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(72) BLIZZARD, WILLIAM ALLEN, US
(72) MCCLUNG, GUY LAMONT, US
(72) KUCK, MARC DAVID, US
(72) CARTER, THURMAN B., US
(71) WEATHERFORD/LAMB, INC., US

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(54) **FRAISE UTILE DANS UN PUITS DE FORAGE ET PROCEDE DE FRAISAGE**

(54) **MILL FOR USE IN A WELLBORE AND METHOD OF MILLING**

(57) L'invention concerne une fraise utile dans un puits de forage, ladite fraise comportant un alésage servant à loger une carotte, et étant caractérisée par le fait qu'au moins une partie dudit alésage ne s'étend pas de manière axiale par rapport à ladite fraise afin de faciliter, à l'utilisation, la séparation de la carotte d'un matériel tubulaire en cours de fraisage.

(57) A mill for use in a wellbore, said mill comprising a bore (414) for accomodating a core, characterised in that at least a portion of said bore does not extend axially of said mill to, in use, facilitate separation of the core from a tubular being milled.

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(71) Applicants: WEATHERFORD/LAMB, INC. [US/US]; CSC–The United States Corporation Company, 1013 Centre Road, Wilmington, DE (US). LUCAS, Brian, Ronald [GB/GB]; 135 Westhall Road, Warlingham, Surrey CR6 9HJ (GB).

(72) Inventors: BLIZZARD, William, Allen; 4314 Island Hills Drive, Houston, TX 77059 (US). MCCLUNG, Guy, Lamont; Suite 347, 16690 Champion Forest Drive, Spring, TX 77379 (US). KUCK, Marc, David; 2019 S. Gessner #B8, Houston, TX 77063 (US). CARTER, Thurman, B.; 2901 Roseheath Lane, Houston, TX 77073 (US).

(74) Agent: LUCAS, Brian, Ronald; Lucas & Co., 135 Westhall Road, Warlingham, Surrey CR6 9HJ (GB).

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(57) Abstract

A mill for use in a wellbore, said mill comprising a bore for accomodating a core, characterised in that at least a portion of said bore does not extend axially of said mill to, in use, facilitate separation of the core from a tubular being milled.

Mill for Use in a Wellbore and Method of Milling

This invention relates to a mill for use in a wellbore and to a method of milling.

Mills are used, inter alia, for cutting windows in the walls of tubulars prior to sidetracking and similar operations.

One of the problems which arises with known mills is generally referred to as "coring". In particular, as the mill forms the window it reaches a position where the centre of the mill is substantially in line with the wall of the tubular in which the window is being formed. As the mill is rotated the tubular is milled away with the exception of a solid bar of metal which enters a bore which extends longitudinally of the mill.

Frequently, the solid bar of metal (referred to as a "core") breaks away from the tubular and the formation of the window continues unimpeded. However, if the core does not break then the whole milling operation can be delayed pending remedial treatment.

The aim of the present invention is to help ensure that the core breaks away from the tubular.

According to the present invention there is provided a mill for use in a wellbore, said mill comprising a bore for accommodating a core part from a tubular being milled, characterised in that at least a portion of said bore does not extend axially of said mill to, in use, facilitate separation of the core part from the tubular being milled.

Further features of the present invention are set out in Claims 2 et seq.

For a better understanding of the present invention, reference will now be made, by way of example, to the accompanying drawings, in which:-

Fig. 1A is a side view of a first embodiment of a mill according to the present invention;

Fig. 1B is a cross-section of the mill shown in Fig. 1A;

Fig. 1C is a cross-section on line 1C-1C of Fig.1B;

Figs. 2 to 11 and 12A are side views, partly in cross-section, of eleven further embodiments of a mill according to the present invention;

Fig. 12B shows, to an enlarged scale, a detail of the mill shown in Fig. 12A; and

Fig. 12C is a simplified end view of the detail shown in Fig. 12B.

Referring to Figs. 1A, 1B and 1C there is shown a mill 300 which has a body 302, milling surfaces 304, and fluid courses 306 between the milling surfaces 304. An upper internally threaded end 308 provides for releasable connection to a workstring of pipe or coiled tubing.

A central bore 310 extends from the top of the body 302 downwardly and communicates with fluid bores 312 that provide a path for fluid to exit the body to flush milled cuttings and debris up and away from the mill and with a bore 314 that extends from the lower end of the central bore 310 down to the bottom of the body 302.

The milling surfaces 304, the lower end of the body 302, and the interior surface of at least a lower portion of the bore 314 may be dressed with milling material, e.g. but not limited to milling inserts and/or crushed tungsten carbide matrix milling material. By using such material in the bore 314 the separation of a core from a tubular being milled is facilitated. It is also within the scope of this invention to dress the upper end of the bore 314 or the whole bore 314 and/or the lower end of the central bore 310 with such material.

The bore 314 (and the bores in the other embodiments disclosed herein) may have an inner diameter sized in relation to a core that will be produced by milling with the mill 300 (or with the mills in the other embodiments). In one aspect, the bore diameter is slightly larger than the wall thickness of the tubular being milled. In another aspect the bore diameter is significantly larger than the width of a core being produced by milling so the core does not impede washing fluid flow out from the bore 314 and, in such a case, one or more fluid flow bores like the fluid flow bores 312 may be optional.

As shown in Fig. 1B, there is a bend in the compound bore 310-314 where the bore 314 meets the bore 310 so that the top of a core proceeding to the bend (or into the angled portion of the bore 314 itself) is held and more easily twisted away from a tubular being milled, thus inhibiting or preventing damaging "coring" of the mill by a core that moves unimpeded up into a mill's inner body. Such coring can result in a cessation of milling and/or in the production of a relatively large core that is difficult to manipulate and remove, particularly if it drops from the mill's interior and falls down into the wellbore.

Fig. 2 shows a mill 320 with a body 322 having a threaded top end 324; a lower end 326 dressed with milling material 328; a top flow bore 330 extending from the top of the body 322 downwardly; washing fluid channels 332 in fluid communication with the bore 330 and the space outside the mill 320; a core bore 334 extending up from a lower opening 336; and a twist bore 338 interposed between and in fluid communication with the top flow bore 330 and the core bore 334. As with the bend between the bores 310-314 (Fig. 1B), the twist bore facilitates the holding of the top of a core and separation of the core from a tubular being milled. As shown the bores have essentially the same inner diameter, but it is within the scope of this invention for all three diameters to be different; for the twist bore to be larger or smaller in inner diameter than the other two bores; for any two of the bores to have a similar inner diameter; and, in one aspect, for the core bore to be slightly larger than the width of a core to be produced and for the twist bore and/or top bore to be larger or smaller in inner diameter than the core bore (all as with all multi-bore mill embodiments disclosed herein); and, depending on the core bore diameter, the washing fluid channels (at least one, two, or three in certain embodiments) are optional for all multi-bore mill embodiments herein. In cross-section the bore 330 is substantially in the center of a cylindrically shaped body 322, as is the bore 334 in a lower cylindrical bottom piece 339.

It is within the scope of this invention to employ any bend angle between two bore portions (e.g. as with the top and core bores of Fig. 1B) and/or to use any bent, twisted, curved, helical, or undulating intermediate bores to receive and hold a core top end to facilitate the core's separation from a tubular being milled. Such an intermediate bore itself may include a plurality of sub-bores at angles to each other.

For ease of manufacture, shipping, and/or assembly any mill disclosed herein may be made of multiple pieces that are threaded together, welded together, or otherwise secured together for use. For example the mill 320 may be made of two pieces, shown schematically as a top piece 336 above a line 337 (Fig. 2) and a bottom piece 339 below the line 337. Appropriate threading, in certain embodiments, is used with extensions for the threads if needed.

Fig. 3 shows a mill 340 with a cylindrical body 342 having a threaded top end 344; a lower end 346 dressed with milling material 348; a top flow bore 350 (off center in the body 342) extending from the top of the body 342 downwardly; washing fluid channels 352 in fluid communication with the bore 350 and the space outside the mill 340; a core bore 354 (substantially centered in the body) extending up from a lower opening 356; and a twist bore 358 interposed at an angle between and in fluid communication with the top flow bore 350 and the core bore 354. As with the bend between the bores 310-314 (Fig. 1B), the twist bore facilitates holding of a top core end and separation of a core from a tubular being milled. In the mill 340, the top bore 350 is offset from a center of the body 342 and the core bore is essentially at the center. These positions may be reversed.

Fig. 4 shows a mill 360 (similar to the mill 300) with a body 362 having a threaded top end (not shown); a lower end 366 dressed with milling material 368; a top flow bore 370 extending from the top of the body 362 downwardly; washing fluid channels 372 in fluid communication with the bore 370 and the space outside the mill 360; a core/fluid bore 374 extending up from a lower opening 376; and a twist bore 338 interposed between and in fluid communication with the top flow bore 370 and the core bore 374. As with the bend between the bores 310-314 (Fig. 1B), the twist bore facilitates holding of a top core end and separation of the core from a tubular being milled. If a core does not move up to the twist bore, the angle of the core/fluid bore 374 alone facilitates core separation.

Fig. 5 shows a mill 380 having a cylindrical threaded top part 383 with a bottom threaded end 384 and a top threaded end 385; a lower part 386 with a top threaded end 387 and a bottom end 389 dressed with milling material 388; a top flow bore 390 (off center) in the top part 383 extending downwardly at an angle from center; washing fluid channels 392 in fluid communication with a core bore 394 and the space outside the mill 380; the core bore 394 extending at an angle from a longitudinal axis of the lower part 386 up from a lower opening 396 to a top end of the lower part 386; and a hollow coupling 398 interposed between and in fluid communication with the top flow bore 390 and the core bore 394.

The hollow coupling 398 has a fluid bore 399 therethrough that is in fluid communication with the top flow bore 390 and the core bore 394. The coupling 398 and parts 383 and 386 may be marked exteriorly so that upon connection a top opening 382 of the core bore is mis-aligned with a bottom opening 381 of the top flow bore 390 so that entry is inhibited or prevented of a top end of a core passing up through the coupling 398 into the bottom opening 381. A coupling such as the coupling 398 (with either exterior or interior type threads, or one type on one end and the other type on the other end) may be used with any mill disclosed herein and any such mill may be made up with a top part and bottom part as is the mill 380. A line (as the line 337, Fig. 2) separating two such mill pieces can be positioned through a twist or bent bore or either above such a bore or below it for any embodiment herein.

Fig. 6 shows a mill 400 with a cylindrical mill body 402 and a top threaded end 404. A flushing fluid flow channel 406 extends from the top of the body down into a broader cylindrical part 408 of the body where it branches into a side fluid flow channel 410 having a side exit 412 and a core channel 414 that extends down to a bottom center opening 416. The core channel 414 is disposed and sized for receiving a core of material formed when the mill 400 mills an opening in a tubular in a wellbore in the earth. The core channel 414 is offset with respect to the flushing fluid flow channel and the core channel 414 is at an angle to a longitudinal axis of the mill body 402. Matrix milling material 418 and/or milling inserts (e.g. of tungsten carbide) is applied to an interior surface at the lower end of the core channel 414 to facilitate separation of a core entering into the core channel from a tubular being milled.

Fig. 7 shows a mill 420 with a cylindrical mill body 422 and a top threaded end 424. A flushing fluid flow channel 426 extends from the top of the body down into a broader part 428 of the body where it branches into a side fluid flow channel 430 having a side exit 432 and a core channel 434 that extends down to a bottom center opening 436. The core channel 434 is disposed and sized for receiving a core of material formed when the mill 420 mills an opening in a tubular in a wellbore in the earth. Preferably the core channel 434 is offset with respect to the flushing fluid flow channel and, in one aspect, the core channel 434 is at an angle to a longitudinal axis of the mill body 422. A short horizontal intermediate flow channel 439 interconnects the flushing fluid flow channel 426 and the core channel 434. Matrix milling material 438 and/or milling inserts (e.g. of tungsten carbide) is applied to an interior surface at the lower end of the core channel 434 to facilitate separation of a core entering into the core channel from a tubular being milled. As with other embodiments, such milling material may be used on all or any part of the bore to facilitate core separation and/or milling of a core.

Fig. 8 shows a mill 440 with a cylindrical mill body 442 and a top threaded end 444. A flushing fluid flow channel 446 extends from the top of the body down into a broader part 448 of the body where it continues into a side fluid flow channel 450 having a side exit 452 and a core channel 454 that extends down to a bottom center opening 456. The core channel 454 is disposed and sized for receiving a core of material formed when the mill 440 mills an opening in a tubular in a wellbore in the earth. The core channel 454 is offset with respect to the flushing fluid flow channel and the core channel 454 is at an angle to the longitudinal axis of the mill body 442. The side exit fluid flow channel 452 may exit at any desired point on the side of the mill body or at an opening on the mill body bottom (as may any flushing channel in any of the mills shown). Matrix milling material 458 and/or milling inserts (e.g. of tungsten carbide) is applied to an interior surface at the lower end of the core channel 454 to facilitate separation of a core entering into the core channel from a tubular being milled.

Fig. 9 shows a mill 460 with a cylindrical mill body 462 and a top threaded end 464. A flushing fluid flow channel 466 extends from the top of the body down into a broader part 468 of the body where it continues into a lower fluid flow channel 470 having a bottom exit 472. A core channel 474 extends up from the bottom of the body 462 from an opening 476. The core channel 474 is disposed and sized for receiving a core of material formed when the mill 460 mills an opening in a tubular in a wellbore in the earth. The core channel 474 is offset with respect to the flushing fluid flow channel and is at an angle to a longitudinal axis of the mill body 462. The core channel 474 ends at a top end thereof 475 which a core may abut and beyond which the core will not move. Matrix milling material 478 and/or milling inserts (e.g. of tungsten carbide) is applied to an interior surface at the lower end of the core channel 474 to facilitate separation of a core entering into the core channel from a tubular being milled.

Fig. 10 shows a mill 480 with a mill body 402 and a top threaded end 484. A flushing fluid flow channel 486 extends from the top of the body down into a broader part 488 of the body where it branches into a side fluid flow channel 490 having a side exit 492 and intermediate flow channels 491 and 493 that intercommunicate with a core channel 494 that extends down to a bottom center opening 496. The core channel 494 is disposed and sized for receiving a core of material formed when the mill 400 mills an opening in a tubular in a wellbore in the earth. The core channel 494 is offset with respect to the flushing fluid flow channel and is at an angle to the longitudinal axis of the mill body 482. Matrix milling material 498 and/or milling inserts (e.g. of tungsten carbide) is applied to an interior surface at the lower end of the core channel 494 to facilitate separation of a core entering into the core channel from a tubular being milled. In one aspect the channels 491 and 493 are sized so that a core will not enter them. As with the mill of Fig. 2, any mill described herein may be made of two or more interconnectible pieces. In one aspect such a multipiece design facilitates creation of the various interior channels.

Figs. 11 and 12A show variations of the mill 380 of Fig. 5.

Fig. 11 shows a mill 380 with an interiorly threaded channel 394a open at its bottom to the space below the mill 380. A core bore insert 399a with an exteriorly threaded body is removably secured in the channel 394a. The core bore insert has a core channel 398a sized in diameter and/or in length for receiving a core of anticipated size from a tubular of known wall thickness and for facilitating separation of said core from said tubular. The core channel 398a extends from the top end of the core bore insert 399a to the bottom end thereof. The channels 398a and 394 are in fluid communication and fluid can initially flow out through the bottom end of the channel 398a. The threading on the insert is preferably handed so that mill rotation does not unscrew the insert. In addition to or instead of threaded mating, a core bore insert according to this invention may be welded in place and/or held in place with pins or bolts through the mill body and insert body.

The mill 380 in Fig. 12A has a core bore insert 397, like the core bore insert 399, but with a smaller diameter core channel 396. The outer diameter of both core bore inserts 399a and 397 is the same so that either core bore insert is usable in a single mill. It is within the scope of this invention to provide multiple (two, three, four or more) core bore inserts, each having a different diameter and/or a different length to handle anticipated cores of different diameter and/or different length. Such a core bore insert or set of two or more different core inserts may be used with any known mill and with any mill described herein which has a suitable channel or recess for receiving the core bore insert(s).

Matrix milling material and/or inserts 395 (collectively "milling material") may be used in the core bore insert's channel as described above for core bores in other embodiments, on all or part of the channel.

In any core bore insert disclosed herein, the core bore channel may be angled from a longitudinal axis of the core bore insert and/or angled from a longitudinal axis of a mill body of a mill in which the core bore insert is removably or permanently emplaced. Alternatively (or additionally) any channel in a mill into which a core bore insert is emplaced may be at an angle to a longitudinal axis of the mill or in line with said axis. The core bore insert may itself contain a multi-component channel with one part at an angle to another part. Also, the core channel may extend for the full length of the core bore insert and be in fluid communication with another fluid flow channel in a mill, or the core channel of the core bore insert may (like the core channel 474, e.g.) simply terminate at some point within the core bore insert.

CLAIMS:

1. A mill for use in a wellbore, said mill comprising a bore for accommodating a core part from a tubular being milled, characterised in that at least a portion of said bore does not extend axially of said mill to, in use, facilitate separation of the core part from a tubular being milled.

2. A mill for use in a wellbore, said mill comprising

a body having a top and a bottom and a first fluid flow channel extending longitudinally therethrough from top to bottom, the first fluid flow channel having an upper end and a lower end,

milling apparatus on the body,

the lower end of the first fluid flow channel having an opening for, in use, receiving a core of material from a tubular member milled by the mill, characterized by:

at least a portion of the first fluid flow channel being offset from the remainder thereof to facilitate separation of the core from the tubular member.

3. A mill as claimed in Claim 2, further comprising

at least one side fluid flow channel having an inner end in fluid communication with the first fluid flow channel and an outer end in fluid communication with a space outside the mill so that, in use, fluid pumped down the first fluid f low channel can flow out into the space.

4. A mill as claimed in Claim 2 or 3, wherein the first fluid flow channel comprises an upper portion and a lower portion, the upper portion extending through the body of the mill and the lower portion extending through the body of the mill at an angle to the upper portion so that separation of a core with an upper end passing through the lower portion and into the upper portion is facilitated by receipt of the upper end of said core in the upper portion of the first fluid flow channel.

5. A mill as claimed in Claim 4, wherein

the mill body including a top body and a bottom body connected to the top body, the top body includes the upper portion of the first fluid flow channel and the bottom body including the lower portion of the first fluid flow channel.

6. A mill as claimed in Claim 5, further comprising a coupling interposed between and connecting together the top body and the bottom body, the coupling having a coupling fluid flow bore therethrough in fluid communication with the upper portion of the first fluid flow channel of the top body and with the lower portion of the first fluid flow channel of the bottom body.

7. A mill as claimed in Claim 6, wherein the coupling fluid flow bore has an inner diameter larger than an inner diameter of the upper portion of the first fluid flow bore and larger than an inner diameter of the lower portion of the first fluid flow bore.

8. A mill as claimed in claim 7, wherein the upper portion of the first fluid flow bore is offset from the lower portion of the first fluid flow bore, the coupling disposed so that entry of a core top end into the upper portion of the first fluid flow bore is inhibited, the core top end passing from the lower portion of the first fluid flow bore into the coupling fluid flow channel.

9. A mill as claimed in any of Claims 2 to 8, wherein the lower portion of the first fluid flow channel has a lower opening at a bottom of the body.

10. A mill as claimed in Claim 9, wherein the lower opening is located substantially at the center of a lower portion of the body.

11. A mill as claimed in Claim 9 or 10, wherein the lower portion of the first fluid flow channel is located substantially at the center of the body, the upper portion thereof is offset from said center, and the first fluid flow channel has an intermediate portion interconnecting the upper and lower portions and at an angle to each of said upper and lower portions.

12. A mill as claimed in Claim 9, 10 or 11, wherein a first portion of the first fluid flow channel is located

substantially at the center of the body, a second portion thereof is offset from said center, and the first fluid flow channel has an intermediate portion interconnecting the first and second portions and at an angle to each of said first and second portions.

13. A mill as claimed in Claim 10, wherein the body has a center at its lowest portion and the lower opening is offset from said center.

14. A mill as claimed in any of Claims 2 to 11, wherein the body has a lower end with a lower surface thereacross, said lower surface inclined upwardly from an outer edge of the lower end up to a central point of the lower end to facilitate movement of the mill outwardly from a tubular member being milled in a wellbore.

15. A mill as claimed in any of Claims 2 to 14, wherein the body has a lower end having an outer lower surface around a circumference of the body, said outer lower surface tapering inwardly from a level above a lowest boundary of the lower end to said lowest boundary.

16. A mill as claimed in any of Claims 2 to 15, wherein the body has a lower end with an extended outer circumferential surface positionable substantially parallel to and for co-acting with an inner surface of a mill guide in a wellbore.

17. A mill as claimed in any of Claims 2 to 16, further comprising a mill guide in contact with the body of the wellbore mill, said mill guide comprising a hollow body with an upper end and an upper end opening and a lower end with a lower end opening, the lower end opening having a slanted portion to permit the mill to contact an interior portion of the tubular in the wellbore at the desired milling location while the mill also contacts a portion of the lower end of the mill guide.

18. A method of milling an opening in a selected tubular of a tubular string in a wellbore, which method comprises the steps of:

installing a mill as claimed in any preceeding claim on a

working string into the wellbore at a selected desired point for milling the opening in the tubular, and
rotating the mill to mill an opening in the selected tubular.

19. A method according to Claim 18, comprising
creating a core of material of the selected tubular member by milling down the selected tubular, said core received through said opening into at least the lower end of the first fluid flow channel, and
separating with said mill said core from said selected tubular member.

20. A method according to Claim 17, further comprising
positioning a mill guide in said tubular string in said wellbore, said mill guide comprising a hollow body with an upper end and an upper end opening and a lower end with a lower end opening, the lower end opening having a slanted portion to permit the mill to contact an interior portion of the tubular in the wellbore at the desired milling location while the mill also contacts a portion of the lower end of the mill guide, and
urging said mill toward said selected tubular with said mill guide.

21. A method according to Claim 18, 19 or 20, further comprising
positioning a whipstock in said tubular string in said wellbore, and
contacting said whipstock with said mill to divert said mill toward said selected tubular.

22. A method according to Claim 18, 19, 20 or 21, further comprising
rotating said mill with a downhole motor disposed in said working string.

23. A method according to any of Claims 18 to 22, wherein the working string is a string consisting of tubulars from the group consisting of pipe and coiled tubing.

24. A mill for use in a wallbore, said mill comprising

a mill body with milling apparatus thereon and a top and a bottom and a side exterior surface,

at least one flushing fluid flow channel extending down from the top of the body to an exit opening on the side exterior surface, fluid pumpable from above the wellbore mill down into the flushing fluid flow channel and out from the exit opening to move material milled by the wellbore mill up away from the wellbore well, and

a core channel extending from a bottom center opening at a bottom of the mill body and up thereinto for receiving a core of material from a tubular milled by the wellbore mill, the core channel at an angle to a longitudinal axis of the mill body.

25. A mill as claimed in Claim 24, wherein the core channel has a top end within the mill body beyond which the core does not move.

26. A mill as claimed in Claim 24 or 25, wherein the core channel has a core channel opening on the side exterior surface through which a portion of the core may move.

27. A mill as claimed in Claim 24, 25 or 26, including at least one intermediate fluid flow channel with fluid communication with the at least one flushing fluid flow channel and the core channel for providing flushing fluid into the core channel.

28. A mill as claimed in Claim 27, wherein the at least one intermediate fluid flow channel is at an angle of at least 90□ to the core channel.

29. A mill as claimed in Claim 27 or 28, further comprising a mill guide in contact with the body of the wellbore mill, said mill guide comprising a hollow body with an upper end and an upper end opening and a lower end with a lower end opening, the lower end opening having a slanted portion to permit the mill to contact an interior portion of the tubular in the wellbore at the desired milling location while the mill also contacts a portion of the lower end of the mill guide.

30. A mill for use in a wellbore, said mill comprising
a body having a top and a bottom,
milling apparatus on the body, and
a core bore insert channel extending up from the bottom of the body for receiving a core bore insert for holding therein.

31. A mill as claimed in Claim 30, further comprising
a core bore insert within the core bore channel, the core bore insert having a first core channel therethrough with a first diameter for receiving a core milled from a wellbore tubular.

32. A mill as claimed in Claim 30 or 31, wherein the core bore insert is removably held in the core bore channel.

33. A mill as claimed in Claim 31 or 32, further comprising
at least one second core bore insert emplaceable in the core bore insert channel of the wellbore mill body,
the at least one second core bore insert having an inner diameter different from the first diameter of the first core bore insert.

34. A mill as claimed in Claim 31, 32 or 33, wherein an amount of milling material is on at least a portion of the first core channel to facilitate separation of a core from a tubular.

35. A core bore insert for insertion within a core bore insert channel in a body of a wellbore mill, the core bore insert comprising
a body with a top and a bottom,
a first core channel extending from the bottom of the body toward the top and having a first core channel inner diameter, and
the first core channel sized to receive a core milled from a wellbore tubular by the wellbore mill.

36. A core bore insert as claimed in Claim 35, further comprising
milling material on at least a portion of the core

channel to facilitate separation of a core from a tubular.

37. A core bore insert as claimed in Claim 35, further comprising at least one additional core bore insert, said at least one additional core bore insert having an inner diameter different than the first core channel inner diameter.

38. A core bore insert as claimed in Claim 35, 36 or 37, further comprising at least one additional core bore insert, said at least one additional core bore insert having a length different than the first length wherein the first core channel has a first length from one end thereof to the other.

39. A core bore insert as claimed in Claim 35, 36, 37 or 38, wherein the core bore channel extends all the way through the body from top to bottom.

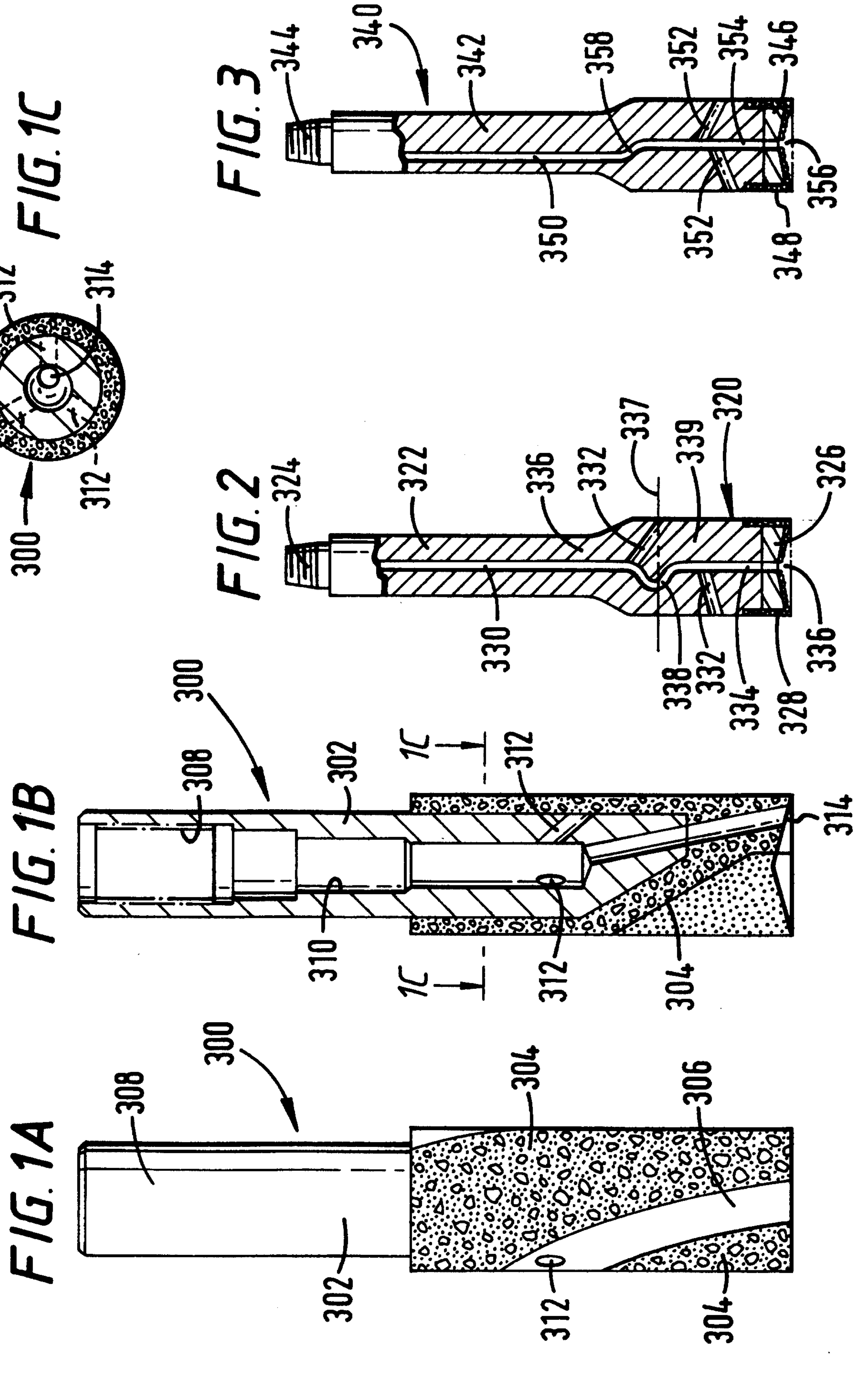
FIG.1A
FIG.1B
FIG.1C
FIG.2
FIG.3
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1C
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FIG. 4

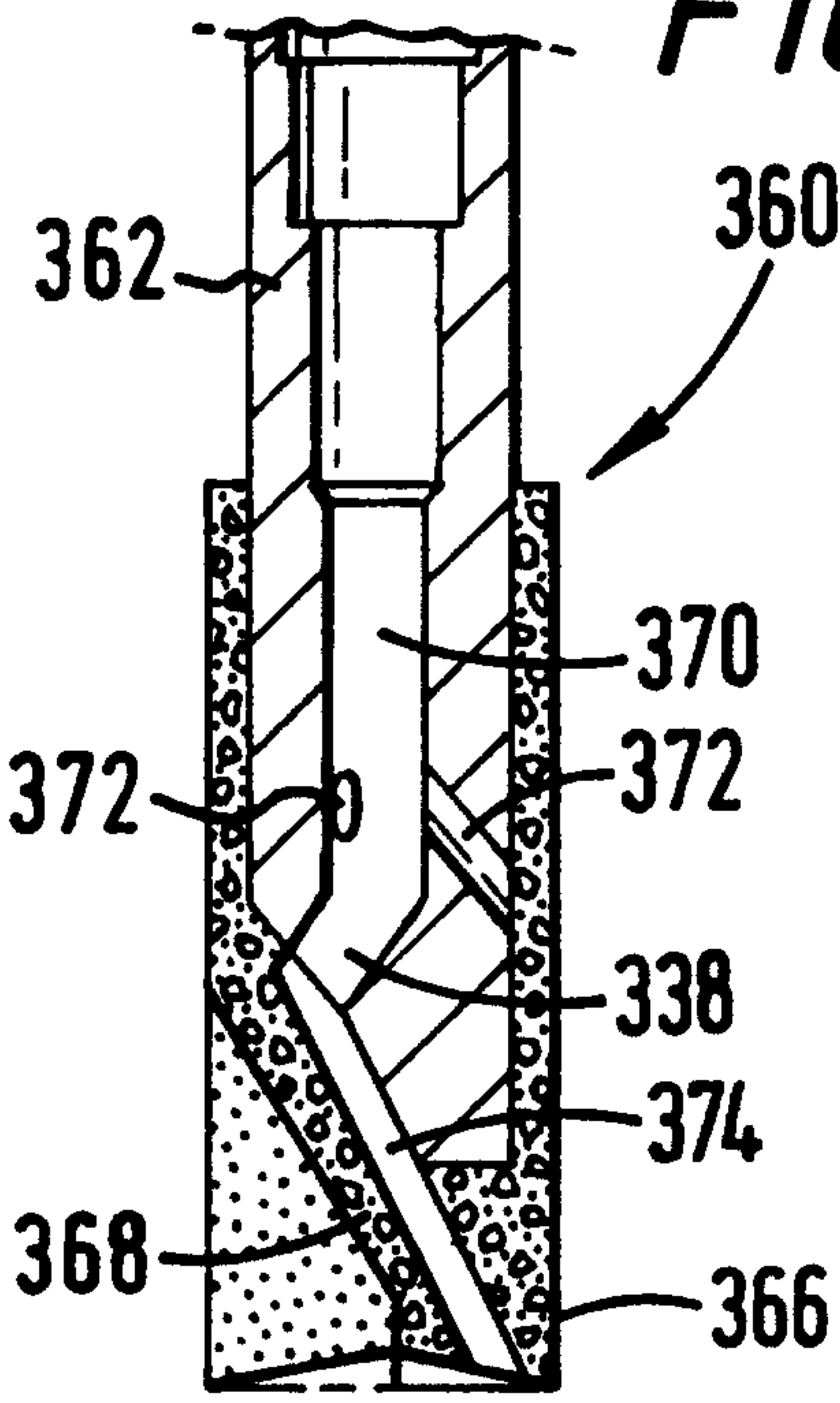

FIG. 5

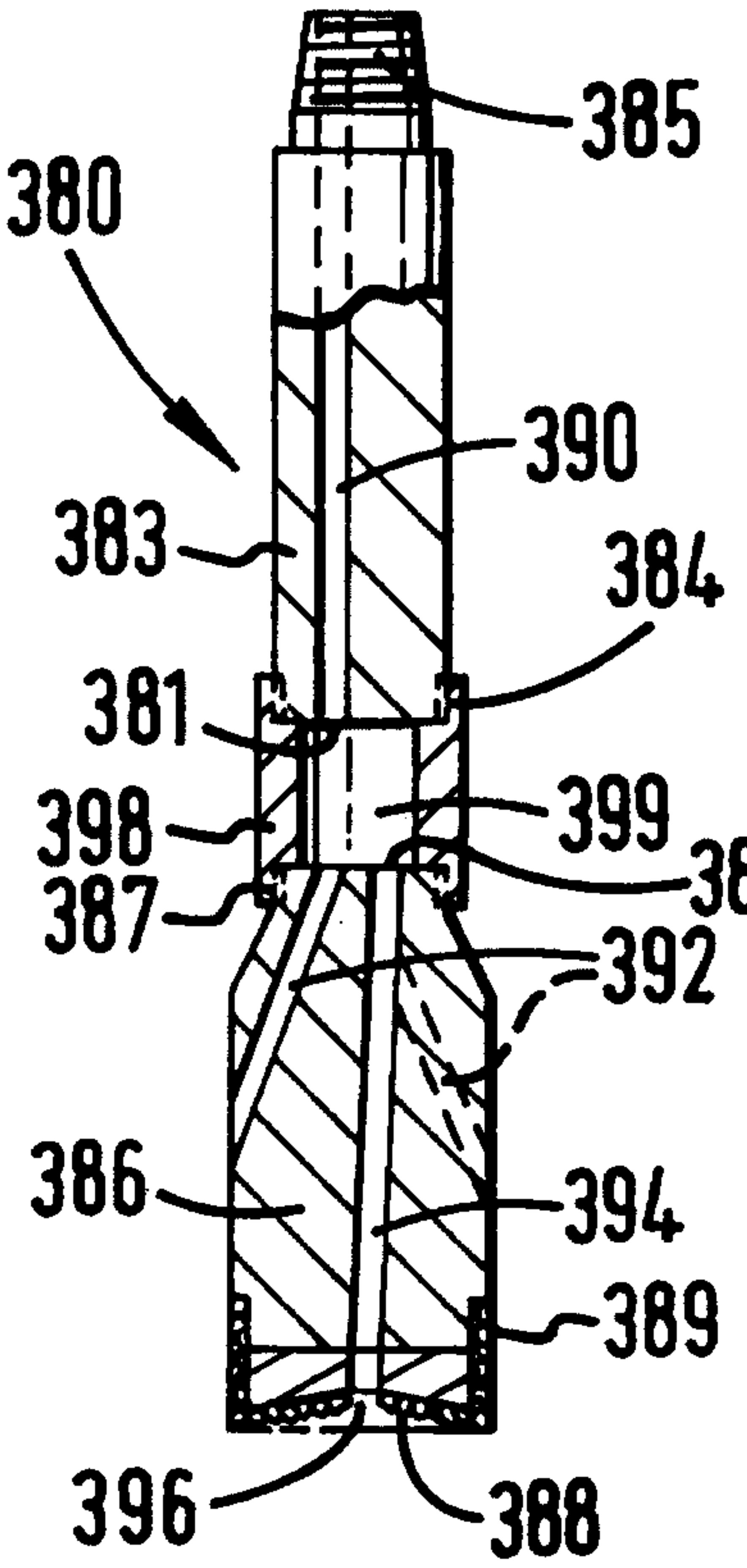

FIG. 6

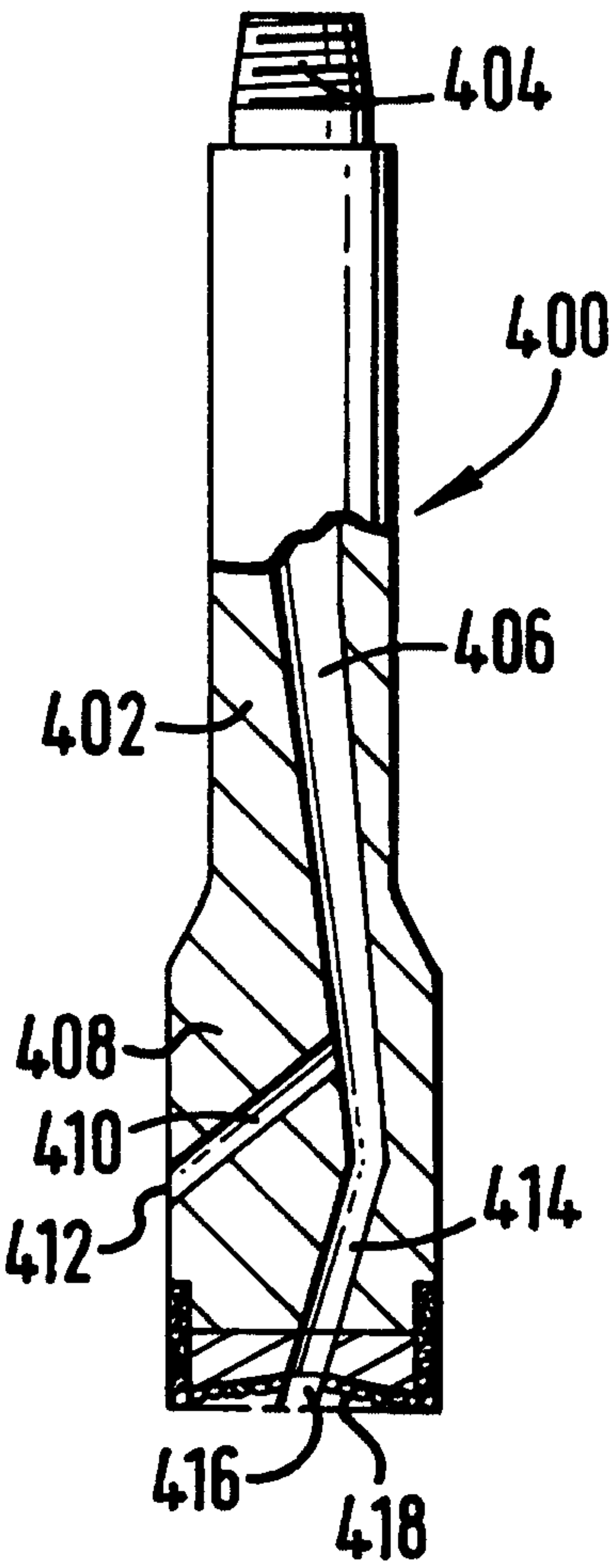

FIG. 7

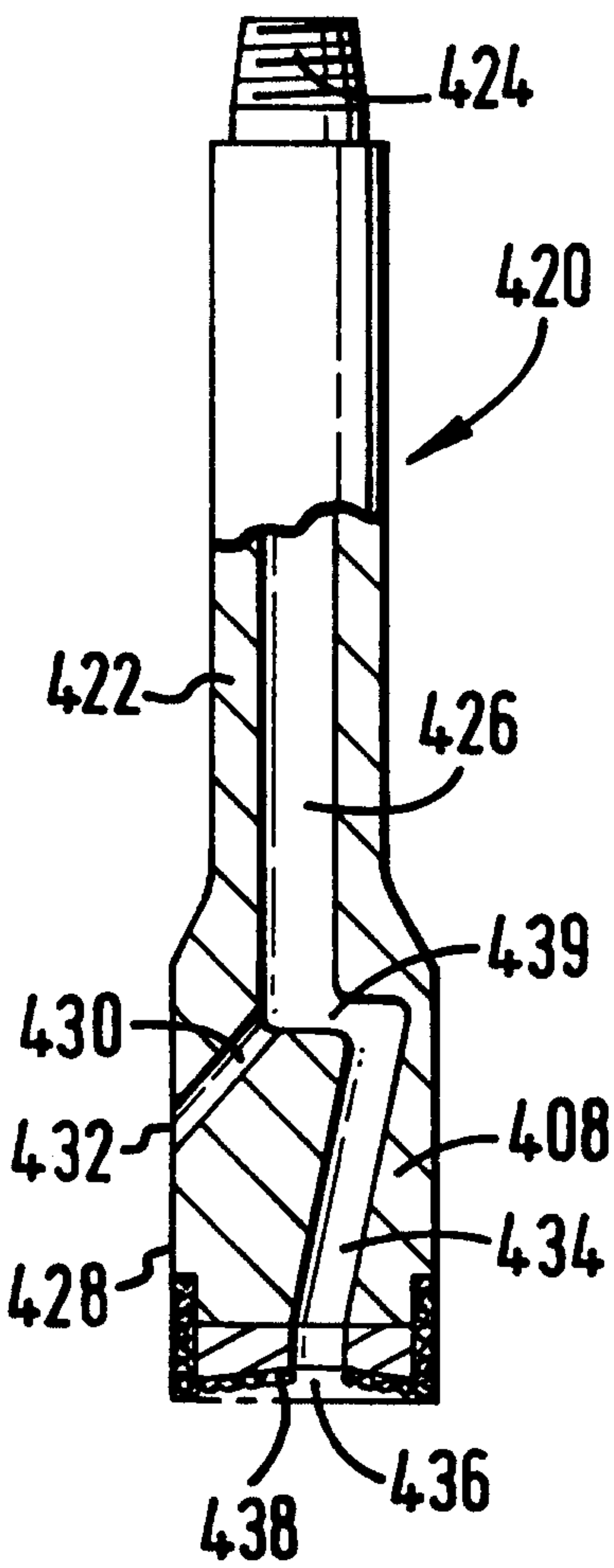

FIG. 8

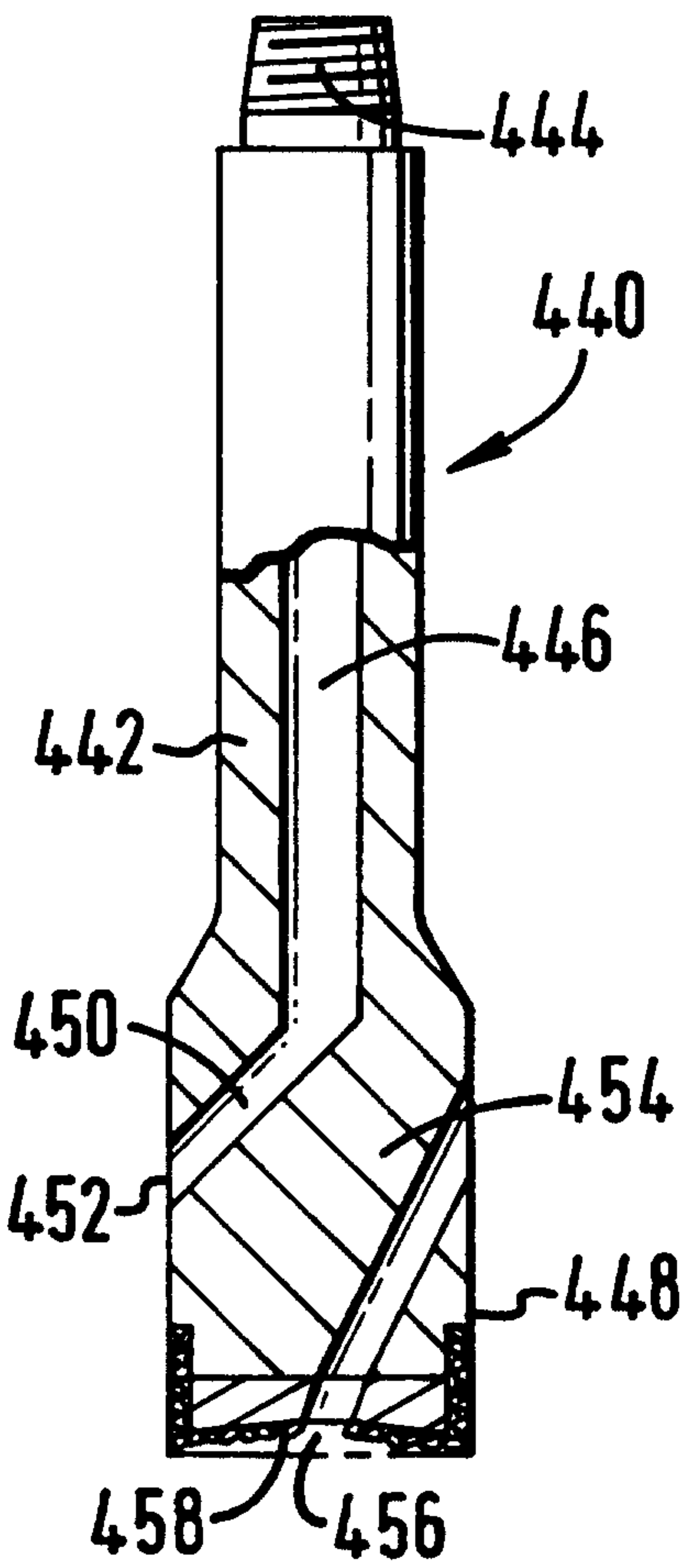

FIG. 9

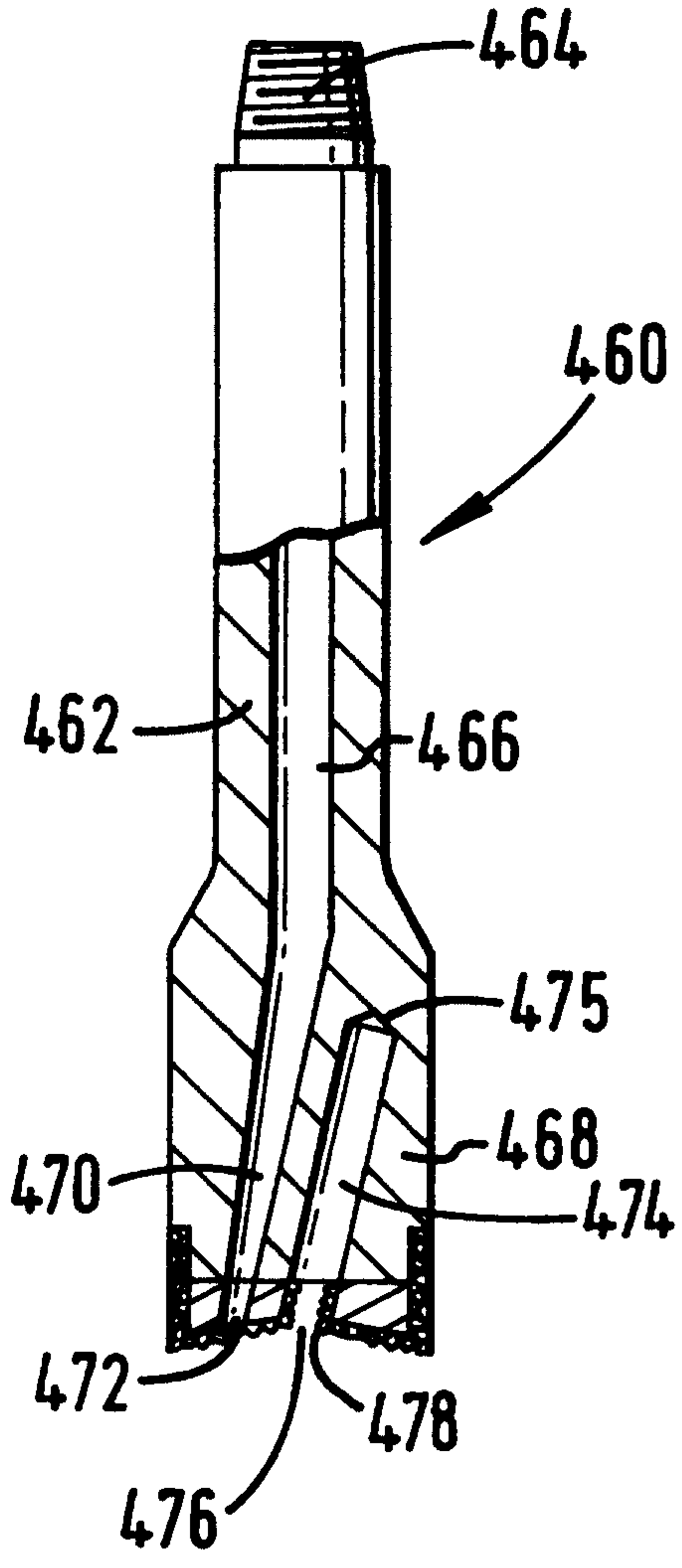
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FIG. 10

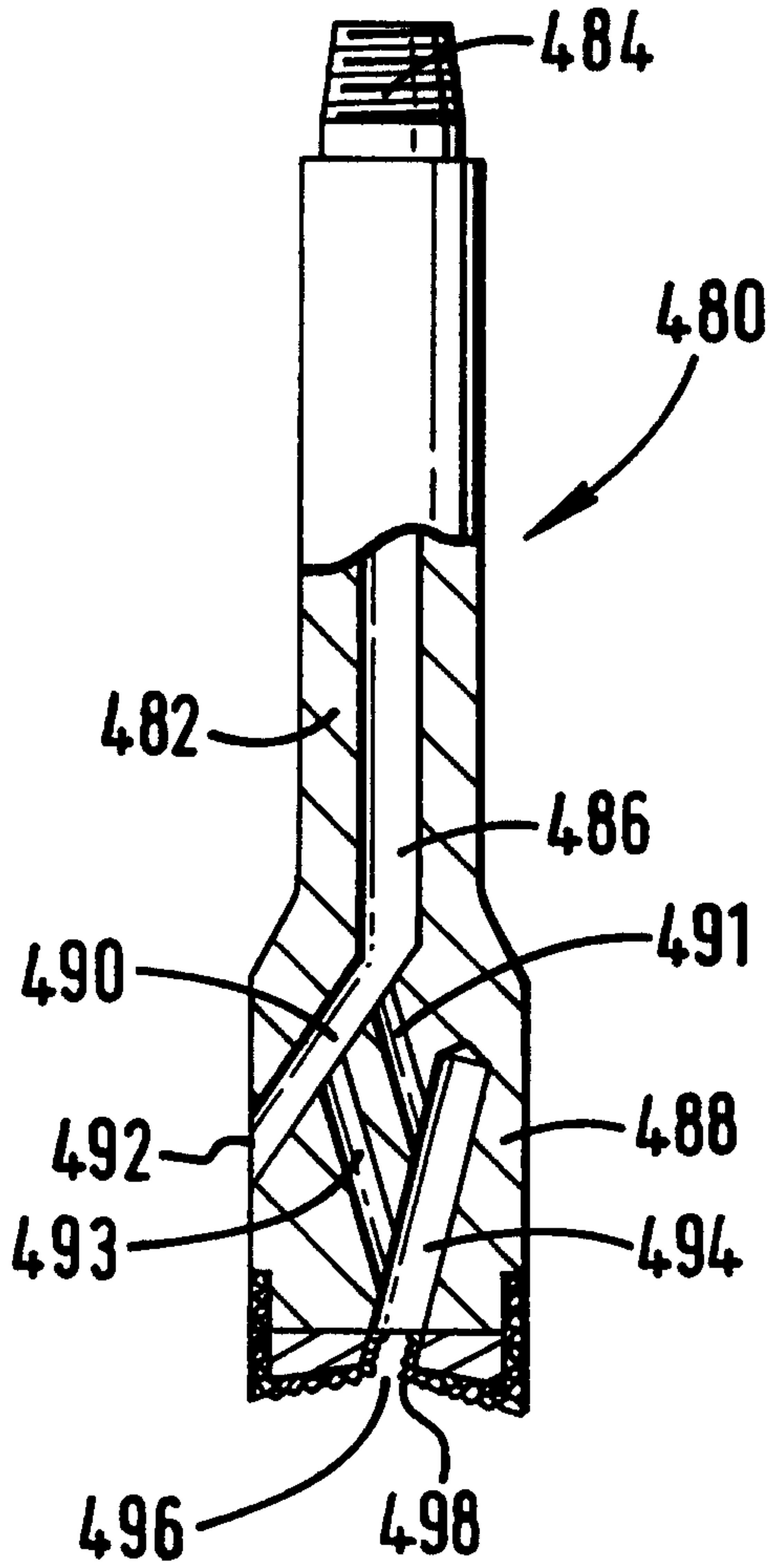
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FIG. 11

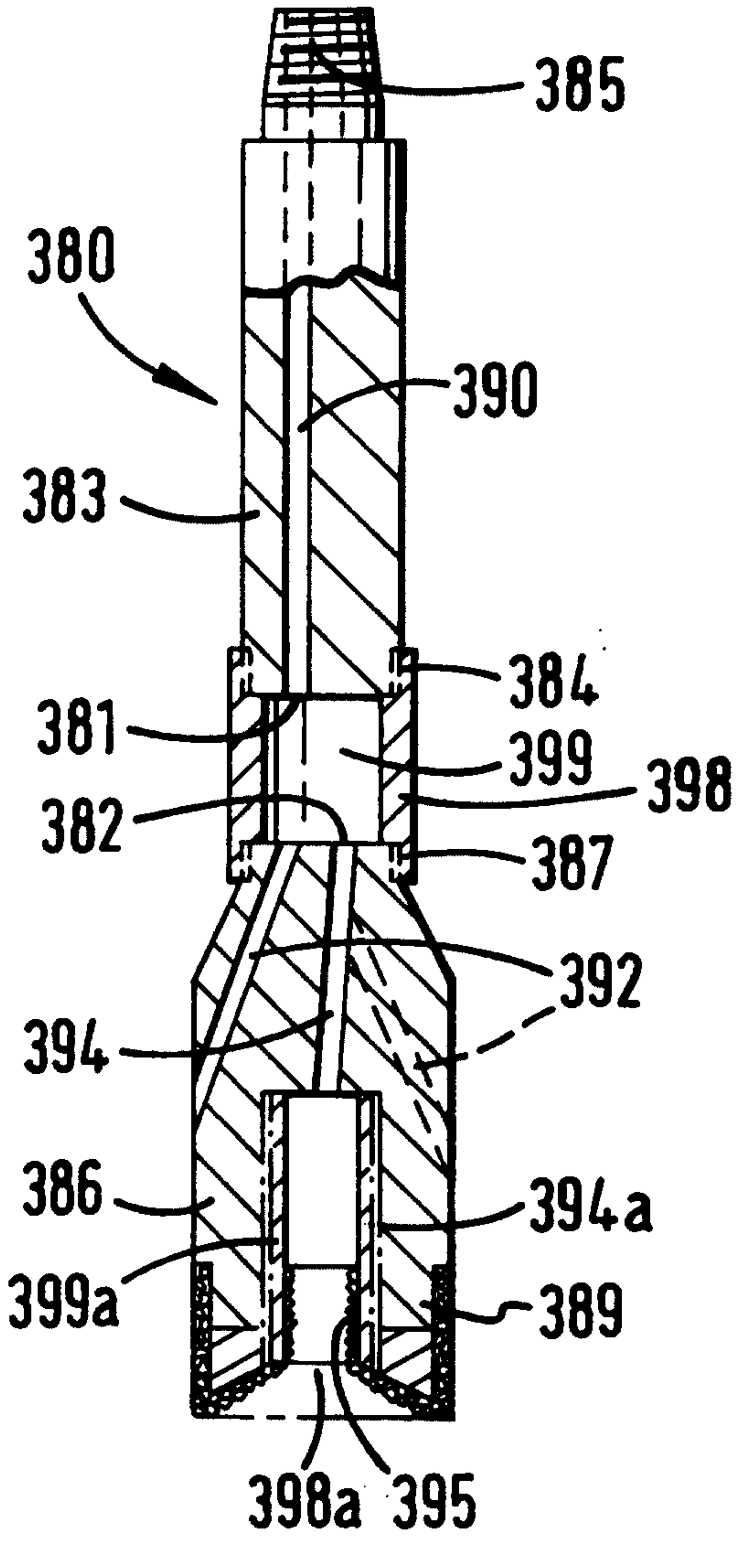

FIG. 12A

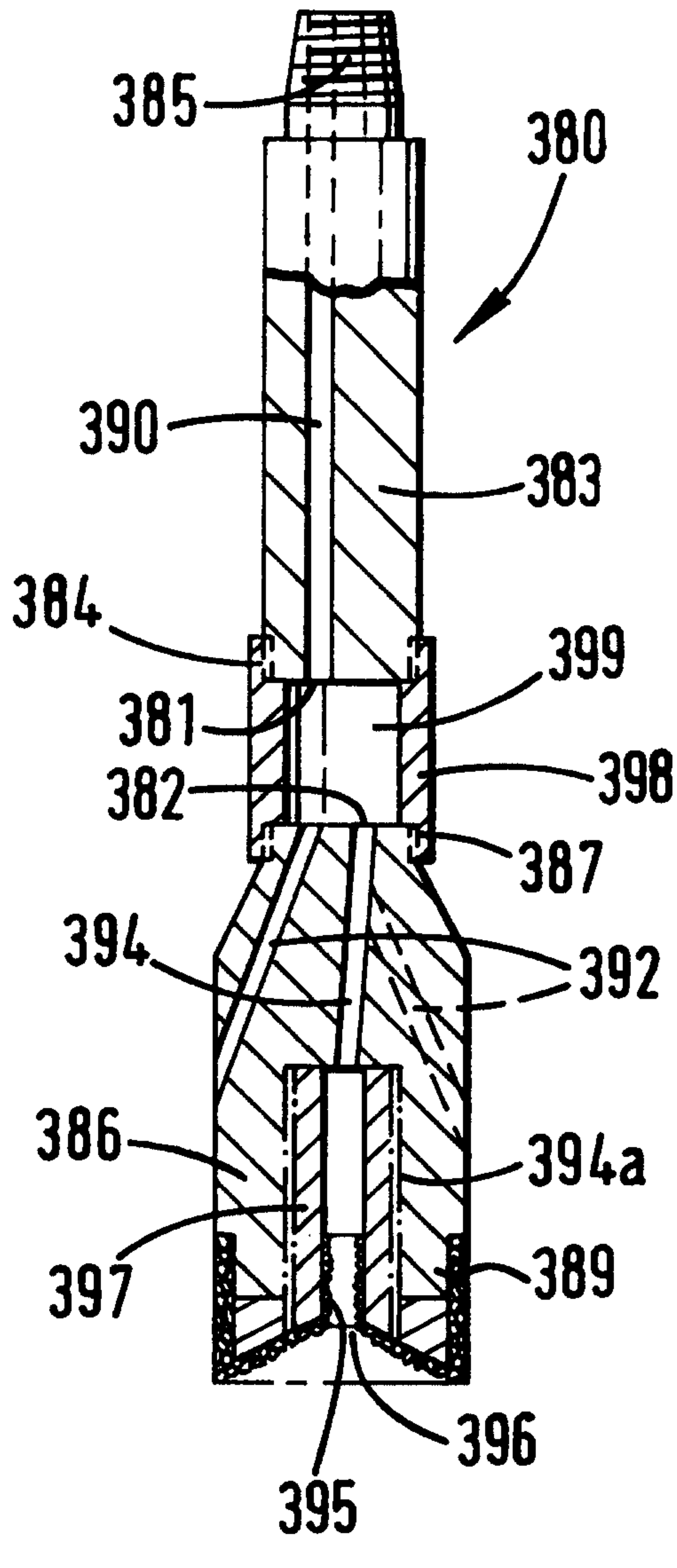

FIG. 12B

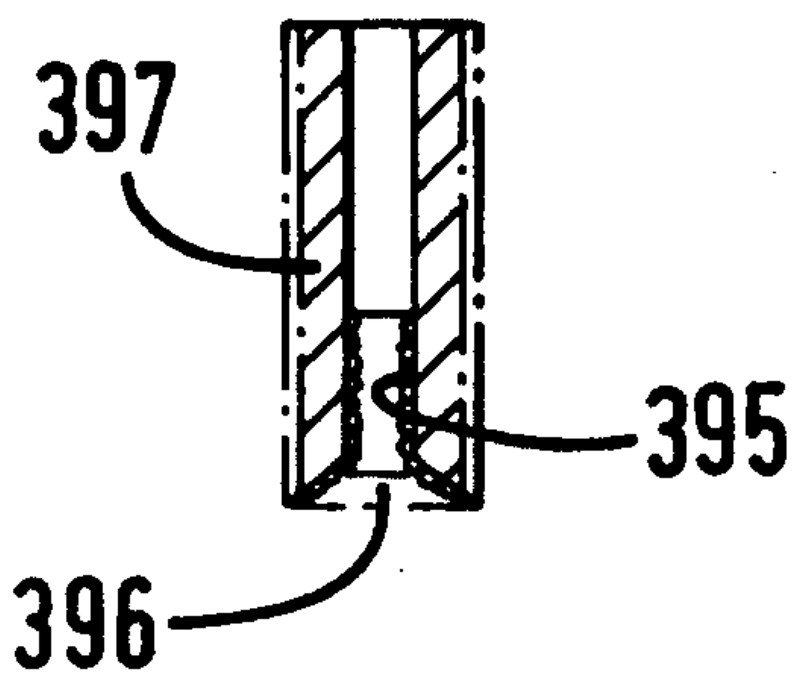

FIG. 12C