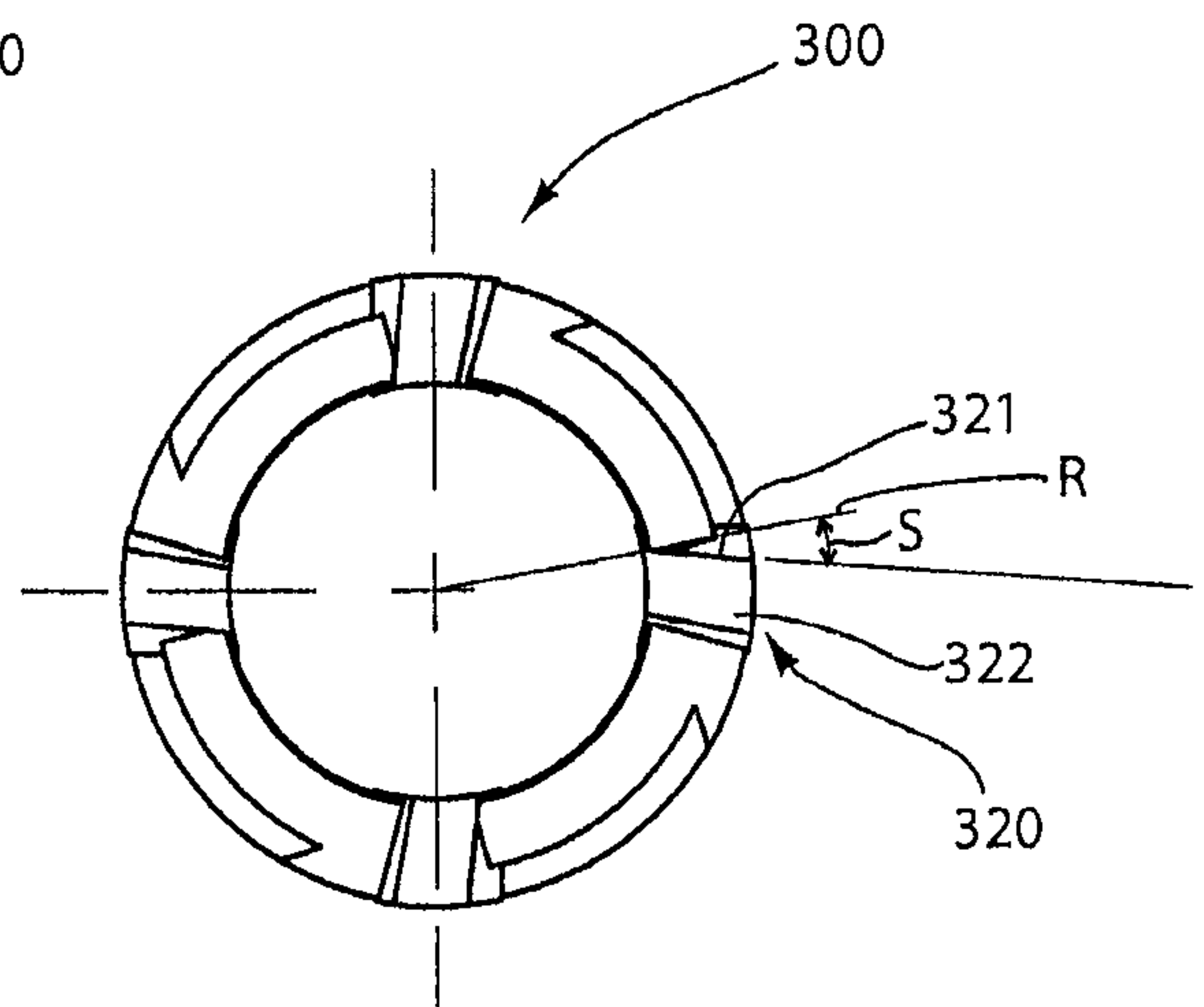


FIG. 3C

