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(54) APPARATUS FOR ANCHORING AN INTRAVASCULAR DEVICE ALONG A GUIDEWIRE

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(21) Appl. No.: **10/373,481**

(22) Filed: **Feb. 24, 2003**

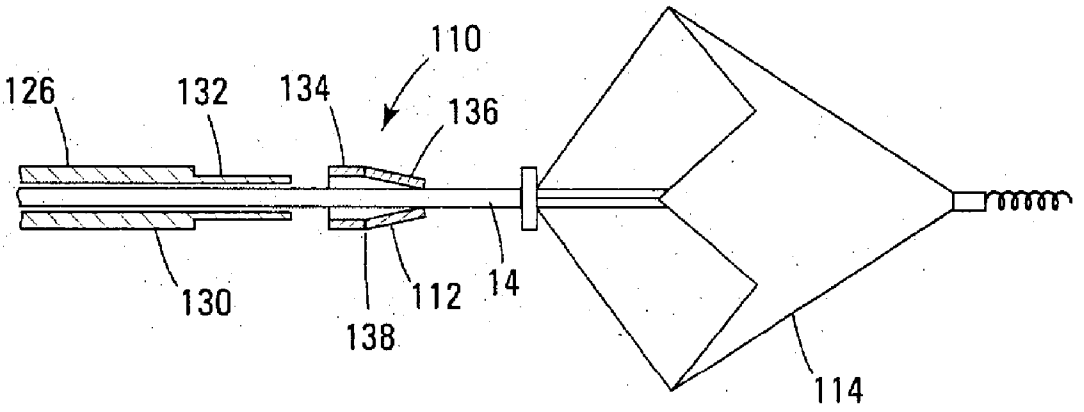
Publication Classification

(51) **Int. Cl.**[7] **A61F 2/06**

(52) **U.S. Cl.** **606/200**

(57) **ABSTRACT**

Anchoring mechanisms for releasably securing an intravascular device along an elongated member such as a guidewire or catheter. The anchoring mechanism may include an object that can be actuated between an unlocked position and a locked position. In the unlocked position, the anchoring mechanism is slidably and rotationally disposed about the elongated member. In the locked position, the anchoring mechanism is releasably secured to the elongated member, preventing movement thereon. A placement mechanism such as a tubular member can be utilized to actuate the anchoring mechanism between the unlocked and locked positions.



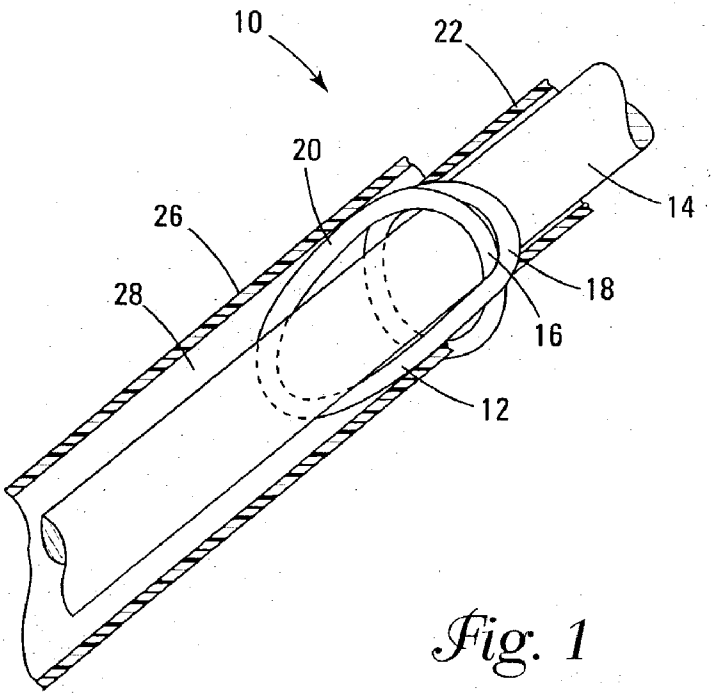


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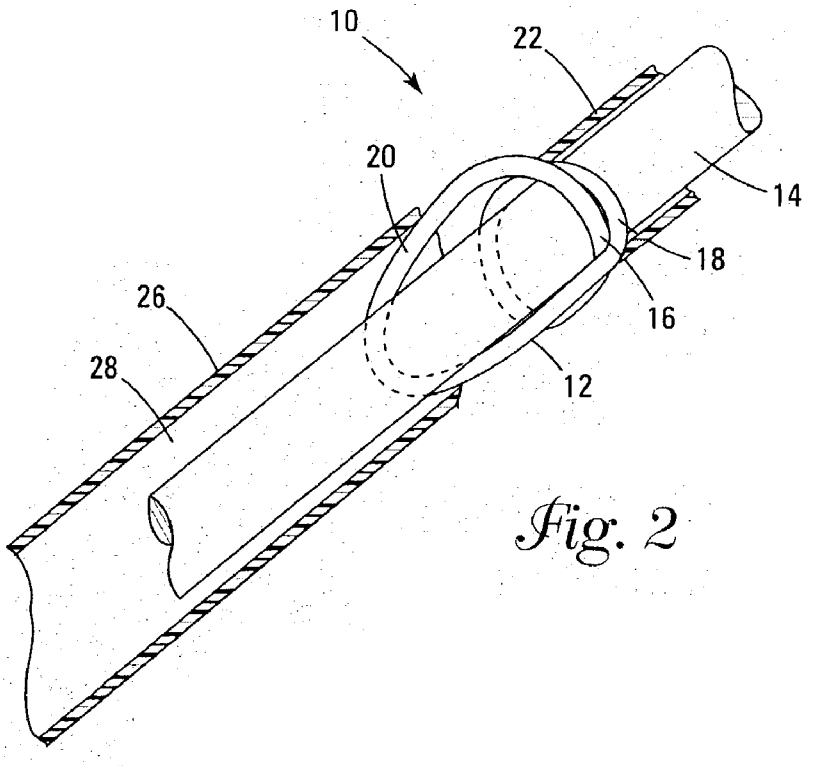


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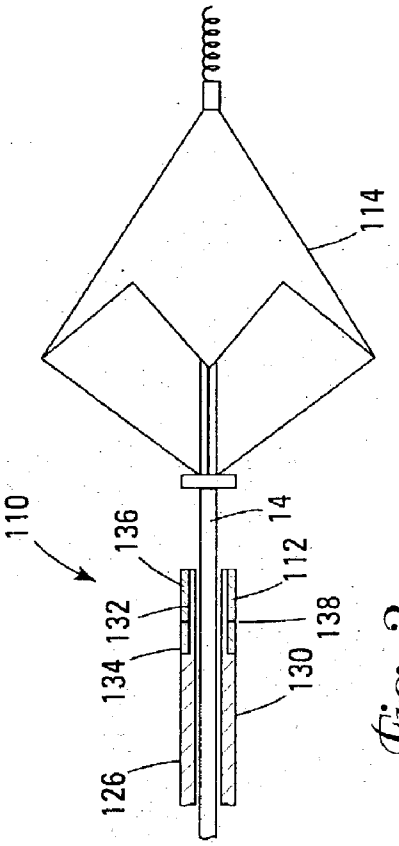

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Fig. 3

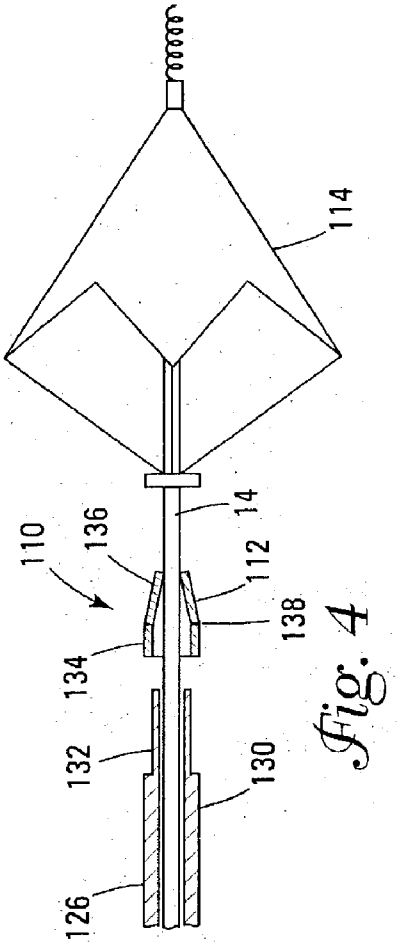

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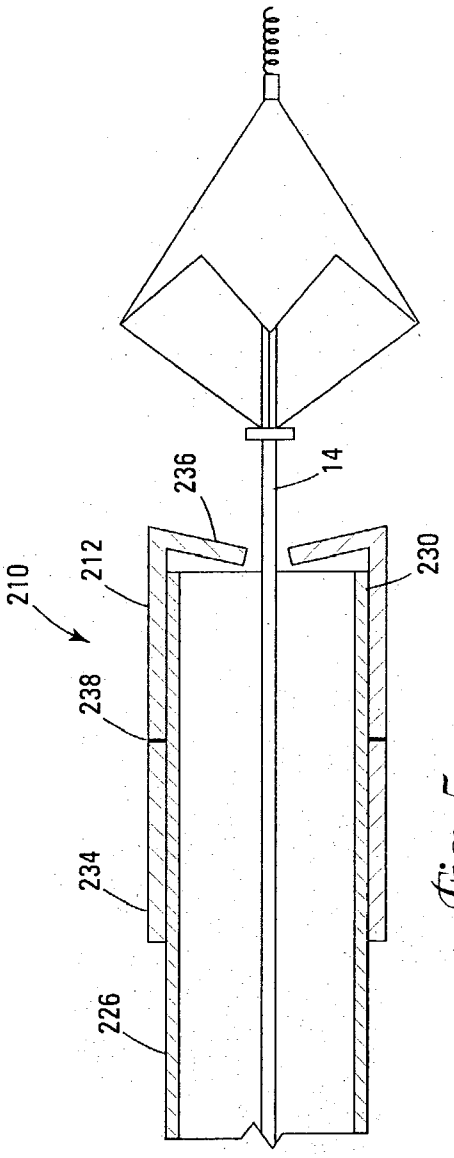


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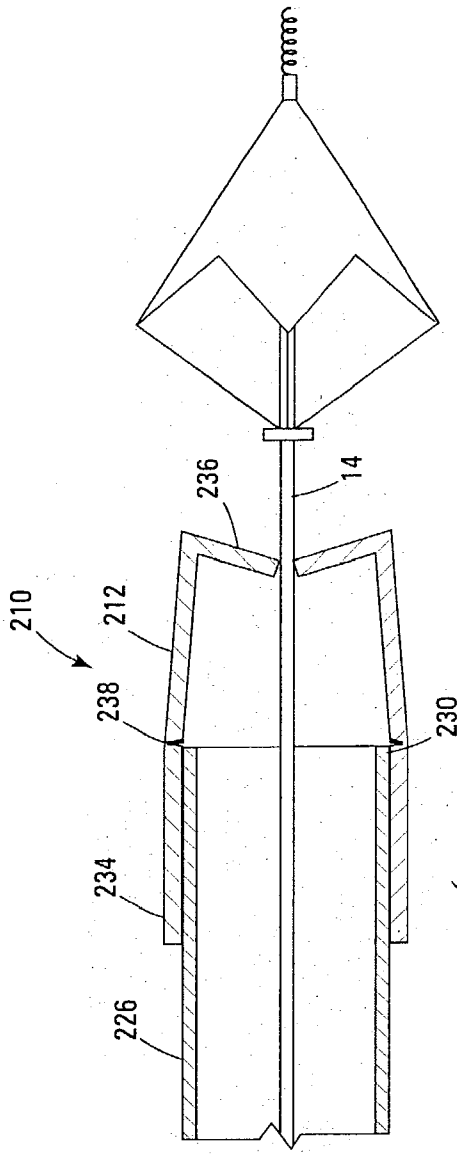


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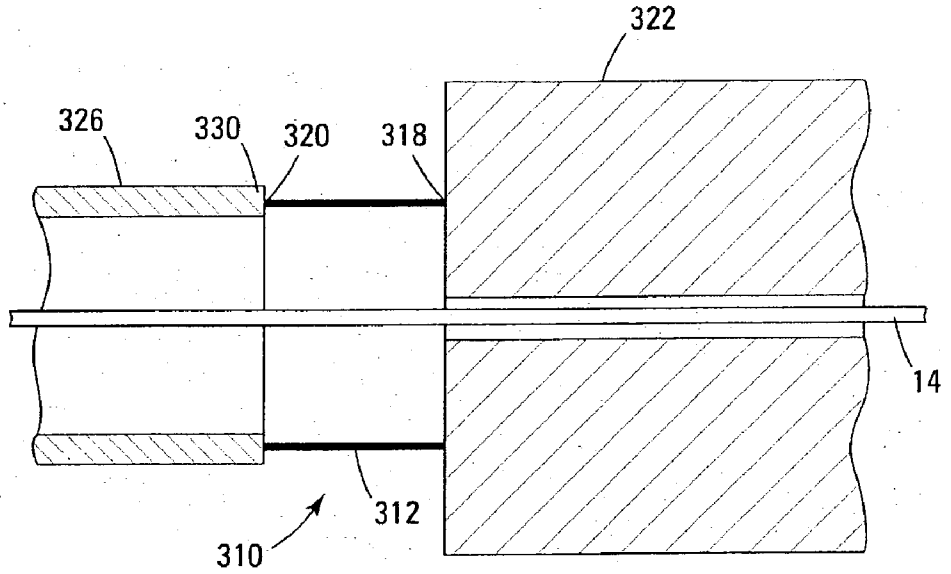


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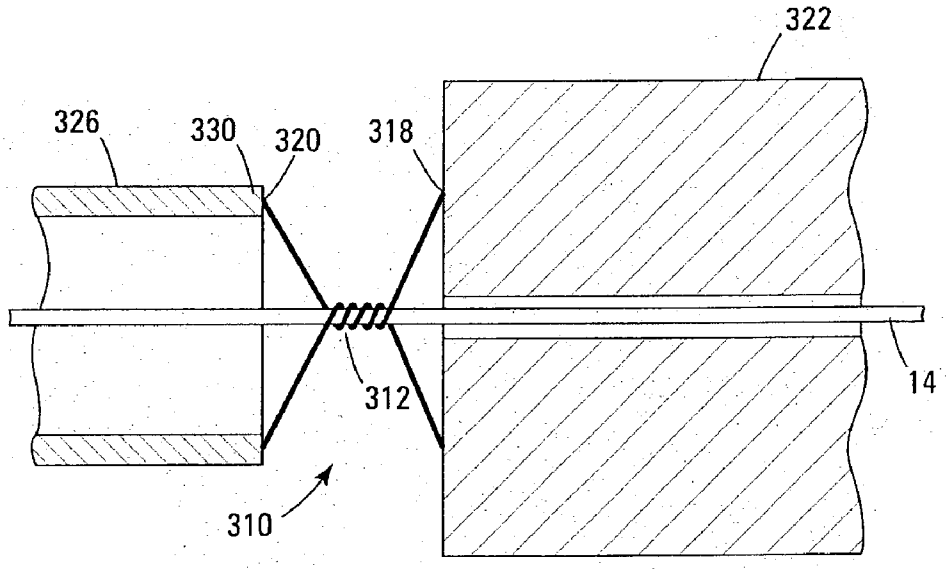


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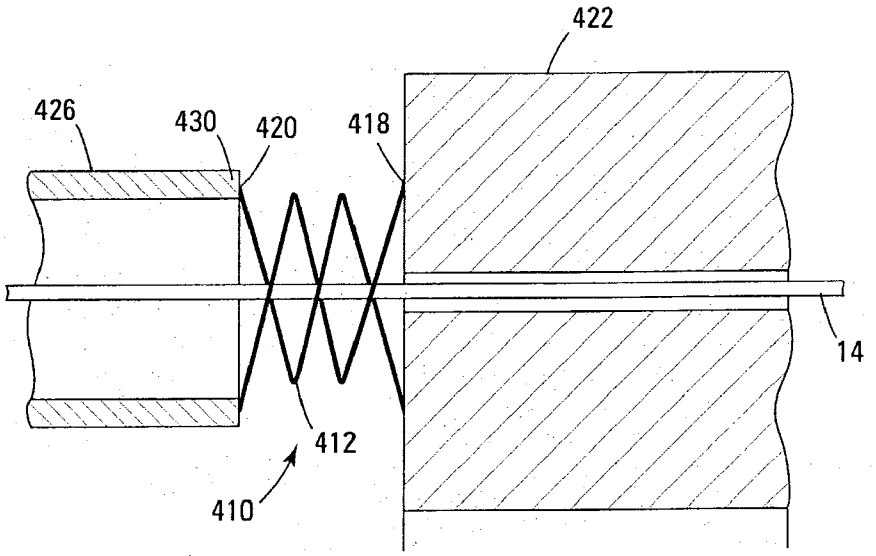


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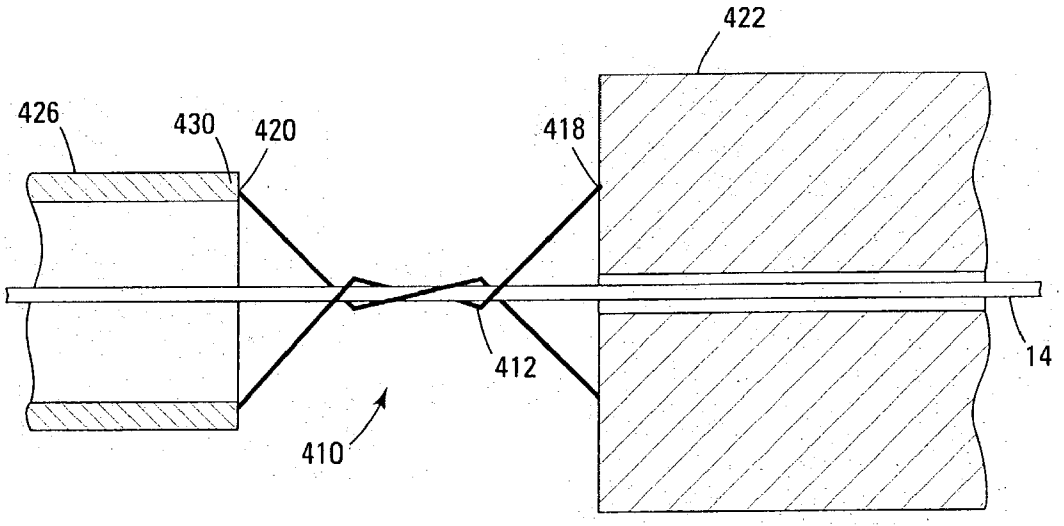


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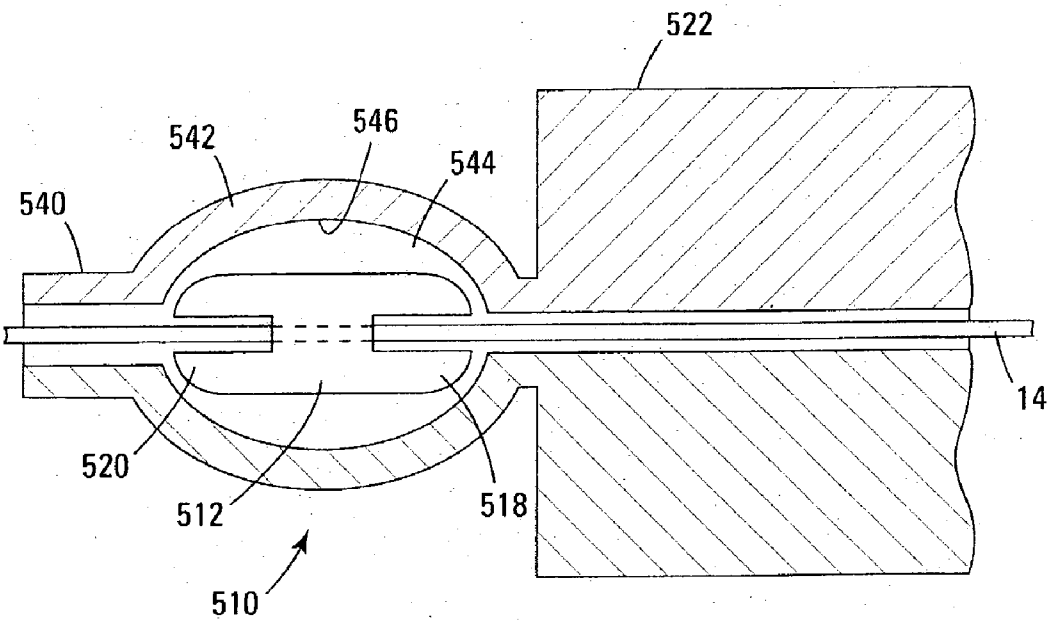

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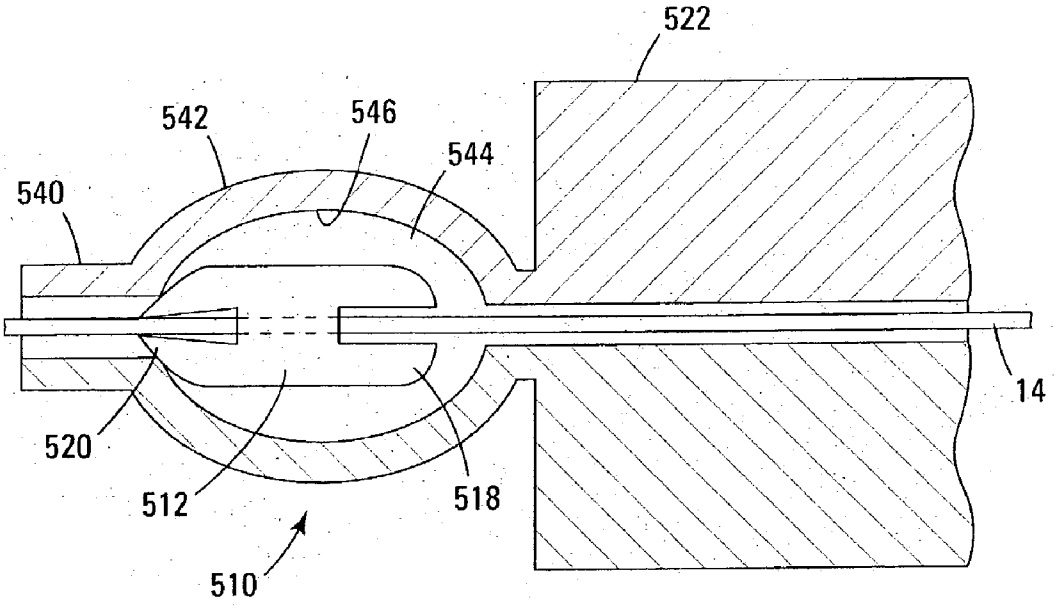

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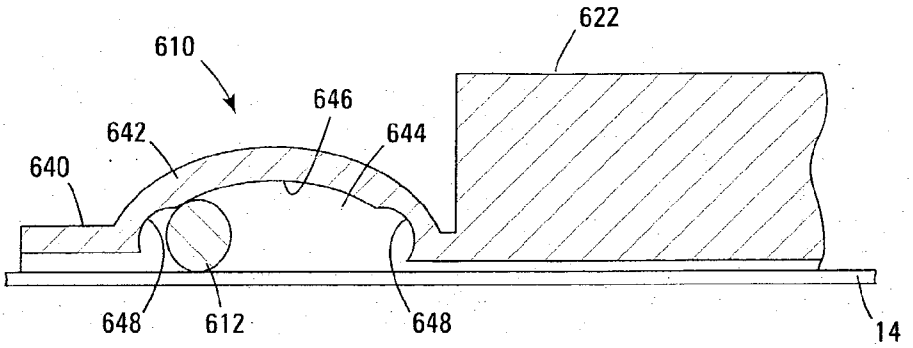


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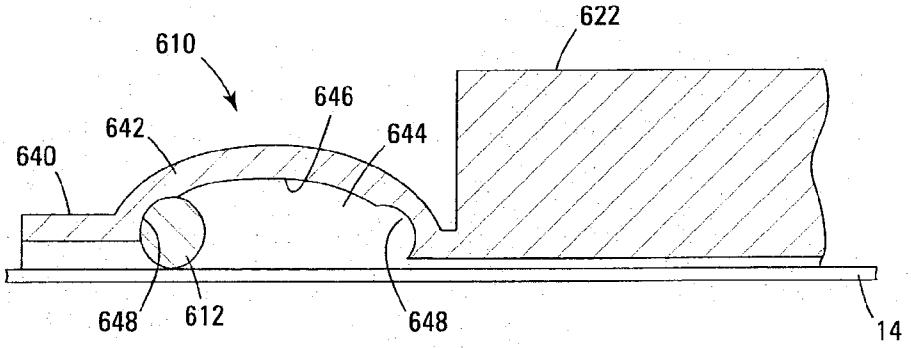


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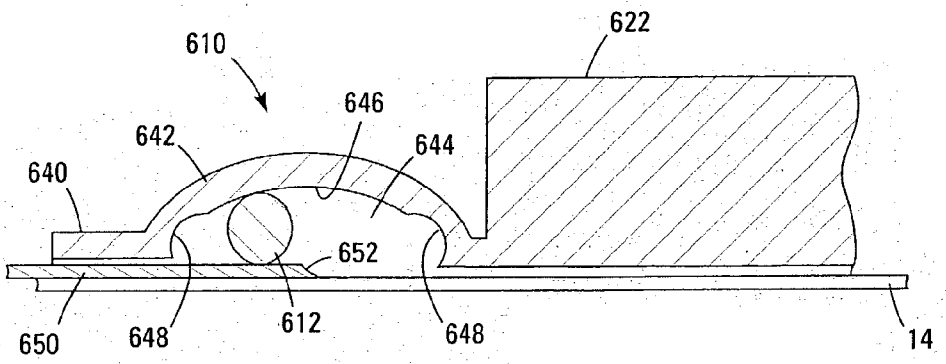


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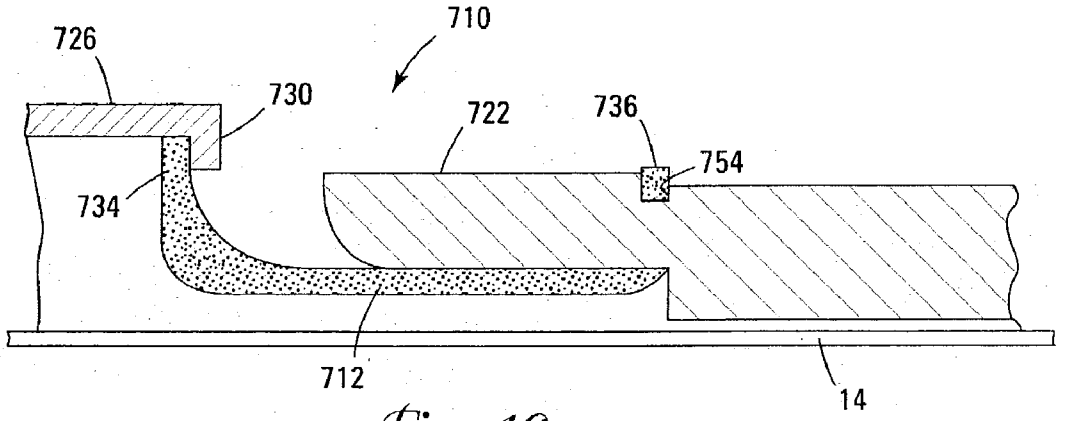

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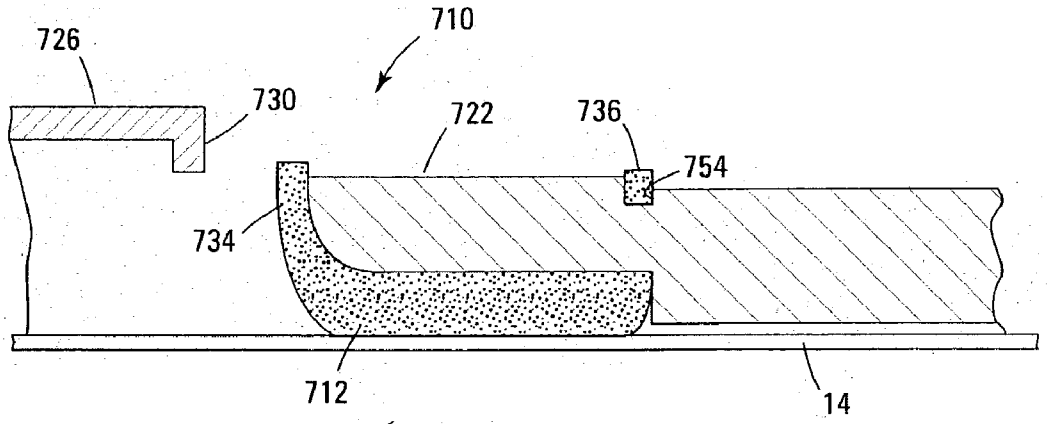

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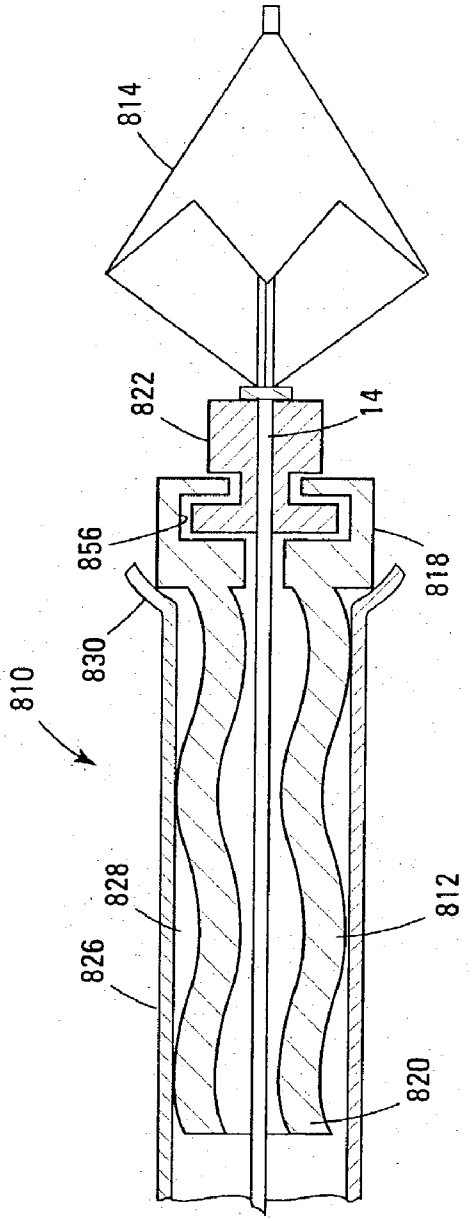

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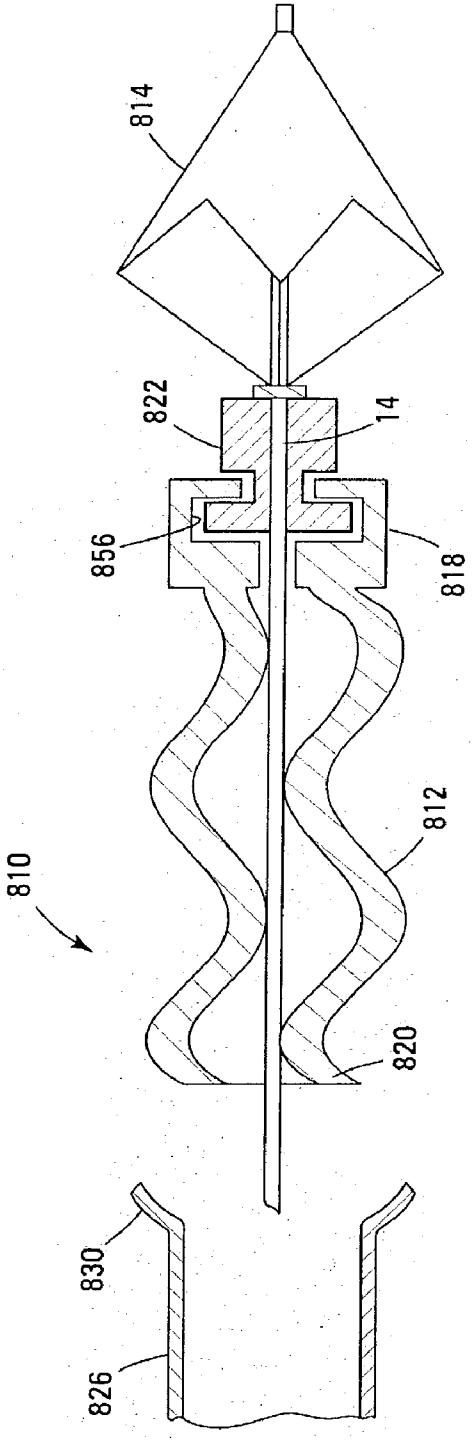

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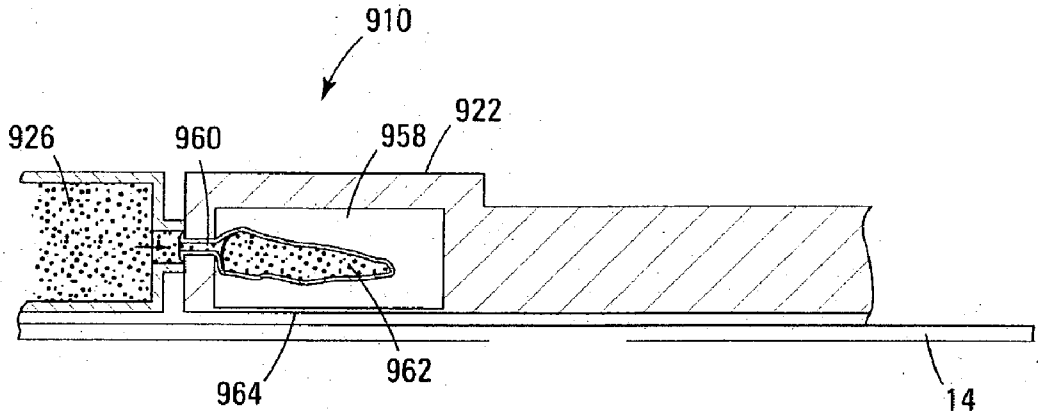


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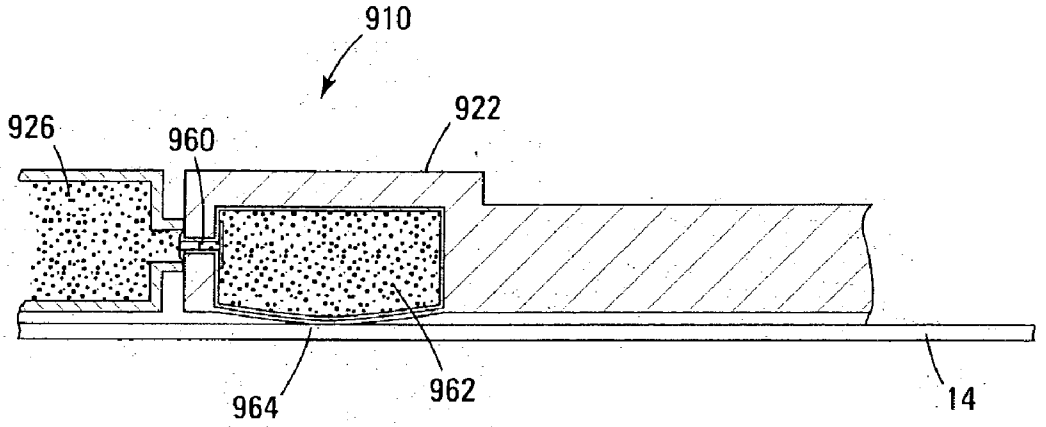


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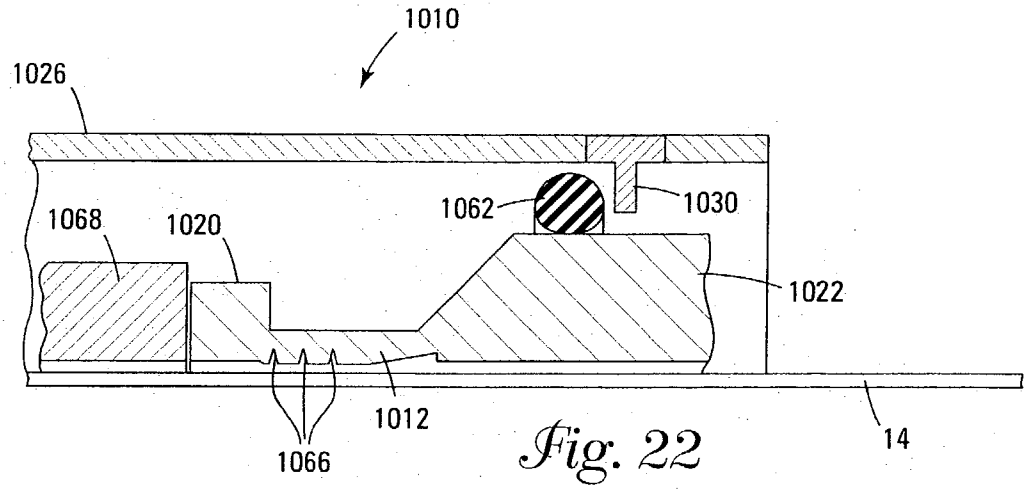

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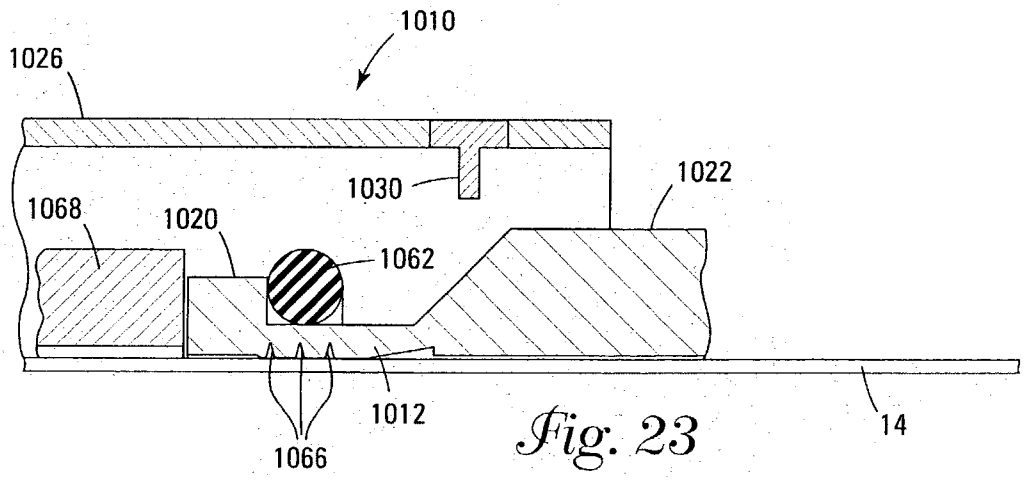

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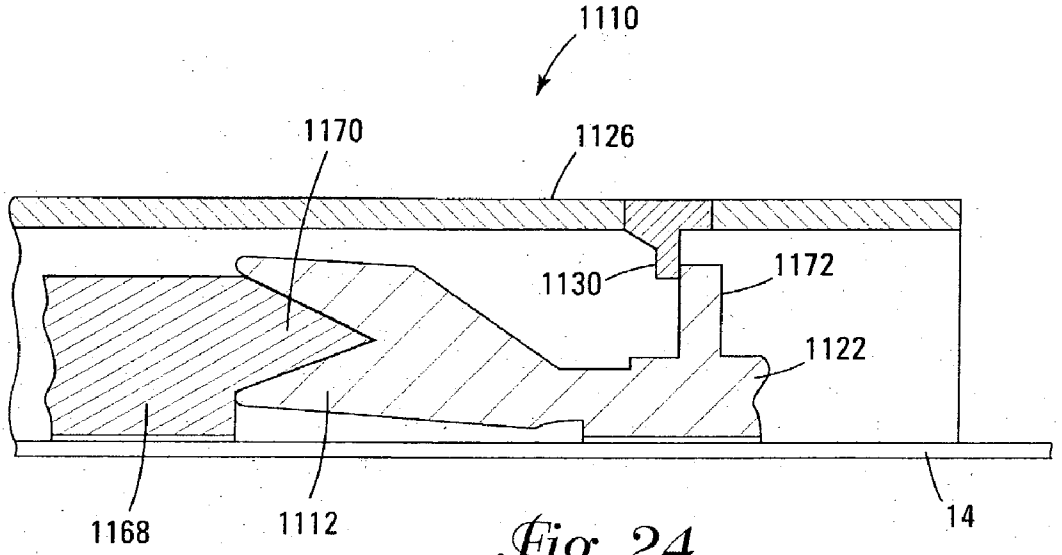

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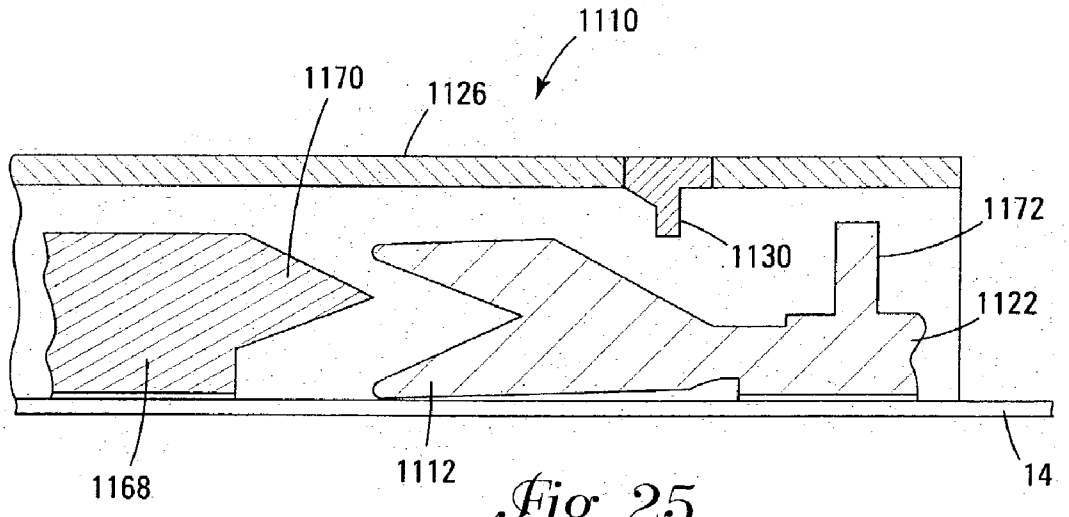

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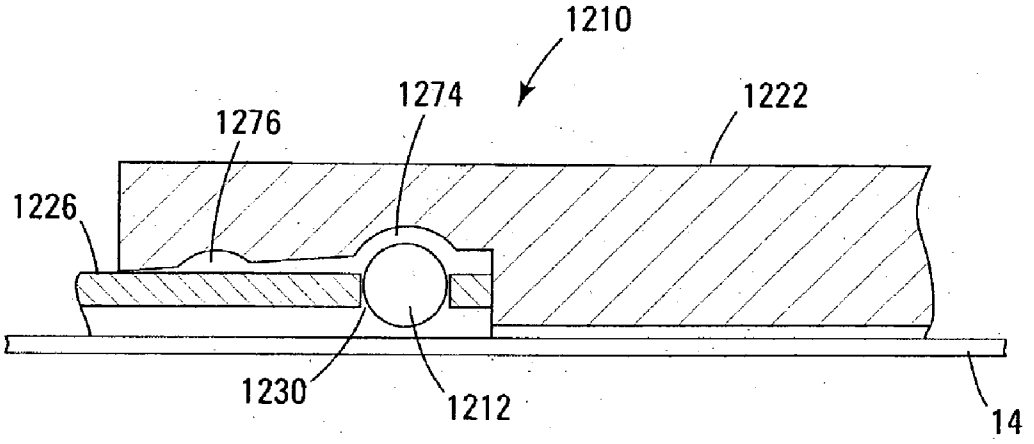

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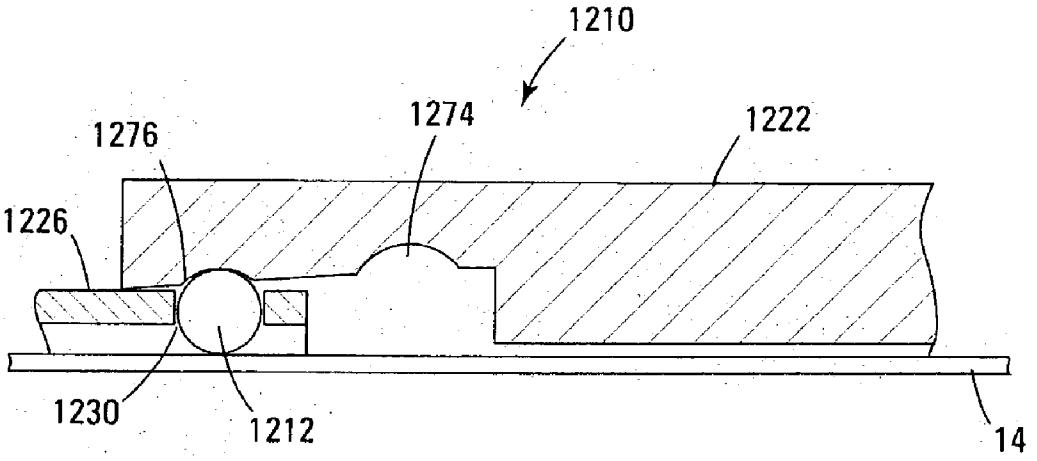

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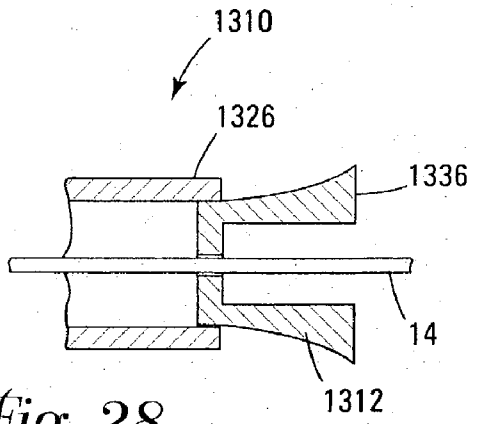


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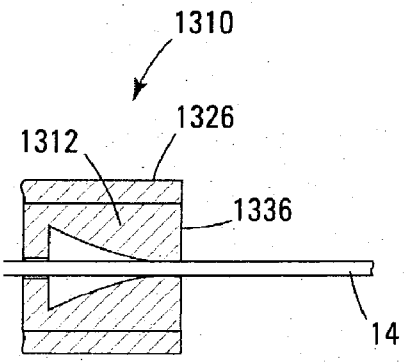


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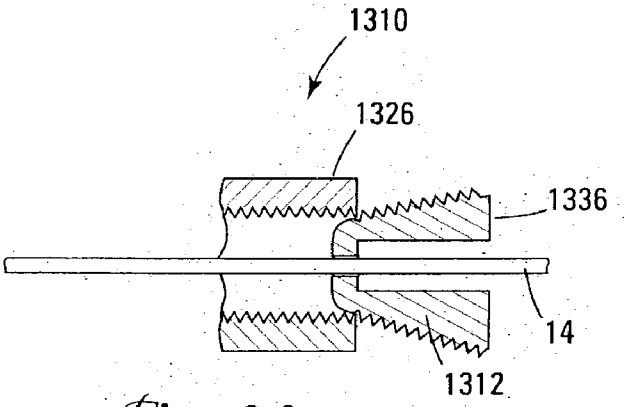


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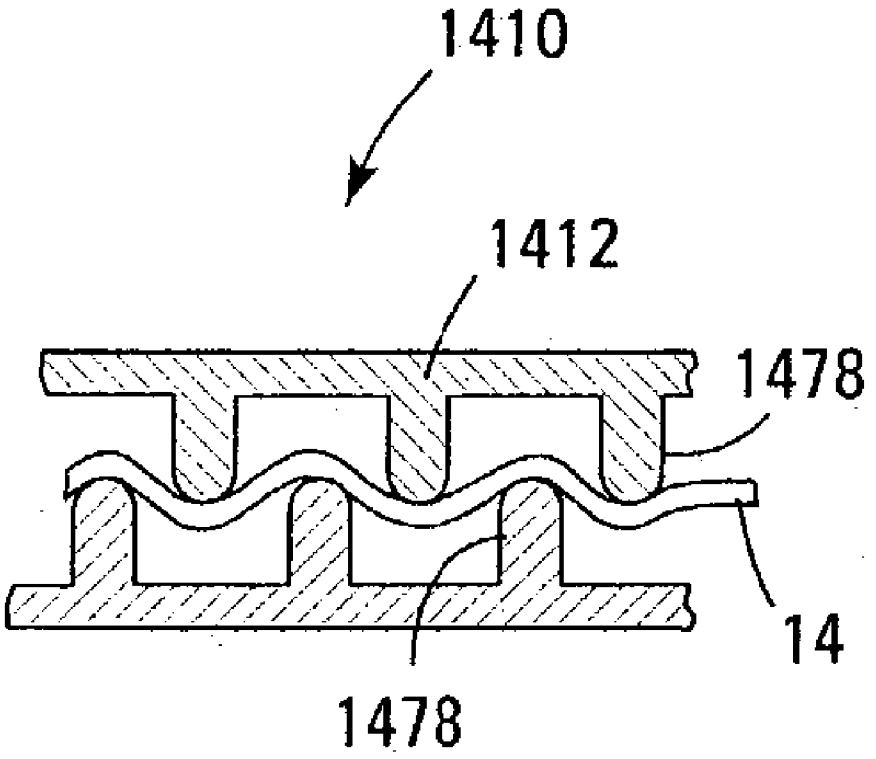


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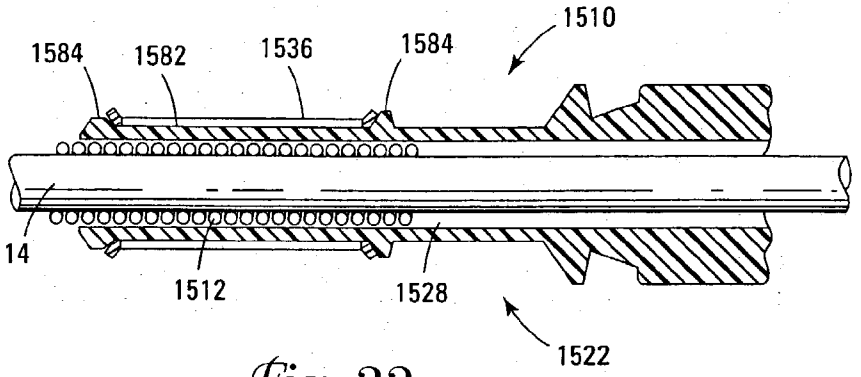


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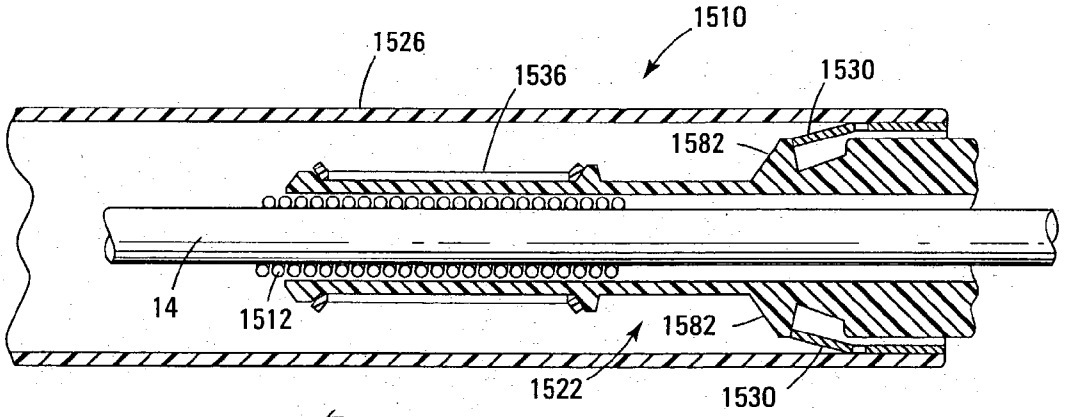


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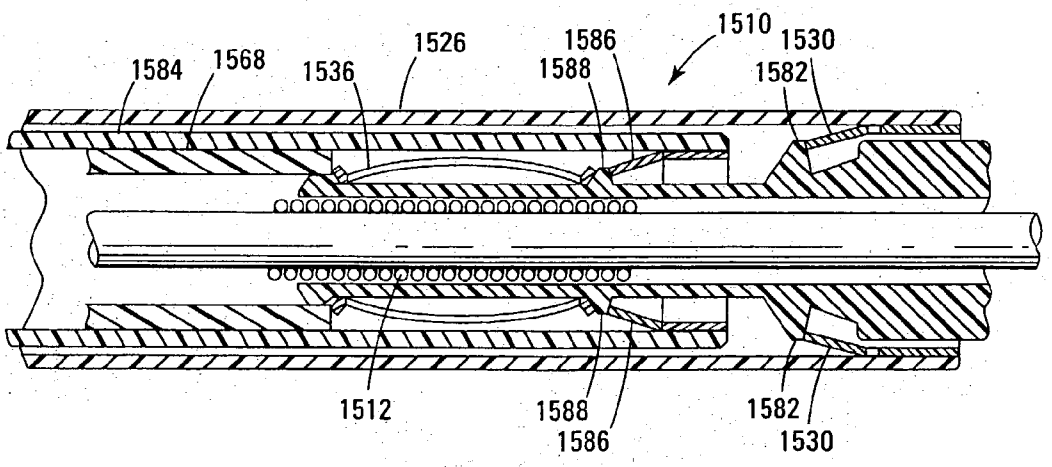


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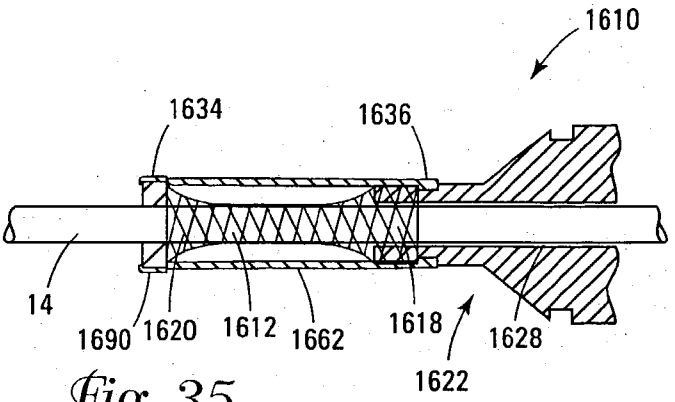


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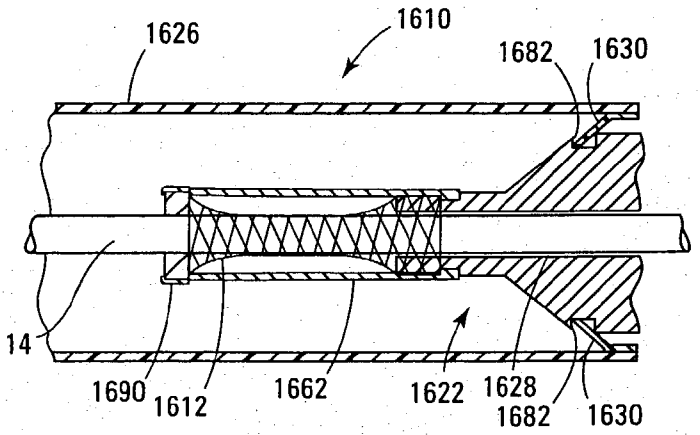
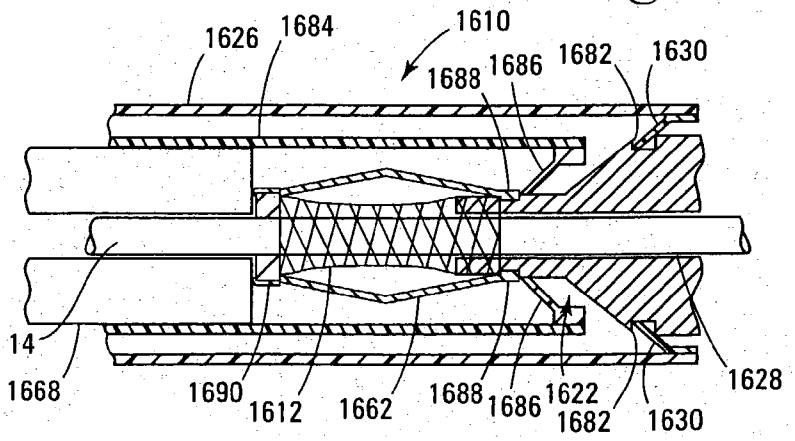


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Fig. 37



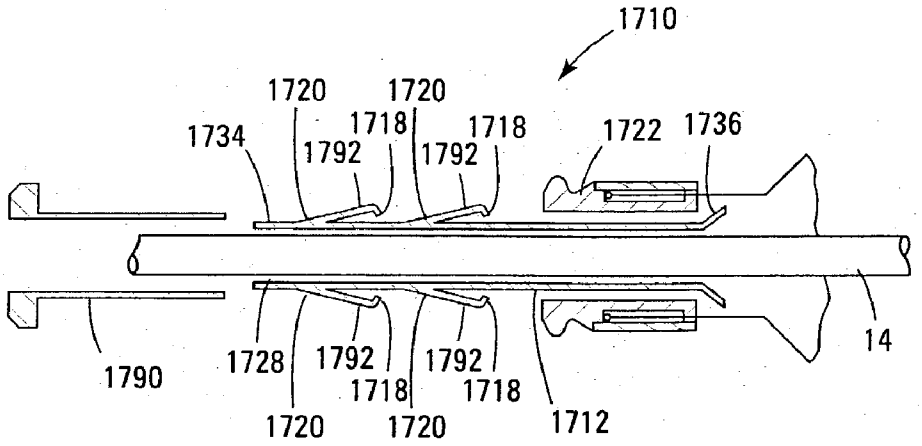


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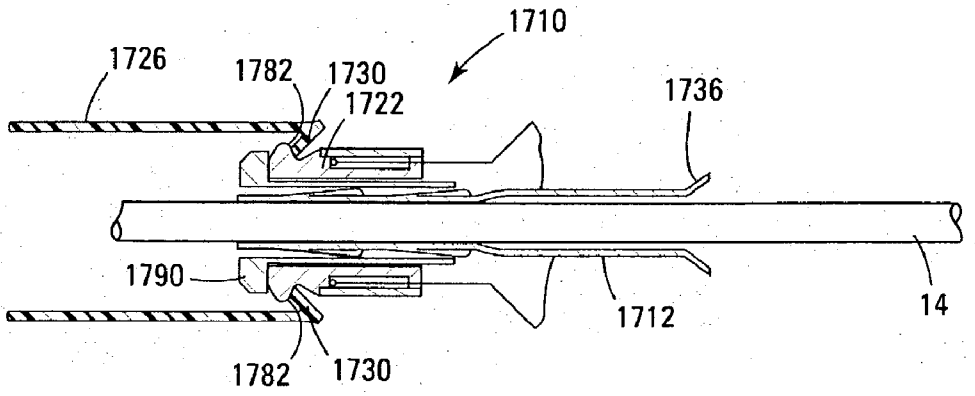


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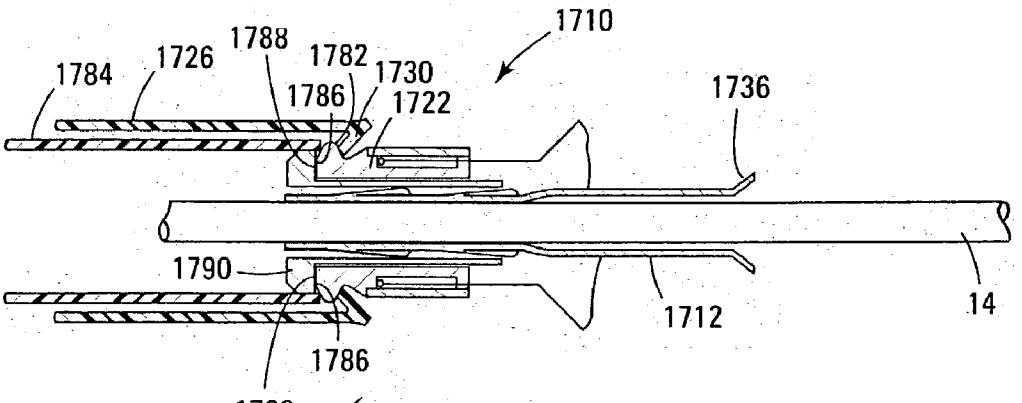


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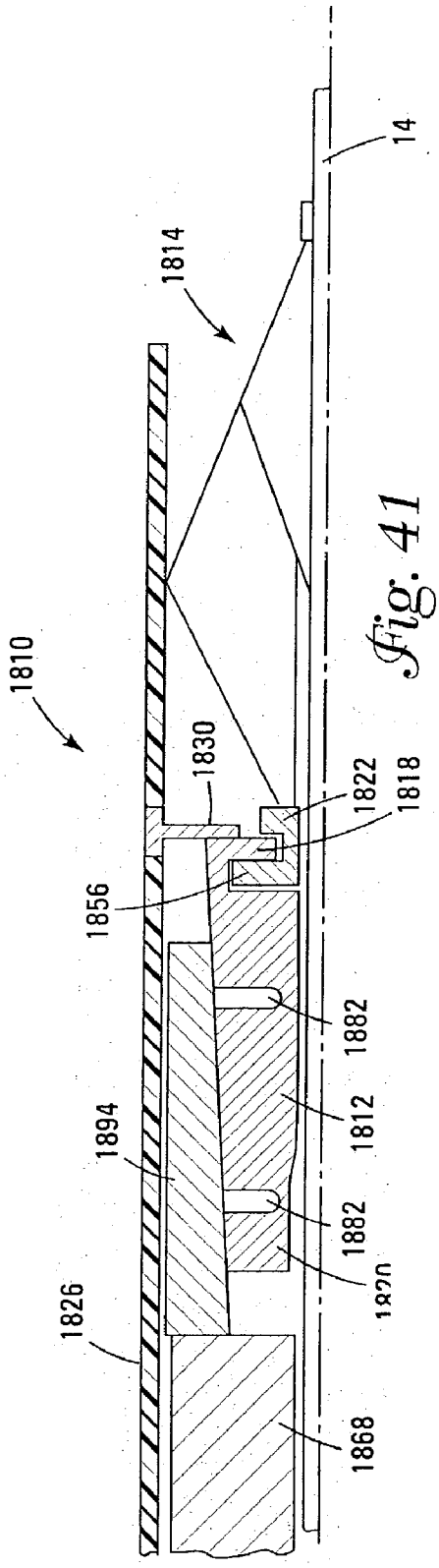

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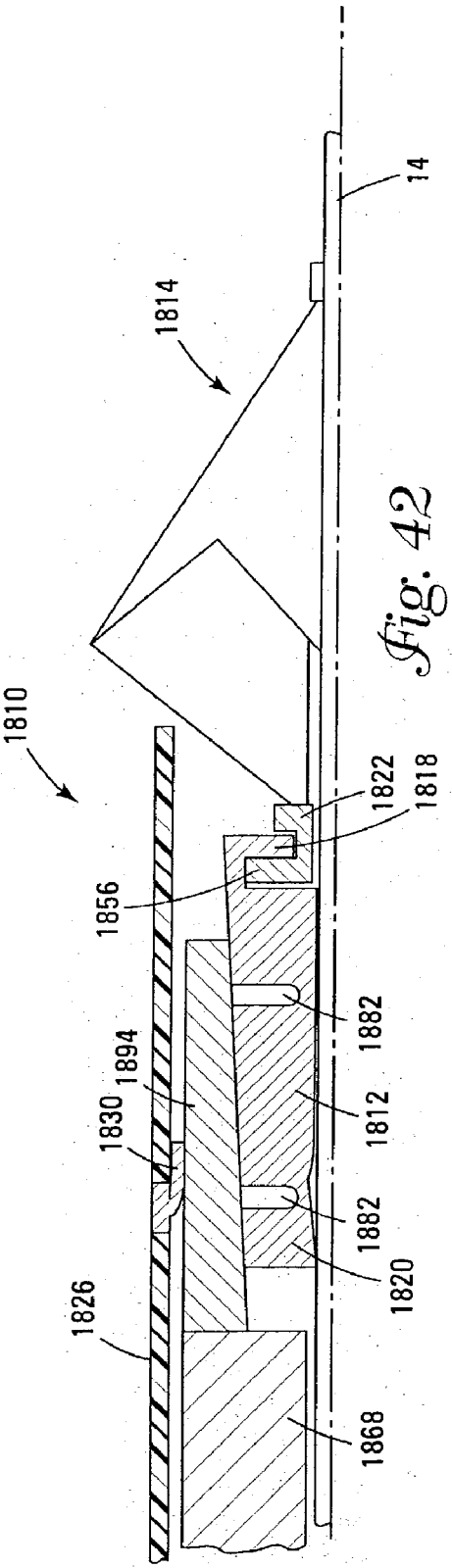

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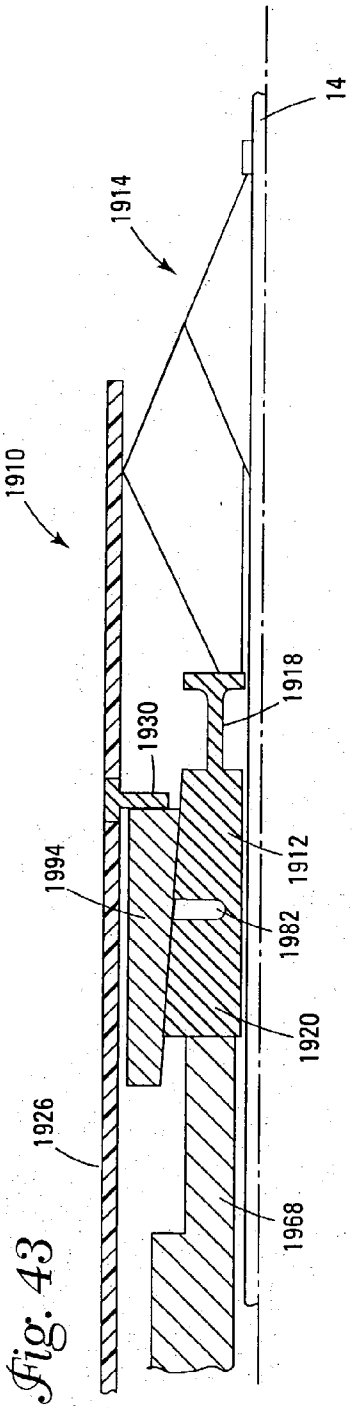


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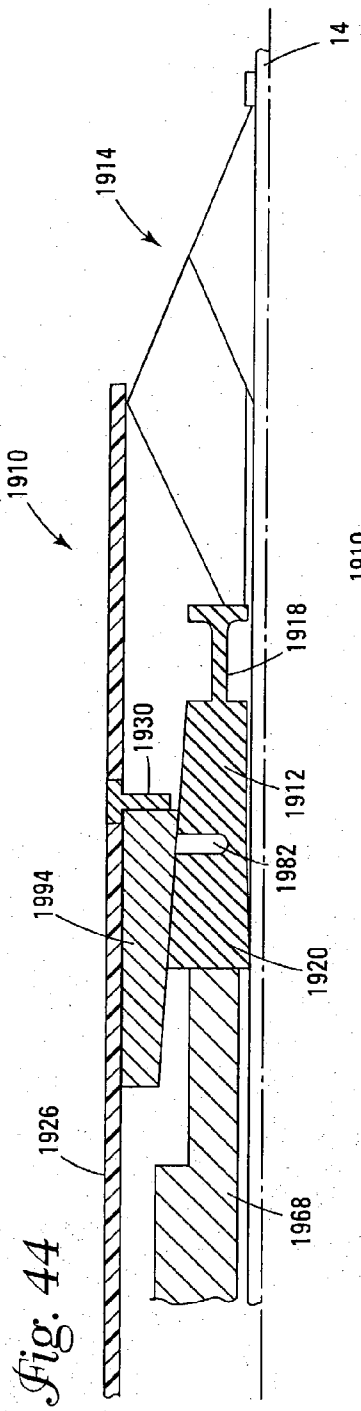


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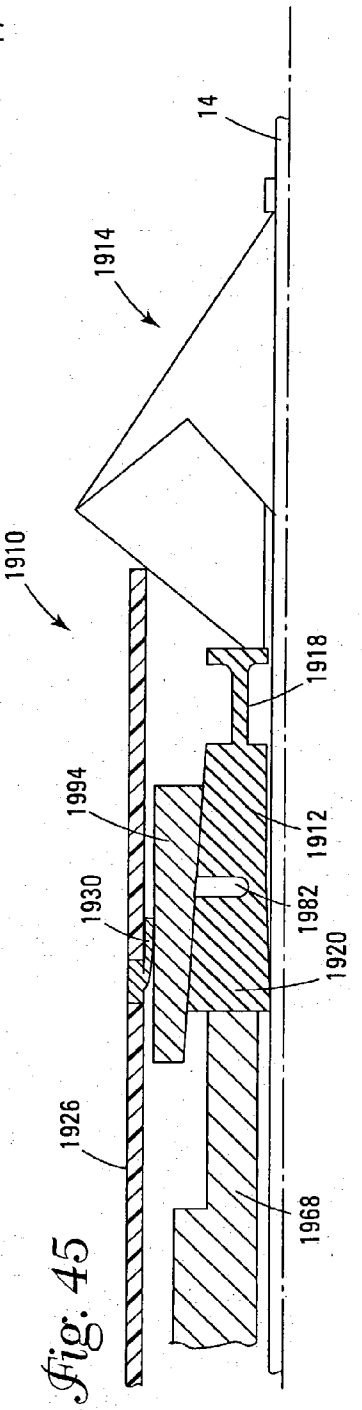


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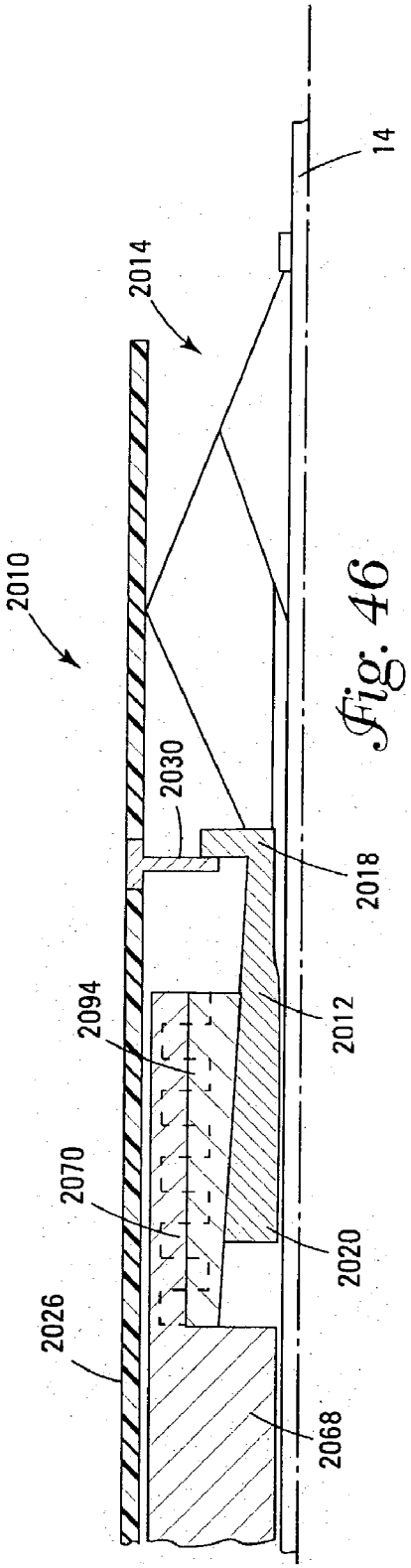

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Fig. 46

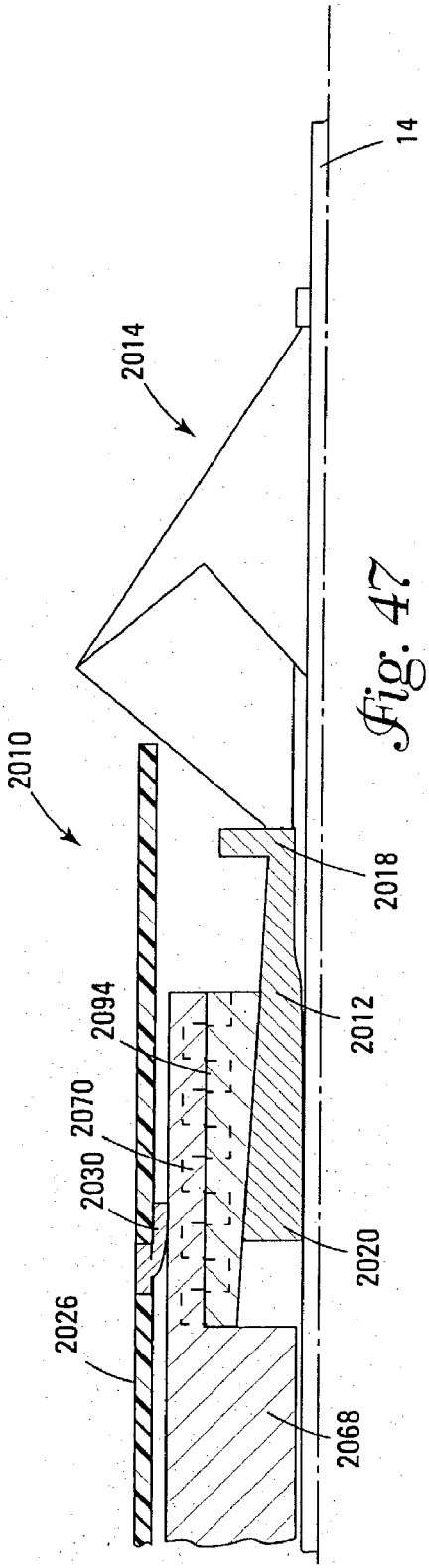

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Fig. 47

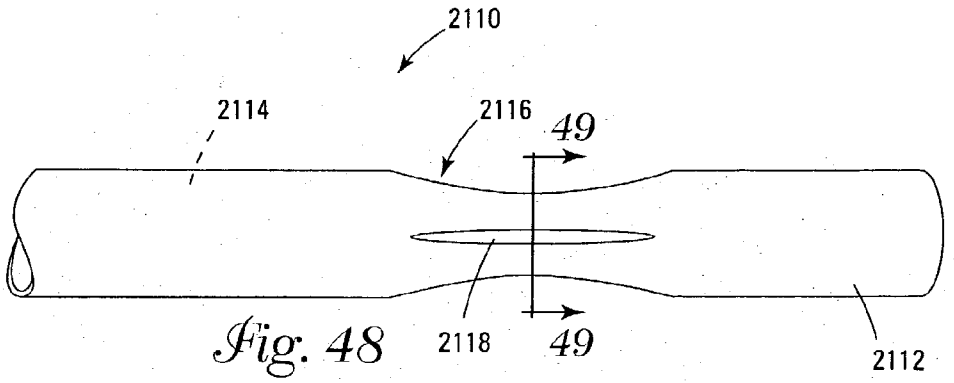


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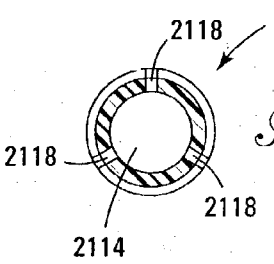


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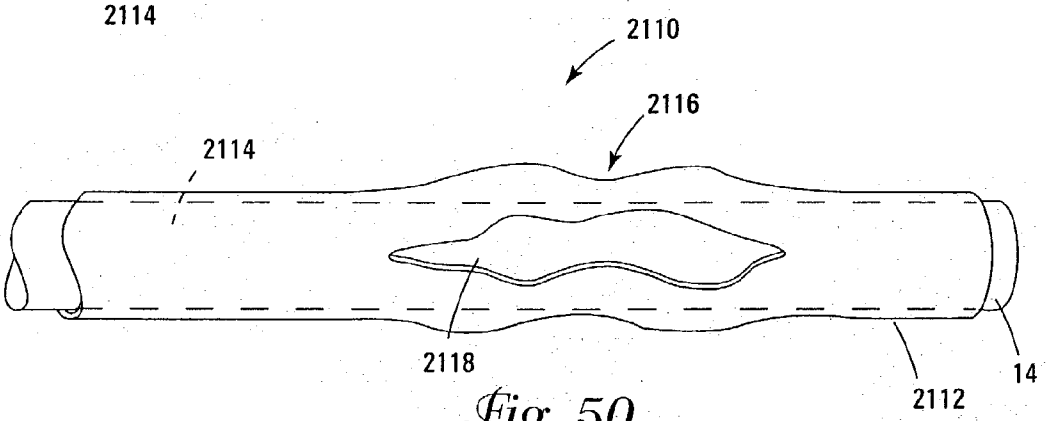


Fig. 50

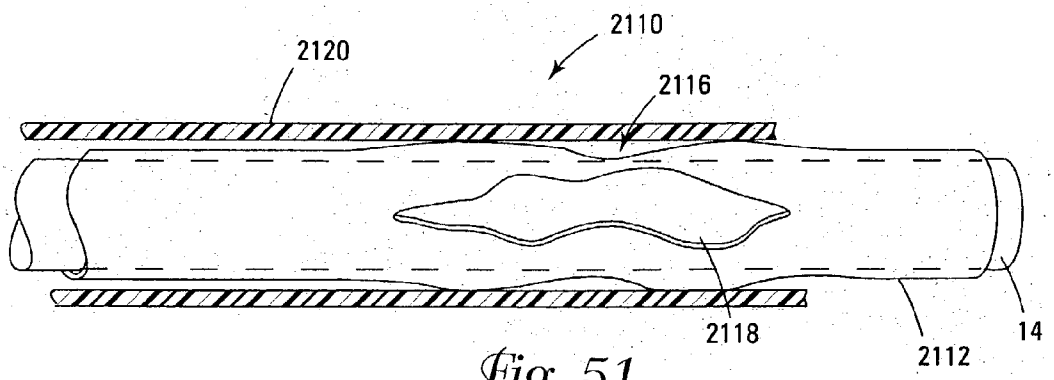
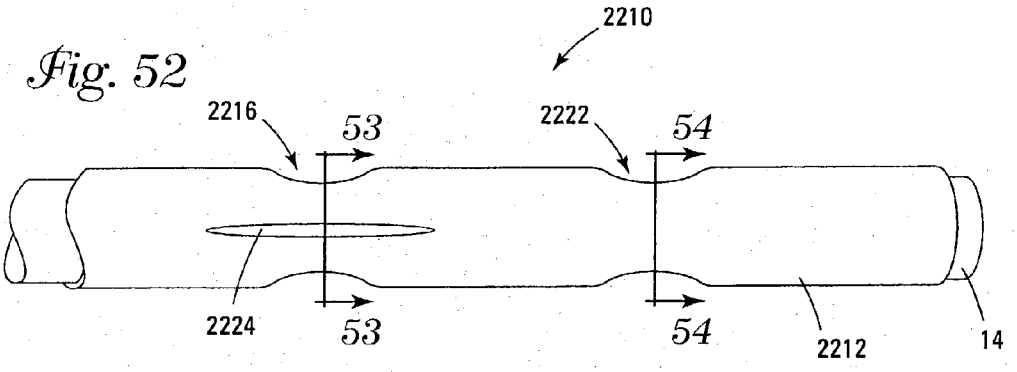


Fig. 51

Fig. 52



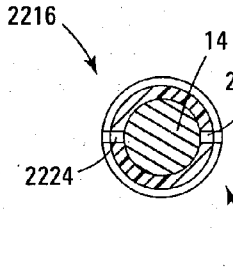


Fig. 53

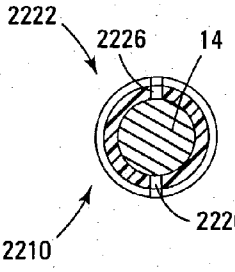


Fig. 54

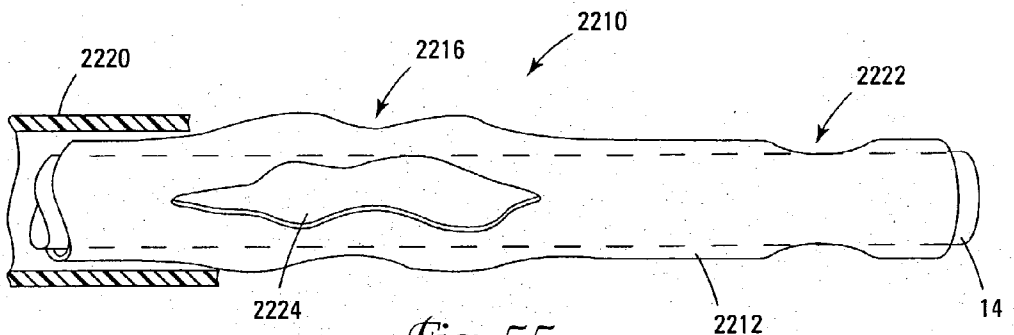


Fig. 55

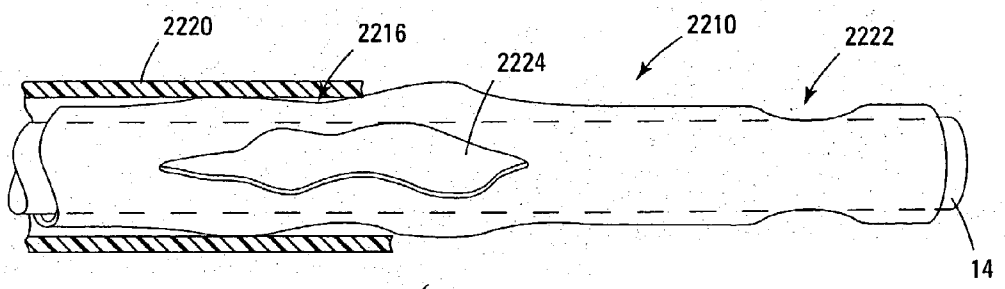


Fig. 56

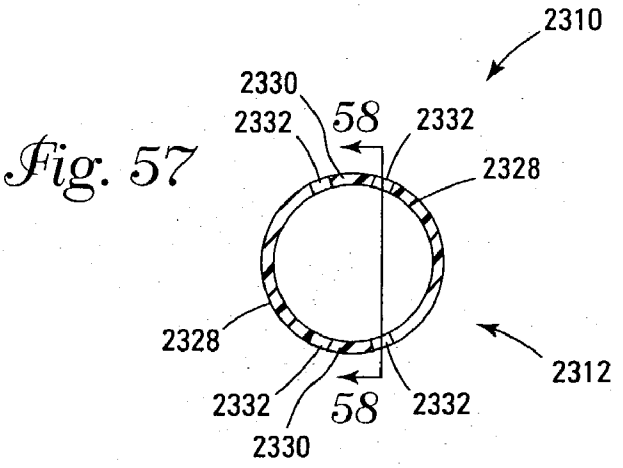


Fig. 57

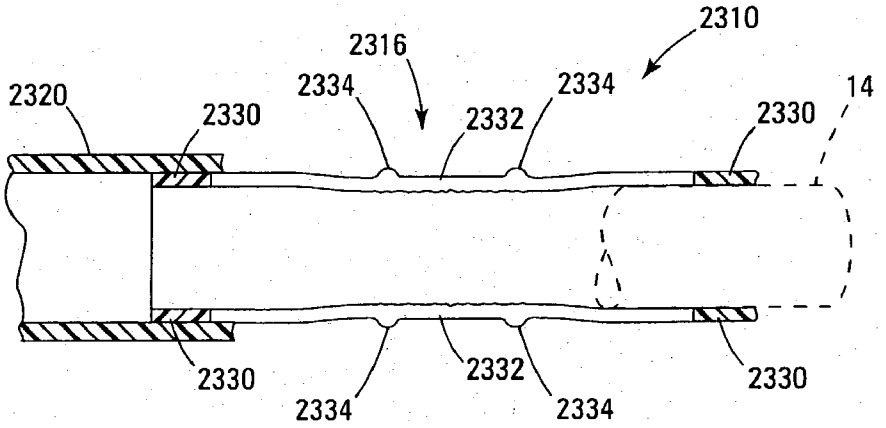


Fig. 58

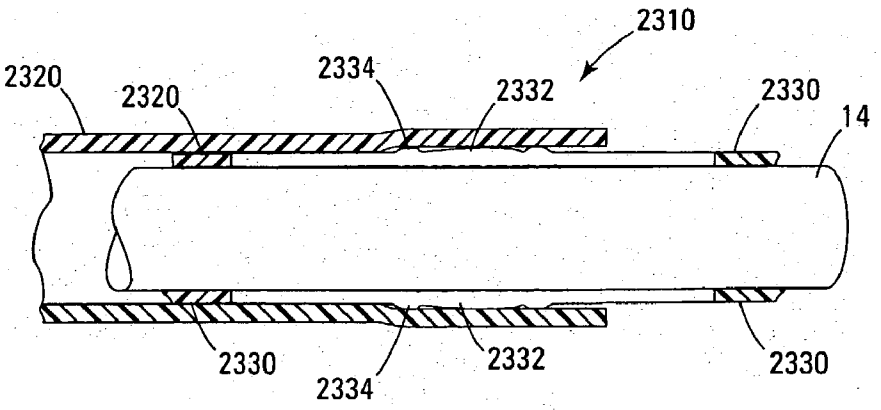


Fig. 59

APPARATUS FOR ANCHORING AN INTRAVASCULAR DEVICE ALONG A GUIDEWIRE

FIELD OF THE INVENTION

[0001] The present invention pertains to anchoring mechanisms for intravascular devices. More specifically, the present invention relates to anchoring mechanisms for releasably securing an intravascular device to an elongated member disposed within a blood vessel.

BACKGROUND OF THE INVENTION

[0002] Medical procedures to treat occlusive vascular diseases, such as angioplasty, atherectomy and stent deployment, routinely involve the insertion and subsequent removal of various intravascular devices. In an angioplasty procedure, for example, a physician will typically advance a guidewire having an attached embolic protection filter to a desired location within the body, and subsequently deploy a balloon catheter to dislodge embolic debris or thrombus from a lesion. In some instances, the physician may wish to deploy more than one device during the procedure. For example, if the first embolic protection filter becomes occluded with debris dislodged during the angioplasty procedure, the physician may wish to replace the occluded filter with a second filter.

[0003] One limitation with the prior art is the inability to deploy more than one device along a single guidewire without having to remove the guidewire from the patient's body. Although more recent developments in the art have focused on the use of multiple wires to rapidly deploy and exchange such devices, techniques employing a single guidewire typically require the physician to remove the guidewire from the body prior to the insertion of another device.

SUMMARY OF THE INVENTION

[0004] The present invention pertains to anchoring mechanisms for intravascular devices. More specifically, the present invention relates to anchoring mechanisms for releasably securing an intravascular device to a guidewire disposed within the vasculature of a patient.

[0005] In one exemplary embodiment of the present invention, an anchoring mechanism for releasably securing an intravascular device to a guidewire comprises an embolic protection filter actuatable between an unlocked (i.e. disengaged) position and a locked (i.e. engaged) position. In the unlocked position, the anchoring mechanism is slidably and rotationally disposed along the guidewire, allowing the embolic protection filter to be advanced through the patient's vasculature. In the locked position, the anchoring mechanism is releasably secured to the guidewire, substantially preventing movement of the device along the guidewire. In certain implementations of the present invention, a placement device can be utilized to place the anchoring mechanism at a desired point along the guidewire. In other implementations, a retrieval mechanism can be utilized to disengage the anchoring mechanism from the guidewire.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] **FIG. 1** is a cross-sectional view of an anchoring mechanism in accordance with an embodiment of the present invention, wherein the anchoring mechanism includes a spring coil;

[0007] **FIG. 2** is another cross-sectional view of the anchoring mechanism of **FIG. 1**, wherein the anchoring mechanism is releasable secured to the guidewire;

[0008] **FIG. 3** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a split tube segment;

[0009] **FIG. 4** is another cross-sectional view of the anchoring mechanism of **FIG. 3**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0010] **FIG. 5** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes one or more leaf clamps;

[0011] **FIG. 6** is another cross-sectional view of the anchoring mechanism of **FIG. 5**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0012] **FIG. 7** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes one or more wires;

[0013] **FIG. 8** is another cross-sectional view of the anchoring mechanism of **FIG. 7**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0014] **FIG. 9** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a spring;

[0015] **FIG. 10** is another cross-sectional view of the anchoring mechanism of **FIG. 9**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0016] **FIG. 11** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a cam;

[0017] **FIG. 12** is another cross-sectional view of the anchoring mechanism of **FIG. 11**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0018] **FIG. 13** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention employing a cam;

[0019] **FIG. 14** is another cross-sectional view of the anchoring mechanism of **FIG. 13**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0020] **FIG. 15** is yet another cross-sectional view of the anchoring mechanism of **FIG. 13**, wherein a decoupling tube is utilized to disengage the anchoring mechanism from the guidewire;

[0021] **FIG. 16** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes an elastomeric object;

[0022] **FIG. 17** is another cross-sectional view of the anchoring mechanism of **FIG. 16**, wherein the anchoring mechanism releasably secured to the guidewire;

[0023] **FIG. 18** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a shape-memory tube;

[0024] **FIG. 19** is another cross-sectional view of the anchoring mechanism of **FIG. 18**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0025] **FIG. 20** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes an expandable balloon;

[0026] **FIG. 21** is another cross-sectional view of the anchoring mechanism of **FIG. 20**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0027] **FIG. 22** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes an O-ring;

[0028] **FIG. 23** is another cross-sectional view of the anchoring mechanism of **FIG. 22**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0029] **FIG. 24** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes one or more deflectable tabs;

[0030] **FIG. 25** is another cross-sectional view of the anchoring mechanism of **FIG. 24**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0031] **FIG. 26** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a circular object;

[0032] **FIG. 27** is another cross-sectional view of the anchoring mechanism of **FIG. 26**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0033] **FIG. 28** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a flared collet;

[0034] **FIG. 29** is another cross-sectional view of the anchoring mechanism of **FIG. 28**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0035] **FIG. 30** is another cross-sectional view of the anchoring mechanism of **FIG. 28**, wherein the anchoring mechanism further includes threads;

[0036] **FIG. 31** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes an offset block;

[0037] **FIG. 32** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a split-jawed collet and a spring;

[0038] **FIG. 33** is another cross-sectional view of the anchoring mechanism of **FIG. 32**, wherein a retrieval sheath is secured to the anchoring mechanism;

[0039] **FIG. 34** is another cross-sectional view of the anchoring mechanism of **FIG. 32**, wherein a second sheath and decoupling tube are utilized to disengage the anchoring mechanism from the guidewire;

[0040] **FIG. 35** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a sleeve;

[0041] **FIG. 36** is another cross-sectional view of the anchoring mechanism of **FIG. 35**, wherein a retrieval sheath is secured to the anchoring mechanism;

[0042] **FIG. 37** is another cross-sectional view of the anchoring mechanism of **FIG. 35**, wherein a second sheath and decoupling tube are utilizing to disengage the anchoring mechanism from the guidewire;

[0043] **FIG. 38** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes one or more latches;

[0044] **FIG. 39** is another cross-sectional view of the anchoring mechanism of **FIG. 38**, wherein a retrieval sheath is secured to the anchoring mechanism;

[0045] **FIG. 40** is another cross-sectional view of the anchoring mechanism of **FIG. 35**, wherein a second sheath is advanced along the guidewire;

[0046] **FIG. 41** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a wedge;

[0047] **FIG. 42** is another cross-sectional view of the anchoring mechanism of **FIG. 41**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0048] **FIG. 43** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention employing a wedge;

[0049] **FIG. 44** is another cross-sectional view of the anchoring mechanism of **FIG. 43**, wherein the object is advanced along the wedge in a second position;

[0050] **FIG. 45** is yet another cross-sectional view of the anchoring mechanism of **FIG. 43**, wherein anchoring mechanism is releasably secured to the guidewire in a third position;

[0051] **FIG. 46** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention employing a threaded wedge;

[0052] **FIG. 47** is another cross-sectional view of the anchoring mechanism of **FIG. 46**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0053] **FIG. 48** is a perspective view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a slotted tube;

[0054] **FIG. 49** is a cross-sectional view of the anchoring mechanism of **FIG. 48** along line **49-49**;

[0055] **FIG. 50** is another perspective view of the anchoring mechanism of **FIG. 48**, wherein the anchoring mechanism is shown slidably disposed along a guidewire after heat setting;

[0056] **FIG. 51** is another perspective view of the anchoring mechanism of **FIG. 48**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0057] **FIG. 52** is a perspective view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a slotted tube having multiple necked-down regions;

[0058] **FIG. 53** is a cross-sectional view of the anchoring mechanism of **FIG. 52** along line **53-53**, showing the first necked-down portion;

[0059] **FIG. 54** is a cross-sectional view of the anchoring mechanism of **FIG. 52** along line **54-54**, showing the second necked-down portion;

[0060] **FIG. 55** is another perspective view of the anchoring mechanism of **FIG. 52**, wherein the anchoring mechanism is slidably disposed along the guidewire;

[0061] **FIG. 56** is another perspective view of the anchoring mechanism of **FIG. 52**, wherein the anchoring mechanism is releasably secured to the guidewire;

[0062] **FIG. 57** is a cross-sectional view of an anchoring mechanism in accordance with another embodiment of the present invention, wherein the anchoring mechanism includes a slotted tube having a wall with varying section moduli;

[0063] **FIG. 58** is another cross-sectional view of the anchoring mechanism of **FIG. 57** along line **58-58**, wherein the anchoring mechanism is slidably disposed along the guidewire; and

[0064] **FIG. 59** is another cross-sectional view of the anchoring mechanism of **FIG. 57**, wherein the anchoring mechanism is releasably secured to the guidewire.

DETAILED DESCRIPTION OF THE INVENTION

[0065] The following description should be read with reference to the drawings wherein like reference numerals indicate like elements throughout the several views. The detailed description and drawings illustrate example embodiments of the claimed invention. The drawings, which are not necessarily to scale, depict several embodiments and are not intended to limit the scope of the invention. Although examples of construction, dimensions, materials and manufacturing processes are illustrated for the various elements, those skilled in the art will recognize that many of the examples provided have suitable alternatives that may be utilized.

[0066] **FIG. 1** is a cross-sectional view illustrating an anchoring mechanism **10** in accordance with an exemplary embodiment of the present invention. Anchoring mechanism **10** comprises a spring coil **12** slidably and rotationally disposable about a guidewire **14** in an unlocked (i.e. disengaged) position, and releasably securable to the guidewire **14** in a locked (i.e. engaged) position.

[0067] Spring coil **12** comprises a wire coil segment **16** adapted to receive guidewire **14**, a distal portion **18**, and a proximal portion **20**. The distal portion **18** of spring coil **12** is attached to a proximal end **22** of an intravascular device such as an embolic protection filter (not shown). The proximal portion **20** of spring coil **12** extends proximally in a U shape such that when unconstrained radially, the proximal portion **20** of spring coil **12** expands radially, causing the wire coil segment **16** to contract and frictionally engage the guidewire **14**.

[0068] In certain embodiments, spring coil **12** may be formed as a separate component, and then attached to the intravascular device proximal end **22** prior to insertion in the patient. Attachment of the spring coil **12** to the intravascular device proximal end **22** may be accomplished by any number of suitable attachment means, including soldering, welding, crimping and/or adhesive bonding. In other embodiments, the spring coil **12** and intravascular device may be formed as a single member using, for example, a mold injection process.

[0069] Spring coil **12** may be formed of any number of suitable materials biocompatible with the body. For example, spring coil **12** may be formed of a metal such as **303** or **316** stainless steel. Alternatively, the spring coil **12** may be formed of a polymeric material such as polypropylene (PP), polyvinyl chloride (PVC), polyethylene and/or polytetrafluoroethylene (PTFE). In one particular implementation, spring coil **12** may comprise a shape-memory material such as nickel-titanium alloy (Nitinol).

[0070] A placement tube **26** can be used to advance the anchoring mechanism **10** to a desired location within a blood vessel, and to actuate the spring coil **12** between the locked and unlocked positions. Placement tube **26** has an inner lumen **28** configured to disengage spring coil **12** from the guidewire **14** when disposed about the proximal portion **20**. As shown in **FIG. 1**, placement tube **26** can be used to compress the proximal portion **20** of spring coil **12** inwardly towards the guidewire **14**, causing the wire coil segment **16** to expand slightly to permit the spring coil **12** to slide and rotate about the guidewire **14**.

[0071] To engage the anchoring mechanism **10** along the guidewire **14**, placement tube **26** is withdrawn proximally until the proximal portion **20** of spring coil **12** is unconstrained within the inner lumen **28**, as shown in **FIG. 2**. Once unconstrained by the placement tube **26**, the proximal portion **20** of spring coil **12** expands radially, causing the wire coil segment **16** to compress about the guidewire **14**.

[0072] To release the anchoring mechanism **10** from the guidewire **14**, placement tube **26** can be advanced distally along guidewire **14** until the proximal portion **20** is contained at least in part within inner lumen **28**. Continued advancement of the placement tube **26** distally compresses the proximal portion **20**, forcing the wire coil segment **16** to expand outwardly and disengage from the guidewire **14**. Once disengaged from the guidewire **14**, the anchoring mechanism **10** and attached intravascular device can then be withdrawn from the patient's body.

[0073] **FIG. 3** illustrates an anchoring mechanism **110** in accordance with another exemplary embodiment of the present invention. Anchoring mechanism **110** comprises a split tube segment **112** having a proximal section **134**, a distal section **136**, and a bend region **138**. The distal section **136** of split tube segment **112** is biased to deflect inwardly to frictionally engage the guidewire **14**.

[0074] A placement tube **126** can be utilized to advance the split tube segment **112** along the guidewire **14**, and to

actuate the distal section **136** between the unlocked and locked positions. Placement tube **126** has a proximal portion (not shown) and a distal portion **130**. The distal portion **130** of placement tube **126** includes a reduced outer diameter portion **132** having an outer diameter that is smaller than the inner diameter of split tube segment **112**, allowing the split tube segment **112** to slide thereon, thereby preventing the distal section **136** of split tube segment **112** from frictionally engaging the guidewire **14**.

[**0075**] To frictionally engage the anchoring mechanism **110** about the guidewire, placement tube **126** is retracted proximally along the guidewire **14**, permitting the distal section **136** of the split tube segment **112** to deflect inwardly and compress against the guidewire **14**, as shown in **FIG. 4**. To disengage the anchoring mechanism **110** from the guidewire **14**, placement tube **126** can be advanced distally, forcing the distal section **136** of split tube segment **112** to disengage from the guidewire **14**.

[**0076**] In the exemplary embodiment illustrated in FIGS. **3-4**, split tube segment **112** is configured to function as a proximal stop for embolic protection filter **114**, preventing movement of the filter **114** proximally thereof. As with any of the embodiments described herein, however, the split tube segment **112** may be attached to, or form part of, an embolic protection filter **114**. In such cases, the anchoring mechanism may be utilized to releasably secure the embolic protection filter **114** directly to the guidewire **14**.

[**0077**] In another exemplary embodiment illustrated in **FIG. 5**, an anchoring mechanism **210** in accordance with the present invention may include one or more leaf clamps. Anchoring mechanism **210** comprises a tube segment **212** having a proximal section **234**, a distal section **236**, and a bend region **238**. The distal section **236** of tube segment **212** is biased to bend inwardly towards the guidewire **14**, forming one or more leaf clamps adapted to frictionally engage the guidewire **14** in a locked position.

[**0078**] A placement tube **226** can be utilized to advance the tube segment **212** along the guidewire **14**, and to actuate the distal section **236** between the unlocked and locked positions. Placement tube **226** has a distal section **230** having an outer diameter that is smaller than the inner diameter of the tube segment **212**, allowing the distal section **230** of placement tube **226** to slide within tube segment **212**. When placement tube **226** is inserted within tube segment **212** distal the bend region **238**, the distal section **236** of tube segment **212** is substantially prevented from engaging the guidewire **14**, as shown in **FIG. 5**.

[**0079**] To engage the anchoring mechanism **210** along the guidewire **14**, placement tube **226** is retracted proximally until the distal section **230** of the placement tube **226** is proximal bend region **238**, permitting the distal section **236** of the tube segment **212** to deflect inwardly and compress against the guidewire **14**, as shown in **FIG. 6**. To subsequently release the lock, placement tube **226** can be advanced distally, forcing the distal section **236** of tube segment **112** to disengage from the guidewire **14**.

[**0080**] **FIG. 7** illustrates an anchoring mechanism **310** in accordance with another exemplary embodiment of the present invention. Anchoring mechanism **310** comprises a tubular member **326** and one or more wires **312** adapted to frictionally engage the guidewire **14** in a locked position. Tubular member **326** has a proximal end (not shown) and a distal end **330**. Each wire **312** is attached at a distal end **318** to the proximal end **322** of an intravascular device (e.g. an embolic protection filter). The proximal end **320** each wire **312**, in turn, is attached to the distal end **330** of the tubular member **326**.

[**0081**] To engage the anchoring mechanism **310** along the guidewire **14**, tubular member **326** is rotated in either a clockwise or counterclockwise direction until the one or more wires **312** frictionally engage the guidewire **14**, as shown in **FIG. 8**. If desired, an optional coating can be applied to the wires **312** and/or the guidewire **14** to increase the frictional force therebetween.

[**0082**] To subsequently release the anchoring mechanism **310** from the guidewire **14**, placement tube **326** can be rotated in an opposite direction until the one or more wires **312** disengage from the guidewire **14**. Once disengaged, the anchoring mechanism **310** and intravascular device can then be removed from the patient's body.

[**0083**] In a similar embodiment illustrated in **FIG. 9**, an anchoring mechanism **410** in accordance with an exemplary embodiment of the present invention may include a tubular member **426** and a spring **412**. Spring **412** is formed of a flexible wire having a distal end **418** and a proximal end **420**. The distal end **418** of spring **412** is attached to the proximal portion **422** of an embolic protection filter. The proximal end **420** of spring **412**, in turn, is attached the distal end **430** of tubular member **426**.

[**0084**] In an unlocked position illustrated in **FIG. 9**, spring **412** is adapted to slide and rotate about guidewire **14**, allowing the intravascular device to be advanced along the guidewire **14** and placed at a desired location within the body. To engage the spring **412** along the guidewire **14**, tubular member **426** is withdrawn proximally, forcing the spring **412** to stretch axially and compress radially about the guidewire **14**. As with the previous embodiment, an optional coating can be applied to increase the frictional force between the guidewire **14** and the spring **412**.

[**0085**] In another exemplary embodiment illustrated in **FIG. 11**, an anchoring mechanism **510** in accordance with the present invention may employ a cam. Anchoring mechanism **510** comprises a tube segment **540** coupled to a proximal portion **522** of an embolic protection filter (not shown). Tube segment **540** includes an expanded portion **542** defining an inner chamber **544** having an inner wall surface **546**.

[**0086**] Disposed within inner chamber **544** is an object **512** having a distal section **518** and a proximal section **520**. The distal and/or proximal sections **518**, **520** may each include a notch that permits the object ends **518**, **520** to bend inwardly when compressed radially against the inner wall surface **546** of inner chamber **544**.

[**0087**] In a first (i.e. unlocked) position illustrated in **FIG. 11**, the object **512** is positioned within chamber **544** such that neither the proximal end **520** nor the distal end **518** of object **512** is in contact with the inner wall surface **546**. In this position, the object **512** is slidably and rotationally disposed along the guidewire **14**, allowing the intravascular device to be placed within the patient's vasculature.

[**0088**] To engage the anchoring mechanism **510** along the guidewire **14**, the tube segment **540** and attached intravas-

cular device can be moved along the guidewire **14**, forcing the object **512** disposed within the chamber **544** to compress against the inner wall surface **546**. Continued advancement of the tube segment **540** along the guidewire **14** forces one of the notched ends (e.g. proximal end **520**) to bend inwardly and frictionally engage the guidewire **14**, as shown in **FIG. 12**.

[**0089**] Although the exemplary embodiment illustrated in FIGS. **11-12** shows an object having a notch formed on or both ends, it is contemplated that other objects can be utilized without deviating from the scope of the invention. In certain embodiments, for example, the object may comprise a ball, wedge or coil. In other embodiments, the geometry of the inner wall surface may be .circular, rectangular or have an irregular shaped surface.

[**0090**] In one such variation illustrated in FIGS. **13-15**, an anchoring mechanism **610** in accordance with an exemplary embodiment of the present invention comprises a circular object **612** disposed within a chamber **644** having an irregularly shaped inner wall surface **646**. The inner wall surface **646** of tube segment **642** includes one or more recesses **648** substantially conforming in size and shape to the dimensions of the circular object **612**.

[**0091**] In an first (i.e. unlocked), the circular object **612** is positioned within the inner chamber **644** such that the object **612** is not in contact with either of the recesses **648**. To engage the anchoring mechanism **610** along the guidewire **14**, tube segment **640** is moved along the guidewire **14** until the circular object **612** locks into one of the recesses **648**, as shown in **FIG. 14**.

[**0092**] To disengage the anchoring mechanism **610** from the guidewire **14**, a decoupling tube **650** can be advanced along the guidewire **14** to disengage the circular object **612** from the recessed surface **648**, as shown in **FIG. 15**. The distal end **652** of the decoupling tube **650** -may have a geometry corresponding in size and shape to the particular object employed. For example, the distal end **652** of decoupling tube **650** may be curved slightly to correspond with the shape of the circular object **612**.

[**0093**] **FIG. 16** illustrates an anchoring mechanism **710** in accordance with another exemplary embodiment of the present invention. An elastomeric object **712** is coupled to a reduced inner diameter portion **722** disposed on the proximal end **722** of an embolic protection filter (not shown). The elastomeric object **712** is attached at a distal end **736** to the reduced inner diameter portion **722** at notch **754**, and at a proximal end **734** to a placement tube **726**. In use, the elastomeric object **712** is configured to lock onto the guidewire **14** when unconstrained by a tab disposed on the distal end **730** of the placement tube **726**.

[**0094**] In a first (i.e. unlocked) position illustrated in **FIG. 16**, placement tube **726** is configured to attach to a proximal end **734** of the elastomeric object **712**, causing it to stretch axially and disengage from the guidewire **14**. To engage the anchoring mechanism **710** along the guidewire **14**, placement tube **726** is retracted proximally, causing the proximal end **734** of the elastomeric object **712** to detach from the tab on the distal end **730** of the placement tube **726**. Once detached, the elastomeric object **712** reverts to its natural, pre-stretched state, causing it to frictionally engage the guidewire **14**, as shown in **FIG. 17**.

[**0095**] **FIG. 18** illustrates an anchoring mechanism **810** in accordance with yet another exemplary embodiment of the present invention. Anchoring mechanism **810** comprises a shape memory tube **812** having a pre-defined shape which, when compressed radially by a placement tube **826**, functions in an unlocked position, and when unconstrained radially, functions in a locked position. To bias the shape memory tube **812** to radially expand and frictionally engage the guidewire **14** in the locked position, a super elastic material such as a nickel titanium alloy (Nitinol) may be used.

[**0096**] In the exemplary embodiment illustrated in **FIG. 18**, the distal end **818** of shape memory tube **812** further includes a joint **856** adapted to permit rotation of the shape memory tube **812** relative to the proximal end **822** of embolic protection filter **814**. In use, joint **856** permits rotation of the embolic protection filter within the patient's body while substantially preventing movement of the intravascular device along the guidewire **14**.

[**0097**] A placement tube **826** may be utilized to advance the shape memory tube **812** and embolic protection filter **814** along the guidewire **14**, and to actuate the shape memory tube **812** between the unlocked and locked positions. Placement tube **826** has a proximal end (not shown), a distal end **830**, and an inner lumen **828**. The inner lumen **828** is configured in size and shape to radially compress the shape memory tube **812** therein, allowing the anchoring mechanism **810** to slide and rotate about the guidewire **14**. To engage the anchoring mechanism **810** along the guidewire **14**, placement tube **826** can be withdrawn proximally, allowing the shape memory tube **812** to revert to its pre-defined shape and frictionally engage the guidewire **14**, as shown in **FIG. 19**.

[**0098**] To disengage the anchoring mechanism **810** from the guidewire **14**, placement tube **826** is advanced distally until the distal end **830** is located proximate and proximal the proximal end **820** of shape memory tube **812**. Continued advancement of the placement tube **826** distally causes the shape-memory tube **812** to radially compress within inner lumen **828** and disengage from the guidewire **14**. The distal end **830** of shape memory tube **812** may be flared slightly to facilitate advancement of the placement tube **826** about the shape memory tube **812**.

[**0099**] **FIG. 20** illustrates an anchoring mechanism **910** in accordance with yet another exemplary embodiment of the present invention. Anchoring mechanism **910** comprises a proximal end portion **922** of an embolic protection filter (not shown) containing an expandable lumen **958** having an inlet port **960** and an expandable balloon **962**. A pressure source **926** in fluid communication with the inlet port **960** is adapted to provide fluidic pressure to the expandable balloon **962** to actuate the device between the unlocked and locked positions.

[**0100**] As shown in **FIG. 21**, when fluidic pressure from pressure source **926** is applied to inlet port **960**, balloon **962** expands within expandable lumen **958** forcing the innermost portion **964** of the expandable lumen **958** to deflect inwardly and engage the guidewire **14**. To disengage the anchoring mechanism **910** from the guidewire **14**, fluid is evacuated from the balloon **962**, causing the innermost portion **962** of the expandable lumen **958** to disengage from the guidewire **14**.

[0101] **FIG. 22** illustrates an anchoring mechanism **1010** in accordance with yet another exemplary embodiment of the present invention. Anchoring mechanism **1010** comprises a proximal portion **1022** of an embolic protection filter (not shown) having a deflectable section **1012** thereon actuatable between an unlocked (i.e. disengaged) position and a locked (i.e. engaged) position.

[0102] Deflectable section **1012** has a relatively small outer diameter, allowing the deflectable section **1012** to deflect radially and compress along the guidewire **14** when an elastomeric O-ring **1062** is disposed thereon. One or more notches **1066** disposed at various locations along the inner diameter of deflectable section **1012** may also be employed to engage the deflectable section **1012** along the guidewire **14**.

[0103] In a first position shown in **FIG. 22**, deflectable section **1012** is disengaged from the guidewire **14**, allowing the intravascular device to slide and rotate about the guidewire **14**. To engage the anchoring mechanism **1010** along the guidewire **14**, a push tube **1068** is positioned proximate and proximal the proximal end **1020** of the intravascular device. Holding the intravascular device stationary with push tube **1068**, a placement tube **1026** having an inwardly facing tab **1030** is withdrawn proximally, forcing the O-ring **1062** to slide proximally to a second position about the deflectable section **1012**, as shown in **FIG. 23**. The inward force exerted by the O-ring **1062** forces the deflectable section **1012** to bend inwardly and compress against the guidewire **14**.

[0104] **FIG. 24** illustrates an anchoring mechanism **1110** in accordance with yet another exemplary embodiment of the present invention. Anchoring mechanism **1110** comprises a placement tube **1126**, a push tube **1168** and a plurality of radial tabs **1112** extending from the proximal portion **1122** of an embolic protection filter (not shown). The deflectable radial tabs **1112** are biased inwardly such that when unconstrained by push tube **1168**, the radial tabs **1112** deflect inwardly towards the guidewire **14**.

[0105] Push tube **1168** includes a tapered distal end **1170** having a size and shape that corresponds with the size and shape of the deflectable radial tabs **1112**. The placement tube **1126** includes one or more inwardly facing tabs **1130** that can be utilizing to transport the anchoring mechanism **1110** along the guidewire **14**, and to subsequently release the anchoring mechanism **1110** once engaged.

[0106] To engage the anchoring mechanism **1110** along the guidewire **14**, push tube **1168** is retracted proximally until the deflectable radial tabs **1112** are unconstrained by the tapered distal end **1170** of push tube **1168**. Once unconstrained, the radial tabs **1112** deflect inwardly and frictionally engage the guidewire **14**, as shown in **FIG. 25**. Once engaged, the placement tube **1126** can then be retracted proximally, causing the embolic protection filter to deploy within the patient's vessel.

[0107] To disengage the anchoring mechanism **1110** from the guidewire **14**, placement tube **1126** is advanced distally until the one or more tabs **1130** are positioned proximate and proximal a corresponding tab **1172** located on the embolic protection filter. Continued advancement of the placement tube **1126** distally causes the one or more inwardly facing tabs **1130** to bend slightly, allowing the one or more radial tabs **1130** to displace distal the corresponding tab **1172** located on the embolic protection filter. The push tube **1168** can then be advanced distally, forcing the deflectable radial tabs **1112** to disengage the anchoring mechanism **1110** from the guidewire **14**.

[0108] **FIG. 26** illustrates an anchoring mechanism **1210** in accordance with yet another exemplary embodiment of the present invention. Anchoring mechanism **1210** comprises a circular object **1212**, a placement tube **1226** having an opening **1230** adapted to contain the circular object **1212**, and two recesses **1274**, **1276** disposed on the proximal portion **1222** of an embolic protection filter (not shown). The anchoring mechanism **1210** is slidably and rotationally disposed along the guidewire **14** when the circular object **1212** is engaged within the first (i.e. larger) recess **1274**, and releasably secured to the guidewire **14** when the circular object **1212** is engaged within the second (i.e. smaller) recess **1276**.

[0109] In a first position illustrated in **FIG. 26**, the circular object **1212** is disposed within the first recess **1274**. The first recess **1274** is configured in size and shape to allow the circular object **1212** to rotate therein, allowing the anchoring mechanism **1210** to be moved along the guidewire **14**. To engage the anchoring mechanism **1210** along the guidewire **14**, placement tube **1226** is withdrawn proximally until the circular object **1212** engages the second recess **1276**, as shown in **FIG. 27**. The second recess **1276** has a smaller inner diameter such that, when the circular object **1212** is retracted from the first recess **1274** to the second recess **1276**, the circular object **1212** compresses against the guidewire **14**.

[0110] **FIG. 28** illustrates an anchoring mechanism **1310** in accordance with yet another exemplary embodiment of the present invention employing a flared collet **1312**. As shown in **FIG. 28**, the flared collet **1312** includes a reduced inner diameter distal portion **1336** that permits the collet **1312** to deflect inwardly and frictionally engage the guidewire **14** when compressed radially by a placement tube **1326**.

[0111] To engage the collet **1312** along the guidewire **14**, placement tube **1326** is advanced distally, forcing the distal portion **1336** of the collet **1312** to bend inwardly and frictionally engage the guidewire **14**, as shown in **FIG. 29**. To disengage the collet **1312** from the guidewire **14**, the placement tube **1326** is retracted proximally until the distal portion **1336** disengages from the guidewire **14**.

[0112] In an alternative embodiment illustrated in **FIG. 30**, the inner diameter of placement tube **1326** may include threads adapted to engage a corresponding set of threads disposed on the outer diameter of the collet **1312**. To engage the collet **1312** along the guidewire **14**, placement tube **1326** is rotated until the threads on the placement tube **1326** engage the threads on the collet **1312**. Continued rotation of the placement tube **1326** relative to the collet **1312** causes the collet **1312** to frictionally engage the guidewire **14** in a manner similar to that described with respect to **FIG. 29**.

[0113] **FIG. 31** illustrates an anchoring mechanism **1410** in accordance with another exemplary embodiment of the present invention utilizing an offset block. Clamping mechanism **1410** comprises a tubular member **1412** having a plurality of radially offset tabs **1478** extending inwardly

towards the guidewire **14**. The offset tabs **1478** are staggered at various locations along the inner diameter of the tubular member **1412**. In use, the radially offset tabs **1478** prevent movement of the anchoring mechanism **1410** along the guidewire **14** in the absence of a force applied thereto by the operator.

[**0114**] **FIG. 32** illustrates yet another exemplary embodiment of the present invention utilizing a split jawed collet operatively coupled to a spring seat. As shown in a locked position in **FIG. 32**, anchoring mechanism **1510** comprises a proximal portion **1522** of an embolic protection filter having an inner lumen **1528** configured to receive the guidewire **14**.

[**0115**] Secured within the inner lumen **1528** of proximal portion **1522** is a spring **1512** that is frictionally engageable along guidewire **14** in a locked position, and slidably and rotationally disposed about guidewire **14** in an unlocked position. Spring **1512** may be formed from a laser cut tube comprised of a shape memory material such as Nitinol. Alternatively, spring **1512** may be formed from a metal such as **303** or **316** stainless steel. In some embodiments, spring **1512** may be formed from a highly radiopaque material (e.g. 316L stainless steel or platinum) to permit fluoroscopic monitoring of the device.

[**0116**] A split jawed collet **1536** disposed about a spring seat **1582** formed on the proximal portion **1522** of the embolic protection filter may be used to actuate the spring **1512** between the locked and unlocked positions. Split jawed collet **1536** can be formed from a split tubular member, similar to that shown with respect to FIGS. **28-29**. In a locked position illustrated in **FIG. 32**, the split jawed collet **1536** compresses between several notches **1584** formed on seat **1582**, which biases the spring **1512** axially, forcing the spring **1512** to frictionally engage the guidewire **14**.

[**0117**] To disengage the spring **1512** from the guidewire **14**, the operator advances a retrieval sheath **1526** having one or more retrieval fingers **1530** distally until the one or more retrieval fingers **1530** lock onto a first enlarged outer diameter section **1582** formed on proximal portion **1522**, as shown in **FIG. 33**. The one or more retrieval fingers **1530** are configured to bend in only a single direction, allowing the retrieval sheath **1526** to lock onto the proximal portion **1522** of the embolic protection filter. The one or more retrieval fingers **1530** may be formed from any number of suitable materials such as Nitinol, nylon, polyether-ether ketone (PEEK), etc.

[**0118**] Once the retrieval sheath **1526** is engaged along the proximal portion **1522** of the filter, the operator next advances a second sheath **1584** along the guidewire until a second set of retrieval fingers **1586** engage a second enlarged outer diameter section **1588** formed on proximal portion **1522**. Once the second set of retrieval fingers **1586** engage the second enlarged outer diameter section **1588**, a push tube **1568** is advanced distally, forcing the split jaw collet **1536** to compress axially, causing the spring **1512** to frictionally disengage from the guidewire, as shown in **FIG. 34**. The embolic protection filter can then be retracted along guidewire **14** and removed from the patient's body, if desired.

[**0119**] **FIG. 35** illustrates an anchoring mechanism **1610** in accordance with yet another exemplary embodiment of the present invention utilizing a sleeve **1612**. Anchoring mechanism **1610** comprises a proximal portion **1622** of an embolic protection filter (not shown) having an inner lumen **1628** configured to receive the guidewire **14**.

[**0120**] A spring **1662** attached to the proximal portion **1622** can be utilized to frictionally engage the sleeve **1612** along the guidewire **14**. Spring **1662** has a proximal end **1634** and a distal end **1636**. The proximal end **1634** of spring **1662** is attached to a tubular member **1690** slidably disposed along guidewire **14**. The distal end **1636** of spring **1662** is fixedly attached to the proximal portion **1622** of the embolic protection filter.

[**0121**] Sleeve **1612** may be formed from a loosely braided material such as Dacron, and is configured to radially collapse when placed under tension by the spring **1662**. The sleeve **1612** is secured at a distal end **1618** to the proximal portion **1622** of the filter. The proximal end **1620** of the sleeve, in turn, is attached to the tubular member **1690**. In a locked position illustrated in **FIG. 35**, the spring **1662** forces the sleeve **1612** into tension axially, forcing the sleeve **1612** to radially compress and frictionally engage the guidewire **14**.

[**0122**] To disengage the sleeve **1612** from the guidewire **14**, the operator advances a retrieval sheath **1626** having one or more retrieval fingers **1630** distally along the guidewire **14** until the one or more retrieval fingers **1630** lock onto a first notch **1682** located on the proximal portion **1622**, as shown in **FIG. 36**. Once the retrieval sheath **1626** is engaged along the proximal portion **1622** of the filter, the operator next advances a second sheath **1684** along the guidewire **14** until a second set of retrieval fingers **1686** engage a second notch **1688** form on the outer diameter of proximal portion **1622** proximal the first notch **1682**. Once the second set of retrieval fingers **1686** engage the second notch **1688**, a push tube **1668** is advanced along the guidewire **14**, forcing the spring **1662** into compression, and causing the sleeve **1612** to radially expand and disengage from the guidewire **14**, as shown in **FIG. 37**.

[**0123**] **FIG. 38** illustrates an anchoring mechanism **1710** in accordance with yet another exemplary embodiment of the present invention. Anchoring mechanism **1710** comprises a tubular member **1712** slidably and rotationally disposed a guidewire **14**, a locking tube **1726**, and a filter mount **1722**. Tubular member **1712** has a proximal end **1734**, a distal end **1736**, and an inner lumen **1728** configured to receive the guidewire **14**. The filter mount **1722**, which forms the proximal portion of an embolic protection filter (not shown), is slidably and rotationally disposed about the tubular member **1712**. The distal end **1736** of tubular member **1712** is flared slightly such that, in use, the filter mount **1722** is prevented from sliding off the distal end **1736** of the tubular member **1722**. If desired, the filter mount **1722** may be formed of a radiopaque material such as stainless steel, gold or platinum to enable the operator to fluoroscopically judge the location of the device within the patient's body.

[**0124**] Tubular member **1712** further includes one or more latches **1792** adapted to frictionally engage the guidewire **14** when actuated. The latches **1792** may be formed by cutting the tubular member **1712** at various locations along its length and/or radius. The proximal end **1720** of each latch **1792** is attached to the tubular member **1712**, and acts as a pivot to permit the latches **1792** to bend inwardly towards

the guidewire **14**. The distal end **1718** of each latch **1792**, in turn, is bent at an angle of approximately 90°, forming a contact surface to frictionally engage the guidewire **14**. A slight upward deflection is heat set into each latch **1792** to permit the tubular member **1712** to slide along the guidewire **14** when unconstrained radially.

[**0125**] A locking tube **1726** may be utilized to frictionally engage the one or more latches **1792** along the guidewire **14**. Locking tube **1726** has an inner diameter slightly larger than the outer diameter of tubular member **1712**, allowing the tube **1726** to slide over the tubular member **1712** to engage the one or more latches **1792**.

[**0126**] To frictionally engage the guidewire **14**, the locking tube **1726** is advanced distally along the guidewire **14** to a location proximate and proximal the proximal end **1734** of tubular member **1712**. Continued advancement of the locking tube **1726** distally forces the latches **1792** to rotate inwardly and frictionally engage the guidewire **14**, as shown in **FIG. 39**.

[**0127**] To subsequently disengage the latches **1792** from the guidewire **14**, a retrieval system similar to that described with respect to FIGS. **35-37** may be employed. For example, as shown in **FIG. 39, a** retrieval sheath **1726** having one or more retrieval fingers **1730** may be advanced along the guidewire **14** and secured to the filter mount **1722** at a first notch **1782**. Once engaged, a second sheath **1784** having a second set of retrieval fingers **1786** may be advanced along the guidewire **14** and locked onto a second notch **1788** formed on the locking tube **1726**, as shown in **FIG. 40**. The second sheath **1784** can be retracted proximally until the one or more latches **1792** are unconstrained radially, allowing the tubular member **1712** to slide and rotate along the guidewire **14**. The operator can then retract the second sheath **1784** proximally, causing the one or more latches **1792** to disengage from the guidewire **14**.

[**0128**] **FIG. 41** illustrates an anchoring mechanism **1810** in accordance with yet another exemplary embodiment of the present invention utilizing a wedge. Anchoring mechanism **1810** comprises an object **1812** that is slidably and rotationally disposed about a guidewire **14** in an unlocked position, and releasably secured to the guidewire **14** in a locked position. Object **1812** has a proximal section **1820** and a distal section **1818**. The proximal section **1820** of object **1712** is configured to bend or flex inwardly towards the guidewire **14** when compressed radially by a wedge **1894**.

[**0129**] In the exemplary embodiment illustrated in **FIG. 41**, object **1812** tapers distally, having a smaller outer diameter on proximal section **1820** than on the distal section **1818**. One or more notches **1882** disposed within the outer surface of the object **1812** further permit the proximal section **1820** to bend or flex inwardly when wedge **1894** is advanced thereon.

[**0130**] The distal section **1818** of object **1812** may further optionally include a joint **1856** adapted to permit rotation of the object **1812** relative to the proximal portion **1822** of the embolic protection filter **1814**. In use, joint **1856** permits rotation of the embolic protection filter **1814** within the vessel while substantially preventing movement of the anchoring mechanism **1810** along the guidewire **14**.

[**0131**] To frictionally engage the object **1812** along the guidewire **14**, a push tube **1868** can be advanced distally, forcing the wedge **1894** to slide along the object **1812**. A sheath **1826** having a force-calibrated tab **1830** adapted to bend in only one direction in response to a sufficient force exerted thereon can be utilized to hold the object **1812** in place when advancing the wedge **1894**. Continued movement of the wedge **1894** relative to the object **1812** causes the object **1812** to compress radially, forcing the proximal section **1820** to bend inwardly and frictionally engage the guidewire **14**. Once engaged, the retrieval sheath **1826** can be withdrawn proximally until the force-calibrated tab **1830** bends and compresses against the wedge **1894**, and until the embolic protection filter **1814** is deployed within the vessel, as shown in **FIG. 42**. The push tube **1868** can then be withdrawn proximally from the body, if desired.

[**0132**] In an alternative embodiment illustrated in FIGS. **43-45**, an anchoring mechanism **1910** in accordance with the present invention may include an object **1912** that tapers proximally. As shown in **FIG. 43**, object **1912** has a larger outer diameter on the proximal section **1920** than on the distal section **1918**. The proximal section **1920** is configured to bend or flex inwardly towards the guidewire **14** when compressed radially by a wedge **1994**. One or more notches **1982** disposed within the outer surface of the object **1912** further permit the proximal section **1920** to bend or flex inwardly when wedge **1994** is advanced thereon.

[**0133**] In a first (unlocked) position illustrated in **FIG. 43**, object **1912** is slidably and rotationally disposed about the guidewire **14**. To frictionally engage the object **1912** along the guidewire **14**, a push tube **1968** is advanced distally against the object **1912**, forcing the object **1912** to slide relative to the wedge **1994**, as shown in **FIG. 44**. A sheath **1926** having a force-calibrated tab **1930** adapted to bend in only one direction in response to a sufficient force exerted thereon can be utilized to hold the wedge **1994** stationary when advancing the object **1912** via the push tube **1968**. Continued advancement of the push tube **1968** distally, or in the alternative, retraction of the retrieval sheath **1926** proximally, causes the force-calibrated tab **1930** to bend and compress against the wedge **1994**, as shown in **FIG. 45**.

[**0134**] In an alternative embodiment illustrated in FIGS. **46-47**, an anchoring mechanism **2010** in accordance with the present invention may include a push tube **2068** having threads configured to engage a corresponding set of threads disposed on the wedge **2094**. Anchoring mechanism **2010** comprises an object **2012** having a proximal section **2020** and a distal section **2018**, a retrieval sheath **2026**, a wedge **2094**, and a push tube **2068**. The object **2012** tapers proximally, and forms the proximal portion of an embolic protection filter **2014**. The proximal section **2020** of object **2012** is configured to bend or flex inwardly towards the guidewire **14** when compressed radially by the wedge **2094**.

[**0135**] In the exemplary embodiment illustrated in FIGS. **46-47**, wedge **2094** includes threads on its outer diameter configured to mate with a corresponding set of threads disposed on a reduced inner diameter distal portion **2070** of the push tube **2068**.

[**0136**] To frictionally engage the object **2012** along the guidewire **14**, push tube **2068** is retracted proximally, forcing the proximal section **2020** of the object **2012** to bend inwardly and frictionally engage the guidewire **14**. Once engaged, the retrieval sheath **2026** may be withdrawn proximally, causing the force-calibrated tab **2030** to bend and compress against the wedge **2094**, as shown in **FIG. 47**.

[0137] **FIG. 48** illustrates an anchoring mechanism **2110** in accordance with yet another exemplary embodiment of the present invention utilizing a slotted tube. As shown in **FIG. 48**, anchoring mechanism **2110** comprises a slotted tube **2112** having an inner lumen **2114** configured to slidably receive a guidewire (not shown). As with any of the previous embodiments, the slotted tube **2112** may form the proximal portion of an embolic protection filter, or may act as a proximal stop to prevent proximal movement of the filter along the guidewire.

[0138] In the exemplary embodiment illustrated in **FIG. 48**, slotted tube **2112** comprises a thin-wall tube formed from a shape-memory material such as Nitinol. Slotted tube **2112** includes a necked-down portion **2116** having an inner diameter that is slightly smaller than the outer diameter of the guidewire. Several slots **2118** located within the necked-down portion **2116** are configured to expand slightly to allow the guidewire to slide within lumen **2114** when the slotted tube **2112** is unconstrained radially. As can be seen in greater detail in **FIG. 49**, the slots **2118** are circumferentially disposed 120° apart from each other, and extend through the wall of the slotted tube **2112**.

[0139] To expand the slots **2116** in an outward direction, the slotted tube **2112** can be heat treated at an appropriate temperature using, for example, a heater or a laser. Once heated, the slots **2118** deform slightly, allowing the guidewire **14** to be inserted through the slotted tube **2112**, as shown in **FIG. 50**. To facilitate heat setting of the slots **2116**, a shape memory material such as Nitinol can be used. In an alternative implementation, the slots **2118** can be formed using an annealed steel or polymeric material. For example, the slots **2116** can be molded to a particular dimension using a polymeric material such as polytetraflouroethylene, polyvinylchloride or ABS plastic.

[0140] To engage the anchoring mechanism **2110** along the guidewire **14**, a locking tube **2120** is advanced along the guidewire **14** to a point proximate and proximal the necked-down portion **2116** of slotted tube **2112**. The locking tube **2120** has an inner diameter that is slightly larger than the outer diameter of the slotted tube **2112**, allowing the locking tube **2120** to be advanced over the slotted tube **2112**. To releasably secure the slotted tube **2112** to the guidewire **14**, the operator continues to advance the locking tube **2120** distally until the necked-down portion **2116** compresses against the guidewire **14**, as shown in **FIG. 51**.

[0141] In an alternative embodiment illustrated in FIGS. **52-56**, the slotted tube may include several necked down regions located along its length configured to releasably secure to the guidewire **14**. As shown in **FIG. 52**, anchoring mechanism **2210** comprises a slotted tube having a first necked-down region **2216**, and a second necked-down region **2220** located distal the first necked-down region **2216**. The first necked-down region **2216** includes two slots **2224** circumferentially disposed 180° apart from each other, and that extend through the wall of the slotted tube **2212**, as shown in **FIG. 53**. The second necked-down region **2222**, in turn, includes two slots **2226** that are radially offset 90° from the slots **2224** on the first necked-down region **2216**, as shown in **FIG. 54**.

[0142] To engage the anchoring mechanism **2210** along the guidewire **14**, a locking tube **2220** similar to that discussed with respect to **FIG. 51** is advanced along the guidewire **14** to a point proximate and proximal to the first necked-down portion **2216** of slotted tube **2212**, as shown in **FIG. 56**. Continued advancement of the locking tube **2220** about the first necked-down portion **2216** compresses the slotted tube **2212** against the guidewire **14**, as shown in **FIG. 51**. Further advancement of the locking tube **2220** distally causes the second necked-down portion **2222** to compress against the guidewire **14** in a similar manner.

[0143] Although the exemplary embodiment illustrated in FIGS. **52-56** illustrates two locking portions **2216**, **2222** along the length of the slotted tube **2212**, it is to be understood that other configurations are possible without deviating from the scope of the invention. For example, a slotted tube having three or more necked-down regions can be employed. Moreover, the number of slots (e.g. 4, 5, 6, etc.) disposed within each necked-down region can be increased, if desired, to provide a greater number of locations for the slotted tube to frictionally engage the guidewire.

[0144] To further increase the frictional force exerted on the guidewire, the inner diameter of the slotted tube may include a roughened surface. The roughened surface may be formed by welding several small beads to the inner surface, sand blasting the inner surface, or by machining small grooves into the inner surface of the slotted tube. The slotted tube may also be formed from a material having a relatively porous surface, thereby increasing the roughness of the surface.

[0145] In another alternative embodiment illustrated in FIGS. **57-59**, an anchoring mechanism **2310** in accordance with the present invention may include a slotted tube **2312** comprising one or more portions **2328** having a relatively large section modulus, and one or more portions **2330** having a relatively small section modulus. As shown in a pre-heat treated position in **FIG. 57**, the slotted tube **2312** may include several circumferentially disposed slots **2332** extending through the wall of the slotted tube **2312**. The one or more portions **2328** having a relatively large section modulus are configured to distribute the axial force applied to the slotted tube when the embolic protection filter is moved along the guidewire **14**. In use, the slots **2332** formed about the slotted tube **2312** are configured to expand slightly to allow the guidewire **14** to slide and rotate within the slotted tube **2312** when unconstrained radially.

[0146] As can be seen in **FIG. 58**, the slots **2332** may be formed in a direction substantially parallel to centerline of the slotted tube. The slots **2332** may be heat treated as discussed with respect to the previous embodiment, or may be formed during manufacture. Although the slots **2332** illustrated in **FIG. 58** are disposed along a line substantially parallel to the centerline of the slotted tube **2312**, other configurations are possible. In one embodiment, for example, the one or more slots may be helically disposed about the slotted tube **2312**.

[0147] To engage the anchoring mechanism **2310** along the guidewire **14**, a locking tube **2320** can be advanced along the guidewire **14** to a point proximate and proximal to the necked-down portion **2316** of slotted tube **2312**. Continued advancement of the locking tube **2312** distally about the necked-down portion **2316** compresses the slotted tube **2312** against the guidewire **14**, as shown in **FIG. 59**. Several protrusions **2334** disposed on the outer diameter of the

slotted tube **2312** are configured to frictionally engage the locking tube **2320** against the slotted tube **2312**.

[**0148**] Having thus described the several embodiments of the present invention, those of skill in the art will readily appreciate that other embodiments may be made and used which fall within the scope of the claims attached hereto. Numerous advantages of the invention covered by this document have been set forth in the foregoing description. Changes may be made in details, particular in matters of shape, size and arrangement of parts without exceeding the scope of the invention. For example, while several of the embodiments illustrated herein illustrate the attachment of an embolic protection filter to the guidewire, it is to be understood that other intravascular devices may employ the anchoring mechanisms discussed herein. It will be understood that this disclosure is, in many respects, only illustrative.

What is claimed is:

1. An anchoring mechanism for releasably securing an intravascular device to an elongated member disposed within a body lumen, said anchoring mechanism comprising:

an object actuatable between an unlocked position and a locked position, wherein the object is slidably and rotationally disposed about the elongated member in the unlocked position, and is releasably secured to the elongated member in the locked position; and

placement means for actuating said object between the unlocked position and locked position.

2. An anchoring mechanism for releasably securing an intravascular device to an elongated member disposed within a body lumen, said anchoring mechanism comprising:

an object actuatable between an unlocked position and a locked position, wherein, the object is slidably and rotationally disposed about the elongated member in the unlocked position, and is releasably secured to the elongated member in the locked position;

placement means for actuating said object between the unlocked position and locked position; and

retrieval means for disengaging the object from the locked position to the unlocked position.

3. An intravascular device comprising:

an embolic protection filter slidably disposed on a guidewire; and

anchoring means for attaching the embolic protection filter to the guidewire, said anchoring means comprising an anchoring mechanism actuatable between an unlocked position and a locked position, wherein the anchoring mechanism is slidably disposed along the guidewire in the unlocked position, and is releasably secured to the guidewire in the locked position.

4. An intravascular device comprising:

an embolic protection filter slidably disposed on a guidewire;

anchoring means for attaching the embolic protection filter to the guidewire, said anchoring means comprising an object actuatable between an unlocked position and a locked position, wherein the anchoring mechanism is slidably disposed along the guidewire in the unlocked position, and is releasably secured to the guidewire in the locked position; and

placement means for actuating said anchoring mechanism between the unlocked position and locked position.

5. An anchoring mechanism for releasably securing an intravascular device to an elongated member disposed within a body lumen, said anchoring mechanism comprising an object actuatable between an unlocked position and a locked position, wherein the object is slidably and rotationally disposed about the elongated member in the unlocked position, and is releasably secured to the elongated member in the locked position.

6. The anchoring mechanism of claim 5, wherein said elongated member is a guidewire.

7. The anchoring mechanism of claim 5, wherein said elongated member is a catheter.

8. The anchoring mechanism of claim 5, wherein said object comprises a spring coil having a proximal portion and a distal portion.

9. The anchoring mechanism of claim 8, wherein the proximal portion of said spring coil extends proximally in a U-shape configuration such that when unconstrained radially, the spring coil is releasably secured to the elongated member.

10. The anchoring mechanism of claim 5, wherein said object comprises a split tube segment.

11. The anchoring mechanism of claim 5, wherein said object comprises one or more leaf clamps.

12. The anchoring mechanism of claim 5, wherein said object comprises one or more wires.

13. The anchoring mechanism of claim 5, wherein said object comprises a helical spring.

14. The anchoring mechanism of claim 5, wherein said object comprises a cam.

15. The anchoring mechanism of claim 5, wherein said object comprises an elastomeric object.

16. The anchoring mechanism of claim 5, wherein said object comprises a shape memory tube.

17. The anchoring mechanism of claim 5, wherein said object comprises an expandable balloon.

18. The anchoring mechanism of claim 5, wherein said object comprises an O-ring.

19. The anchoring mechanism of claim 5, wherein said object comprises a plurality of deflectable radial tabs.

20. The anchoring mechanism of claim 5, wherein said object comprises a circular object disposable within several recesses.

21. The anchoring mechanism of claim 5, wherein said object comprises a collet.

22. The anchoring mechanism of claim 21, wherein said collet is a flared collet.

23. The anchoring mechanism of claim 21, wherein said collet is a threaded collet.

24. The anchoring mechanism of claim 5, wherein said object comprises an offset block.

25. The anchoring mechanism of claim 5, wherein said object comprises a split jawed collet operatively coupled to a spring.

26. The anchoring mechanism of claim 5, wherein said object comprises a sleeve operatively coupled to a spring.

27. The anchoring mechanism of claim 5, wherein said object comprises a tubular member having one or more latches.

28. The anchoring mechanism of claim 5, wherein said object comprises a wedge.

29. The anchoring mechanism of claim 28, wherein said wedge is a threaded wedge.

30. The anchoring mechanism of claim 5, wherein said object comprises a slotted tube having at least one necked-down portion.

31. The anchoring mechanism of claim 5, further comprising placement means for actuating said object between the unlocked position and locked position.

32. The anchoring mechanism of claim 31, wherein said placement means comprises a tubular member.

33. The anchoring mechanism of claim 5, further comprising retrieval means for disengaging the object from the locked position to the unlocked position.

34. An anchoring mechanism for releasably securing an intravascular device to an elongated member disposed within a body lumen, said anchoring mechanism comprising:

an object actuatable between an unlocked position and a locked position, wherein the object is slidably and rotationally disposed about the elongated member in the unlocked position, and is releasably secured to the elongated member in the locked position; and

placement device actuatable to move said object between the unlocked position and locked position.

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