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(19) **United States**

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Smith et al.

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(54) **DEVICES AND METHODS FOR PERCUTANEOUS TISSUE RETRACTION AND SURGERY**

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(73) Assignee: **Warsaw Orthopedic, Inc.**, Warsaw, IN (US)

(21) Appl. No.: **14/744,745**

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Filed: **Dec. 14, 2006**

U.S. Applications:

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(51) **Int. Cl.**
A61B 1/32 (2006.01)
A61B 17/02 (2006.01)

(52) **U.S. Cl.**
CPC ***A61B 17/02*** (2013.01)

(58) **Field of Classification Search**
CPC A61B 17/02; A61B 17/0218; A61B 17/3423
USPC 600/210, 208, 214
See application file for complete search history.

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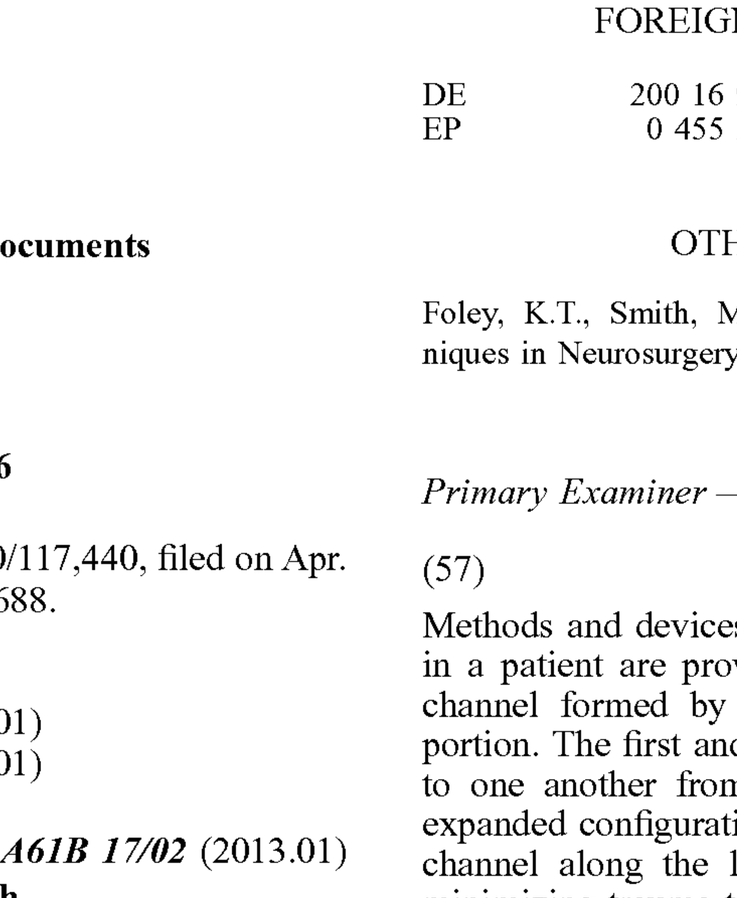
Primary Examiner — Beverly M Flanagan

(57) **ABSTRACT**

Methods and devices for performing percutaneous surgery in a patient are provided. A retractor includes a working channel formed by a first portion coupled to a second portion. The first and second portions are movable relative to one another from an unexpanded configuration to an expanded configuration to increase the size of the working channel along the length of the working channel while minimizing trauma to skin and tissue.

11 Claims, 12 Drawing Sheets



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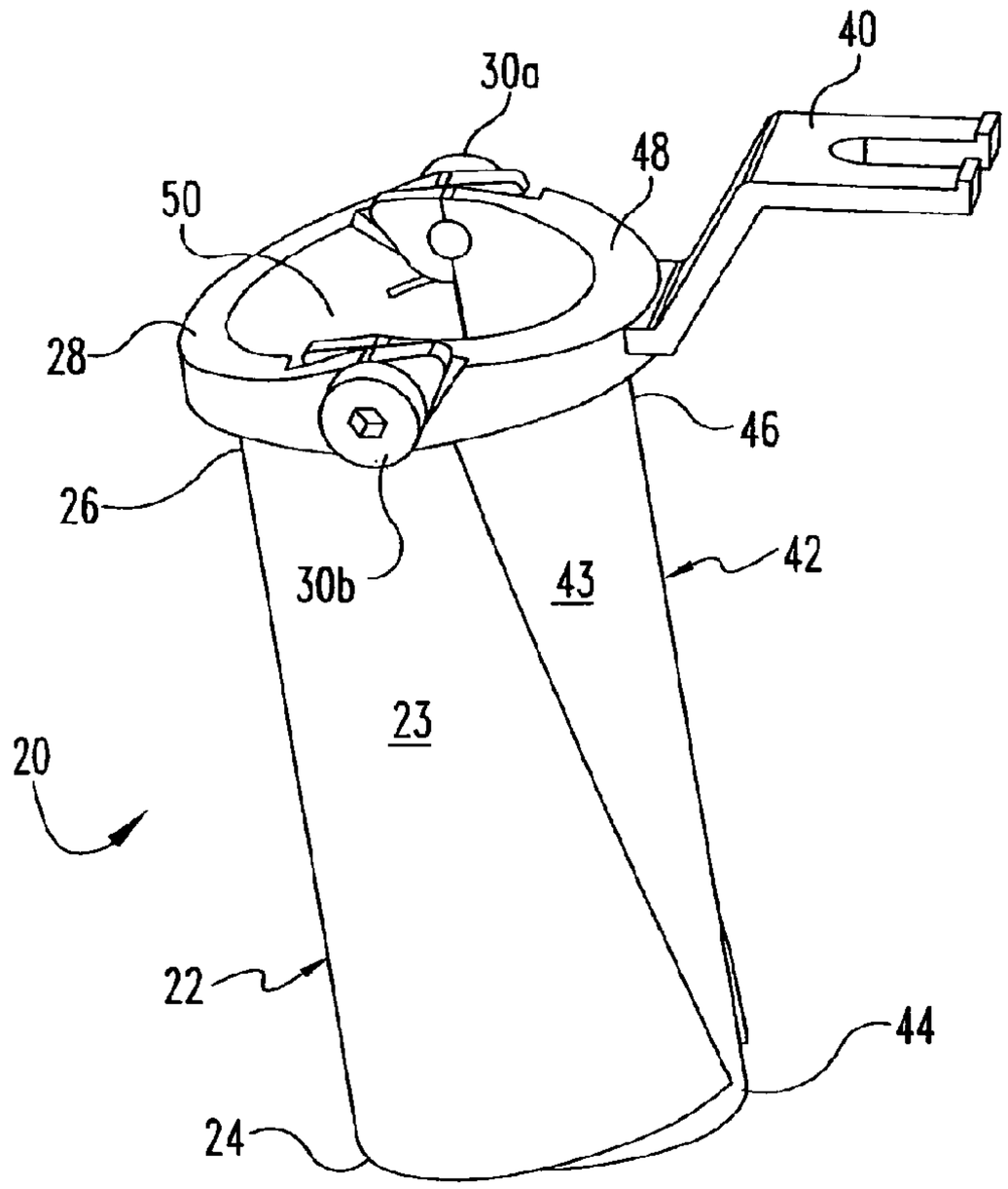
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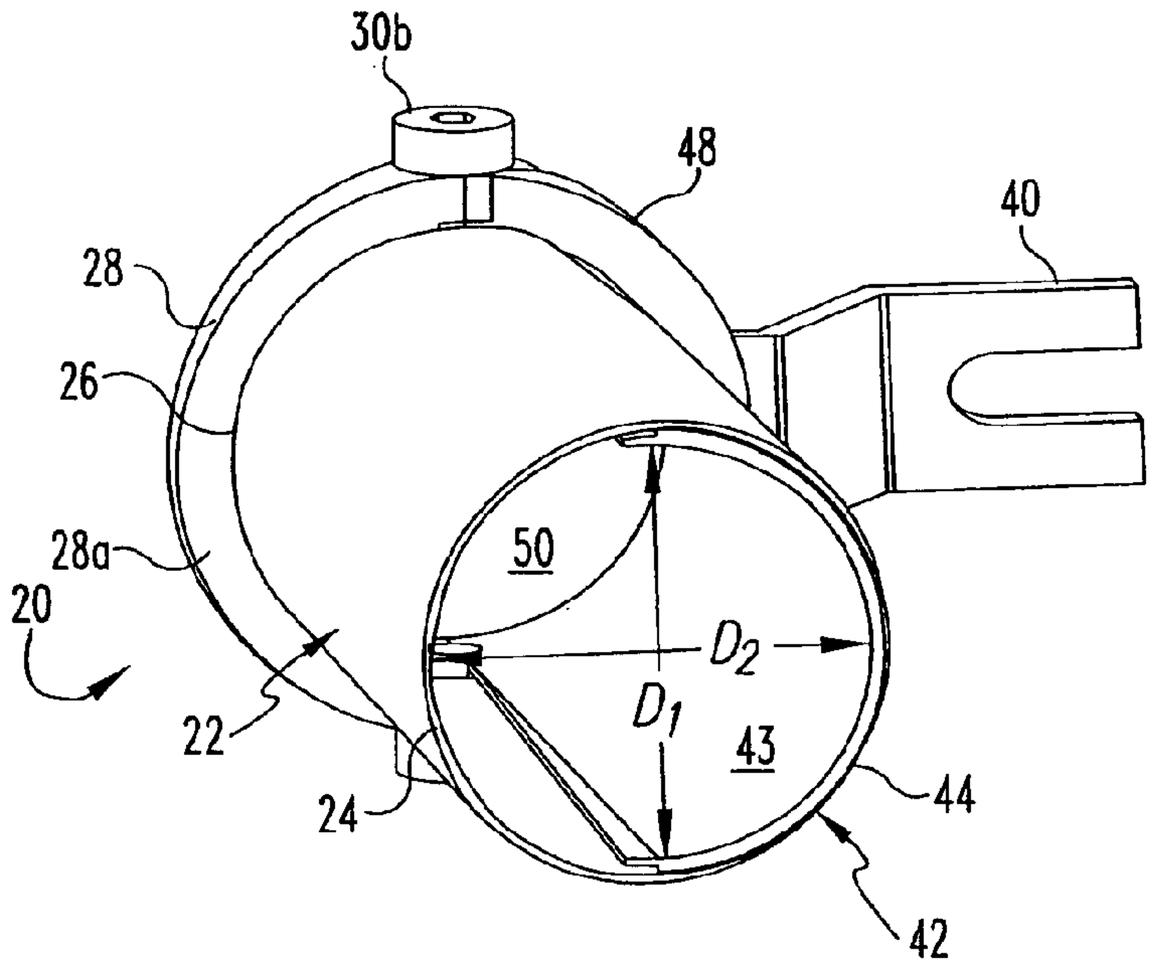
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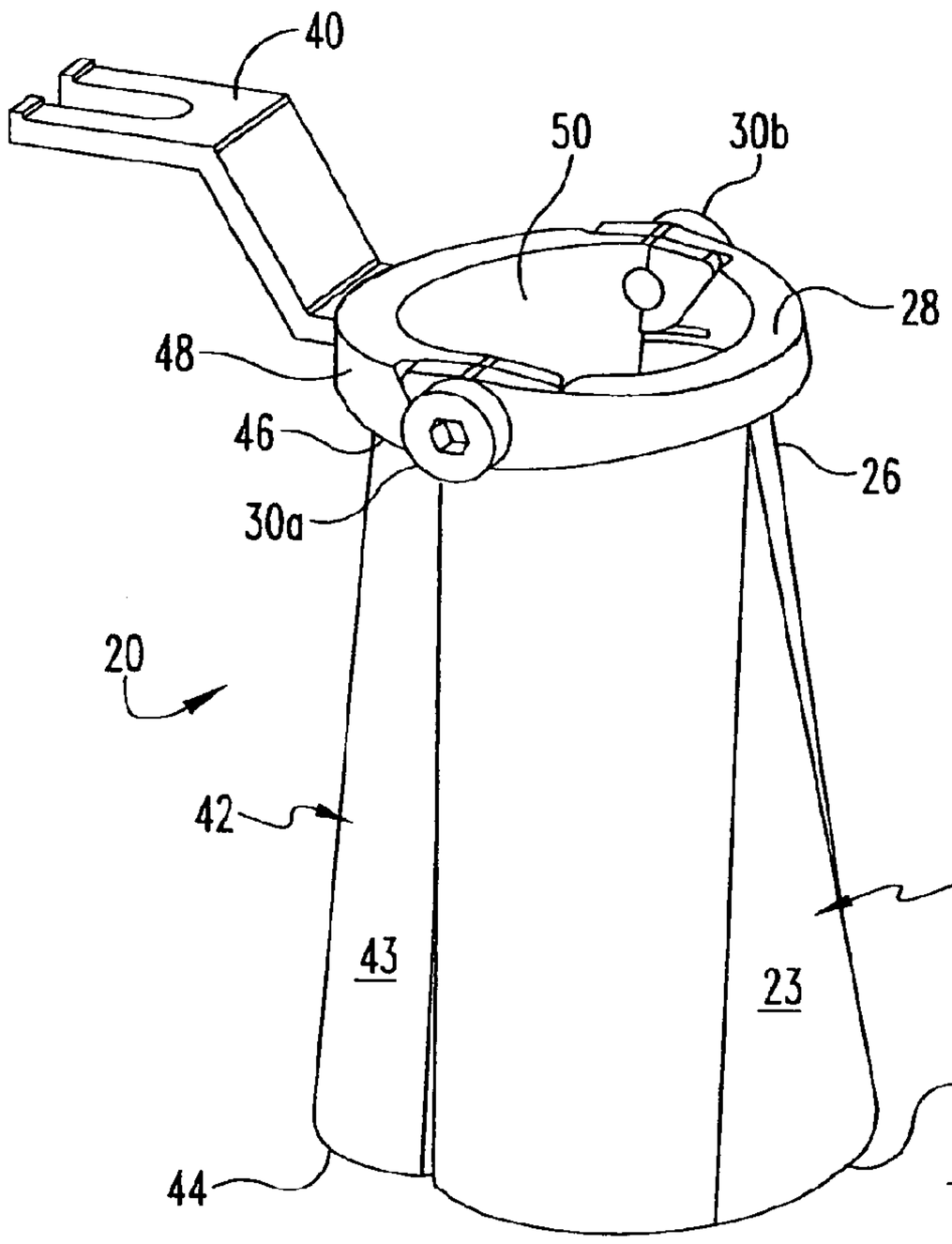
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Fig. 3

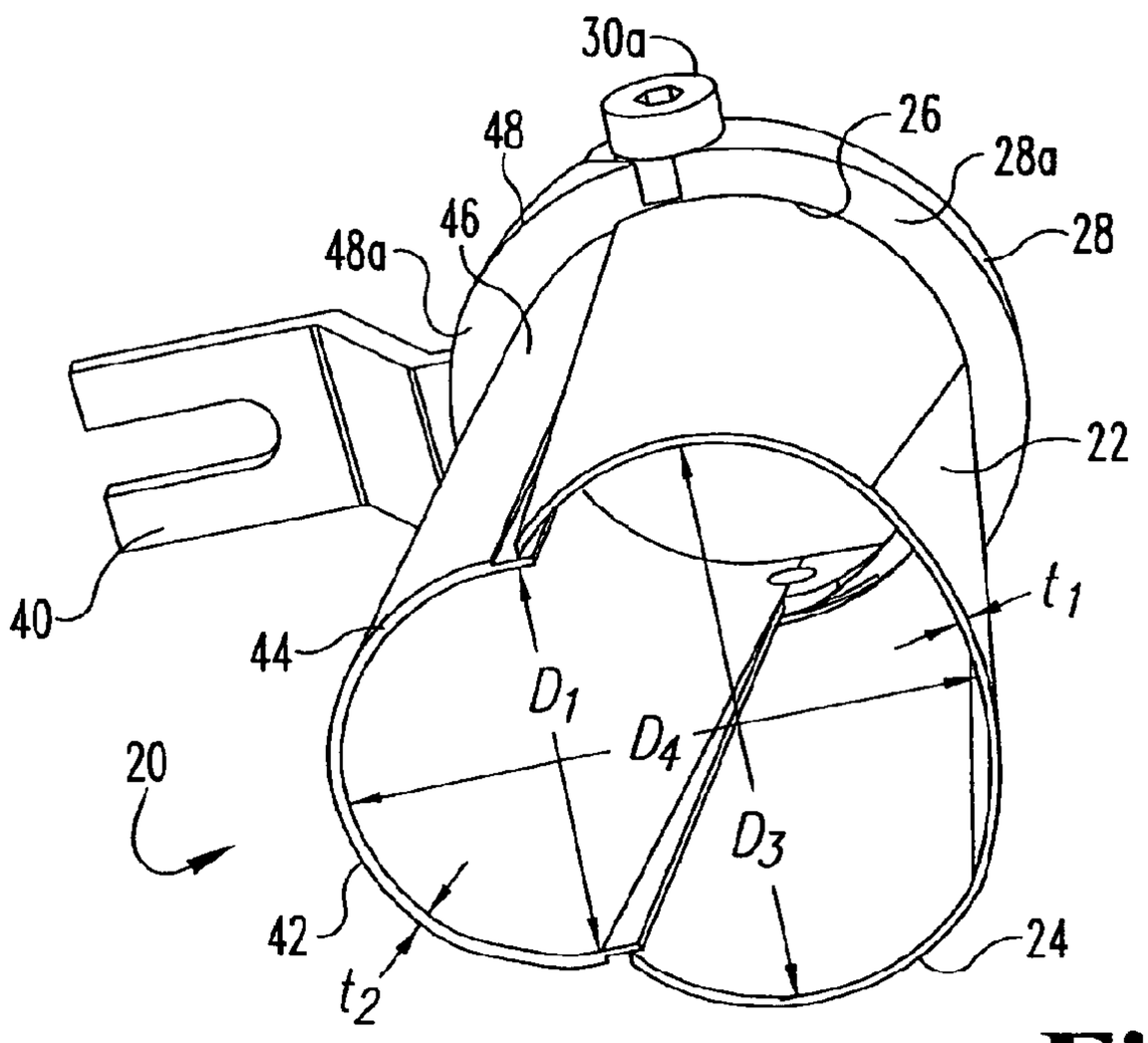
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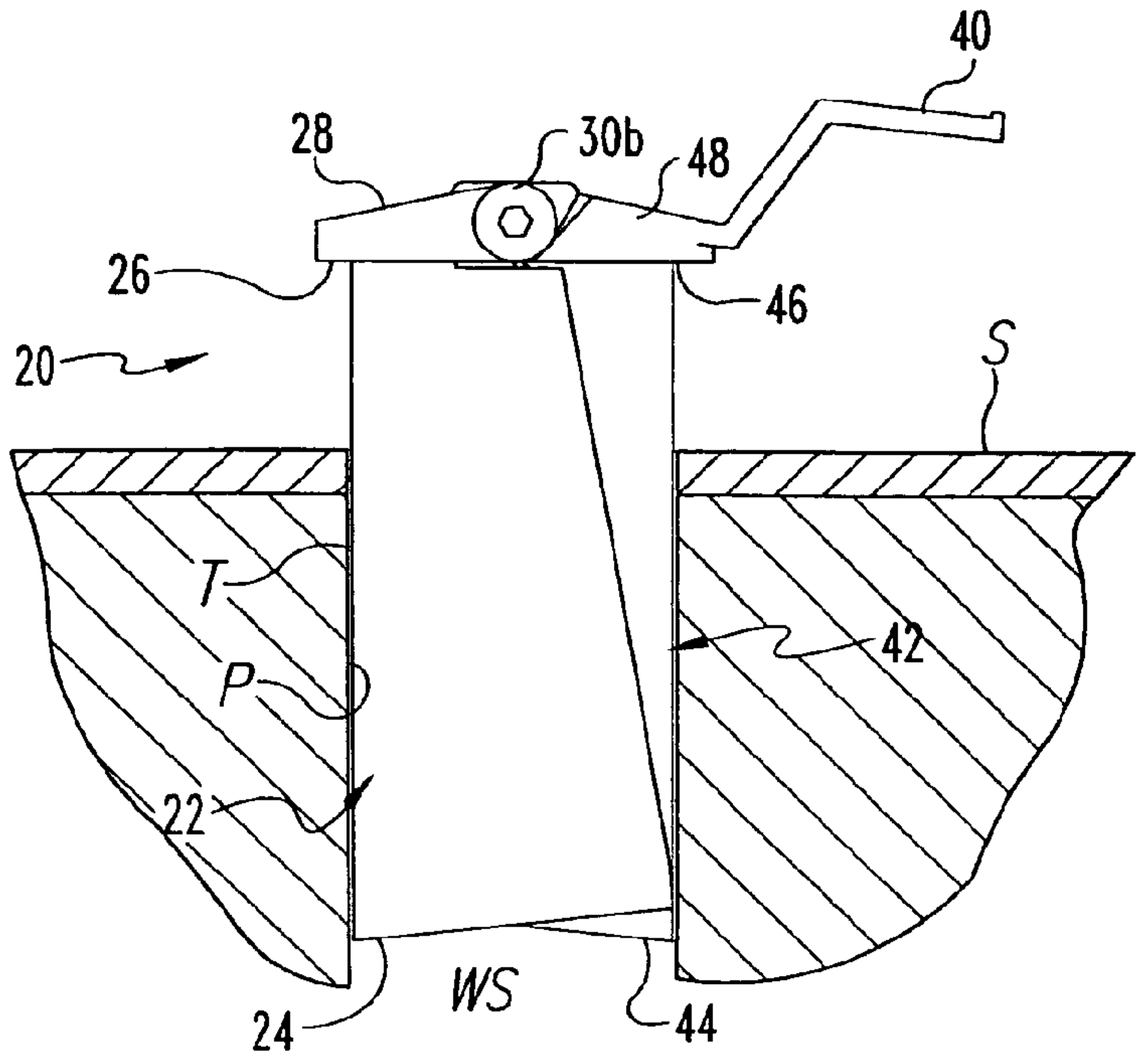
Fig. 4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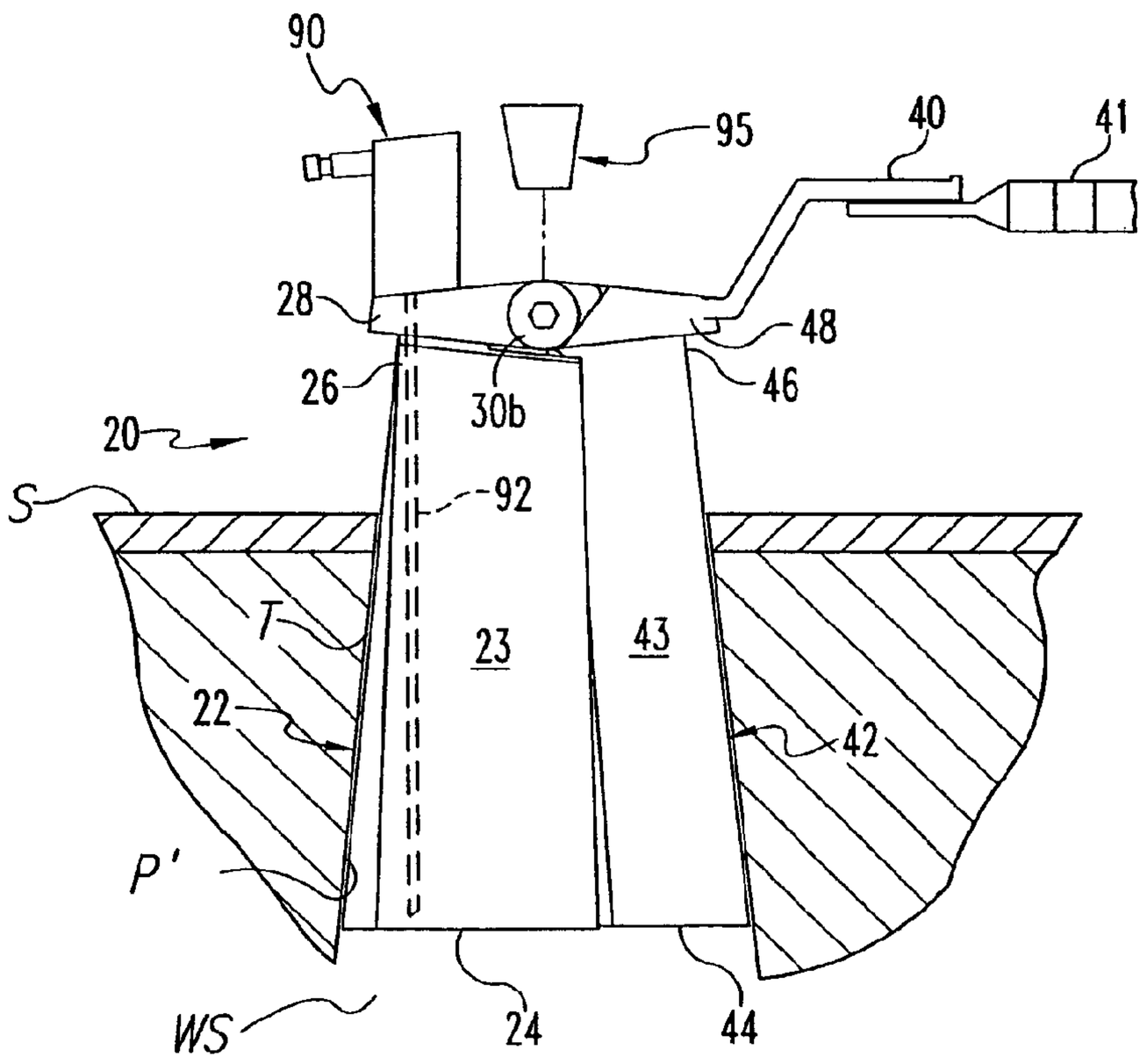
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Fig. 6

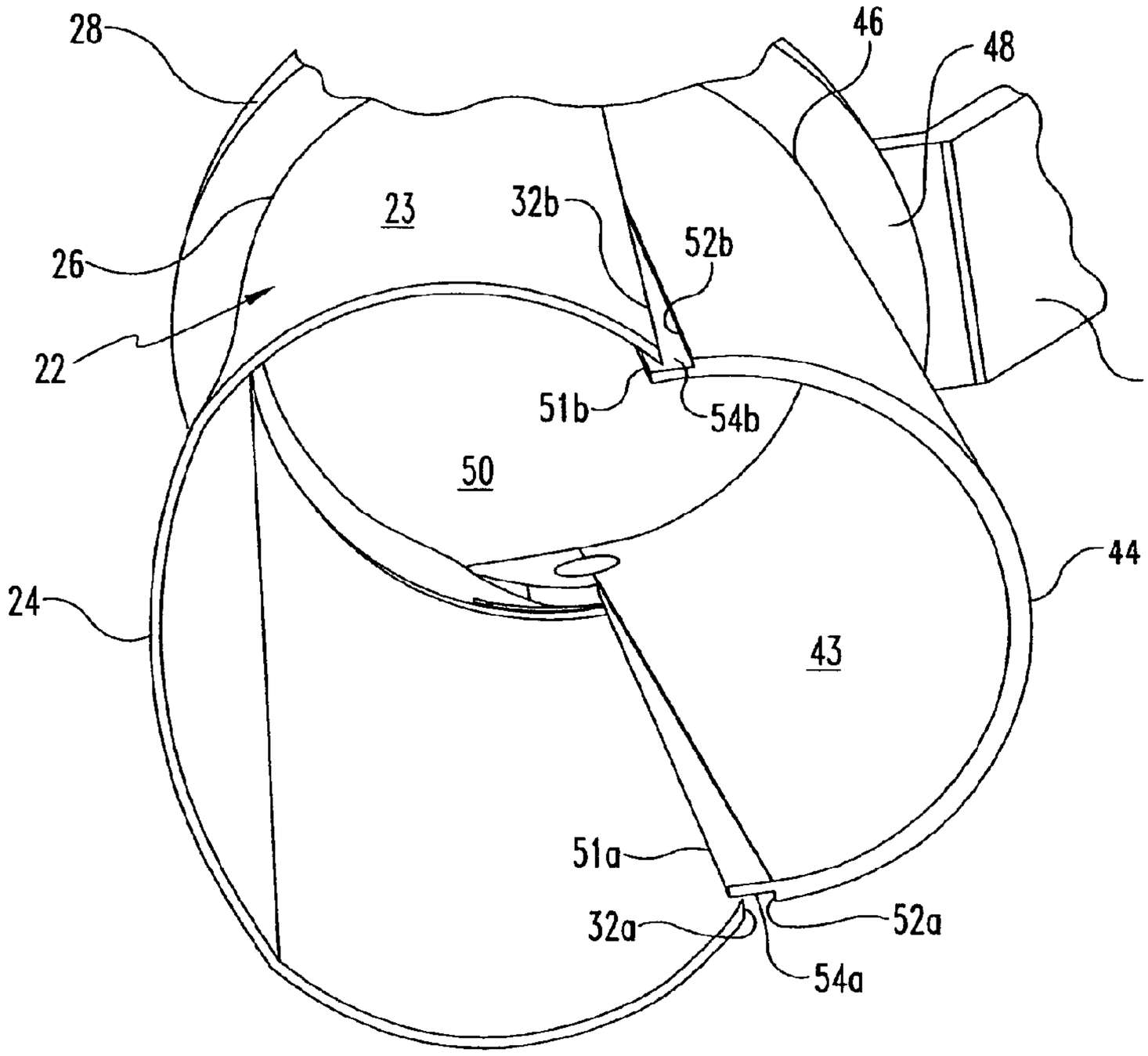
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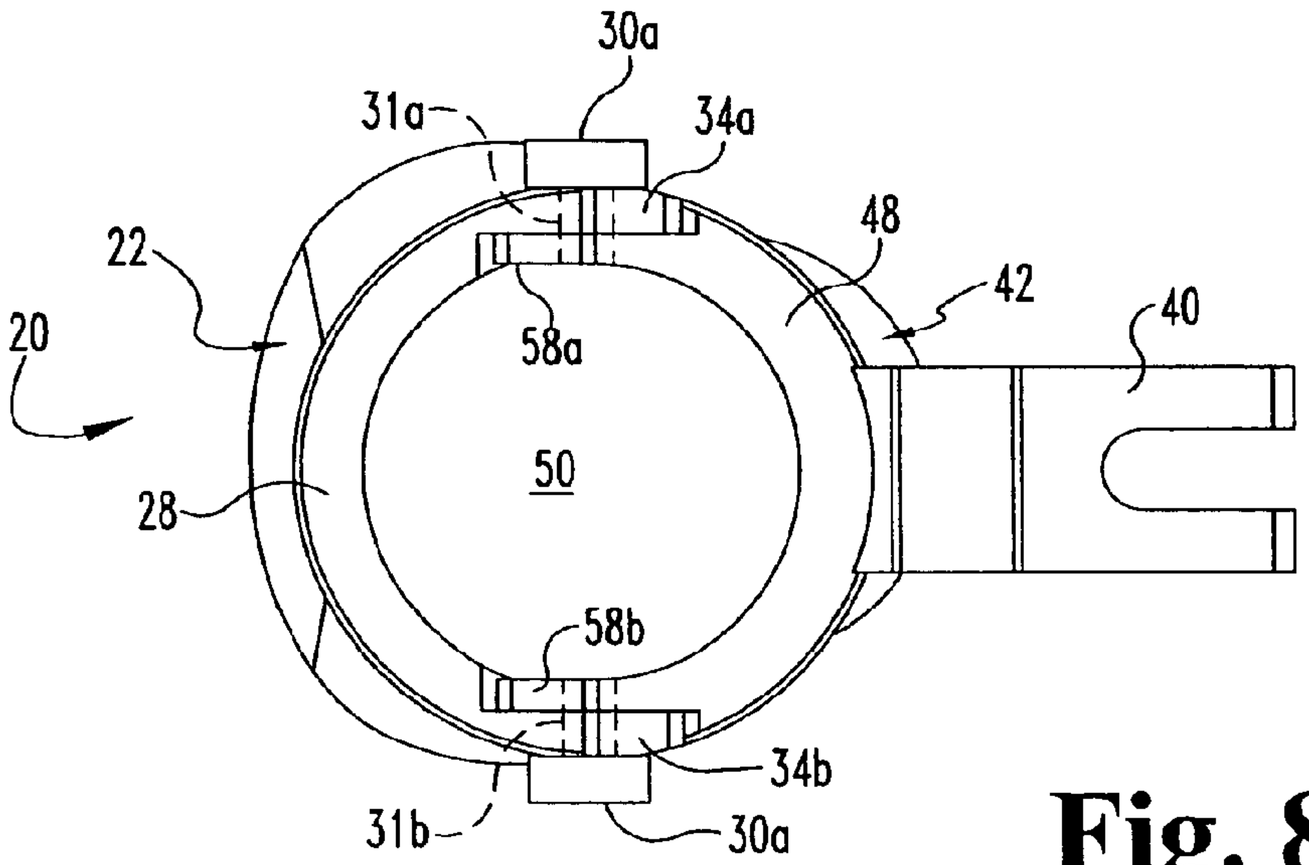
Fig. 7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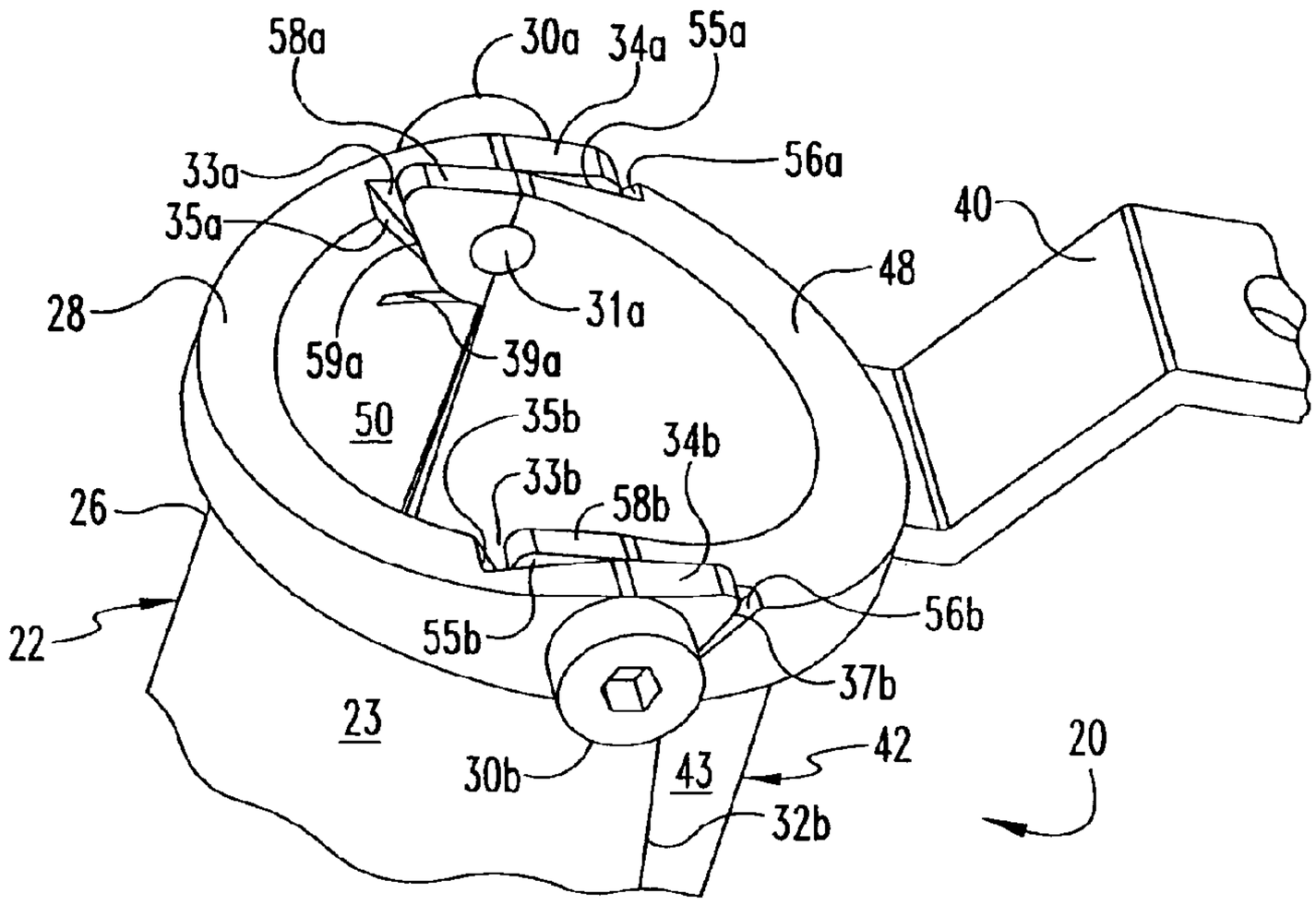
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Fig. 9

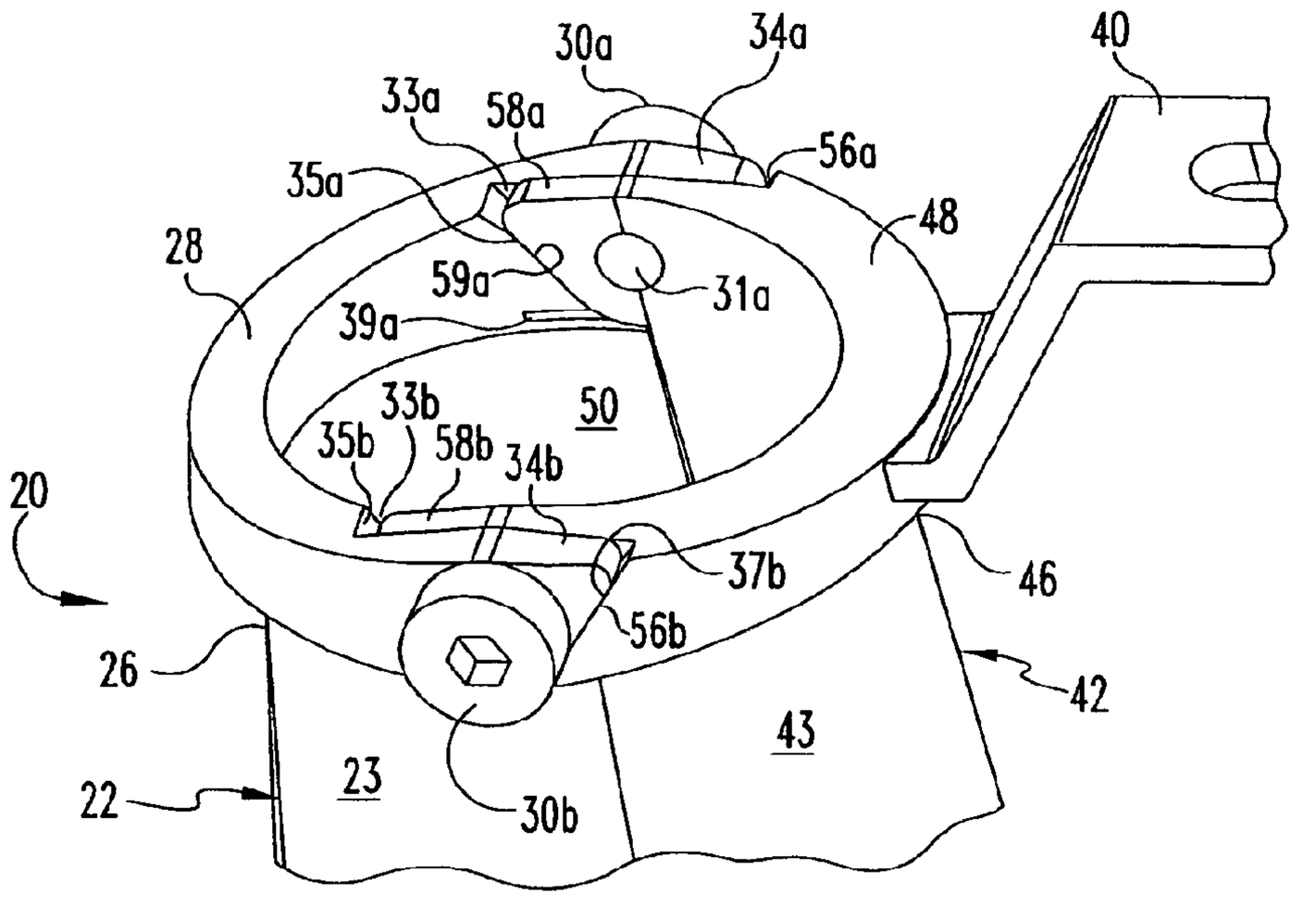
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Fig. 10

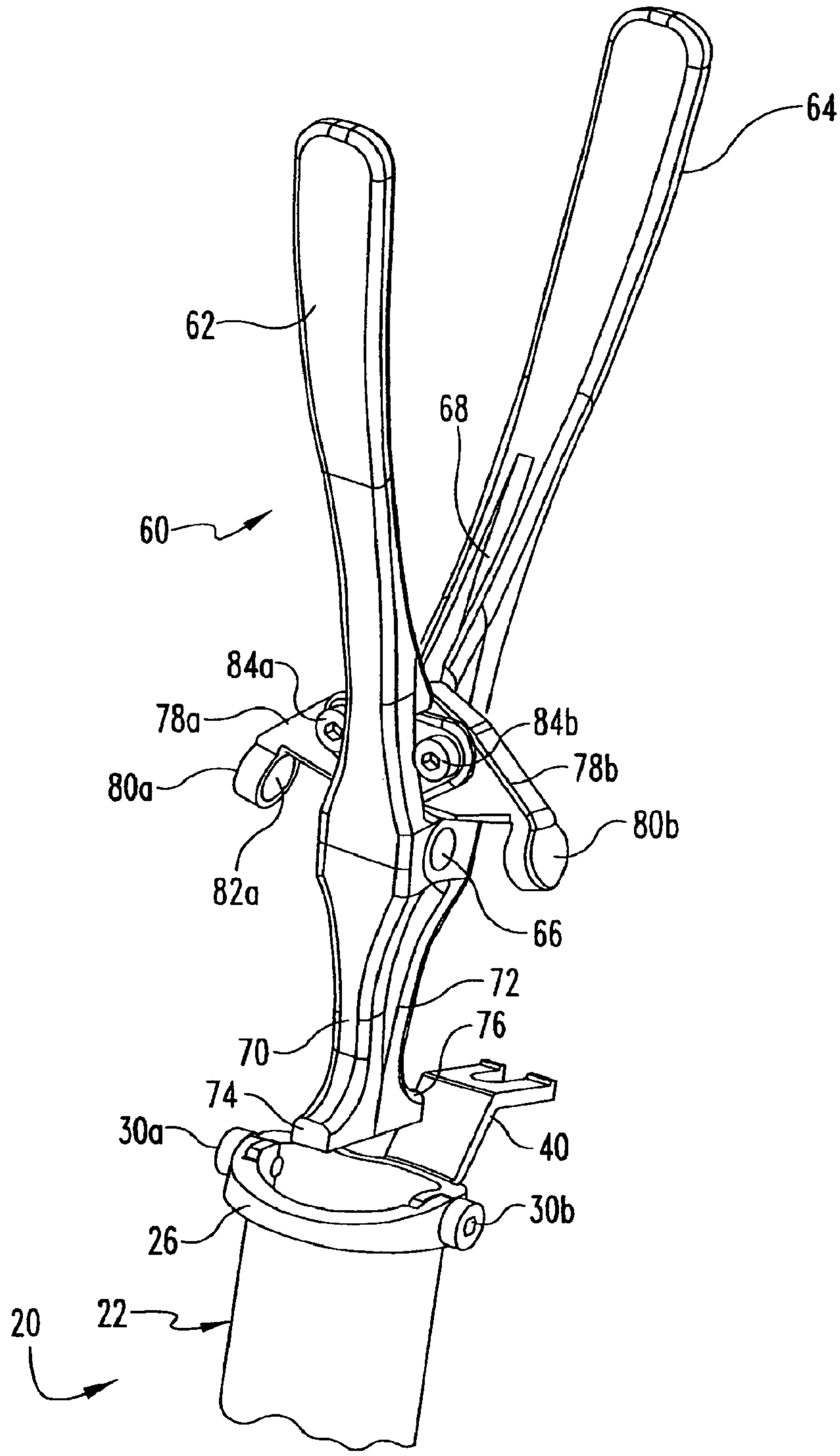
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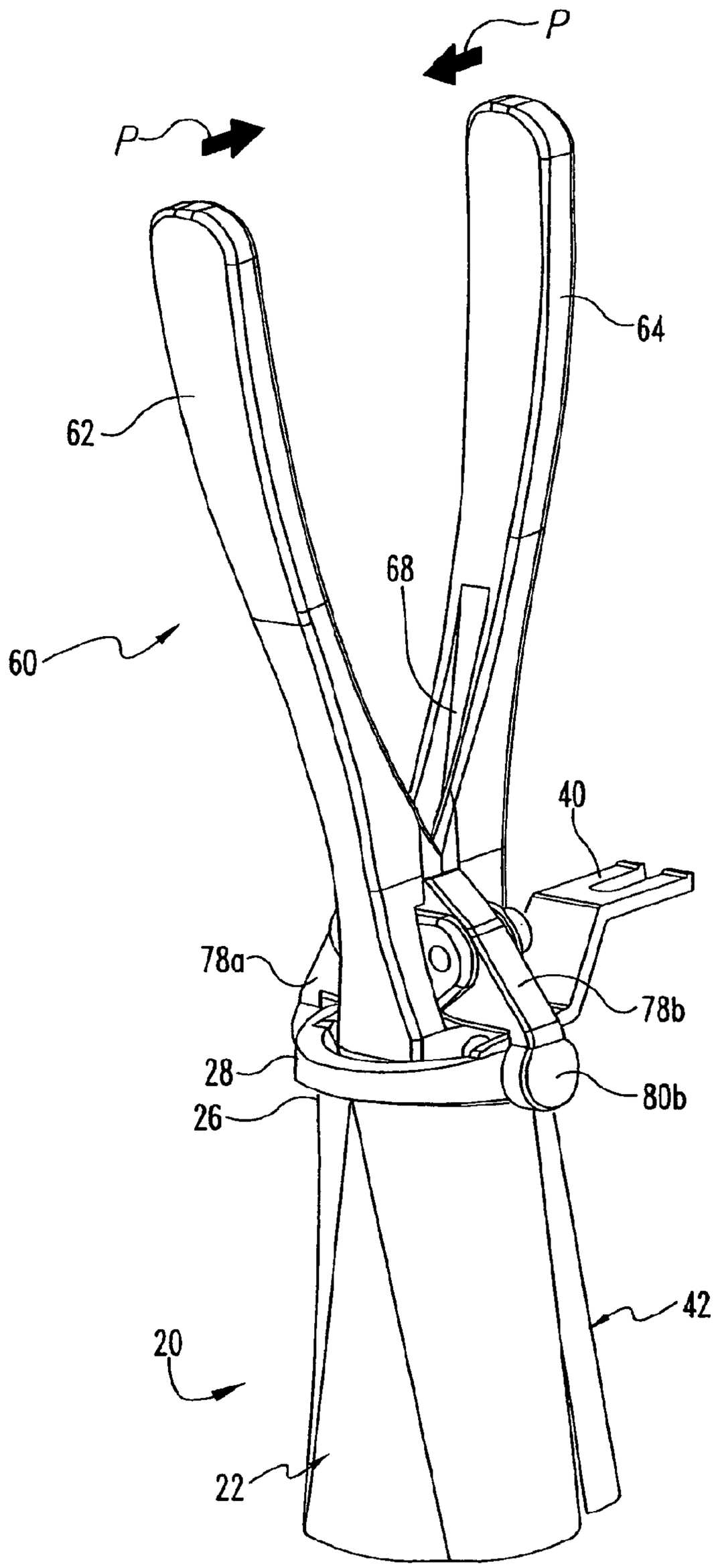
Fig. 11



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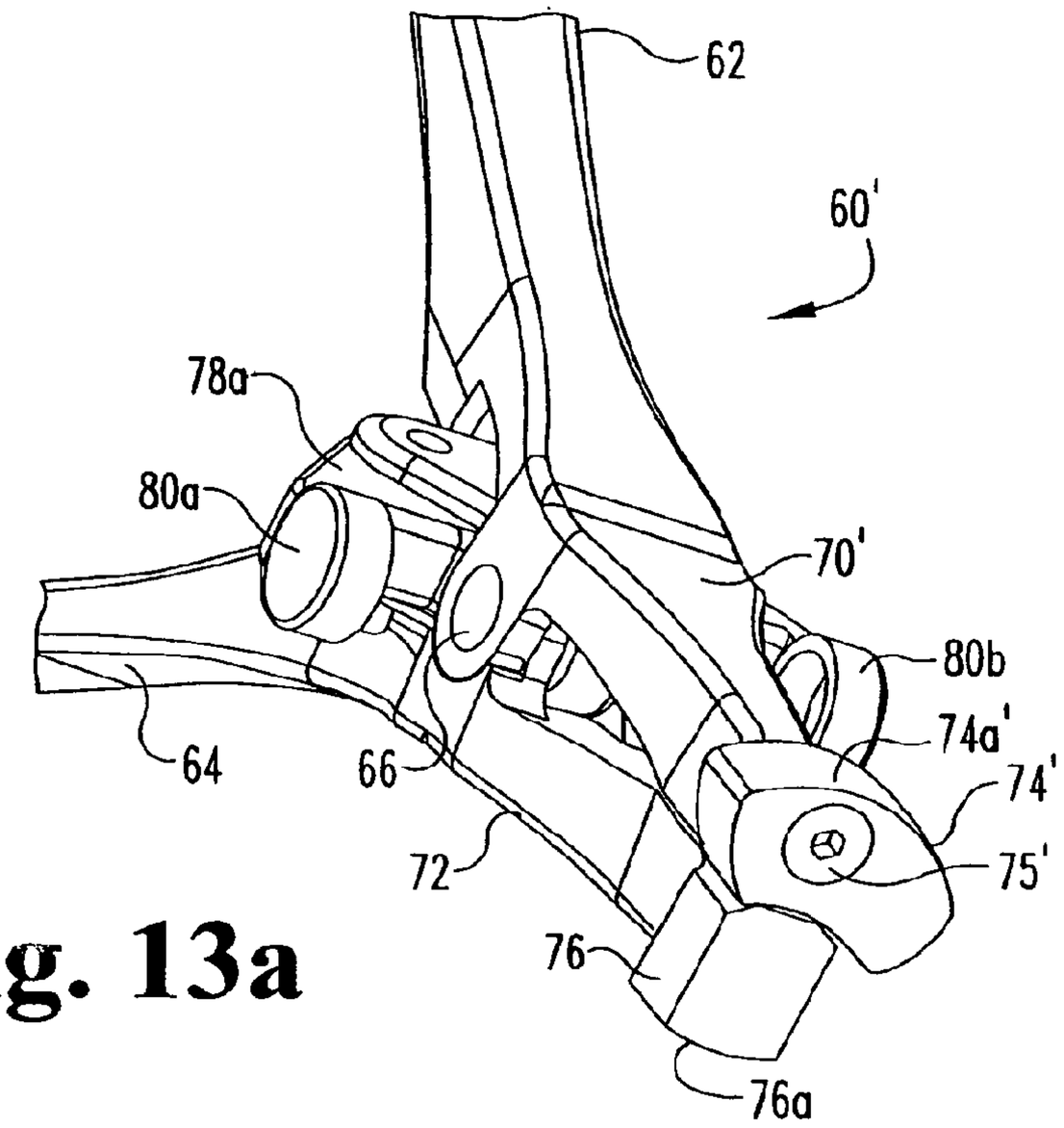

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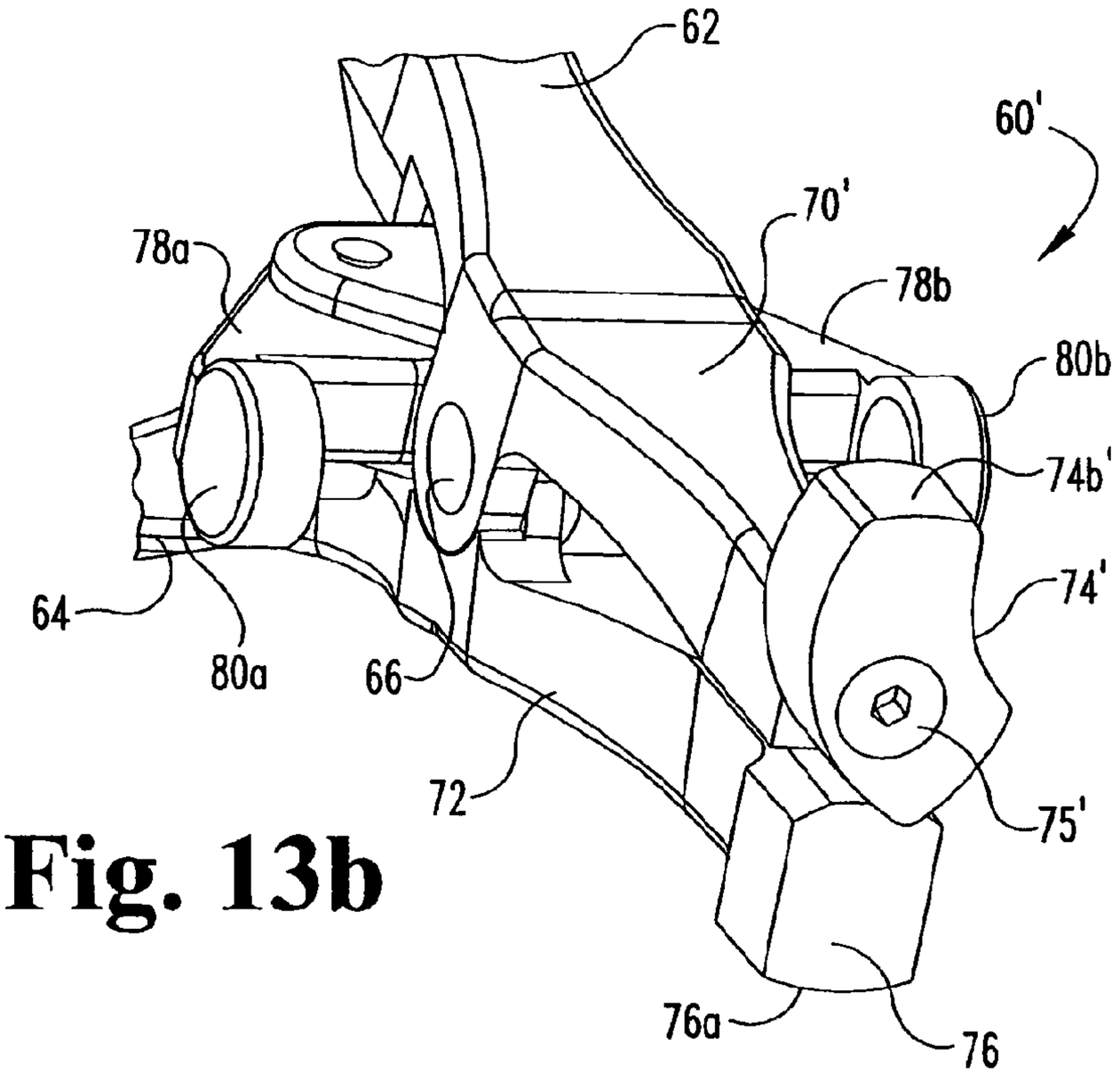

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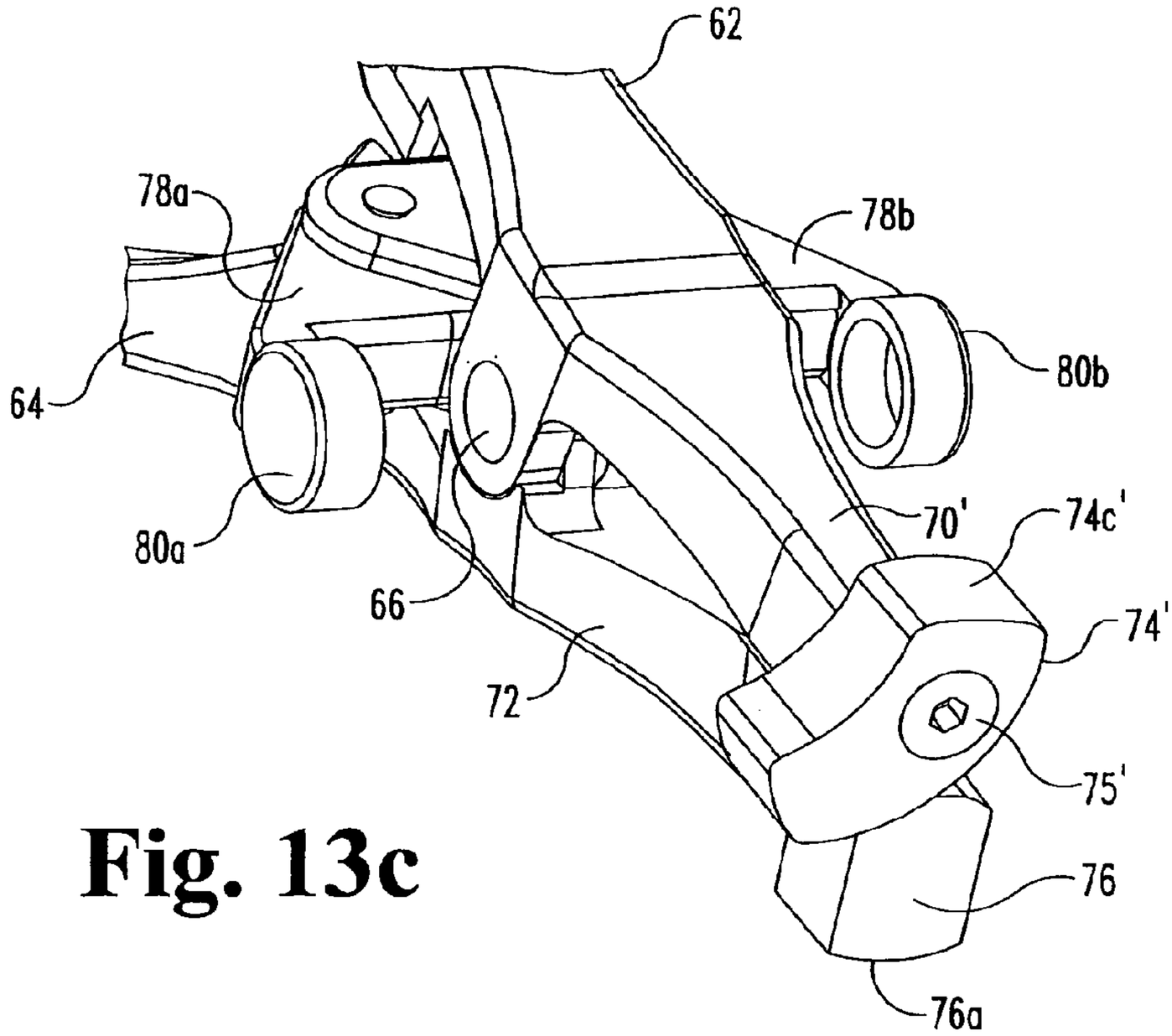

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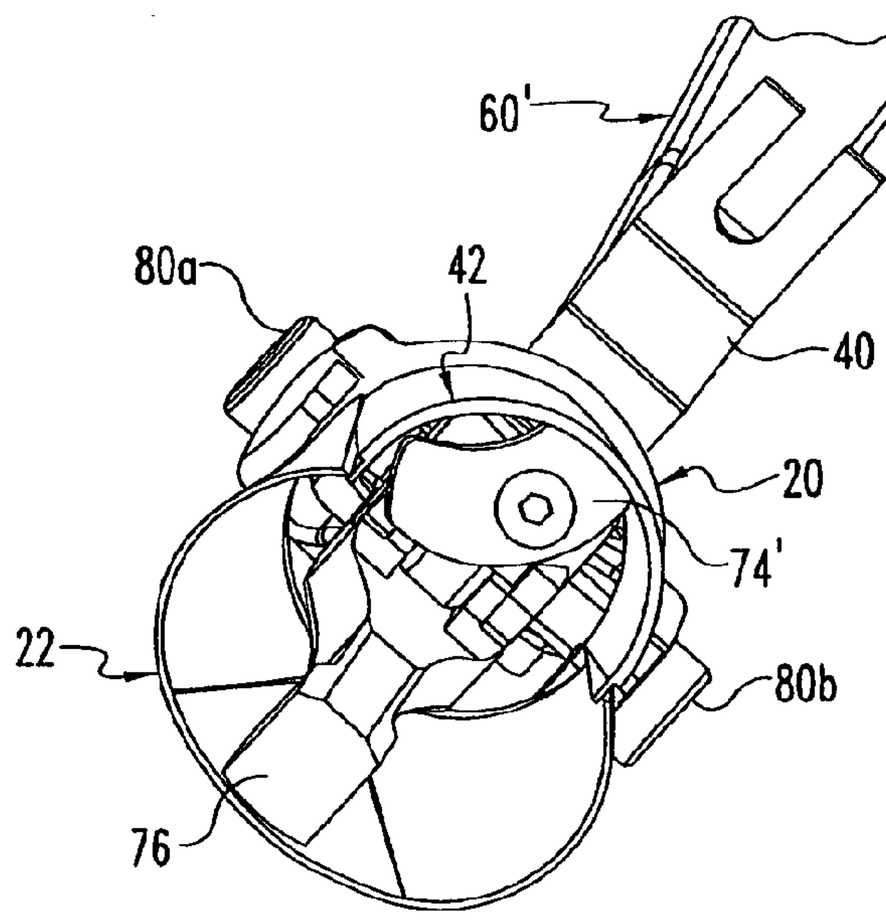

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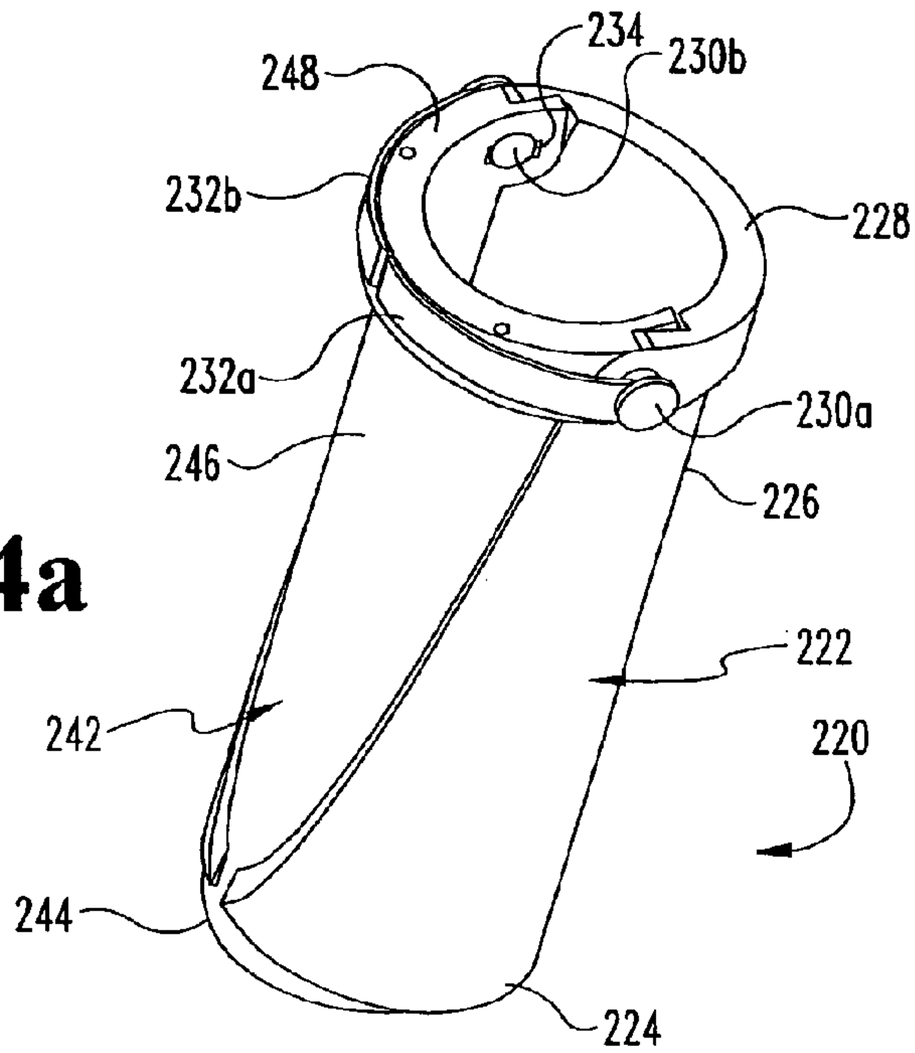

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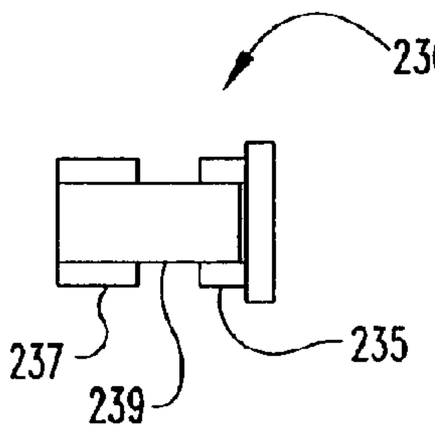

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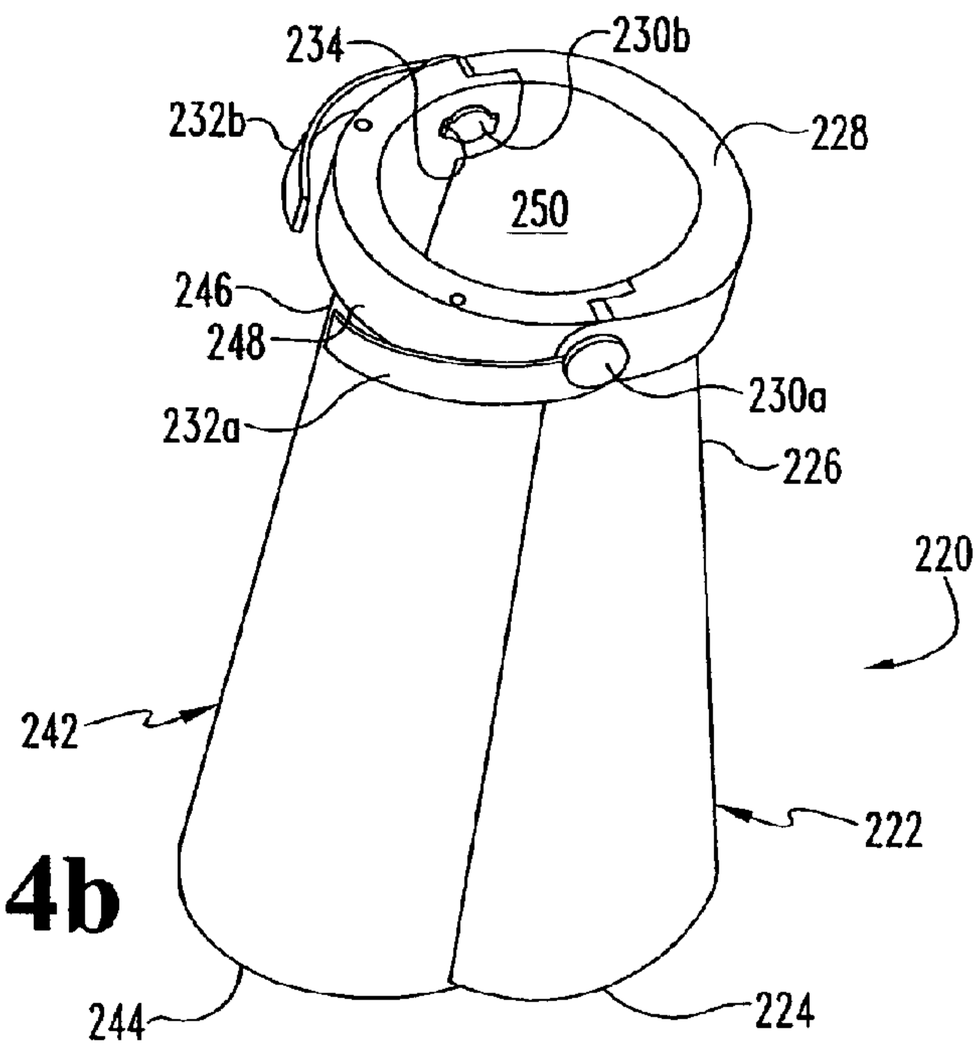

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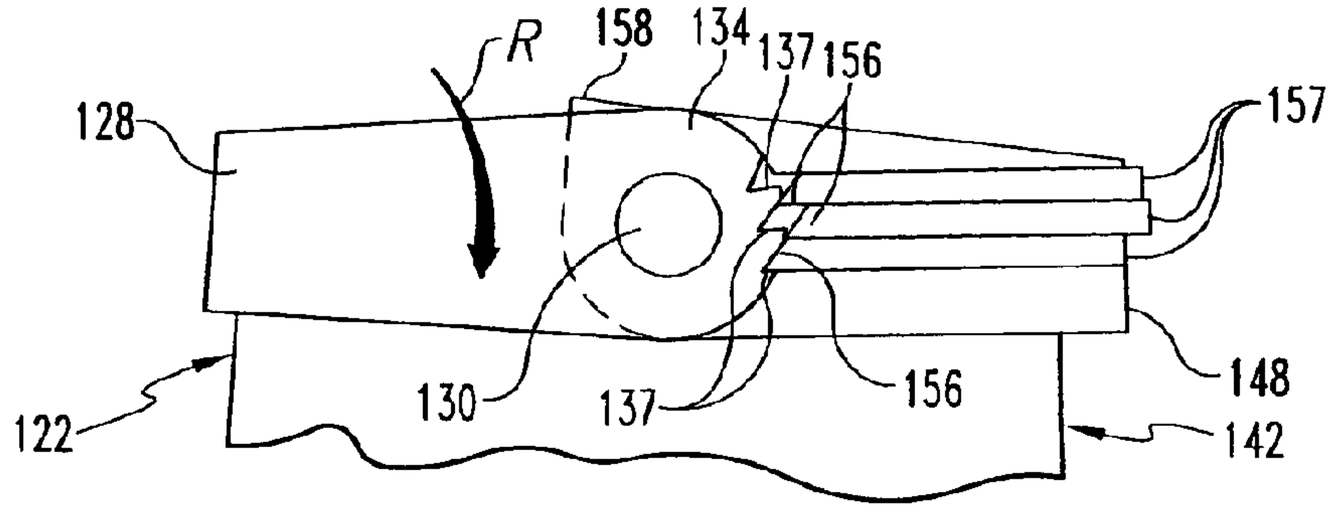

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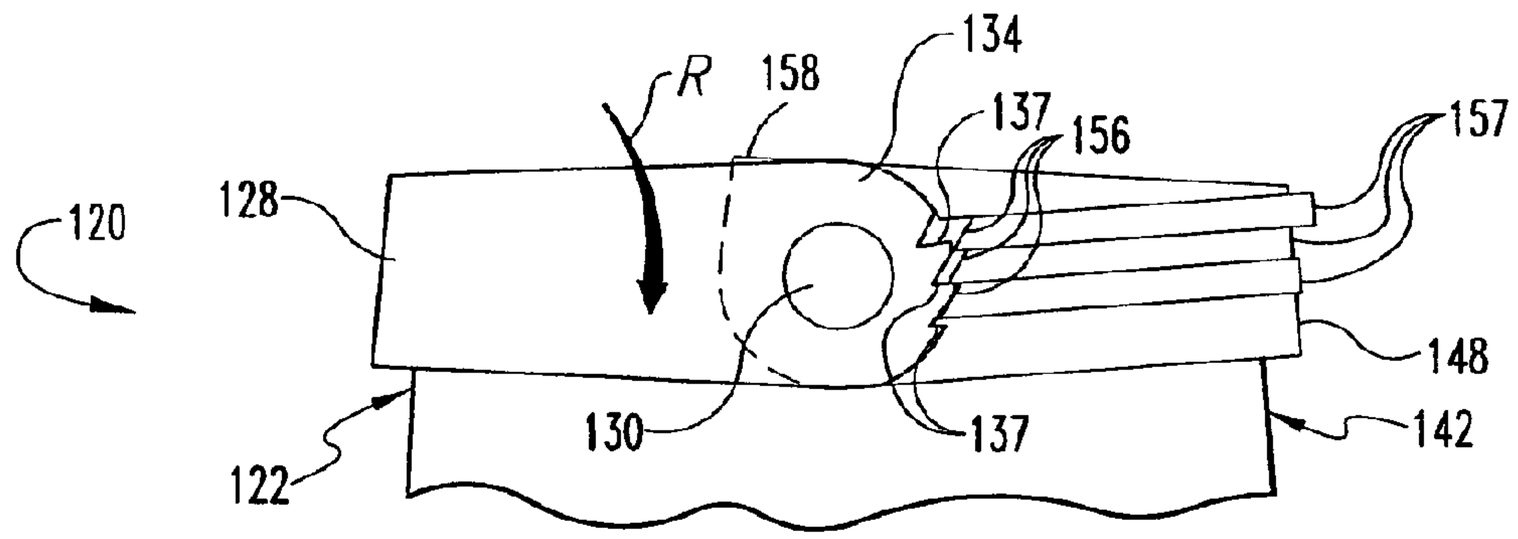

Fig. 15b

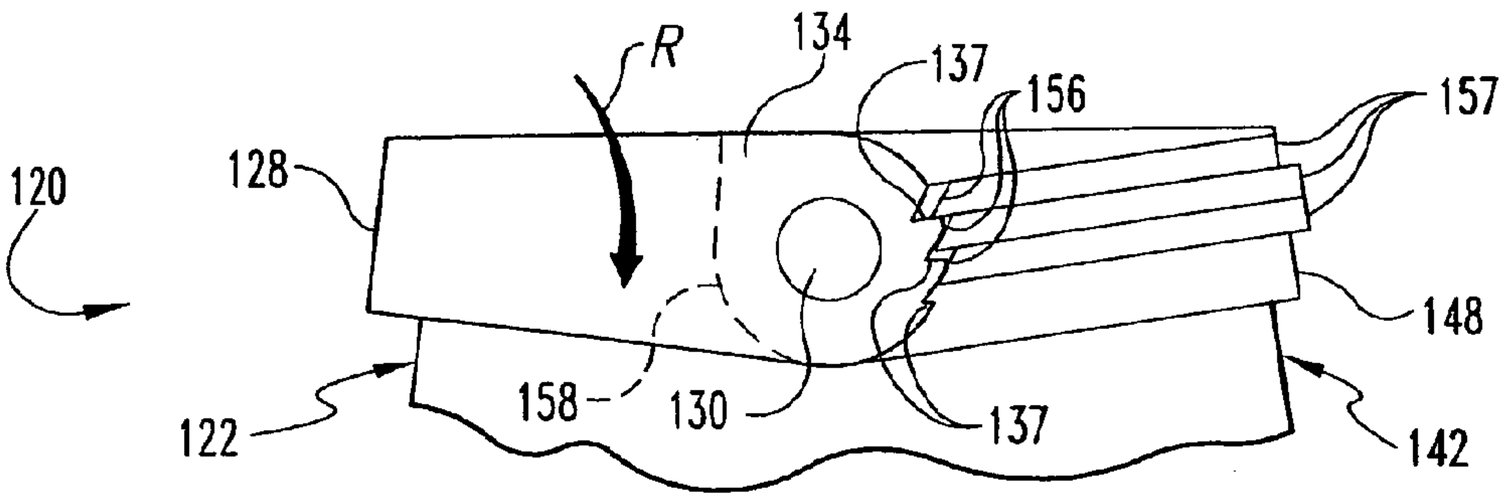

Fig. 15c

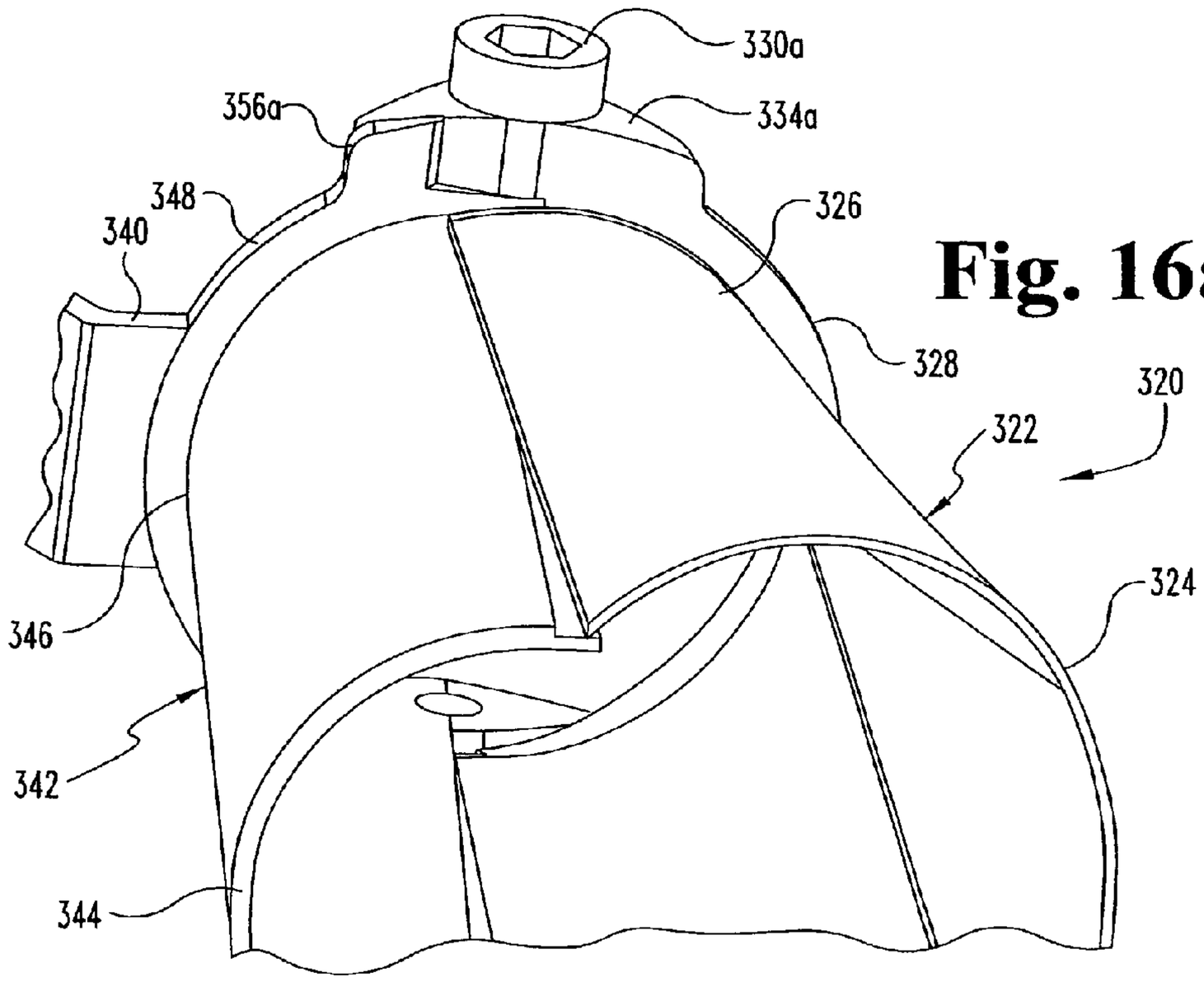

Fig. 16a

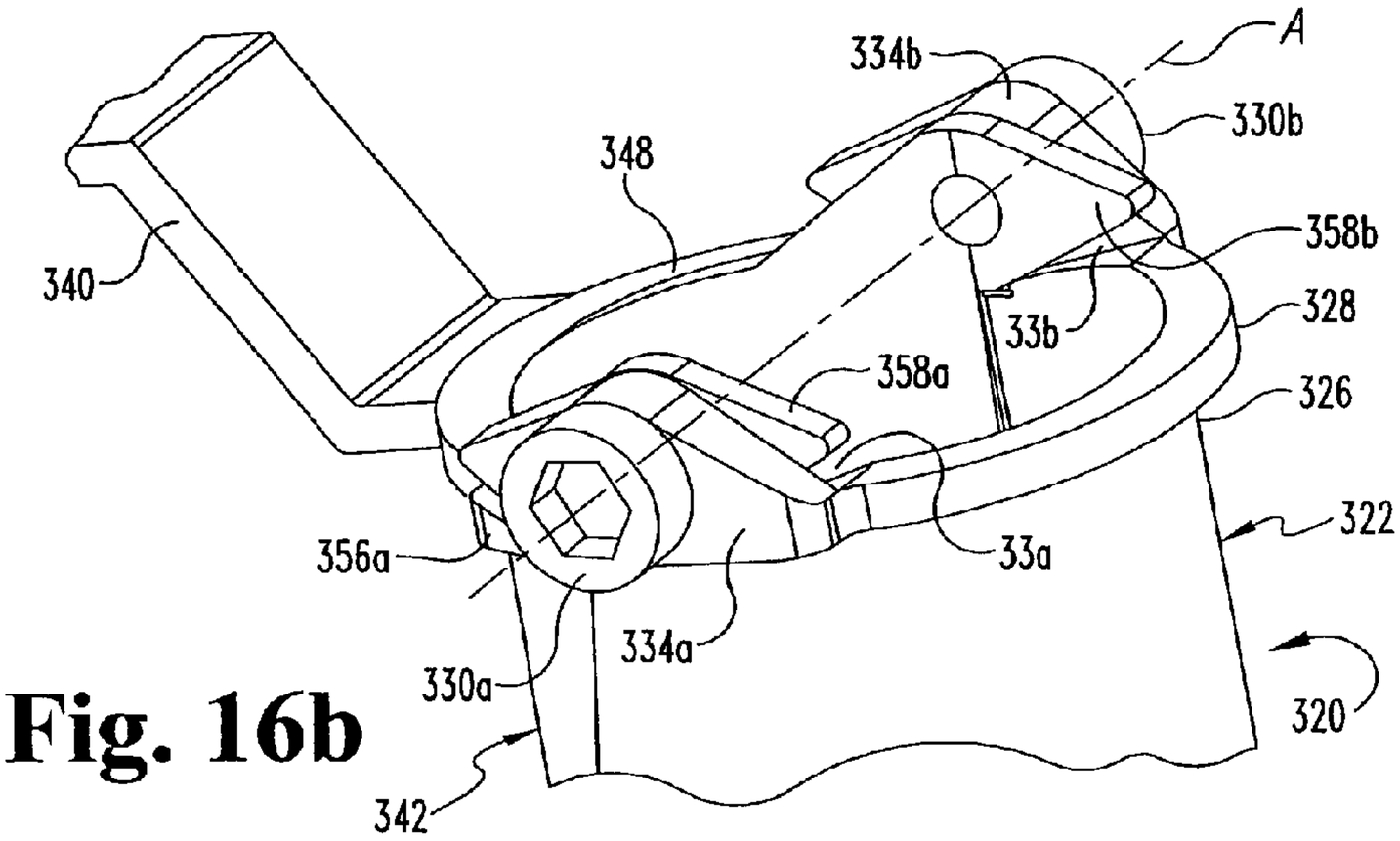

Fig. 16b

DEVICES AND METHODS FOR PERCUTANEOUS TISSUE RETRACTION AND SURGERY

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a divisional application of U.S. patent application Ser. No. 10/117,440 filed on Apr. 5, 2002, now issued as U.S. Pat. No. 7,261,688 on Aug. 28, 2007, which is incorporated herein by reference in its entirety.

BACKGROUND

The present invention relates to devices, instruments and methods for performing percutaneous surgeries.

Traditional surgical procedures for pathologies located deep within the body can cause significant trauma to the intervening tissues. These open procedures often require a long incision, extensive muscle stripping, prolonged retraction of tissues, denervation and devascularization of tissue. These surgeries can require operating room time of several hours and several weeks of post-operative recovery time due to the use of general anesthesia and the destruction of tissue during the surgical procedure. In some cases, these invasive procedures lead to permanent scarring and pain that can be more severe than the pain leading to the surgical intervention.

The development of percutaneous procedures has yielded a major improvement in reducing recovery time and post-operative pain because minimal muscle and tissue dissection is required and the procedures can be performed under local anesthesia. For example, minimally invasive surgical techniques are desirable for spinal and neurosurgical applications because of the need for access to locations deep within the body and the danger of damage to vital intervening tissues. While developments in minimally invasive surgery are steps in the right direction, there remains a need for further development in minimally invasive surgical devices and techniques.

SUMMARY

The present invention is directed to methods and devices for performing surgery in a patient. One specific application concerns devices, instruments and techniques for percutaneous, minimally invasive spinal surgery. A further specific application includes percutaneous tissue retraction to provide access to the surgical location in the patient. Another specific application includes surgery performed through the percutaneously retracted tissue under direct vision at any location in the body. Also contemplated are surgical methods and techniques employing the instruments and devices described herein.

DESCRIPTION OF THE FIGURES

FIG. **1** is a perspective view looking toward one side of a retractor in an unexpanded configuration.

FIG. **2** is a perspective view looking toward the bottom of the retractor of FIG. **1**.

FIG. **3** is a perspective looking toward the other side of the retractor of FIG. **1** with the retractor in an expanded configuration.

FIG. **4** is a perspective view looking toward the bottom of the expanded retractor of FIG. **3**.

FIG. **5** is a side view of the retractor shown in FIG. **1** inserted through an incision in a patient with the retractor in an unexpanded configuration.

FIG. **6** is the retractor of FIG. **5** in an expanded configuration and with viewing instruments diagrammatically shown.

FIG. **7** is a perspective view looking toward the bottom of the expanded retractor of FIG. **3**.

FIG. **8** is a top plan view of the expanded retractor of FIG. **3**.

FIG. **9** is a perspective view of the upper portion of the unexpanded retractor of FIG. **1**.

FIG. **10** is a perspective view of the upper portion of the expanded retractor of FIG. **3**.

FIG. **11** is a perspective view of the upper portion of the unexpanded retractor of FIG. **1** with an expansion instrument positioned adjacent thereto.

FIG. **12** is a perspective view of the retractor of FIG. **3** with the expansion instrument of FIG. **11** positioned therein to move the retractor to its expanded configuration.

FIGS. **13**a-**13**d illustrate another embodiment expansion instrument having an adjustable foot.

FIGS. **14**a-**14**c illustrate another embodiment expandable retractor and a coupling member comprising a portion thereof.

FIGS. **15**a-**15**c illustrate the proximal end of yet another embodiment expandable retractor.

FIGS. **16**a-**16**b illustrate another embodiment expandable retractor.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended. Any such alterations and further modifications in the illustrated devices and described methods, and such further applications of the principles of the invention as illustrated herein are contemplated as would normally occur to one skilled in the art to which the invention relates.

The present invention provides instruments and methods for performing percutaneous surgery, including spinal surgeries that include one or more techniques such as laminotomy, laminectomy, foramenotomy, facetectomy, discectomy, interbody fusion, spinal nucleus or disc replacement, and implant insertion, for example. The surgery is performed through a working channel or passageway provided by a retractor. Viewing of the surgical site at the working end of the retractor can be accomplished with optics mounted on the retractor, positioned over the retractor, and/or through a viewing system such as lateral fluoroscopy. The retractor is expandable in situ to increase the size of the working channel to facilitate access to the working space at the distal end of the retractor while minimizing trauma to tissue surrounding the retractor. The retractor can be used with any surgical approach to the spine, including anterior, posterior,

posterior mid-line, lateral, postero-lateral, and/or antero-lateral approaches, and in other regions besides the spine.

In FIGS. **1-2** there is illustrated a retractor **20** that includes a first portion **22** coupled to a second portion **42**. First portion **22** has a distal end **24** and an opposite proximal end **26**. Second portion **42** has a distal end **44** and an opposite proximal end **46**. In the illustrated embodiment, first portion **22** is pivotally coupled to second portion **42** at proximal ends **26**, **46**. A working channel **50** is formed by first portion **22** and second portion **42**. Working channel **50** extends between and opens at distal ends **24**, **44** and proximal ends **26**, **46**. Retractor **20** is movable to an expanded configuration, as shown in FIGS. **3-4**, by pivoting first portion **22** and second portion **42** relative to one another about proximal ends **26**, **46**. Other coupling arrangements are also contemplated that allow first portion and second portion **42** to be moved away from one another to expand retractor **20** and increase the size of working channel **50** between its distal and proximal ends.

Retractor **20** is insertable through skin and tissue of a patient to provide working channel **50** to the surgical site. It is contemplated that retractor **20** is inserted through the skin and tissue in an unexpanded configuration, such as shown in FIGS. **1-2**. After insertion into the patient, retractor **20** is expanded through the skin and tissue to an expanded configuration that increases the size of working channel **50** from proximal ends **26**, **46** to distal ends **24**, **44**.

First portion **22** includes a semi-cylindrical body **23** extending between distal end **24** and proximal end **26**. A collar **28** extends about proximal end **26**, and forms a lip **28**a extending about the outer surface of body **23**. Second portion **42** includes a semi-cylindrical body **43** extending between distal end **44** and proximal end **46**. A collar **48** extends about proximal end **46** of second portion **42**, and defines a lip **48**a extending about the outer surface of body **43**. A first coupling member **30**a pivotally couples a first side of first portion **22** to second portion **42** at their proximal ends **26**, **46**. A second coupling member **30**b opposite first coupling member **30**a pivotally couples the other side of first portion **22** to second portion **42** at their proximal ends **26**, **46** along another side of retractor **20**.

In the illustrated embodiment, first and second coupling members **30**a, **30**b are pins that extend through aligned holes or passageways provided through collars **28**, **48** to pivotally couple first portion **22** to second portion **42**. Other coupling arrangements are also contemplated at proximal ends **26**, **46** of first and second portions **22**, **42**. For example, proximal end **26** of first portion **22** may be hingedly attached to proximal end **46** of second portion **42** with one or more hinges at each side of retractor **20**. In another embodiment, at least the proximal ends of first portion **22** and second portion **42** are formed of a single piece of material and a resilient hinge couples first portion **22** to second portion **42** at their proximal ends **26**, **46**. Other embodiments contemplate a slotted arrangement extending around the proximal end of one of the retractor portions and one or more pins from the other retractor portion received in the slotted arrangement.

A bracket **40** extends from and is integrally formed with or attached to collar **48** of second portion **42**. Bracket **40** can also be provided on collar **28** in lieu of or in addition to bracket **40** on collar **48**. Bracket **40** extends away from working channel **50** and is connectable to one end of a flexible or articulatable arm **41** (FIG. **6**.) The opposite end of arm **41** (not shown) can be mounted on the surgical table or other support device. Arm **41** supports retractor **20** in the patient yet allows percutaneous manipulation and re-positioning of retractor **20**.

Body **23** of first portion **22** extends around at least a portion of body **43** of second portion **42**. Body **23** has a perimeter length along distal end **24** which is greater than the perimeter length of body **23** at proximal end **26**. Body **43** of second portion **42** includes a perimeter length along distal end **44** which is the same or can be about the same as the perimeter length of body **43** adjacent proximal end **46**. Body **23** of first portion **22** can be flexible enough to extend around second portion **42** in form fitting relationship when retractor **20** is the unexpanded configuration of FIGS. **1** and **2** to minimize the profile of retractor **20**. Body **23** flexes outwardly and rides along the outer surface of body **43** of second portion **42** as first portion **22** and second portion **42** are pivoted relative to one another to the expanded configuration of retractor **20**.

In one specific embodiment, first portion **22** and second portion **42** are each made from surgical grade stainless steel. Other materials are also contemplated for bodies **23**, **43**, including, for example, plastics and metals and metal alloys, such as, for example, spring steel, shape memory metals and alloys, and aluminum. It is contemplated that body **23** can be provided with a cross-sectional thickness t**1** that provides the desired flexibility, yet is sufficiently rigid to maintain retraction of the skin and tissue. Body **43** of second portion **42** can be provided with a thickness t**2** that can be the same or greater than thickness t**1** of first portion **22**. The reduced thickness of body **23** provides it greater flexibility to flex inwardly and outwardly expand around body **43** of second portion **42**. Thickness t**2** provides second portion **43** greater rigidity to resist bending or bowing under the forces exerted on it by body **23** during and after movement of retractor **20** to its expanded configuration.

In the unexpanded configuration, working channel **50** has a generally circular cross-section along retractor **20**, as best shown in FIG. **2**. Working channel **50** has a first width D**1** between the opposite edges of second portion **42** positioned in first portion **22**. A second width D**2** is defined between the mid-portions of first body **23** and second body **43** in the direction of expansion of first portion **22** relative to second portion **42**. In the illustrated embodiment, first and second widths D**1** and D**2** are substantially the same since unexpanded working channel **50** has a generally circular cross-section. In the expanded configuration, as shown in FIG. **4**, the portion of the expanded working channel **50** extending along the opposite edges of second body **43** maintains first width D**1**. However, first body **23** is flexed outwardly relative to second body **43**, and defines a third width D**3** between the sides of first body **23** that is greater than first width D**1**. In the expanded configuration of working channel **50**, first body **23** and second body **43** define a fourth width D**4** in the direction of expansion of first portion **22** relative to second portion **42** that is greater than second width D**2**. It is further contemplated that width D**4** can be greater than widths D**1** and D**3**.

Various configurations for working channel **50** are contemplated. In the unexpanded configuration, working channel **50** can have a cylindrical shape with, for example, a circular, oval, elliptical, or polygonal cross-section. In the expanded configuration, working channel **50** can have a frusto-conical shape with, for example a cross-section that is figure-eight or snowman shaped, oval, elliptical, circular or polygonal. In at least the direction of expansion, the size of the cross-section of working channel **50** decreases from distal end to the proximal end of retractor **20**.

In one specific application for spinal surgery, it is contemplated that, after insertion of retractor **20**, first portion **22** and second portion **42** are expanded predominantly in one

direction to retract muscle and tissue along pathway P. For example, retractor **20** can be primarily or predominantly expandable in the direction of the spinal column axis. Since the muscle tissue adjacent the spine has a fiber orientation that extends generally in the direction of the spinal column axis, the expansion of retractor **20** separates the muscle tissue along the fibers, thus minimizing their separation and the resultant tearing and trauma to the muscle tissue is minimized. It is also contemplated in other techniques employing retractor **20** that working channel **50** expands primarily in a direction other than along the spinal column axis or in areas other than spine. Embodiments of retractor **20** are also contemplated in which working channel **50** is circular or polygonal in cross-section and expands substantially the same amount in all directions.

Referring now to FIGS. **5-6**, positioning of retractor **20** through the skin S and tissue T of the patient will be described. An incision is made in skin S adjacent the location of a patient's anatomy to be accessed. For example, in spinal surgery, the incision can be made at a vertebral level at a location that provides access to the disc space between adjacent vertebrae or to one or more vertebra through a desired approach. Prior to insertion of retractor **20**, skin S and tissue T can be sequentially dilated via guidewires and/or one or more dilators of increasing size to form a pathway P through skin S and tissue T to the surgical site in the patient. In such procedures, retractor **20** is positioned over the last inserted dilator in pathway P for retractor **20**. Working channel **50** through retractor **20** provides access to a working space WS at the distal end of retractor **20** when the guidewires and dilators, if used, are removed therefrom.

For the entire surgery or for certain procedures, it may be desired by the surgeon to increase the size of working channel **50** to facilitate access working space WS below the distal end of retractor **20**, or to even provide a greater working space WS. Retractor **20** can be pivoted from its unexpanded, insertion configuration to an expanded configuration as shown in FIG. **6**. In the expanded configuration, first portion **22** and second portion **42** are pivoted away from one another about first and second coupling members **30**a, **30**b at proximal ends **26**, **46**. In the expanded configuration, pathway P' through skin S and tissue T is formed by first portion **22** and second portion **42**. The size of working space WS can be increased while minimizing trauma to the tissue and skin along pathway P.

Working channel **50** has a tapered configuration that reduces in size from the distal end of retractor **20** adjacent working space WS through skin S to the proximal end of retractor **20**. The tapered working channel provides the surgeon greater access and increased visualization of working space WS. The tapered working channel **50** also allows greater angulation of instruments placed through working channel **50**, more selection in positioning of instruments within working channel **50**, and the ability to position instruments adjacent the inner wall surfaces of the expanded first and second portions **22**, **42**, increasing the room available at working space WS for multiple instruments.

Viewing instruments can be positioned in or adjacent to working channel **50** to facilitate surgeon viewing of working space WS and the operative site. For example, an endoscopic viewing element **90** can be mounted on the proximal end of retractor **20** such that its scope portion **92** extends along working channel **50**. A microscopic viewing element **95** can also be positioned over the proximal end of retractor **20** for viewing working space WS and the surgical site. Other imaging techniques, such as lateral fluoroscopy, can be used alone or in combination with the endoscopic and microscopic viewing elements. Further examples of such viewing instruments and mounting or orienting the same relative to retractor **20** are provided in U.S. patent application Ser. No. 09/815,963 filed on Mar. 23, 2001, which is hereby incorporated herein by reference in its entirety. It is further contemplated that other instruments can be mounted on the proximal end of retractor **20**, such as nerve root retractors, tissue retractors, irrigation and/or aspiration instruments, illumination instruments and the like for use in surgical procedures through retractor **20** in the working space.

Referring now to FIG. **7**, further details regarding the engagement of first portion **22** and second portion **42** when retractor **20** is in the expanded configuration will be provided. First body **23** of first portion **22** includes a first edge **32**a extending between distal end **24** and proximal end **26**. First body **23** of first portion **22** includes an opposite second edge **32**b extending between distal end **24** and proximal end **26**. Second portion **42** includes a first edge **51**a extending along one side of second body **43** and an opposite second edge **51**b extending along the opposite side of second body **43**. First edge **51**a includes a grooved portion **54**a extending from distal end **44** along at least a portion of the length of first edge **51**a. An engagement surface **52**a extends along grooved portion **54**a. Similarly, second edge **51**b includes grooved portion **54**b extending from distal end **44** along at least a portion of the length of second edge **51**b. An engagement surface **52**b extends along grooved portion **54**b.

With retractor **20** in its expanded configuration, first edge **51**a of second body **43** is is adjacent first edge **32**a of first body **23**, and second edge **51**b of body **43** is adjacent second edge **32**b of first body **23**. First edge **32**a resides at least partially in grooved portion **54**a, and second edge **32**b resides at least partially in grooved portion **52**b. First edge **32**a contacts engagement surface **52**a along grooved portion **54**a to maintain retractor **20** in its expanded configuration. Similarly, second edge **32**b contacts engagement surface **52**b in grooved portion **54**b to maintain retractor **20** in its expanded configuration. The flexible second portion **22** tends to return toward its unexpanded configuration, thus first and second edges **32**a, **32**b frictionally engage the engagement surfaces extending along each of the grooved portions **54**a, **54**b. This locks first portion **22** with respect to second portion **42** in the expanded configuration, resisting collapse of the working channel by pressure of the surrounding tissue on first and second portions **22**, **42** and facilitating manipulation of retractor **20** in the tissue without collapse of the working channel.

Other means for locking first and second portion **22**, **42** in the expanded configuration are also contemplated. For example, second portion **42** can be provided with a ridge or protrusion at each of its opposite edges, and first portion **44** can engage the ridge or protrusion.

By maintaining a closed configuration for the working channel between first portion **22** and second portion **42** in the expanded configuration, migration of tissue into working channel **50** is prevented by the walls of first and second portions **22**, **42**. Other embodiments contemplate that working channel **50** is not completely enclosed.

Referring now to FIGS. **8-10**, further details regarding proximal ends **26**, **46** of first and second portions **22**, **42** will be described. Collar **28** includes a recess **33**a formed adjacent first edge **32**a on one side of first portion **22**, and a second recess **33**b opposite first recess **33**a on the other side of first portion **22**. Recess **33**a includes an engagement surface **35**a along an inner side thereof, and second recess **33**b includes an engagement surface **35**b extending along an inner side thereof. A first extension **34**a extends along the

outside of first recess **33**a, and a second recess **34**b extends along the outside of second recess **33**b. First extension **34**a and second extension **34**b extend beyond the adjacent first edge **32**a and second edge **32**b, respectively, of body **23** of first portion **22**.

Second portion **42** includes a first recess **55**a along one side of second portion **42**, and a second recess **55**b along another side of second portion **42**. First recess **55**a includes an engagement surface **56**a, and second recess **55**b includes an engagement surface **56**b. A first extension **58**a extends along the inner side of first recess **55**a, and a second extension **58**b extends along the inner side of second recess **55**b. First extension **58**a includes an engagement surface **59**a, and second extension **55**b also includes a similarly situated engagement surface. First extension **58**a resides within first recess **33**a adjacent first extension **34**a of first portion **22**, and second extension **58**b resides within second recess **33**b adjacent second extension **34**b of first portion **22**. First coupling member **30**a includes a pin extending through passage **31**a of first extension **34**a of first portion **22** and pivotally couples first extension **58**a of second portion **42** thereto. Second coupling member **30**b includes a pin extending through passage **31**b of second extension **34**b of first portion **22** and pivotally couples second extension **58**b of second portion **42** thereto.

With retractor **20** in its unexpanded configuration as shown in FIG. **9**, a gap is formed between engagement surfaces **35**a, **35**b of first portion **22** and engagement surfaces **59**a, **59**a of extensions **58**a, **58**b of second portion **42**. As retractor **20** is moved to its expanded configuration as shown in FIG. **10**, engagement surfaces **59**a, **59**a contact engagement surfaces **35**a, **35**b of first portion **22**. Also, engagement surfaces **37**a, **37**b of extensions **34**a, **34**b of first portion **22** contact engagement surfaces **56**a, **56**b of second portion **42**. The contact between the engagement surfaces of the recesses and extensions limit the pivotal movement of first portion **22** relative to second portion **42**. First portion **22** can include a relieved portion **39**a below first engagement surface **59**a and a similar relief under second engagement surface **35**b. The reliefs allow some flexing of engagement surfaces **35**a, **35**b to ensure engagement surfaces **59**a, **59**b of extensions **58**a, **58**b fully seat on engagement surfaces **35**a, **35**b.

Referring now to FIGS. **11-12** there is shown retractor **20** with an expansion instrument **60**. Expansion instrument **60** includes a first handle **62** pivotally coupled to a second handle **64** with pin **66**. A leaf spring **68** can extend between first handle **62** and second handle **64** to bias handles **62**, **64** in a closed position as shown in FIG. **11**. Extending distally from the pivotal connection of first handle **62** and second handle **64** are first distal portion **70** and second distal portion **72**, respectively. Distal portion **70** includes a foot **74** at a distal end thereof, and distal portion **72** includes a foot **76** at a distal end thereof. Feet **74**, **76** extend toward first portion **22** and second portion **42**, respectively when expansion instrument **60** is inserted in working channel **50** of retractor **20**.

Expansion instrument **60** includes a first arm **78**a and a second arm **78**b above pin **66**. First arm **78**a is pivotally coupled to first and second handles **62**, **64** via coupler **84**a, and second arm **78**b is pivotally coupled to first and second handles **62**, **64** via coupler **84**b. First and second arms **78**a, **78**b extend transversely to the orientation of feet **74**, **76**. First arm **78**a includes an engagement member **80**a having a receptacle **82**a positionable over the head of first coupling member **30**a. Second arm **78**b includes an engagement member **80**b having a receptacle positionable over the head of second coupling member **30**b.

As shown in FIG. **12**, expansion instrument **60** is mountable on retractor **20** by pivoting first arm **78**a so that first coupling member **30**a is captured in receptacle **82**a of engagement member **80**a, and second coupling member **30**b is captured in receptacle **82**b of engagement member **80**b. The engagement of expansion instrument **60** to retractor **20** ensures that expansion instrument **60** is not inserted too far into working channel **50** before and during insertion, and allows the application a steady and uniform expansion force without expansion instrument **60** slipping relative to retractor **20**. With expansion instrument **60** mounted on retractor **20**, handles **62**, **64** are pressed toward one another in order to move feet **74**, **76** away from one another transverse to the pivot axis of first portion **22**, second portion **42** and into contact with adjacent first portion **22** and second portion **42**. Feet **74**, **76** apply a force on first portion **22** and second portion **42** to pivot first and second portions **22**, **42** about their proximal ends to move retractor **20** to its expanded configuration. Retractor **20** can be locked in the expanded configuration by engagement of edges **32**a, **32**b of first portion **22** with the respective engagement surfaces of second portion **42**.

To collapse retractor **20** to its unexpanded configuration, expansion instrument **60** is rotated 90 degrees so the feet **74**, **76** can apply an expansion force to first portion **22** in the direction of the pivot axis of first portion **22** and second portion **42**. The expansion of first portion **22** in this direction disengages or unlocks edges **32**a, **32**b from engagement surfaces **52**a, **52**b of second portion **42** and allows first portion **22** and second portion **42** to pivot relative to one another to unexpand retractor **20**. Retractor **20** can then be withdrawn from the tissue in its unexpanded condition, minimizing pressure on the adjacent tissue as retractor **20** is withdrawn.

Referring now to FIGS. **13**a-**13**d, there is shown another embodiment expansion instrument **60'**. Except as otherwise provided, expansion instrument **60'** can be similar to expansion instrument **60** discussed above, and like elements between expansion instruments **60** and **60'** are designated with the same reference numeral. Expansion instrument **60'** includes a movable foot **74'** coupled to distal portion **70'**. In the illustrated embodiment, foot **74'** is rotatable about pin **75'** relative to distal portion **70'** in order to position selected ones of the retractor portion contact surfaces **74**a', **74**b' or **74**c' adjacent one of the retractor portions **22**, **42**.

The contact surfaces **74**a', **74**b' and **74**c' are located at differing distances from pin **75'** to allow the surgeon to select the desired amount of expansion for retractor **20**. Foot **74'** is rotated about pin **75'** to select the desired contact surface by orienting the desired contact surface away from contact surface **76**a of foot **76**. For example, as shown in FIG. **13**a, contact surface **74**a' is selected to provide minimum expansion since it is located closest to pin **75'**. In FIG. **13**b contact surface **74**b' is selected to provide maximum expansion since it is located furthest away from pin **75'**. In FIG. **13**c contact surface **74**c' is selected to provide intermediate expansion since it has a distance from pin **75'** that is between the distances of contact surface **74**a' and contact surface **74**b'. FIG. **13**d shows expansion instrument **60'** mounted on retractor **20** with contact surface **74**c' of foot **74** in contact with second portion **42** and contact surface **76**a of foot **76** in contact with first portion **22** of retractor **20**.

It is further contemplated that the amount of expansion provided by each of the contact surfaces **74**a', **74**b' and **74**c' can correspond to a particular retractor length. For example,

with expansion instrument **60'** mounted on the retractor, the depth which expansion instrument **60'** extends into the retractor is the same no matter the length of the retractor. Thus, to provide the same size opening at the distal end of the retractor, the first and second portions of a shorter retractor will be separated a greater amount at the depth of feet **74'**, **76** than will a longer retractor. Accordingly, contact surface **74**a' can be selected for a longer length retractor, contact surface **74**b' can be selected for a shorter length retractor, and contact surface **74**c' can be selected for an intermediate length retractor.

Of course, expansion instruments **60**, **60'** can be oriented so that feet **74**, **74'** contact first portion **22** and foot **76** contacts second portion **42**. It is further contemplated that expansion instruments **60**, **60'** can be provided so that they are not mountable on the retractor, but rather are held in position at the desired depth in the retractor for expansion of the retractor.

It is contemplated that for spinal surgery various retractors **20** can be provided in a kit with lengths ranging from 20 millimeters to 100 millimeters in increments of 10 or 20 millimeters. It is further contemplated that retractor **20** can be provided in a kit with various diameters, such as 14, 16, 18, 20, 21 or 25 millimeters in its unexpanded configuration. It should be understood, however, that the present invention contemplates that retractor **20** can have other lengths and diameters and can be provided in a kit with different increments. The appropriate length for retractor **20** will depend on the depth of the desired surgical location below the skin S of the patient, the anatomical location of the surgery, and the patient's anatomy. These factors in retractor selection can be evaluated through pre-operative planning prior to surgery by x-rays or other known imaging technique, and can be adjusted during the surgical procedure if necessary since retractors of differing lengths and diameters can be made available.

In FIGS. **14**a-**14**b, there is shown another embodiment expandable retractor **220**. In FIG. **14**a, retractor **220** is in its unexpanded configuration and in FIG. **14**b retractor **220** is in its expanded configuration. Retractor **220** is similar in many respects to retractor **20** discussed above. Retractor **220** includes a first portion **222** having a distal end **224**, a proximal end **226**, and a collar **228** at proximal end **226**. Retractor **220** further includes a second portion **242** having a distal end **244**, a proximal end **246**, and a collar **248** at proximal end **246**. First coupling member **230**a and second coupling member **230**b pivotally couple first portion **222** to second portion **242**. A first lever arm **232**a is connected with and extends from first coupling member **230**a around collar **248**, and a second lever arm **232**b is connected with and extends from second coupling member **230**b around collar **248**.

In the unexpanded configuration, lever arms **232**a, **232**b are adjacent collar **248**, and coupling members **230**a, **230**b project outwardly from collar **228** as shown in FIG. **14**a. Coupling members **230**a, **230**b, as shown in FIG. **13**c, have a first keyed portion **237** configured to engage slotted hole **234** of collar **248**. The cylindrical portions **239** of coupling members **230**a, **230**b rotatably reside in the slotted hole (not shown) extending through collar **228** of first portion **222**. This allows first portion **222** to be pivoted relative to second portion **242** about coupling members **230**a, **230**b.

When first portion **222** is pivoted relative to second portion **242** to the expanded configuration, the slotted portions of slotted hole **234** and the slotted hole through collar **228** are aligned. Coupling members **230**a, **230**b can be pressed inwardly so that a second keyed portion **235** of coupling members **230**a, **230**b engages the slotted hole formed through collar **228**, while the first keyed portion **237** remains engaged in slotted hole **234** of collar **248**, thus fixing first portion **222** relative to second portion **242**. Lever arms **232**a, **232**b extend away from collar **248** when first portion **222** is locked relative to second portion **242**. To move retractor **220** to the unexpanded configuration, lever arms **232**a, **232**b are pressed toward collar **248** to move coupling members **230**a, **230**b and their second keyed portions **235** out of engagement with the slotted holes in collar **228** of first portion **222**. First portion **222** can then pivot toward second portion **242** to collapse retractor **220** for withdrawal from the patient.

In this embodiment, rather than providing an engagement surface along the opposite edges of second portion **242**, the keyed engagement of coupling members **230**a, **230**b and first and second portions **222**, **242** locks retractor **220** in its expanded configuration. However, the provision of a grooved portion and engagement surface is not precluded.

Other means for maintaining first and second portions of the retractor in an expanded configuration are also contemplated. For example, in FIGS. **15**a-**15**c another embodiment expandable retractor **120** is shown with a ratchet and pawl type mechanism at the proximal ends of first portion **122** and second portion **142**. In this embodiment, rather than providing a grooved portion and engagement surface along the opposite edges of second portion **142**, the ratchet and pawl mechanism maintains retractor **120** in its expanded configuration. However, the provision of a grooved portion and engagement surface is not precluded.

First portion **122** includes a collar **128** at its proximal end. Collar **128** includes an extension **134** extending from each side thereof, it being understood that only one side is shown in FIGS. **15**a-**15**c. Similarly, second portion **142** includes an extension **158** extending from each side thereof that is positionable alongside extension **134** of first portion **122**, it being understood that only one side is shown in FIGS. **15**a-**15**c. A pin **130** pivotally couples extensions **134**, **158** to one another. Extension **134** includes a number of teeth **137** formed at the end thereof that are engageable with ends **156** of pawls **157** extending around collar **148**. Pawls **157** are biased into engagement with teeth **137** and moveable relative to collar **148** for disengagement of ends **156** with teeth **137**.

When in the unexpanded configuration (not shown) teeth **156** are not engaged by any of the pawls **157**. In FIG. **15**a, retractor **120** is expanded by pivoting first portion **122** in the direction of arrow R relative to second portion **142** so that lower pawl **157** is biased into engagement with lower tooth **137**. In FIG. **15**b, first portion **122** is further pivoted in the direction of arrow R relative to second portion **142** to expand retractor **120** with the end **156** of middle pawl **157** in engagement with the middle tooth **137**. In FIG. **15**c first portion **122** is further pivoted in the direction of arrow R relative to second portion **142** to expand retractor **120** with the end **156** of upper pawl **157** in engagement with the upper tooth **137**. It is contemplated that teeth **137** and pawls **157** can be spaced so that retractor **120** is expanded incrementally. In one specific embodiment, the teeth **136** and pawls **157** are spaced so that first portion **122** is pivoted in 5 degree increments relative to second portion **142**, ranging from 0 degrees to 15 degrees. Other increments are also contemplated.

FIGS. **16**a-**16**b illustrate another embodiment retractor **320** that is similar to retractor **20** but includes another proximal end configuration. In FIG. **16**b, retractor **320** is in its unexpanded configuration and in FIG. **16**a retractor **320**

is in its expanded configuration. Retractor **320** includes a first portion **322** having a distal end **324**, a proximal end **326**, and a collar **328** at proximal end **326**. Retractor **320** further includes a second portion **342** having a distal end **344**, a proximal end **346**, and a collar **348** at proximal end **346**. First coupling member **330**a and second coupling member **330**b pivotally couple first portion **322** to second portion **342** about a pivot axis A. Collars **328**, **348** have a height that is less than the height of collars **28**, **48** of retractor **20**, reducing the retractor length. Viewing instruments and other instruments can be positioned in, over, and/or attached to retractor **320** as discussed above with respect to retractor **20**.

Collar **328** includes a first extension **334**a extending along one side thereof and above collar **328**, and a second extensions **334**b extending along the other side thereof and above collar **328**. First extension **334**a and second extension **334**b are offset laterally with respect to collar **328** to form recesses for receiving respective ones of the extensions **358**a, **358**b of collar **348** therealong so that extensions **358**a, **358**b do not protrude into the working channel of retractor **320**. Extensions **358**a, **358**b extend above collar **348**. Aligned holes are provided through adjacent extensions **334**a, **358**a and adjacent extensions **334**b, **358**b to receive coupling members **330**a, **330**b. Pivot axis A is thus offset proximally from the proximal ends of collars **328**, **348** so that first portion **322** and second portion **342** are expandable through their respective proximal ends to coupling members **330**a, **330**b.

Collar **328** includes a first contact surface **335**a below first extension **358**a of collar **348**, and a second contact surface **335**b below second extension **358**b of collar **348**. Collar **348** includes a first lateral extension **356**a that provides a contact surface below first extension **334**a of collar **328**, and an opposite second lateral extension that provides a contact surface below second extension **334**b of collar **328**. With retractor **320** in its unexpanded configuration as shown in FIG. **16**b, a gap is formed between the adjacent extensions and engagement surfaces of collars **328**, **348**. When retractor **320** is expanded sufficiently, extensions **334**a, **334**b engage respective ones of the contact surfaces of collar **348**, and extensions **358**a, **358**b engage respective ones of the contact surfaces of collar **328**, preventing over-expansion of retractor **320**.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected. For example, certain embodiments contemplate that the first and second portions of the retractor are not provided with proximal end collars. Other embodiments contemplate the first and second portions are not pivotally coupled to one another, but rather to intermediate members extending between the first and second portions along each side of the retractor.

What is claimed is:

1. A kit for use in percutaneous surgery, comprising:

a retractor having a working channel extending between a proximal end and a distal end of said retractor, said retractor having a first portion coupled to a second portion, said first and second portions movable relative to one another for engagement in an expanded configuration, wherein:

said first portion and said second portion each include opposite edges extending between a proximal end and a distal end thereof;

said second portion includes an engagement surface extending along at least a portion of each of said opposite edges thereof;

in said unexpanded configuration said edges of said first portion extend around said second portion;

in said expanded configuration said opposite edges of said first portion engage adjacent ones of said engagement surfaces of said second portion;

an expansion instrument positionable in said working channel and engageable with said first portion and said second portion to move said first and second portions to said expanded configuration, wherein with said working channel in said expanded configuration said expansion instrument is positionable in said working channel to disengage said first and second portions for movement to an unexpanded configuration and

a series of tubular tissue dilators positionable one over the other to sequentially dilate bodily tissue, wherein said working channel of said retractor is sized for positioning about said tissue dilators when in an unexpanded configuration.

2. The kit of claim **1**, wherein said first portion is pivotally coupled to said second portion at said proximal end of said retractor and said first and second portions are pivotal between said unexpanded configuration and said expanded configuration.

3. The kit of claim **1**, wherein said expansion instrument is mountable on a proximal end of said retractor.

4. A kit for use in percutaneous surgery, comprising:

a retractor having a working charnel extending between a proximal end and a distal end of said retractor, said retractor having a first portion coupled to a second portion in an unexpanded configuration, wherein said first and second portions are movable relative to one another for engagement in an expanded configuration to expand said working channel between said proximal and distal ends, wherein said working channel has a generally circular cross-section in said unexpanded configuration and in said expanded configuration said first and second portions define said working channel with a first width between opposite edges of said first and second portions and said first and second portions define a second width in a direction of expansion of the first and second portions that is transverse to said first width and greater than said first width, wherein said first width and said second width are measured on the same plane, where the plane is orthogonal to the longitudinal axis of said retractor;

a series of tubular tissue dilators positionable one over the other to sequentially dilate bodily tissue, wherein said working channel of said retractor is sized for positioning around said tissue dilators when said retractor is in said unexpanded configuration; and

an expansion instrument positionable in said working channel and engageable with said first portion and said second portion to move said first and second portions to said expanded configuration.

5. The kit of claim **4**, wherein said first portion substantially envelopes said second portion in said unexpanded configuration.

6. The kit of claim **4**, wherein said first portion is pivotally coupled to said second portion at proximal ends of said first and second portions and in said expanded configuration distal ends of said first and second portions are pivoted away from one another about said pivotally coupled proximal ends.

7. The kit of claim 4, wherein said first portion is pivotally coupled to said second portion along a pivot axis located proximally of proximal ends of said first portion and said second portion.

8. The kit of claim 4, wherein when in said expanded configuration:

said working channel tapers in size from said distal end to said proximal end; and

said second portion includes opposite edges extending between distal and proximal ends of said second portion that overlap adjacent edges of said first portion adjacent a distal end of said first portion.

9. The kit of claim 4, wherein said retractor forms a tubular body in said unexpanded configuration and said series of tissue dilators includes a series of elongated tubes of increasing diameter.

10. The kit of claim 4, wherein in both said expanded and said unexpanded configurations said first portion and said second portion enclose said working channel between said proximal and distal ends of said working channel.

11. A kit for use in percutaneous surgery, comprising:

a retractor having a working channel extending between a proximal end and a distal end of said retractor, said retractor having a first portion coupled to a second portion in an unexpanded configuration, wherein said first and second portions are movable relative to one another for engagement in an expanded configuration to expand said working channel between said proximal and distal ends, wherein:

said first portion and said second portion each include opposite edges extending between a proximal end and a distal end thereof;

said second portion includes an engagement surface extending along at least a portion of each of said opposite edges thereof;

in said unexpanded configuration said edges of said first portion extend around said second portion;

in said expanded configuration said opposite edges of said first portion engage adjacent ones of said engagement surfaces of said second portion; and

a series of tubular tissue dilators positionable one over the other to sequentially dilate bodily tissue, wherein said working channel of said retractor is sized for positioning around said tissue dilators when said retractor is in said unexpanded configuration.

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