Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2550801 C 2010/07/20

(11)(21) 2 550 801

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 2006/06/22

(41) Mise à la disp. pub./Open to Public Insp.: 2007/12/22

(45) Date de délivrance/Issue Date: 2010/07/20

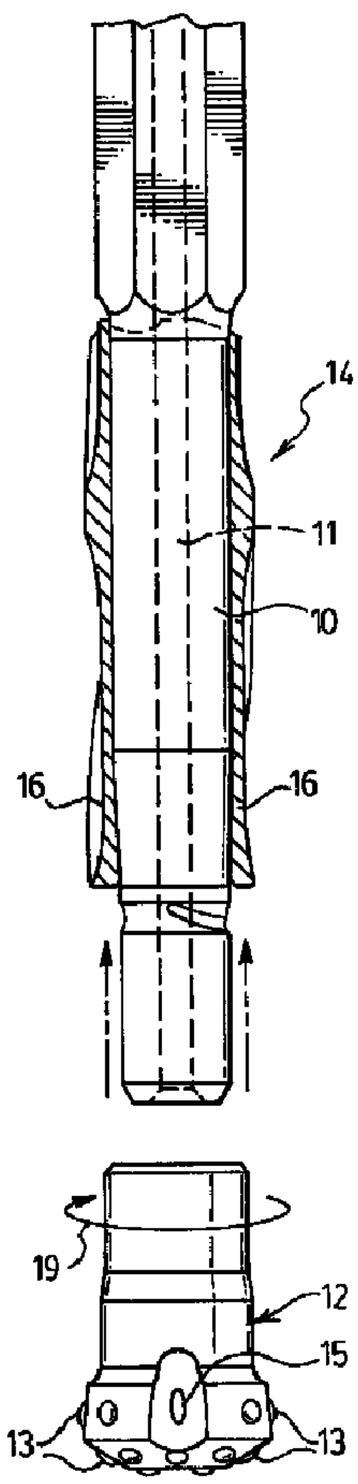
(51) Cl.Int./Int.Cl. *E21B 17/10* (2006.01), *E21B 1/00* (2006.01), *E21B 10/38* (2006.01)

(72) Inventeur/Inventor:
YAO, JING JAMES, CA

(73) Propriétaire/Owner:
BOART LONGYEAR INC., CA

(74) Agent: SMART & BIGGAR

(54) Titre : EQUIPEMENT DE FORAGE
(54) Title: DRILLING EQUIPMENT



(57) Abrégé/Abstract:
A percussion rock drill comprising a drill string having in combination a drill rod, a drilling bit threaded on the end of said drill rod, and at least one ridged reinforcing drill string guiding sleeve sleeved on and bonded to the drill rod with the first sleeve located

CA 2550801 C 2010/07/20

(11)(21) 2 550 801

(13) C

(57) Abrégé(suite)/Abstract(continued):
immediately next to the drilling bit. The sleeve has an outer cylindrical surface having a diameter substantially the same as but not larger than the diameter of a hole that the bit would cut under operation of the rock drill. The sleeve preferably has cuttings guiding passageways in its periphery which preferably are helically fluted.

ABSTRACT OF THE DISCLOSURE

A percussion rock drill comprising a drill string having in combination a drill rod, a drilling bit threaded on the end of said drill rod, and at least one ridged reinforcing drill string guiding sleeve sleeved on and bonded to the drill rod with the first sleeve located immediately next to the drilling bit. The sleeve has an outer cylindrical surface having a diameter substantially the same as but not larger than the diameter of a hole that the bit would cut under operation of the rock drill.

The sleeve preferably has cuttings guiding passageways in its periphery which preferably are helically fluted.

DRILLING EQUIPMENT

FIELD OF THE INVENTION

This invention relates to drilling equipment for the drilling of holes in rock by percussive techniques, where the drill bit is subjected to repeated axial impacts, whilst being rotated in the hole.

BACKGROUND OF THE INVENTION

One of problems with such drilling equipment is that, under the drilling pressure, the drill has a degree of wobble giving the drill a tendency to deflect on even bend and therefore wander off a straight line path as the drill advances into the rock. As a result, the drill may actually miss the anomaly.

One proposal that has met with some measure of success is disclosed in U.K. Patent Application GB 2212091 A, published July 19th, 1989.

This U.K. disclosure called for the use of a very large and strong bit that would not bend under the impact drilling action of percussion drilling. This large bit however resulted in the drilling of a significantly larger hole than that drilled by conventional drills. As a result, the wobble of the drill bit in the large hole tended to lead the drill to wander off line. To counterbalance this effect to some extent the drill bit was provided with flushing channels shown as helically fluted passages formed in its outer cylindrical periphery. The purpose of these flushing passages was to enable the cuttings to be more easily carried away from the bit's cutting face for delivery up the hole under the flushing action of water or other medium delivered through the bit to the drilling face.

While the use of this strong heavy bit with its flushing passages was found to reduce wandering of the drill, the cost of replacing the bit when its cutting buttons or blades became worn rendered its use very expensive.

SUMMARY OF THE INVENTION

This invention was developed to enable essentially straight line drilling to be economically achieved while still using conventional or standard bits and working with conventional drill rods.

According to the broad aspect of the invention, the economical essentially straight line drilling with a percussion drill is achieved using a conventional drill rod having a threaded end to receive a conventional drilling bit. Beyond the threaded end, the drill rod is specially machined and fitted with at least one rigid cylindrical reinforcing drill guiding sleeve which is permanently bonded to the drill rod. The at least one sleeve (or first sleeve if more than one reinforcing sleeve is used) is located immediately next to the threaded end of the drill **rod**. The outer diameter of this sleeve is substantially equal to but not greater than the diameter of the hole being drilled.

Accordingly, the present invention provides a percussion rock drill comprising: a drill string having in combination; a drill rod terminating in a threaded end and including a tapered section located proximate the threaded end, and the drill rod also including first and second constant diameter sections arranged so that the first constant diameter section is positioned between the tapered section and the second constant diameter section, the first constant diameter section having an outside diameter that is different than an outside diameter of the second constant diameter section; a drilling bit configured to engage the threaded end of said drill rod; and a reinforcing sleeve sleeved on and bonded to said drill rod, said reinforcing sleeve including a first tapered section within which the tapered section of the drill rod is positioned, the reinforcing sleeve also including second and third sections arranged so that the second section is positioned between the tapered section and the third section of the reinforcing sleeve, and the first constant diameter section of the drill rod being positioned in the second section of the reinforcing sleeve, and the

second constant diameter section of the drill rod being positioned in the third section of the reinforcing sleeve.

The present invention also provides a drill rod having a threaded end to receive a conventional drilling bit, said drill rod being machined to provide a tapered first section tapering down to said threaded end, a second machined section connected to the end of said first section remote from said threaded rod end, and a third machined section connected to said second machined section, said second and third drill rod machined sections having predetermined lengths and having uniform diameters throughout their lengths, and the first machined section having an outside diameter that is different than an outside diameter of the second machined section.

According to a preferred form of the invention, the reinforcing sleeve is provided with cuttings guide passages formed in its cylindrical periphery. Preferably these passages are helically fluted passages.

With applicant's arrangement when the cutting elements of the bit become worn, the drill rod is simply retracted and a new bit is provided to replace the worn one.

Because of the reinforcement provided to the end of the drill rod by the surrounding permanently affixed rigid sleeve, the drill rod end will not bend under the drilling action. As a result, any tendency for the drill rod to wander off line is precluded.

Moreover, since the machined end of the drill rod surrounded by the sleeve is maintained out of contact with the rock, there is no wear on the machined drill rod surfaces.

The interior of the reinforcing sleeve is also specially machined and is installed in such a manner as hereinafter more fully described to bond it to the drill rod. With this arrangement, the reinforcing sleeve or sleeves rotate as part of the

drill rod and are secured against any movement relative to the drill rod under the impacts of the percussion drilling.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will become apparent from the following detailed description taken in conjunction with the drawings in which

Figure 1 is a perspective view of a percussion drill as shown in the U.K. Patent Application GB 2212091 A in a rock hole drilling position;

Figure 2 is a vertical sectional view of a percussion rock drill according to the present invention in a rock hole drilling position with the end of the drill rod being reinforced with a single permanently secured reinforcing sleeve.

Figure 3 is a part vertical sectional part perspective view showing the drill bit ready to be threaded on to the drill rod (the details of the threads of the drill bit being conventional are not shown);

Figure 4 is a perspective view of the drill rod reinforcing sleeve secured to the end of the drill rod together with a vertical sectional view of the bit after it has been threaded on to the threaded end of the drill rod;

Figure 5 is a perspective view of a drill string corresponding to that shown in Figure 4 except that the cutting elements are shown as cutting blades rather than buttons;

Figure 6 is a perspective view of the reinforcing sleeve;

Figure 7 is an elevational view of the machined lower end of the drill rod of Figures 2 and 3 prior to the attachment of the reinforcing sleeve. The attached bit is shown only diagrammatically.

Figure 8 is an elevational view of the machined drill rod with the bit attached and showing in cross section the reinforcing sleeve which is bonded to the drill rod.

Figure 9 is a perspective view showing a drill string having two drill rod guiding sleeves permanently affixed or bonded to the drill rod. Again both of these sleeves have fluted cuttings passages. The use of the two sleeves provides for increased drill string guidance under the percussion drilling action.

DETAILED DESCRIPTION ACCORDING TO THE PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

Referring first to Figure 1, this Figure illustrates a percussion drill string according to the disclosure in the British Application GB 2212091 A. This prior art drill string consists of a bit 1, an extension body 2, a first drill rod 3, a drill rod connector 4 and a second drill rod 5. The bit 1 is very large and strong compared to the conventional bits that thread on to the threaded end of the conventional drill rods. Bit 1 has a cylindrical outer surface 6 into which are cut cuttings flow passages 7 shown as helically fluted passages. This large bit 1 under the rotating and reciprocating impacts forces of percussion drilling cuts a large hole leading to a wobble of the drill string causing it a degree of deviation from the desired straight line drilling.

Once the cutting elements of the bit, either cutting buttons or blades, are worn, then this large heave bit 1 has to be replaced. The cost of the bit per se is such as to render the cost of drilling using this bit very expensive.

To this cost is the added cost of the extension body 2 which is similarly provided with helically fluted guide passages 8. Similarly, the drill rod connector 4 with its helically fluted passages 9 adds further to the cost.

Figure 2 illustrates a drill string DS in accordance with the present invention. This drill string DS utilizes a conventional drill rod 10 having a

threaded end 21 (again the details of the threads at end of the drill rod being conventional are not shown).

As conventional, drill rod 10 has a central passage 11 for the delivery of a flushing medium therethrough.

The end of the drill rod 10 immediately next to the threaded end 21 is specially machined in accordance with the invention.

More particularly, the end of the drill rod immediately next to the threaded end 21 is machined to provide a tapered reducing diameter section 10.1. Next to this section 10.1 is a section 10.2 having a constant diameter and a predetermined length followed by a section 10.3 having a predetermined length and a constant diameter slightly greater than section 10.2

Sleeved on the end of the drill rod 10 immediately adjacent the threaded end 21 is a rigid specially machined reinforcing sleeve 14 having a cylindrical outer periphery of substantially the same but not greater than the diameter of the hole being cut under the percussion drilling action of the drill string DS.

More particularly, as best seen in Figure 8, the interior of the sleeve 14 is machined to provide a first section 14.1 having a reducing diameter to match and fit over section 10.1 of the drill rod. With this arrangement, sleeve 14 is prevented from moving along the drill rod away from the threaded end 21, and provides a means to accurately locate the sleeve on the drill rod.

The second machined section 14.2 of the sleeve 14 has a constant inner diameter larger than the diameter of section 14.1 and substantially equal to the diameter of drill rod section 10.2. Section 14.2 is followed by a machined section 14.3 which has a diameter slightly smaller than section 14.2 and also slightly smaller than the diameter of drill rod section 10.3.

The length of the machined sleeve sections 14.1, 14.2 and 14.3 is the same as the length of the drill rod machined section 10.1, 10.2, and 10.3

To install sleeve 14 it is first heated to a temperature of several hundred degrees causing it to expand. It is then hammered or driven on to the drill rod 10 until sleeve section 14.3 registers with drill rod section 10.3 at which point sleeve section 14.2 registers with drill rod section 10.2 and sleeve section 14.1 registers with drill rod section 10.1. On cooling sleeve 14 shrinks and becomes permanently affixed or bonded to the drill rod against any movement whatsoever thereon.

The drill bit 12, as is usual, is provided with flushing passages 15 in communication with the drill rod passage 11 and arranged to deliver flushing medium to the cutting face of the bit 12.

The outer cylindrical periphery of the sleeve 14 is provided with cuttings passageways 16 formed therein to assist in the flow of the cuttings of the hole being drilled to deliver same out against the wall 17 of the hole 18.

Preferably, as shown in Figures 4, 5 and 6, these flushing passages 15 are helically fluted passages.

Figure 3, by the arrow 19, shows the rotation of the drill string to be counterclockwise whereas the fluted passages 16 are of opposite hand to deliver the cuttings out against the wall of the hole 18.

Figure 5 illustrates a drill string corresponding to that shown in Figures 2, 3 and 4 with the exception that the cutting elements are shown as blades 20 rather than buttons 13.

It will be appreciated that the reinforcing sleeve 14 braces the end of the drill rod against bending and wandering off line under any wobble effect on the drilling bit 12 under the percussion drilling action allowing the drilling to proceed on essentially straight line drilling.

Sleeve 14, of course, isolates the machined end of the drill bit from contact with the wall of the hole precluding any wear thereof by the rock being cut.

In turn, should the outer periphery of the sleeve 14 whose diameter is substantially equal to but not greater than the diameter of the hole being cut contact the wall of the hole causing any slight wear, this wear would simply result in slightly reducing the depth of the fluted sleeve passages 16.

When the cutting elements 13 or 20 of the drill bit 12 become worn, the drill string is simply retracted and a fresh sharp bit 12 or bit 20 is threaded on to the end of the drill rod 10.

With applicant's arrangement, it has been found that the bond between sleeve 14 and the drill rod 10 is such that it will withstand several tonnes of pull back force without being dislodged.

Figure 7 shows the drill rod 10 machined to have a single reinforcing sleeve applied and bonded thereto as explained above.

Figure 8 shows the drill rod 10 of Figure 7 having the single reinforcing sleeve 14 affixed or bonded thereto. Sleeve 14 is shown in section to clearly illustrate the interior machining to provide the machined sections 14.1, 14.2 and 14.3. Also the grooving of the outer cylindrical periphery to provide the cuttings passageways 16 is illustrated.

As discussed above, this single sleeve 14 in its cold state could not be sleeved on to the drill rod. However, as explained above, with the sleeve heated sufficiently to cause it to expand, it can then be fed on to the machined end of the drill rod under sufficient force such as that delivered by a hammer until sleeve sections 14.3, 14.2 and 14.1 exactly register with machine drill rod sections 10.3, 10.2 and 10.1. On cooling, the sleeve will shrink to grip, bond with and become permanently attached to the drill rod. In other words, the sleeve becomes part of the drill rod to withstand with absolutely no displacement the rotational and impact forces of percussion drilling.

Figure 9 is a perspective view of a drill string according to the invention wherein the drill rod is provided with two reinforcing sleeves 14 each permanently affixed or bonded to the drill rod utilizing the invention. The provision of the second sleeve adds further guidance of the drill string under the percussion drilling action. It will be understood that one or more further such reinforcing sleeves may be used to even further increase drill string guidance.

It will be appreciated that various modifications to the drill string may be made without departing from the scope of the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A percussion rock drill comprising:

a drill string having in combination;

a drill rod terminating in a threaded end and including a tapered section located proximate the threaded end, and the drill rod also including first and second constant diameter sections arranged so that the first constant diameter section is positioned between the tapered section and the second constant diameter section, the first constant diameter section having an outside diameter that is different than an outside diameter of the second constant diameter section;

a drilling bit configured to engage the threaded end of said drill rod; and

a reinforcing sleeve sleeved on and bonded to said drill rod, said reinforcing sleeve including a first tapered section within which the tapered section of the drill rod is positioned, the reinforcing sleeve also including second and third sections arranged so that the second section is positioned between the tapered section and the third section of the reinforcing sleeve, and the first constant diameter section of the drill rod being positioned in the second section of the reinforcing sleeve, and the second constant diameter section of the drill rod being positioned in the third section of the reinforcing sleeve.

2. A percussion rock drill as claimed in Claim 1 having at least one additional reinforcing drill string guiding sleeve sleeved on and bonded to said drill rod.

3. A rock drill as claimed in Claim 1 or 2 in which the outer peripheral surface of said sleeve has cuttings guide passages formed therein.

4. A rock drill as claimed in Claim 1, 2 or 3 in which said bit has cutting elements comprising cutting buttons.

5. A rock drill as claimed in Claim 1, 2 or 3 in which said bit has cutting elements comprising cutting teeth or blades.

6. A percussion drill as claimed in Claim 2 in which said cuttings guide passages are helically fluted.

7. The percussion rock drill as recited in any one of claims 1 to 6, wherein the outside diameter of the first constant diameter section of the drill rod is less than the outside diameter of the second constant diameter section of the drill rod.

8. The percussion rock drill as recited in any one of claims 1 to 6, wherein the second section of the reinforcing sleeve has an inside diameter that is larger than a maximum inside diameter of the first tapered section of the reinforcing sleeve.

9. The percussion rock drill as recited in any one of claims 1 to 6, wherein the second section of the reinforcing sleeve has a substantially constant inside diameter.

10. The percussion rock drill as recited in any one of claims 1 to 6, wherein the second section of the reinforcing sleeve has an inside diameter that is substantially equal to the outside diameter of the first constant diameter section of the drill rod.

11. The percussion rock drill as recited in any one of claims 1 to 6, wherein the third section of the reinforcing sleeve has an inside diameter that is less than an inside diameter of the second section of the reinforcing sleeve.

12. The percussion rock drill as recited in any one of claims 1 to 6, wherein the third section of the reinforcing sleeve has an inside diameter that is less than the outside diameter of the second constant diameter section of the drill rod.

13. The percussion rock drill as recited in any one of claims 1 to 12, wherein the drill rod defines a central passage arranged for fluid communication with a flushing passage defined by the drill bit.

14. A drill rod having a threaded end to receive a conventional drilling bit, said drill rod being machined to provide a tapered first section tapering down to said threaded end, a second machined section connected to the end of said first section remote from said threaded rod end, and a third machined section connected to said second machined section, said second and third drill rod machined sections having predetermined lengths and having uniform diameters throughout their lengths, and the first machined section having an outside diameter that is different than an outside diameter of the second machined section.

15. A drill rod as claimed in Claim 14 having a cylindrical rigid reinforcing sleeve overlying and bonded to said machine drill rod sections.

16. A drill rod as claimed in Claim 15 in which said sleeve has cuttings flow passageways formed in its outer peripheral surface.

17. A drill rod as claimed in Claim 16 in which said cuttings passageways are helically fluted.

18. The drill rod as recited in any one of claims 14 to 17, wherein the drill rod defines a central passage.

FIG.1.
(PRIOR ART)

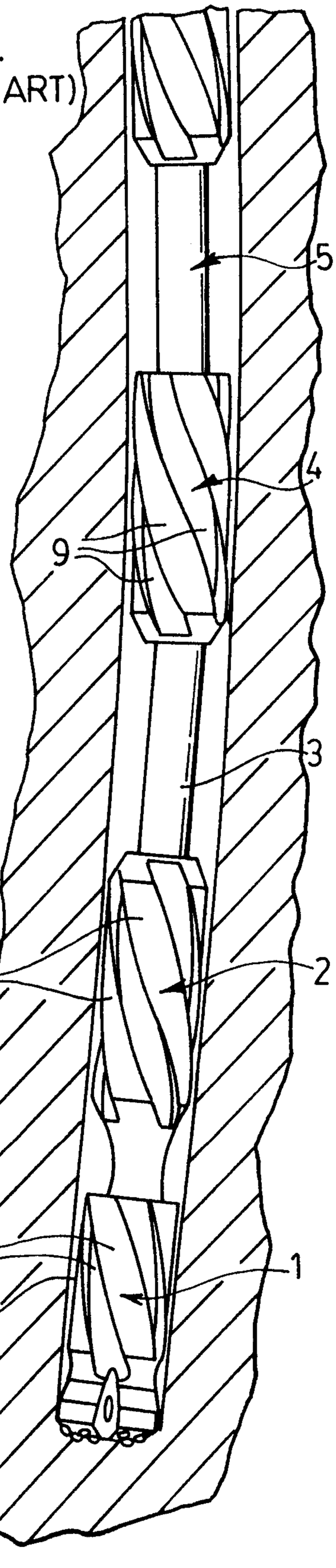


FIG.2.

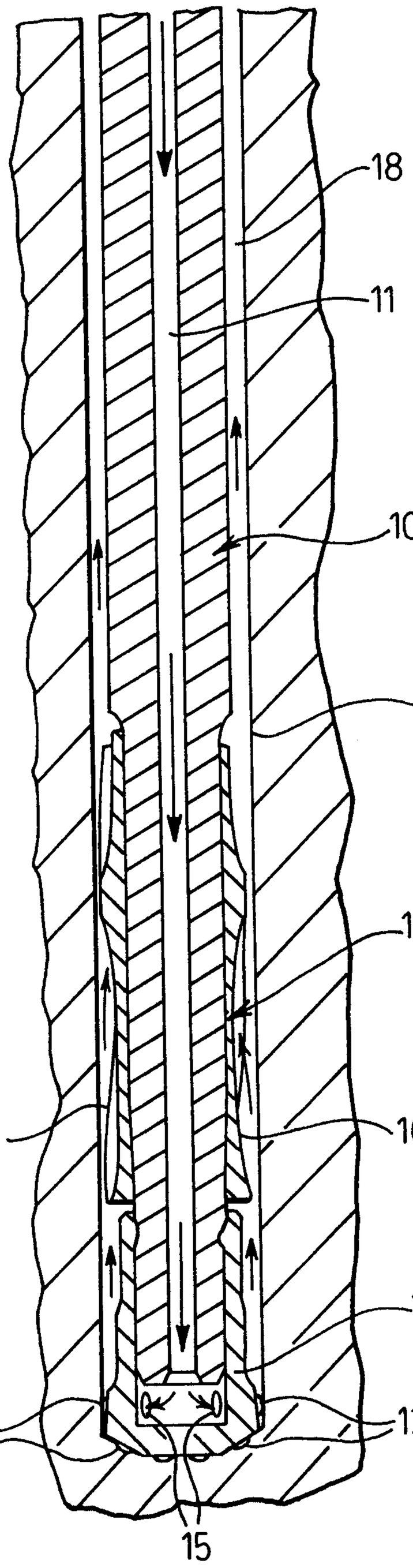


FIG.3.

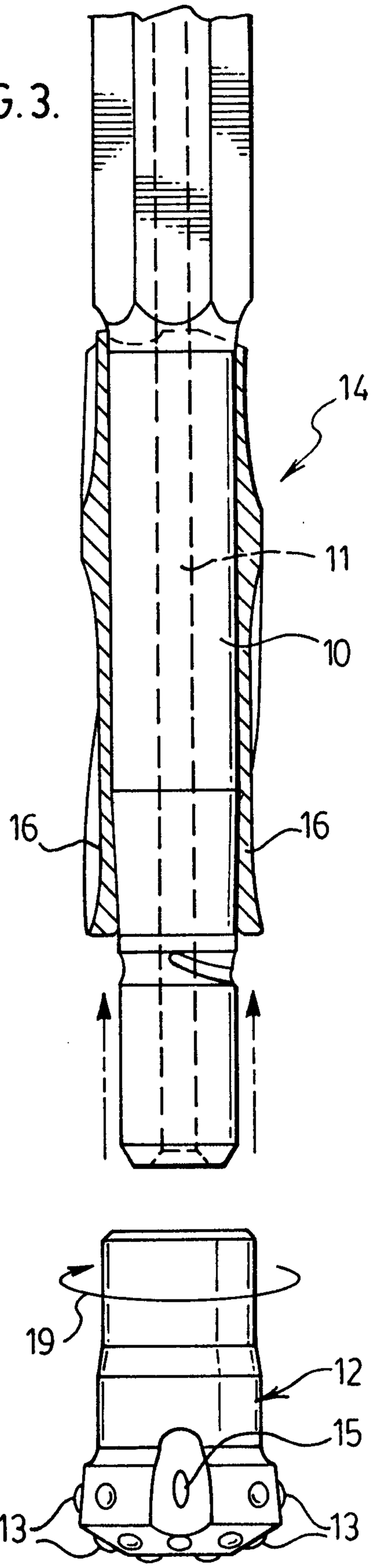
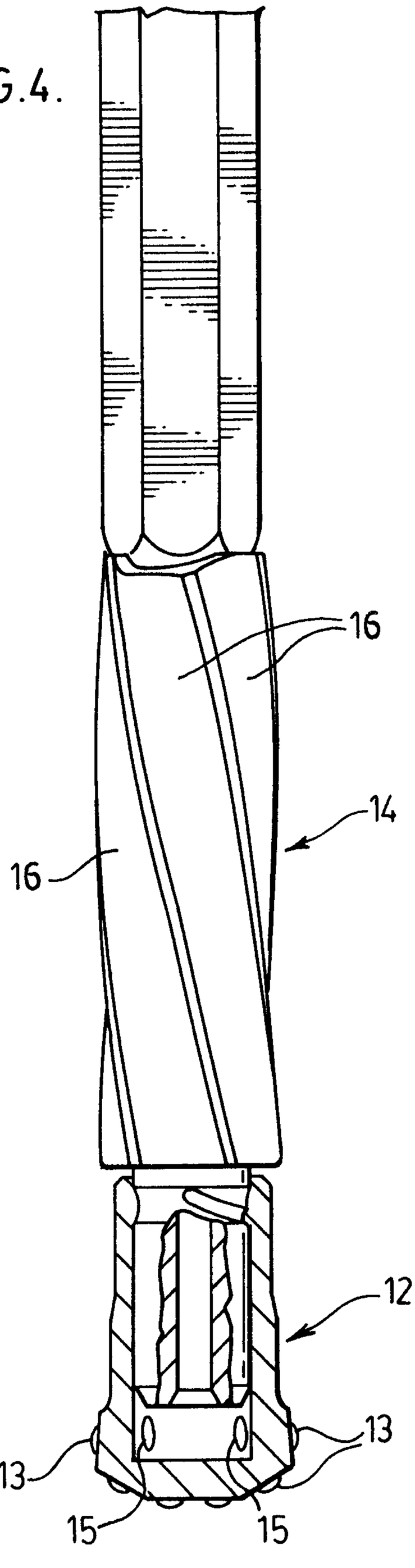


FIG.4.



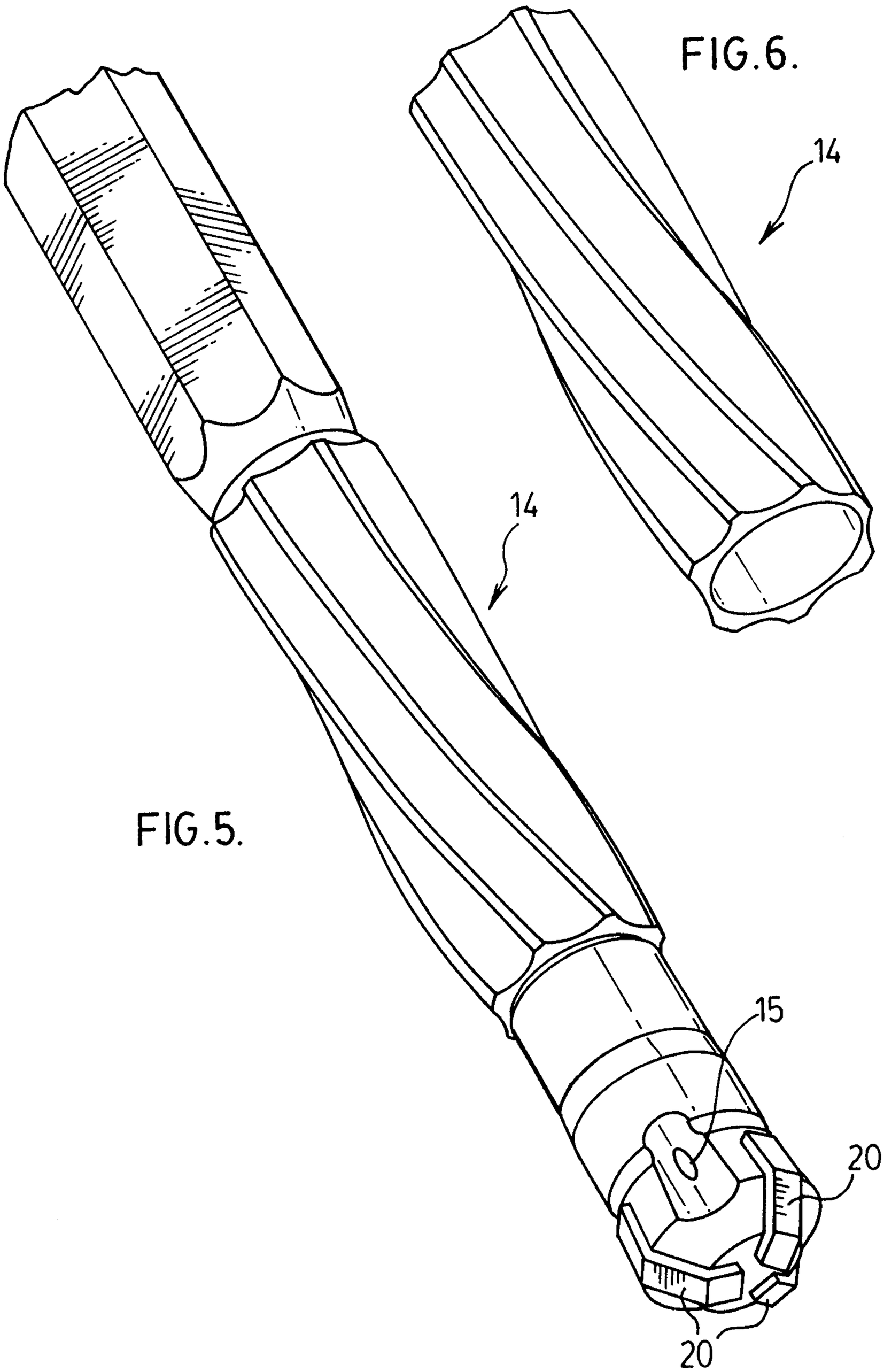


FIG.5.

FIG.6.

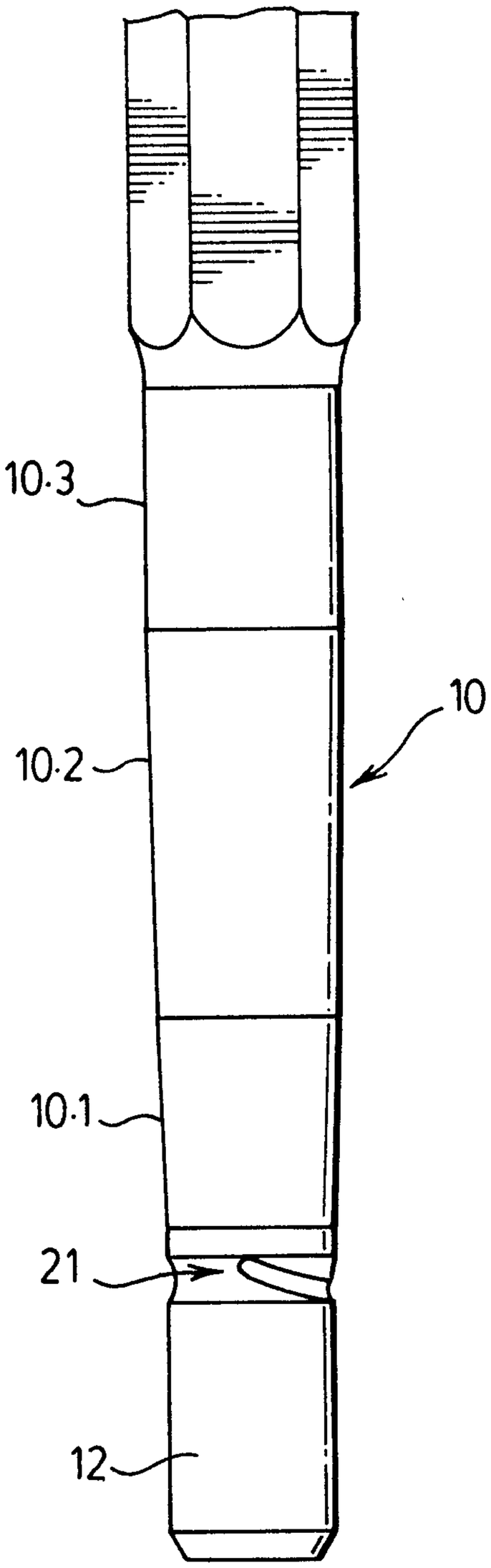


FIG.7.

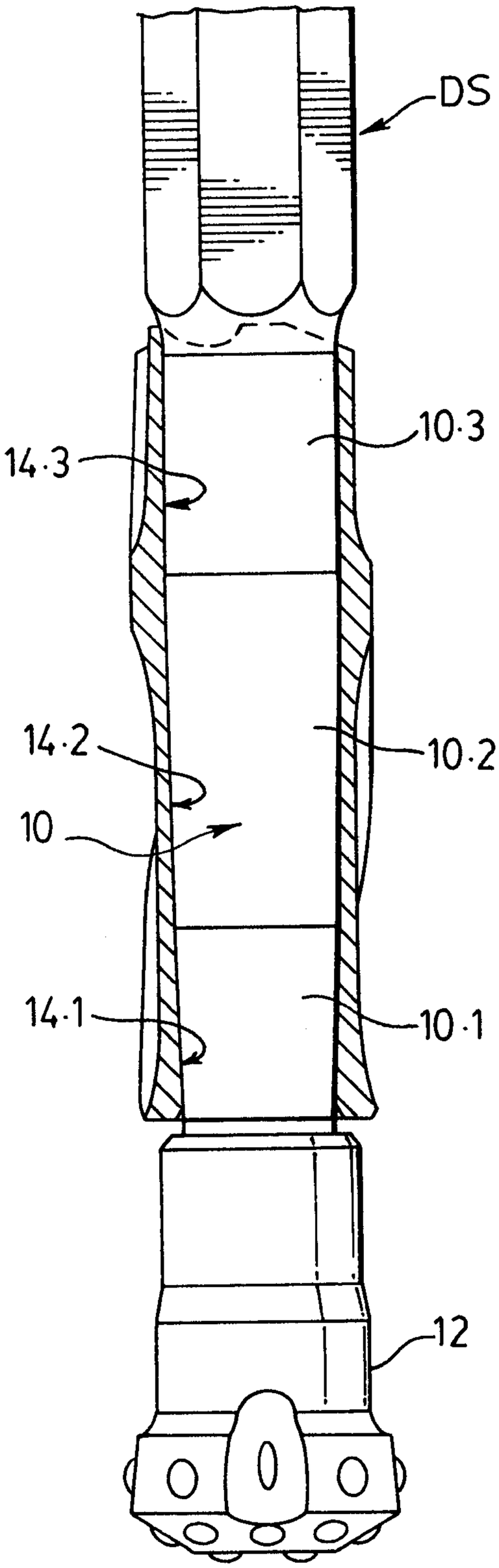


FIG.8.

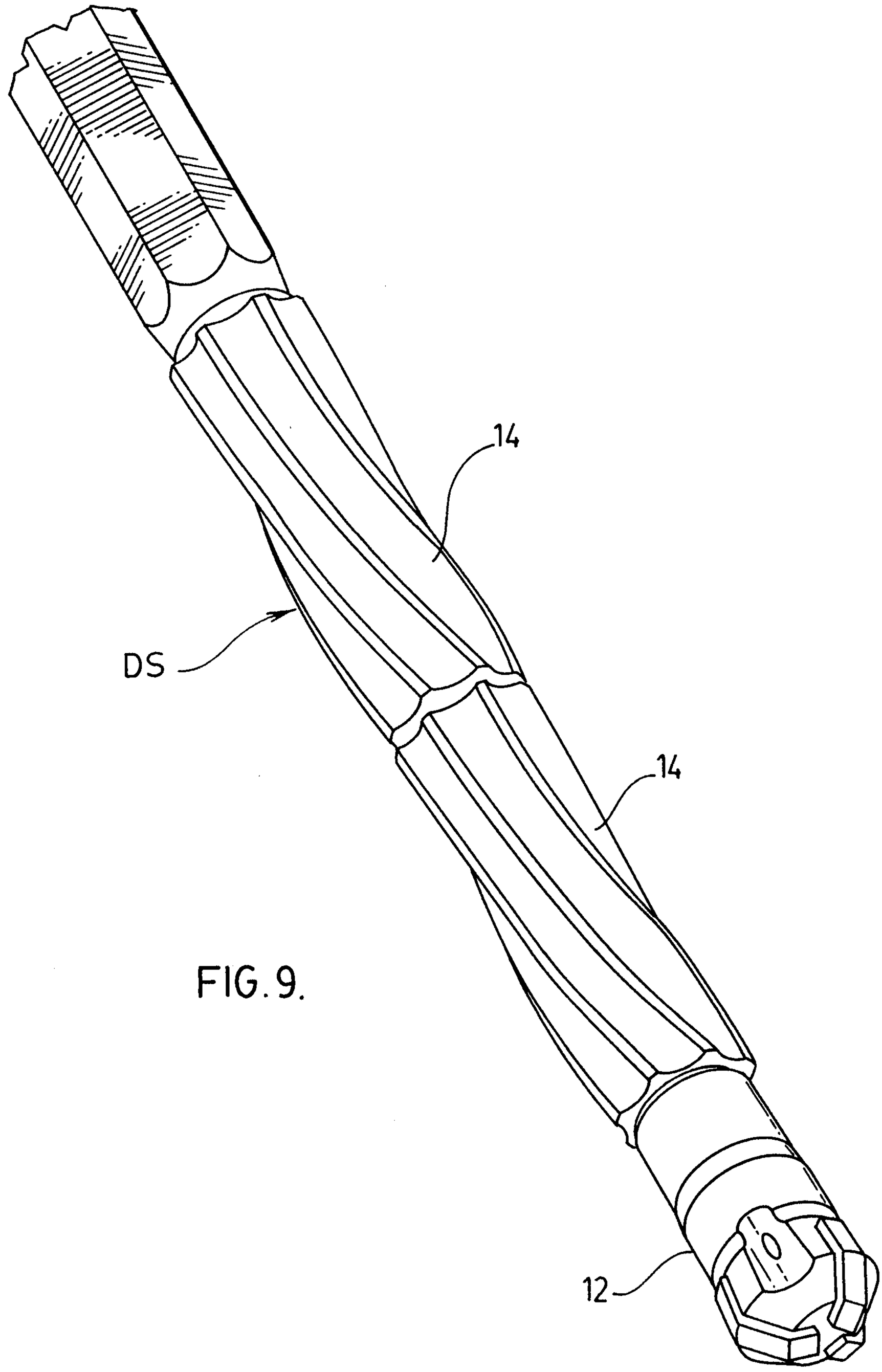
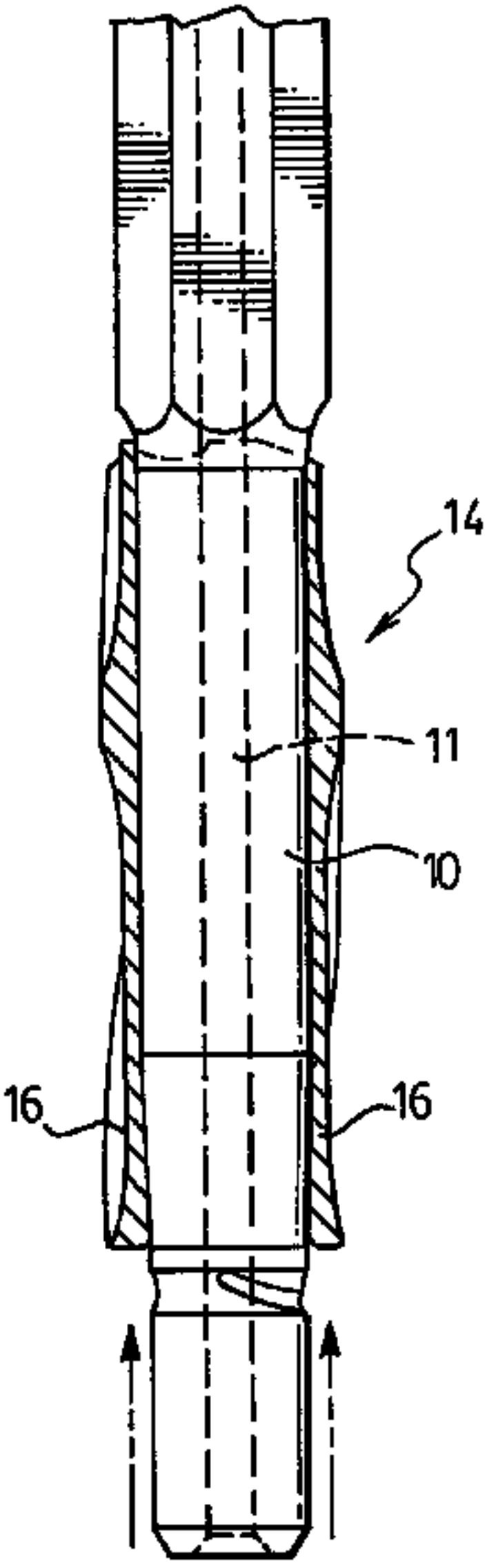
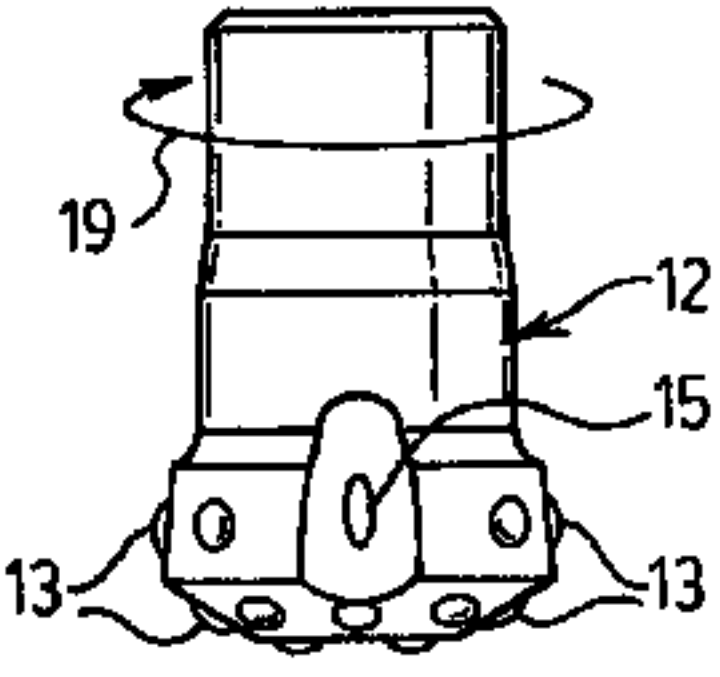


FIG. 9.


14
11
10
16
16


19
12
15
13
13