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Gillespie et al.

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(54) **BONE GRAFT HARVESTER**

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Related U.S. Application Data

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(51) **Int. Cl.**[7] **A61B 10/00**
(52) **U.S. Cl.** **600/567**; 606/80
(58) **Field of Search** 600/562, 561, 600/567, 570; 606/79, 80, 81, 82, 83, 84, 85, 86, 179, 167, 169, 170, 171, 176, 177, 178, 180; 604/164.01–164.09; 433/165; 408/199; D15/138–139; D8/59

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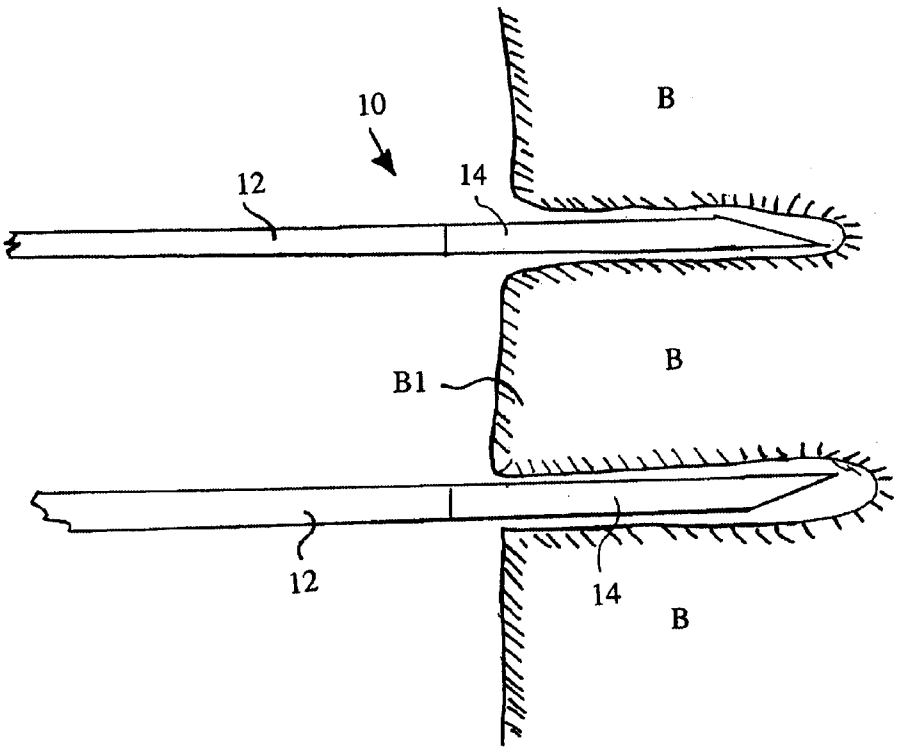
(57) **ABSTRACT**

A bone graft harvesting drill, comprising: a flexible tubular member and a hollow cylindrical drill bit mounted to a distal end of the flexible tubular member.

14 Claims, 20 Drawing Sheets



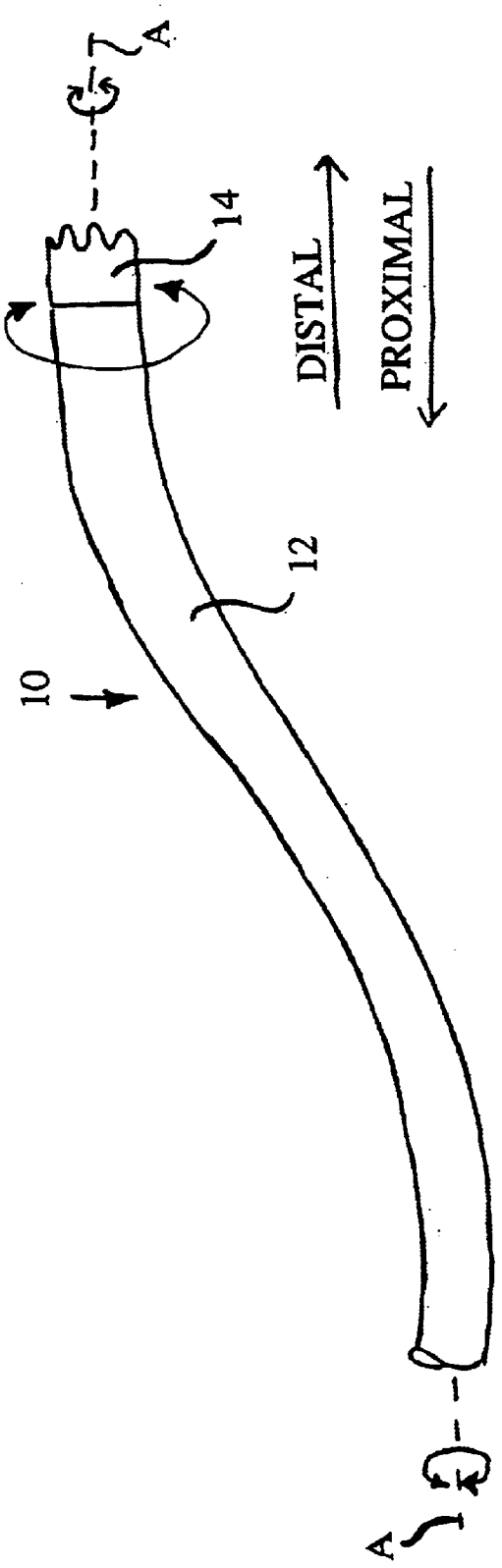


FIG. 1

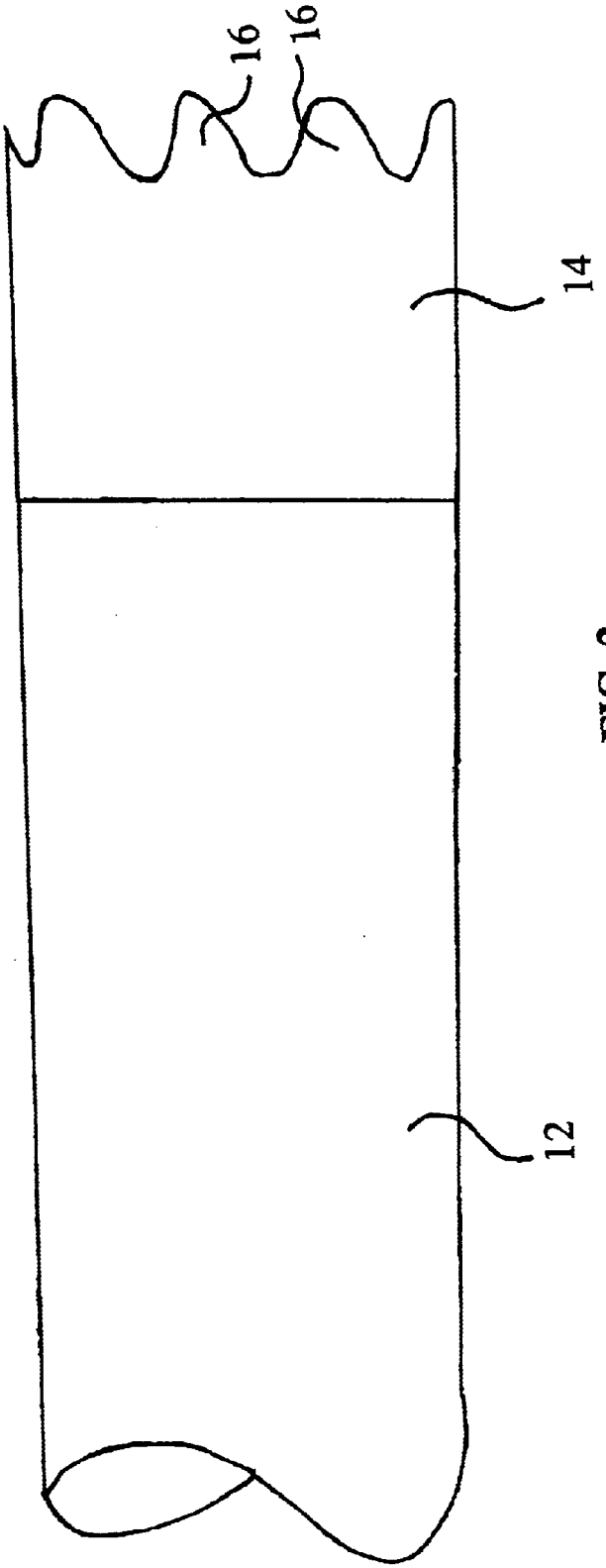


FIG. 2

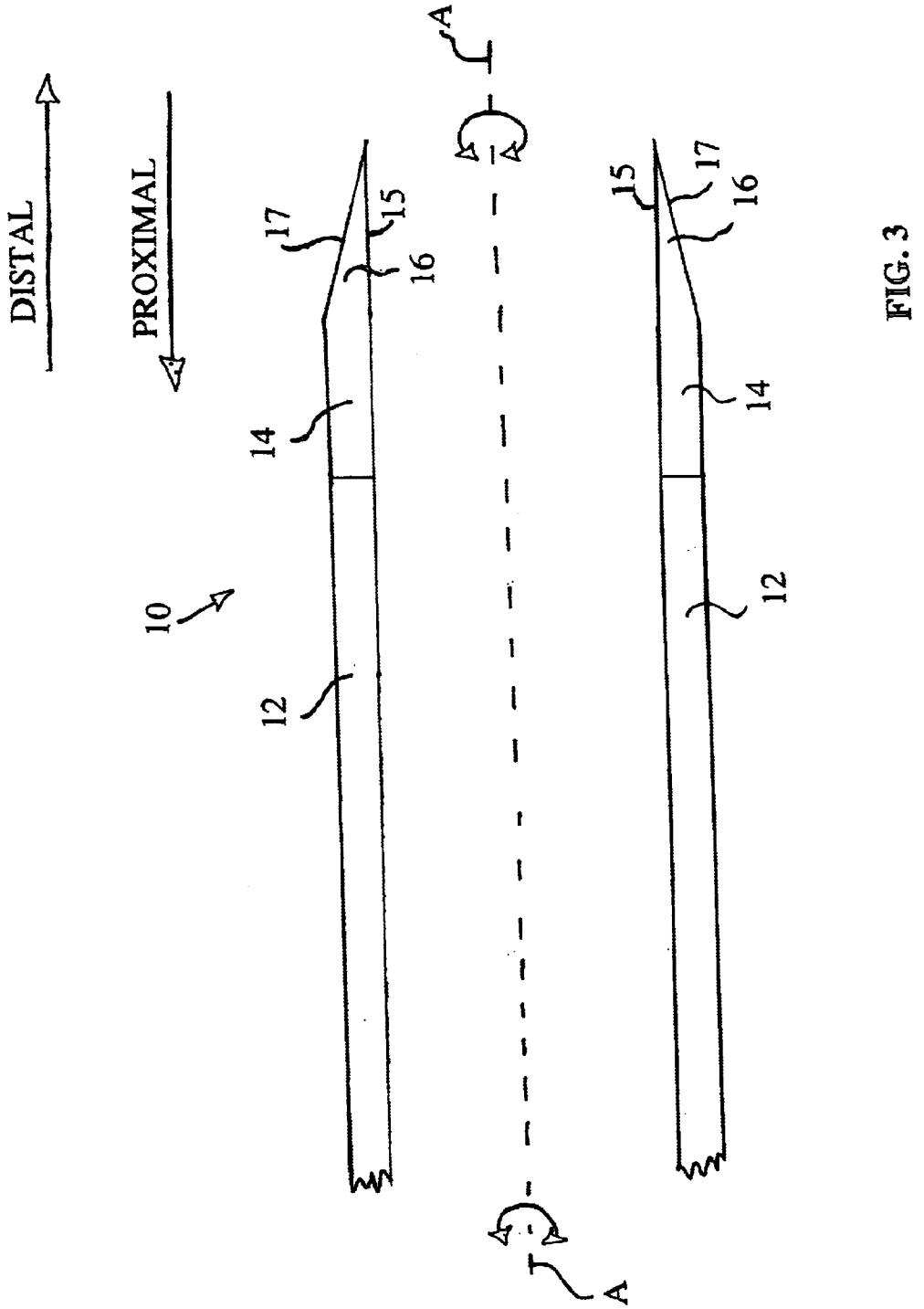


FIG. 3

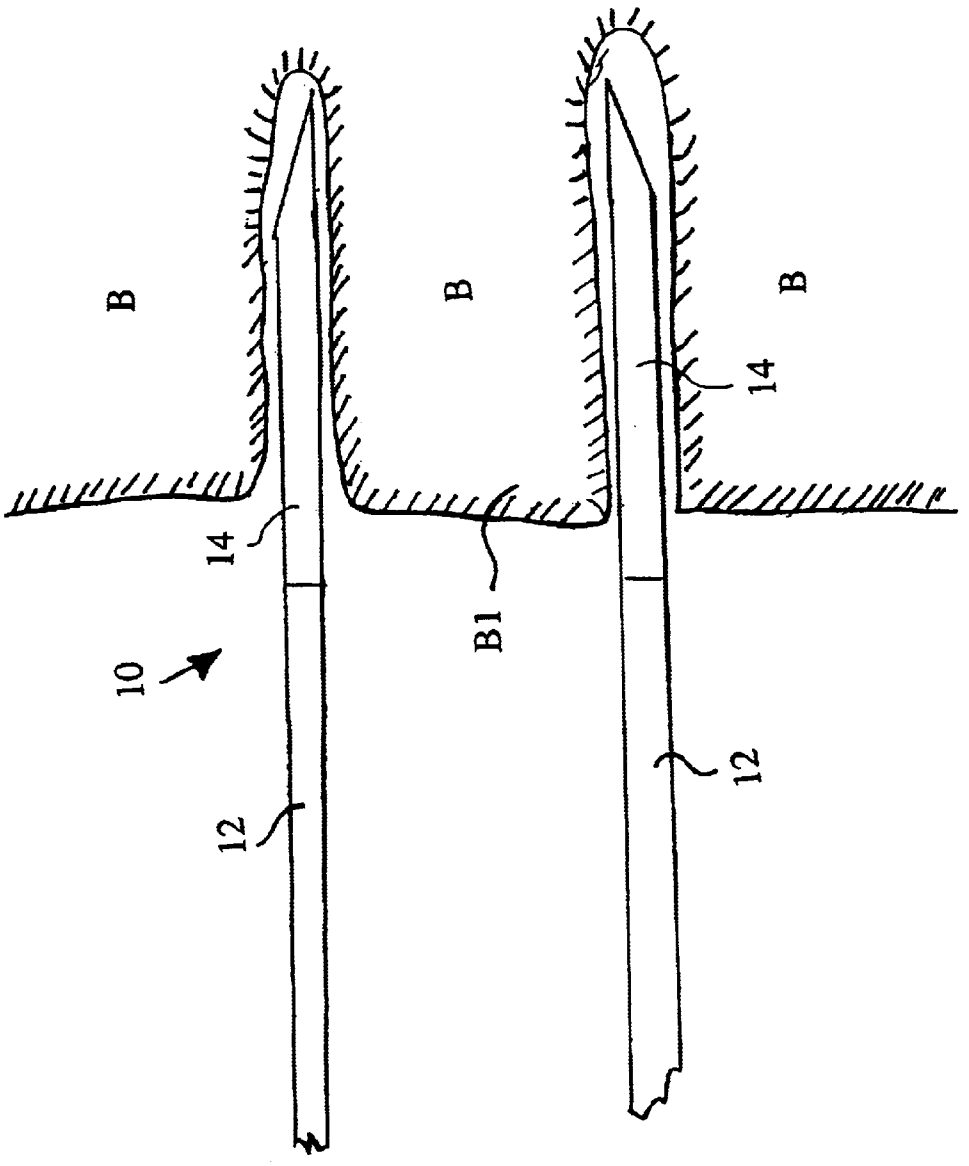


FIG. 4

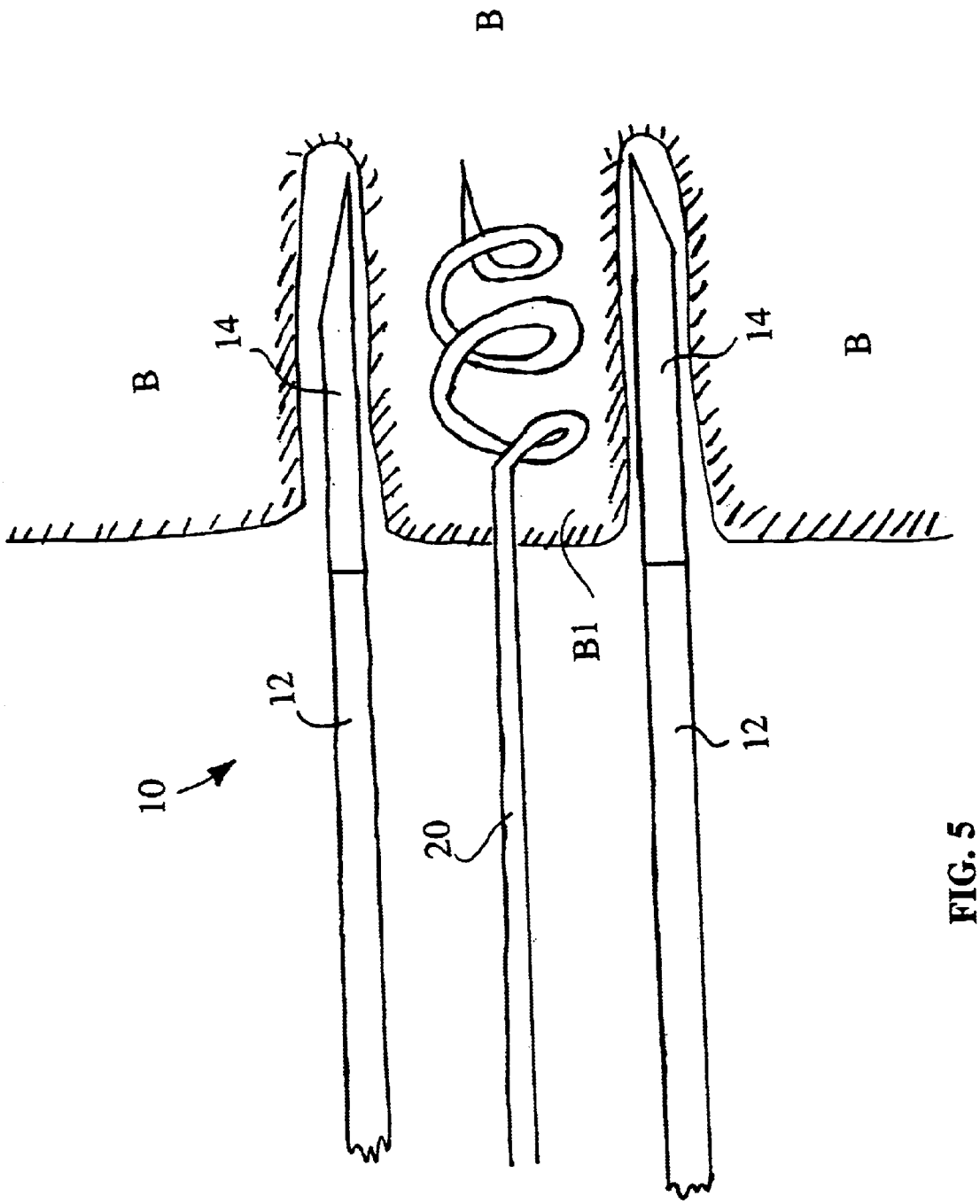


FIG. 5

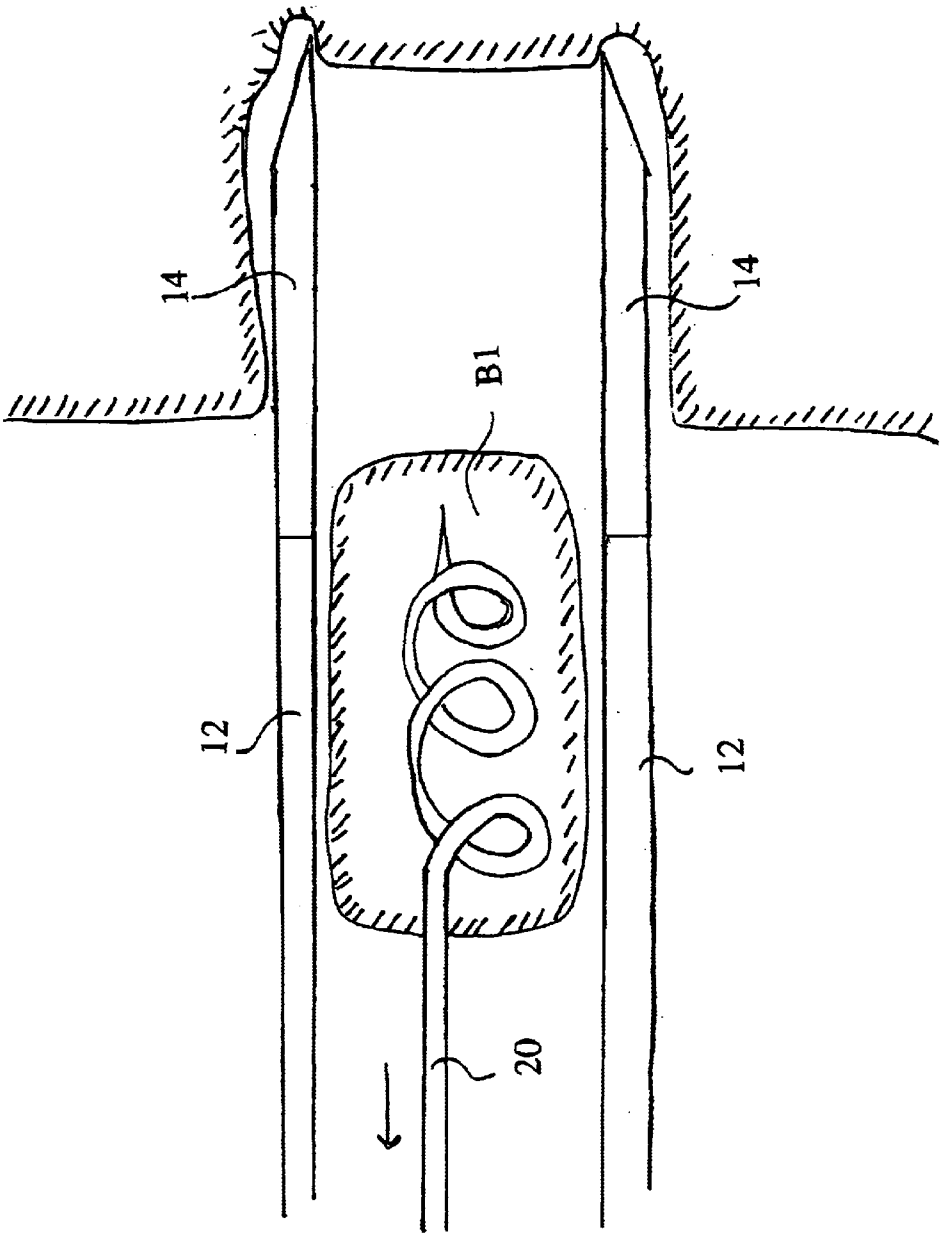


FIG. 6

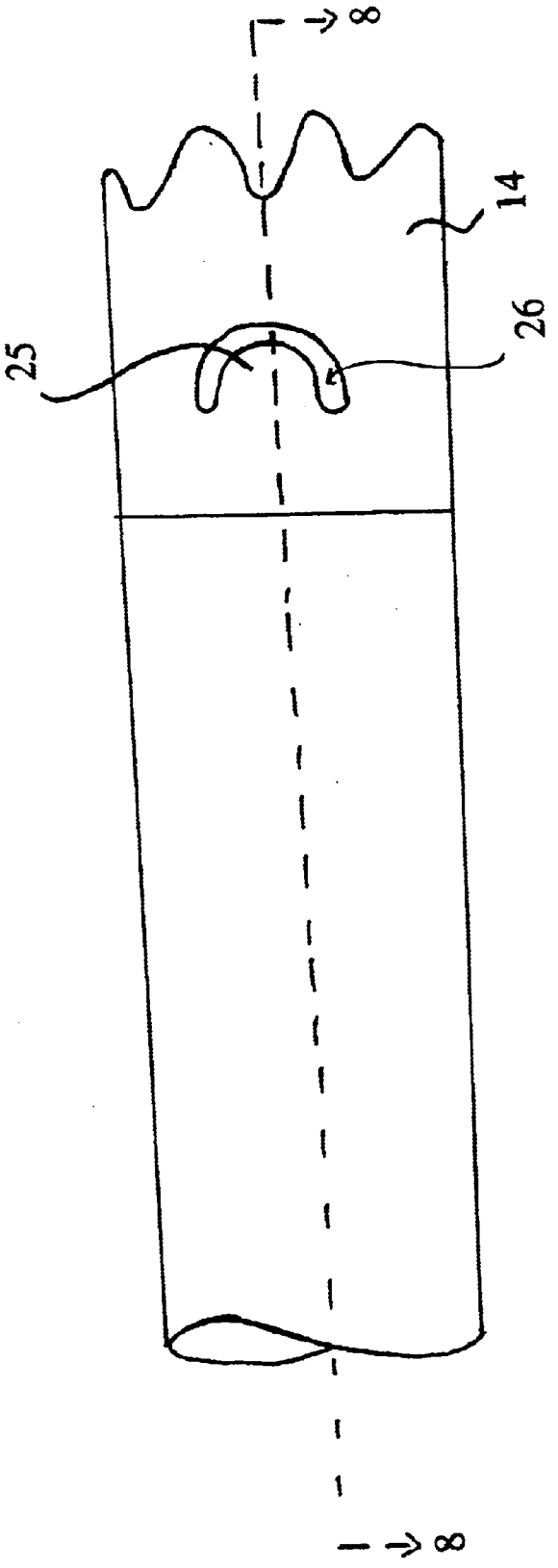


FIG. 7

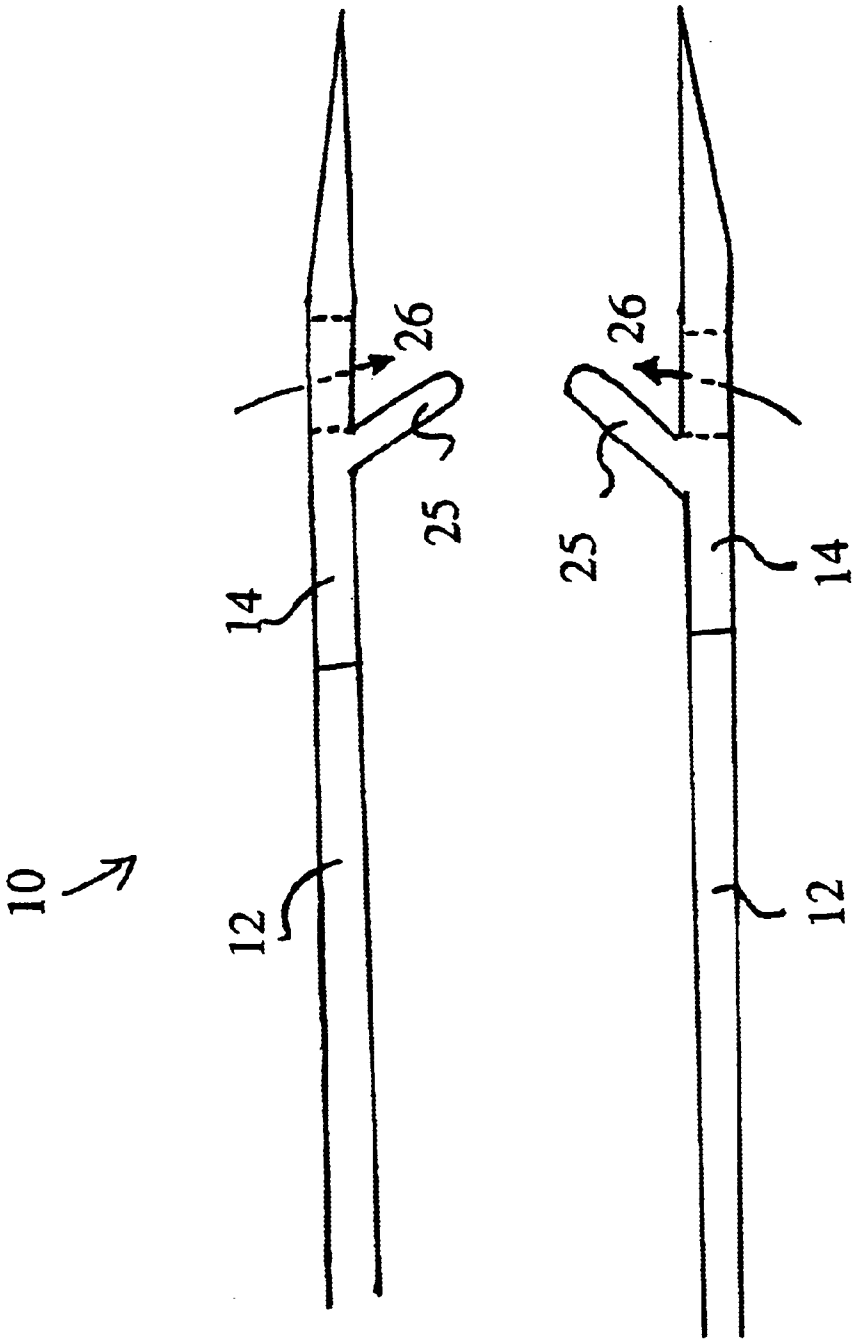


FIG. 8

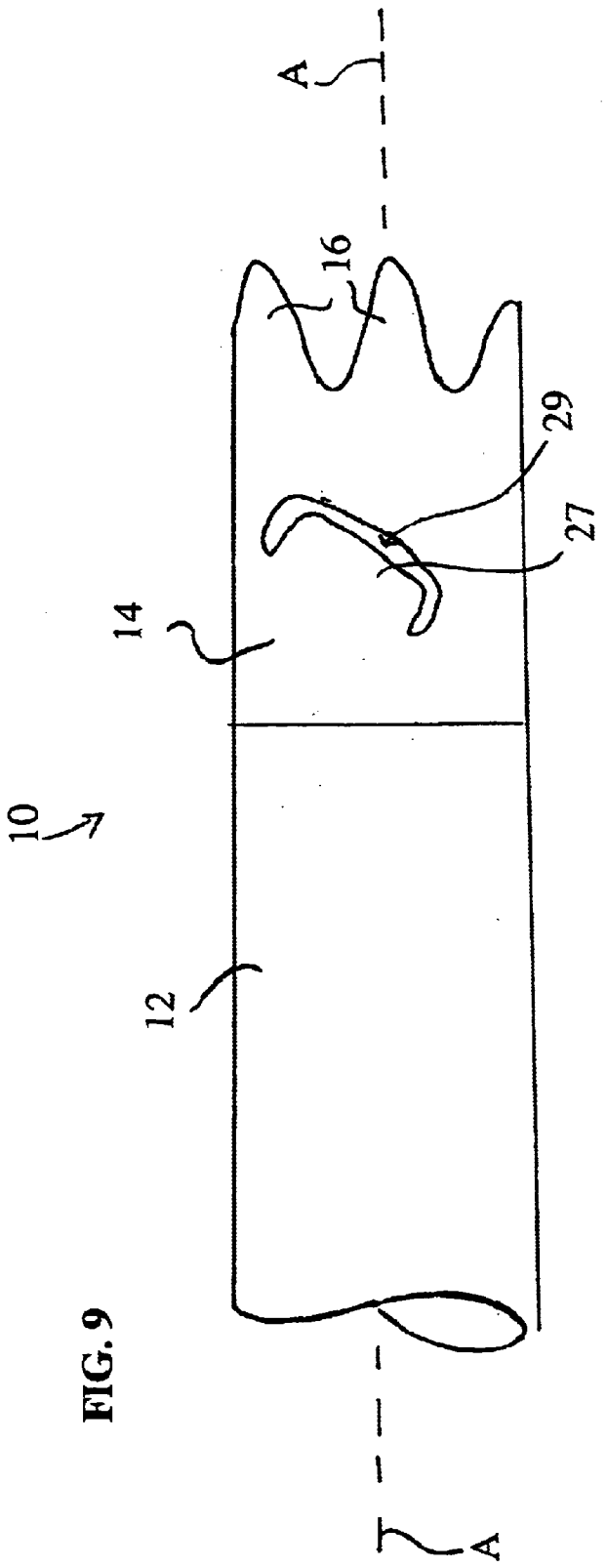
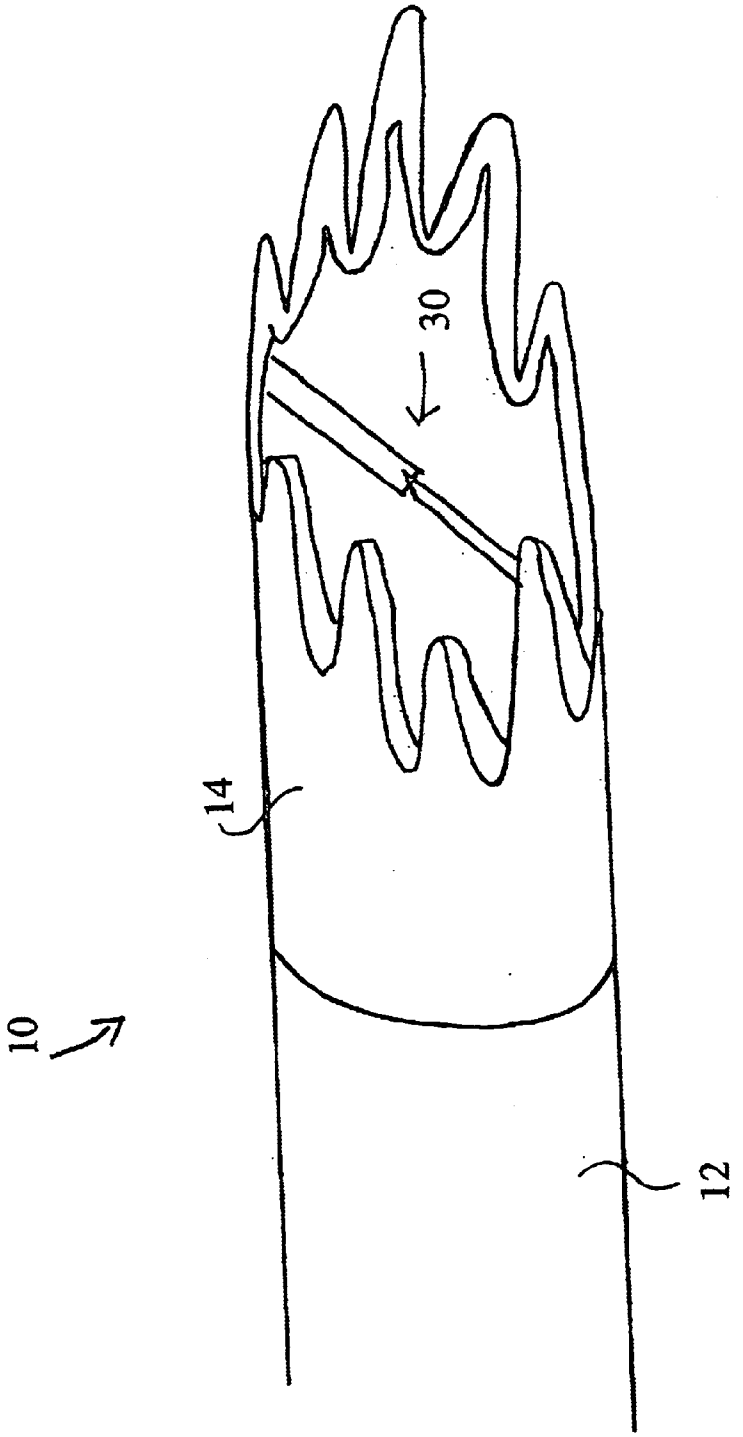


FIG. 9

FIG. 10



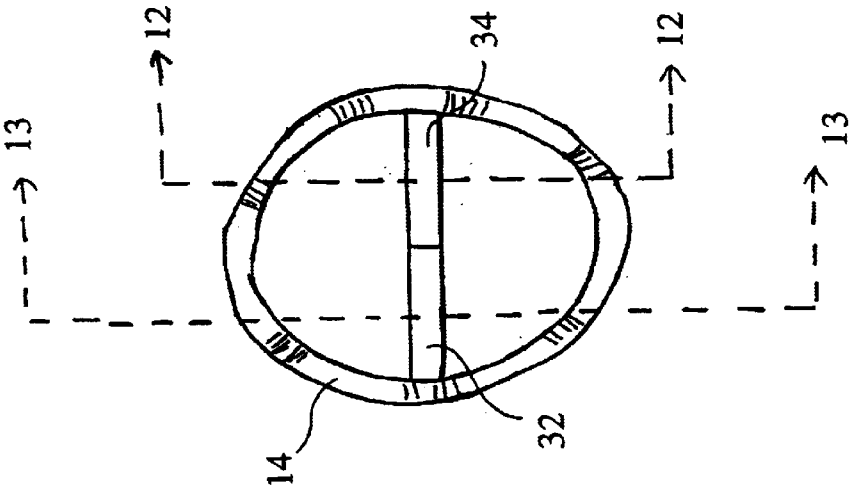


FIG. 11

FIG. 12

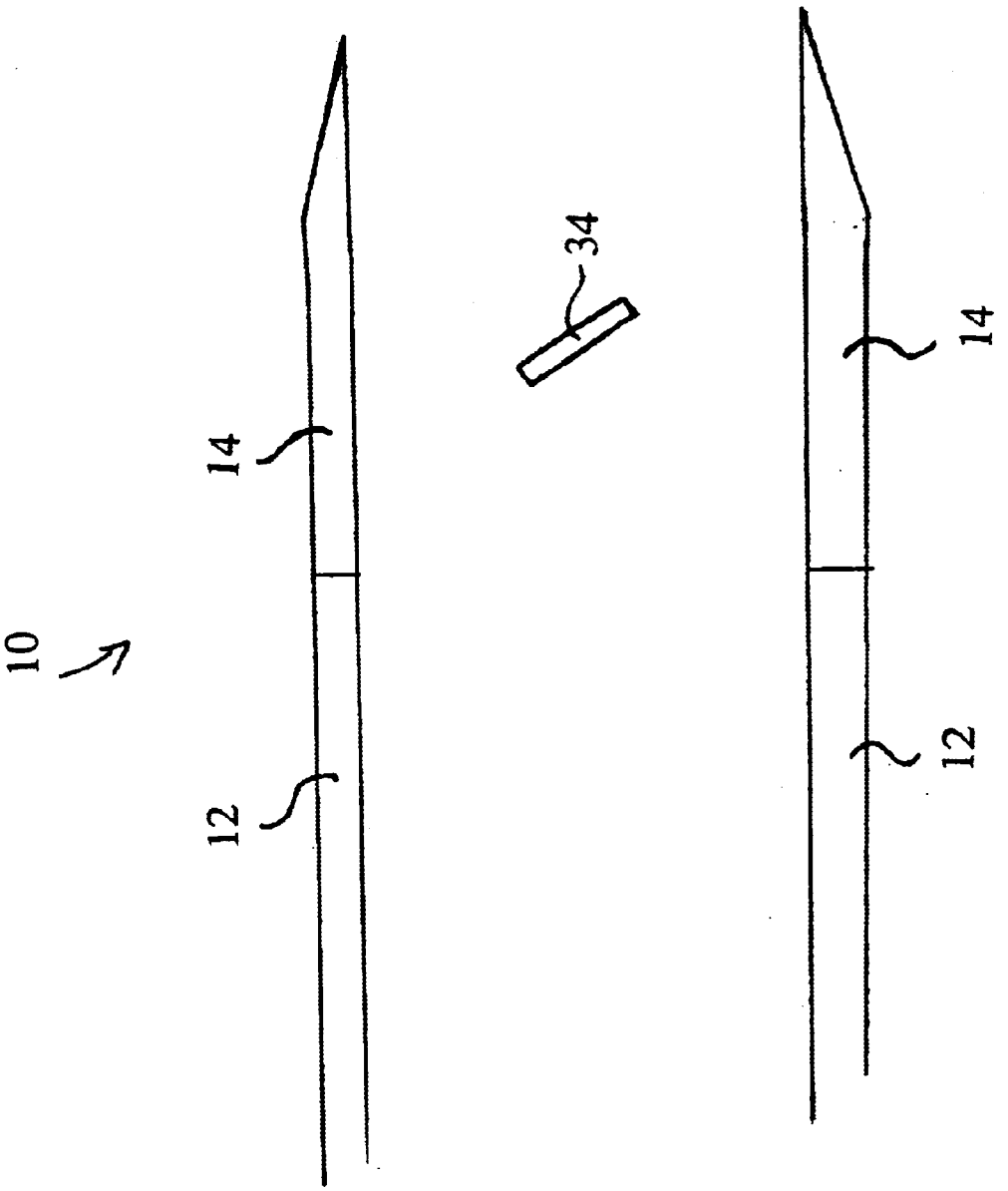
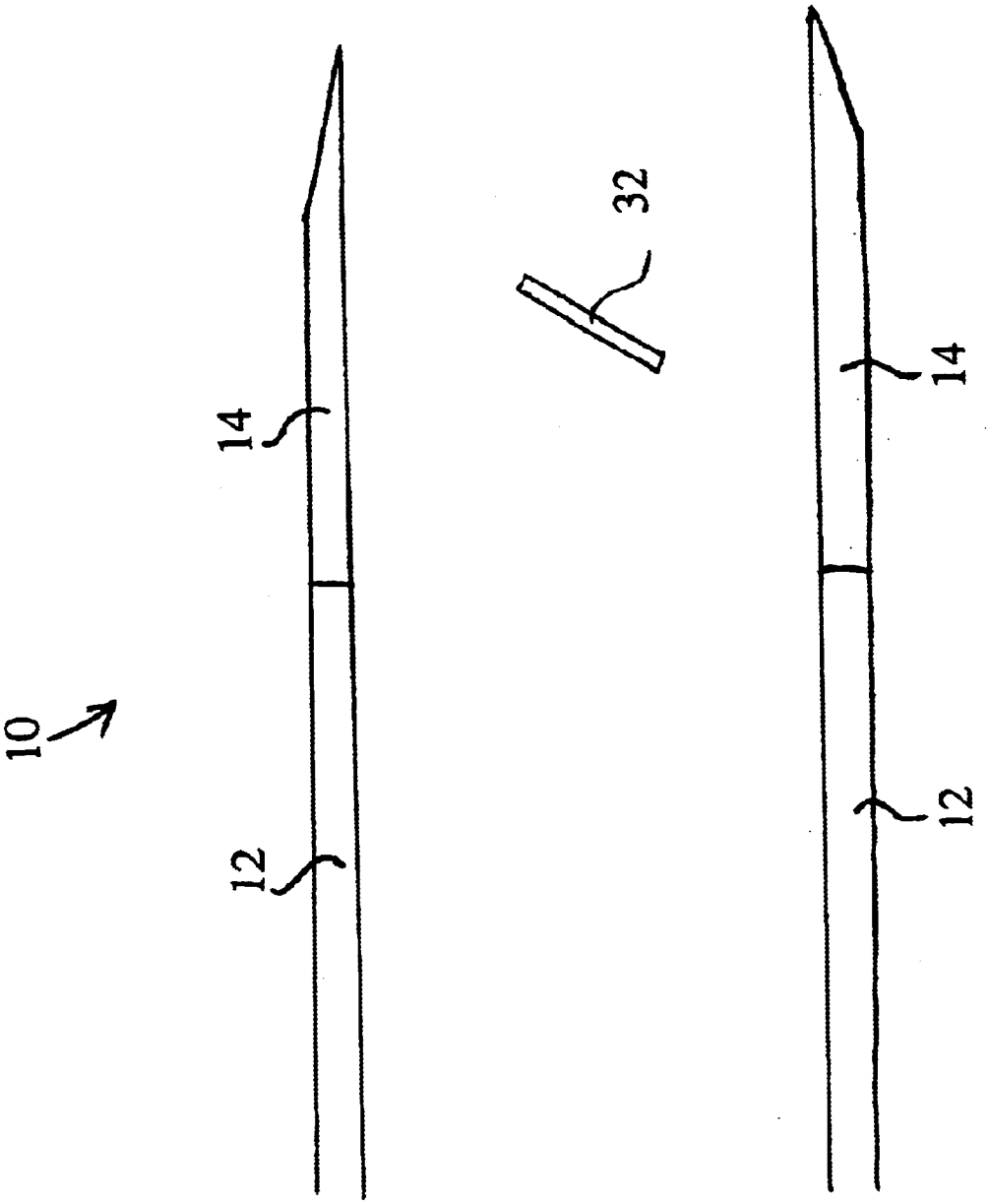


FIG. 13



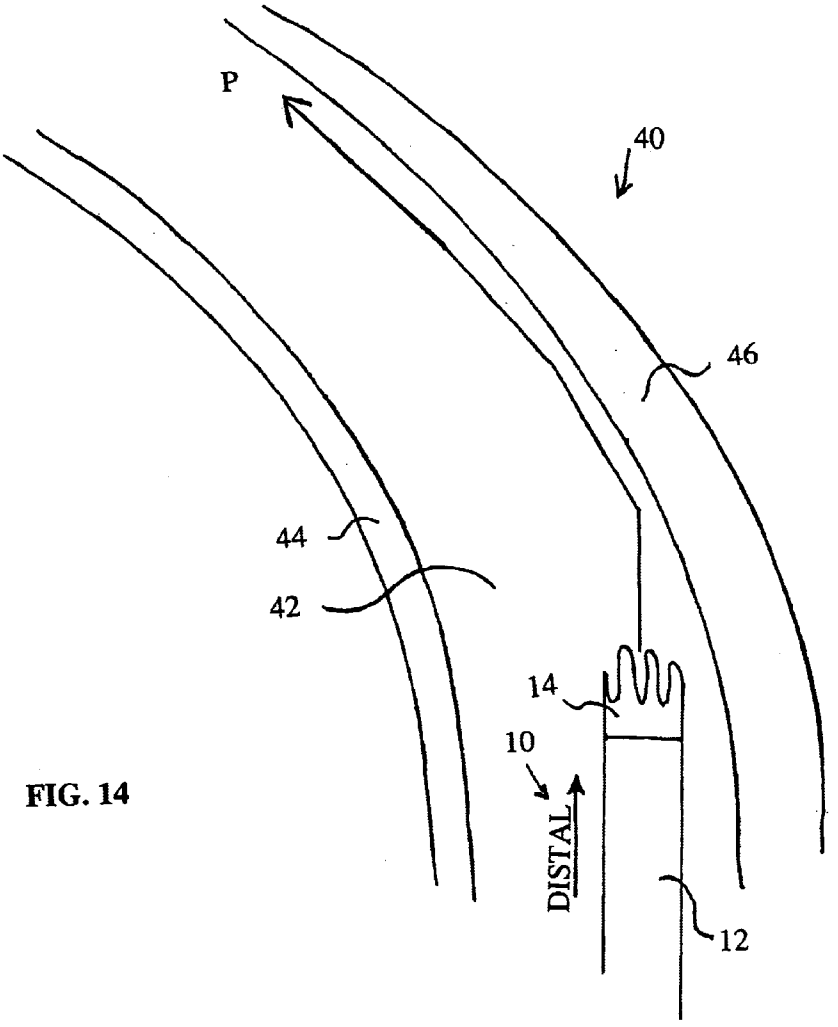


FIG. 14

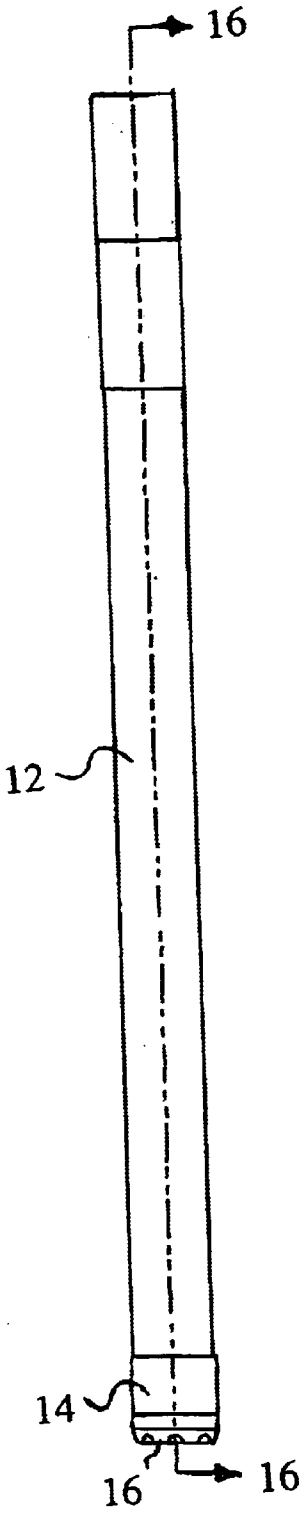


FIG. 15

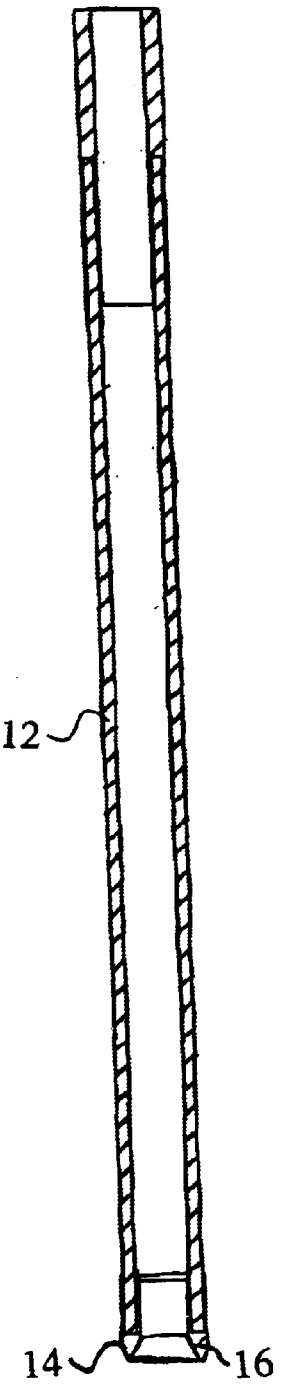


FIG. 16

FIG. 17

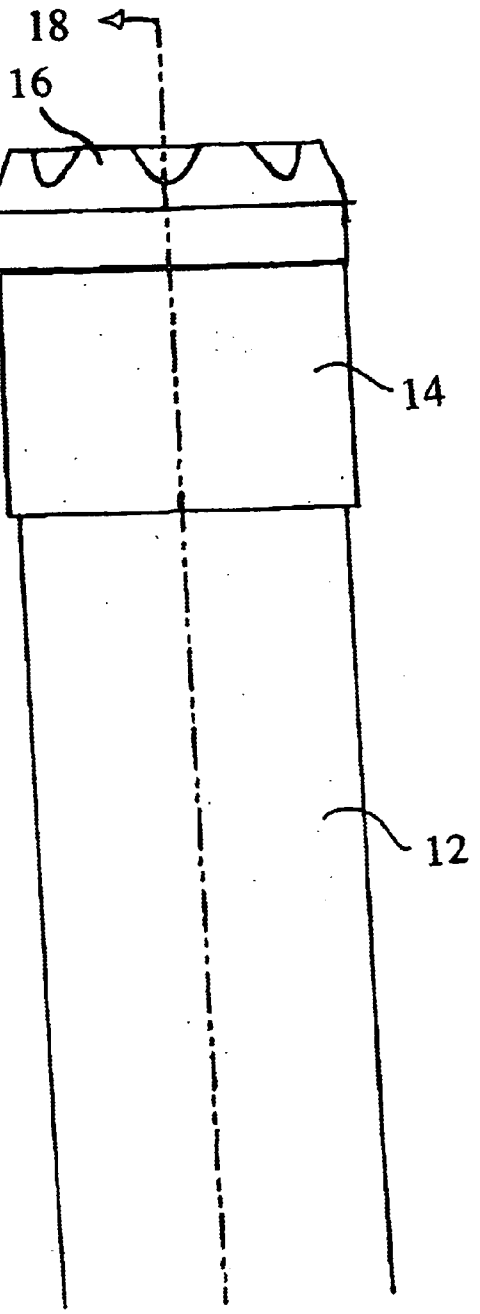
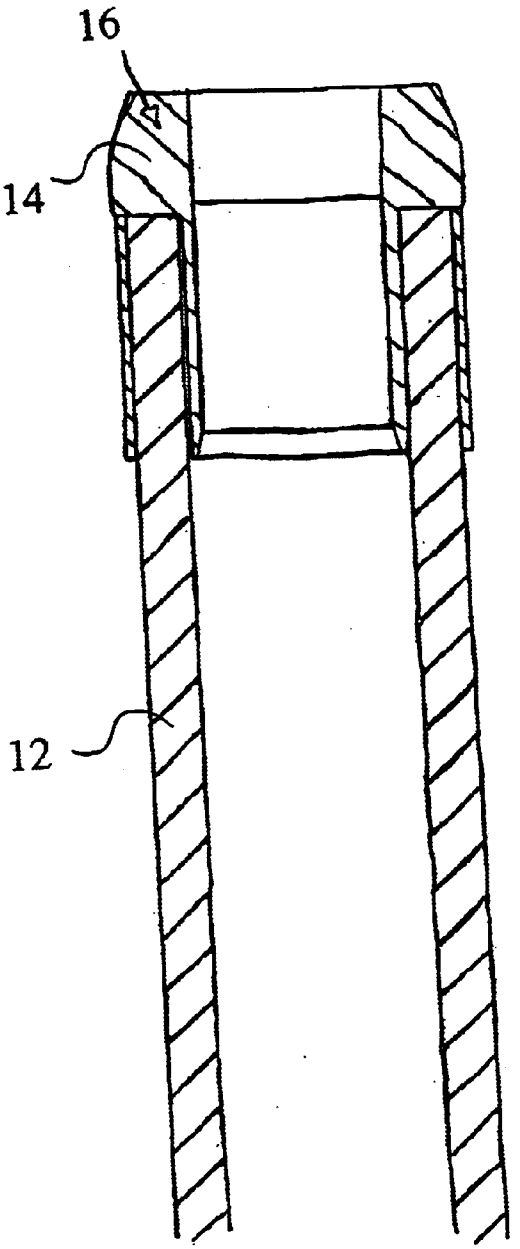


FIG. 18



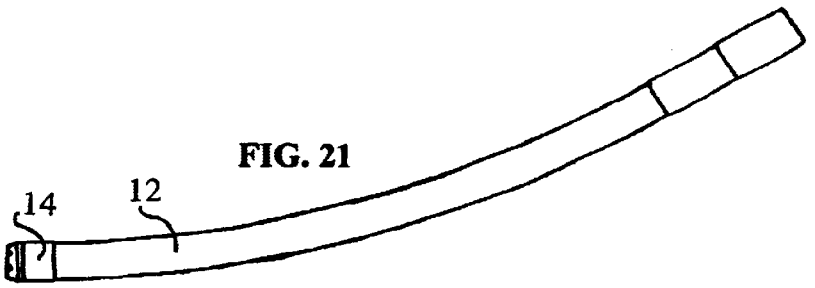


FIG. 21

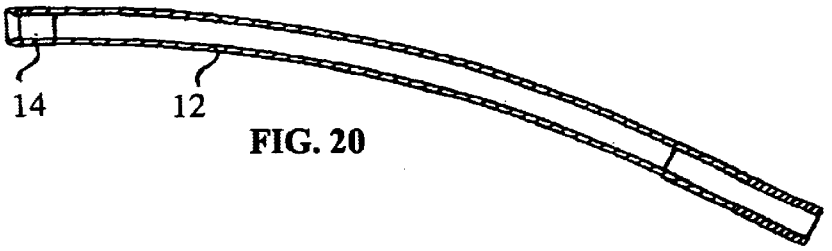


FIG. 20

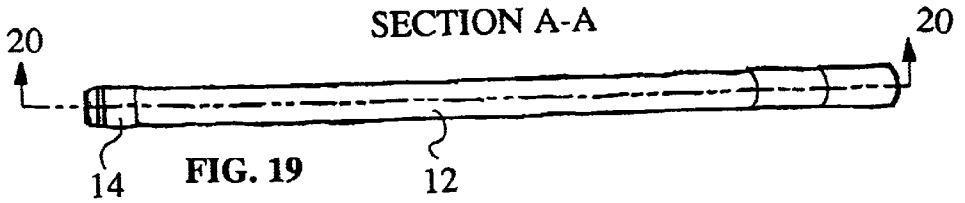


FIG. 19

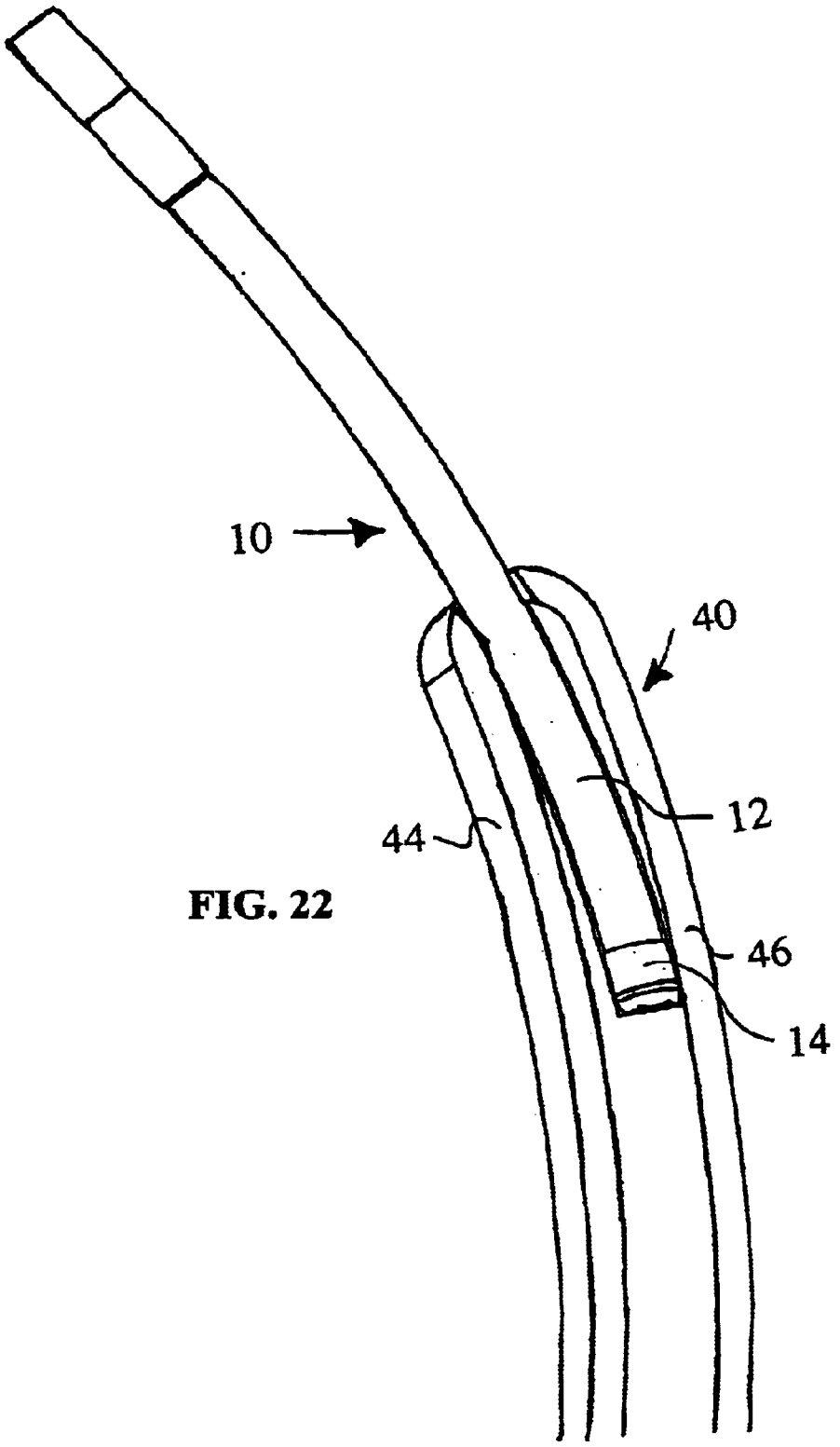


FIG. 22

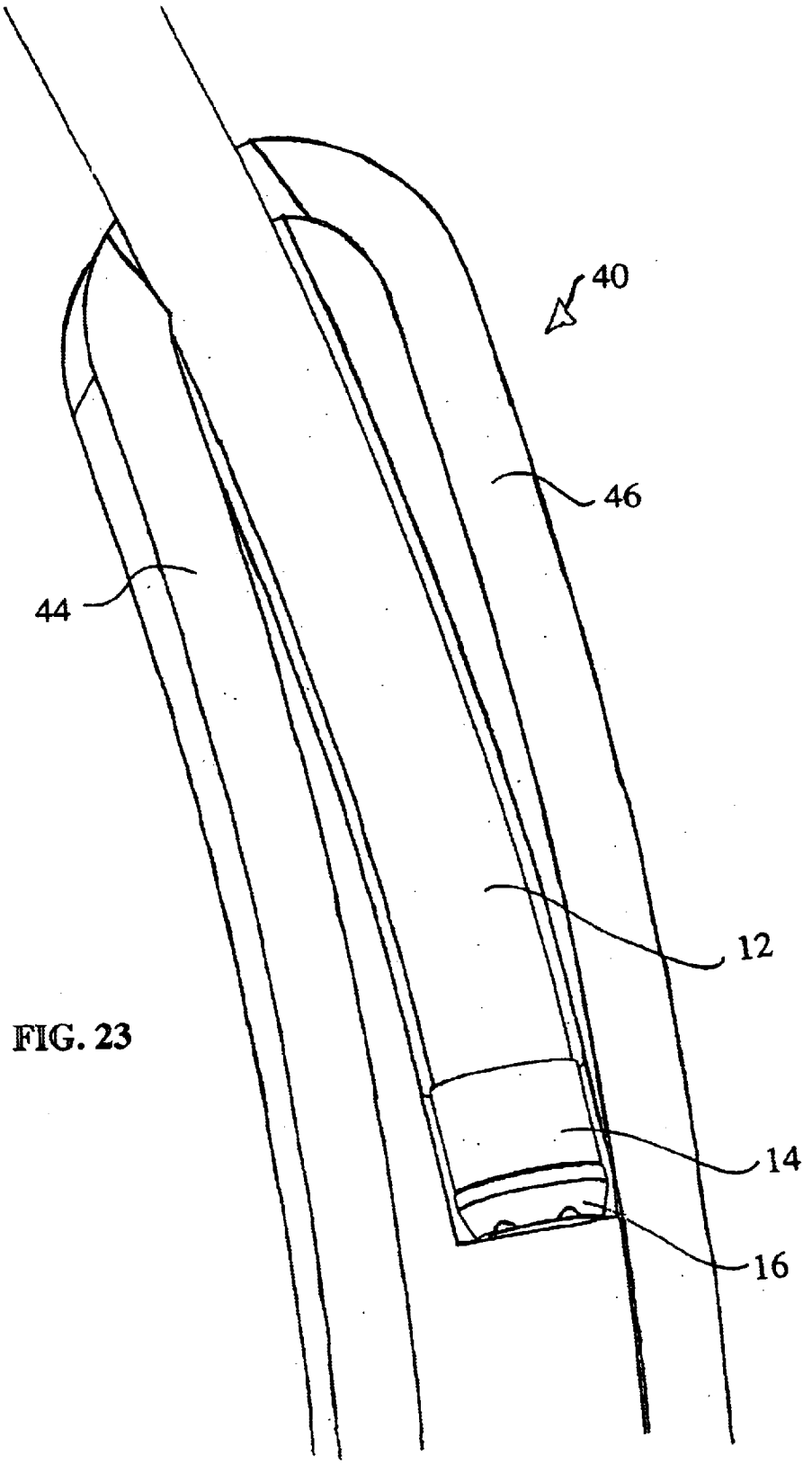


FIG. 23

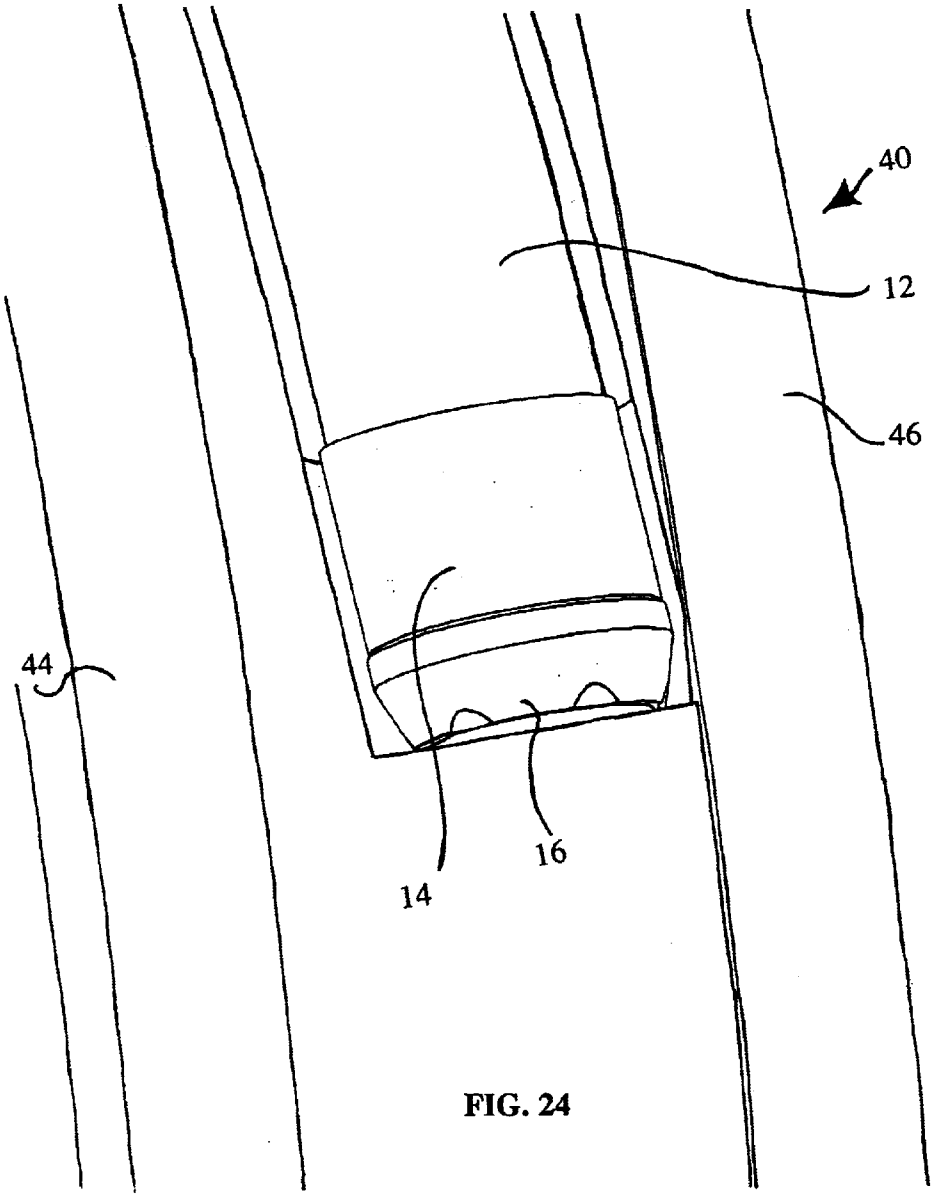


FIG. 24

BONE GRAFT HARVESTER

CROSS-REFERENCES TO RELATED APPLICATIONS

This application claims the benefit of prior provisional application no. 60/167,192 filed Nov. 23, 1999, the full disclosure of which is incorporated herein by reference.

The present invention relates to systems for removing bone graft material from a patient, and in particular to systems for removing bone graft material from a patient's ilium.

SUMMARY OF THE INVENTION

The present invention provides a bone graft harvesting drill comprised of a flexible tubular member having a hollow cylindrical drill bit mounted at its distal end. An advantage of the present harvesting drill is that it can be used to remove softer cancellous bone from between the harder cortical plates of the patient's ilium. Specifically, the present harvesting drill can be advanced in a path between the plates of the ilium, with the drill automatically tending to deflect off the hard cortical surfaces of the bone such that the drill instead bores a path therebetween through the cancellous bone material.

In preferred aspects, the drill bit has a plurality of wavy or sinusoidal teeth which may be sharpened such that the outer surfaces of the teeth taper inwardly towards their distal ends, wherein the inner surfaces of the teeth are aligned with the walls of the drill bit. An advantage of sharpening the teeth such that their outer surfaces slant inwardly while their inner surfaces remain parallel is that as the outer surface of the distal tip of the drill bit comes into contact with the curved inner surface of the cortical plate of the patient's ilium, the bevel or chamfer at the distal tip causes the distal tip to deflect away from the cortical bone. As the main body of the drill is flexible in radial directions, (i.e.: perpendicular to a longitudinally extending axis passing therethrough), and is preferably relatively rigid in compression along the longitudinal axis of the drill, a transverse load on the beveled end of the drill bit results in a "passive steering" condition. This "passive steering" feature of the device allows the harvesting drill to take the desired path of least resistance through the softer cancellous bone while preserving the harder cortical bone. Should the outermost edges of the drill tip instead be sharp, and not beveled or chamfered, the drill bit may instead have a tendency to catch the inner surface of the cortical bone and would undesirable pass through the ilium into the surrounding tissue. Another advantage of the beveled tip is that it is easier to push the drill through the bone during cutting.

In preferred aspects, an optional tissue removing insert is slidably received through the inner bores of the flexible tubular member and the drill bit. This tissue removing insert is specifically adapted to anchor into and, when rotated, tear away tissues which have become disposed within the inner bore of the drill bit.

In further optional aspects of the present invention, inwardly facing projections are found on the drill bit. These projections are specifically adapted to tear away tissues which have become disposed within the inner bore of the drill bit. In preferred aspects, the inwardly facing projection is formed from a C-shaped or L-shaped cut through the wall of the drill bit wherein the inner flange is bent inwardly into the bore of the drill bit. In alternate preferred aspects, a blade spans across the bore of the drill bit to tear away tissues protruding therein. An advantage of this embodiment of the invention is that the blade acts as a morcillator to premasticate the tissue prior to placement into the patient.

In a preferred method of using the present invention, the flexible tube and attached drill bit are rotated, however, they may instead be oscillated such that they preferentially cut through the softer cancellous tissues, avoiding harder cortical tissues.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of the present invention.

FIG. **2** is a close-up of the distal end of the present invention.

FIG. **3** is a sectional view of the distal end of the present invention.

FIG. **4** is a sectional view of the distal end of the present invention showing in the present invention cutting into a bone.

FIG. **5** corresponds to FIG. **4**, but shows a tissue removing insert anchored into a tissue mass protruding into the inner bore of the present invention.

FIG. **6** shows removal of the tissue mass from the inner bore of the invention.

FIG. **7** is a side elevation view of an embodiment of the invention having an inwardly facing projection in the drill bit.

FIG. **8** is a view corresponding to line **8—8** in FIG. **7**.

FIG. **9** is similar to FIG. **7**, but shows the inwardly facing projection posed at an angle.

FIG. **10** shows an embodiment of the distal end of the present invention using a blade spanning across the inner bore of the drill bit.

FIG. **11** is a front view corresponding to FIG. **10**.

FIG. **12** is a view taken along line **12—12** in FIG. **11**.

FIG. **13** is a view taken along line **13—13** in FIG. **11**.

FIG. **14** is an illustration of the direction of travel of the present invention it moves between the tables of the ilium.

FIG. **15** is a side elevation view of the present invention.

FIG. **16** is a sectional view corresponding to line **16—16** in FIG. **15**.

FIG. **17** is a side elevation view of the distal tip of the present invention.

FIG. **18** is a sectional view corresponding to line **18** in FIG. **17**.

FIG. **19** is a side elevation view of the present invention.

FIG. **20** is a sectional view corresponding to line **20—20** in FIG. **19**.

FIG. **21** is a side elevation view corresponding to FIGS. **19** and **20**.

FIG. **22** is a schematic view of the present drill positioned between the tables of the ilium.

FIG. **23** is a close-up view of corresponding to FIG. **22**.

FIG. **24** is a close-up view of corresponding to FIG. **23**.

DESCRIPTION OF THE SPECIFIC EMBODIMENTS

Referring to FIG. **1**, the present invention comprises a bone graft harvesting drill **10** comprised of a flexible tubular member **12** with a hollow cylindrical drill bit **14** mounted to the distal end of the flexible tubular member **12** as shown. Preferably, the tubular member **12** is made from a biocompatable thermoplastic such as polyethylene or polypropylene, however, many other plastics could be used.

The drill bit **14** is preferably made from stainless steel, however, other materials could be used, such as hard metals or hard thermoplastics.

As can be seen in FIG. **2**, drill bit **14** has a plurality of teeth **16** which wrap around its circumference. Preferably, teeth **16** are "wavy" or sinusoidal in shape as shown. An advantage of such a serrated tooth is that it is non-clogging, as opposed to a typical triangular saw tooth, which has a tendency to catch materials in the spaces between the teeth. A further advantage is that the aggressiveness of the tip of the drill is more easily controlled in the serrated type tip than in more conventional saw tooth forms. If the bit becomes too aggressive, damage to the inner planes of the cortical bone may occur. Furthermore, the serrated type tip is much easier and more cost effective to manufacture than conventional saw tooth forms.

Referring to FIG. **3**, a sectional view of drill **10** is shown. Teeth **16** have inner surfaces **15** and outer surfaces **17**. In a preferred aspect, outer surfaces **17** taper inwardly towards the distal end of drill **10**. Inner surfaces **15** are preferably aligned parallel with one another and parallel with the outer surface of drill bit **14** as shown. An advantage of having outer surfaces **17** taper inwardly (as opposed to having inner surfaces **15** tapered outwardly), is that the drill bit **14** can be advanced to cut into tissues more easily.

FIG. **4** shows drill **10** cutting into bone B. In a preferred aspect of the invention, drill **10** is rotated, about a central longitudinal axis A extending therethrough.

As seen in FIG. **4**, a mass of bone tissue B1 will enter into the central bore of drill **10** as drill **10** is cut into the bone. In an optional preferred aspect of the present invention, a tissue removing insert **20** is introduced into the central bore of drill **10** as shown in FIG. **5**. Insert **20** may comprise a screw-type mechanism as illustrated, or any other system for gripping into and tearing away tissue mass B1. As seen in FIG. **6**, insert **20** is used to tear away and remove tissue mass B1 from the inner bore of drill **10**, such that tissue mass B1 can be used as bone graft material. The sequence of steps illustrated in FIGS. **4**, **5**, and **6** can preferably be repeated again and again as drill **10** advances further and further into bone B.

An additional preferred aspect of the invention is illustrated in FIGS. **7** and **8** in which an inwardly facing projection **25** which may be formed by a C-shaped cut **26** in drill bit **14** is found. Specifically, as seen in FIG. **8**, projection **25** is bent to face inwardly into the inner bore of drill **10**. An advantage of the projections **25** facing inwardly are that as drill **10** is advanced, projections **25** will tend to tear away tissue protruding therein such that the tissue can easily be removed from the central bore of drill such that it can be used for bone graft purposes. In preferred aspects, a plurality of projections **25** can be disposed around the circumference of drill bit **14**. Preferably, such inwardly facing projections **25** will be disposed equidistantly around the circumference of drill bit **14**. In preferred aspects, two, three, four or more of inwardly facing projections **25** may be used.

FIG. **9** shows an inwardly facing projection **27** formed by a C-shaped cut **29** wherein projection **27** is disposed at an angle to axis A. An advantage of projection **27** being angled to axis A is that it will tend to screw into the tissue mass disposed within the inner bore of drill **10**, such that the tissue mass can be more easily torn away and removed.

FIG. **10** shows an alternate embodiment of the present invention in which a blade **30** spans across the bore of drill bit **14** as shown. As can be seen more clearly in FIGS. **11**, **12**, and **13**, blade **30** may comprise two sections **32** and **34** which may be oppositely angled such that as drill **10** is rotated, each of blades **32** and **34** cut into the tissue which becomes disposed within the inner bore of drill bit **14** such that the tissue can be easily removed from the inner bore of drill bit **14**.

FIGS. **14** and **22** to **24** show a preferred direction of travel for drill **10** wherein drill **10** is introduced into ilium **40** into a region of cancellous bone **42** disposed between ilium tables **44** and **46**. Tables **44** and **46** comprise a very hard cortical bone. As such, as drill **10** is advanced in a distal direction, drill bit **14** will tend to be deflected along table **46** such that it cuts through cancellous bone **42**, without cutting through either **15** of tables **44** or **46**. This is achieved by tube **12** being flexible such that it is able to respond to deflections of movement of drill bit **14** as drill **10** travels along path P as shown.

Bending of flexible tubular member **12** is also shown in FIGS. **20** and **21**.

What is claimed is:

1. A bone graft harvesting drill, comprising:

a flexible tubular member; and

a cylindrical drill bit mounted to a distal end of the flexible tubular member,

wherein the drill bit has a plurality of teeth having outer surfaces tapering inwardly towards their distal ends.

2. The bone graft harvesting drill of claim **1**, wherein said cylindrical drill bit includes a hollow inner bore, and further comprising:

a tissue removing insert received within the hollow inner bore of the drill bit.

3. The bone graft harvesting drill of claim **2**, wherein the tissue removing insert is adapted to be slidably positioned within the inner bore of the drill bit.

4. The bone graft harvesting drill of claim **1**, wherein the drill bit comprises an inner bore, and at least one projection facing inwardly into the inner bore of the drill bit and dimensioned to tear away tissues disposed within the inner bore of the drill bit.

5. The bone graft harvesting drill of claim **4**, wherein the at least one projection comprises a plurality of inwardly facing projections disposed equidistantly around the circumference of the drill bit.

6. The bone graft harvesting drill of claim **4**, wherein the at least one projection is formed from a C-shaped or L-shaped cut passing through the wall of the drill bit.

7. The bone graft harvesting drill of claim **4**, wherein the at least one projection comprises a blade spanning across the inner bore of the drill bit.

8. A method of harvesting bone graft material, comprising:

inserting a distal end of a hollow cylindrical drill into a patient's ilium, the distal end of a hollow cylindrical drill comprising a flexible tubular member, with a hollow cylindrical drill bit mounted to the distal end of the flexible tubular member; and

rotating or oscillating the flexible tubular member about a longitudinal axis extending therethrough; and,

advancing the hollow cylindrical drill such that cut away tissue is deposited in the inner bore of the hollow cylindrical drill.

9. The method of claim **8**, wherein the hollow cylindrical drill is advanced such that the distal end of the cylindrical drill bit deflects off an inner boundary of the outer surface of the ilium, thereby cutting the cancellous bone while avoiding cutting cortical bone.

10. The method of claim 8, further comprising:

slidably inserting a tissue removal insert into the inner bores of the flexible tubular member and cylindrical drill bit;

anchoring the tissue removal insert into a mass of tissue protruding into the bore of the cylindrical drill bit;

tearing away the mass of tissue by rotating the tissue removal insert; and

removing the mass of tissue from within the bore of the cylindrical drill bit by slidably removing the tissue removal insert from the inner bore of the cylindrical drill bit.

11. The method of claim 8, further comprising:

tearing away a mass of tissue protruding into the bore of the cylindrical drill bit with a protrusion which faces inwardly from an inner wall of the cylindrical drill bit into the bore of the cylindrical drill bit.

12. The method of claim 8, further comprising:

tearing away a mass of tissue protruding into the bore of the cylindrical drill bit with a blade spanning across the bore of the drill bit.

13. The method of claim 8, wherein the hollow cylindrical drill is inserted in a percutaneous cannulated approach.

14. A method of drilling bone, comprising:

providing a generally cylindrical drill bit having a beveled outer distal periphery;

inserting said generally cylindrical drill bit through an aperture formed in a patient's cortical bone; and

rotating said generally cylindrical drill bit such that, when advanced through said aperture, said drill bit deflects off an inner wall of said cortical bone and thereby avoids penetrating said cortical bone other than through said aperture.

* * * * *