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(57) Abstract: Devices and methods are disclosed to conduct fluid away from or deliver fluid to an area of a treatment site of a patient's body. In one example, a catheter is provided having a terminal end with a non-linear shape such that fluid is delivered to or drained from an area of a treatment site. In another example, a catheter includes a fluid exchange portion and a member attached to the fluid exchange portion for biasing fluid flow at the treatment site. In another example, a catheter includes a terminal end with a fluid exchange portion. The terminal end may further include a diffuser. The terminal end may further include a barrier.



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PATENT APPLICATION

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CATHETER

FIELD OF THE INVENTION

[0001] The invention relates to devices and methods for transporting fluid to or from a treatment site of a patient's body.

BACKGROUND

[0002] Many medical procedures benefit from transporting fluid to or from a treatment site of a patient's body. Devices for transporting fluid in a medical procedure are generally referred to as catheters. They may be used to provide drainage or administer treatment fluids. For example, catheters may be used to drain fluids from organs or from areas of abnormal fluid collection such as in a surgical wound following a surgical procedure. Catheters may also be used to deliver fluid to a treatment site to provide a vast range of therapies from cancer treatment to nutritional supplementation. A few exemplary therapies include stimulating tissue growth, administering antibiotics, flushing away impurities, killing or halting the reproduction of cancer cells, and relieving pain.

[0003] Catheters may be used in gravity driven arrangements such as with a collection container located below the treatment site or a medication container located above the treatment site. Likewise, catheters may be used in pressurized arrangements. For example, suction may be applied to a drainage catheter to draw fluids away from the treatment site. Suction devices may include elastomeric bulbs, spring actuated bellows, electromechanical vacuum pumps, and other known medical suction devices. Pressurized fluid may also be delivered through a catheter to the treatment site. For example, fluid infusion devices may include manual syringes, elastomeric infusion devices, spring loaded infusion devices, electromechanical infusion devices, and other known infusion devices.

[0004] Typical prior catheters are linear devices having one or more openings formed along a portion of their length through which fluid passes. They often perform poorly due to an inability to drain fluids from or deliver fluids to a sufficiently large area to encompass the entire treatment site. In addition, tissue folds and tissue apposition further affect the movement and collection of fluid making it difficult for prior catheters to adequately address the treatment site.

[0005] For example, where a treatment site encompasses a two or three dimensional treatment area, prior drainage catheters are only able to drain fluid from a relatively small, linear portion of the treatment area often leaving behind pockets of fluid.

[0006] Similarly, prior infusion catheters only deliver treatment fluid to a relatively small, linear portion of the treatment site leaving much of the site untreated. Prior infusion catheters may also deliver too much treatment fluid to a relatively small area resulting in pooling of treatment fluid or contact with non-target tissues. For example, infusion catheters may be used to deliver pain relieving medication directly to a surgical site to provide, for example, post-operative relief of pain resulting from a surgical intervention. If the medication does not reach tissue disrupted during the surgical intervention, it may not relieve the pain. Alternatively, if the medication is delivered indiscriminately, undesired interactions may occur with local structures such as, for example, spinal nerves or vital organs.

SUMMARY

[0007] Aspects of the invention provide devices and methods to conduct fluid away from or deliver fluid to an area of a treatment site of a patient's body. Fluid delivered to a treatment site will be referred to as treatment fluid and may be any material delivered to the treatment site to obtain a desired effect. For example treatment fluid may be water, saline, antibiotics, antiviral agents, hormones, growth factors, anti-inflammatories, analgesics, anesthetics, and/or any other material useful in treating a patient. For example, anesthetics may include marcaine, rupivacaine, bupivacaine, and/or any other anesthetic or combinations thereof.

[0008] Embodiments of the invention may be used in any procedure in which it is desirable to deliver fluid to or remove fluid from a treatment site. The use of such devices and methods will be described with some specific examples illustrating the delivery of an anesthetic to a surgical site for the treatment of post-operative pain and/or removal of fluids from a surgical site. Examples of such surgical procedures include surgery of the head, neck, chest, back, abdomen, and the extremities. Examples include general surgery, cosmetic surgery, joint surgery, and spine surgery. However, it will be apparent to one having skill in the art that the disclosed devices and methods may be used to treat a variety of other conditions by drainage of fluids from and delivery of fluids to a treatment site.

[0009] In one aspect of the invention, a catheter includes a first or connection end and an opposite, second or terminal end. A fluid conduit extends between the connection end and the terminal end for passing fluids. The terminal end includes an elongated hollow body having a wall defining the terminal end of the fluid conduit and one or more openings formed through the wall for passage of fluid between the fluid conduit and an exterior of the conduit. The terminal end may describe a non-linear path such that fluid is delivered to or drained

from an area generally within a plane. The terminal end may describe a non-linear path such that fluid is delivered to or drained from a three-dimensional area. The terminal end may be flexible to permit adjustment of the coverage area of the catheter. Such adjustment may be accomplished within a plane by moving portions of the terminal end relative to one another to cover varying areas. Such adjustment may be accomplished in three dimensions by moving portions of the terminal end relative to one another to cover varying non-planar areas. The non-linear configuration of the terminal end results in portions of the terminal end separating tissue layers at the treatment site and maintaining fluid communication between the tissue layers over a two-dimensional or three-dimensional treatment site to extend the effective treatment area. Furthermore, the non-linear configuration extends peripherally into the tissue folds and irregularities to separate tissue layers and enhance fluid transport between the layers and adjacent the terminal end. Enhancement of fluid transport reduces the number of catheters required to transport fluid to and/or away from the treatment site. The one or more openings in the wall of the conduit may be positioned at any circumferential position around the wall. They may be placed parallel to the plane of the non-linear path of the terminal end so that they open within the space between tissue layers to avoid blocking of the openings by overlying tissue. The non-linear path of the terminal end may have a predetermined shaped that conforms to the margins of a particular surgical site. The shape may be polygonal, ovoid, spiral, or random shaped.

[0010] The terminal end may include more than one conduit. Multiple conduits may be adjustable two-dimensionally and/or three-dimensionally relative to one another to vary the fluid distribution pattern of the terminal end. Multiple conduits may provide for different functions. For example, one or more conduits may be used to infuse fluids to the treatment

site while one or more other conduits may be used to drain fluids away from the treatment site.

[0011] The terminal end of the catheter may have a first non-linear configuration and a second configuration into which it may be modified. For example, the terminal end may have a non-linear deployed configuration for fluid transport to or from a two-dimensional or three-dimensional area and a delivery or removal configuration. The delivery or removal configuration may be smaller than the deployed configuration to ease placement or removal of the terminal end at a desired location of a patient's anatomy. For example, the delivery or removal configuration may be folded, rolled, straightened, stretched, compressed, twisted, deflated, and/or otherwise manipulated relative to the deployed configuration.

[0012] In another aspect of the invention, a catheter includes a first or connection end and an opposite, second or terminal end. A fluid conduit extends between the connection end and the terminal end for passing fluids. The terminal end includes a fluid exchange portion. The fluid exchange portion may include an elongated hollow body having a wall defining the terminal end of the fluid conduit and one or more openings formed through the wall for passage of fluid between the fluid conduit and an exterior of the conduit. The terminal end may include more than one conduit. Multiple conduits may be adjustable two-dimensionally and/or three-dimensionally relative to one another to vary the fluid distribution pattern of the terminal end. The multiple conduits may be mounted in a predetermined relative spaced relationship to one another.

[0013] The terminal end may include a member attached to the one or more conduits. The member may interconnect portions of the one or more conduits to position the portions in a

desired configuration. The member may be flexible to allow repositioning of the portions from an original position to alternate positions.

[0014] The member may include a barrier to fluid flow to impede fluid flow in specific predetermined directions. The barrier may be connected to the one or more conduits to bias fluid flow in a preferential direction or to impede fluid flow in a non-preferential direction. The barrier may serve as a connecting member for spacing portions of the one or more conduits. The barrier may be permanently secured to the terminal end or removably secured to the terminal end. The barrier may be separate from the terminal end and placed relative to the terminal end to protect selected portions of the patient's anatomy from the fluid being delivered. The barrier may, for example, impede fluid flow by juxtaposition of a fluid impervious structure and/or by absorption of fluid. The barrier may be made resorbable or durable. The barrier may be made of polymers, ceramics, metals, plant tissue, animal tissue, and/or other suitable materials. The barrier may be in the form of a block, sheet, film, layer, sponge, and/or other suitable form adapted or adaptable to the anatomic site where the barrier function is desired. The barrier may be provided pre-shaped and sized for a particular application and/or it may permit intraoperative shaping and sizing by the user. For example, the barrier may be made of a thin polymer film. In another example, the barrier may be made of collagen forming a relatively fluid impervious membrane.

[0015] The barrier may separate tissue layers at the treatment site and maintain fluid communication between the tissue layers over a two-dimensional or three-dimensional treatment site to extend the effective treatment area. Furthermore, the barrier may extend peripherally into the tissue folds and irregularities to separate tissue layers and enhance fluid

transport between the layers and adjacent the barrier. Enhancement of fluid transport reduces the number of catheters required to transport fluid to and/or away from the treatment site.

[0016] The one or more openings in the wall of the conduit may be positioned at any circumferential position around the wall. They may be placed parallel to the plane of the non-linear path of the terminal end so that they open within the space between tissue layers to avoid blocking of the openings by overlying tissue.

[0017] The barrier may have a predetermined shaped that conforms to the margins of a particular surgical site. The shape may be polygonal, ovoid, spiral, or random shaped.

[0018] The terminal end of the catheter may have a first configuration and a second configuration into which it may be modified. For example, the terminal end may have a deployed configuration for fluid transport to or from a treatment site and a delivery or removal configuration. The delivery or removal configuration may be smaller than the deployed configuration to ease placement or removal of the catheter at a desired location of a patient's anatomy. For example, the delivery or removal configuration may be folded, rolled, stretched, compressed, twisted, deflated, straightened and/or otherwise manipulated relative to the deployed configuration.

[0019] In another aspect of the invention, a catheter includes a first or connection end and an opposite, second or terminal end. A fluid conduit extends between the connection end and the terminal end for passing fluids. The terminal end includes a fluid exchange portion. The fluid exchange portion may include a hollow body having a wall defining the terminal end of the fluid conduit and one or more openings formed through the wall for passage of fluid between the fluid conduit and an exterior of the conduit. The catheter may include more than one fluid conduit. Multiple fluid conduits may provide the same or different functions. For

example, the catheter may have one or more infusion conduits to conduct treatment fluid to a treatment site and one or more aspiration conduits to conduct fluids away from a treatment site. Infusion and aspiration conduits may be incorporated in the same catheter or they may be provided in separate catheters placed independently at a treatment site.

[0020] The terminal end may include a diffuser having an outer surface. The diffuser may include a plurality of independent channels able to transport fluid between the conduit and discrete portions of the outer surface. The diffuser may include a network of interconnected pores able to distribute fluid throughout the diffuser and the outer surface. The diffuser may be permanently secured to the terminal end or removably secured to the terminal end. The diffuser may be placed separately at the treatment site independent of the terminal end. A separately placed diffuser may wick fluid to or from an area defined by an exterior surface of the diffuser. The diffuser may be resorbable or durable. The diffuser may be made of polymers, ceramics, metals, plant tissue, animal tissue, and/or other suitable materials. The diffuser may include fibers, fabric, sponge, textures and/or other suitable diffusing structures. For example, the diffuser may include a textured surface. The surface may be textured by stamping, knurling, roughening, and/or by other suitable means. The surface may also be textured by forming raised lines, bumps, ridges, and/or other suitable features. The texture may include fibers. The diffuser may include a network of fibers able to conduct fluid within, along, or between the fibers. The fibers may be adhered to a surface or free standing. For example, the network may be made by weaving, knitting, braiding, felting, bonding, and/or other suitable textile process. For example, the diffuser may include a fabric made of woven synthetic fibers in a generally planar arrangement and positionable between opposing

tissues to transport fluid over an extended area by wicking fluid along and between the fibers via capillary action. The diffuser may be made of a

[0021] The terminal end may include a barrier to fluid flow to impede fluid flow in specific predetermined directions. The barrier may be connected to the one or more conduits to bias fluid flow in a preferential direction or to impede fluid flow in a non-preferential direction. The barrier may be permanently secured to the terminal end or removably secured to the terminal end. The barrier may be separate from the terminal end and placed relative to the terminal end to isolate selected portions of the patient's anatomy from the fluid flow. The barrier may, for example, impede fluid flow by juxtaposition of a fluid impervious structure and/or by absorption of fluid. The barrier may be made resorbable or durable. The barrier may be made of polymers, ceramics, metals, plant tissue, animal tissue, and/or other suitable materials. The barrier may be in the form of a block, sheet, film, layer, and/or other suitable form adapted or adaptable to the anatomic site where the barrier function is desired. The barrier may be provided pre-shaped and sized for a particular application and/or it may permit intraoperative shaping and sizing by the user. For example, the barrier may be made of a thin polymer film. In another example, the barrier may be made of collagen forming a relatively fluid impervious membrane. The barrier may be coupled to a diffuser to provide fluid flow through portions of the diffuser while blocking fluid flow through other portions of the diffuser.

[0022] The barrier and/or diffuser may separate tissue layers at the treatment site and maintain fluid communication between the tissue layers over a two-dimensional or three-dimensional treatment site to extend the effective treatment area. Furthermore, the barrier and/or diffuser may extend peripherally into the tissue folds and irregularities to separate

tissue layers and enhance fluid transport between the layers and adjacent the barrier and/or diffuser. Enhancement of fluid transport reduces the number of catheters required to transport fluid to and/or away from the treatment site.

[0023] The one or more openings in the wall of the conduit may be positioned at any circumferential position around the wall. They may be placed parallel to the plane of the non-linear path of the terminal end so that they open within the space between tissue layers to avoid blocking of the openings by overlying tissue.

[0024] The barrier and/or diffuser may have a predetermined shaped that conforms to the margins of a particular surgical site. The shape may be polygonal, ovoid, spiral, or random shaped.

[0025] The terminal end of the catheter may have a first configuration and a second configuration into which it may be modified. For example, the terminal end may have a deployed configuration for fluid transport to or from a treatment site and a delivery or removal configuration. The delivery or removal configuration may be smaller than the deployed configuration to ease placement or removal of the terminal end at a desired location of a patient's anatomy. For example, the delivery or removal configuration may be folded, rolled, collapsed, stretched, compressed, twisted, deflated, straightened and/or otherwise manipulated relative to the deployed configuration.

[0026] The catheter may be placed at the treatment site in an inside-out placement method in which it is placed in an open wound and the connection end is passed out of the patient's body leaving the terminal end at the treatment site. Alternatively, the catheter may be placed at the treatment site in an outside-in placement method in which the terminal end is introduced from outside the patient's body to the treatment site. Where a surgical incision is

present near the treatment site, the catheter may extend through the incision. Alternatively, the catheter may extend through another opening, such as a stab incision, formed for the purpose of passing a portion of the catheter.

[0027] The catheter may be placed at the treatment site in an inside-out placement method in which it is placed in an open wound and the connection end is passed out of the patient's body leaving the terminal end at the treatment site. Alternatively, the catheter may be placed at the treatment site in an outside-in placement method in which the terminal end is introduced from outside the patient's body to the treatment site. Where a surgical incision is present near the treatment site, the catheter may extend through the incision. Alternatively, the catheter may extend through another opening, such as a stab incision, formed for the purpose of passing a portion of the catheter.

[0028] Conduits may be made of any suitable biocompatible material. For example, conduits may be made of a biocompatible polymer. For example, conduits may be made of a heat settable elastic polymer. For example, the conduit may be made of or contain a thermoplastic elastomer such as a styrenic block copolymer, polyolefin, thermoplastic polyurethane, thermoplastic copolyester, thermoplastic polyamide, and/or their various blends. For example, the conduit may contain or be made of a polyether block amide or PEBA. PEBA is available from Arkema under the tradename of PEBAX®.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] Various examples of the present invention will be discussed with reference to the appended drawings. These drawings depict only illustrative examples of the invention and are not to be considered limiting of its scope.

[0030] FIG. 1A is a perspective view of an embodiment of the invention;

[0031] FIG. 1B is a top plan view of the embodiment of claim 1A;

[0032] FIG. 1C is a cross-sectional view of the embodiment of claim 1A, taken along line C-C of FIG. 1B;

[0033] FIG. 2A is a perspective view of the embodiment of FIG. 1A, illustrating a method of installation;

[0034] FIG. 2B is a perspective view of the embodiment of FIG. 1A, illustrating a method of installation;

[0035] FIG. 2C is a perspective view of the embodiment of FIG. 1A, illustrating a method of installation;

[0036] FIG. 2D is a perspective view of the embodiment of FIG. 1A, illustrating a method of installation;

[0037] FIG. 2E is a perspective view of the embodiment of FIG. 1A, illustrating a method of installation;

[0038] FIG. 3A is a perspective view of an embodiment of the invention similar to FIG. 1A illustrating a shape variation;

[0039] FIG. 3B is a top plan view of an embodiment of the invention similar to FIG. 1A illustrating a shape variation;

[0040] FIG. 4A is a top plan view of an embodiment of the invention similar to FIG. 1A illustrating the inclusion of a second fluid conduit;

[0041] FIG. 4B is a top plan view of an embodiment of the invention similar to FIG. 1A illustrating the inclusion of a second fluid conduit;

[0042] FIG. 4C is a partial perspective view of an embodiment of the invention similar to FIG. 1A illustrating the inclusion of a second fluid conduit;

[0043] FIG. 5A is a perspective view of an embodiment of the invention similar to FIG. 1A illustrating a shape variation;

[0044] FIG. 5B is a perspective view of the embodiment of FIG. 5A illustrating the deployment of the embodiment of FIG. 5A;

[0045] FIG. 6A is a perspective view of an embodiment of the invention similar to FIG. 1A illustrating a shape variation; and

[0046] FIG. 6B is a perspective view of an embodiment of the invention similar to FIG. 1A illustrating a shape variation.

[0047] FIG. 7A is a bottom perspective view of an embodiment of the invention;

[0048] FIG. 7B is a top perspective view of the embodiment of FIG. 7A;

[0049] FIG. 7C is a cross-sectional view taken along line C-C of FIG. 7B;

[0050] FIG. 7D is a cross-sectional view taken along line C-C of FIG. 7B and further illustrating the embodiment of FIG. 7A in place at a treatment site;

[0051] FIG. 7E is a perspective view of an embodiment of the invention similar to FIG. 7A illustrating an alternate surface texture.

[0052] FIG. 8A is a top perspective view of an embodiment of the invention; and

[0053] FIG. 8B is a bottom perspective view of the embodiment of FIG. 8A.

[0054] FIG. 9A is a perspective view of an embodiment of the invention;

[0055] FIG. 9B is a perspective view of a size variation of the embodiment of FIG. 9A;

[0056] FIG. 9C is a perspective view of the embodiment of FIG. 9A shown in situ at a treatment site;

[0057] FIG. 10A is a perspective view of an embodiment of the invention;

[0058] FIG. 10B is a partial sectional view of the embodiment of FIG. 10A;

[0059] FIG. 10C is a cross-sectional view of a variation of the embodiment of FIG. 10A;

[0060] FIG. 11A is a bottom perspective view of an embodiment of the invention;

[0061] FIG. 11B is a top perspective view of the embodiment of FIG. 11A;

[0062] FIG. 11C is a cross-sectional view taken along line C-C of FIG. 11B;

[0063] FIG. 11D is a cross-sectional view of the embodiment of FIG. 11A shown in situ at a treatment site;

[0064] FIG. 12A is an exploded perspective view of an embodiment of the invention;

[0065] FIG. 12B is a top perspective view of the embodiment of FIG. 12A;

[0066] FIG. 12C is a bottom perspective view of the embodiment of FIG. 12A;

[0067] FIG. 13A is a side view of an embodiment of the invention;

[0068] FIG. 13B is a cross-sectional view taken along line B-B of FIG. 13A;

[0069] FIG. 14 is a perspective view of an embodiment of the invention;

[0070] FIG. 15A is a perspective view of an embodiment of the invention;

[0071] FIG. 15B is a detail view of a portion of the embodiment of FIG. 6A; and

[0072] FIG. 16 is a perspective view of an embodiment of the invention.

DESCRIPTION OF THE ILLUSTRATIVE EXAMPLES

[0073] FIGS. 1A-C depict a catheter 100 having a connection end 101 and a terminal end 102. The terminal end 102 is in the form of an elongated fluid conduit 104 having a sidewall 106 and openings 108 communicating from the interior of the conduit 104 to the exterior of the conduit 104. The conduit 104 is formed into a non-linear original, or free state, shape for infusion or aspiration of fluid from a treatment site. The conduit 104 contains or is made of an elastic shape memory material so that it is biased toward and tends to return to the original, free state, non-linear shape but can be straightened or compressed for insertion and extraction. For example, the conduit 104 may be made of a heat settable elastic polymer allowing it to be formed into a non-linear, original, free state shape and then heated and cooled to lock-in the shape such that it is biased toward and tends to return to the heat-set shape. For example, the conduit may be made of or contain a thermoplastic elastomer such as a styrenic block copolymer, polyolefin, thermoplastic polyurethane, thermoplastic copolyester, thermoplastic polyamide, and/or their various blends. For example, the conduit may contain or be made of a polyether block amide or PEBA. PEBA is available from Arkema under the tradename of PEBAX®. In the illustrative example of FIG. 1, the conduit 104 is made of PEBA and is shaped into an original non-linear shape having a repeating back and forth two-dimensional pattern having a first directional axis 110 corresponding to the pattern length 111 and a second directional axis 112 corresponding to the pattern width 113. In the illustrative example of FIG. 1, a generally straight first portion 114 of the conduit crosses the length axis 110 generally perpendicular to the axis. A first bend 116 connects the first portion to a generally straight second portion 118 generally parallel to the first portion 114 which also crosses the length axis 110 generally perpendicular to the axis. A second

bend 120 connects the second portion to a generally straight third portion 122 generally parallel to the second portion 118 which also crosses the length axis 110 generally perpendicular to the axis. Any number of portions may be connected in this manner to create a terminal end 102 of a desired size. The illustrative pattern of FIG. 1 may be described as a serpentine or zigzag shape comprising a regular repeating pattern of two or more curvilinear segments. In particular, the illustrative pattern of FIG. 1 forms a continuous path comprised of different curvilinear segments that are bounded by a perimeter defined by the length 111 and width 113, the segments being spaced generally equal distances from one another.

[0074] In the illustrative example of FIG. 1, the sidewall 106 has a first dimension 124 generally parallel to the length dimension. For a conduit 104 having a tubular shape, the first dimension corresponds to the diameter of the conduit. The spacing 126 between adjacent portions in the original non-linear shape may vary from 1 to 100 times the first sidewall dimension. More particularly, the spacing may vary from 1 to 20 times the first sidewall dimension. Still more particularly, the spacing may vary from 2-5 times the first sidewall dimension.

[0075] The openings 108 may be located in the generally straight portions and excluded from the bends to help prevent kinking of the conduit 104 that might occur if the openings 108 were located in the bends.

[0076] The illustrative terminal end 102 may be placed in a treatment site as shown in FIGS. 1B-1C. A surgical incision 130 provides access to a treatment site 140 between overlying tissue layers 142, 144. The terminal end 102 is placed between the tissue layers 142, 144 to drain or infuse the treatment site. The conduit 104 tends to create and/or maintain folds or separations 146 between the tissue layers 142, 144 to facilitate fluid flow through

openings 108 and along the length 132 and width 134 of the treatment site. The spacing 126 of the segments, the diameter of the conduit 104, and the length 111 and width 113 of the terminal end all contribute to the coverage area of the terminal end 102. The openings 108 may be positioned at any circumferential position around the conduit 104. In the illustrative example of FIG. 1, they are positioned parallel to the plane of the two dimensional pattern so that they open within the space between tissue layers to avoid blocking of the openings by overlying tissue. This opening 108 orientation is best seen in FIG. 1C.

[0077] The incision 130 may be closed temporarily or permanently with a fastener 136. The fastener may be a staple, suture, surgical adhesive, butterfly closure, or other suitable fastener. One or more fasteners may be placed at the skin surface, subcutaneously, intrafascially, intramuscularly, or otherwise.

[0078] FIG. 2 illustrate devices and methods for introducing the catheter 100 of FIG. 1 into a treatment site. FIG. 2A illustrates an introducer in the form of a trocar 200 connectable to the connection end 101 of the catheter 100 in order to pass the connection end 101 out of the patient in an inside-out placement method. For example, during a surgical procedure having an incision 202 to permit access to a surgical site, the catheter 100 may be placed before the incision is closed. The trocar 200 is connected to the connection end 101 such as by insertion of the connection end 101 into a bore in the trocar 200 or inserting a barb extending from the trocar into the conduit of the connection end 101. The trocar 200 includes a sharp cutting tip 204 which is then passed from the surgical site through adjacent tissues and out of the skin through a puncture wound 206. The connection end 101 of the catheter 100 is pulled through the puncture wound 206 and the catheter 100 is positioned in the desired treatment site within the surgical insult. One or more layers of tissues are closed including the incision 202. The

connection end 101 is connected to, for example, a fluid suction device or a fluid delivery device and treatment is initiated.

[0079] FIGS. 2B-2C illustrate an introducer 210 useable to pass the terminal end 102 of the catheter 100 into a patient to deliver the terminal end 102 to a treatment site 222 in an outside-in placement method. The introducer 210 in the illustrative example of FIGS. 2B-2C is in the form of a hollow tube or needle having a side wall 212 defining a lumen 214 extending from a proximal end 216 to a distal end 218. In use, a puncture wound 220 is created communicating from outside the patient through the patients tissues to the treatment site 222. If necessary, a space may be created by separating tissue layers at the treatment site by inserting and sweeping a probe into the treatment site. The distal end 218 of the introducer 210 is inserted through the puncture wound 220 and into the treatment site 222. In the illustrative example of FIG. 2B, the distal end 218 of the introducer 210 is inserted into a distal portion 224 of the treatment site 222. The terminal end 102 of the catheter 100 is fed through the introducer 210, straightening the bends 116, 120 as necessary so that it will pass through the lumen 214. As the terminal end 102 is delivered to the treatment site 222, the introducer may be withdrawn to help distribute the terminal end 102 throughout the treatment site 222 and allow it to return toward its original, free state. FIG. 2B shows the catheter 100 partially inserted with the introducer withdrawn partway from the distal portion 224 of the treatment site to near a proximal portion 226 of the treatment site 222.

[0080] FIGS. 2D-2E illustrate another introducer 250 useable to pass the terminal end 102 of the catheter 100 into a patient to deliver the terminal end 102 to a treatment site in an outside-in placement method. Like the introducer of FIGS. 2B-2C, the introducer 250 in the illustrative example of FIGS. 2B-2C is in the form of a hollow tube or needle having a side

wall 252 defining a lumen 254 extending from a proximal end 256 to a distal end 258. The lumen 254 is sized to receive the terminal end 102 of the catheter 100 in a folded or collapsed state as shown in FIG. 2D in which the segments of the terminal end 102 are compressed to lie closely together. The compressed terminal end 102 may be pre-loaded into the introducer 250 prior to insertion of the distal end 258 of the introducer into the treatment site or the introducer 250 may be inserted first and then the terminal end 102 of the catheter loaded into the introducer 250. With the introducer 250 inserted at the treatment site, the terminal end 102 of the catheter 100 may be expelled from the distal end 258 of the introducer 250 and allowed it to return toward its original, free state.

[0081] The illustrative pattern of the terminal end 102 of FIG. 1 is bounded by a generally rectangular perimeter and in its original or free state is adapted to fit within a rectangular treatment site. The shape of the terminal end 102 may be changed intraoperatively to fit a desired treatment site by compressing, expanding, bending, stretching and/or otherwise manipulating the conduit 104 and fitting it within the treatment site where it will be constrained from returning to its original free state by the surrounding tissues. For example, to fit a longer or shorter treatment site, the terminal end 102 may be stretched or compressed along the length axis while maintaining its generally serpentine or zigzag shape. The shape of the terminal end 102 may be changed in three dimensions by moving the segments apart in a direction perpendicular to the first and second directional axes 110, 112.

[0082] The original non-linear shape may be varied, for example, by making the connecting bends smaller or larger, making the connected portions longer or shorter, angling the portions so that they are not generally perpendicular to the length axis, and/or making the shape of the connected portions themselves non-straight. In this way, the terminal end 102 may be formed

with an original, free state, size and shape adapted to fit a particular wound geometry. The terminal end 102 may be provided in various configurations of length and width from which an appropriate size may be selected for a particular treatment site.

[0083] FIG. 3A illustrates a catheter 300 having a terminal end 302 with an alternate shape produced by varying the length of the generally straight portions 304 of the pattern interconnected by bends 306. A terminal end pattern may be produced that is bounded by a generally elliptical perimeter by increasing the length of each of the generally straight portions 304 in a first portion 305 of the pattern as they progress from near the connection end 308 toward the center 310 of the pattern and then decreasing the length of each of the generally straight portions 304 in a second portion 311 of the pattern as they progress from near the center 310 of the pattern toward the tip 312 of the terminal end 302. FIG. 3B illustrates a catheter 320 having a terminal end 322 with an alternate shape produced by replacing the generally straight portions with generally curved portions 324 to produce a non-linear shape having a repeating back and forth two-dimensional pattern of elongate curved segments 324 joined by bends 326. The pattern has a length 330 and a width 332. The bends have generally shorter radii 326 than the segments 324 and in the embodiment shown transcribe more than ninety degrees such that the segments 324 repeatedly cross the longitudinal axis 328. A terminal end pattern bounded by any desired shape may be produced by varying the size, shape, and spacing of the segments forming the terminal end 302.

[0084] FIGS. 4A-C illustrate variations on the terminal end of FIG 1. FIG. 4A depicts a catheter terminal end 400 having a dual conduit 401 including a first, infusion conduit 402 and a second, aspiration conduit 404. In the illustrative example of FIG. 4, the infusion and

aspiration conduits 402, 404 are arranged coaxially with the aspiration conduit inside of the infusion conduit. Alternatively, for example, the conduits 402, 404 could be side-by-side. The dual conduit includes straight portions 406 and bends 408 arranged like those in FIG. 1 with the straight portions generally perpendicular to a length axis 410. Treatment fluid 412 is delivered to the treatment site via openings 414 in the outer wall of the infusion conduit 402. The aspiration conduit 404 extends beyond the end 416 of the infusion conduit to form a fluid receiving portion 418. The fluid receiving portion 418 bends back in a direction generally perpendicular to the straight portions 406 to underlie the infusion portion of the terminal end 400. The fluid receiving portion 418 includes openings 420 for receiving treatment fluid for removal by the aspiration conduit 404. In use, the fluid receiving portion 418 is positioned at the treatment site where treatment fluid tends to pool and/or adjacent portions of the treatment site from which fluid is to be excluded. For example, the catheter terminal end may be positioned in a surgical wound, e.g. from a reconstructive surgical procedure such as breast or knee reconstruction procedure, in which treatment fluid, such as an anesthetic, can be advantageously applied over an extended area of disrupted tissue having a length and a width and in which the wound tends to drain to a lower portion of the treatment site. In another example, the fluid receiving portion 418 may be positioned adjacent to nerve roots to capture and transport away anesthetic fluid to protect the nerve root.

[0085] FIG. 4B depicts a terminal end 430 similar to that of FIG. 4A except that the straight portions 432 are generally parallel to a length axis 434. Treatment fluid 436 is delivered to the treatment site via openings 438 in the outer wall of the infusion conduit 440. The aspiration conduit 442 extends beyond the end 444 of the infusion conduit to form a fluid

receiving portion 446. The fluid receiving portion 446 continues the pattern of bends and straight portions and extends generally parallel to the straight portions 432 to underlie the infusion portion of the terminal end 400.

[0086] FIG. 4C depicts an aspiration conduit 452 and an infusion conduit 454 in which the infusion conduit is located within an inner lumen 456 of the aspiration conduit 452 over a portion of its length. The aspiration conduit 452 includes openings 458 for aspirating fluid away from a treatment site. The infusion conduit 454 exits from the aspiration conduit lumen 456 via one of the openings 458 to form a terminal end 460 similar to those of FIGS. 4A and 4B having a repeating pattern of segments with openings 462 for infusing fluid to a treatment site.

[0087] FIGS. 5A-B depict a fluid delivery device in the form of a terminal end 500 of a catheter. The terminal end 500 includes one or more conduits 502, 504, 506, 508 having a deployed configuration with a non-linear original or free state such as, e.g. a curled shape or “pig tail”. The conduits 502-508 may be formed from shape memory tubing so that when deployed they tend to curl and cover an extended area but which allows the tubing to be straightened for deployment and/or extraction. Fluid openings 510 communicate fluid between the interior of the conduits and the treatment site. Multiple conduits may be joined at their connection ends 512 by a junction or manifold to a common supply line, not shown. While shown pre-formed into curled configurations, the conduits 502-508 may be formed into any suitable shape to transport fluid to or from a treatment area. For example, the conduits 502-508 may be formed into arcs, helixes, serpentine patterns, polygons of any number of sides, and/or any other two-dimensional or three-dimensional regular, irregular, or random shape. Any number of conduits may be used to provide a desired coverage pattern.

[0088] An introducer 514 may be used to aid in placing the conduits 502-508 at a treatment site. The introducer 514 has a relatively narrow, hollow interior 516 defined by a wall 518 that constrains the conduits 502-508 to a compact delivery configuration. Upon ejecting the conduits 502-508 from the introducer 514, they resume the expanded, deployed configuration of their original free state shape. In the illustrative example of FIG. 5 a tubular introducer is slidably disposed about the conduits 502-508. A retainer 520 joins the conduits 502-508 at their connection ends and may be coupled to them to fix their relative spacing both axially and radially. Alternatively, the retainer 520 may permit the conduits 502-508 to slide relative to the retainer 520 to permit adjustment of their relative positions. The introducer 514 includes a connector 522 and the retainer 520 includes a connector 524 cooperatively engageable with the introducer connector.

[0089] In use, the introducer 514 is placed in a first or delivery position as shown in FIG. 5A in which the shaped portions of the conduits 502-508 are constrained to a compact delivery configuration within the introducer. In this example, the conduits 502-508 are straightened inside the introducer 514. The delivery end 526 of the introducer 514 is positioned at a desired location relative to a treatment site and the conduits 502-508 are expelled from the introducer 514 such as by sliding the retainer 520 toward the introducer 514 and into the second or deployed position shown in FIG. 5B wherein the conduits expand into their deployed original, free state configuration. The conduits 502-508 may be fixed relative to the retainer to provide a fixed deployed configuration or they may be adjustable relative to the retainer either before or after deployment to tailor the deployed configuration.

Alternatively, the retainer may be omitted and the conduits 502-508 manipulated individually within the introducer and treatment site. The connectors 522 and 524 may be engaged, such

as by clamping, to fix the relative position of the introducer 514 and retainer 520. The introducer 514 and/or retainer 520 may be left in the patient's body or they may be removed leaving just the conduits 502-508. The introducer may be used as a guide to straighten the conduits 502-508 as they are removed.

[0090] The exemplary terminal end 500 of FIG. 5 advantageously expands to aspirate or infuse fluids over an expanded area while also having a relatively small extraction profile and force since the conduits 502-508 straighten upon being pulled away from the treatment site. Furthermore, the ability to fix the relative positioning of one conduit in relationship to another conduit allows for a selectable area of coverage.

[0091] FIGS. 6A-B depict variations on the shape of a terminal end. FIG. 6A depicts a fluid delivery device in the form of a terminal end 600 of a catheter 602. The end 600 includes an elongated fluid conduit 604 formed into a coil with openings 610 that communicate fluid from the interior of the conduit 604 to the exterior while the coil separates tissue folds and provides a fluid delivery area within the tissue. The conduit 604 is formed from shape memory material so that it may be straightened for delivery and/or extraction but maintain the coiled configuration while deployed. FIG. 6B depicts a fluid delivery device similar to that of FIG. 6A but further having a groove 606 formed on a first side of the conduit 604 and a mating tongue 608 formed on an opposite side of the conduit 604. The conduit 604 is formed into a coil with the tongue 608 engaging the groove 606. The tongue and groove configuration creates a fluid barrier in the deployed condition yet allows the conduit 604 to be uncoiled during extraction to ease the extraction.

[0092] FIGS. 7A-1D depict a terminal end 700 of a catheter 702 having a front or "wet" side 704 and a back or barrier side 706. The terminal end 700 includes an elongated body 714

having a wall 716 defining an outer surface 718 and one or more elongated lumens. In the illustrative example of FIG. 7, the wall 716 defines a single, centrally positioned lumen 720 in fluid communication with a corresponding conduit 722 of the catheter 702. A plurality of wall openings 724 are spaced along the length of the elongated body 714 communicating from the lumen 720 to the outer surface 718 through the wall 716. The wall 716 has a width 717.

[0093] A barrier 726 is attached to the outer surface 718 of the elongated body 714 adjacent the openings 724. In the illustrative example of FIG. 7, the elongated body 714 is “D”-shaped with a flat side and the barrier 726 is attached to the flat side along the length of the elongated body 714 and is configured to lie in a plane with the elongated body 714 projecting outwardly from it. The barrier 726 has a length 708, a width 710, and a depth 712. The barrier 726 includes barrier holes 728 aligned with and in fluid communication with the wall openings 724 to allow fluid flow from adjacent the barrier surface into the lumen 720. The barrier 726 is fluid resistant and separates the front side 704 from the back side 706 of the terminal end 700. In the illustrative example of FIG. 7, the barrier is a fluid impermeable polyurethane membrane.

[0094] The terminal end 700 of FIG. 7 may be used to selectively direct treatment fluid to a treatment site. For example, the front side 704 may be positioned adjacent a treatment site and treatment fluid infused from lumen 720, through wall openings 724 and into contact with the treatment site. The barrier 726 blocks the flow of treatment fluid toward the back side 706 of the terminal end 700 to shield tissues adjacent the back side 706 from the treatment fluid.

[0095] In another example, the terminal end 700 of FIG. 7 may be used to selectively aspirate fluid from a treatment site. For example, the front side 704 may be positioned adjacent a treatment site and fluid aspirated through wall openings 724, into lumen 720 and out through conduit 722. The barrier 726 blocks the flow of fluid from the back side 706 of the terminal end 700 to shield tissues adjacent the back side 706 from the low pressure associated with aspiration.

[0096] In the illustrative example of FIG. 7D, the terminal end 700 of FIG. 7 may be used as an aspiration catheter in combination with a separate source of treatment fluid (not shown). For example, the terminal end 700 may be positioned at a surgical site with the front side 704 adjacent to a nerve root 742 and the back side 706 toward a source of anesthetic fluid. As anesthetic fluid is infused into the site, the flow of the anesthetic toward the nerve root is impeded by the barrier 726 and any body fluids and excess anesthetic are removed from the vicinity of the nerve root 742 through the openings 724, into lumen 720 and out through conduit 722.

[0097] In the illustrative example of FIG. 7E, the front side 704 further includes projections 750 creating a textured surface to improve fluid flow through openings 724. The projections prevent adjacent tissue from pressing against, or being drawn into, and sealing the openings 724. In the illustrative example, the projections are a plurality of bumps alternating with openings 724. However, the projections 750 may be distributed across the surface of the front side or elsewhere on the terminal end 700 to improve fluid flow. The projections may be molded integrally with the front side 704, adhered to the front side 704, formed by deforming the front side 704, deposited, cast, and/or otherwise formed. For example, the

projections 750 may be formed by depositing a liquid component and causing it to cure into a solid polymer such as a UV curable adhesive.

[0098] In the illustrative example of FIG. 7, the catheter 702 has a larger diameter than the elongated body 714 and defines a step 734 between them. This change in diameter facilitates removal of the terminal end 700 by withdrawal through an opening in the patient's body sized for the catheter 702. Pulling on the catheter 702 to extract the terminal end 700 from the treatment site tends to cause the terminal end 700 to collapse behind the step 734 for easier passage through a tissue opening.

[0099] In the illustrative example of FIG. 7, the barrier width 710 may be between 1 and 100 times the wall width 717. More particularly, the barrier width 710 may be between 2 and 20 times the wall width 717. More particularly, the barrier width may be between 2 and 5 times the wall width.

[00100] FIGS. 8A-B depict a terminal end 800 of a catheter 801 similar to that of FIGS. 7A-C. The terminal end 800 includes a palmate network 802 of conduits 804, 806, 808, 810, 812, 814, 816 including openings 821 for passing fluid between the interior of the conduits 804-816 and the exterior. In this example, peripheral conduits 804-814 extend in a generally divergent pattern from a central conduit 816 much like the vein pattern of a leaf. A member 820 having a first, front surface 822 and an opposing second, back surface 824 is attached to one side of the network 802, for example, to underlie the network. The conduits 804-816 tend to spring open into a deployed configuration and the member 820 interconnects the conduits 804-816 to maintain a desired spatial configuration. The member 820 may also form a barrier as in the example of FIG. 7. In an infusion arrangement, fluid exits the conduits 804-816 and is delivered to the first surface 822 and is distributed over the first

surface to an area of the treatment site. In an aspiration arrangement, fluid collects on the surface 822 and is removed through openings 821 and conduits 804 816. The conduits 804 816 in this example are relatively thick polygonal structures that tend to separate adjacent tissue into folds at the treatment site to facilitate fluid communication over an area within the treatment site. The conduits 804 816 may be semi-rigid to facilitate tissue separation. Semi-rigid conduits also facilitate maintaining fluid flow by resisting crushing or kinking such as, for example, due to patient movement. The member 820 may be in the form of a thin sheet-like membrane. In the illustrative example of FIG. 8, the member is a fluid impermeable polyurethane membrane.

[00101] Each of the various examples of terminal ends described herein have a length, a width, and a depth. The length of the terminal end may vary over a broad range to suit a variety of treatment sites. For example, the length may range from a few millimeters to tens of centimeters. In particular, the length may range from 1 to 30 centimeters. More particularly the length may range from 5 to 20 centimeters. The width of the terminal end may vary over a broad range to suit a variety of treatment sites. For example, the width may range from a few millimeters to tens of centimeters. In particular, the width may range from 0.5 to 30 centimeters. More particularly the width may range from 1 to 15 centimeters. The depth of the terminal end may vary over a broad range to suit a variety of treatment sites. For example, the depth may range from a fractions of a millimeter to tens of millimeters. In particular, the depth may range from 0.05 to 20 millimeters. More particularly the depth may range from 0.5 to 10 millimeters.

[00102] FIG. 9 depicts an illustrative example of a fluid delivery device in the form of a terminal end 900 of a catheter for placement in a patient at a treatment site. The terminal

end 900 includes a diffuser body 902 having a depth 904, width 906, and length 908. A first conduit 910 is positioned within the diffuser body 902 near a first portion 912 of the body 902. In use, fluid is transported between the first conduit 910 and the diffuser body 902. For example, wound fluid may be absorbed by the diffuser and transported to the first conduit 910 via small openings 913 through the conduit wall for removal from the treatment site. Alternatively, treatment fluid may be delivered by the first conduit 910 to the diffuser body 902 so that the fluid wicks through the diffuser body 902 to evenly wet a surface 918 of the diffuser body 902 and transfer to tissues adjacent to the surface 918 at the treatment site. Optionally, a second conduit 914 is positioned adjacent to the diffuser body 902 near a second portion 916 of the body 902. The conduits 910, 914 may be removably positioned allowing them to be withdrawn from the diffuser while leaving the diffuser in place after treatment has been concluded. In the illustrative example of FIG. 9A, the first conduit 910 is an infusion conduit and the second conduit is an aspiration conduit 914. The first, or infusion, conduit 910 delivers treatment fluid to the diffuser body. The aspiration conduit 914 collects and transports body fluid and excess treatment fluid away from the treatment site.

[00103] An optional fluid impermeable barrier 920 may be positioned on one or more surfaces of the diffuser body 902 to prevent fluid transport through the portion of the diffuser body 902 covered by the barrier. Selection of the diffuser shape, infusion conduit position and flow rate, aspiration conduit position and flow rate, and/or location of fluid barriers permits the treatment fluid delivery properties of the terminal end 900 to be tailored. In the illustrative example of FIG 9, the infusion and aspiration conduits 910, 914 extend only partially along the length of the diffuser body 902 leaving a conduit-free, trimmable portion

922. The trimmable portion 922 is sized to be sufficiently short so that the fluid delivery to the trimmable portion 922 is not significantly less than the fluid delivery to the rest of the diffuser body 902. This trimmable portion 922 may be trimmed to fit the length of the terminal end 900 to the treatment site without cutting into a fluid conduit and without significantly changing the fluid delivery properties of the terminal end 900.

[00104] FIG. 9B illustrates how a second terminal end 930 may be provided having a different length 932 than the first terminal end 900 of FIG. 9A. The length 908 of the first terminal end 900 may be approximately equal to the fully trimmed length 934 of the second terminal end 930. By arranging the lengths in this way, it is possible to provide infinite adjustability of length within a range of possible lengths ranging from the fully trimmed length 936 of the first terminal end 900 to the length 932 of the second terminal end 930. Any number of terminal ends may be provided to cover a desired range of lengths. Likewise, trimmable portions may be provided to allow for adjustment of the depth and width of the diffuser body 902.

[00105] FIG. 9C depicts terminal end 900 placed in the depth of a surgical wound to deliver anesthetic to tissues disrupted during an operation on a patient's spine. The infusion conduit 910 and diffuser body 902 distribute the anesthetic over the surface of the diffuser body to treat adjacent tissues. The barrier 920 is positioned on a portion of the diffuser body 902 near a nerve root 942 to protect the nerve root 942 from anesthetic treatment fluid. The aspiration conduit 914 is positioned below the barrier 920 to aspirate body fluids and excess anesthetic.

[00106] FIG. 10 depicts a terminal end 1000 of a catheter 1002 having a length 1001, a width 1003, and a depth perpendicular to the length 1001 and width 1003. The end 1000

may be formed integrally with the catheter 1002 or the end 1000 may be formed separately from the catheter 1002 and joined to it, as shown. The end 1000 includes a plurality of fluid conduits 1004, 1006, 1008, 1010. Adjacent conduits are connected by intermediate portions 1012, 1014, 1016 that aid in spacing the conduits 1004-1010 in desired relative positions. The intermediate portion 1012-1016 may be in the form of a flexible sheet and the conduits 1004-1010 may be formed from shape memory tubing having a first, or rest, shape to which the tubing returns after being constrained to an alternate shape and then released. In the illustrative example of FIG. 10A, the conduits 1004-1010 are joined at a junction 1018 to a common line 1020. The conduits 1004-1010 are formed to spring away from one another as they extend away from the junction 1018. Intermediate portions 1012-1016 constrain the conduits 1004-1010 to a generally parallel, palmate configuration. The conduits 1004-1010 include openings 1022 formed through the conduit wall for passage of fluid between the interior and exterior of the conduits 1004-1010. In an infusion configuration, the intermediate portions 1012-1016 receive fluid exiting the openings 1022 and distribute it over the surface of the terminal end 1000. In an aspiration configuration, the intermediate portions 1012-1016 collect fluids from the treatment site for evacuation via the openings 1022. The intermediate portions 1012-1016 and openings 1022 may be positioned so that the openings 1022 communicate with only one side of the intermediate portions 1012-1016 so that the terminal end 1000 may be used to preferentially transport fluid to or from some portions of a treatment site. Alternatively, the intermediate portions 1012-1016 and openings 1022 may be positioned so that some openings 1022 communicate with one side of the intermediate members 1012-1016 and other openings 1022 communicate with the other side of the intermediate members 1012-1016 to transport fluid to or from both sides of the terminal end

1000. Alternatively, the openings 1022 may be positioned so that an opening 1022 communicates with both sides of the intermediate portions 1012-1016 simultaneously such as by positioning the opening 1022 to communicate with both sides as shown in FIG. 10B. The intermediate portions 1012-1016 may have a fluid impervious surface that allows the fluid to flow across the surface to distribute it in a thin sheet-like fashion. The intermediate portions 1012-1016 may have porous surfaces so that they wick the fluid across an area. The intermediate portions 1012-1016 may be porous and permeable so that they wick the fluid through them between opposite sides of the intermediate portions 1012-1016. The intermediate portions 1012-1016 may include a laminate structure having an porous layer 1024 on one side that wicks fluid and a fluid impervious layer 1026 on an opposite side to impede fluid flow as shown in FIG. 10C.

[00107] While four fluid conduits 1004-1010 have been shown, it is to be understood that any number of conduits may be used. Furthermore, while tubular conduits have been depicted, conduits having any cross-sectional shape may be used including, for example, polygonal, curved, annular, and other cross-sectional shapes.

[00108] During delivery, the terminal end 1000 can be folded and/or rolled into a small delivery configuration, not shown, and placed at the treatment site. The terminal end is then released whereupon the delivery conduits will tend to spring away from one another, as permitted by the surrounding tissue, into the configuration shown in FIG. 10A. In the illustrative example of FIG. 10, the common line 1020 has an outside diameter less than that of the catheter 1002 such that a step 1030 is formed between them. This change in diameter facilitates removal of the terminal end 1000 by withdrawal through an opening in the patient's body sized for the catheter 1002. Pulling on the catheter 1002 or common line 1020

to extract the terminal end 1000 from the treatment site tends to cause the conduits 1004-1010 to move toward one another due to pressure from surrounding patient tissues. The terminal end 1000 collapses behind the step 1021 to a constrained configuration approximately the same diameter as the catheter 1002.

[00109] FIG. 11 depicts a terminal end 1100 of a catheter 1102 having a fluid infusion side 1104 and a fluid aspiration side 1106 and including a length 1101, a width 1103, and a depth 1105. The terminal end 1100 includes an elongated body 1108 having a wall 1110 (FIG. 11C) defining an outer surface 1112 and one or more elongated aspiration lumens. In the illustrative example of FIG. 11, the wall 1110 defines a single, centrally positioned aspiration lumen 1114 in fluid communication with a corresponding aspiration conduit 1116 (FIG. 11A) of the catheter 1102. A plurality of aspiration openings 1118 are spaced along the length of the elongated body 1108 communicating from the aspiration lumen 1114 to the outer surface 1112 through the wall 1110. The wall 1110 further defines one or more elongated infusion lumens. In the illustrative example of FIG. 11, the wall defines two infusion lumens 1120 extending parallel to the aspiration lumen 1114 in fluid communication with corresponding infusion conduits 1122 (one shown in FIG. 11A) of the catheter 1102. A plurality of infusion openings 1124 are spaced along the length of the elongated body 1108 communicating from the infusion lumens 1120 to the outer surface 1112 through the wall 1110. In the illustrative example of FIG. 11, the infusion openings 1124 are oriented approximately 90 degrees relative to the aspiration openings 1118.

[00110] A barrier 1126 is attached to the outer surface 1112 of the elongated body 1108 adjacent the aspiration openings 1118. In the illustrative example of FIG. 11, the elongated body 1108 is “D”-shaped with a flat side. The barrier 1126 is attached to the flat

side along the length of the elongated body 1108 and is configured to lie in a plane with the elongated body 1108 projecting outwardly from it. The barrier 1126 includes openings 1128 aligned with and in fluid communication with the aspiration openings 1118 to allow fluid flow from adjacent the barrier surface into the aspiration lumen. The barrier 1126 is fluid resistant and separates the fluid aspiration side 1106 from the fluid infusion side 1104 of the terminal end 1100. In the illustrative example of FIG. 11, the barrier is a fluid impermeable polyurethane membrane.

[00111] A diffuser 1130 is attached to the outer surface 1112 of the elongated body 1108 opposite the barrier 1126. In the illustrative example of FIG. 11, the diffuser 1130 conforms to the curved surface of the elongated body 1108 and is attached to the barrier 1126. The infusion openings 1124 communicate with the diffuser 1130. In the illustrative example of FIG. 11, the diffuser is a woven polyester fabric that wicks treatment fluid throughout the diffuser via capillary action.

[00112] The infusion side 1104 of the terminal end 1100 infuses treatment fluid into a treatment site while the aspiration side 1106 aspirates fluid away from a treatment site. The barrier 1126 prevents fluid flow directly from the infusion openings 1124 to the aspiration openings 1118. The barrier 1126 also isolates patient tissues on the aspiration side 1106 from treatment fluid delivered by the infusion side 1104.

[00113] In the illustrative example of FIG. 11, the catheter 1102 has a larger diameter than the elongated body 1108 and defines a step 1134 between them. This change in diameter facilitates removal of the terminal end 1100 by withdrawal through an opening in the patient's body sized for the catheter 1102. Pulling on the catheter 1102 to extract the

terminal end 1100 from the treatment site tends to cause the terminal end 1100 to collapse behind the step 1134 for easier passage through the tissue opening.

[00114] FIG. 11D illustrates the terminal end 1100 placed in tissue 1140 that has been disrupted during a surgical procedure. The infusion side 1104 is oriented toward tissues to be treated with treatment fluid and the aspiration side 1106 is oriented toward an area to be drained and/or isolated from treatment fluid such as a nerve root 1142. In use, for example, the infusion conduits 1122 of the catheter are attached to a source of treatment fluid and the aspiration conduit 1116 is attached to a vacuum source. Treatment fluid flows along the infusion lumens 1120 and out through the infusion openings 1124 where it enters the diffuser and is wicked throughout the diffuser and into contact with tissues adjacent to the infusion side 1104 of the terminal end of the catheter. Body fluids and excess treatment fluid flow through the aspiration openings 1118, into the aspiration lumen 1114, and out through the aspiration conduit 1116. The tissue 1140 is treated while the nerve 1142 is protected from the treatment fluid and the surgical wound is drained.

[00115] FIGS. 12A-C depict a terminal end 1200 of a catheter 1202 similar to that of FIG. 11 but having an additional member 1204 covering the diffuser 1130. In the illustrative embodiment of FIGS. 12A-C, the member 1204 conforms closely to the diffuser 1130 to separate the diffuser from surrounding tissue to prevent tissue from adhering to the diffuser. The member 1204 may be in the form of a tissue growth inhibiting membrane. For example, the member 1204 may be a fluid impermeable polyurethane membrane. The member 1204 is perforated with a plurality of holes 1206 to permit fluid dispersed through the diffuser to exit the terminal end 1200.

[00116] The embodiment of FIGS. 12A-C further includes projections 1208 creating a textured surface to improve fluid flow through adjacent openings. The projections prevent adjacent tissue from pressing against and sealing the openings. In the illustrative example, the projections are a plurality of bumps alternating with openings aspiration openings 1128 to improve drainage from the surgical site. However, the projections 1208 may be distributed across the surface in a two-dimensional pattern or elsewhere on the terminal end 1200 to improve fluid flow. The projections may be molded integrally with the surface, adhered to the surface, formed by deforming the surface, deposited, cast, and/or otherwise formed. For example, the projections 1208 may be formed by depositing a liquid compound and causing it to cure into a solid polymer such as a UV curable adhesive.

[00117] FIG. 13 illustrates an example of how the infusion and aspiration conduits 1122, 1116 may be configured for insertion through tissues adjacent a treatment site in an inside-out placement method. A trocar 1300 includes a leading end with a sharpened tip 1302 for penetrating tissue and a hollow trailing end 1304 for receiving the catheter 1102. The trailing end 1304 includes a tubular outer wall 1306 defining an opening 1308 at an end opposite the tip 1302. The aspiration and infusion conduits 1122, 1116 are received through the opening 1306 into the trailing end. The trocar 1300 and catheter 1102 remain joined by friction until a sufficiently large force is applied to overcome friction or the end of the catheter 1102 is cut.

[00118] FIG. 14 illustrates an alternate configuration for passing the catheter 1102. A trocar 1400 includes a leading end with a sharpened tip 1402 for penetrating tissue and a trailing end 1404 including first and second barbs 1406, 1408. The first barb 1406 is sized for

insertion into the aspiration conduit 1122 in tight friction fitting relationship. The second barb 1408 is hollow with an interior bore 1410 sized to receive the infusion conduits 1116.

[00119] FIG. 15 illustrates a catheter 1102 and a passing configuration similar to the prior examples. However, in the example of FIG. 15 the infusion conduits 1116 are inserted into an infusion common line 1520 in fluid communicating relationship and sealed to the common line 1520 such as with, for example, a UV curable potting adhesive as is commonly used with medical fluid tubing. This arrangement reduces the number of infusion conduits 1116 that must be connected to an infusion apparatus and eliminates the need for a separate "Y"-connector by providing a single, common line 1520 that can be connected. The trocar 1510 includes a leading end with a sharpened tip 1512 for penetrating tissue and a hollow trailing end 1514 for receiving the aspiration conduit 1122 and common line 1520.

[00120] FIG. 16 depicts a terminal end 1600 of a catheter 1602. The terminal end 1600 includes fluid conduits 1604, 1606 that curve in an elliptical path and transport fluid to or from openings 1608 on the interior of the elliptical path. A barrier 1610 receives the fluid and distributes it along a textured surface. In the illustrative example of FIG. 16, the texture is provided by grooves 1612 formed into the barrier 1610. The grooves 1612 aid in fluid flow by wicking fluid across the fluid impervious barrier 1610 surface. The fluid might otherwise be blocked by abutment of patient tissues. The barrier 1610 surface may be textured by stamping, knurling, roughening, and/or by other suitable means. The barrier surface may also be textured by forming raised lines, bumps, ridges, and/or other suitable features. The barrier surface may be textured by adhering a textile to the surface. For example a network of fibers may be adhered to the surface so that fluids may wick across the surface. Each of the various examples of terminal ends described herein have a length, a

width, and a depth. The length of the terminal end may vary over a broad range to suit a variety of treatment sites. For example, the length may range from a few millimeters to tens of centimeters. In particular, the length may range from 1 to 30 centimeters. More particularly the length may range from 5 to 20 centimeters. The width of the terminal end may vary over a broad range to suit a variety of treatment sites. For example, the width may range from a few millimeters to tens of centimeters. In particular, the width may range from 0.5 to 30 centimeters. More particularly the width may range from 1 to 15 centimeters. The depth of the terminal end may vary over a broad range to suit a variety of treatment sites. For example, the depth may range from a fractions of a millimeter to tens of millimeters. In particular, the depth may range from 0.5 to 20 millimeters. More particularly the depth may range from 0.5 to 10 millimeters.

[00121] A treatment kit may be provided including one or more catheters according to various aspects of the invention. Optionally the kit may include an introducer. Optionally the kit may include an infusion source. Optionally the kit may include a drainage container.

CLAIMS

What is claimed is:

1. An infusion catheter for delivering treatment fluid to a treatment site of a patient, the catheter comprising:

a first elongated fluid infusion conduit having a sidewall, the first conduit defining a fluid path from a location outside of the patient to the treatment site, the first conduit being flexible and defining an infusion portion having at least one opening communicating from the interior of the conduit to the exterior of the conduit through the sidewall, the infusion portion defining a non-linear first shape in its free state such that it tends to return to the first shape after being distorted into a second shape, the first shape defining a generally planar repeating back and forth two-dimensional pattern having a first directional axis corresponding to the pattern length and a second directional axis corresponding to the pattern width.

2. The catheter of claim 1 wherein the first shape comprises:

a generally straight first portion that crosses the length axis generally perpendicular to the length axis;

a generally straight second portion, generally parallel to the first portion, which also crosses the length axis generally perpendicular to the length axis;

a generally straight third portion generally parallel to the second portion which also crosses the length axis generally perpendicular to the length axis;

a first bend connecting the first portion to the second portion; and

a second bend connecting the second portion to the third portion.

3. The catheter of claim 2 wherein the at least one opening is located only in the generally straight portions and not in the bends.
4. The catheter of claim 3 wherein the at least one opening comprises a plurality of openings in each straight portion.
5. The catheter of claim 1 wherein the at least one opening is generally parallel to the generally planar two-dimensional pattern.
6. The catheter of claim 1 wherein the first shape has a generally planar first side and a generally planar second side opposite the first side, the at least one opening communicating through the sidewall between the first and second sides to expel fluid generally parallel to the first and second sides.
7. The catheter of claim 2 wherein the conduit has a transverse conduit dimension transverse to the conduit, the spacing between adjacent portions in the original non-linear shape being between 1 and 100 times the transverse conduit dimension.
8. The catheter of claim 7 wherein the spacing between adjacent portions in the original non-linear shape is between 1 and 20 times the transverse conduit dimension.
9. The catheter of claim 8 wherein the spacing between adjacent portions in the original non-linear shape is between 2 and 5 times the transverse conduit dimension.
10. The catheter of claim 1 wherein the first shape comprises a serpentine shape comprising a regular repeating pattern of two or more curvilinear segments.
11. The catheter of claim 1 wherein the first shape comprises a continuous path of differently shaped curvilinear segments that are bounded by a perimeter defined by the length and width of the pattern.

12. The catheter of claim 11 wherein the segments are generally spaced equal distances from one another.
13. The catheter of claim 11 wherein the perimeter is generally rectangular.
14. The catheter of claim 11 wherein the perimeter is generally elliptical.
15. The catheter of claim 1 further comprising:
 - a second elongated fluid evacuation conduit having a sidewall and defining an evacuation portion having at least one opening communicating from the exterior of the conduit to the interior of the conduit through the sidewall, the second conduit defining a fluid path from the treatment site to a location outside of the patient.
16. The catheter of claim 15 wherein the second catheter extends beyond a terminal end of the first catheter, the first conduit defining a proximal infusion portion and the second conduit defining a distal evacuation portion.
17. The catheter of claim 16 wherein the first and second conduits are arranged coaxially with the second conduit inside of the first conduit in the proximal infusion portion, the catheter including alternating generally straight portions and bends, the generally straight portions being generally perpendicular to the length axis, the evacuation portion bending back in a direction generally perpendicular to the straight portions to underlie the infusion portion.
18. The catheter of claim 16 wherein the first and second conduits are arranged coaxially with the second conduit inside of the first conduit in the proximal infusion portion, the catheter including alternating generally straight portions and bends, the generally straight portions being generally perpendicular to the length axis, the evacuation

portion bending back in a direction generally parallel to the straight portions to underlie the infusion portion.

19. An infusion catheter for delivering treatment fluid to a treatment site of a patient, the catheter comprising:

a plurality of fluid infusion conduits each having a sidewall, each conduit defining a fluid path from a location outside of the patient to the treatment site, each conduit being flexible and defining an infusion portion having at least one opening communicating from the interior of the conduit to the exterior of the conduit through the sidewall, each infusion portion defining a first shape in its free state such that it tends to return to the first shape after being distorted into a second shape, the plurality of conduits being in fluid communication at a first end such that fluid delivered to the first end is distributed to the plurality of infusion portions.

20. The catheter of claim 19 wherein the first shape is selected from the group of shapes consisting of arcs, helixes, serpentine patterns, and polygons.

21. An infusion catheter for delivering treatment fluid to a treatment site of a patient, the catheter comprising:

a fluid infusion conduit having a sidewall and defining a fluid path from a location outside of the patient to the treatment site, the conduit being flexible and defining an infusion portion having at least one opening communicating from the interior of the conduit to the exterior of the conduit through the sidewall, the infusion portion having a non-linear first shape in its free state such that it tends to return to the first shape after being distorted into a second shape, the first shape defining a generally planar spiral coil having a plurality of loops of diminishing size.

22. The catheter of claim 21 wherein the coil has a generally planar first coil side and a generally planar second coil side, the conduit defining a groove formed on a first edge of the conduit and a mating tongue formed on an opposite edge of the conduit such that the when the conduit is in the first, coiled shape the tongue engages the groove to define a barrier between the loops to impede fluid flow from the first coil side to the second coil side.

23. A treatment kit for delivering treatment fluid to a treatment site of a patient, the catheter comprising:

a catheter having a first elongated fluid infusion conduit having a sidewall, the first conduit defining a fluid path from a location outside of the patient to the treatment site, the first conduit being flexible and defining an infusion portion having at least one opening communicating from the interior of the conduit to the exterior of the conduit through the sidewall, the infusion portion defining a non-linear first shape in its free state such that it tends to return to the first shape after being distorted into a second shape, the first shape defining a generally planar repeating back and forth two-dimensional pattern having a first directional axis corresponding to the pattern length and a second directional axis corresponding to the pattern width; and

an introducer defining a lumen through which the conduit can pass when the conduit is distorted into the second shape.

24. A method for delivering treatment fluid to a treatment site of a patient, the method comprising:

providing a catheter having a first elongated fluid infusion conduit having a sidewall, the first conduit defining a fluid path, the first conduit being flexible and

defining an infusion portion having at least one opening communicating from the interior of the conduit to the exterior of the conduit through the sidewall, the infusion portion defining a non-linear first shape in its free state such that it tends to return to the first shape after being distorted into a second shape, the first shape defining a generally planar repeating back and forth two-dimensional pattern having a first directional axis corresponding to the pattern length and a second directional axis corresponding to the pattern width;

placing the infusion portion at a treatment site of the patient; and

delivering treatment fluid through the infusion portion to the treatment site.

25. The method of claim 24 wherein placing the infusion portion comprises:

separating tissue layers at the treatment site to create a space between the tissue layers;

placing the non-linear portion of the catheter in the space between the tissue layers; and

transporting fluid to the space between the tissue layers.

26. The method of claim 24 wherein the two-dimensional pattern has a predetermined shape conforming to the margins of the treatment site.

27. The method of claim 24 wherein placing the infusion portion comprises:

distorting the infusion portion into the second shape;

placing the infusion portion at the treatment site; and

allowing the infusion portion to return to the first shape.

28. The method of claim 24 wherein placing the infusion portion comprises:

inserting an introducer from outside the patient into the treatment site, the introducer defining a lumen;

inserting the infusion portion through the lumen and into the treatment site by straightening the infusion portion as it passes through the lumen.

29. The method of claim 24 wherein placing the infusion portion comprises:

inserting an introducer from outside the patient into the treatment site, the introducer defining a lumen;

inserting the infusion portion through the lumen and into the treatment site by folding the infusion portion into a compact configuration as it passes through the lumen.

30. The method of claim 24 wherein placing the infusion portion comprises:

placing the infusion portion at the treatment site to cover a non-linear treatment area;

passing a trocar attached to the first conduit through the skin of the patient; and

passing an end of the first conduit through the skin of the patient.

31. The method of claim 24 wherein placing the infusion portion comprises placing the

infusion portion at the treatment site to cover a non-linear treatment area; and

delivering treatment fluid comprises delivering pain relieving medication.

32. The method of claim 24 wherein the catheter further comprises a second elongated

fluid evacuation conduit having a sidewall and defining an evacuation portion having

at least one opening communicating from the exterior of the conduit to the interior of the conduit through the sidewall, the method further comprising:

placing the evacuation portion at the treatment site.

33. A catheter capable of transporting fluid between a treatment site of a patient and a location outside of the patient, the catheter comprising:

a connection end locatable outside of the patient;

an elongated fluid conduit; and

a terminal end locatable at the treatment site, the conduit defining a fluid path between the connection end and the terminal end, the terminal end comprising:

a first fluid exchange portion having a wall defining an outer surface and an inner lumen in fluid communication with the conduit, the first fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall; and

a barrier connected to and extending from the first fluid exchange portion, the barrier being resistant to fluid flow, the first fluid exchange portion and the barrier cooperating to bias fluid flow in a preferential direction or to impede fluid flow in a non-preferential direction.

34. The catheter of claim 33 further comprising a second fluid exchange portion, the barrier being connected to the second fluid exchange portion, the barrier forming a connecting bridge between the first and second fluid exchange portions.

35. The catheter of claim 34 wherein the barrier spaces the first and second fluid exchange portions in a predetermined pattern.

36. The catheter of claim 33 wherein the barrier is removably secured to the terminal end.
37. The catheter of claim 33 wherein the barrier comprises a fluid resistant structure.
38. The catheter of claim 33 wherein the barrier comprises a fluid absorbing structure.
39. The catheter of claim 33 wherein the barrier comprises a resorbable material.
40. The catheter of claim 33 wherein the barrier comprises a fluid resistant sheet-like structure connected to the first fluid exchange portion and extending outwardly from the first fluid exchange portion to define a fluid resistant area adjacent the fluid exchange portion.
41. The catheter of claim 40 wherein the barrier comprises a thin polymeric film.
42. The catheter of claim 33 wherein the fluid exchange portion has a first configuration and a second configuration into which it may be modified, the first configuration defining a larger planar area than the second configuration.
43. The catheter of claim 33 wherein the wall has an outer transverse width dimension and the barrier has a width dimension parallel to the wall width dimension, the barrier width being between 1 and 100 times the wall width.
44. The catheter of claim 43 wherein the barrier width is between 2 and 20 times the wall width.
45. The catheter of claim 43 wherein the barrier width is between 2 and 5 times the wall width.
46. A catheter capable of transporting fluid between a treatment site of a patient and a location outside of the patient, the catheter comprising:
 - a connection end locatable outside of the patient;
 - an elongated fluid conduit; and

a terminal end locatable at the treatment site, the conduit defining a fluid path between the connection end and the terminal end, the terminal end comprising:

a first fluid exchange portion having an elongated tubular wall defining an outer surface and an inner lumen in fluid communication with the conduit, the first fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall; and

a barrier connected to the elongated wall and extending on opposing sides of the elongated wall in the form of a generally planar sheet having a first barrier surface and a second barrier surface, the at least one opening being in fluid communication with one of the first barrier surface and the second barrier surface, the barrier and at least one opening cooperating to bias fluid exchange adjacent one of the barrier surfaces and impede fluid exchange adjacent the other of the barrier surfaces.

47. The catheter of claim 46 wherein the tubular wall comprises a "D"-shaped cross section having a flat side, the first barrier surface being attached to the flat side with the elongated body projecting outwardly from the first barrier surface.
48. The catheter of claim 14 wherein the at least one opening comprises a plurality of openings in the flat side and the barrier comprises holes aligned with and in fluid communication with the plurality of openings such that the inner lumen is in fluid communication with the second barrier surface.

49. The catheter of claim 48 wherein the barrier comprises a fluid impermeable polymer membrane.
50. The catheter of claim 46 wherein the terminal end further comprises a length generally parallel to the elongated tubular wall and the first and second barrier surfaces, a width generally transverse to the elongated tubular wall and generally parallel to the first and second barrier surfaces, and a depth generally transverse to the elongated tubular wall and the first and second barrier surfaces, the length being in the range of 1 to 30 centimeters, the width being in the range of 0.5 to 30 centimeters, and the depth being in the range of may range of 0.05 to 20 millimeters
51. The catheter of claim 46 wherein the elongated fluid conduit and the terminal end define a junction between them, an elongated fluid conduit portion of the junction having a first junction outer transverse dimension and a terminal end portion of the junction having a second junction outer transverse dimension, the first junction dimension being larger than the second junction dimension.
52. The catheter of claim 51 wherein the elongated fluid conduit and the terminal end form a step between them.
53. The catheter of claim 52 wherein the barrier is collapsible behind the step to facilitate passage of the barrier through patient tissues at the treatment site.
54. The catheter of claim 46 further comprising a plurality of fluid exchange portions each in fluid communication with the conduit, the plurality of fluid exchange portions being arranged in a palmate pattern having a central fluid exchange portion and a plurality of fluid exchange portions extending outwardly from the central fluid exchange portion.

55. A catheter capable of transporting fluid between a treatment site of a patient and a location outside of the patient, the catheter comprising:
- a connection end locatable outside of the patient;
 - an elongated fluid conduit; and
 - a terminal end locatable at the treatment site, the conduit defining a fluid path between the connection end and the terminal end, the terminal end comprising:
 - a fluid exchange portion having an elongated tubular wall defining an outer surface and an inner lumen in fluid communication with the conduit, the fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall; and
 - a generally planar member connected to the elongated wall and extending outwardly on opposing sides of the elongated wall, the member being positionable between tissue layers at the treatment site and being operable to collect fluid from the treatment site and conduct it to the first fluid exchange portion.
56. A catheter capable of transporting fluid between a treatment site of a patient and a location outside of the patient, the catheter comprising:
- a connection end locatable outside of the patient;
 - an elongated fluid conduit; and
 - a terminal end locatable at the treatment site, the conduit defining a fluid path between the connection end and the terminal end, the terminal end comprising:

a fluid exchange portion having an elongated tubular wall defining an outer surface and an inner lumen in fluid communication with the conduit, the fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall; and a generally planar member connected to the elongated wall and extending outwardly on opposing sides of the elongated wall, the member being positionable between tissue layers at the treatment site and being operable to receive treatment fluid from the fluid exchange portion and disperse the treatment fluid to the treatment site.

57. A method of transporting fluid between a treatment site of a patient and a location outside of the patient, the method comprising:

providing a catheter having a connection end locatable outside of the patient, an elongated fluid conduit, and a terminal end locatable at the treatment site, the conduit defining a fluid path between the connection end and the terminal end, the terminal end comprising, a first fluid exchange portion having a wall defining an outer surface and an inner lumen in fluid communication with the conduit, the first fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall, and a barrier connected to and extending from the first fluid exchange portion; placing the terminal end at the treatment site; and positioning the barrier to bias fluid flow at the treatment site in a preferential direction or to impede fluid flow in a non-preferential direction.

58. A method of delivering fluid to a treatment site of a patient, the method comprising:

providing a catheter having a connection end locatable outside of the patient, an elongated fluid conduit, and a terminal end locatable at the treatment site, the conduit defining a fluid path between the connection end and the terminal end, the terminal end comprising, a first fluid exchange portion having a wall defining an outer surface and an inner lumen in fluid communication with the conduit, the first fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall, and a barrier connected to and extending from the first fluid exchange portion; placing the terminal end at the treatment site with the at least one opening directed to deliver fluid to a target location; and positioning the barrier to shield non-target locations from the fluid.

59. A method of removing fluid from a treatment site of a patient, the method comprising:

providing a catheter having a connection end locatable outside of the patient, an elongated fluid conduit, and a terminal end locatable at the treatment site, the conduit defining a fluid path between the connection end and the terminal end, the terminal end comprising, a first fluid exchange portion having a wall defining an outer surface and an inner lumen in fluid communication with the conduit, the first fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall, and a barrier connected to and extending from the first fluid exchange portion; placing the terminal end at the treatment site with the at least one opening directed to remove fluid from a target location; and

positioning the barrier to shield non-target locations from fluid removal.

60. A method of delivering anesthetic to body tissue adjacent a nerve and simultaneously draining body fluids at a treatment site of a patient, the method comprising:
- providing a first anesthetic infusion catheter having a fluid delivery end;
 - providing a second drainage catheter having a terminal end, the terminal end comprising a fluid exchange portion having a wall defining an outer surface and an inner lumen, the fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall, and a barrier connected to and extending from the first fluid exchange portion;
 - placing the delivery end of the first catheter at the treatment site adjacent the body tissue;
 - placing the terminal end of the second catheter at the treatment site with the at least one opening directed toward the nerve and the barrier between the body tissues undergoing treatment and the nerve;
 - delivering anesthetic to the body tissue via the first catheter;
 - impeding the flow of anesthetic toward the nerve with the barrier;
 - draining body fluid from the treatment site through the at least one opening.

61. A method of removing fluid from a treatment site of a patient, the method comprising:
- providing a catheter having a terminal end including a fluid exchange portion having an elongated tubular wall defining an outer surface and an inner lumen, the fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall; and a generally planar

- member connected to the elongated wall and extending outwardly on opposing sides of the elongated wall;
- positioning the member between tissue layers at the treatment site;
- conducting fluid from the treatment site along the surface of the member to the fluid exchange portion; and
- removing fluid from the treatment site through the fluid exchange portion.
62. A method of delivering fluid to a treatment site of a patient, the method comprising:
- providing a catheter having a terminal end including a fluid exchange portion having an elongated tubular wall defining an outer surface and an inner lumen, the fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall; and a generally planar member connected to the elongated wall and extending outwardly on opposing sides of the elongated wall;
- positioning the member between tissue layers at the treatment site;
- delivering fluid to through the fluid exchange portion to the member; and
- dispersing the fluid at the treatment with the member.
63. A catheter capable of transporting fluid between a treatment site of a patient and a location outside of the patient, the catheter comprising:
- a connection end locatable outside of the patient;
- an elongated fluid conduit; and
- a terminal end locatable at the treatment site, the conduit defining a fluid path between the connection end and the terminal end, the terminal end comprising:

a first fluid exchange portion having a wall defining an outer surface and an inner lumen in fluid communication with the conduit, the first fluid exchange portion having at least one opening communicating between the inner lumen and the outer surface of the wall;

a diffuser having a surface and a network channels in fluid communication with the first fluid exchange portion and the diffuser surface; and

a barrier adjacent to the diffuser, the barrier being resistant to fluid flow, the diffuser and the barrier cooperating to bias fluid flow in a preferential direction.

64. The catheter of claim 63 wherein the diffuser is attached to the terminal end.

65. The catheter of claim 64 wherein the barrier is attached to the diffuser.

66. The catheter of claim 63 wherein the diffuser is operable to wick fluid between the first fluid exchange portion and the diffuser surface.

67. The catheter of claim 63 wherein the diffuser includes a fibrous structure defining the channels.

68. The catheter of claim 67 wherein the diffuser includes a fabric.

69. The catheter of claim 68 wherein the fabric is a woven fabric.

70. The catheter of claim 63 wherein the diffuser includes a textured surface defining the channels.

71. The catheter of claim 63 wherein the diffuser includes a sponge defining the channels.

72. The catheter of claim 63 wherein the barrier includes a fluid impervious member.

73. The catheter of claim 63 wherein the barrier includes a polymer film.

74. A catheter capable of transporting fluid between a treatment site of a patient and a location outside of the patient, the catheter comprising:
- a connection end locatable outside of the patient;
 - an elongated first fluid conduit; and
 - a terminal end locatable at the treatment site, the conduit defining a fluid path between the connection end and the terminal end, the terminal end comprising:
 - a plurality of second fluid conduits in fluid communication with the first fluid conduit;
 - a flexible sheet-like member connected to the plurality of second fluid conduits, the member having a first surface and an opposite second surface, the first surface being in fluid communication with the second fluid conduits.
75. The catheter of claim 74 wherein the second fluid conduits are operable to deliver fluid to the first surface.
76. The catheter of claim 74 wherein the second fluid conduits are operable to remove fluid from the first surface.
77. The catheter of claim 74 wherein the second fluid conduits project outwardly from the first surface.
78. The catheter of claim 74 wherein the second fluid conduits include a shape memory material tending to return to a preset first shape after being deformed into a second shape and the flexible sheet-like member connects the second fluid conduits in a predetermined spatial relationship.

79. The catheter of claim 20 wherein the flexible sheet-like member connects the second fluid conduits in a palmate configuration.
80. The catheter of claim 74 wherein the first surface is fluid resistant such that fluid delivered to the first surface flows over the surface.
81. The catheter of claim 74 wherein the first surface includes a wicking material operable to wick fluid delivered to the first surface over the surface.
82. The catheter of claim 82 wherein the flexible sheet like member includes at least one opening between the first and second surfaces and the flexible sheet is operable to wick fluid between and over the first and second surfaces
83. The catheter of claim 74 wherein the flexible sheet like member includes a laminate structure having a porous layer and a non-porous layer adjacent one another.
84. A catheter capable of transporting fluid between a treatment site of a patient and a location outside of the patient, the catheter comprising:
a first elongated fluid conduit;
a second elongated fluid conduit; and
a terminal end locatable at the treatment site, the first conduit defining a fluid path to the terminal end and the second conduit defining a fluid path from the terminal end, the terminal end comprising:
a first fluid exchange portion defining a first outer surface and a first inner lumen in fluid communication with the first conduit, the first fluid exchange portion having at least one opening communicating between the first inner lumen and the first outer surface; and

a second fluid exchange portion defining a second outer surface and a second inner lumen in fluid communication with the second conduit, the second fluid exchange portion having at least one opening communicating between the second inner lumen and the second outer surface.

85. The catheter of claim 46 wherein the terminal end further comprises a barrier, the barrier having a first barrier surface and an opposing second barrier surface, the first inner lumen being in fluid communication with the first barrier surface and the second inner lumen being in fluid communication with the second barrier surface, the catheter being operable to simultaneously deliver fluid to the first barrier surface and remove fluid from the second barrier surface.
86. The catheter of claim 85 further comprising a diffuser in fluid communication with the barrier.
87. The catheter of claim 86 wherein the diffuser is attached to the barrier adjacent the first barrier surface.
88. The catheter of claim 86 wherein the first and second fluid exchange portions share a common housing defining the first inner lumen, the second inner lumen, the first outer surface, and the second outer surface.
89. The catheter of claim 88 wherein the common housing comprises a “D”-shaped cross section having a flat side and a curved side, the first barrier surface being attached to the flat side with the common housing projecting outwardly from the first barrier surface and the diffuser being attached to the curved side in fluid communication with the first barrier surface.

90. The catheter of claim 89 wherein the at least one opening in communication with the second inner lumen comprises a plurality of openings in the flat side and the barrier comprises holes aligned with and in fluid communication with the plurality of openings such that the inner lumen is in fluid communication with the second barrier surface.
91. The catheter of claim 48 wherein the barrier comprises a fluid impermeable polymer membrane.
92. The catheter of claim 91 wherein the terminal end further comprises a length generally parallel to the common housing and the first and second barrier surfaces, a width generally transverse to the common housing and generally parallel to the first and second barrier surfaces, and a depth generally transverse to the common housing and the first and second barrier surfaces, the length being in the range of 1 to 30 centimeters, the width being in the range of 0.5 to 30 centimeters, and the depth being in the range of may range of 0.05 to 20 millimeters
93. The catheter of claim 91 wherein the elongated fluid conduits are contained in a multi-lumen conduit, the multi-lumen conduit and the terminal end defining a junction between them, a multi-lumen conduit portion of the junction having a first junction outer transverse dimension and a terminal end portion of the junction having a second junction outer transverse dimension, the first junction dimension being larger than the second junction dimension.
94. The catheter of claim 51 wherein the multi-lumen conduit and the terminal end form a step between them.

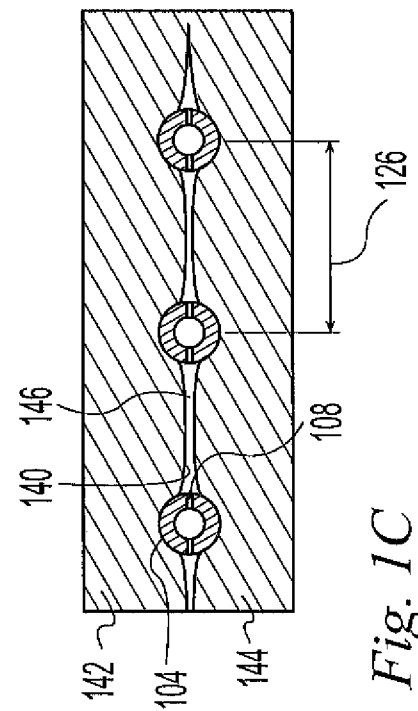
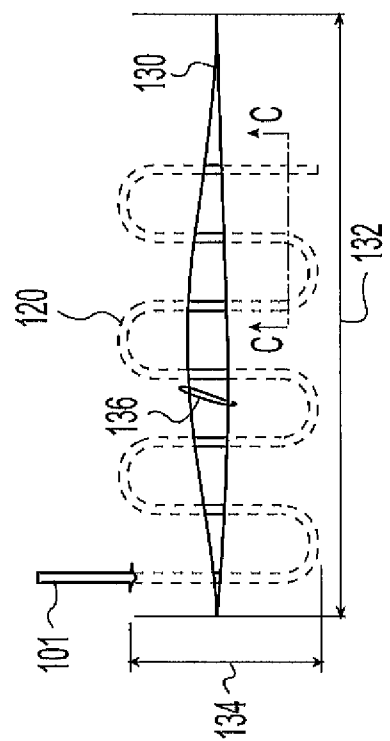
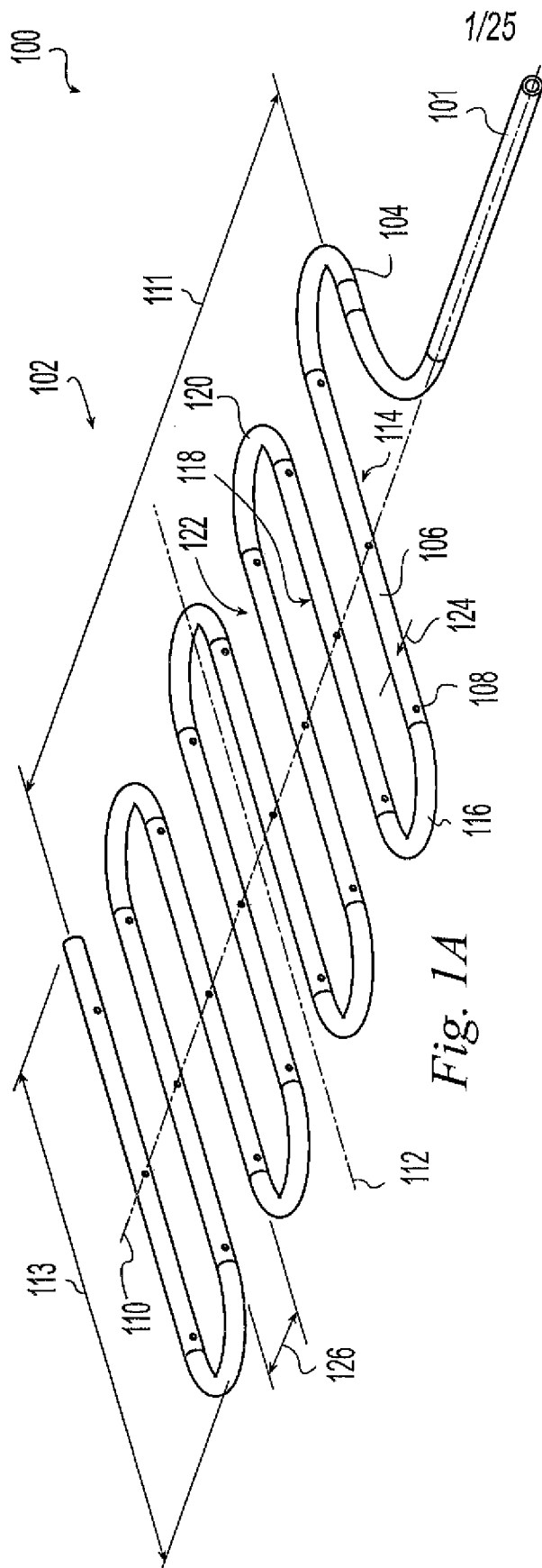
95. The catheter of claim 52 wherein the barrier and diffuser are collapsible behind the step to facilitate passage of the terminal end through patient tissues at the treatment site.
96. A method of transporting fluid between a treatment site of a patient and a location outside of the patient, the method comprising:
- providing a catheter having a first elongated fluid conduit; a second elongated fluid conduit; and a terminal end locatable at the treatment site, the first conduit defining a fluid path to the terminal end and the second conduit defining a fluid path from the terminal end, the terminal end comprising: a first fluid exchange portion defining a first outer surface and a first inner lumen in fluid communication with the first conduit, the first fluid exchange portion having at least one opening communicating between the first inner lumen and the first outer surface; and a second fluid exchange portion defining a second outer surface and a second inner lumen in fluid communication with the second conduit, the second fluid exchange portion having at least one opening communicating between the second inner lumen and the second outer surface;
- and a barrier having a first barrier surface and an opposing second barrier surface, the first inner lumen being in fluid communication with the first barrier surface and the second inner lumen being in fluid communication with the second barrier surface;
- placing the terminal end at the treatment site;
- positioning the barrier to bias fluid flow at the treatment site to impede fluid flow in a non-preferential direction; and

operating the catheter to deliver fluid to the first barrier surface.

97. The method of claim 96 further comprising operating the catheter to remove fluid from the second barrier surface.

98. The method of claim 96 wherein the catheter further comprises a diffuser in fluid communication with the first barrier surface, the method further comprising:
wicking fluid via the diffuser to treat a surface area of tissues at the treatment site.

99. The method of claim 98 wherein the elongated fluid conduits are contained in a multi-lumen conduit, the multi-lumen conduit and the terminal end defining a junction between them, a multi-lumen conduit portion of the junction having a first junction outer transverse dimension and a terminal end portion of the junction having a second junction outer transverse dimension, the first junction dimension being larger than the second junction dimension, the multi-lumen conduit and the terminal end forming a step between them, the method further comprising:
collapsing the barrier and diffuser behind the step to facilitate passage of the terminal end through patient tissues at the treatment site.



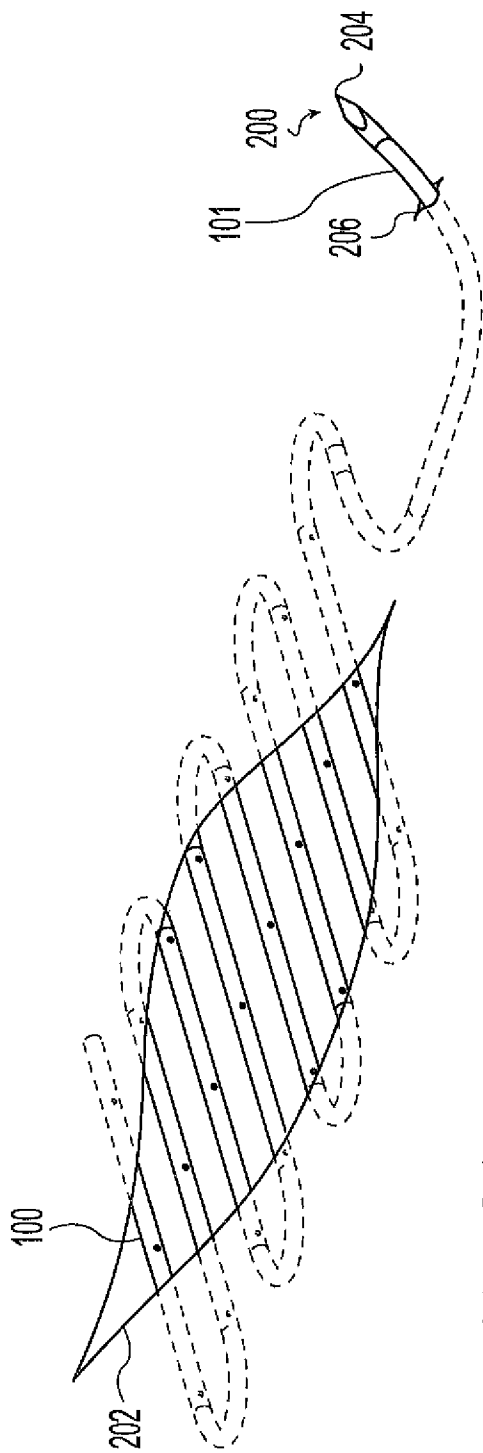


Fig. 2A

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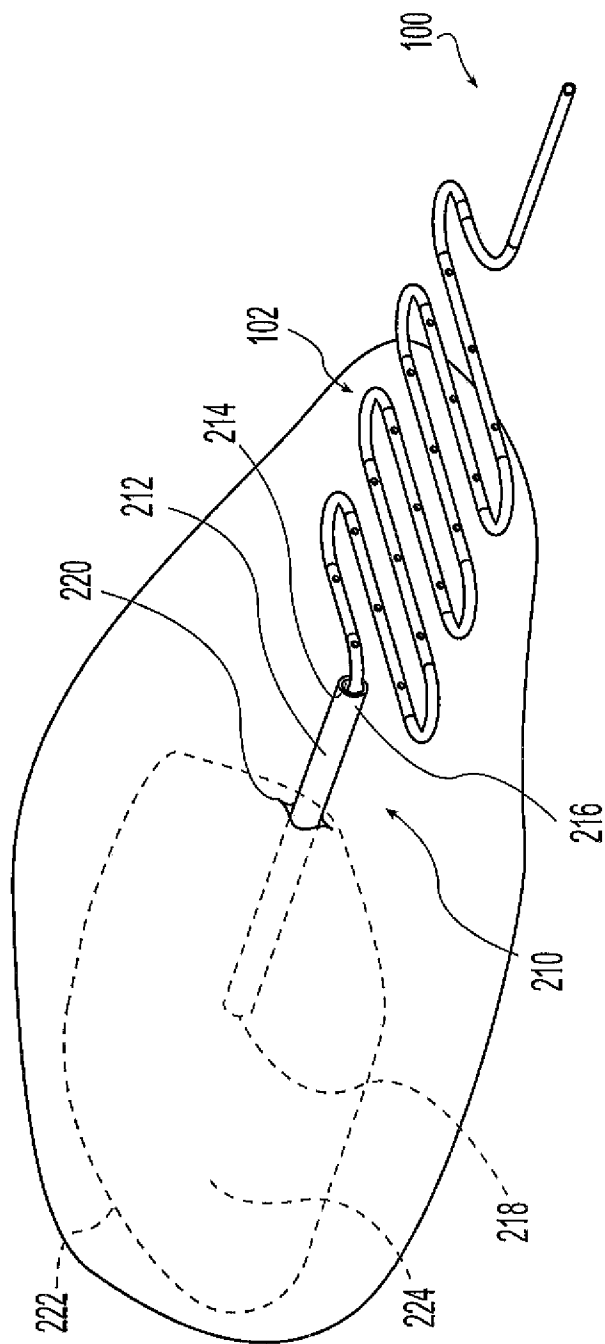


Fig. 2B

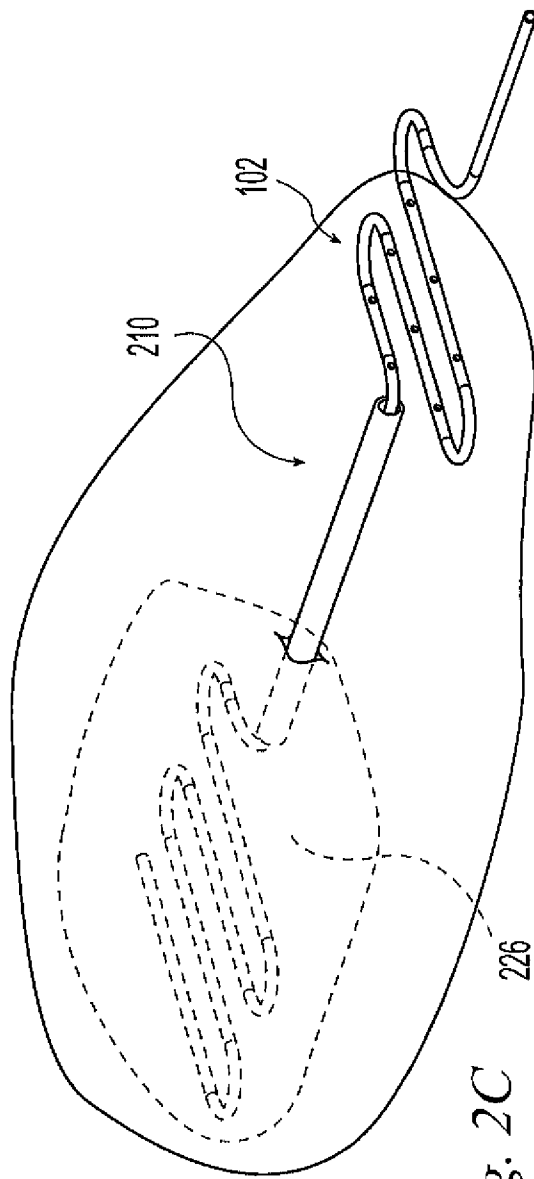


Fig. 2C

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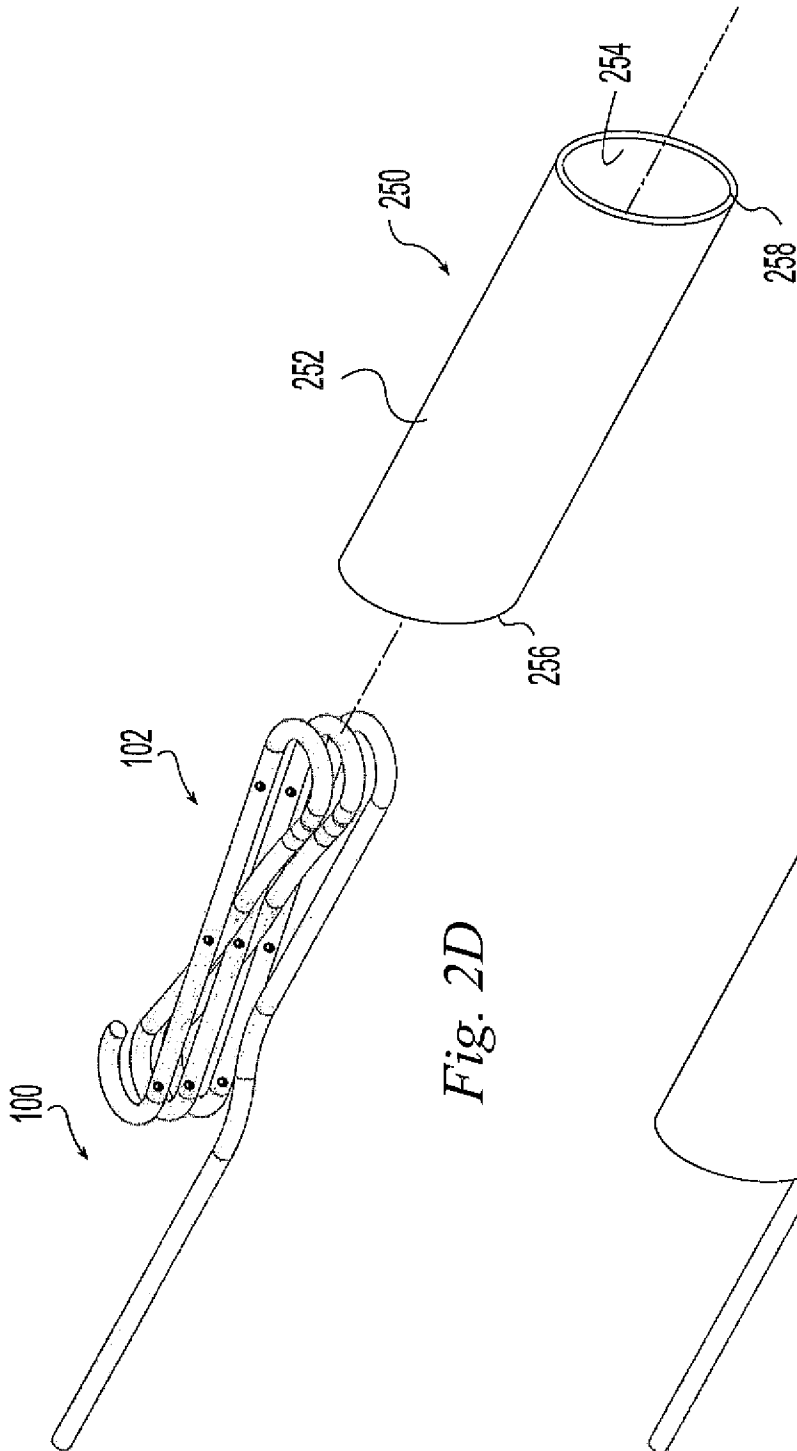


Fig. 2D

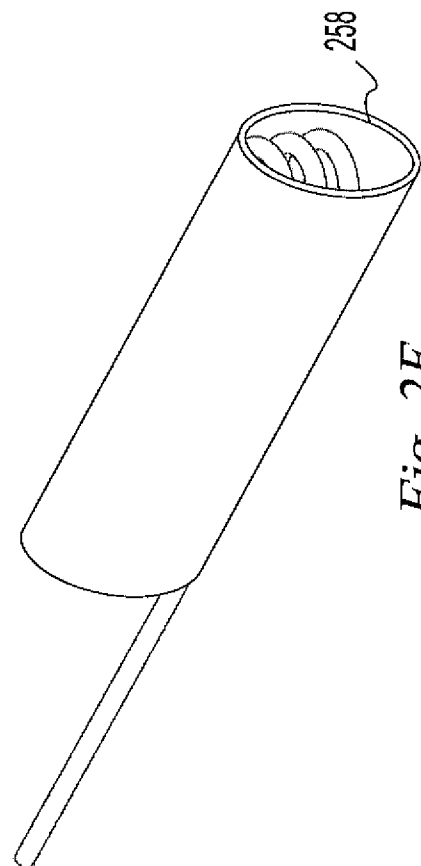
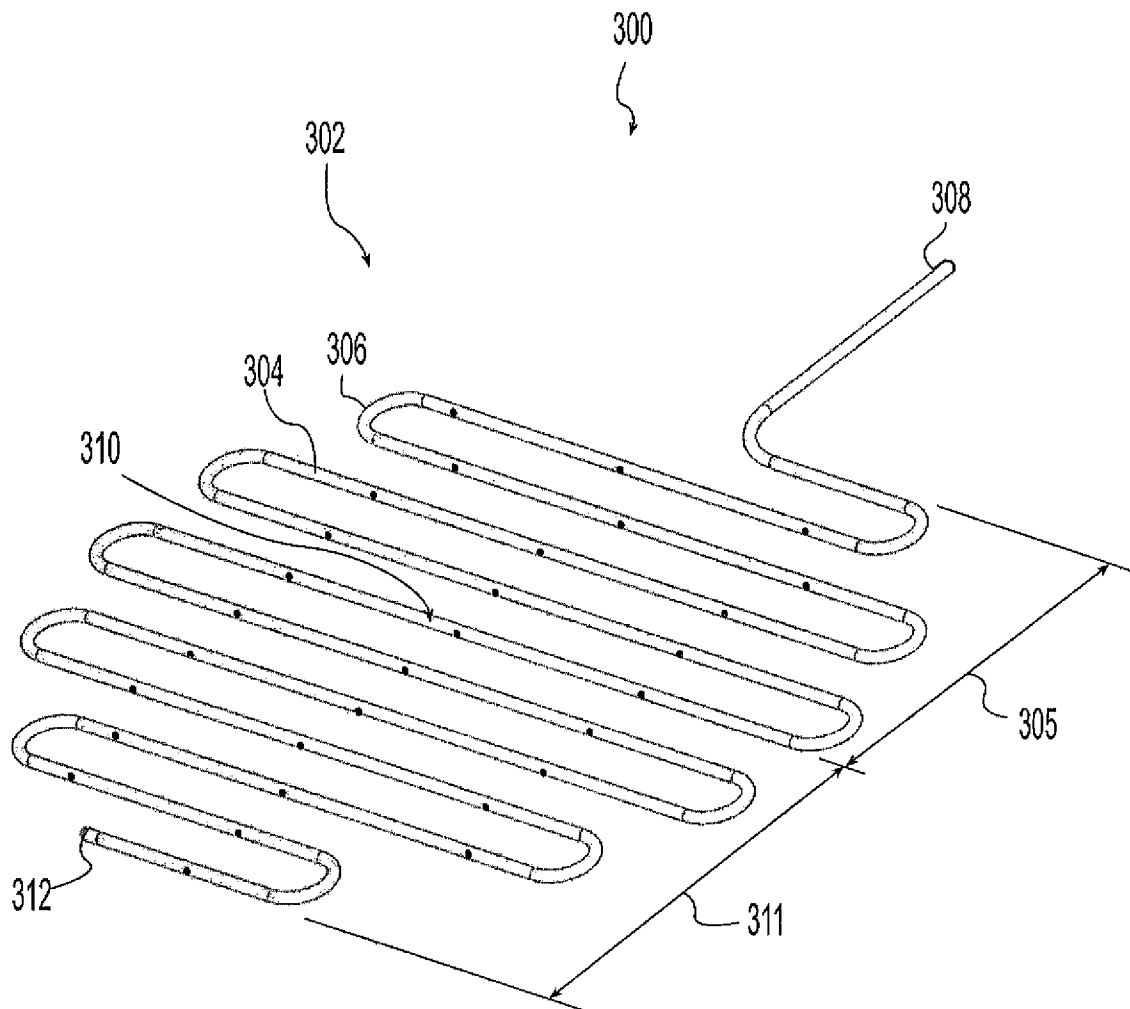


Fig. 2E

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*Fig. 3A*

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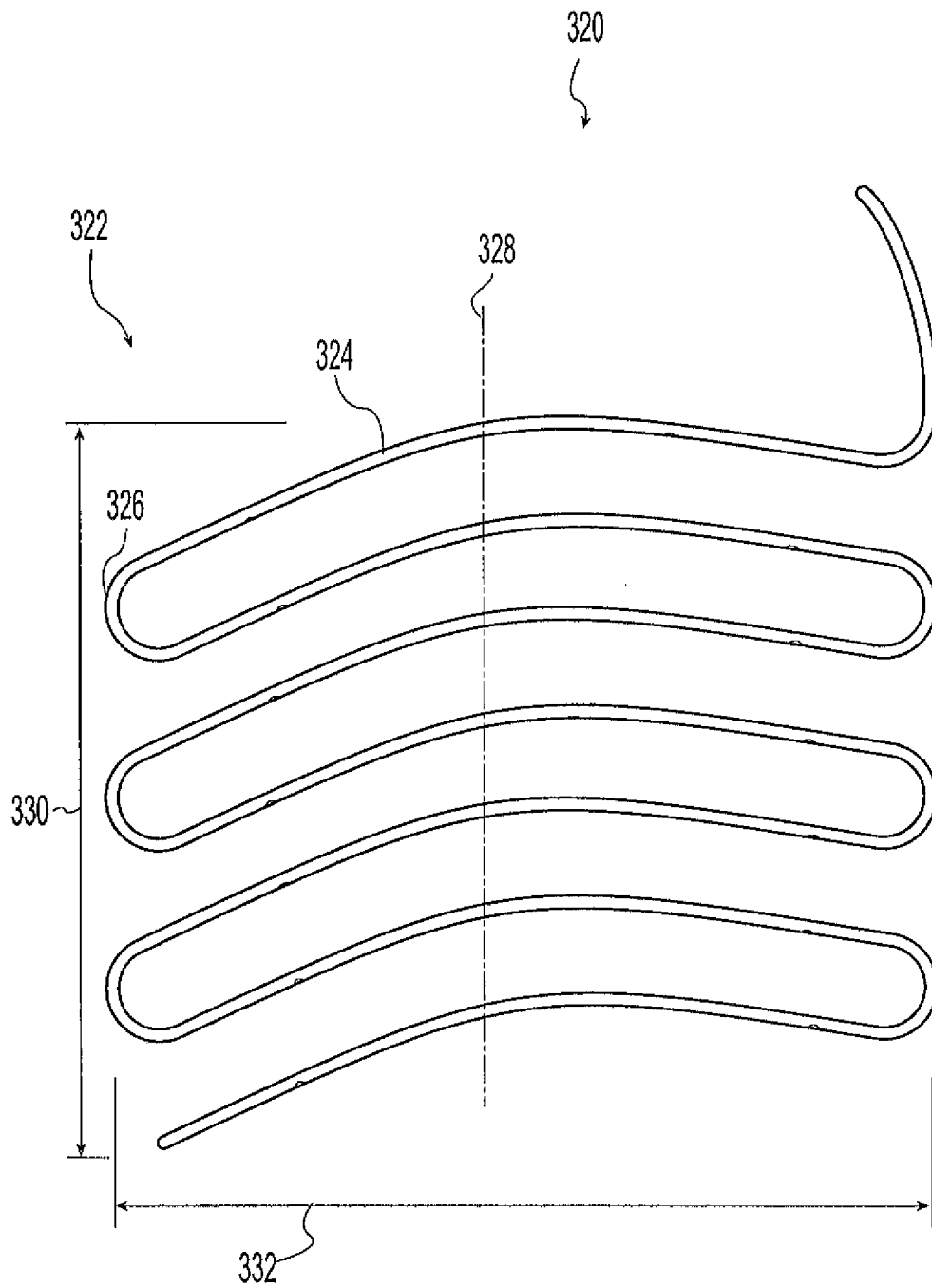
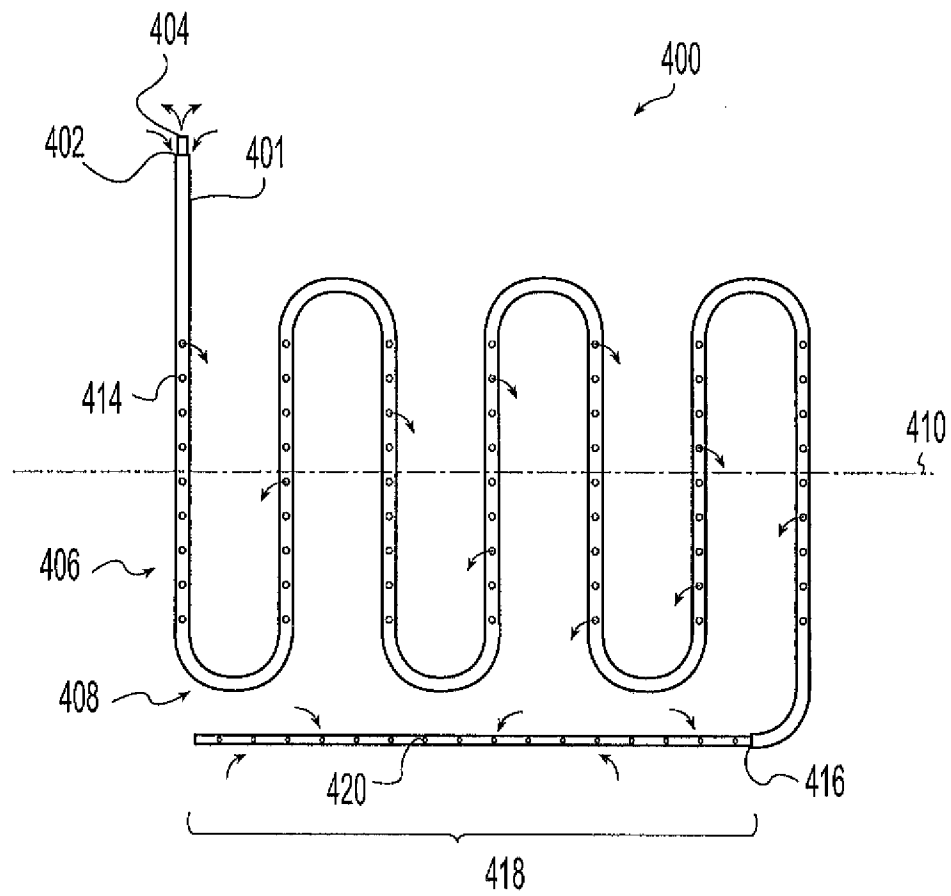
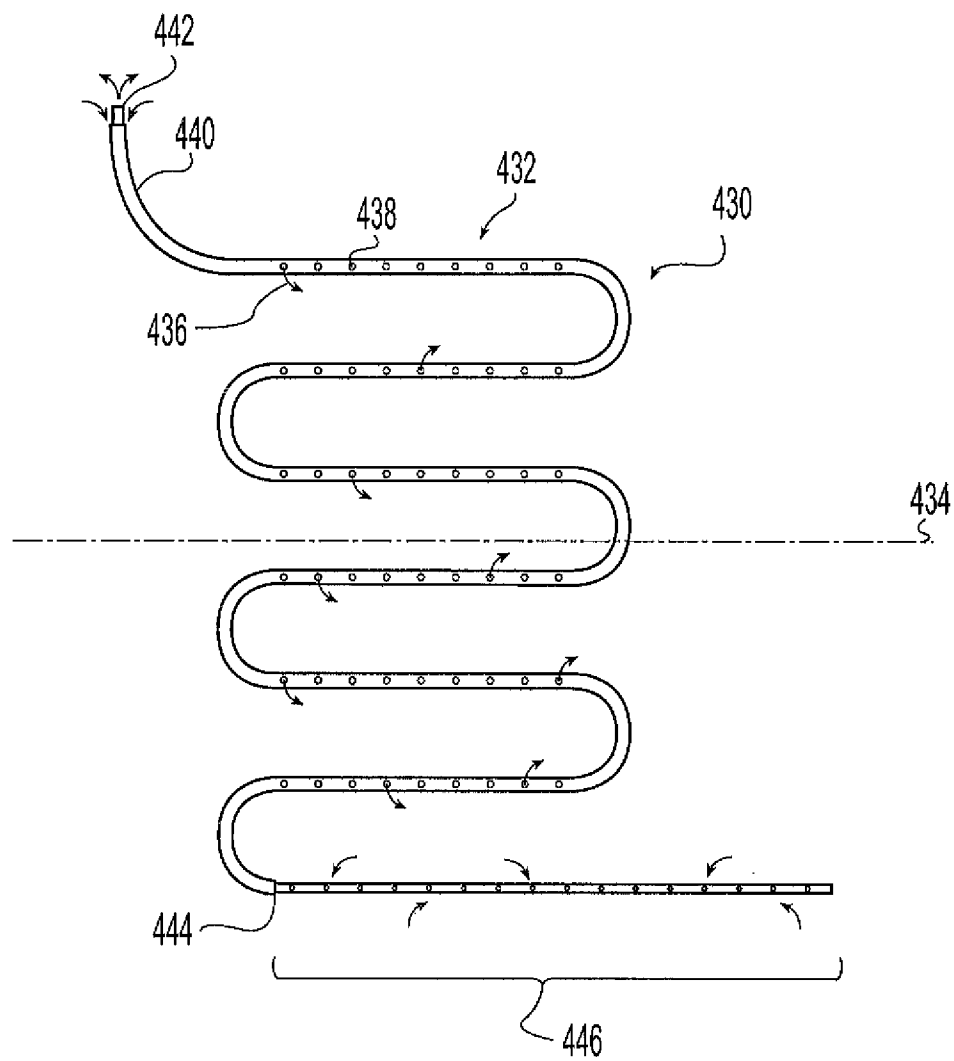


Fig. 3B

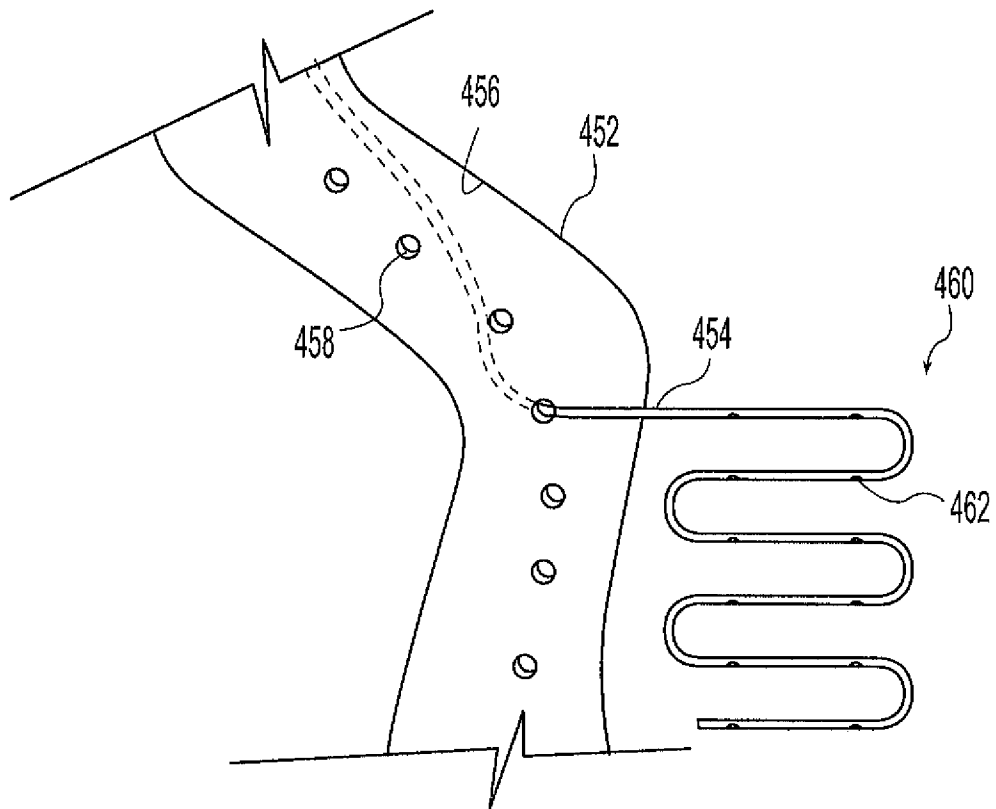
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*Fig. 4A*

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*Fig. 4B*

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*Fig. 4C*

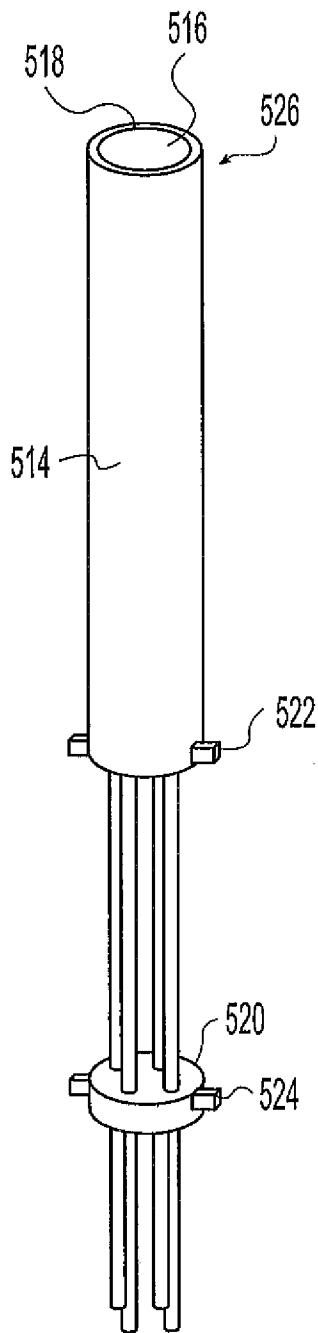


Fig. 5A

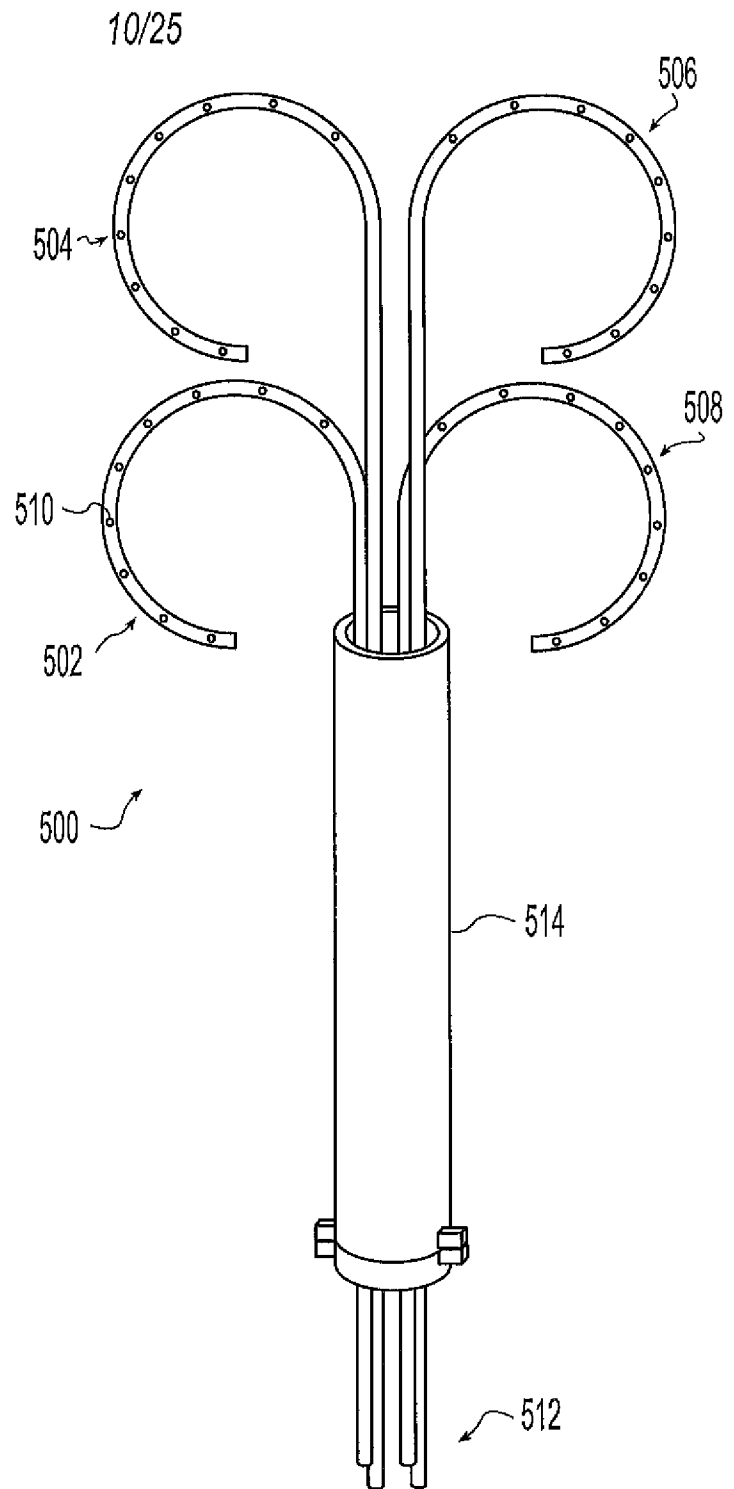


Fig. 5B

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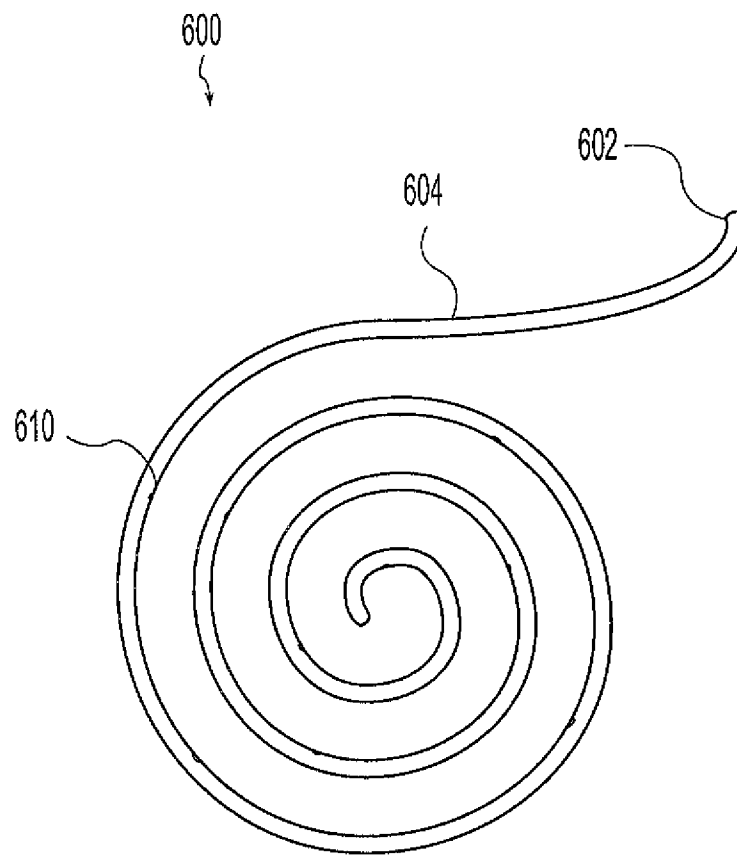


Fig. 6A

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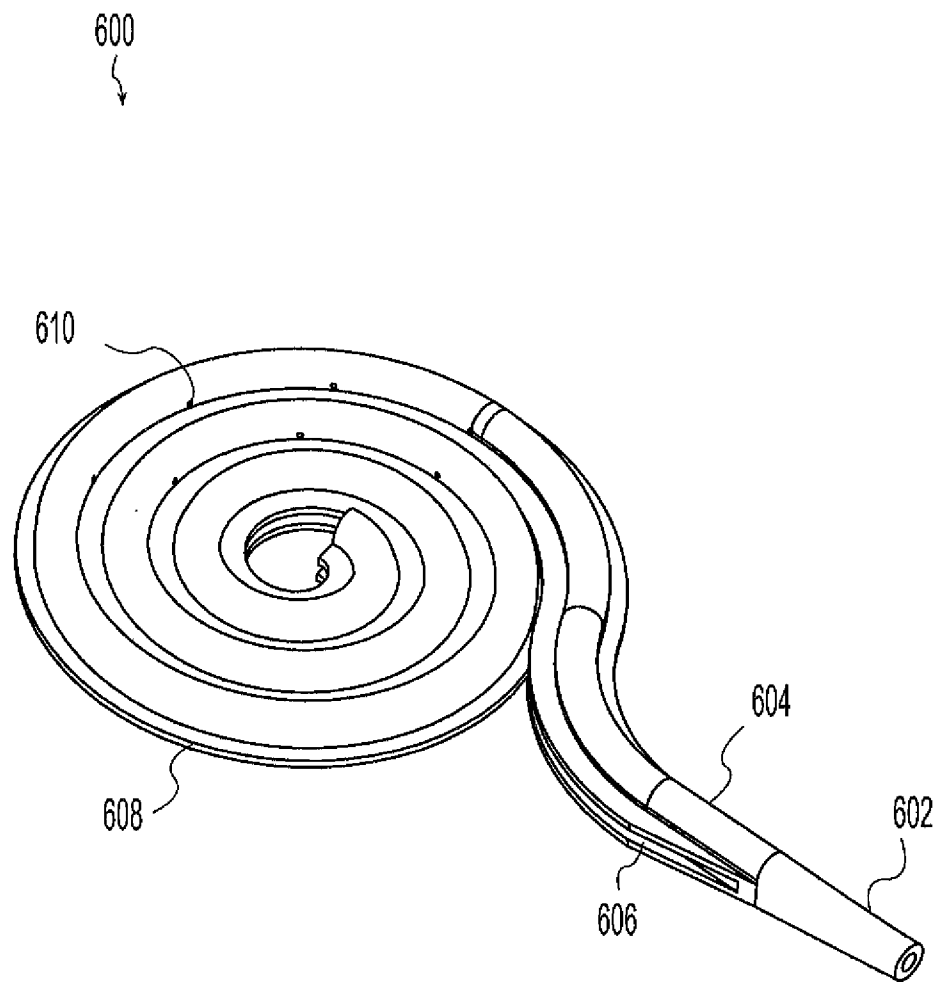
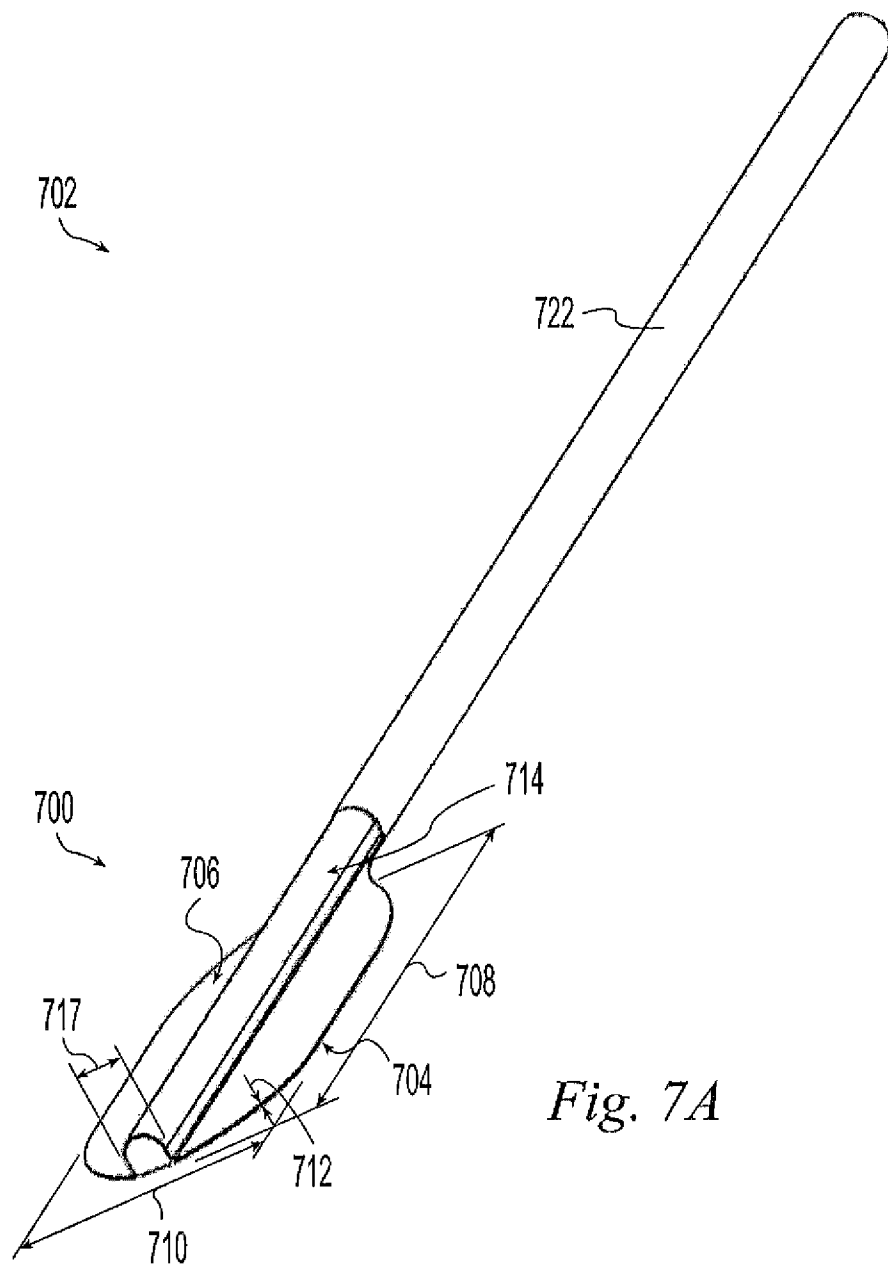
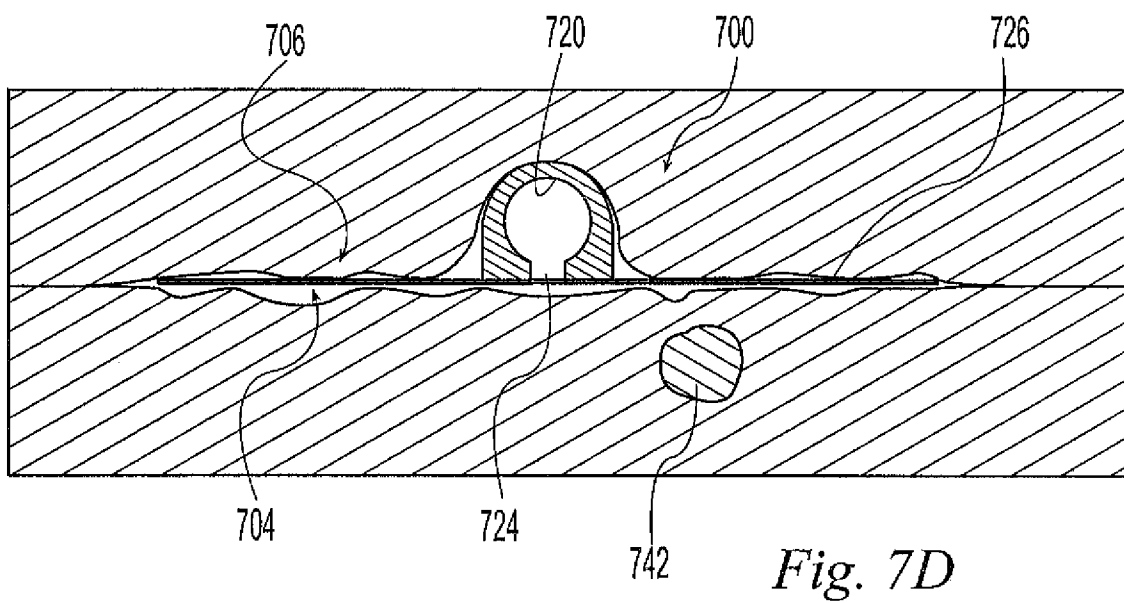
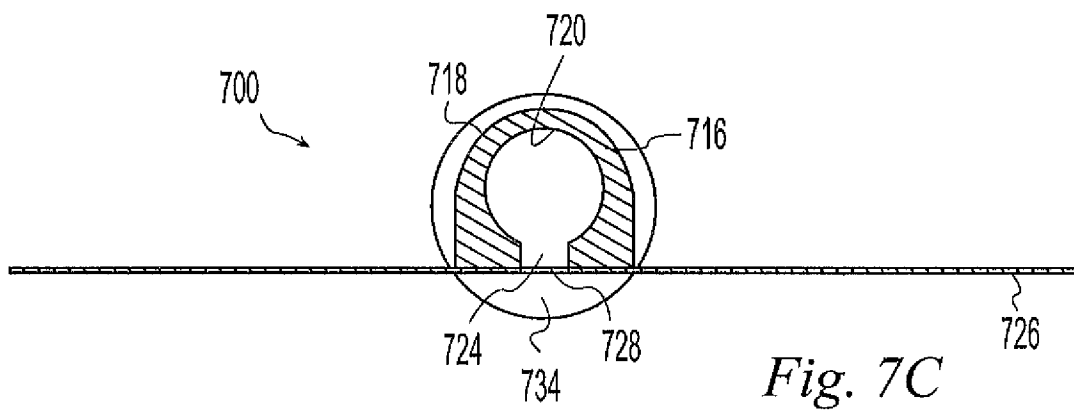
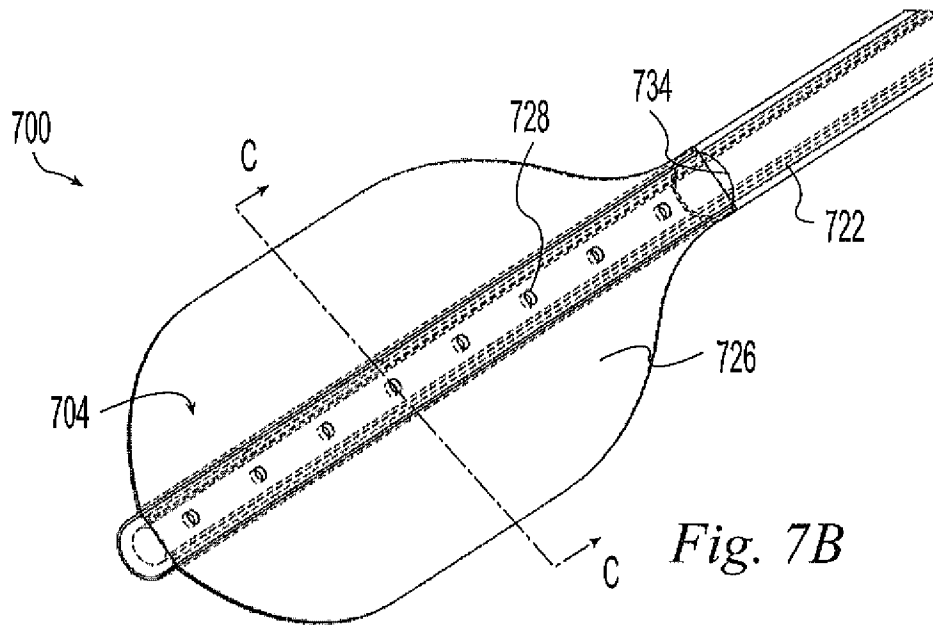


Fig. 6B

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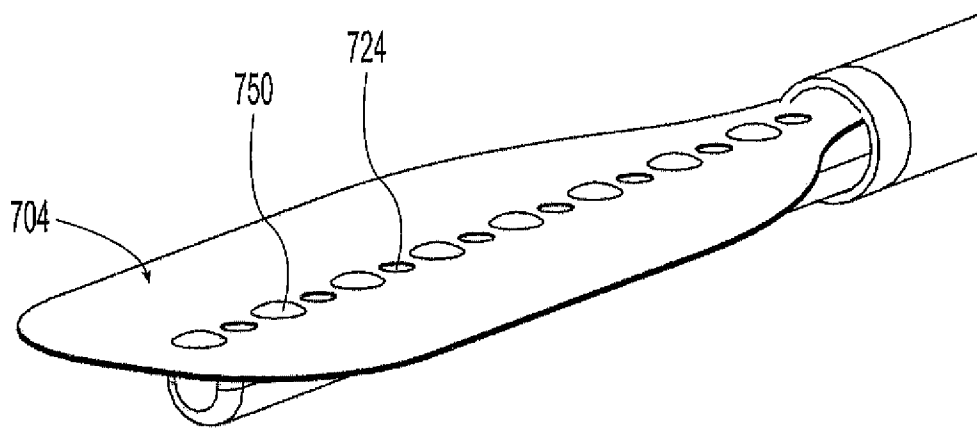


Fig. 7E

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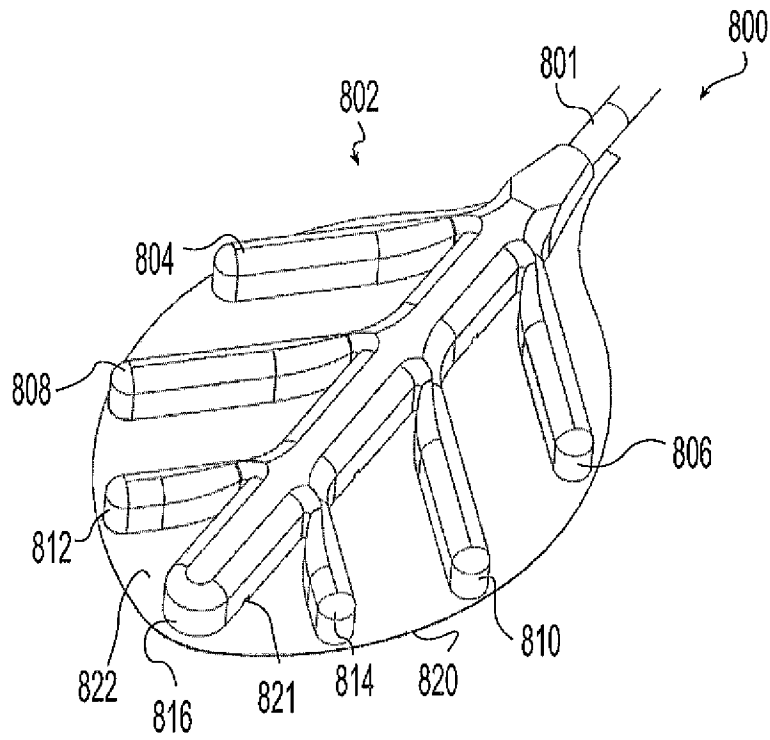


Fig. 8A

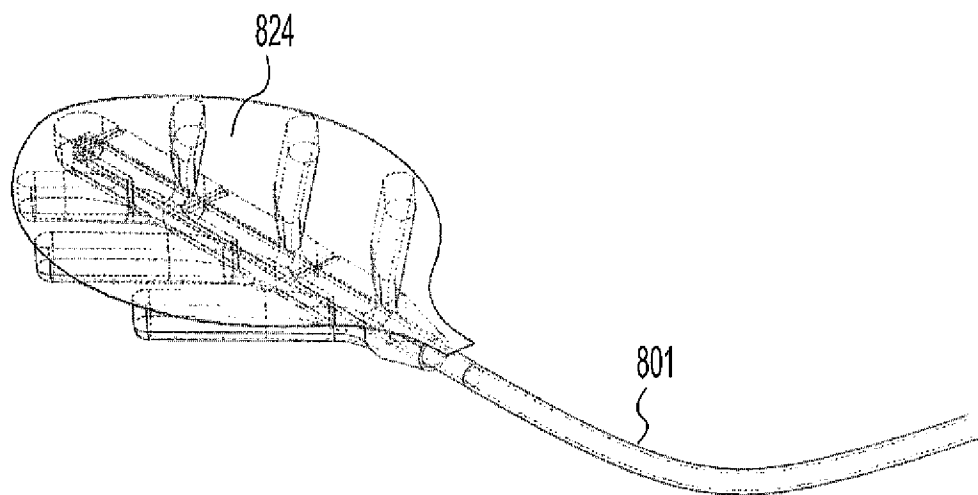
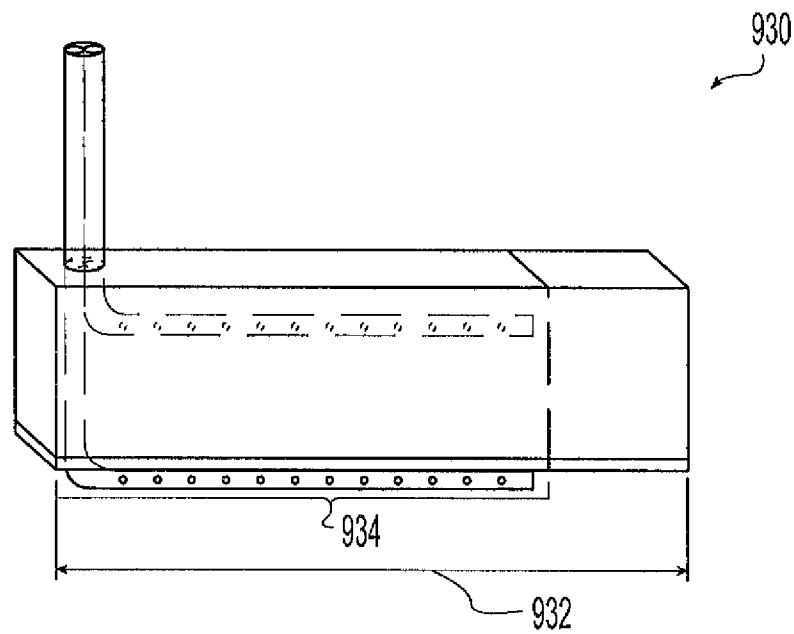
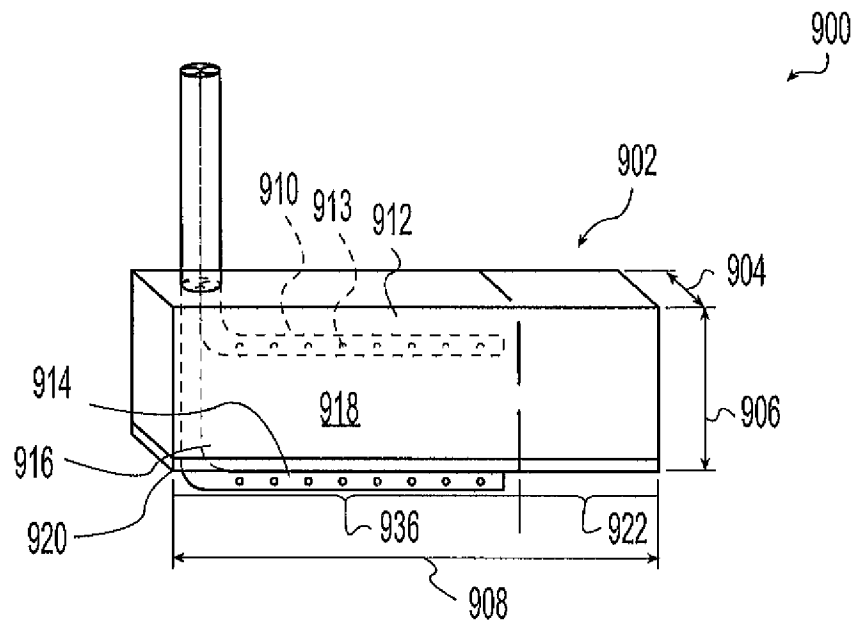


Fig. 8B

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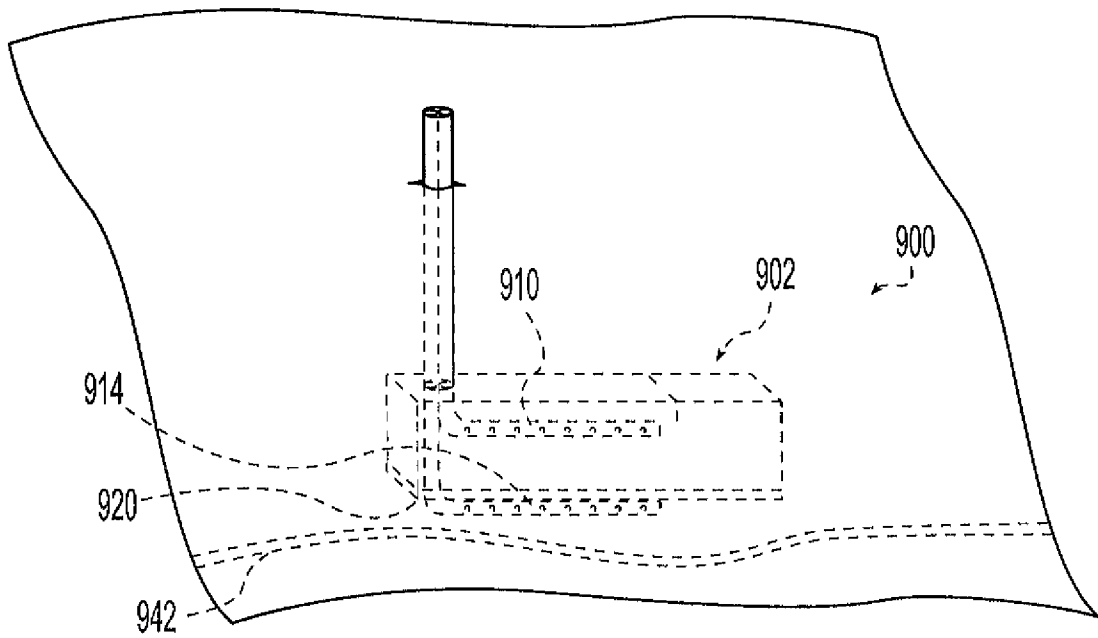


Fig. 9C

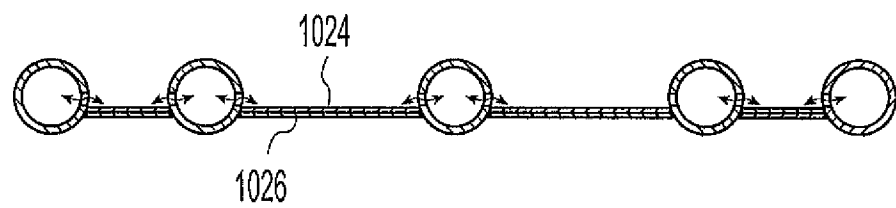
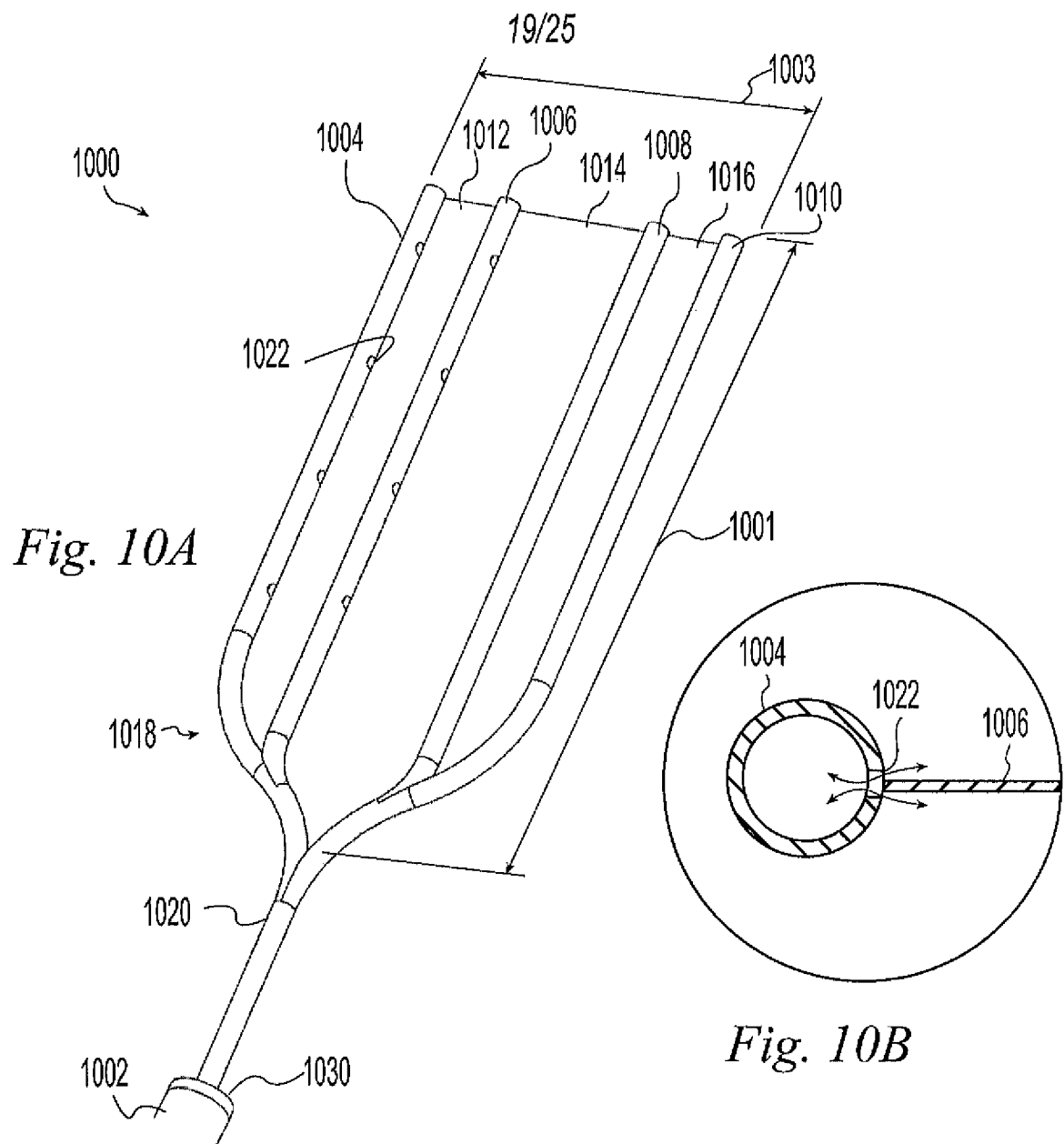
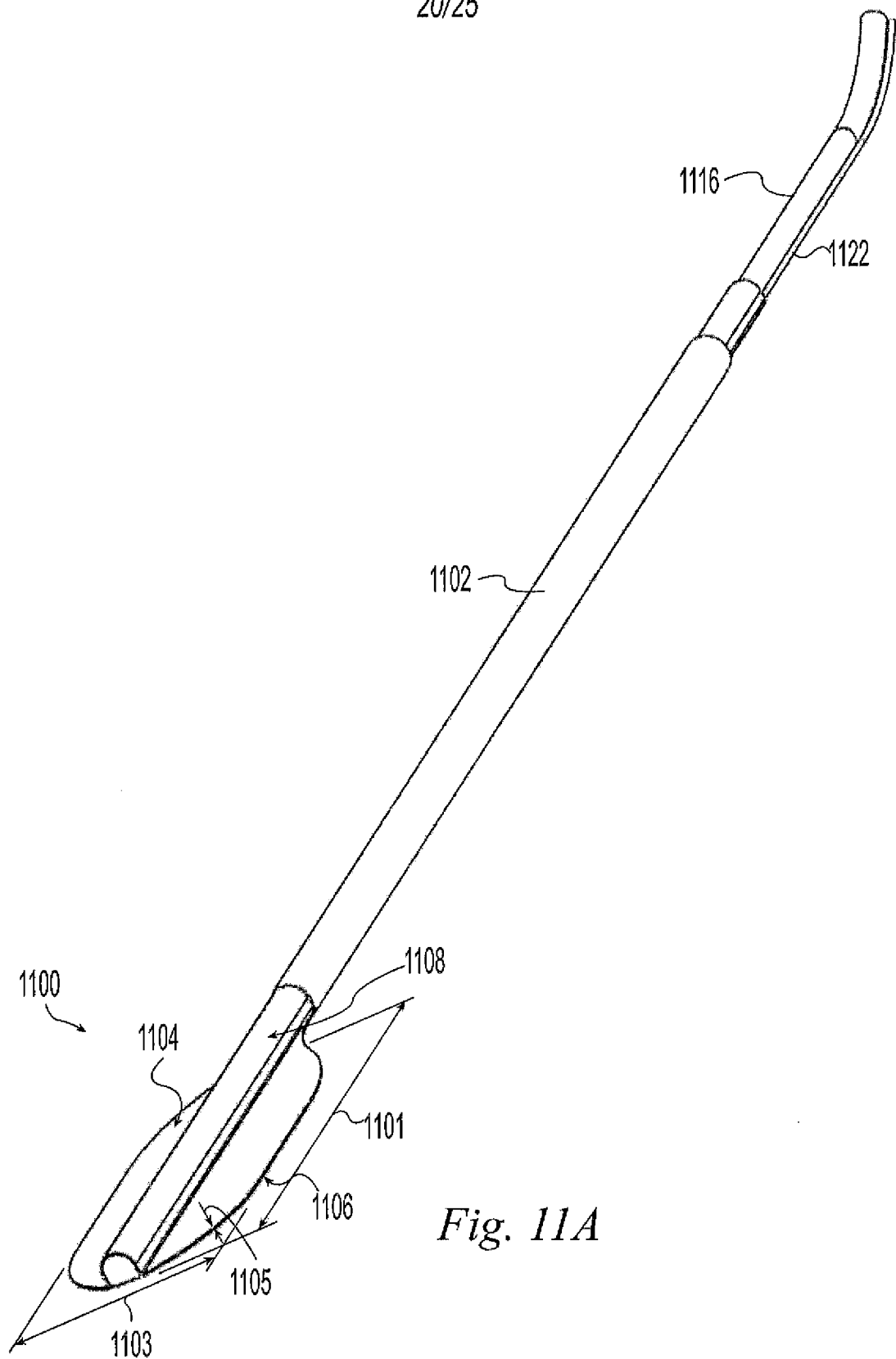
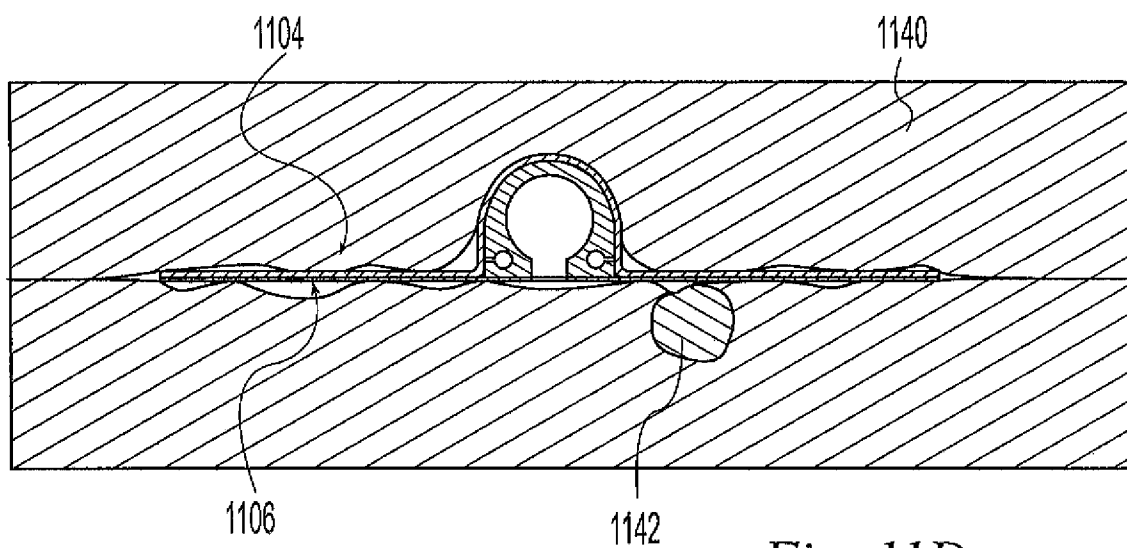
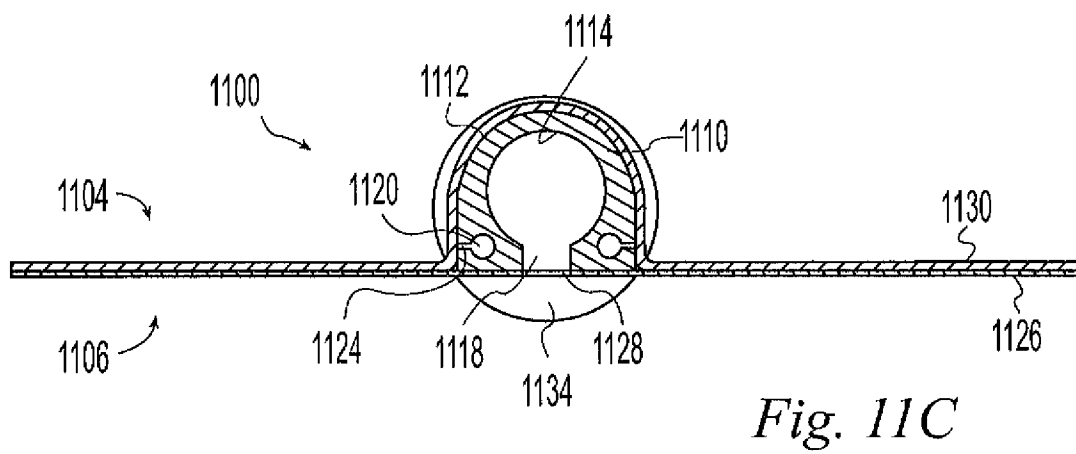
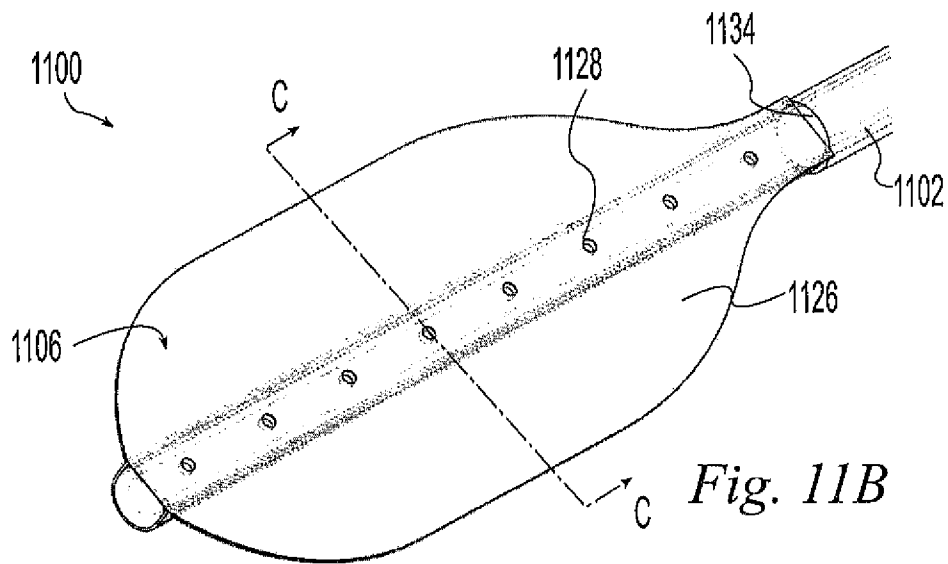


Fig. 10C

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*Fig. 11A*

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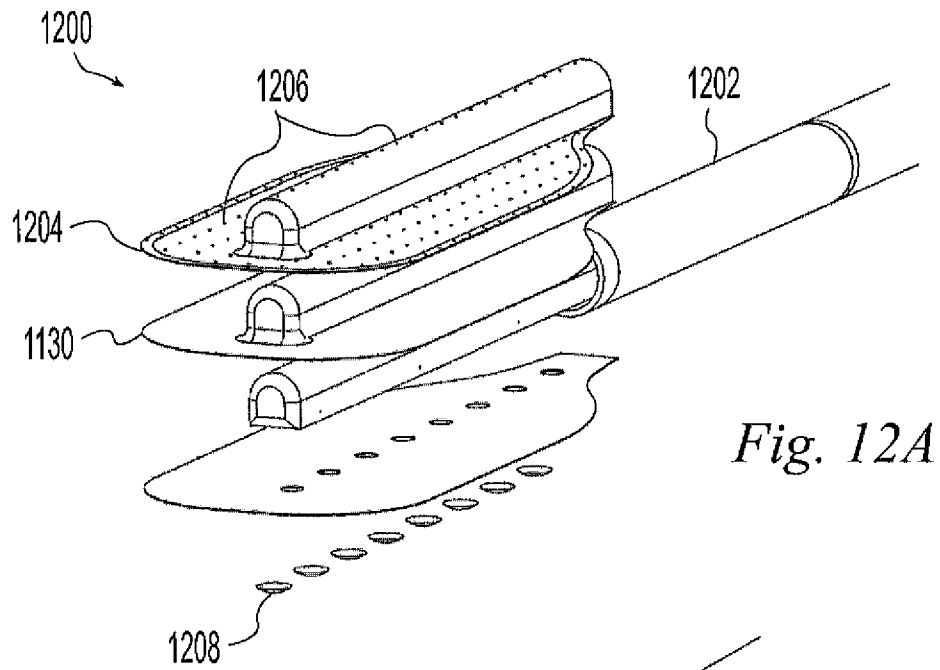


Fig. 12A

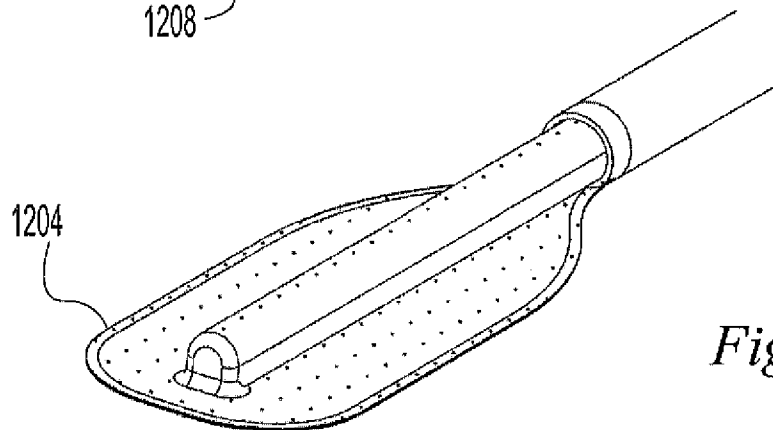


Fig. 12B

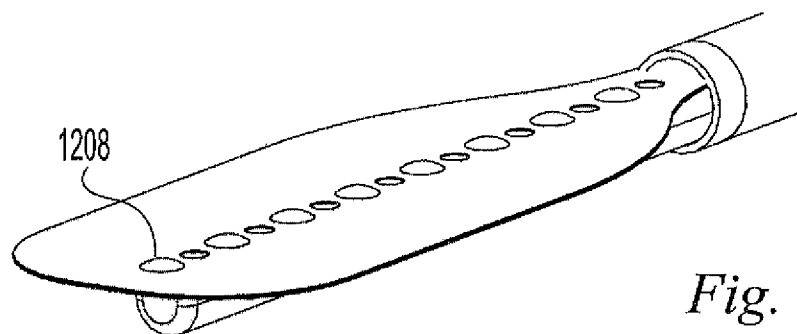


Fig. 12C

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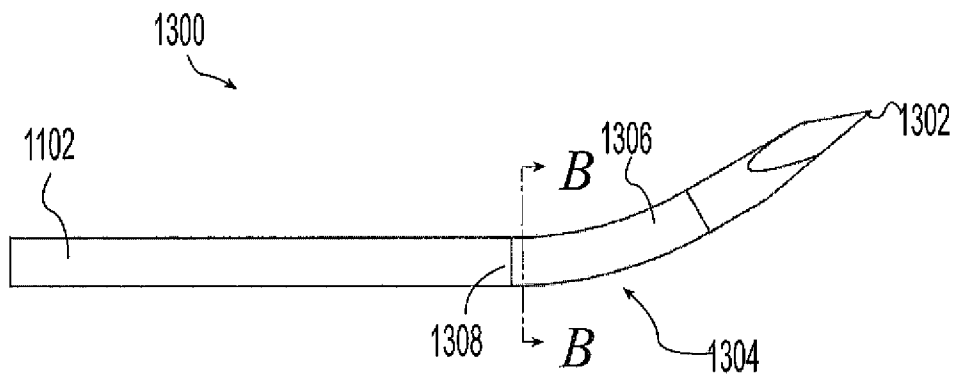


Fig. 13A

Fig. 13B

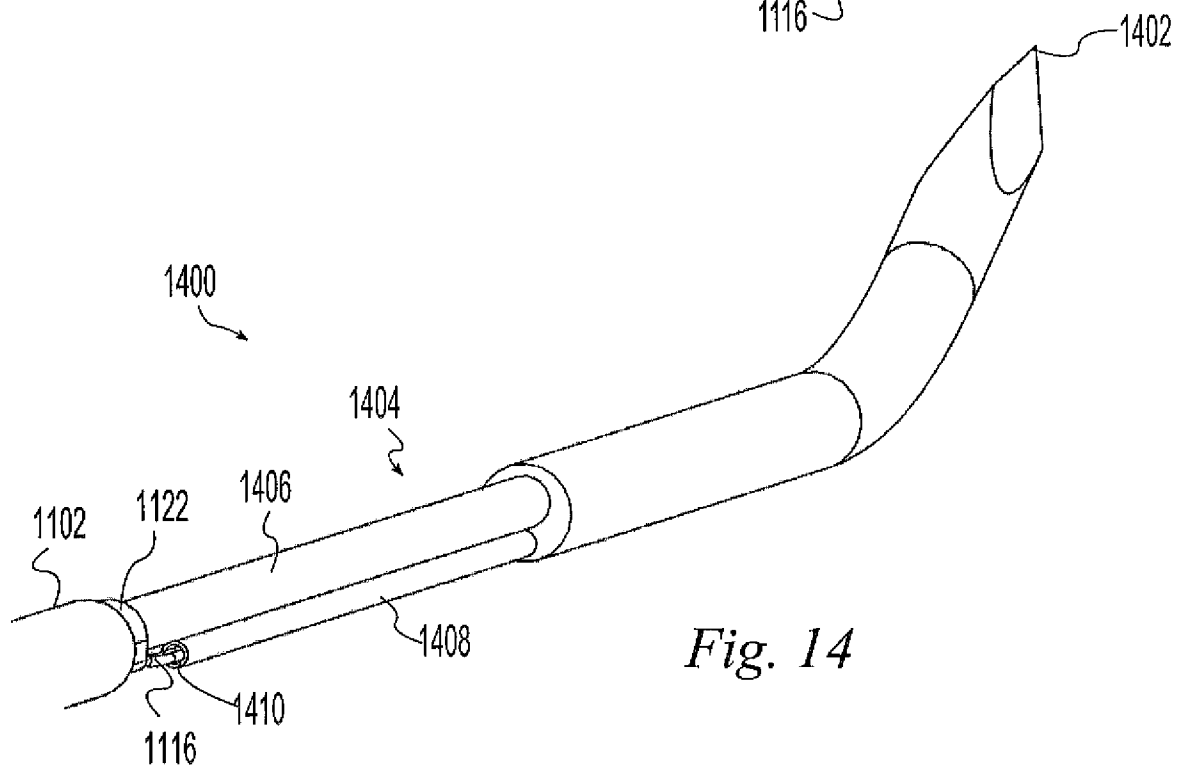
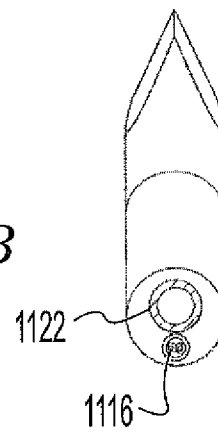
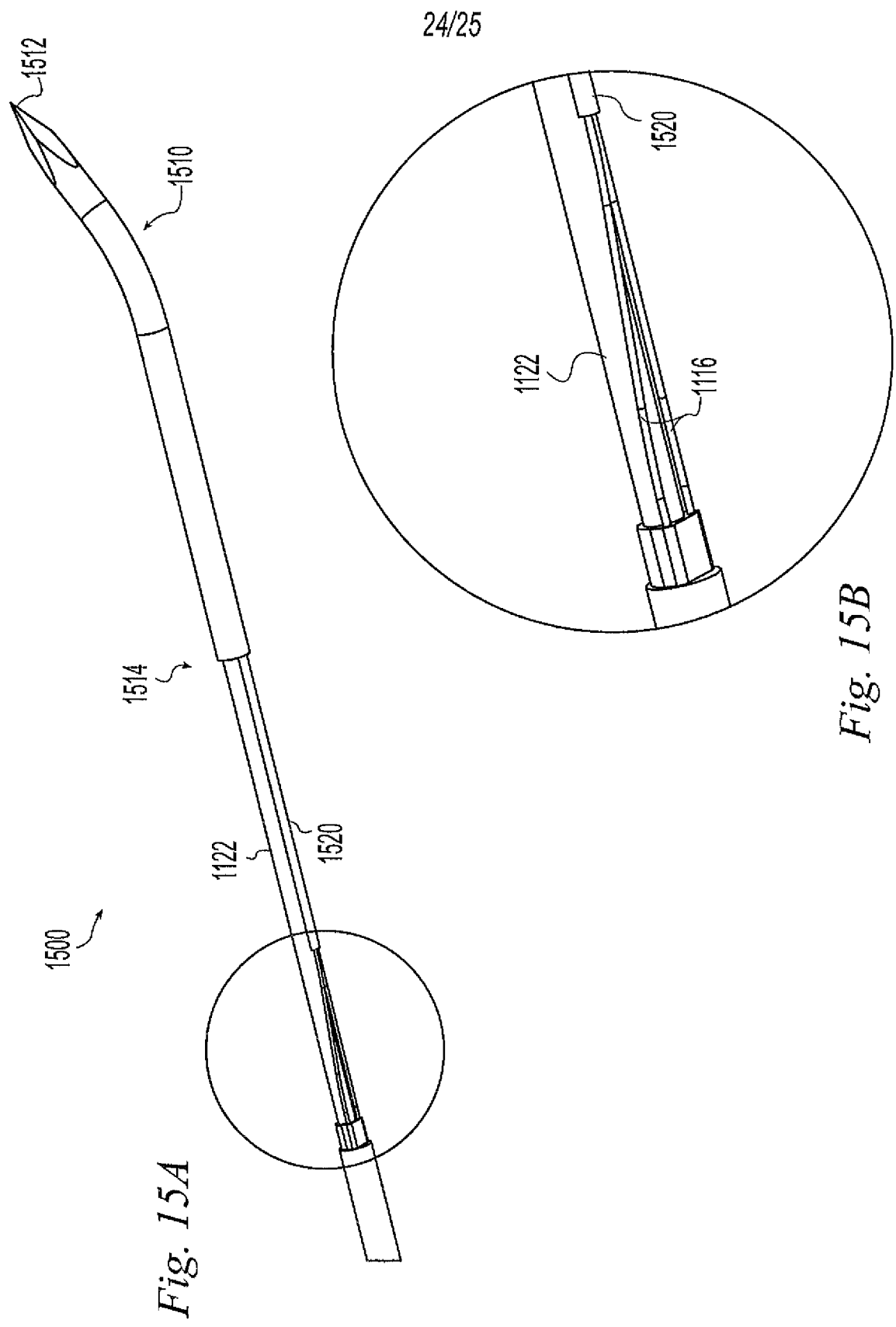
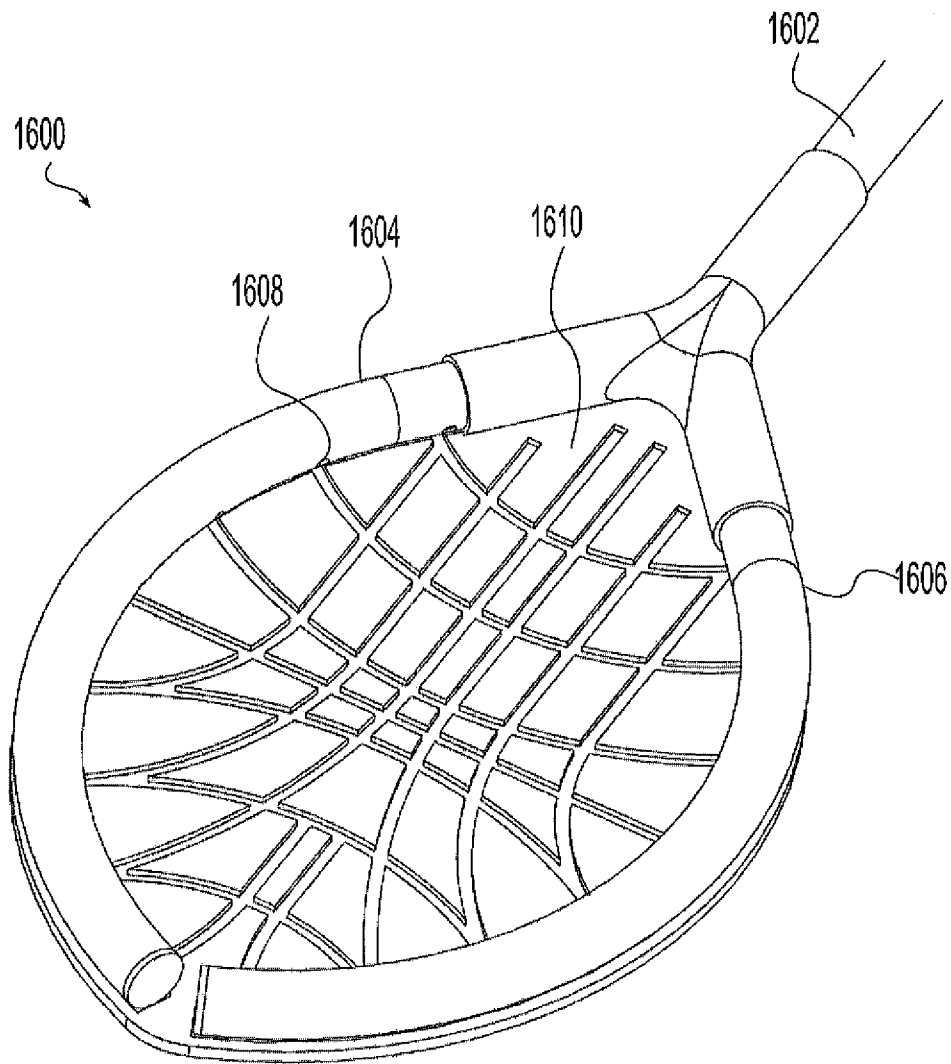


Fig. 14



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*Fig. 16*