



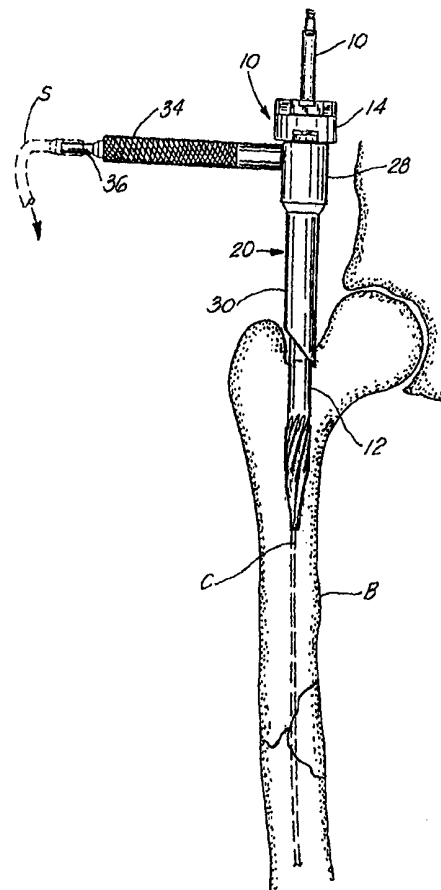
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(54) Title: INTRAMEDULLARY NAIL INSERTION INSTRUMENTS

(57) Abstract

The assembly includes a sleeve (12), a housing (14) and an inner reamer (16). The sleeve is an elongated cylindrically-shaped hollow sleeve that has a proximal and a distal end, with the distal end having a plurality of cutting blades. The housing is attached to the sleeve and is generally cylindrical in shape and it has a top portion, a bottom portion and a through bore. The top portion includes a releasable locking mechanism for engaging the inner reamer within the housing. The inner reamer has an elongated cannulated body and proximal and distal ends. The distal end has a rotatable reaming head and the proximal end has a drill shaft and a connector for connection to a drill. A portion of the body includes an annular collar (158) with a tab (160) for engaging a notch (94) in the housing. The reamer is sized and shaped for insertion through the bore of the housing and the sleeve. The reaming assembly is configured to create an entry portal into the canal of a bone and to provide a working channel in which a plurality of reamers of graduated sizes are inserted for progressively reaming the canal of a bone.



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INTRAMEDULLARY NAIL INSERTION INSTRUMENTS

5 The present invention relates to a surgical tool and method for
accessing the intramedullary canal of a bone and more particularly
to a minimally invasive reaming assembly and method for creating
an entry portal into the canal of a bone and providing a working
channel for reaming the canal of the bone to receive an
intramedullary fracture reduction device.

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Bone fractures are repaired by inserting bone fracture
reduction rods or intramedullary nails into the intramedullary canal
of a bone in order to stay the fracture. In performing this type of
surgery for femoral fractures for example, it is conventional to make
15 an incision near the tip of the greater trochanter extending
proximally in line with the fibres of the gluteus in order to create an
entry portal through the bone and into the canal. However, it has
been found to be difficult to correctly position the entry portal to the
intramedullary canal from the greater trochanter and to ream the
20 canal to the desired size without damaging the surrounding soft
tissue, displacing the previously reduced fracture, or making
extremely large incisions. This is especially true if the patient is
obese or if flexion or abduction of the proximal fragment caused a
portion of the greater trochanter to lie against the ilium.

25

In this type of surgery, after the entry portal has been
established, the canal is progressively reamed to a larger diameter
from a smaller diameter in increments of about 0.5mm, from
generally about 8mm, up to generally about 12.5mm. Typically the
30 surgeon starts with a small reamer, reams the bone, removes the
reamer and then inserts a second reamer, 0.5mm larger in diameter
than the previous reamer. The surgeon repeats this process until
he has reached the required canal diameter for the intramedullary
nail that has been selected for the patient.

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Additionally, this type of surgery can be particularly bloody
which presents other problems. Excess blood can obstruct the
surgeon's view of the site being reamed and excessive blood

flowing from the surgical site can create problems for the surgical staff particularly if the patient has a blood or bone disease. Thus, it is important that the surgical instrumentation provide for suctioning of the blood created by the surgery from the surgical site.

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Several other problems are encountered during the process of repeatedly inserting the different sized reamers in and out of the bone. First, the surgeon can lose the entry portal, even though there may be a guide rod in place, as the soft tissues close around the slender guide rod, eliminating from view the entry portal opening. Further, as the reamers are slid over the guide rod and into the soft tissue, the sharp edges of each reamer rub against the soft tissues. Because this process is repeated a number of times during the reaming process, the soft tissues become very irritated and torn. Additionally, the guide rod can be pulled out of the bone when a reamer is being withdrawn.

A second problem has to do with the actual entry of the reamer into the intramedullary canal of the bone after it has passed through the soft tissues. Since the guide rod is so much smaller than the reamer (3mm compared to at least 8mm), the guide rod frequently will not stay centred in the opening created by the previous reamer, which results in the next reamer getting caught on the edge of the opening created by the previous reamer. Since the next reamer is larger in size, it will not fit smoothly into the opening created by the previous smaller reamer. This situation prevents the surgeon from being able to determine if the next larger reamer is correctly centred before he or she starts reaming the canal. In order for the surgeon to locate the opening with the present instrumentation, he typically has to make a larger incision in order to locate the entry portal and determine the correct centring of the reamers.

There have been a number of attempts to solve these problems. One attempt is found in U.S. Patent 5,624,447 which describes a surgical tool guide and entry portal positioner that provides a cannulated sleeve with a handle and a C-shaped soft tissue protector secured to the sleeve. U.S. Patent 5,569,262

describes a guide tool for surgical devices that is used for directing a surgical device into attachment with a bone segment and is used to protect a surgeon's fingers from the surgical device and from the jagged surface of the bone segment. U.S. Patent 5,443,469

5 describes a tubular tissue protection guard that is inserted into an incision or wound in order to accommodate reaming devices.

While these devices provide protection to the soft tissues, none of them provide a working channel within the bone canal in which to progressively ream out the intramedullary canal of the

10 bone. It would be advantageous to have a device that can be used to both open the entry portal into the canal of a bone and to provide a working channel in which to ream the canal of the bone in a minimally invasive manner. It also would be advantageous to be

15 able to use the subject invention in combination with an entry portal tool that can be used to locate the most desirable placement of the entry portal into the bone.

The present invention consists of a minimally invasive reaming

20 assembly and method for creating the entry portal into the canal of a bone and for providing a working channel in which to ream the canal of a bone. The assembly includes a sleeve, a housing and an inner reamer. The sleeve is an elongated cylindrically-shaped hollow sleeve that has a proximal and a distal end, with the distal end

25 having one or more preferably a plurality of, cutting blades. The housing is adjacent to the sleeve and has a top portion, a bottom portion and a through bore. The top portion includes a releasable locking mechanism for engaging the inner reamer within the

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The inner reamer has an elongated body and proximal and distal ends. The distal end has a rotatable reaming head and the proximal end has a drill shaft and connecting means for connection to a drill. A portion of the body includes an annular collar with a tab

35 for engaging a notch in the housing. The inner reamer is sized and shaped for insertion through the bore of the housing and the sleeve. The reaming assembly allows for the passage of reamers of

graduated sizes for progressively reaming the canal of a bone through the sleeve. In a preferred embodiment, the reaming assembly is used in combination with an entry portal tool for use in correctly placing the entry portal in the bone.

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A better understanding of the invention can be obtained when the detailed description of exemplary embodiments set forth below is reviewed in conjunction with the accompanying drawings, in which:

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Figure 1 is a schematic view of the present invention being used to ream the intramedullary canal of a bone;

Figure 2 is a prospective view of an entry portal tool used in combinations with the present invention;

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Figure 3 is a prospective view of a cannulated obturator of the entry portal tool of Figure 2;

Figure 4 is a bottom plan view of the obturator of Figure 3 taken along lines 4-4;

20

Figure 5 is an exploded view of the handle of the entry portal tool of Figure 2;

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Figure 6A is a side plan view of an alternate embodiment of an the entry portal tool;

Figure 6B is an exploded side plan view of the entry portal tool of Figure 6A;

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Figure 6C is a prospective side view of the handle of the entry portal tool of Figure 6B;

Figure 7A is a prospective view of a third alternate embodiment of an entry portal tool;

Figure 7B is a side plan view of the sheath of the entry portal tool of Figure 7A;

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Figure 7C is a prospective view of the handle of the entry portal tool of Figure 7A;

Figure 7D is a side plan view of the entry portal tool of Figure 7A with a portion of the handle in phantom.

Figure 8 is a side plan view of the present invention in combination with the entry portal tool;

Figure 9 is a side plan view of the invention of Figure 8 with the inner reamer removed.

Figure 10 is an exploded view of the assembly of Figure 8;

Figure 11 is a side plan view of the reaming sleeve of the present invention.

Figure 12 is a plan view of the proximal end of the reaming sleeve of Figure 11 taken along lines 12-12 of Figure 11;

Figure 13 is a partial cross-sectional view of the reaming sleeve of Figure 11 taken along lines 13-13 of Figure 11;

Figure 14 is a plan view of the distal end of the reaming sleeve of Figure 11 taken along lines 14-14 of Figure 11.

Figure 15 is an exploded perspective view of the housing of the present invention.

Figure 16 is a cross-sectional view of the housing of Figure 15 taken along lines 16-16 of Figure 15;

Figure 17 is partial perspective view of the sleeve and housing of Figure 9;

Figure 18 is a partial cross-sectional view of the connection mechanism between the sleeve and the housing of Figure 9;

Figure 19 is a plan view of the bottom of the housing of Figure 15;

Figure 20 is a plan view of the distal end of the sleeve showing the locking mechanism of the housing of Figure 9 in an unlocked position;

Figure 21 is a plan view of the distal end of the sleeve showing the locking mechanism of the housing of Figure 9 in a locked position;

Figure 22 is an exploded side plan view of the reaming component of the present invention of Figure 8;

Figure 23 is an enlarged view of a portion of the reaming component of Figure 22; and

Figures 24-26 are partial cross-sectional views of the connecting mechanism between the inner reamer and the housing of Figure 8.

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An embodiment of the present invention, as shown in Figs. 1 and 10, is a minimally invasive reaming assembly 10 that includes a

reaming sleeve 12, a housing 14 and an inner reamer 16 that fits within the cannulation of reaming sleeve 12. The reaming assembly 10 is used in combination with an entry portal tool 20 to locate the preferred placement of an entry portal and then to create an entry portal to the canal C of a bone B (Figs. 1 and 2). Once the entry portal has been created and the reaming sleeve 12 is positioned in the bone B, the inner reamer 16 is removed from the housing 14 and reaming sleeve 12. The reaming sleeve 12 is then used as a working channel in which to progressively ream the canal of the bone B without losing the entry portal or irritating the soft tissue surrounding the entry portal. In a preferred embodiment, the entry portal tool 20 and the reaming assembly 10 are formed of stainless steel.

Entry portal tool 20 is an elongated, cylindrically-shaped hollow sheath 22 having a proximal end 24, a bevelled distal end 26 and an upper and lower portion 28, 30 (Fig. 2). The upper portion 28 includes at least one generally circular opening 32 in the sheath 22, and in a preferred embodiment has three openings. In one embodiment the openings 32 of the sheath 22 can be threaded. As shown in Figs. 2 and 5, the entry portal tool 20 also includes a handle 34 that can be used by the surgeon to manipulate the entry portal tool 20. The handle 34 is elongated in shape and has proximal and distal ends 36, 38. The distal end 38 is removably connected to a selected circular opening 32 in the sheath 22. The handle 34 includes a through bore 40, a connecting mechanism 42 for connecting and disconnecting the handle 34 to the sheath 22 (Fig. 5). The proximal end 36 is sized and shaped to accept a suction device S known to one skilled in the art that can be attached to the proximal end 36 of the handle 34 in order to suction fluids and bone debris from the reaming site (Fig. 1).

In one embodiment of the handle 34, as shown in Fig. 5, the connecting mechanism 42 is a spring-loaded plunger mechanism that utilises a series of retractable ball bearings 44 to connect and disconnect the handle 34 from a selected generally circular opening 32 in the sheath 22. Although other suitable shaped openings could

be envisaged which would still allow the invention to work. In a second embodiment of the entry portal tool 20A, as shown in Figs. 6A-C, a handle 34A has a connecting mechanism 42A that is a threaded portion 35 at the distal end 38 of the handle 34A. The threaded portion 35 of the handle distal end 38 engages threading in the circular openings 32 of the sheath 22. Preferably, the handle 34A includes a generally cylindrical distal portion 37, a flat middle portion 39 and a generally cylindrical proximal end 41 that is configured to accept a suction device for suctioning fluids from the remaining site.

A third embodiment of the entry portal tool 20B is shown in Figs. 7A-C in which the proximal end 24 of the sheath 22 includes an annular lip 43 placed below circular opening 32. Handle 34B includes an elongated tubular member 45 having a proximal end 47, a distal end 49 and an annular collar 51 that serves as a gripper. Handle 34B also includes a connection portion 53 having a generally cylindrical ring 55 integral with an elongated housing 57. Housing 57 has a through bore 59 sized and shaped to accommodate the distal end 49 of the tubular member 45. Ring 55 includes at least one generally circular opening 61 that is aligned with bore 59 and is similar in size and shape to the circular opening 32 of the handle 34B. Bore 59 and opening 61 allow the distal end 49 of the tubular member 45 to be inserted into housing 57 with the distal end 49 extending into the interior of ring 55. Housing 57 includes a spring mechanism (not shown) connected to the tubular member 45, that allows the distal end 49 of the tubular member 45 to be retracted from the interior of the ring 55 so that ring 55 can be placed upon the proximal end 24 of sheath 22. The annular lip 43 provides a stop for connector portion 53. Once the housing 57 has been placed upon the sheath 22, with opening 32 and 61 being in alignment with each other, the tubular member 45 is released so that it extends through opening 32 a short distance into the interior of the ring 55 (Fig. 7D). The proximal end 47 of the tubular member 45 is configured to accept a suction device for suctioning fluids from the remaining site.

Entry portal tools 20, 20A and B also include a cannulated obturator or elongated cylindrically-shaped tube 50 having a proximal and distal end 52, 54 and a central longitudinal axis LA (Fig. 3). The distal end 54 has a conical top 56 that includes a plurality of openings 58. Although the invention may work when there is only one opening. Preferably, the plurality of openings 58 have a circular centre opening surrounded by five circular openings all of the same size, as shown in Fig. 4. The proximal end 52 includes an annular collar 60 having a diameter greater than tube 50 and sheath 22. Tube 50 includes a cylindrical hub 62 at its proximal end 52 with a hub 62 including openings 64 identical in configuration to the openings 58 of the conical tip 56. Tube 50 also can include a number of cylindrical hubs 66, each having openings 64, placed longitudinally in tube 50 between the proximal and distal ends 52, 54 of tube 50 (Fig. 3). The openings 64 of the hubs 62, 66 and the openings 58 of the conical tip 56 are aligned along parallel lines that are parallel with the central longitudinal axis LA of tube 50. Obturator 50 is sized and shaped for removably inserting into the hollow sheath 22 with the hollow sheath 22 being sized and shaped for removable insertion of the reaming sleeve 14 into the sheath 22 (Fig. 2).

Additionally, the entry portal tools 20, 20A-B are configured to allow for the suctioning of blood out of the intramedullary canal into the reaming sleeve 12 and out the sheath 22, and through handle 34, 34A and B into a collection device.

As described above, the minimally invasive reaming assembly 10 includes reaming sleeve 12, housing 14 and inner reamer 16 (Fig. 10). Reaming sleeve 12, as shown in Figs. 11-14, is an elongated cylindrically-shaped hollow sleeve having a proximal and distal end 68, 70. Distal end 70 includes a plurality of cutting blades 72 of the kind generally known by one skilled in the art of orthopaedic surgery for cutting into the canal of a bone. In a preferred embodiment, the cutting blades 72 extend approximate 35mm up from the distal end 70 of the sleeve 12 on the outer surface 74 of sleeve 12. The outer surface 74 of proximal end 68 of

sleeve 12 includes threading 76 on approximately 6mm in length of the proximal end 68. Positioned at the end of threading 76 is a ring of angled, horizontally extending teeth 78, in which the threading 76 and teeth 78 provide for engagement of the proximal end 68 of the sleeve 12 to the housing 14. Reaming sleeve 12 and housing 14 can be constructed as an integral unit, or sleeve 12 can be constructed without the housing 14 in which case the release mechanism for the inner reamer 16 would be part of the proximal end 68 of sleeve 12. In a preferred embodiment, the sleeve 12 and housing 14 are constructed of two separate pieces or elements that are connected together so that the reaming sleeve 12 can be replaced if necessary.

As illustrated in Figs. 15-18, housing 14 is preferably generally cylindrical in shape and includes a top portion 80, a bottom portion 82 and a centrally located, cylindrical through bore 84. Bore 84 includes threading 85 on a portion of the bore's 84 surface (Figs. 16-18). The threading 85 on bore 84 is configured to mate with the threading 76 on the proximal end 68 of sleeve 12. Top portion 80 includes a first side 86 and a second side 88 separated by a raised centre portion 90. First side 86 is approximately 6mm lower than centre portion 90 (Fig. 15). First side 86 intersects part of centre portion 90 exposing a section of bore 84 creating opening 92 (Figs. 17 and 18). Opening 92 is adjacent a notch 94 on the surface of the first side 86 of housing 14. Notch 94 is sized and shaped to engage a tab 160 on the inner reamer 16. First side 86 also includes a through bore 95 adjacent to notch 94 (Figs. 15 and 17). As shown in Figs. 16 and 20, the part of the bottom portion 82 that is in alignment with first side 86 includes a generally oval-shaped cutout 96, through which bore 95 passes. In a preferred embodiment, cutout 96 is shaped to accommodate a generally oval-shaped locking button 98. Locking button 98 has an outer side 100, an inner side 102, and side walls 104. The inner side 102 of button 98 includes an upwardly extending cylindrical shaft 106 having a threaded opening 108. A notch 110 is placed on a portion of the outer side 100 of button 98, with notch 110 being sized and shaped to catch one of the teeth 78 on sleeve 12 (Figs. 19-21). Preferably,

locking button 98 is a spring-loaded button that is attached to the housing by placing a spiral compression spring 112 over shaft 106 and inserting shaft 106 and spring 112 into bore 95. A threaded screw 114 is inserted into bore 95 from the first side 86 of housing 5 14 and engages the threaded opening 108 in shaft 106 (Fig. 15). Thus, as illustrated in Figs. 24-26, a spring-loaded locking button 98 is provided that can be depressed in order to allow the proximal end 68 of sleeve 12 to be screwed into threaded portion 85 of bore 84 and then released, causing the notch 110 on button 98 to engage 10 one of the teeth 78 on sleeve 12, locking sleeve 12 into the housing 14.

As shown in Fig. 15, a portion of the second side 88 of housing 14 includes a centrally located, generally semicircular cutout 116. 15 Wall 118 of centre portion 90 includes a pair of parallel, horizontally placed through bores 120 positioned on either side of bore 84 that are sized and shaped to accommodate the legs 126 of a release button 122. Release button 122 is provided in order to lock the reamer 16 or release the reamer 16 from housing 14 (Figs. 24-26). 20 In a preferred embodiment, as shown in Fig. 15, release button 122 is generally U-shaped in which base 124 of the U-shape is crescent-shaped and legs 126 of the U-shape are generally cylindrical. Each of the legs 126 have a vertical opening 128 in their distal ends 130. Preferably, release button 122 is a spring-loaded button that is 25 constructed by placing spiral compression springs 132 over legs 126 and inserting legs 126 and springs 132 through bores 120 in the centre portion 90. The extending distal ends 130 of legs 126 are then inserted into corresponding openings 134 of a rectangular block 136, that includes a pair of vertical bores 138, that intersect 30 the block openings 134. Pins (not shown) are inserted through vertical bores 138 and into openings 128 of legs 126 of the button 122, fastening the block 136 to the release button 122 (Fig. 15). In a preferred embodiment, the rectangular block 136 includes a bevelled centre section 137 that allows the inner reamer 16 to be 35 locked in place without releasing button 122.

As illustrated in Figs. 24-26, when the assembled release button 122 is in its closed position on the housing 14, block 136 is positioned against wall 142 of the centre portion 90 which effectively covers notch 94 on the surface of the first side 86 of housing 14 (Fig. 24). When the spring-loaded release button 122 is pressed inwardly toward the centre portion 90, block 136 moves away from wall 142 of the centre portion 90, exposing notch 94 (Fig. 25).

The inner reamer 16 of the reaming assembly 10 has an elongated cannulated body 144 and proximal and distal ends 146, 148 (Figs. 10 and 22). However, elongated body 144 can also be formed from a solid rod that is not cannulated. Distal end 148 has a rotatable reaming head 150 of a type known to one skilled in the art of orthopaedic surgery (Fig. 22). The rotatable reaming head 150 includes a plurality of cutting blades 152 suitable for cutting through the intramedullary canal of a bone. The proximal end 146 of inner reamer 16 includes a connection mechanism 154 configured in the shape of a drive shaft 156 of a type known to one skilled in the art of orthopaedic surgery (Fig. 23). Any suitable connection mechanism 154 can be employed to interconnect or detachably connect the drive shaft 156 to a rotational driver, such as that found in a conventional reaming drill or other suitable device. In a preferred embodiment, inner reamer 16 can include a flexible centre section 147 that allows the reamer 16 to also be used to ream the proximal tibia, thus eliminating the need for a separate instrument. The flexible centre section 147 of inner reamer 16 can be formed by cutting concentric helical cuts in opposite directions in a metal tube so that torque can be applied. The concentric helical cuts will provide both rigidity and flexibility to the centre section 147 of the inner reamer 16.

A portion of inner reamer 16 includes an annular collar 158 that is of a slightly larger diameter than the diameter of cannulated body 144 of inner reamer 16 (Figs. 22 and 23). Collar 158 includes a tab 160 that is sized and shaped to mate with notch 94 housing 14 in order to secure inner reamer 16 in the housing 14. As shown in Figs. 24-26, inner reamer 16 in the housing 14 with the release

button 122 in an open position which exposes notch 94 of housing 14. After tab 160 has been placed in notch 94, the button 122 is released, thus locking tab 160 in notch 94. Alternatively, the bevelled centre portion 137 of the block 136 allows tab 160 to slide into the notch 94 without having to expose notch 94.

In a preferred embodiment, a plurality of reamers (not shown) of graduated sizes are used with the reaming apparatus 10 for progressively reaming the canal of a bone after the initial reaming has been performed with the inner reamer 16. The reamers are typically graduated in 0.5mm increments, however, other graduated dimensions are contemplated.

In a preferred embodiment of the invention, the reaming assembly 10 and the entry portal tool 20 are used in combination to ream in a minimally invasive manner an intramedullary canal (Figs. 1 and 8). Preferably, a surgeon first uses the entry portal tool 20 to locate the most desirable location for the entry portal in the proximal femur or other long or flat bones. The multiple openings 58 and 64 of the conical tip and hubs 62, 66 of the entry portal tool 20 to enable precise placement of the guide pin. This is especially important in repairing fractures of the femoral neck where very precise placement of the entry portal is required.

The surgeon makes an appropriate nominally invasive incision in the patient and using the entry portal tool handle 34, he or she inserts the entry portal sheath 22, with the obturator 50 inserted in the sheath 22, into the incision. The surgeon then places one or more guide pins (not shown) through a selected one of the plurality of openings 58, 64 in the obturator 50, and using fluoroscopy, evaluates the position of the guide pins. If the surgeon desires to change the position of the guide pins, he or she can place one or more of the pins into another opening, or can rotate the obturator 50 within the sheath 22 of the entry portal tool 20. Once the surgeon has selected the best position for the entry portal, he will insert the guide pin into the bone. With the pin firmly imbedded in the bone,

the obturator 50 is removed from the sheath 22 of the entry portal tool 20.

5 The surgeon next inserts the reaming sleeve assembly 10 into sheath 22 and over the guide pin that is firmly imbedded in the bone (Fig. 8). The pin will act as a guide as the reamer assembly 10 reams an entry portal into the canal of the bone (Fig. 9). With the entry portal tool 20 and reamer assembly 10 still in place, the surgeon removed the inner reamer 16 from the assembly 10 by
10 depressing the release button 122 on the housing 14. The one or more guide pins are also removed with the inner reamer 16, however, the reaming sleeve 12 remains in place in the canal of the bone. At this point, the reaming sleeve 12 becomes a working channel through which the intramedullary canal can be opened up
15 to the appropriate diameter using progressively larger sized reamers as described above. A suction device attached to handle 34, 34A-B of the entry portal tool 20, 20A-B allows for the blood produced from the reaming to be suctioned up through holes 71 in the sleeve 12, into the sheath 22 of the entry portal tool 20, 20A-B
20 and out its handle 34, 34A-B in to a collection container. Upon completion of the canal preparation, entry portal tool 20 and the reaming sleeve 12 are removed and an intramedullary nail (pin or rod) is inserted into the canal.

25 Thus, with the minimally invasive reaming assembly 10 of the present invention, an entry portal into the canal of a bone can be created by a surgeon, who then uses the same assembly to provide a working channel in which to progressively ream the canal of the bone without damaging the soft tissues or losing the entry portal into
30 the bone.

Although the present invention has been described with reference to its preferred embodiments, those skilled in the art will recognise changes that may be made in form and structure that do
35 not depart from the spirit of the invention already described in the specification and embodied in the claims that follow.

CLAIMS

1. A minimally invasive reaming assembly for creating an entry portal into the canal of a bone and providing a working channel in which to ream the canal of a bone, the assembly comprising:
- 5
- a) an elongated cylindrically-shaped hollow sleeve having a proximal and a distal end, the distal end having one or more cutting blades.
- 10 b) a housing adjacent to the proximal end of the sleeve, the housing having a top portion, a bottom portion and a through bore, the top portion including releasable engagement means for engagement with an inner reamer.
- c) an inner reamer having an elongated body and proximal and distal ends, the distal end having a rotatable reaming head and the proximal end having connecting means for connection to a drill, a portion of the body including engagement means for engagement with the housing, the reamer being sized and shaped for insertion through the bore of the housing and the sleeve.
- 15
- 20 d) whereas the minimally invasive reaming assembly is configured to create an entry portal into the canal of a bone and to provide a working channel in which a plurality of reamers of graduated sizes are inserted for progressively reaming the canal of a bone.
- 25
2. The assembly of claim 1, wherein the housing and sleeve are separate elements in which the bottom portion of the housing includes engagement means for engaging with an engagement means on the proximal end of the sleeve for releasable attachment of the housing to the sleeve.
- 30
3. The assembly of claim 2, wherein the engagement means of the proximal end of the sleeve includes threading for engaging with a threaded portion on a surface of the housing bore and a ring of horizontally placed teeth positioned below the threading on the sleeve.
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4. The assembly of claim 3, wherein the engagement means of the bottom portion of the housing further includes a spring loaded locking means for releasably engaging the horizontally placed teeth on the sleeve after the sleeve has been threaded into the housing.
- 5
5. The assembly of claim 1, wherein the engagement means of the top portion of the housing includes a notch sized and shaped for mating with a tab placed on an annular collar of the inner reamer.
- 10
6. The assembly of claim 5, wherein the engagement means of the top portion of the housing further includes a spring loaded release means for releasing the tab on the annular collar from the notch of the housing in order to remove the inner reamer from the housing and the sleeve.
- 15
7. The assembly of claim 1, wherein the inner reamer elongated body is cannulated.
8. The assembly of claim 1, used in combination with a
- 20 positioning apparatus configured to locate an entry portal in a patient's bone, the apparatus comprising:
- a) an elongated cylindrically-shaped hollow sheath having a proximal end, a distal end, and an upper and lower portion, the upper portion including at least one generally circular opening in the sheath;
- 25
- b) an elongated handle having a proximal and distal end and a through bore, the distal end including a connecting means for connecting and disconnecting the handle to the sheath;
- 30
- c) an elongated cylindrically-shaped tube having a proximal and distal end, the distal end having a conical tip with a plurality of openings, the proximal end including an annular collar having a greater diameter than the tube, the tube having a central
- 35 longitudinal axis;
- d) the elongated tube including one or more openings at its proximal end, at least one cylindrical hub having one or more

openings being placed longitudinally between the proximal and distal ends of the elongated tube, the openings of the proximal end, the at least one hub and the conical tip being aligned along parallel lines that are parallel with the central longitudinal axis of the tube;

5 e) the elongated tube being sized and shaped for removable insertion into the hollow sheath and the hollow sheath being sized and shaped for removable insertion of the assembly of claim 1 into the hollow sheath;

10 f) wherein the combination of the assembly of claim 1 and the positioning apparatus allows for the correct placement of an entry portal into a patient's bone, the cutting of the entry portal into the bone canal and the reaming of the canal through the sleeve.

15 9. The assembly of claim 8, wherein the housing and sleeve are separate elements in which the bottom portion of the housing includes engagement means for engaging with an engagement means of the proximal end of the sleeve for releasable attachment of the housing to the sleeve.

20 10. The assembly of claim 9, wherein the engagement means of the proximal end of the sleeve includes threading for engaging with a threaded portion on a surface of the housing bore and a ring of horizontally placed teeth positioned below the threading on the sleeve.

25 11. The assembly of claim 10, wherein the engagement means of the bottom portion of the housing further includes a spring loaded locking means for releasably engaging the horizontally placed teeth on the sleeve after the sleeve has been threaded into the housing.

30 12. The assembly of claim 8, wherein the engagement means of the top portion of the housing includes a notch sized and shaped for mating with a tab placed an annular collar of the inner reamer.

35 13. The assembly of claim 12, wherein the engagement means of the top portion of the housing further includes a spring load release means for releasing the tab on the annular collar from the notch of

the housing in order to remove the inner reamer from the housing and the sleeve.

14. The assembly of claim 8, wherein the sheath includes a plurality of generally circular openings.

15. The assembly of claim 8, wherein the elongated handle is configured to allow for the suction of fluids from the reaming site up through the sleeve and out the bore of handle.

16. The assembly of claim 1, wherein the housing is replaced by a releasable engagement means on the proximal end of the sleeve for releasable engagement with an inner reamer.

17. A method of manufacture of a minimally invasive reaming assembly for creating an entry portal into the canal of a bone and providing a working channel in which to ream the canal of a bone comprising the step of connecting;

a) an elongated cylindrically-shaped hollow sleeve having a proximal and a distal end, the distal end having one or more cutting blades;

b) a housing adjacent to the proximal end, of the sleeve, the housing having a top portion, a bottom portion and a through bore, the top portion including releasable engagement means for engagement with an inner reamer;

c) an inner reamer having an elongated body and proximal and distal ends, the distal end having a rotatable reaming head and the proximal end, having connecting means for connection to a drill, a portion of the body including engagement means for engagement with the housing, the reamer being sized and shaped for insertion through the bore of the housing and the sleeve;

whereas the minimally invasive reaming assembly is configured to create an entry portal into the canal of a bone and to provide a working channel in which a plurality of reamers of graduated sizes are inserted for progressively reaming the canal of a bone.

18. An intramedullary nail reaming system comprising an entry portal tool 20, a reaming assembly 10 and an intramedullary nail characterised in that:

- 5 a) the entry portal tool 20 comprises:
- 1) an elongated hollow sheath 22 having a proximal end 24, a distal end 26; and
 - 2) an elongated handle 34 having a distal end 38 that is connected to the proximal end 24 of the sheath 22;
- 10 b) the reaming assembly 10 comprises:
- 1) an elongated hollow reaming sleeve 12 having a proximal end 68 and a distal end 70, the distal end 70 having a plurality of cutting blades 72;
 - 2) a housing 14 adjacent to the proximal end 68 of
15 the sleeve 12, the housing 14 having a through bore 84; and
 - 3) a plurality of reamers 16 each having an elongated body 144, a proximal end 146 and a distal end 148, the distal end 148 having a rotatable reaming head 150 and the proximal end having a connecting mechanism 154 for connection to
20 a drill, a portion of the reamer 16 including engagement means for engagement with the housing 14, each reamer 16 being sized and shaped for insertion through the bore 84 of the housing 14 and the sleeve 12, whereby the reaming heads 150 of each reamer 16 within the plurality of reamers 16 has a different diameter, and one
25 of the plurality of reamers is a final reamer 16 characterised in that it includes the largest diameter reaming head 150; and
- c) an intramedullary nail sized to fit within the opening created by the final reamer 16.

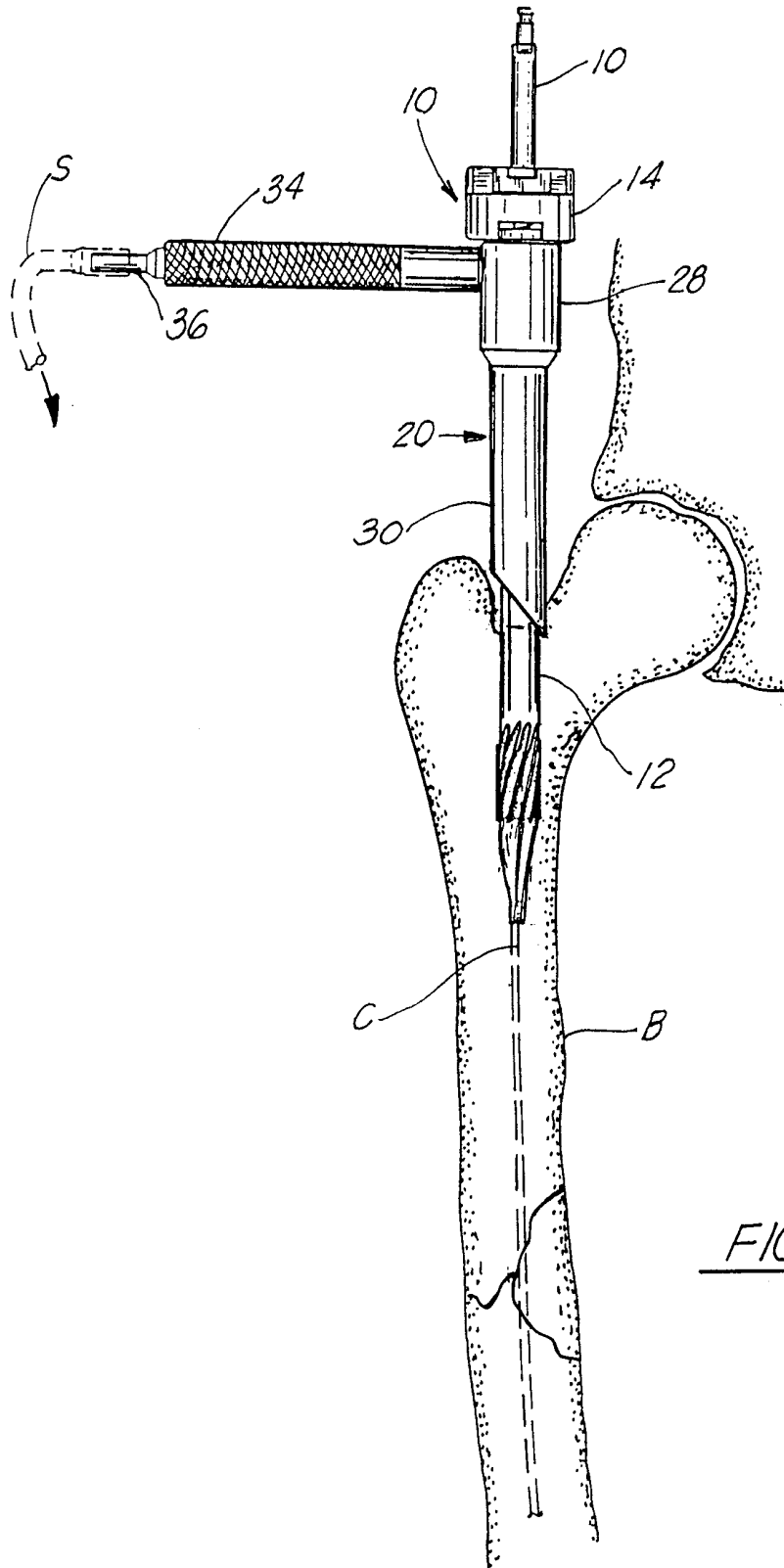
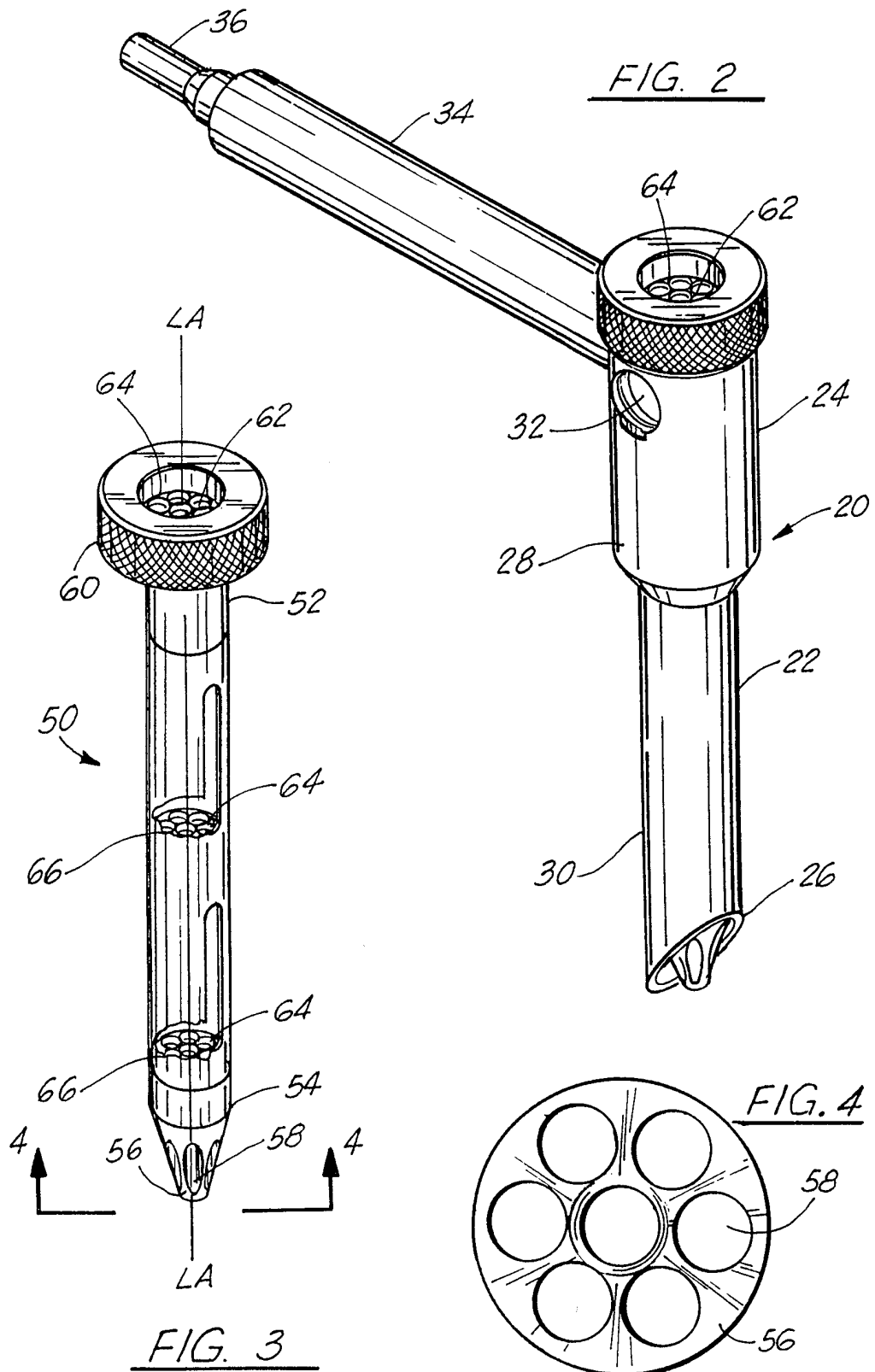
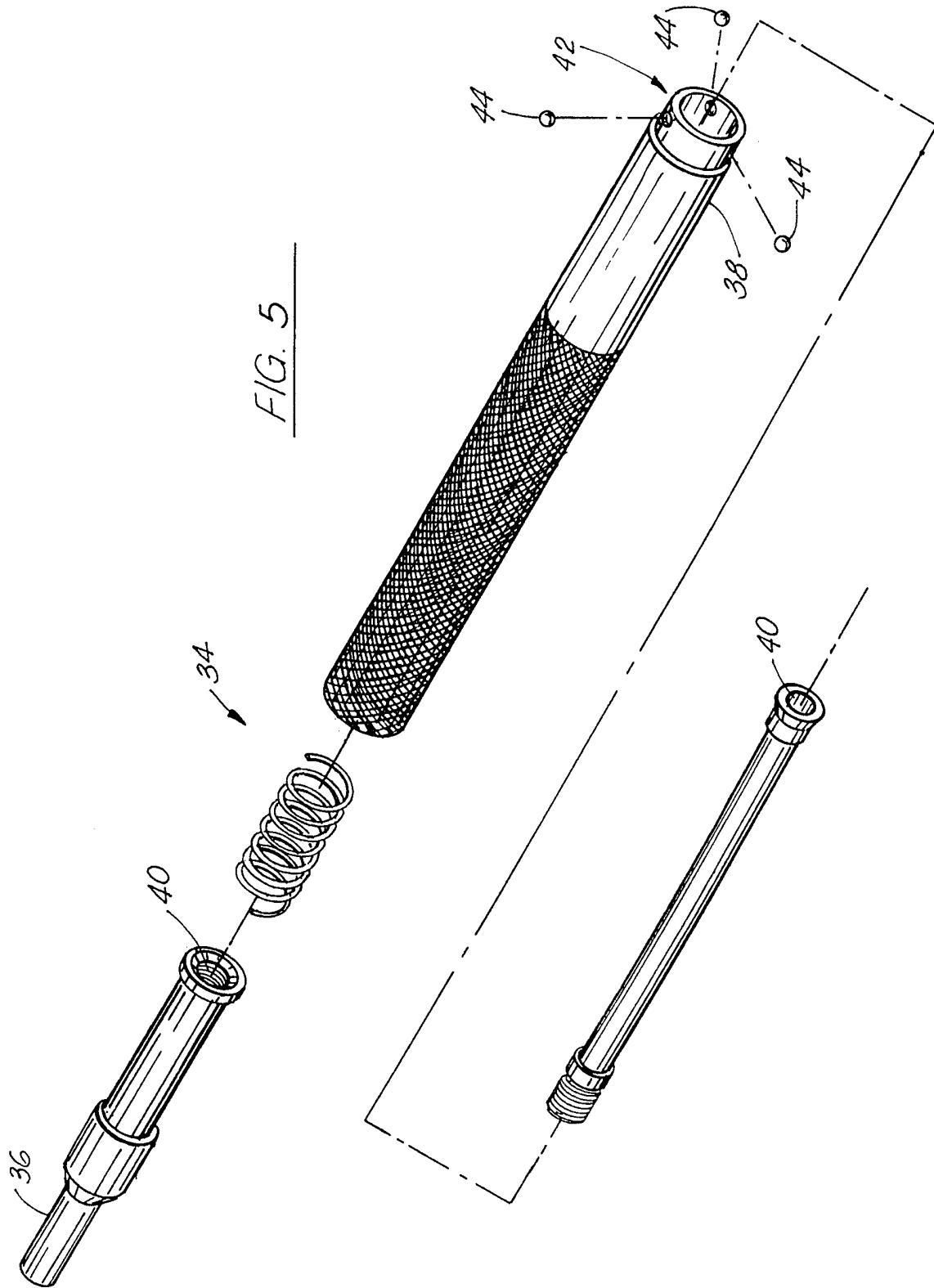


FIG. 1





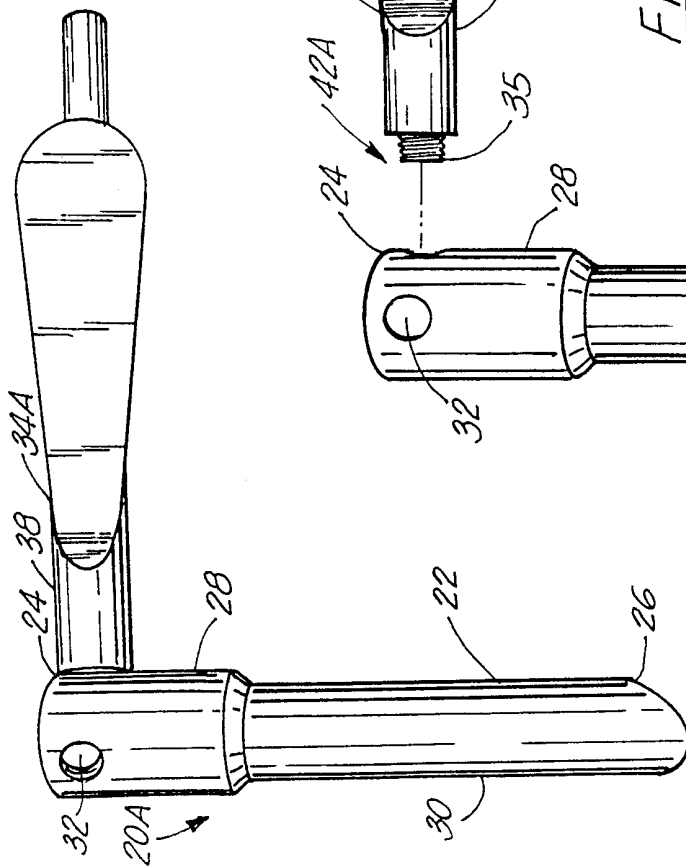


FIG. 6A

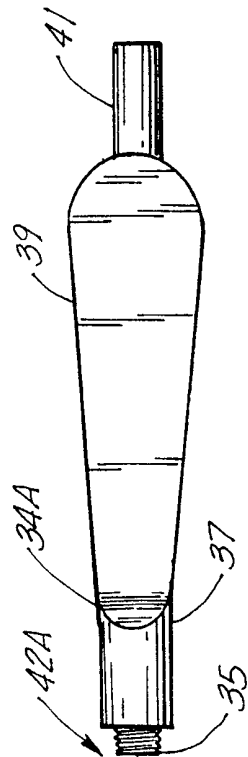


FIG. 6B

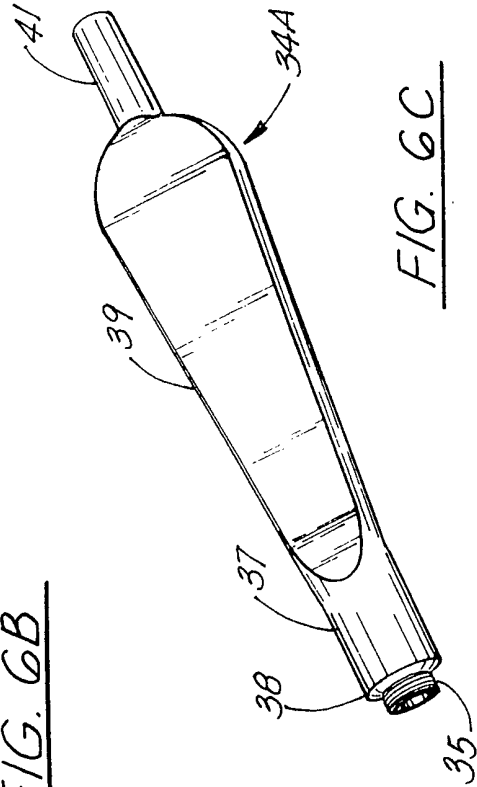


FIG. 6C

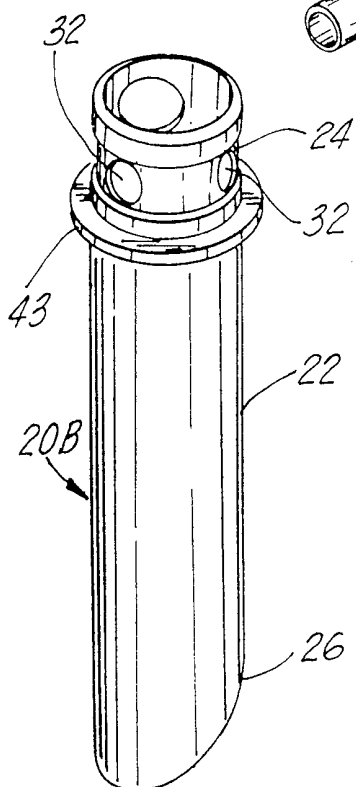
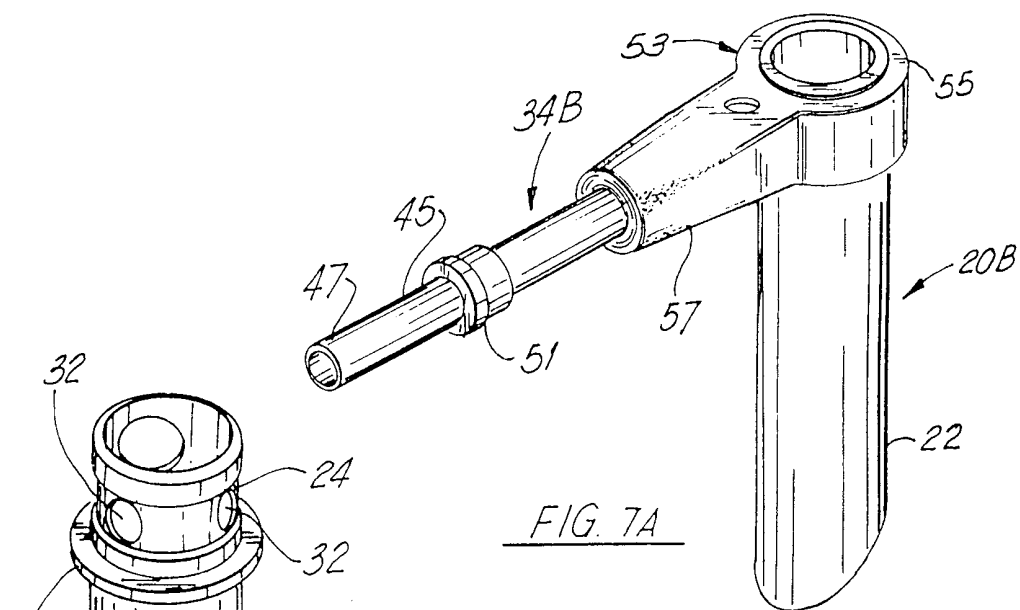


FIG. 7B

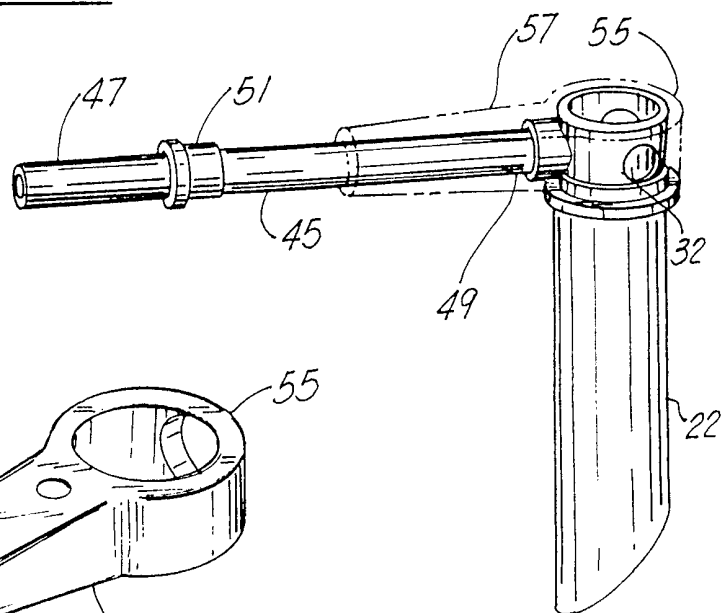


FIG. 7D

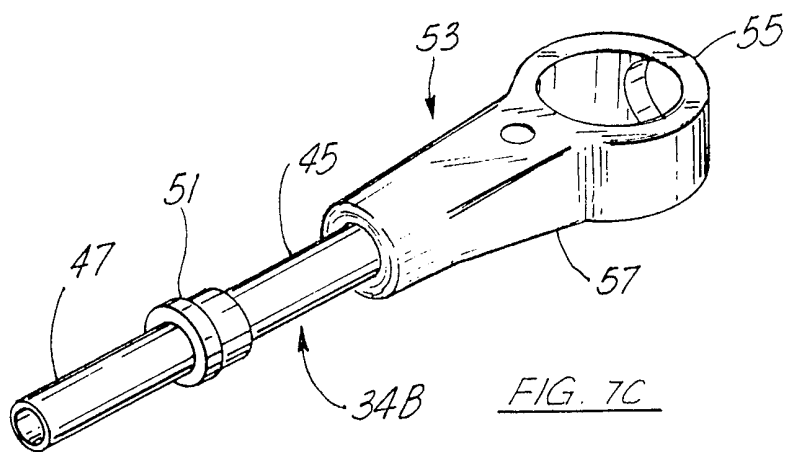


FIG. 7C

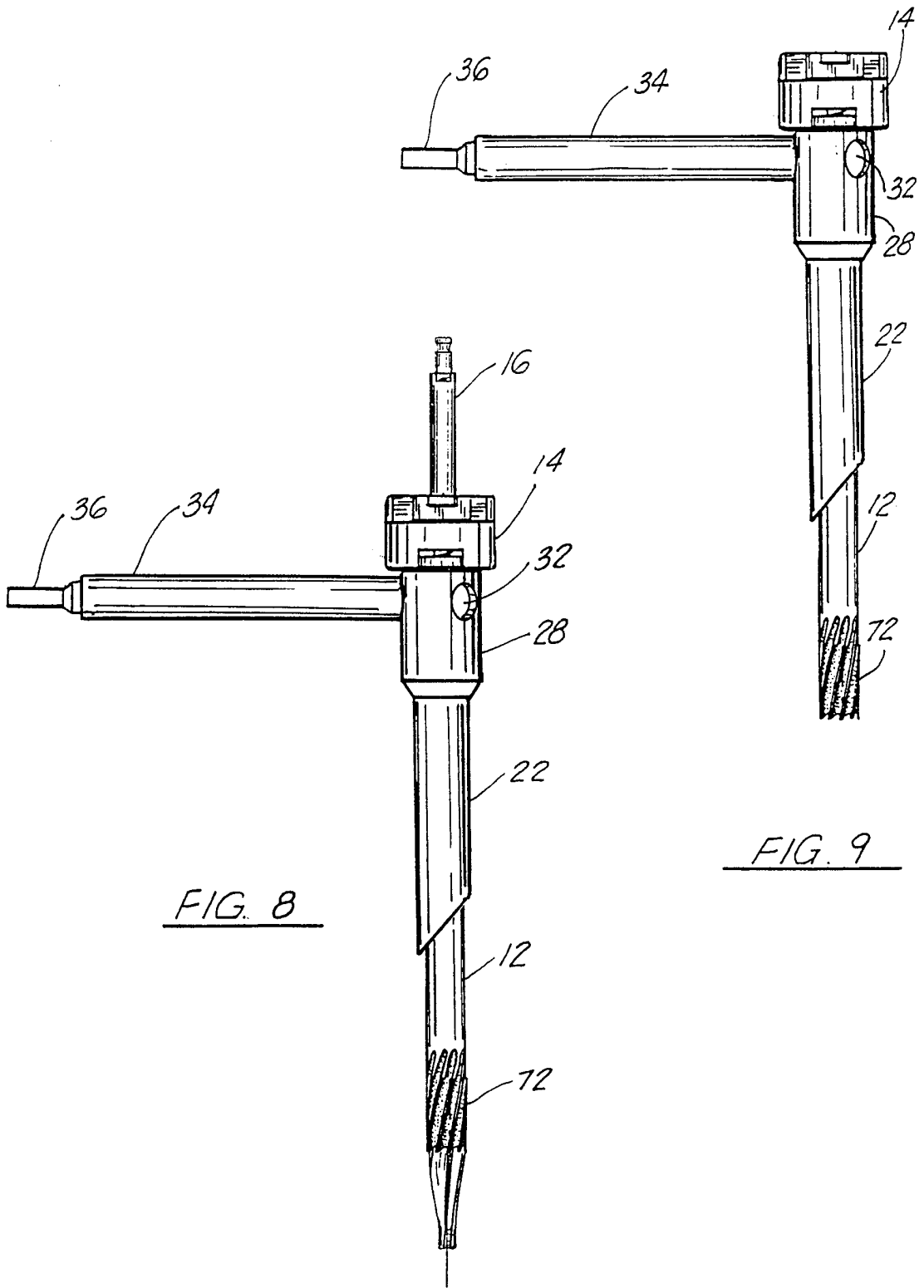


FIG. 8

FIG. 9

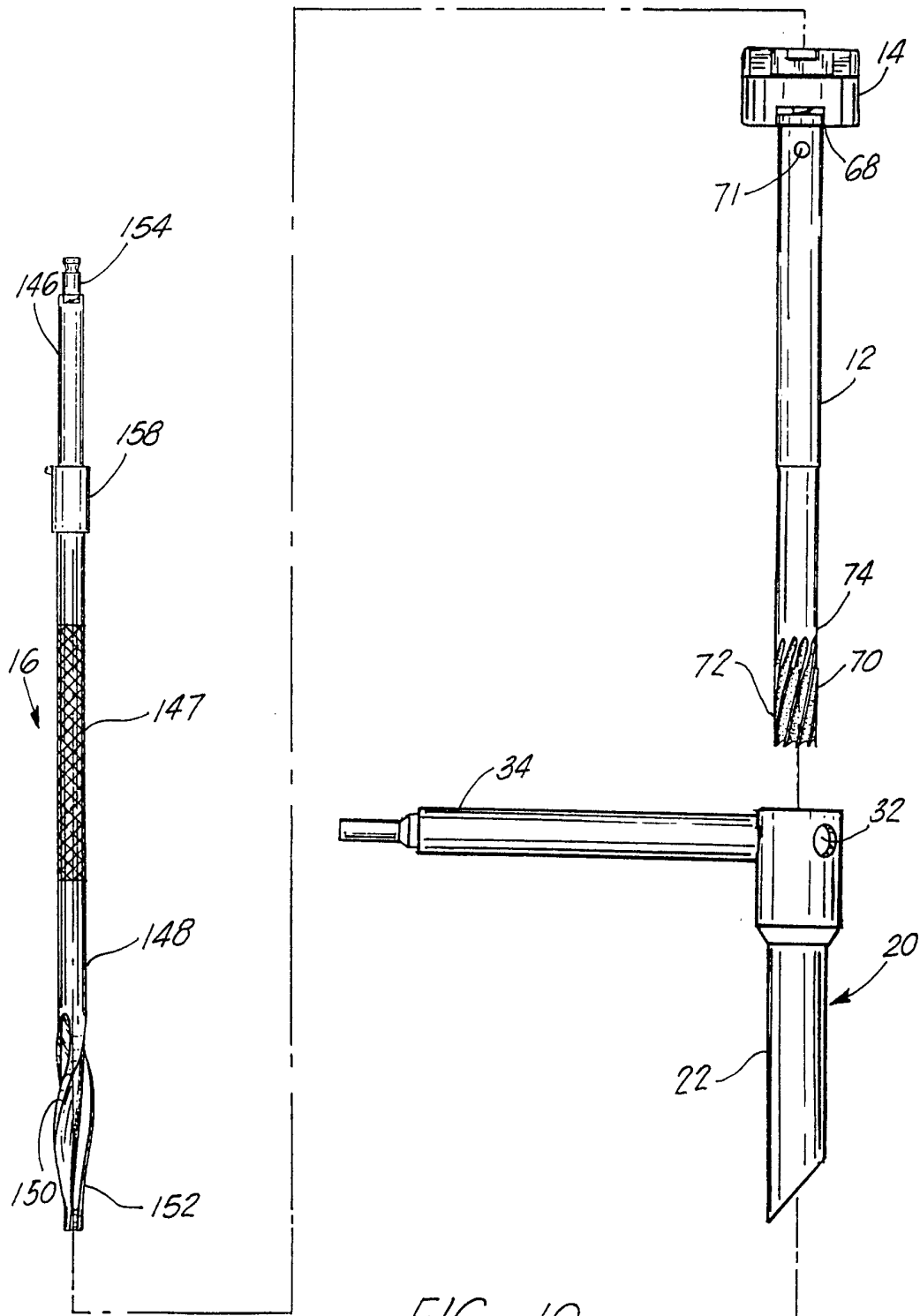


FIG. 10

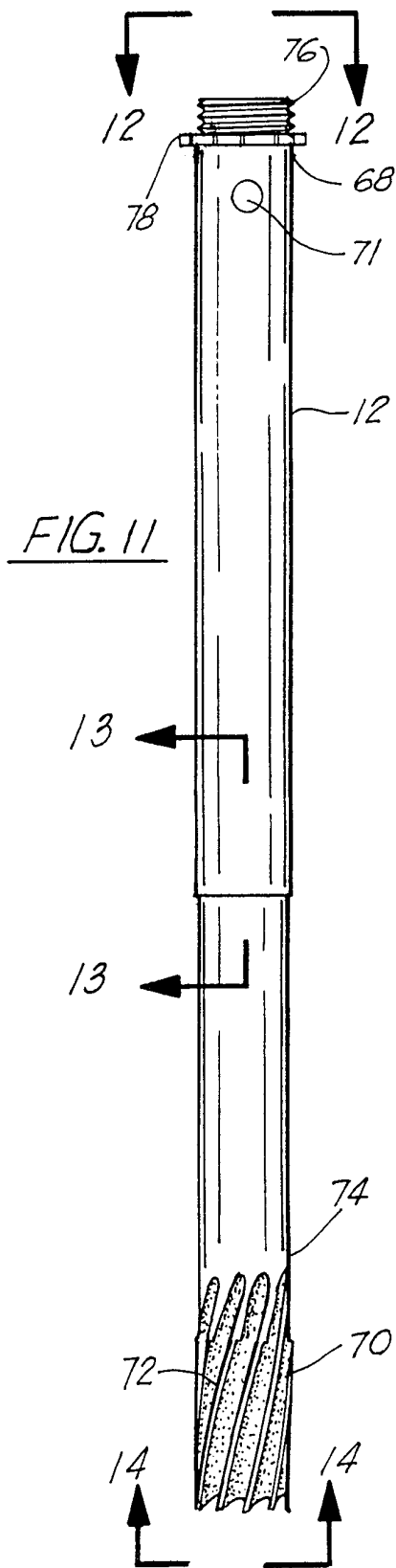


FIG. 11

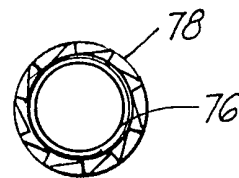


FIG. 12

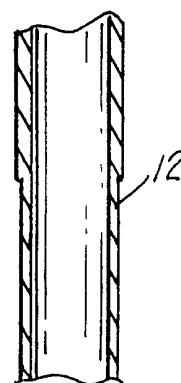


FIG. 13

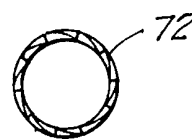


FIG. 14

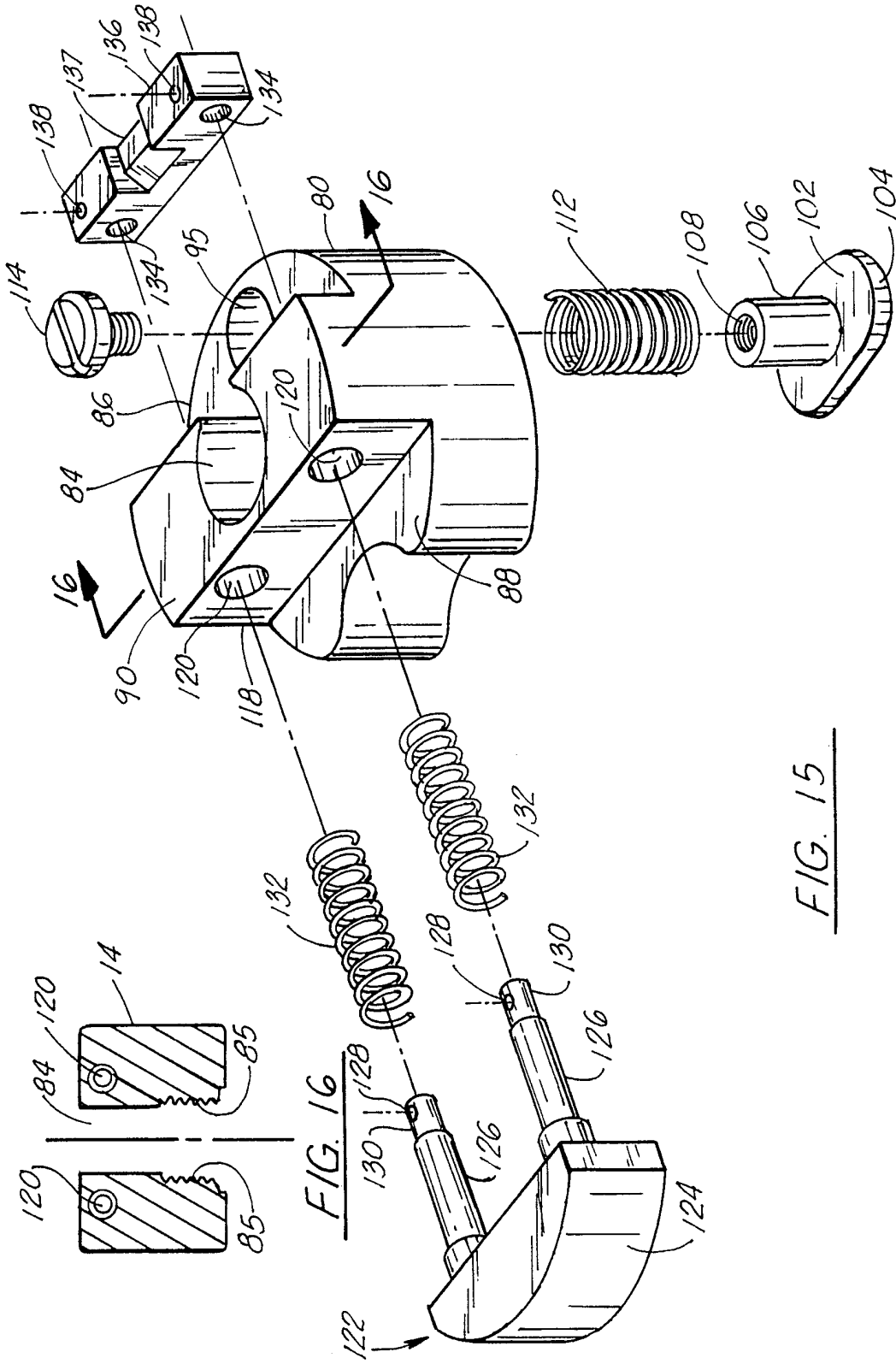


FIG. 15

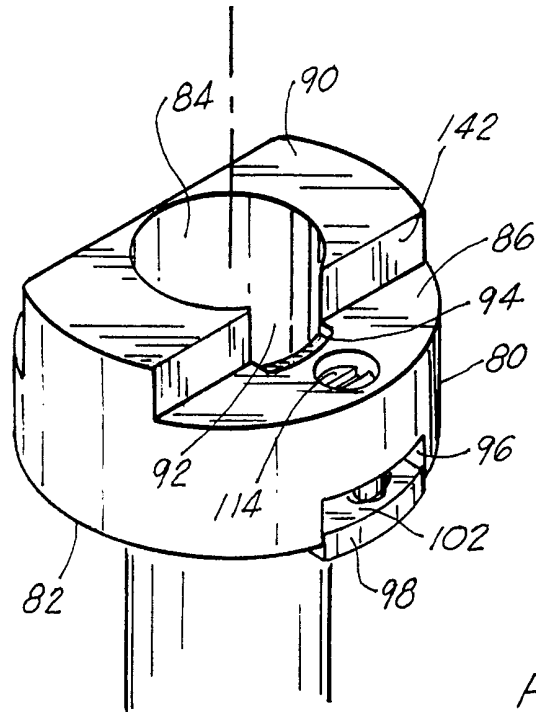


FIG. 17

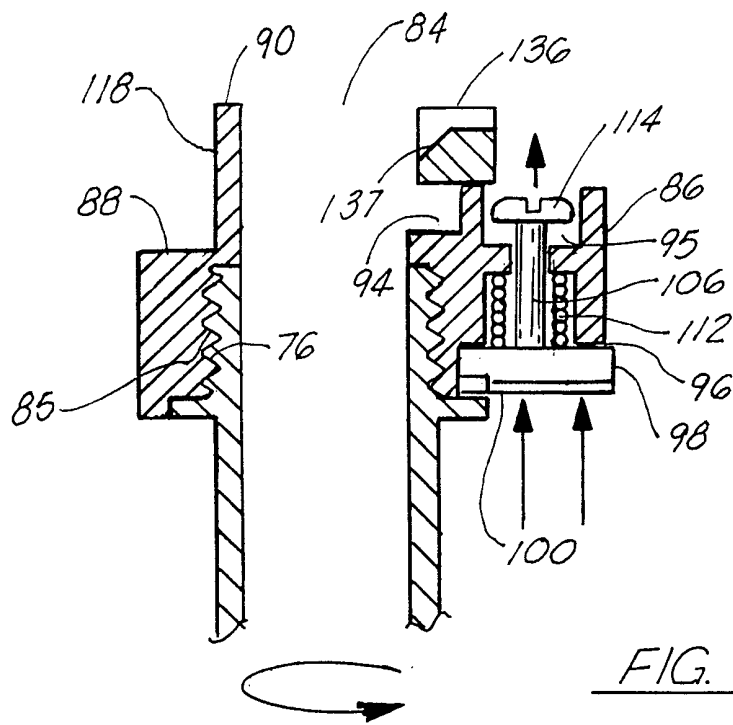


FIG. 18

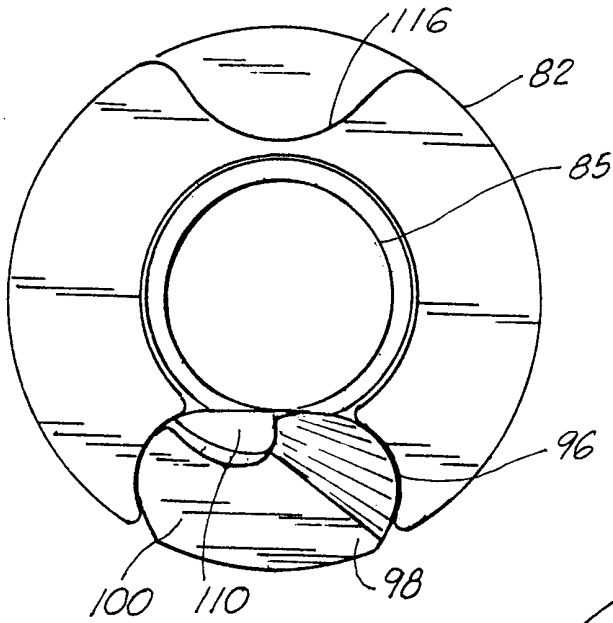


FIG. 19

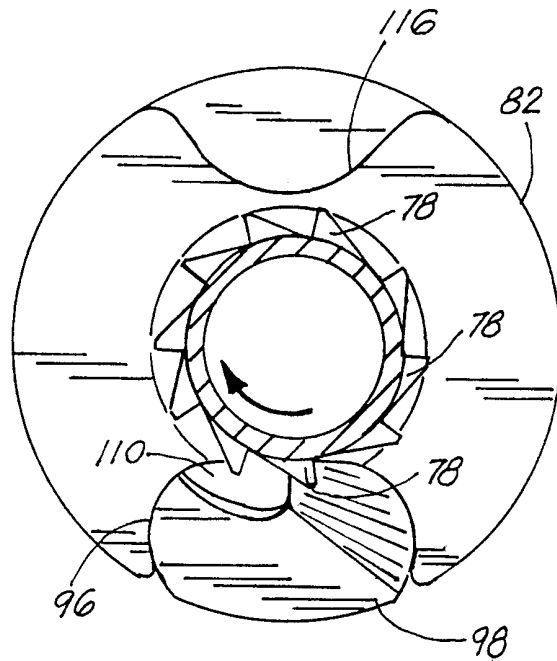


FIG. 20

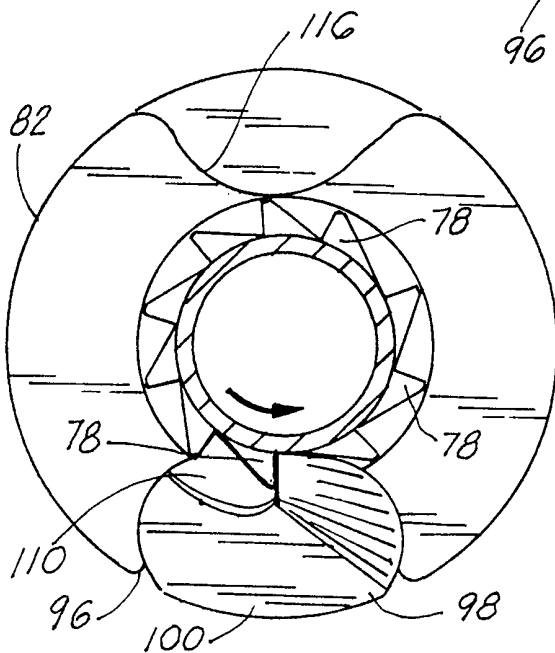


FIG. 21

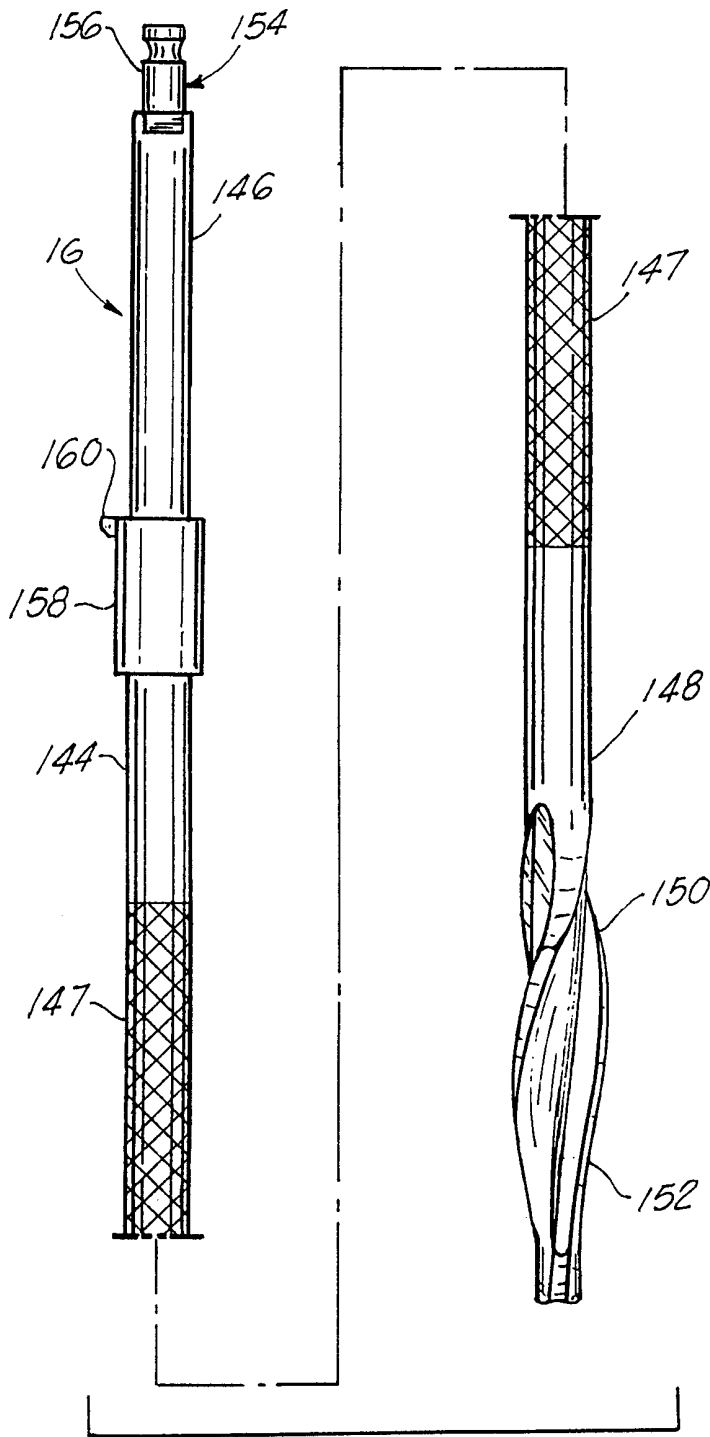
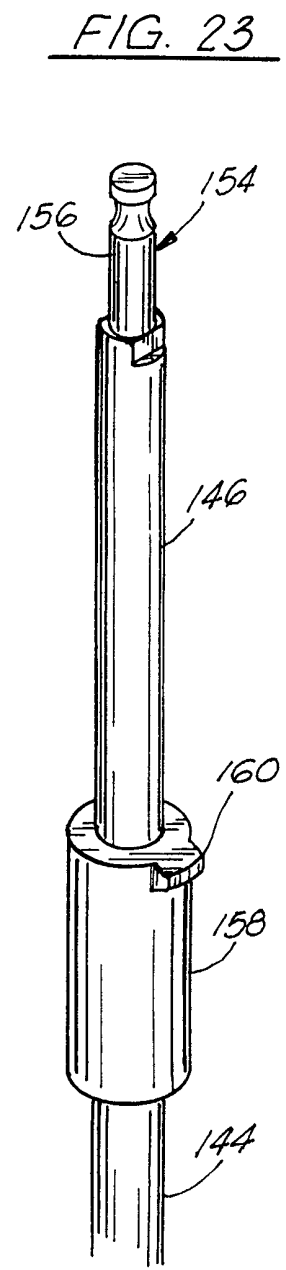


FIG. 22



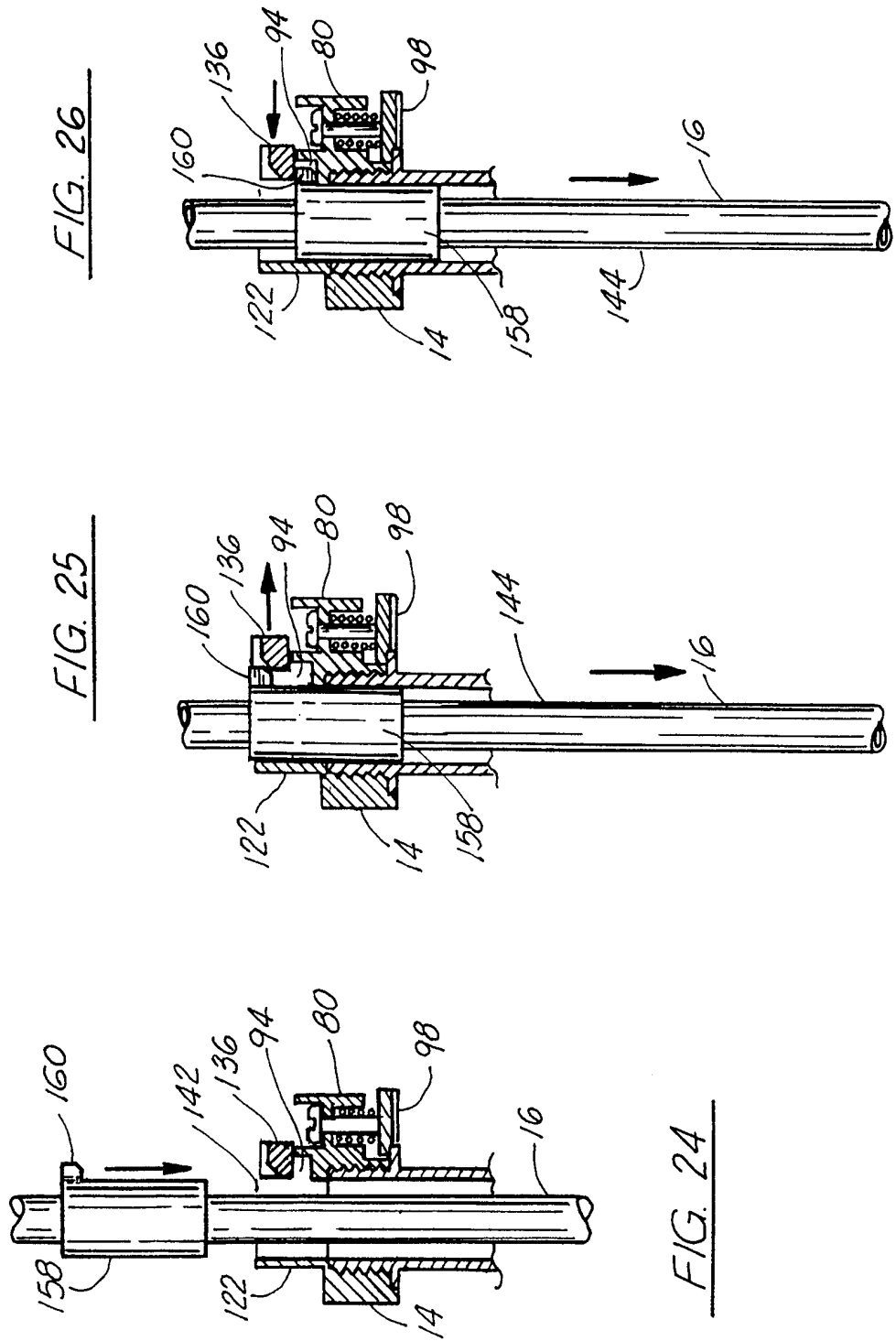


FIG. 26

FIG. 25

FIG. 24

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/14888

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B17/17

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 624 447 A (R.K.MYERS) 29 April 1997 (1997-04-29) cited in the application abstract; figures 1-3,5 ---	1,8, 16-18
A	WO 96 27345 A (G.K.MICHELSON) 12 September 1996 (1996-09-12) page 58, line 11 -page 60, line 16; figure 11A ---	1,8, 16-18
A	US 5 741 253 A (G.K.MICHELSON) 21 April 1998 (1998-04-21) column 7, line 51 -column 8, line 18; figures 3-3A ---	1,8, 16-18
A	DE 35 40 268 A (M.STÜRMER) 14 May 1987 (1987-05-14) claim 1; figure -----	15

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search

6 October 1999

Date of mailing of the international search report

15/10/1999

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/14888

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5624447	A	29-04-1997	NONE
WO 9627345	A	12-09-1996	US 5484437 A 16-01-1996 AU 701744 B 04-02-1999 AU 5025896 A 23-09-1996 AU 7139994 A 03-01-1995 AU 7741598 A 01-10-1998 CA 2213819 A 12-09-1996 CN 1128944 A 14-08-1996 DE 29623246 U 02-01-1998 EP 0703757 A 03-04-1996 EP 0812167 A 17-12-1997 JP 7008514 A 13-01-1995 JP 11500947 T 26-01-1996 WO 9428824 A 22-12-1994 US 5772661 A 30-06-1998 US 5505732 A 09-04-1996 US 5797909 A 25-08-1998 CA 2164859 A 22-12-1994
US 5741253	A	21-04-1998	US 5015247 A 14-05-1991 CA 2168835 A 30-04-1994 US 5593409 A 14-01-1997 US 5785710 A 28-07-1998 US 5505732 A 09-04-1996 US 5797909 A 25-08-1998 US 5484437 A 16-01-1996 US 5772661 A 30-06-1998 AT 169811 T 15-09-1998 AU 3838789 A 12-01-1990 CA 1332999 A 15-11-1994 DE 68928790 D 24-09-1998 DE 68928790 T 25-03-1999 EP 0419564 A 03-04-1991 EP 0712607 A 22-05-1996 WO 8912431 A 28-12-1989
DE 3540268	A	14-05-1987	NONE