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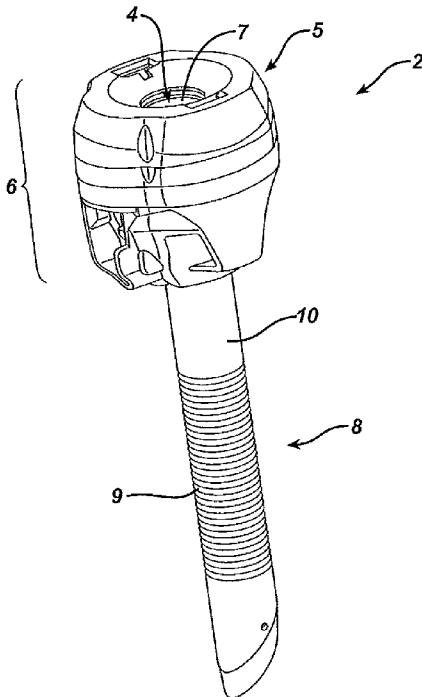
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(54) Title: SURGICAL ACCESS DEVICES WITH SORBENTS

FIG. 1A



(57) Abstract: The present invention generally provides methods and devices for removing fluid from a surgical instrument. Surgical access devices and seal systems are generally provided having one or more valves or seal assemblies to create a closed system between the outside environment and the environment in which the surgical access device is being inserted. The devices of systems can also include a fluid remover in the form of a sorbent element, a scraper element, a wicking element, or any combination thereof that is configured to remove fluid from a working channel of the device or system and/or from a surgical instrument inserted therethrough.

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SURGICAL ACCESS DEVICES WITH SORBENTS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. Patent Application Serial No. 12/110,724, filed on April 28, 2008 and entitled “Absorbing Fluids in a Surgical Access Device;” U.S. Patent Application Serial No. 12/110,727, filed on April 28, 2008 and entitled “Scraping Fluid Removal in a Surgical Access Device” (Atty. Docket No. 100873-242 (END6366USNP1)); U.S. Patent Application Serial No. 12/110,742, filed on April 28, 2008 and entitled “Wicking Fluid Management in a Surgical Access Device” (Atty. Docket No. 100873-243 (END6366USNP3)); and U.S. Patent Application Serial No. 12/110,755, filed on April 28, 2008 and entitled “Fluid Removal in a Surgical Access Device” (Atty. Docket No. 100873-241 (END6366USNP3)), all of which are hereby incorporated by reference in their entireties.

FIELD OF THE INVENTION

[0002] The present invention relates to methods and devices for performing surgical procedures, and in particular to methods and devices for maintaining visibility during surgical procedures.

BACKGROUND OF THE INVENTION

[0003] During laparoscopic surgery, one or more small incisions are formed in the abdomen and a trocar is inserted through the incision to form a pathway that provides access to the abdominal cavity. The trocar is used to introduce various instruments and tools into the abdominal cavity, as well as to provide insufflation to elevate the abdominal wall above the organs. During such procedures, a scoping device, such as an endoscope or laparoscope, is inserted through one of the trocars to allow a surgeon to view the operative field on an external monitor coupled to the scoping device.

[0004] Scoping devices are often inserted and removed through a trocar multiple times during a single surgical procedure, and during each insertion and each removal they can encounter fluid that can adhere to the scopes lens and fully or partially impede visibility through the lens. Furthermore, a scope can draw fluid from inside or outside a patients body into the trocar, where the fluid can be deposited within the trocar until the scope or other instrument is reinserted through the trocar. Upon reinsertion, fluid can adhere to the scopes lens. The scopes lens thus

needs to be cleaned to restore visibility, often multiple times during a single surgical procedure. With limited access to a scope in a body, each lens cleaning can require removing the scope from the body, cleaning the scope lens of fluid, and reintroducing the scope into the body. Such lens cleaning is a time-consuming procedure that also increases the chances of complications and contamination through repeated scope insertion and removal.

[0005] Accordingly, there is a need for methods and devices for maintaining clear visibility through a lens of a scoping device during a surgical procedure.

SUMMARY OF THE INVENTION

[0006] The present invention generally provides methods and devices for preventing fluid deposit onto and/or for removing fluid from a surgical instrument. In one embodiment, an assembly for use in a surgical access device is provided and includes a seal having an opening configured to receive a surgical instrument therethrough, and a sorbent associated with the seal and configured to sorb fluid away from at least one of the opening and a surgical instrument passed through the opening. The sorbent can be an adsorbent element or an absorbent element. The assembly can also include a scraper element positioned adjacent to the seal and configured to scrape fluid off of a surgical instrument extending through the opening in the seal. At least a portion of the scraper element can be hydrophilic. A wicking element can be associated with the scraper and it can be configured to wick away fluid collected near the opening when a surgical instrument is passed through the opening. In another embodiment, a wicking element can be associated with the seal and it can be configured to wick away fluid collected near the opening when a surgical instrument is passed through the opening. In an exemplary embodiment, the seal is configured to scrape fluid off of a surgical instrument passed through the opening, and the sorbent is configured to sorb fluid scraped off of the surgical instrument by the seal. In other embodiments, the sorbent can be formed integrally with the seal. Various seals can be used. For example, the seal can be an instrument seal configured to form a seal when an instrument is inserted therethrough. The assembly can also include a second seal. In certain aspects, the sorbent can be positioned distal of the first and second seals.

[0007] A fluid remover for use in a surgical access device is also provided, and in one embodiment the fluid remover includes a sorbent member having opposed proximal and distal

surfaces and opposed inner and outer sidewalls extending between the proximal and distal surfaces such that the sorbent member has a polygonal cross-sectional shape, such as square or triangular. The proximal surface can be substantially planar, and the inner and outer sidewalls can have a radius of curvature. The inner sidewall can define a central opening extending through the sorbent member, and the sorbent member can include a gap formed therein such that the sorbent is C-shaped. The sorbent member can be formed from a plurality of fibers that are configured to sorb fluid. The plurality of fibers can be oriented longitudinally relative to a longitudinal axis of the central opening. In one embodiment, the inner sidewall can include a plurality of grooves formed therein and extending parallel to a longitudinal axis of the central opening. At least a portion of the sorbent member can be hydrophilic.

[0008] Method for removing fluid from a seal opening are also provided, and in one embodiment the method includes passing a surgical instrument through an opening in a seal in an access device, wherein fluid on the instrument is sorbed by a sorbent element in the access device. The sorbent element can sorb fluid deposited on the seal by the instrument. The sorbent element can adsorb or absorb the fluid. Various seals can be used, and in one embodiment the seal can form a seal when no instrument is inserted therethrough. The method can also include scraping fluid off of the instrument by a scraper, and wherein the sorbent element sorbs fluid off of the scraper.

[0009] In other aspects, a surgical access device is provided having a housing defining a working channel sized and configured to receive a surgical instrument, a seal disposed within the housing, the seal having an opening positioned to receive a surgical instrument passed through the working channel, and a sorbent disposed in the housing and configured to sorb fluid to prevent fluid from being re-deposited on surgical instruments passed through the working channel. The sorbent can be positioned to sorb fluid away from the opening in the seal. The sorbent can be an absorbent or an adsorbent. The housing can have various configurations, and in one embodiment can include a proximal portion containing the seal and a distal cannula extending distally from the proximal portion and configured to be inserted into a body cavity. The seal can be a first seal, and the access device can include a second seal disposed within the housing. The sorbent can be positioned distal of the first and second seals. The device can also include a scraper disposed in the housing and configured to scrape fluid off of a surgical

instrument passed through working channel. The sorbent can be configured to sorb fluid scraped by the scraper. The device can also include a wicking element disposed in the housing and configured to wick fluid away from a surgical instrument passing through the working channel.

[0010] In another embodiment, a surgical access device is provided having a proximal housing, a distal cannula, and a working channel extending through the proximal housing and the distal cannula that is sized and configured to receive a surgical instrument, a seal disposed within the proximal housing configured to seal the working channel when no surgical instrument is disposed therethrough, the seal having an opening extending therethrough and positioned to receive a surgical instrument passed through the working channel, and a fluid remover positioned distal of the seal, the fluid remover having an opening extending therethrough and positioned to receive a surgical instrument passed through the working channel, and the fluid remover being configured such that, when an instrument occludes the opening in the fluid remover, the fluid remover allows insufflation gas to pass from the distal cannula to a proximal side of the fluid remover to thereby equalize a pressure on proximal and distal sides of the fluid remover. In one embodiment, the fluid remover can be positioned such that it is configured to be in a pathway of an insufflation gas flowing from an insufflation port formed in the proximal housing. The fluid remover can include a cut-out formed in at least a portion thereof and configured to allow an insufflation gas to pass from an insufflation port, through the cut-out, and into the distal cannula when an instrument occludes the opening. In an exemplary embodiment, the fluid remover can include a scraper configured to scrape fluid off of a surgical instrument passed through the opening. The fluid remover can also include a sorbent positioned to sorb fluid removed by the scraper. The sorbent can be positioned distal to the insufflation port, and in one embodiment it can be disposed around a substantially cylindrical member. The insufflation port can have a lumen extending therethrough and defining a longitudinal axis, and the scraper can be positioned distal to the longitudinal axis. At least a portion of the fluid remover can be positioned distal to the insufflation port.

[0011] In other aspects, a device for removing fluid from medical instruments is provided and includes a scraper having a substantially planar configuration with a central opening extending therethrough, the central opening being configured to expand to engage and scrape fluid off of a surgical instrument inserted therethrough, the scraper having a distal surface with a plurality of

channels formed therein and extending radially outward from the central opening such that fluid scraped off of an instrument inserted through the central opening can flow through the channels.

[0012] In yet another embodiment, a device for removing fluid from medical instruments is provided and includes a crown, a lid coupled to the crown, and a scraper captured between the crown and lid, the scraper having a central opening formed therethrough and configured to expand to engage an instrument inserted therethrough and to scrape fluid off of the instrument. A plurality of pins can extend between the crown and the lid to mate the crown and lid, the plurality of pins extending through a plurality of openings formed in the scraper.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0014] FIG. 1A is a perspective view of one embodiment of a trocar;

[0015] FIG. 1B is an exploded view of the trocar of FIG. 1A;

[0016] FIG. 1C is a cross-sectional view of a portion of the trocar of FIG. 1A;

[0017] FIG. 1D is a bottom perspective view of an instrument seal assembly for use with the trocar of FIG. 1A;

[0018] FIG. 1E is an exploded view of the instrument seal assembly of FIG. 1D;

[0019] FIG. 1F is a perspective view of a channel seal of the trocar of FIG. 1A;

[0020] FIG. 1G is a bottom perspective view of one embodiment of a scraper of a fluid remover assembly for use with the trocar of FIG. 1A;

[0021] FIG. 1H is a perspective view of one embodiment of a sorbent wick of a fluid remover assembly for use with the trocar of FIG. 1A;

[0022] FIG. 1I is a perspective view of a sorbent element of a fluid remover assembly for use with the trocar of FIG. 1A;

[0023] FIG. 1J is a perspective view of a frame for housing the sorbent element of FIG. 1I;

[0024] FIG. 1K is a perspective view of a lid portion of a fluid remover assembly for use with the trocar of FIG. 1A;

[0025] FIG. 2A is a cross-sectional view of a proximal portion of another embodiment of a trocar;

[0026] FIG. 2B is an exploded view of the trocar of FIG. 2A;

[0027] FIG. 3A is an exploded view of a portion of a trocar having a drop-in fluid remover assembly;

[0028] FIG. 3B is an exploded view of the drop-in fluid remover assembly of FIG. 3A;

[0029] FIG. 3C is a cross-sectional view of a trocar of FIG. 3A;

[0030] FIG. 4A is an exploded view of one embodiment of a scraper assembly for scraping fluid;

[0031] FIG. 4B is a bottom perspective view the scraper assembly of FIG. 4A;

[0032] FIG. 4C is a top perspective view of the scraper assembly of FIG. 4A;

[0033] FIG. 5A is a perspective view of another embodiment of fluid remover assembly having a scraper nested within a sorbent element;

[0034] FIG. 5B is top view of the fluid remover assembly of FIG. 5A;

[0035] FIG. 5C is a cross-sectional view of the fluid remover assembly of FIG. 5A disposed within a trocar housing;

[0036] FIG. 6A is a cross-sectional view of a trocar having one embodiment of a scraper for scraping fluid away from a surgical instrument passed therethrough;

[0037] FIG. 6B is a cross-sectional view of a trocar having another embodiment of a scraper for scraping fluid away from a surgical instrument passed therethrough;

[0038] FIG. 6C is a cross-sectional view of a trocar having yet another embodiment of a scraper for scraping fluid away from a surgical instrument passed therethrough;

[0039] FIG. 7 is a cross-sectional view of another embodiment of a trocar housing having sorbent flapper doors positioned adjacent to a zero-closure seal;

[0040] FIG. 8 is a cross-sectional view of yet another embodiment of a trocar housing having wicking fingers coupled to a sorbent reservoir;

[0041] FIG. 9 is a cross-sectional view of one embodiment of a trocar housing having a sorbent element disposed therein;

[0042] FIG. 10A is a cross-sectional view of one embodiment of a zero-closure seal having extension members for wicking fluid;

[0043] FIG. 10B is a transparent perspective view of the seal of FIG. 10A;

[0044] FIG. 11 is an exploded view of another embodiment of fluid remover assembly having a sorbent element nested between first and second zero-closure seals;

[0045] FIG. 12A is a cross-sectional view of yet another embodiment of a sorbent element having two sorbent bars disposed within a zero-closure seal;

[0046] FIG. 12B is a transparent perspective view of the sorbent element and seal of FIG. 12A;

[0047] FIG. 13 is an exploded view of one embodiment of a trocar housing having a scraper for scraping fluid away from a surgical instrument passed therethrough;

[0048] FIG. 14 is a cross-sectional view of one embodiment of a trocar cap having a scraper for scraping fluid away from a surgical instrument passed therethrough;

[0049] FIG. 15A is a top view of a trocar cap having another embodiment of a scraper for scraping fluid away from a surgical instrument passed therethrough;

[0050] FIG. 15B is a side perspective view of the trocar cap of FIG. 15A;

[0051] FIG. 16 is an exploded view of one embodiment of a multi-layer seal having a sorbent

element disposed between the layers;

[0052] FIG. 17 is a bottom perspective view of one embodiment of a trocar cap having a sorbent element disposed therein;

[0053] FIG. 18A is a bottom perspective view of one embodiment of a wicking element formed on a portion of a seal protector for creating between the seal protector and a seal;

[0054] FIG. 18B is a top perspective view of the portion of the seal protector of FIG. 18A;

[0055] FIG. 19A is a top view of a multi-layer protective member having camming ribs;

[0056] FIG. 19B is a top view of one layer of the protective member of FIG. 19A;

[0057] FIG. 20A is a side perspective view of a deep cone instrument seal having wicking ribs formed on an external surface;

[0058] FIG. 20B is a top perspective view of another embodiment of a deep cone instrument seal having wicking ribs formed on an internal surface;

[0059] FIG. 21 is a perspective view of a multi-layer protective element having holes formed therein for receiving fluid;

[0060] FIG. 22A is an exploded view of a multi-layer protective element;

[0061] FIG. 22B is a cross-sectional view taken across line B-B of one of the protective elements of FIG. 22A;

[0062] FIG. 23A is a side view of one embodiment of a seal having an hourglass configuration for scraping fluid off of a surgical instrument;

[0063] FIG. 23B is a side view of the seal of FIG. 23A showing an instrument passed therethrough;

[0064] FIG. 24A is cross-sectional view of one embodiment of a trocar cannula having overlapping scrapers and a sorbent disposed therein;

[0065] FIG. 24B is an enlarged view of one of the scrapers and sorbents of FIG. 24A;

[0066] FIG. 25 is a perspective view of another embodiment of a scraper for scraping fluid off of a surgical instrument shown passed therethrough;

[0067] FIG. 26 is a perspective view of another embodiment of a device for scraping fluid away from a surgical instrument;

[0068] FIG. 27A is an exploded view of a trocar and removable tip for scraping fluid away from a surgical instrument;

[0069] FIG. 27B is an assembled side view of a distal end of the trocar and removable tip of FIG. 27A;

[0070] FIG. 27C is a perspective view of the removable tip and distal end of the trocar of FIG. 26B;

[0071] FIG. 28 is a partially-transparent side view of one embodiment of wicking element having an hourglass shape;

[0072] FIG. 29 is a perspective view of a trocar having a cannula with slots formed therein for wicking fluid out of the cannula;

[0073] FIG. 30A is a perspective view of another embodiment of a trocar having a proximal housing and a distal cannula;

[0074] FIG. 30B is a cross-sectional side view of the trocar of FIG. 30A;

[0075] FIG. 30C is a perspective view of an instrument seal assembly, a channel seal, a fluid remover assembly, and an insufflation port of the trocar of FIG. 30A;

[0076] FIG. 30D is a cross-sectional side view of the fluid remover and insufflation port of FIG. 30C;

[0077] FIG. 30E is a perspective view of a fluid remover of FIG. 30C;

[0078] FIG. 30F is an exploded view of the fluid remover of FIG. 30E showing a lid, scraper,

crown, and sorbent;

[0079] FIG. 30G is a bottom perspective view of a scraper of FIG. 30F showing channels formed therein;

[0080] FIG. 30H is a cross-sectional view of one of the channels of the scraper of FIG. 30G;

[0081] FIG. 30I is a top view of a lid of FIG. 30F;

[0082] FIG. 30J is a bottom view of the lid of FIG. 30I; and

[0083] FIG. 31 is a bottom view of another embodiment of a lid for use with a fluid remover assembly;

[0084] FIG. 32A is a perspective view of another embodiment of a trocar;

[0085] FIG. 32B is a side perspective view of an instrument seal, a channel seal, a fluid remover, and an insufflation port of the trocar of FIG. 32A;

[0086] FIG. 32C is a side view of the fluid remover and insufflation port of FIG. 32B; and

[0087] FIG. 32D is a side perspective view of the fluid remover of FIG. 32C.

DETAILED DESCRIPTION OF THE INVENTION

[0088] Certain exemplary embodiments will now be described to provide an overall understanding of the principles of the structure, function, manufacture, and use of the devices and methods disclosed herein. One or more examples of these embodiments are illustrated in the accompanying drawings. Those skilled in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary embodiments and that the scope of the present invention is defined solely by the claims. The features illustrated or described in connection with one exemplary embodiment may be combined with the features of other embodiments. Such modifications and variations are intended to be included within the scope of the present invention.

[0089] The present invention generally provides methods and devices for maintaining clear

visibility through a scoping device during surgical procedures, and in particular methods and devices are provided for removing fluid from an access device and/or surgical instrument passed, e.g., inserted and/or withdrawn, through an access device, and/or for preventing fluid from being transferred onto a scoping device passed through an access device. In certain exemplary embodiments, the methods and devices are effective to remove fluid from an access device and/or surgical instrument as the instrument is being withdrawn from the access device, thus preventing the fluid from being deposited onto an instrument being inserted through the access device. However, the methods and devices can be configured to remove fluid prior to and/or during insertion and/or removal.

[0090] A person skilled in the art will appreciate that the term fluid as used herein is intended to include any substance that, when on a surgical instrument, can adversely affect the functioning of the instrument or a surgeon's ability to use it. Fluids include any kind of bodily fluid, such as blood, and any kind of fluid introduced during a surgical procedure, such as saline. Fluids also include fluid/solid mixtures or fluids with particles (such as pieces of tissue) suspended or located therein, as well as viscous materials and gases. A person skilled in the art will also appreciate that the various concepts disclosed herein can be used with various surgical instruments during various procedures, but in certain exemplary embodiments the present invention is particularly useful during laparoscope procedures, and more particularly during procedures in which a scoping device, such as an laparoscope or endoscope, is passed through a surgical access device, such as a trocar, that provides a pathway from a skin incision to a body cavity. As previously explained, during such procedures repeated insertion and withdrawal of the scoping device can deposit fluid within the access device, thus allowing the fluid to be transferred back onto the distal viewing end of the scoping device upon reinsertion therethrough. Various exemplary methods and devices are provided herein to prevent such an occurrence.

[0091] In certain exemplary embodiments, the methods and devices disclosed herein utilize a fluid remover that is effective to remove fluid from an access device and/or surgical instrument passed therethrough. While the fluid remover can have various configurations and it can function in various manners to remove fluid, exemplary fluid removers include scrapers for scraping fluids, sorbents for sorbing fluid, and wicking elements for redirecting or wicking fluid away, e.g., by capillary action. Any combination of fluid removers can be provided, and the

fluid removers can be disposed at various locations within an access device to remove fluid from portions of the access device and/or from surgical instruments, such as scoping devices, passed through the access device. The particular location of the fluid remover(s) can depend on the particular configuration of the access device and/or surgical instrument.

[0092] In certain exemplary embodiments, the fluid remover can include one or more sorbents. The sorbent can be any insoluble (or at least partially insoluble) material or mixture of materials that are capable of sorbing fluids or taking up fluids through a process of one or both of absorption and adsorption. A sorbent material or element can thus include any one of or combination of absorbent materials and/or elements and adsorbent materials and/or elements. In certain exemplary embodiments, the sorbent is formed from a hydrophilic material and/or includes a hydrophilic material to facilitate fluid receipt. For example, the sorbent can be coated using known coating techniques during manufacturing to render one or more portions of the sorbent hydrophilic. In one embodiment, the sorbent can be formed by an extrusion process in which, for example, the fibers can all extend longitudinally in a direction generally parallel to a longitudinal axis of the cylindrical tube, as shown in FIG. 30F. The fibers will thus form a generally cylindrical, hollow tubular member, which can subsequently be cut to form a plurality of sorbents. A sidewall gap or cut-out can also be made to form a C-shaped sorbent, or the sorbent can be formed to have a C-shaped configuration without the need to make any additional cuts. Exemplary shapes and configurations for the sorbent will be discussed in more detail below. A hydrophilic surfactant can be applied to the sorbent, either prior to or after the sorbent is cut. A person skill in the art will appreciate that a variety of techniques can be used to coat the sorbent or portions thereof with a hydrophilic material and/or to form the sorbent or portions thereof from a hydrophilic material. The particular hydrophilic material used can also vary, and exemplary materials will be discussed in more detail below with respect to the scraper. The same hydrophilic materials used with the scraper can also or alternatively be used with the sorbent.

[0093] In general, sorbents that are absorbents remove fluid through a process of absorption, similar to a sponge, in which a liquid diffuses into the volume and/or structure of the absorbent and becomes a part of that volume and/or structure. For example, the sorbent can pick up and retain a liquid distributed throughout its molecular structure causing the absorbent to swell. The

liquid can cause the solid structure to swell 50% or more. Typical absorbents are at least 70% insoluble in excess fluid. Absorbents can have any shape, size, and form known in the art as needed to stand alone and/or fit within, around, or throughout any component of a fluid remover and/or trocar. Certain exemplary embodiments of absorbents include, but are not limited to, comminuted wood pulp fluff, cellulose fibers, polymeric gelling agents, hydrophilic non-wovens, cellulose, sodium polycrylate, cotton, polyethylene terephthalate, polyethylene, polypropylene, polyvinyl chloride, ABS, polyamide, polystyrene, polyvinyl alcohol, polycarbonate, ethylene-methacrylate copolymer, and polyacetal.

[0094] Sorbents that are adsorbents, on the other hand, remove fluid through a process of adsorption by retaining a liquid on their surface including pores and capillaries. Liquid accumulates on the surface of an adsorbent by forming a film of molecules or atoms that are retained thereon as a consequence of surface energy. In some embodiments, an adsorbent material can include one or more insoluble materials (or at least partially insoluble) that can be coated by a liquid on their surface. For example, the adsorbent can be a structure formed from insoluble fibers. The structure can be porous, as voids or spaces can be located between the individual fibers. Thus, liquid can accumulate on the surface of the fibers, thereby filling the voids between the fibers. Typical adsorbents will adsorb fluid without swelling more than 50% in excess liquid. Adsorbents can have any shape, size, and form known in the art as needed to stand alone and/or fit within, around, or throughout any component of a fluid remover and/or trocar. In an exemplary embodiment, the adsorbent is molded to have a predetermined shape and size. Certain exemplary adsorbent materials include, but are not limited to, oxygen-containing compounds, carbon-based compounds, and/or polymer based compounds, among others. For example, adsorbent materials can include silica gels, alumina, zeolites, activated carbon, graphite, cellulose, porous polymer matrices, perlite, metal hydroxides, metal oxides, cellulose acetate, -butyrate and -nitrate, polyamide, polysulfone, vinyl polymers, polyesters, polyolefines and PTFE, as well as porous glass or glass ceramics, graphite oxide, polyelectrolyte complexes, alginate gel, etc.

[0095] While the fluid removers disclosed herein can be used with various surgical access devices known in the art, in certain exemplary embodiments a trocar is provided having one or more fluid removers disposed therein for removing fluid from portions of the trocar and/or from

an instrument, such as a scoping device, passed therethrough. A person skilled in the art will appreciate that a trocar is shown for illustration purposes only, and that virtually any type of access device, including cannulas, ports, etc., can be used. FIGS. 1A-1C illustrate one exemplary embodiment of a trocar 2. As shown, the trocar 2 is generally in the form of a housing 6 having a proximal portion (also referred to herein as a proximal housing) that can house one or more sealing elements and a distal cannula 8 extending distally from the proximal housing 6. The trocar 2 defines a working channel 4 extending therethrough for introducing various instruments into a body cavity. A number of configurations are available for the proximal housing 6. In the illustrated embodiment, the proximal housing 6 has a generally cylindrical shape with a removable cap portion 5 and an inner sidewall 3. An opening 7 can be formed in the proximal end of the housing 6, such that the opening 7 extends through the removable cap 5 and through the remainder of the housing 6 and is coaxial with the working channel 4 extending through the cannula 8. The cannula 8 can also have various configurations, and can include various features known in the art. In the illustrated embodiment, the cannula 8 has a generally elongate cylindrical shape and includes a series of annular ridges 9 formed on an external surface 10 thereof. The opening 7 extending through the proximal housing 6 and the cannula 8 define the working channel 4 that is sized and configured to receive a surgical instrument. One skilled in the art will appreciate that the housing 6 and the cannula 8 can be formed as a unitary structure or as two separate components that are mated to one another. The housing 6 can also include other features, such as a stop-cock valve 13 for allowing and preventing the passage of an insufflation fluid, e.g. carbon dioxide, through the trocar 2 and into a body cavity.

[0096] In use, the distal cannula 8 can be inserted through a skin incision and through tissue to position a distal-most end within a body cavity. The proximal housing 6 can remain external to the body cavity, and various instruments can be inserted through the working channel 4 and into the body cavity. Typically, during surgical procedures in a body cavity, such as the abdomen, insufflation is provided through the trocar 2 to expand the body cavity to facilitate the surgical procedure. Thus, in order to maintain insufflation within the body cavity, most trocars include at least one seal disposed therein to prevent air from escaping. Various seal configurations are known in the art, but typically the trocar 2 includes an instrument seal that forms a seal around an instrument disposed therethrough, but otherwise does not form a seal when no instrument is

disposed therethrough; a channel seal (also referred to herein as a zero-closure seal) that seals the working channel 4 when no instrument is disposed therethrough; or a combination instrument seal and channel seal that is effective to both form a seal around an instrument disposed therethrough and to form a seal in the working channel 4 when no instrument is disposed therethrough. In the embodiment shown in FIGS. 1A-1C the trocar 2 includes an instrument seal 14 and a separate channel or zero-closure seal 24. However, a person skilled in the art will appreciate that various other seals known in the art can be used including, for example, flapper valves, gel seals, diaphragm seals, etc.

[0097] In an exemplary embodiment, as shown in FIGS. 1C-1E, the instrument seal 14 is generally in the form of a multi-layer conical seal 16 and a multi-layer protective member 18 disposed on a proximal surface 15 of the seal 16. As best shown in FIG. 1E, the multi-layer conical seal 16 can include a series of overlapping seal segments 20 that are assembled in a woven arrangement to provide a complete seal body. The seal segments 20 can be stacked on top of one another or woven together in an overlapping fashion to form the multi-layer seal 16 having a central opening 17 therein. The seal segments 20 can be made from any number of materials known to those skilled in the art, but in an exemplary embodiment the seal segments 20 are formed from an elastomeric material. The seal segments 20 can also be molded such that they have a varying thickness across the profile of the seal 16. Varying the thickness across to the profile of the seal 16 can be effective to minimize leakage and reduce drag forces on the instrument. The multi-layer protective member 18 can similarly be formed from a series of overlapping segments 22 that are disposed proximal to the overlapping seal segments 20 and that are configured to protect the seal segments 20 from damage caused by surgical instruments passed through the opening 17 in the seal 16. The protective member 18 can also be formed from various materials, but in certain exemplary embodiments the protective member 18 is formed from a molded thermoplastic polyurethane elastomer, such as PellethaneTM. The segments 20, 22 that form the seal 16 and the protective member 18 can be held together using various techniques known in the art. As shown in FIGS. 1D and 1E, the segments 20, 22 are held together by several ring members that mate to engage the segments 20, 22 therebetween. In particular, the protective member 18 is engaged between a crown 26 and a gasket ring 28, and the seal 16 is engaged between the gasket ring 28 and a retainer ring 30. Pins 32 are used to mate the ring members 26, 28 and to extend through and engage the segments of the seal 16 and

protective member 18.

[0098] When fully assembled, the instrument seal 14 can be disposed at various locations within the trocar 2. In the illustrated embodiment, the instrument seal 14 is disposed in the cap 5 of the trocar 2 at a location just distal of the proximal opening 7 and proximal of a channel seal, as discussed in more detail below. In use, an instrument can be passed through the center of the seal assembly and the seal segments 20, 22 can engage and form a seal around an outer surface of the instrument to thereby prevent the passage of fluids through the seal 14. When no instrument is disposed therethrough, the opening will not form a seal in the working channel 4, however other configurations in which a seal is formed when no instrument is disposed therethrough are also conceivable. Exemplary instrument seal configurations are described in more detail in U.S. Publication No. 2004/0230161 entitled "Trocar Seal Assembly," filed on March 31, 2004, and U.S. Application Serial No. 10/687,502 entitled "Conical Trocar Seal," filed on October 15, 2003, which are hereby incorporated by reference in their entireties.

[0099] The zero-closure seal in the illustrated embodiment is shown in more detail in FIG. 1F, and as shown the illustrated zero-closure seal is in the form of a duckbill seal 24. The seal 24 is configured to form a seal in the working channel 4 when no instrument is disposed therethrough to thus prevent the leakage of insufflation gases delivered through the trocar 2 to the body cavity. As shown, the duckbill seal 24 has a generally circular flange 34 with a sidewall 36 extending distally therefrom. The shape of the sidewall 36 can vary, but in the illustrated embodiment, the sidewall 36 includes opposed flaps 35 that extend at an angle toward one another in a distal direction and that come together at a distal end to form a seal face 38. The opposed flaps 35 are movable relative to one another to allow the seal face 38 to move between a closed position, in which no instrument is disposed therethrough and the seal face 38 seals the working channel 4 of the trocar 2, and an open position in which an instrument is disposed therethrough. The seal can include various other features, as described in more detail in U.S. Application No. 11/771,263, entitled "Duckbill Seal with Fluid Drainage Feature," filed on June 29, 2007, which is hereby incorporated by reference in its entirety.

[00100] In accordance with the present disclosure the general structure of the seals as well as the trocar do not generally form part of the present invention. As such, a person skilled in the art

will certainly appreciate that various seal configurations, as well as various trocars, can be used without departing from the spirit of the invention disclosed herein.

[00101] As indicated above, a fluid remover can be disposed within the trocar 2 to remove fluid from a seal and/or from a surgical instrument extending through the seal. As best shown in FIGS. 1B-1C, the illustrated trocar 2 includes a fluid remover assembly 40 that is disposed within the proximal housing 6 of the trocar 2 at a location distal of the duckbill seal 24. The fluid removal assembly 40 includes a scraper for scraping fluid off of a surgical instrument passed through the working channel 4 in the trocar 2, and a sorbent for sorbing removed fluid. The scraper can also include a wicking feature for wicking fluid away from the opening in the scraper, and/or the sorbent can include a wicking feature for wicking fluid away from the scraper.

[00102] The components of the fluid remover assembly 40 are shown in more detail in FIGS. 1G-1K, and as shown the assembly generally includes a lid 42 (FIG. 1K), a scraper 44 (FIG. 1G), a sorbent wick 46 (FIG. 1H), sorbent cartridges 48 (FIGS. 1I), and a housing or frame 50 (FIG. 1J). When fully assembled, the fluid remover assembly 40 is configured to scrape fluid off of surgical instruments passing through the working channel 4 of the trocar 2, to wick the scraped fluids away, and to sorb them, thereby preventing the fluids from being redeposited on the instrument upon reinsertion through the working channel.

[00103] Referring first to FIG. 1G, the scraper 44 can have a variety of configurations, but in an exemplary embodiment, as shown, the scraper has a generally planar configuration with a circular shape. A central opening 52 is formed through a central portion thereof and is sized and configured to receive a surgical instrument therethrough. In use, the central opening 52 can be coaxial with openings in the instrument and channel seals. The scraper 44 can be formed from various materials, but in an exemplary embodiment the scraper is formed from polyisoprene to allow the scraper 44 to engage and scrape fluid off of any instrument passed therethrough. As further shown in FIG. 1G, a distal-facing surface 54 of the scraper 44 can include a plurality of channels 56 formed therein and extending radially outward from the central opening 52, or from a location just radially outward but adjacent to the central opening 52. The channels 56 can be configured such that fluid scraped off of an instrument by the central opening 52 will flow into

the channels 56 and thereby be wicked away from the opening 52.

[00104] As indicated above, the fluid remover assembly 40 can also include a sorbent wick 46. As shown in FIG. 1H, in an exemplary embodiment the sorbent wick 46 has a generally planar circular portion 62 with a central opening 58 formed therethrough. The central opening 58 can have a diameter slightly larger than a diameter of the central opening 52 in the scraper 44, and it can be configured to be positioned coaxial with the opening 52 in the scraper 44. As further shown in FIG. 1H, the sorbent wick 46 can also include one or more sidewalls 60 extending from the planar circular portion 62. The illustrated sidewalls 60 extend proximally, however they can extend distally depending on the particular configuration of the wick 46. The sidewalls 60 can be configured to sit within the inner sidewall 3 of the trocar housing 6. In use, the sorbent wick 46 can wick and sorb fluid away from the central opening 52 in the scraper 44, and it can deliver the fluid to the sorbent cartridges 48, as discussed in more detail below. The sorbent wick 46, as well as various other sorbent members disclosed herein, can be formed from a variety of sorbent materials as described above.

[00105] The sorbent cartridges 48 are shown in more detail in FIG. 1I, and as shown the cartridges 48 each have a generally semi-circular shape with a width, as measured from an internal surface 64 to an external surface 66, that decreases in a proximal to distal direction to form wedge-shaped members 68. Together, the cartridges 48 can have an annular configuration. In use, the cartridges 48 can sorb fluid from the sorbent wick 46, thereby storing the fluid at a location away from any instrument passed through the working channel 4. The cartridges 48 can be contained within the trocar 2 by a housing or frame 50, as shown in FIG. 1J. The frame 50 can have a generally cylindrical configuration with an opening 68 extending therethrough, and a plurality of ridges 70 protruding radially outward and extending axially along an outer surface 72 thereof. Each sorbent cartridge 48 can be seated between two ridges. In use, the frame 50 can be particularly advantageous as it can protect the sorbent from being contacted by instruments passing through the working channel.

[00106] When fully assembly, the scraper 44 can be seated within the sorbent wick 46, which can rest on top of the frame 50 that holds the sorbent cartridges 48. The lid 42, shown in FIG. 1K, can be seated on top of the scraper 44 and within the sorbent wick 46, and the lid 42 can lock

onto the frame 50, thereby holding the fluid remover assembly 40 together. Referring to FIG. 1C, the entire assembly 40 can be seated within the proximal housing 6 of the trocar 2 just distal of the duckbill seal 24. As a result, when an instrument, such as a scoping device, is passed through the working channel 4 of the trocar 2, any fluid on the instrument will be scraped off of the sidewalls of the instrument by the scraper 44. The fluid will flow through the channels 56 and/or be wicked away from the opening 52 by the sorbent wick 46, which delivers the fluid to the sorbent cartridges 48. As a result, when the instrument is withdrawn, for example, the fluid will be prevented from being deposited onto the instrument seal 14, thereby preventing the fluid from being transferred from the instrument seal 14 back onto the instrument upon reinsertion.

[00107] FIGS. 2A-2B illustrate yet another embodiment of a fluid remover assembly 80 that is similar to the embodiment shown in FIG. 1A. In this embodiment, the proximal housing 79 of the trocar has a frame 82 that is molded into the inner sidewall 81 of the housing 79 for directly seating a sorbent, a scraper, and a lid, thereby eliminating the need for the frame 50 of FIG. 1J. A single sorbent element 86 is also provided, rather than a sorbent wick and separate sorbent cartridges. In particular, the sorbent element 86 in this embodiment has a generally cylindrical configuration with a distal portion 88 that tapers inward on an outer surface 87 thereof to conform to the inner surface 81 of the proximal housing 79 of the trocar. A recess 90 can be formed around an inner surface 92 of a proximal end 93 of the sorbent element 86 to seat a scraper 94, which can have a configuration that is the same as or similar to the scraper 44 described above with respect to FIG. 1G. The recess 90 can engage an outer perimeter 96 of the scraper 94 such that the channels 56 on the scraper 94 can deliver fluid away from the opening 52 in the scraper 94 to the sorbent element 86 surrounding the scraper 94. A cap 98 can sit on top of the scraper 94 and can include a flange 99 that extends around the proximal end 93 of the sorbent element 86. The cap 98 can engage the inner sidewall 81 of the proximal housing 79 of the trocar to retain the scraper 94 and sorbent element 86 therein at a location just distal of the duckbill seal 24. In use, instruments passed through the working channel 4 of the trocar will be engaged by the scraper 94, which scrapes fluid off of the outer surface of the instrument. The fluid is wicked away from the opening 52 in the scraper 94 by the channels 56, which deliver the fluid to the sorbent element 86 surrounding the scraper 94. Thus, similar to the embodiment of FIG. 1A, when the instrument is withdrawn, for example, the fluid will be prevented from being deposited onto the seals, and in particular the instrument seal 14, thereby preventing the fluid

from being transferred from the instrument seal 14 back onto the instrument upon reinsertion.

[00108] A person skilled in the art will appreciate that the fluid remover assemblies 40, 80 can have a variety of other configurations. FIGS. 3A-10B illustrate additional exemplary embodiments of fluid removers, e.g., scrapers, sorbents, and wicking elements, or combinations thereof. In these embodiments, the fluid removers are all located distal of the channel seal, e.g., duckbill seal or other zero-closure seal, and distal of the instrument seal 14. However a person skilled in the art will appreciate that the particular location of the fluid remover can vary and the fluid removers can be positioned anywhere within the trocar.

[00109] FIGS. 3A-3C illustrate one embodiment of a fluid remover assembly 100 having a scraper and a sorbent. In particular, as best shown in FIG. 3B, the fluid remover assembly 100 can include a stabilization cup 106 coupled to a flange 108. The stabilization cup 106 can be formed from a sorbent material and the flange 108 can seat the cup 106 within the proximal housing 6 of the trocar 2, as shown in FIG. 3C. A scraper element in the form of a scraper disc 102 can be positioned between the flange 108 and the stabilization cup 106, and a sorbent ring 104 can be coupled to a distal surface 103 of the scraper disc 102. The scraper disc 102 can have a central opening 105 extending therethrough and configured for scraping fluid off of surgical instruments passed through the working channel 4 of the trocar 2. As an instrument is passed through the working channel 4, fluid can be scraped by the scraper disc 102 and sorbed by the sorbent ring, as well as by the stabilization cup. As can be seen in FIG. 3B, the flange 108, scraper disc 102, and sorbent ring 104 can each optionally include cut-outs 110 to fit around the stop-cock 13 associated with the trocar 2. In use, the fluid remover assembly 100 can be formed as a drop-in unit that fits within the proximal housing 6 of the trocar 2. As shown in FIG. 3C, the assembly 100 can be seated in a distal portion of the proximal housing 6 at a location just distal of the duckbill seal 24. The fluid remover assembly 100 will thus remove fluid from instruments passed through the working channel 4 of the trocar, thereby preventing fluid from being deposited onto the seals, and in particular the instrument seal 14, and/or redeposited onto instruments passed through the working channel 4.

[00110] FIGS. 4A-4C illustrate another embodiment of a fluid remover assembly 114 that is similar to the assembly shown in FIGS. 3A-3C, however in this embodiment the assembly 114

does not include a stabilization cup. As shown, the fluid remover assembly includes a substantially planar circular scraper disc 116 having a central opening 115 for receiving a surgical instrument. The scraper disc 116 can be seated within a flange or retainer ring 118 configured to be positioned within the proximal housing of a trocar. A sorbent ring 120 can be positioned adjacent to a distal surface 117 of the scraper disc 116 and it can act to sorb any fluid that is scraped off of instruments passed through the scraper disc 116. When disposed within a trocar, the flange 118 can act as a support structure to hold the scraper disc 116 and the sorbent ring 120 in a fixed position within the proximal housing. While the position can be distal to the duckbill seal, as indicated above the assembly can be located at various other portions within the trocar, including between the duckbill seal and the instrument seal, proximal to the instrument seal, or within any portion of the cannula.

[00111] In another embodiment, shown in FIGS. 5A-5C, a fluid remover assembly 122 is provided and can have a generally conical configuration with a scraper 124 having a proximal generally planar flange 125 and a conical body 126 extending distally therefrom and defining a central opening 128. The conical body 126 can have a plurality of slits 127 extending proximally from a distal end thereof and designed to reduce insertion and withdrawal forces on a surgical instrument passed therethrough. The conical body 126 can be surrounded by a conical sorbent element 130 such that the conical body 126 is nested within the conical sorbent element 130. When assembled and disposed within a trocar, as shown in FIG. 5C, the flange 125 can be seated within the proximal housing 6 just below the duckbill seal 24 and it can mate to or engage the inner sidewall of the housing 6 to retain the fluid remover assembly therein. In use, as an instrument is passed through the working channel, the scraper 124 can engage and scrap fluid off of the instrument and the sorbent element 130 can sorb the fluid. A person skilled in the art will appreciate that any number of geometries can be used in a similar way. Also, a size or diameter of a flange can be adjusted as needed, or the flange can be removed, to seat the fluid remover assembly at other locations within the trocar.

[00112] FIGS. 6A-6C illustrate additional embodiments of conical scrapers 132a, 132b, 132c that are similar to the scraper 124 described above and shown in FIGS. 5A-5C. As with the previous embodiment, the scrapers 132a, 132b, 132c in FIGS. 6A-6C are positioned distal to the duckbill seal 24. Such a configuration can prevent fluid on instruments being inserted and/or

withdrawn from being deposited onto the duckbill seal, as well as the more-proximally located instrument seal 14. In an exemplary embodiment, each scraper 132a, 132b, 132c can be made from a pliable material and can include at least one slit formed therein and configured to allow the scrapers 132a, 132b, 132c to radially expand. A variety of configurations are available for the slit(s). In the embodiment shown in FIG. 6A, a single slit 134 extends diagonally around the scraper 132a such that the slit 134 follows the shape of the cone. In another embodiment shown in FIG. 6B, multiple slits 137 extend proximally from the distal end of the cone and terminate at a location 139 just distal to the proximal end. Such a configuration can yield a scraper having multiple scraping segments 138. As further shown in FIG. 6B, each scraping segment 138 can also include a notch or cut-out 140 formed in an outer surface at the distal end thereof to allow the segment 138 to expand and contact as instruments are passed therethrough. FIG. 6C illustrates another exemplary embodiment of a cone shaped scraper 132c. Similar to the scraper 132b shown in FIG. 6B, the scraper 132c includes several slits 142 that extend proximally from the distal end thereof. In this embodiment, however, the slits 142 increase in width in a distal to proximal direction such that each scraping segment 143 has a distal end 144 with a width that is greater than a width of a proximal end 145 thereof. As indicated above, in use the slit(s) 134, 137, 142 formed in the scrapers 132a, 132b, 132c allow the scrapers to radially expand as a surgical instrument is passed therethrough, thus accommodating instruments of various sizes while still being effective to scrape fluid off of the instruments.

[00113] FIG. 7 illustrates another embodiment of a fluid remover positioned just distal of a channel seal, e.g., duckbill seal 150, in a proximal housing of a trocar. In this embodiment, the fluid remover is in the form of sorbent flapper doors 152. The flapper doors 152 can have various shapes and sizes, and they can be formed from any number of components. For example, the flapper doors 152 can be in the form of two sidewalls 153 that are movable relative to one another. The sidewalls 153 can have a profile that is similar to the profile of the duckbill seal 150. In other embodiments, the flapper doors 152 can have a shape that corresponds to the shape of the duckbill seal 150. A person skilled in the art will appreciate that various configurations are possible. The flapper doors 152 can be seated inside the proximal housing 6 and attached to the housing 6 by any attachment means known in the art, including by mechanical means, adhesives, etc. The flapper doors 152 can define an opening 154 therebetween for receiving a surgical instrument, and the opening 154 can be positioned just

distal of the seal face 151. In use, the flapper doors 152 can move from a closed or substantially closed position to an open position as an instrument is passed through the duckbill seal 150 and the flappers door 152. The doors 152 can contact and engage the surgical instrument as it is being passed therethrough to sorb fluids off of the instrument. The flapper doors 152 can also sorb any excess fluid that is scraped off of the instrument by the duckbill seal 150 and that falls distally from the duckbill seal 150.

[00114] In a similar embodiment, shown in FIG. 8, the fluid remover can be in the form of a wicking element rather than a sorbent. In the illustrated embodiment, the wicking element is in the form of first and second wicking fingers 160a, 160b that are coupled to opposed outer edges 162 of the seal face 161 on the duckbill seal 163. The wicking fingers 160a, 160b can be in the form of elongate members that follow the natural shape of the inner sidewall 165 of the proximal housing 6 of the trocar 2 so that fluid will run naturally down the fingers 160a, 160b. The wicking fingers 160a, 160b can also include a sorbent reservoir 164 disposed on a distal end thereof. In the illustrated embodiment, the sorbent reservoir 164 on each finger 160a, 160b is in the shape of ring seated within the proximal housing 6 and effective to sorb the fluids wicked away from the duckbill seal 163 by the wicking fingers 160a, 160b. The sorbent reservoir 164 can, however, have various other configurations such as ring segments. In use, as fluids are deposited on the duckbill seal 163 by instruments passing therethrough, the fluid will naturally flow to outer corners or edges of the seal face 161. The surface difference between the wicking fingers 160a, 160b and the duckbill seal 24 will cause fluid to flow from the seal 163 to the fingers 160a, 160b and down the fingers 160a, 160b into the sorbent reservoir 164. As will be appreciated by those skilled in the art, the wicking fingers 160a, 160b can be formed integrally with the duckbill seal 163 or can simply be in close contact with sealing face 161 of the duckbill seal 163.

[00115] FIG. 9 illustrates another embodiment of a fluid remover that is positioned distal of a zero-closure seal. Similar to the embodiment shown in FIG. 7, the fluid remover is in the form of a sorbent. However, in this embodiment the sorbent is a sorbent grommet 172. The grommet 172 can have a generally circular or conical configuration with an opening 173 formed therethrough, as shown, but it can have any number of other geometries to facilitate passage of an instrument therethrough. The grommet 172 can also include multiple slits 174 formed therein

and extending radially outward from the opening 173 to reduce insertion and withdrawal forces on an instrument being passed therethrough. In use, the grommet 172 can be seated within a distal portion of the proximal housing 6 of the trocar, just distal of the duckbill seal 166, and the opening 173 can be positioned coaxial with the working channel 4. As a surgical instrument is passed therethrough, the grommet 172 will contact the instrument and sorb any fluid on the instrument. The grommet 172 can also sorb any fluid that drips off of the duckbill seal 166 as the seal 166 scrapes the instrument.

[00116] In other embodiments, the zero-closure seal itself can be modified to include a fluid remover. For example, FIGS. 10A and 10B illustrate another embodiment of a duckbill seal 176 in which the seal face 168 is extended distally and expanded in width to cause the outer ends of the seal face 168 to contact the inner sidewall 169 of the proximal housing 6 of the trocar, thereby forming a wicking element. In use, when an instrument is passed through the duckbill seal 176, the seal face 168 will scrape fluid off of the instrument. The fluid will naturally run outward toward the outer-most edges of the seal face 168. Since the outer edges are in contact with the inner sidewall 169 of the proximal housing 6, the fluid will be wicked away from the seal face 168 and onto the inner sidewall 169 of the housing 6. While not shown, the housing 6 can optionally include a sorbent disposed therein for sorbing the fluid wicked away from the seal.

[00117] FIG. 11 illustrates another embodiment of a modified zero-closure seal 186. In this embodiment, a sorbent element 180 is nested inside of the duckbill seal 177, and a second duckbill seal 178 is nested within the sorbent element 180. The nested sorbent 180 and the nested duckbill seal 178 can have two sealing walls, 182, 184 similar to the duckbill seal 177, that meet at a seal face that is configured to form a seal when no instrument is disposed therein and that are configured to open when a surgical instrument is passed therethrough. The body of the nested sorbent 180 and the nested duckbill 178 can each have a profile similar or identical to the duckbill seal 177, except smaller in size to all fit for a nested configuration. The components 177, 178, 180 can merely be seated within one another, or they can be attached to one another using various attachment mechanisms known in the art, including a press fit, glue, etc. In use, the seal face of all three components will contact a surgical instrument as it is passed through the seal assembly. The sorbent 180 will thus sorb any fluid on the instrument, as well as fluid

scraped off of the instrument by the duckbill seal 177 and the nested duckbill seal 178.

[00118] FIGS. 12A-12B illustrate another embodiment of a modified zero-closure seal 190. In this embodiment, the duckbill seal 191 includes two sorbent bars 192 disposed therein and extending thereacross. The sorbent bars 192 can be positioned to extend substantially parallel to the seal face 193, or to extend substantially perpendicular as shown. The seal 190 can also include a sorbent ring 194 positioned around an inner sidewall 193 of the duckbill seal 191 and in contact with the sorbent bars 192. The sorbent ring 194 can provide a reservoir for fluid collected by the sorbent bars 192. In use, the sorbent bars 192 will contact and engage a surgical instrument as it is passed through the duckbill seal 191, and will thus sorb fluid away from the surgical instrument.

[00119] As indicated above, the various fluid remover embodiments disclosed herein can be located anywhere within a trocar or other access device, including distal of a channel seal, between a channel seal and an instrument seal, or proximal of an instrument seal. The position of the fluid remover can also vary relative to an insufflation port, as will be discussed in more detail below. The fluid removers can also be formed integrally with the seal(s) and/or portions of the housing, and any combination of fluid removers can be used. FIGS. 13-22B illustrate various exemplary embodiments of fluid removers that are formed integrally or incorporated into an instrument seal, or located adjacent to an instrument seal and thus proximal to a channel seal.

[00120] Turning first to FIG. 13, in this embodiment the fluid remover 200 is in the form of a combination scraper and sorbent. In particular, the fluid remover 200 includes a generally planar circular scraper disc 202 having an opening 204 formed therethrough and configuration to be positioned coaxial with the working channel 4 in the trocar 2. The opening 204 can be sized and configured to form a seal around an instrument passed therethrough. The fluid remover 200 can also include a sorbent disk 206 disposed concentrically around the opening 204 in the scraper 202. In use, the scraper 202 will scrape fluid off of instruments passed therethrough, and the sorbent disk 206 will sorb the scraped fluid. The fluid remover 200 can be disposed within the proximal housing 6 of the trocar 2 using various techniques, but as shown in FIG. 13 the fluid remover 200 is configured to be engaged between the removable cap 5 and the distal portion of the proximal housing 6 of the trocar 2. As a result, the scraper 202 and sorbent 206 will be

positioned in alignment with the working channel 4 extending through the housing 6, and will also be positioned between the proximal instrument seal and the distal channel seal.

[00121] FIG. 14 illustrates another embodiment of a fluid remover 210 having a combination scraper and sorbent, however in this embodiment the fluid remover 210 is fully disposed within the removable cap 5 containing the instrument seal. As shown, a scraper 212 can be cone shaped and can be positioned just distal of the instrument seal. In other embodiments the scraper 212 can be planar. The scraper 212 can also replace or function as the instrument seal. A sorbent ring 214 can be positioned concentrically around and in contact with an opening 216 in the distal end of the of the conical scraper 212. As a result, the sorbent ring 214 will sorb any fluid scraped away from a surgical instrument extending through the scraper 212.

[00122] In yet another embodiment, shown in FIGS. 15A and 15B, the fluid remover can be in the form of a scraper that is part of the instrument seal 218. As shown, the instrument seal 218 is a multi-layer seal having the protector disposed on a proximal surface thereof, as previously described with respect to FIG. 1E. The scraper can be in the form of a second protector 222 that is disposed distal to the multi-layer seal segments. The second protector 222 can have the same configuration as the protector of FIG. 1E, however the second protector 222 can define an opening 224 that is configured to contact and engage a surgical instrument passed through the seal 218. Accordingly, in use, the second protector 222 can engage and scrape fluid away from instruments passed through the seal 218.

[00123] In another embodiment, shown in FIG. 16, the fluid remover can be in the form of a multi-layer sorbent that is positioned between the multiple layers 20 of the seal 16, as shown, or that is positioned between the multiple layers 22 of the seal protector 18. The sorbent can be in the form of multiple sorbent sheets 232 that are layered in between the layers of the seal 16 (or seal protector 18). Thus, in use, when an instrument is passed through the instrument seal, the sheets 232 will sorb any fluids scraped off of the instrument by the seal 14, thereby preventing fluid from accumulating around the opening of the seal 14 and being reapplied to a surgical instrument as it is reinserted therethrough. The sorbent sheets 232 can be effective to sorb fluid, as well as to interrupt surface tension and/or capillary action between the seal and the protector. Thus, there should be no fluid in or near the seal opening and/or protector opening that will be

able to touch or collect on an instrument being passed therethrough.

[00124] FIG. 17 illustrates another embodiment of a sorbent fluid remover. In this embodiment, the sorbent is in the form of a grommet 242 having a configuration similar to the grommet 172 previously described with respect to FIG. 9. However, in this embodiment the grommet 242 is positioned adjacent to a distal surface 244 of the instrument seal 14, rather than the zero-closure seal 24. In particular, as shown in FIG. 17, the grommet 242 can be disposed concentrically around a distal opening 246 formed in the removable cap 5 such that instruments passed through the instrument seal 14 will contact the grommet 242, which will sorb fluids off of the instrument. The grommet 242 can also sorb any fluid that is scraped from or drips from the instrument seal 14.

[00125] In another embodiment shown in FIGS. 18A and 18B, a wicking element is formed integrally with the multi-layer seal protector 18 previously described with respect to FIG. 1E. As previously explained, the multi-layer seal 16 can have a natural shape that is slightly conical and it can include an opening sized to receive an instrument therethrough. The protector 18 likewise has an opening, however in the embodiment shown in FIGS. 18A and 18B the length of a protector 240 is decreased to thereby increase the diameter of the opening defined by the protector 18. As a result, the protector 240 will have an opening that is larger than the opening in the seal 16 to create a flattened profile against the conical shape of the seal 16, thereby creating a gap between the protector 240 and seal 16. As surgical instruments are removed from the trocar, the gap will prevent fluids from collecting between the layers 20 of the seal 16 and will allow the protector 240 to wick fluids away from the opening of the seal 16. Thus, if fluid is deposited on the seal 16, there will be no capillary action to hold the fluid between the seal 16 and the protector 240, thereby allowing the fluids to drain. In addition, when an instrument is passed through the protector 240 and seal 16, the gap created between the seal 16 and protector 18 will prevent fluid from being squeezed from between the seal 16 and protector 240 and onto an instrument.

[00126] In another embodiment shown in FIGS. 19A and 19B, the multi-layer seal protector 248 has a wicking element in the form of camming ribs 250 disposed on a surface of each individual protector layer 249 so that the ribs 250 create pockets between the layers for wicking away and

retaining fluid scraped off of instruments by the instrument seal. In the illustrated embodiment, the ribs 250 are offset by 90 degrees, although other geometries are possible as will be appreciated by those skilled in the art. In one embodiment, the ribs 250 can be disposed on a top or proximal surface of the protector. Thus, as a surgical instrument is passed through the instrument seal 14, the instrument will contact the ribs 250 to thereby cam open the protector 248 and the seal, preventing the surgical instrument from coming into contact with the surface of the protector 248 and/or the seal. In another embodiment, the ribs 250 can be disposed on a bottom or distal surface of the protector, thereby creating a gap between the protector 248 and the seal to prevent capillary action and the trapping of fluid between the seal and protector 248.

[00127] FIGS. 20A and 20B illustrate another embodiment of an instrument seal 254 having ribs for wicking fluid away from an opening in the seal 254. In this embodiment, the instrument seal 254 is in the form of a deep cone seal having a flange 260 with a conical sidewall 262 extending distally therefrom. A distal portion 264 of the conical sidewall 262 tapers inward to define an opening 258 in the distal end 264 of the seal 254. In the embodiment shown in FIG. 20A, the sidewall 262 can include one or more ribs 266 formed on an external surface 261 thereof and extending between proximal and distal ends of the sidewall 262, terminating at the opening 258. The external ribs 266 can be effective to wick fluid away from the opening 258 in the seal 254. In the embodiment shown in FIG. 20B, the ribs 266 are formed on the inner surface 268 of the sidewall 262 and extend between proximal and distal ends of the sidewall 262, terminating at the opening 258. The ribs 266 will thus have a camming effect, causing any instrument inserted through the seal 254 to contact the ribs 266 to cam open the seal 254, rather than contacting an inner surface 268 of the seal 254.

[00128] In another embodiment, shown in FIG. 21, the multi-layer seal protector 269 can include a plurality of holes 270 formed in the individual layers 271 of the protector 269 to form a wicking element for wicking fluid away from the seal. As fluid is trapped between the protector 269 and the seal when an instrument is passed through the instrument seal, the holes 270 act to wick away fluid from the seal and from the opening in the seal. The fluid can be retained within the holes 270 by surface tension so that an instrument passed through the seal will not contact the fluid retained in the holes 270.

[00129] Various other modifications can also be made to the multi-layer seal protector previously described in FIG. 1E to remove fluid from the seal or from instruments passed through the seal. In another embodiment, shown in FIGS. 22A and 22B, the protector segments 272 can include surface features, such as a roughened surface 276, formed on the distal surface thereof. As shown in FIG. 22B, when the protector segments 272 are positioned against the seal segments 20, the roughened surface 276 will create a gap that separates the protector 273 from the seal, thus providing a path for fluid to wick away from the opening in the seal and from between the protector 273 and the seal.

[00130] FIGS. 23A-23B illustrate another embodiment of a seal 280 that is configured to remove fluid. In this embodiment, the seal 280 has an hourglass configuration such that the seal 280 is a combination trocar and instrument seal. In other words, the seal 280 is effective to both form a seal within the working channel of the trocar when no instrument is disposed therethrough and to form a seal around an instrument disposed therethrough. The hourglass shape of the seal 280 allows a central portion 282 of the seal 280, which in a natural state is in a closed configuration as shown in FIG. 23A, to open and engage an instrument passed therethrough, as shown in FIG. 23B, and thereby scrape any fluid off of the instrument. Due to the curvature in inner sidewalls 284 of the seal 280, the removed fluid will flow away from the central portion thus preventing the fluid from being redeposited onto an instrument reinserted therethrough. The hourglass configuration of the seal 280 is also advantageous in that it will accommodate instruments of various sizes. The central portion 282 can also move or float relative to the central axis of the working channel in the trocar, thus accommodating off-axis instruments.

[00131] FIGS. 24A-29 illustrate various other exemplary embodiments of fluid removers. While certain embodiments are described as being disposed or formed in the cannula, a person skilled in the art will appreciate that, as with previous embodiments, the embodiments of FIGS. 24A-29 can likewise be disposed at various locations within a trocar and that various combinations of fluid removers can be used.

[00132] In the embodiment shown in FIGS. 24A and 24B, the fluid remover is in the form of a plurality of scraper elements that extend at least partially across the working channel 4 of the

cannula 8. The scraper elements can be relatively thin and can take the shape and form of wipers 292, as best shown in FIG. 24B, that will scrape or squeegee fluid off of a surgical instrument passed through the cannula 8. The wipers 292 can be fixedly or hingedly coupled to an inner sidewall 294 of the cannula 8, and they can be flexible to accommodate instruments of various sizes, and to allow both insertion and withdrawal of the instruments. The cannula 8 can also include any number of wipers 292, and the wipers 292 can be spaced apart from one another, or they can be in a stacked configuration. The wipers 292 can have a conical configuration such that each wiper 292 extends around the entire inner diameter of the cannula 8. Alternatively, the wipers 292 can be formed into individual segments that are positioned a distance apart from one another, e.g., approximately 90 degrees apart within the interior surface 294 of the cannula 8. The segments can be layered within the cannula 8 so that different parts of the surgical instrument come into contact with the wipers 292 at different heights as the instrument is being passed therethrough. The wipers 292 can also be in contact with a sorbent element 296, or include a sorbent portion, such that the collected fluid drips onto or is wicked into the sorbent material and away from possible contact with a reinserted instrument. As shown in FIGS. 24A-24B, the sorbent element 296 is located adjacent to the inner sidewall 294, and thus radially outward from the wiper body 292. The sorbent elements 296 can be formed into a wall of the cannula 8, so that the cannula 8 is partially formed from the sorbent elements 296. The sorbent elements 296 can also be formed within grooves in the cannula wall and/or can be adhered directly to the cannula wall by any attachment mechanism known in the art, for example an attachment ring 297. In use, as an instrument is passed through the cannula 8, the instrument will be scraped on all sides simultaneously by the plurality of wipers 292. The fluid will flow outward where it will be sorbed by the sorbent element 296.

[00133] FIGS. 25 illustrates another exemplary embodiment of a scraper 300. In this embodiment, the scraper 300 is substantially cone shaped increasing in diameter in a distal direction. A proximal end 302 of the scraper 300 includes an opening 304 formed therethrough, and a fluid collection member is formed at a distal end 306 thereof and extends inwardly. The fluid collection member can have a variety of configurations and can be generally configured to collect fluid scraped by the scraper 300. In one exemplary embodiment, as shown, the fluid collection member can be in the form of a substantially C-shaped lip 308 extending inwardly from the distal end 306 of the scraper 300. At least a portion of the fluid collection member can

also optionally be sorbent thereby enabling the fluid collection member to both collect and sorb fluid scraped by the scraper. The scraper 300 can be formed from a pliable material such that it can radially expand to engage a surgical instrument extending therethrough. In use, the narrow proximal end of the scraper 300 can engage a surgical instrument passed therethrough to thereby scrape fluid away from the instrument. The fluid scraped away from the instrument will run down an inner surface 310 of the scraper 300 and be collected and/or sorbed by the fluid collection member disposed at the distal end 306 of the scraper 300. While the scraper 300 is generally indicated as being disposed in the cannula 8, the scraper 300 can likewise be disposed anywhere within the trocar 2, including in the proximal housing 6.

[00134] FIG. 26 illustrates another exemplary embodiment of a scraper 312. In this embodiment, the scraper 312 includes first and second rotatable members 314a, 314b that are configured to rotate and engage a surgical instrument as the instrument is passed therethrough. The first and second rotatable members 314a, 314b can have a variety of shapes and sizes. In the illustrated embodiment, the first and second rotatable members 314a, 314b are spool shaped. The spools can be configured such that the geometry of second member 314b complements that of the first member 314a. As shown, the first member 314a includes a substantially spherically shaped central portion 316 that corresponds with a concave cut-out 318 in the second member 314b. The geometry of the spools can have several shapes including, but not limited to, straight sided cylindrical, c-shaped, and indented cylindrical. The first and second rotatable members 314a, 314b can be positioned at a variety of locations in the cannula, or within the proximal housing of a trocar, and they can be formed from a variety of materials including, but not limited to, rigid, pliable, and sorbent materials. In use, the rotatable members 314a, 314b can rotate and engage a surgical instrument passed therethrough to thereby scrape and optionally sorb fluid away from the instrument.

[00135] FIGS. 27A-27C illustrate another embodiment of a fluid remover in the form of a removable tip or sleeve 322 that can be removably coupled to a distal end 324 of the cannula 8. As shown, the sleeve 322 is in the form of a generally cylindrical housing with a tapered distal end 326, similar to the distal end 324 of the cannula 8. A proximal end 328 of the sleeve 322 can be sized to fit over and engage the distal end of the cannula 8, e.g., by interference fit, and the distal end of the housing can include an opening 330 formed therein and sized to receive a

surgical instrument therethrough. The sleeve 322, or at least a portion of the sleeve 322 surrounding the opening 330 at the distal end 326, can be formed from a compliant or expandable material to allow the opening in the sleeve 322 to radially expand as an instrument is passed therethrough. Exemplary compliant materials include, but are not limited to, polyisoprene, pellathane, and silicone. In use, as a surgical instrument is passed through the opening 330 in the sleeve 322, the opening 330 will scrape fluid off of the instrument, thereby preventing the fluid from being dragged into the trocar and deposited on the seals.

[00136] In another embodiment shown in FIG. 28, an hourglass shaped seal 340, similar to the seal 280 described with respect to FIGS. 23A-23B is provided, however the seal 340 includes a wicking element in the form of one or more cut-outs or slots 342 formed in the central, reduced-diameter portion 344. Similar to the seal 280 previously described with respect to FIG. 23A and 23B, the hourglass shape will allow the central portion 344 to scrape or squeegee fluid from a surgical instrument passed therethrough. The cut-outs or slots 342 will allow the scraped fluid to be wicked through the slots 342 to an exterior surface 346 of the seal 340.

[00137] In another embodiment shown in FIG. 29, the wicking element can take the form of a plurality of slots 350 formed in the working channel 4 of a cannula 352. The slots 350 can have any size and shape sufficient to transfer fluid disposed on an inner surface of the cannula 352 to an outside surface 354 of the cannula 352. Thus, as an instrument is passed through the cannula 352, any fluid that drips down the inner surface of the cannula 352 will be transferred to the external surface 354 of the cannula 352 through the slots 350.

[00138] FIGS. 30A-30J illustrate another embodiment of a trocar 400 having a fluid remover 430 disposed therein. As shown, the trocar 400 has a proximal housing 402 and a distal cannula 404 with a working channel 408 formed through and extending between proximal and distal ends 400a, 400b thereof. The housing 402 can include one or more seals that are effective to seal the working channel 408, i.e., to prevent the escape of insufflation, when no instrument is disposed therethrough and/or when an instrument is disposed therethrough. As shown in FIGS. 30B and 30C, the housing 402 includes a proximal instrument seal, in the form of a multi-layer seal 412, that is effective to form a seal around an instrument inserted therethrough, and a distal channel seal, such as a duckbill seal 410, that is effective to seal the working channel when no instrument

is inserted therethrough. One exemplary embodiment of a duckbill seal 410 that can be used with the present invention is disclosed in U.S. Patent Application Serial No. 11/771,263 filed on June 29, 2007 and entitled "Duckbill Seal With Fluid Drainage Feature," by Paul T. Franer and Thomas A. Gilker. Such a duckbill is particularly useful as it has a low profile and has fluid drainage features that can assist in further preventing fluid from being redeposited onto instruments inserted through the seals. A person skilled in the art will appreciate that any number, type, and configuration of channel and/or instrument seals can be positioned within the housing 402 at various locations. The housing can also include an insufflation port 406 is formed in the housing 402 for providing an insufflation gas to the working channel 408.

[00139] As indicated above, the housing 402 can include a fluid remover 430 positioned therein and configured to remove fluid from a surgical instrument inserted therethrough. The fluid remover 430 can have an opening 470 formed through a center portion thereof, in axial alignment with the working channel 408, for receiving a surgical instrument. The opening 470 can be effective to remove fluid from a surgical instrument upon insertion and/or withdrawal therethrough. In an exemplary embodiment, the fluid remover 430 is preferably positioned distal to the seals 412, 410 so that fluid collected on the instrument when disposed in a body cavity can be removed from the surgical instrument before it is withdrawn through the seals 412, 410, thus preventing the fluid from being deposited on the seals and thereafter deposited onto an instrument inserted into the trocar. In order to position the fluid remover 430 distal to the seals 412, 410, the fluid remover 430 will positioned proximal to, distal to, or in the path of the insufflation port. Where the fluid remover 430 is positioned in the path of or distal to the insufflation port, it is preferably configured so that it does not block the path of an insufflation gas from the port through the distal cannula 404. During many surgical procedures using a trocar, insufflation is used to expand the body cavity into which the trocar extends. Trocars can thus have an insufflation port, such as the port 406 shown in FIGS. 30A-30C, that is positioned distal to the seals 412, 410 so that the seals are effective to prevent gas from flowing out of the proximal housing 402. In this way, a constant flow of gas is maintained through the distal cannula 404 and into the body cavity. Since the port 406 is positioned distal to the seals 412, 410, in an exemplary embodiment, in order to maintain a low profile housing and position the fluid remover 430 distal of the seals, the fluid remover 430 can be positioned adjacent to or distal to the port 406. As such, the fluid remover 430 is preferably configured to allow air to pass

therethrough and/or therearound such that it does not block the flow of insufflation gas from the port 406 to the cannula 404 when an instrument is inserted through the opening 470 in the fluid remover 430. In other words, the fluid remover 430 can have a configuration that allows the passage of insufflation gas from the port 406 to the distal cannula 404 even when an instrument is disposed through the fluid remover 430. FIGS. 30A-30J illustrate one such embodiment of the fluid remover 430 that is in the pathway of the flow of gas from the port 406 to the cannula 404. In this embodiment, a cut-out or pathway is provided in a portion of the fluid remover 430 to allow the passage of gas therethrough from the port 406 to the cannula 404, as will be discussed in more detail below. The fluid remover 430 can also include other features to facilitate the passage of gas therethrough, as will be discussed in more detail below.

[00140] The fluid remover 430 can have various configurations and it can include any one or more of a wicking element, a sorbent, and a scraper. FIGS. 30C-30F illustrate one embodiment of the fluid remover 430 that is positioned distal to the seals 412, 410 and in proximity to the insufflation port 406. The fluid remover 430 generally includes a sorbent 414 disposed within the housing and disposed around a crown 420, a scraper 422 positioned on a proximal surface of the crown 420, and a lid 418 positioned against a proximal surface of the scraper 422.

[00141] As shown in more detail in FIGS. 30F and 30G, the scraper 422 of the fluid remover 430 can have many shapes and configurations, but in the illustrated embodiment the scraper 422 is disc shaped and has an opening 424 formed through a center portion thereof. The scraper 422 can be configured to remove fluid from a surgical instrument passing through the opening 424 by contacting the surgical instrument and scraping and/or squeegeeing its circumference. In an exemplary embodiment, the scraper 422 is formed from a flexible and resilient material to allow the opening 424 of the scraper 422 to expand around and engage an outer wall of an instrument passed therethrough.

[00142] The scraper 422 can also include features to direct fluid flow. For example, as shown in FIG. 30G, the scraper can include one or more channels 422c formed in a distal surface thereof and extending radially outward from the opening 424 such that fluid scraped off of an instrument being withdrawn through the opening 424 will flow through the channels and radially away from the opening 424. As further shown in FIGS. 30F and 30G, the scraper 422 can also include one

or more holes 422h formed therethrough for receiving pins formed on the crown 420, as will be discussed in more detail below. The holes 422h allow the scraper 422 to rest on a proximal surface of the crown 420 and to be captured between the crown 420 and the lid 418. The holes 422h can also have a size that allows air to pass therethrough when the pins of the crown 420 are disposed therein. Such a configuration can assist in preventing the fluid remover 430 from functioning as a seal, as will be discussed in more detail below. In some embodiments, however, the scraper 422 can also be formed as an instrument seal and/or as a scraper for smaller diameter surgical instruments and a seal for larger diameter surgical instruments.

[00143] In certain exemplary embodiments, in order for the scraper 422 to effectively wick fluid radially outward from the opening and toward the sorbent, all or portions of the scraper can be formed from or can include a hydrophilic material. For example, the scraper can be formed from a hydrophilic material, such as a nylon, and/or the scraper can be spray coated, dip-coated, plasma etched, or otherwise coated using various known coating techniques, with a surfactant coating that renders the scraper or portions thereof hydrophilic. In an exemplary embodiment, where the scraper is formed from a hydrophobic material, such as a polyisoprene, a hydrophilic coating is applied to the scraper to render the scraper hydrophilic. The coating can be applied to any one or more of the surfaces of the scraper, and it can be applied at any stage during manufacturing. In one embodiment, the scraper can be soaked in a surfactant bath during manufacturing to render the entire scraper hydrophilic. Exemplary coating materials include, by way of non-limiting example, Dodecylbenzene sodium sulfonate (SDBS), and Sodium Dodecyl Sulfate (SDS). The coating is preferably one that remains stable during sterilization, such as gamma and thermal sterilization.

[00144] A person skilled in the art will appreciate that various factors can be altered to facilitate the wicking action of the scraper. For example, the contact angle of a drop of fluid on a hydrophilic surface of the scraper can be optimized so that fluid will spread upon contact with the surface. In certain exemplary embodiments, the hydrophilic material can have a low contact angle, such as 90 degrees or less. Other factors that can affect the ability of the scraper to wick fluid away from the opening include the smoothness of the surface, the geometry of the wicking channels, and the surface tension of the fluid being applied. For example, the channel geometry can be designed so as to provide the capillary forces necessary to drive fluid to a minimum

capillary height so that the fluid will extend just past the outer wall of the crown 420 to reach the sorbent 414. The channel geometry can be altered to achieve the desired capillary height. FIG. 30H illustrates one exemplary embodiment of a channel geometry that is optimized to facilitate the capillary action of the channel. As shown, the channel has a generally U-shaped cross-sectional shape, with the inner corners, located at the base of the channel, being rounded and having a radius of curvature r_1 , and the outer corners, located at the opening of the channel, being rounded and have a radius of curvature r_2 . The channel can also have a width w at the base, as measured between the opposed sidewalls of the channel, that differs from a width w_1 at the opening, as measured between the outer rounded corners, and that also differs from a maximum width w_2 as measured from the outer-most ends of the channel at the opening. The difference between width w and width w_1 is indicated by reference x . The channel can further have a maximum height h , as measured from the base to the outer-most ends of the channel at the opening, that differs from a height h_1 , as measured from the base to the outer rounded corners. The particular dimensions of the channel can vary. For example, the radius of curvature r_1 at the base of the channel can be less than the radius of curvature r_2 at the opening of the channel, and the width w at the base of the channel is less than the width w_1 at the opening, which in turn is less than the maximum width w_2 such that the width of the channel gradually increases from the base to the opening. In an exemplary embodiment, however, the width w at the base of the channel is preferably equal to or greater than the width w_1 at the opening. The dimensions and cross-sectional shape of the channel can also vary along the entire length of the channel. For example, the channel can have a height and/or width that increases or decrease radially outward, such that the height and/or width of the channel near the central opening in the scraper is either less than or greater than the height and width of the channel near the outer perimeter of the scraper. Each channel can also reach a maximum height and/or width at a certain distance from the central opening, and the height and/or width can then remain constant along the remainder of the channel extending radially outward from that location. A person skilled in the art will appreciate that the channel can be modified to obtain a desired capillary height so as to cause fluid to be driven from the scraper opening, past the crown, and to the sorbent.

[00145] As indicated above, other modifications can be made to achieve an optimum wicking effect. In another embodiment, the scraper and sorbent can both be configured to have a surface energy gradient, such that the surface energy increases as fluid travels from the opening in the

scraper, along the channels, and into the sorbent.

[00146] The fluid remover 430 can also include a scraper crown 420, shown most clearly in FIG. 30F, that can extend distally from a distal surface of the scraper 422 and that can assist in mounting the scraper 422 and sorbent 414 within the housing. The scraper crown 420 can have various configurations, but in the illustrated embodiment it has a ring shaped body 434 with multiple pins 436 extending proximally therefrom. The pins 436 can extend through the corresponding holes 422h formed in the scraper 422 and into holes 418h formed in the lid 418, as shown in FIG. 30J. The crown 420 and lid 418 can be mated to one another using various techniques, such as a pressed fit or interference fit, adhesive or welding, etc. By engaging the scraper 422 between the lid 418 and the crown 420, the scraper 422 can have an outer diameter that is less than an inner diameter of the housing 402 such that a gap G is provided between the scraper 422 and the housing 402, as shown in FIG. 30D. The gap G will allow air to flow proximally past the scraper 422.

[00147] As further shown in FIG. F, the scraper crown 420 can also include a cut-out 426 formed in a sidewall thereof. One or more flange members 440 can extend radially outward from a sidewall of the scraper crown 420 on each side of the cut-out 426 formed through the crown 420 to define a pathway. The flange members 440 can be positioned to axially align with the a cut-out formed in the sorbent 414 and a cut-out formed in the lid 418, as will be discussed in more detail below, to form a complete pathway that allows the flow of insufflation gas from the insufflation port 406, through the cut-outs, and to the working channel 408 into the distal cannula 404. This allows insufflation to be delivered through the cannula while an instrument is passed through the fluid remover 430 and occludes the working channel. The flange portions 440 can be positioned on either side of an opening 442 of the insufflation port 406, through which the insufflation gas flows. As a result, a pressure on each side of the fluid remover will be equalized.

[00148] The shaped scraper lid 418 is shown in more detail in FIGS. 30I and 30J, and it can have a generally circular or ring-shaped configuration that rests proximal to the scraper. In use, the lid 418 can serve to protect the proximal surface 432 of the scraper 422 from the insertion of sharp surgical instruments by acting as a guide or funnel for the surgical instrument into the

opening 424 of the scraper 422. As indicated above, the scraper lid 418 can include one or more holes 418h formed in a distal surface thereof for receiving the pins 436 formed on the crown 420. The scraper lid 418 can also include an opening 418o through which a surgical instrument can extend that is in axial alignment with the opening 424 formed in the scraper 422, and a cut-out 448 formed in a sidewall or perimeter of the scraper lid 418 that aligns with the cut-out 446 formed in the scraper crown 420 and the sorbent 414.

[00149] As shown in FIG. 30J, in one embodiment the scraper lid 418 can further include a circular bead or compression ridge 450 protruding distally beyond a distal-most surface thereof such that the ridge extends toward and presses against the proximal surface of the scraper 422 to hold the scraper 422 in controlled compression between the compression ridge 450 on the lid 20 and the proximal surface of the crown 420. The compression ridge 450 can also function to seal off and prevent fluid from flowing back toward the opening of the scraper 422.

[00150] While there can be many configurations for the fluid remover 430, in the embodiment shown in FIGS. 30B-30E, the fluid remover 430 also includes a sorbent 414 positioned circumferentially around the scraper crown 420 and configured to sorb fluid scraped by the scraper 422. As shown in FIG. 30F, the sorbent 414 can be configured to be positioned around the scraper crown 420, and thus can have a cut-out 444 formed therein that aligns with the cut-out 426 formed in the crown 420. The terminal ends of the sorbent 414 will thus abut the flange 440 on the crown 420. As a result, the sorbent 414 will be substantially C-shape. The cut-out 444 in the sorbent 414 will also allow air to flow all the way around the outside of the scraper 422, due to the gap G between the outer perimeter of the scraper 422 and the housing. The cut-out in the sorbent 414 will thus continue to allow air to pass by and around the scraper 422 in the event the sorbent 414 becomes clogged. This is particularly advantageous, as air forced to flow through the sorbent 414 could potentially push fluid out of the sorbent 414. The sorbent 414 can be secured around the scraper crown 420 using any method known in the art including, for example, an adhesive or simply by an interference fit between an interior wall of the housing 402 and the scraper crown 420. As will be appreciated by those skilled in the art, the sorbent 414 can have a solid ring shape, or any other shape, and it can be composed of multiple individual portions as needed.

[00151] While the sorbent 414 preferably has a shape that corresponds to the shape of the crown 420, the sorbent 414 can be configured to be compressed between the crown 420, the scraper 422, and the housing 402. Thus, the sorbent 414 can have an initial cross-sectional shape that is more square and it can deform into a shape that is more triangular. The sorbent 414 can be formed from various materials that allow it to be compressed, while still allowing the sorbent 414 to sorb fluid. The sorbent 414 can also be permeable such that air can flow therethrough.

[00152] The particular size of the sorbent 414 can also vary, but in an exemplary embodiment the sorbent 414 has an inner diameter that is greater than a diameter of the opening 424 in the scraper, such that the sorbent 414 will only contact the scraper 422 at a location radially outward of the opening 424. This will allow fluid to flow from the opening, through the channels 422c, and then sorbed by the sorbent. In an exemplary embodiment, the sorbent is positioned radially outward of the holes 422h formed in the scraper, as this allows the sorbent 414 to be positioned around the crown 420.

[00153] As indicated above, when the fluid remover 430 is fully assembled, it can rest within a distal portion of the proximal housing 402. The sorbent 414 can be positioned in contact with an inner surface of the housing 402, the crown 420 can be disposed within the sorbent 414, the scraper 422 can rest on the crown 420 and be positioned in contact with the sorbent, and the lid can be positioned on the scraper 422 and be mated to the crown 420. The lid 418 can optionally be sonic welded or otherwise fixedly mated to the housing 402 to secure the fluid remover 430 therein. As shown in FIG. 30F, the sorbent 414 can include surface features, such as longitudinally extending grooves 415 formed on an inner surface thereof and configured to align with and receive the pins 436 on the scraper crown 420.

[00154] When disposed within the housing 402, the fluid remover 430 will be positioned in the path of insufflation. In particular, referring again to FIGS. 30C and 30D, the insufflation port 406 has a lumen 460 extending therethrough. The lumen 460 defines a longitudinal axis LA and has a cylindrical interior surface with a proximal-most interior surface 462 and a distal-most interior surface 464. The fluid remover 430 is generally positioned in the pathway of the lumen 460 and more particularly, it is positioned such that the proximal-most interior surface 462 of the lumen 460 is positioned distal to the scraper 422 and the longitudinal axis LA extends through a

mid-portion of the sorbent 414. In other words, the sorbent 414 is positioned in the path of the flow of gas from the insufflation port 406 to the distal cannula. A person skilled in the art will appreciate that the various components of the fluid remover 430 can be positioned at various locations relative to the insufflation port 406. Since portions of the fluid remover 430 in the illustrated embodiment are positioned in the pathway of air flow from the insufflation port 406 to the distal cannula, the cut-outs 426 and 444 in the crown 420 and sorbent 414 will allow airflow to pass therethrough and into the distal cannula.

[00155] In use, a surgical instrument can be inserted through the seals 412, 410 and through the opening 470 in the fluid remover 430 as needed in a particular procedure. Using the insufflation port 406, insufflation gas can be introduced into the working channel 408 of the trocar 400 such that insufflation is achieved distal to the seals 412, 410 and to the fluid remover 430. The insufflation gas can travel along the pathway defined by the flange portions 440, through the cut-outs 426, 444 in the crown 420 and sorbent 414, respectively, and into the working channel 408 of the distal cannula 404. In this way, the fluid remover 430 can be distal to the seals 412, 410 to remove fluid from instruments being withdrawn while allowing the flow of insufflation gas into the distal cannula. As a surgical instrument is withdrawn from the working channel 408, fluid scraped from the surgical instrument by the scraper 422 flows radially outward and is sorbed by the sorbent 414, thus keeping the fluid away from any instrument that may be reinserted into the working channel 408. The fluid remover 430 thus allows for the removal of fluid from a surgical instrument at a position distal to the seals 412, 410 while also allowing the introduction of insufflation gas distal to both the seals 412, 410. A person skilled in the art will appreciate the variations possible for the positioning of seals and fluid removers to allow insufflation distal to both.

[00156] FIG. 31 illustrates another embodiment of a lid 418' for use with a fluid remover. In this embodiment, rather than including a cut-out 448 formed in a sidewall of the lid 418 for allowing air to pass by the lid 418 in a proximal direction toward the seals, the lid 418' includes a plurality of holes or openings 448' formed therein and positioned radially around a perimeter of the lid 418'. The lid 418' can include any number of holes at any location and having any size. The holes 448' are merely configured to prevent the fluid remover from forming a seal, if not needed, as it may be desirable to maintain a zero pressure differential across the fluid remover in

order to prevent air from forcing fluid out of the sorbent.

[00157] FIGS. 32A-32D illustrate yet another embodiment of a trocar 500 having a fluid remover 530 disposed therein. As shown, the trocar 500 has a proximal housing 502 and a distal cannula 504 with a working channel 508 formed through and extending between proximal and distal ends thereof. As shown in FIG. 32B, the housing 502 can include an instrument seal, such as a deep cone seal 512 (only a proximal rim is shown), positioned within a channel seal, such as a duckbill seal 510. A person skilled in the art will appreciate that any number, type, and configuration of channel and/or instrument seals can be positioned within the housing 502. The housing can also include an insufflation port 506 is formed in the housing 502 for providing an insufflation gas to the working channel 508.

[00158] In this embodiment, the fluid remover 530 differs from fluid remover 430 described above in that it is positioned more distal relative to the insufflation port. In general, the fluid remover 530 has an opening 570 formed through a center portion thereof, in axial alignment with the working channel 508, for receiving a surgical instrument. The opening 570 can be effective to remove fluid from a surgical instrument upon insertion and/or withdrawal therethrough. The fluid remover 530 is positioned distal to the seals 512, 510 so that fluid can be removed from the surgical instrument before it is withdrawn through the seals 512, 510 in order to prevent the deposit of fluid on the seals. As with fluid remover 430, fluid remover 530 can have a configuration that allows the passage of insufflation gas from the port 506 to the distal cannula 504 even when an instrument is disposed through the fluid remover 530. In particular, in this embodiment the fluid remover 530 is generally positioned in the pathway of the lumen 560 of the insufflation port 506 and more particularly, it is positioned such that the longitudinal axis LA of the lumen 560 extends through a substantially center portion of the scraper lid 518. The proximal-most interior surface 562 of the port is thus generally aligned with a top wall 556 of the scraper lid 518. As shown in FIG. 32B, the scraper 522 is thus positioned distal to the longitudinal axis LA of the lumen 560 and can generally be positioned in alignment with the distal-most interior surface 564 of the lumen 560. In other embodiments, the scraper 522 can be positioned entirely distal or proximal to the distal-most interior surface 564 of the lumen 460. A person skilled in the art will appreciate that the fluid remover 530 can be positioned in any number of ways relative to the lumen 560.

[00159] Since portion of the lid 518 and the scraper 522 are positioned in the path of insufflation, the lid 518 and scraper 522 in this embodiment can each have a cut-out 548, 546 that is positioned within the pathway of the insufflation gas to allow the gas to flow into the working channel 508, as shown in FIG. 32D. The cut-outs 548, 546 can align with the corresponding cut-outs 526, 544 in the crown 520 and the sorbent 514, respectively, similar to the crown 420 and sorbent 414 discussed above. As further shown in FIG. 32D, the scraper lid 518 can also include a rim or flange 550 extending around a proximal portion thereof and located proximal to the cut-out 548 formed in the sidewall of the scraper lid 518. As a result, the notch 546 is not a complete cut-out, but is defined on three sides by two opposed notch side walls 552a, 552b, and a top wall 556 and thus the top wall 556 can optionally serve as a proximal, sealed boundary for the insufflation gas pathway that will be described below. In an exemplary embodiment, the top wall 556 can be positioned in alignment with the proximal-most interior surface 562 of the lumen 560 in the insufflation port.

[00160] In another embodiment, all of the above described fluid remover embodiments can be formed into a single “drop-in” unit as needed. The drop-in unit can include sorbent elements, scraper elements, wicking elements, and/or combinations thereof. These elements can be combined as needed into an externally configured unit that can be placed into an existing trocar system as needed. Thus, the drop-in unit will fit in and around any seals and components disposed within the proximal housing, including the removable cap, and/or within the cannula. For example, the drop-in unit can be configured to fit below or distal to one or more sealing elements and/or it can be configured to fit above or proximal to one or more sealing elements. Alternatively or in addition, the drop-in unit can be configured to have components that fit above, below, or in between sealing elements. The drop-in unit can also include the seals therein such that the entire unit can be placed into an empty housing of a trocar. The drop-in unit can also be removable as needed, and the unit, or portions thereof, can be reusable.

[00161] Methods for removing fluid from a surgical instrument are also provided. In an exemplary embodiment, a surgical instrument can be passed through an access device and a fluid remover in the access device can remove any fluid on the instrument, or fluid deposited on a seal within the access device by the instrument. In one exemplary embodiment, a fluid remover can engage a surgical instrument passed through an access device, such as a trocar, upon removal of

the instrument to thereby remove fluid from the instrument, thus preventing the fluid from accumulating on the seal(s) and/or from being redeposited on instruments passing therethrough. As indicated above, the fluid remover can be formed from any combination of one or more sorbing, scraping, and wicking elements. A person skilled in the art will appreciate that virtually any combination of sorbing, scraping, and wicking elements can form the fluid remover resulting in a variety of methods for removing fluid that can include any combination of sorbing, scraping, and wicking fluid away from a surgical instrument and/or from a seal or other portion of a trocar or other access device.

[00162] A person skilled in the art will appreciate that the present invention has application in conventional endoscopic and open surgical instrumentation as well application in robotic-assisted surgery.

[00163] The devices disclosed herein can be designed to be disposed of after a single use, or they can be designed to be used multiple times. In either case, however, the device can be reconditioned for reuse after at least one use. Reconditioning can include any combination of the steps of disassembly of the device, followed by cleaning or replacement of particular pieces, and subsequent reassembly. In particular, the device can be disassembled, and any number of the particular pieces or parts of the device can be selectively replaced or removed in any combination. By way of non-limiting example, the scraper and/or sorbent can be removed, cleaned, re-coated with a hydrophilic material, sterilized, and reused. Upon cleaning and/or replacement of particular parts, the device can be reassembled for subsequent use either at a reconditioning facility, or by a surgical team immediately prior to a surgical procedure. Those skilled in the art will appreciate that reconditioning of a device can utilize a variety of techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

[00164] Preferably, the devices described herein will be processed before surgery. First, a new or used instrument is obtained and if necessary cleaned. The instrument can then be sterilized. In one sterilization technique, the instrument is placed in a closed and sealed container, such as a plastic or TYVEK bag. The container and its contents are then placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, or high-energy electrons. The

radiation kills bacteria on the instrument and in the container. The sterilized instrument can then be stored in the sterile container. The sealed container keeps the instrument sterile until it is opened in the medical facility.

[00165] It is preferred that device is sterilized. This can be done by any number of ways known to those skilled in the art including beta or gamma radiation, ethylene oxide, steam.

[00166] One skilled in the art will appreciate further features and advantages of the invention based on the above-described embodiments. Accordingly, the invention is not to be limited by what has been particularly shown and described, except as indicated by the appended claims. All publications and references cited herein are expressly incorporated herein by reference in their entirety.

[00167] What is claimed is:

CLAIMS:

1. A surgical access device, comprising:
 - a proximal housing, a distal cannula, and a working channel extending through the proximal housing and the distal cannula that is sized and configured to receive a surgical instrument;
 - a seal disposed within the proximal housing configured to seal the working channel when no surgical instrument is disposed therethrough, the seal having an opening extending therethrough and positioned to receive a surgical instrument passed through the working channel;
 - and
 - a fluid remover positioned distal of the seal, the fluid remover having an opening extending therethrough and positioned to receive a surgical instrument passed through the working channel, and the fluid remover being configured such that, when an instrument occludes the opening in the fluid remover, the fluid remover allows insufflation gas to pass from the distal cannula to a proximal side of the fluid remover to thereby equalize a pressure on proximal and distal sides of the fluid remover.
2. The surgical access device of claim 1, wherein the fluid remover is positioned such that it is configured to be in a pathway of an insufflation gas flowing from an insufflation port formed in the proximal housing.
3. The surgical access device of claim 1, wherein the fluid remover includes a cut-out formed in at least a portion thereof and configured to allow an insufflation gas to pass from an insufflation port, through the cut-out, and into the distal cannula when an instrument occludes the opening.
4. The surgical access device of claim 1, wherein the fluid remover includes a scraper configured to scrape fluid off of a surgical instrument passed through the opening.
5. The surgical access device of claim 4, wherein the fluid remover includes a sorbent positioned to sorb fluid removed by the scraper.
6. The surgical access device of claim 5, wherein the sorbent is positioned distal to the insufflation port.

7. The surgical access device of claim 5, wherein the sorbent is disposed around a substantially cylindrical member.
8. The surgical access device of claim 4, wherein the insufflation port has a lumen extending therethrough and defining a longitudinal axis, and wherein the scraper is positioned distal to the longitudinal axis.
9. The surgical access device of claim 1, wherein at least a portion of the fluid remover is positioned distal to the insufflation port.
10. A surgical access device, comprising:
 - a housing defining a working channel sized and configured to receive a surgical instrument;
 - a seal disposed within the housing, the seal having an opening positioned to receive a surgical instrument passed through the working channel; and
 - a sorbent disposed in the housing and configured to sorb fluid to prevent fluid from being re-deposited on surgical instruments passed through the working channel.
11. The surgical access device of claim 10, wherein the sorbent is positioned to sorb fluid away from the opening in the seal.
12. The surgical access device of claim 10, wherein the sorbent comprises an absorbent.
13. The surgical access device of claim 10, wherein the sorbent comprises an adsorbent.
14. The surgical access device of claim 10, wherein the housing includes a proximal portion containing the seal and a distal cannula extending distally from the proximal portion and configured to be inserted into a body cavity.
15. The surgical access device of claim 14, wherein the seal comprises a first seal, and the access device further comprises a second seal disposed within the housing, and wherein the sorbent is positioned distal of the first and second seals.
16. The surgical access device of claim 10, further comprising a scraper disposed in the housing and configured to scrape fluid off of a surgical instrument passed through working

channel.

17. The surgical access device of claim 16, wherein the sorbent is configured to sorb fluid scraped by the scraper.
18. The surgical access device of claim 10, further comprising a wicking element disposed in the housing and configured to wick fluid away from a surgical instrument passing through the working channel.
19. An assembly for use in a surgical access device, comprising:
 - a seal having an opening configured to receive a surgical instrument therethrough; and
 - a sorbent associated with the seal and configured to sorb fluid away from at least one of the opening and a surgical instrument passed through the opening.
20. The assembly of claim 19, wherein the sorbent is an adsorbent element.
21. The assembly of claim 19, wherein the sorbent is an absorbent element.
22. The assembly of claim 19, further comprising a scraper element positioned adjacent to the seal and configured to scrape fluid off of a surgical instrument extending through the opening in the seal.
23. The assembly of claim 22, wherein at least a portion of the scraper element is hydrophilic.
24. The assembly of claim 22, further comprising a wicking element associated with the scraper and configured to wick away fluid collected near the opening when a surgical instrument is passed through the opening.
25. The assembly of claim 19, further comprising a wicking element associated with the seal and configured to wick away fluid collected near the opening when a surgical instrument is passed through the opening.
26. The assembly of claim 19, wherein the seal is configured to scrape fluid off of a surgical instrument passed through the opening, and the sorbent is configured to sorb fluid scraped off of

the surgical instrument by the seal.

27. The assembly of claim 19, wherein the sorbent is formed integrally with the seal.

28. The assembly of claim 19, wherein the seal comprises an instrument seal configured to form a seal when an instrument is inserted therethrough.

29. The assembly of claim 19, wherein the seal comprises a first seal, and the seal assembly further comprises a second seal.

30. The assembly of claim 29, wherein the sorbent is positioned distal of the first and second seals.

31. A fluid remover for use in a surgical access device, comprising:

a sorbent member having opposed proximal and distal surfaces and opposed inner and outer sidewalls extending between the proximal and distal surfaces such that the sorbent member has a polygonal cross-sectional shape, the proximal surface being substantially planar, and the inner and outer sidewalls having a radius of curvature, the inner sidewall defining a central opening extending through the sorbent member, and the sorbent member including a gap formed therein such that the sorbent is C-shaped, wherein the sorbent member is formed from a plurality of fibers that are configured to sorb fluid.

32. The fluid remover of claim 31, wherein the inner sidewall includes a plurality of grooves formed therein and extending parallel to a longitudinal axis of the central opening.

33. The fluid remover of claim 31, wherein the plurality of fibers are oriented longitudinally relative to a longitudinal axis of the central opening.

34. The fluid remover of claim 31, wherein the polygonal cross-sectional shape of the sorbent member comprises a square.

35. The fluid remover of claim 31, wherein the polygonal cross-sectional shape of the sorbent member comprises a triangle.

36. The fluid remover of claim 31, wherein at least a portion of the sorbent member is

hydrophilic.

37. A method for removing fluid from a seal opening, comprising:

passing a surgical instrument through an opening in a seal in an access device, wherein fluid on the instrument is sorbed by a sorbent element in the access device.

38. The method of claim 37, wherein the sorbent element sorbs fluid deposited on the seal by the instrument.

39. The method of claim 37, wherein the sorbent adsorbs fluid.

40. The method of claim 37, wherein the sorbent absorbs fluid.

41. The method of claim 37, wherein the seal forms a seal when no instrument is inserted therethrough.

42. The method of claim 37, wherein fluid on the instrument is scraped off of the instrument by a scraper, and wherein the sorbent element sorbs fluid off of the scraper.

43. A device for removing fluid from medical instruments, comprising:

a scraper having a substantially planar configuration with a central opening extending therethrough, the central opening being configured to expand to engage and scrape fluid off of a surgical instrument inserted therethrough, the scraper having a distal surface with a plurality of channels formed therein and extending radially outward from the central opening such that fluid scraped off of an instrument inserted through the central opening can flow through the channels.

44. A device for removing fluid from medical instruments, comprising:

a crown;
a lid coupled to the crown; and
a scraper captured between the crown and lid, the scraper having a central opening formed therethrough and configured to expand to engage an instrument inserted therethrough and to scrape fluid off of the instrument.

45. The device of claim 44, wherein a plurality of pins extend between the crown and the lid to mate the crown and lid, the plurality of pins extending through a plurality of openings formed

in the scraper.

FIG. 1A

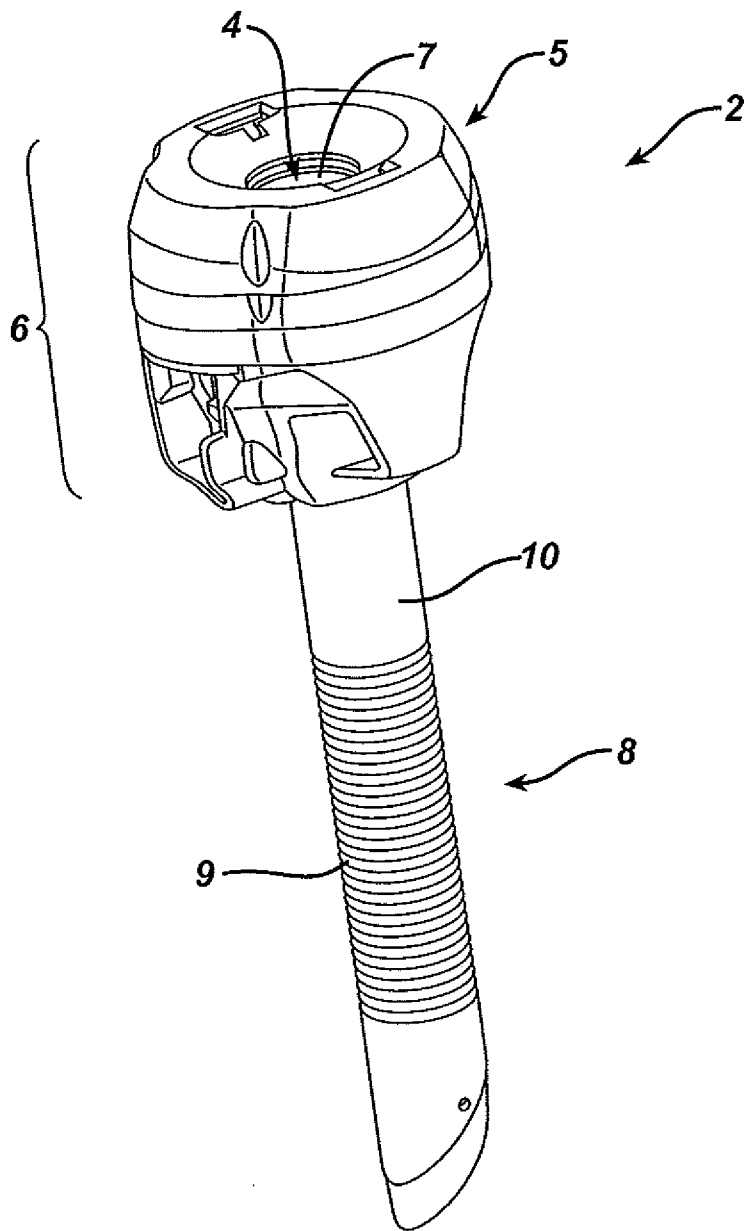


FIG. 1B

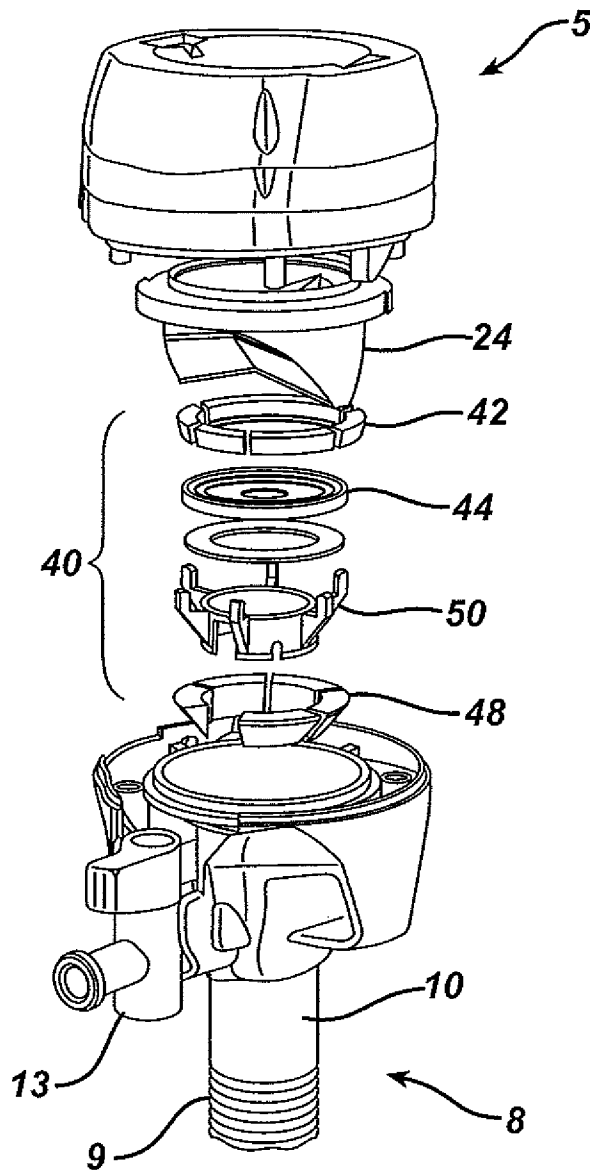


FIG. 1C

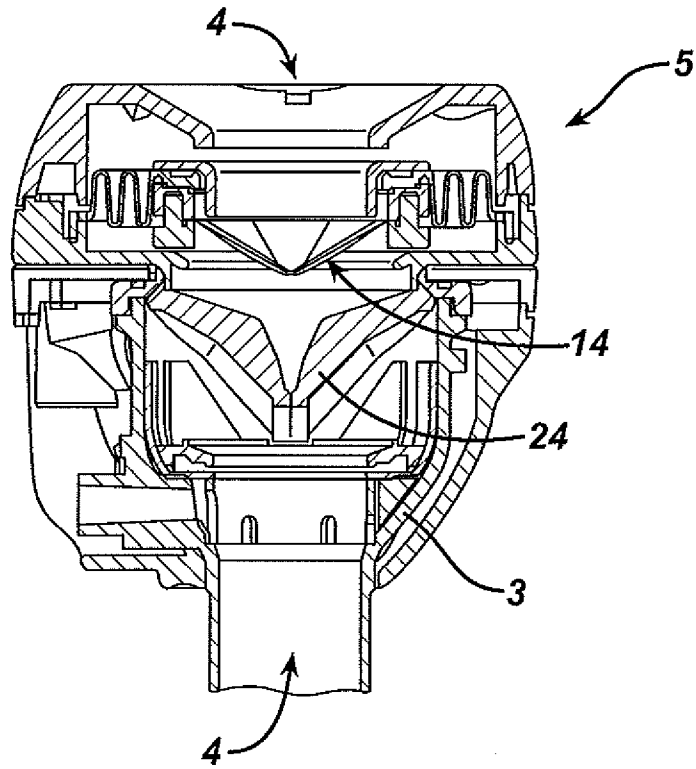
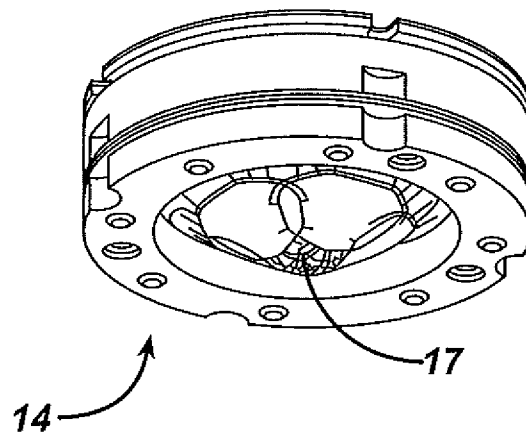


FIG. 1D



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FIG. 1E

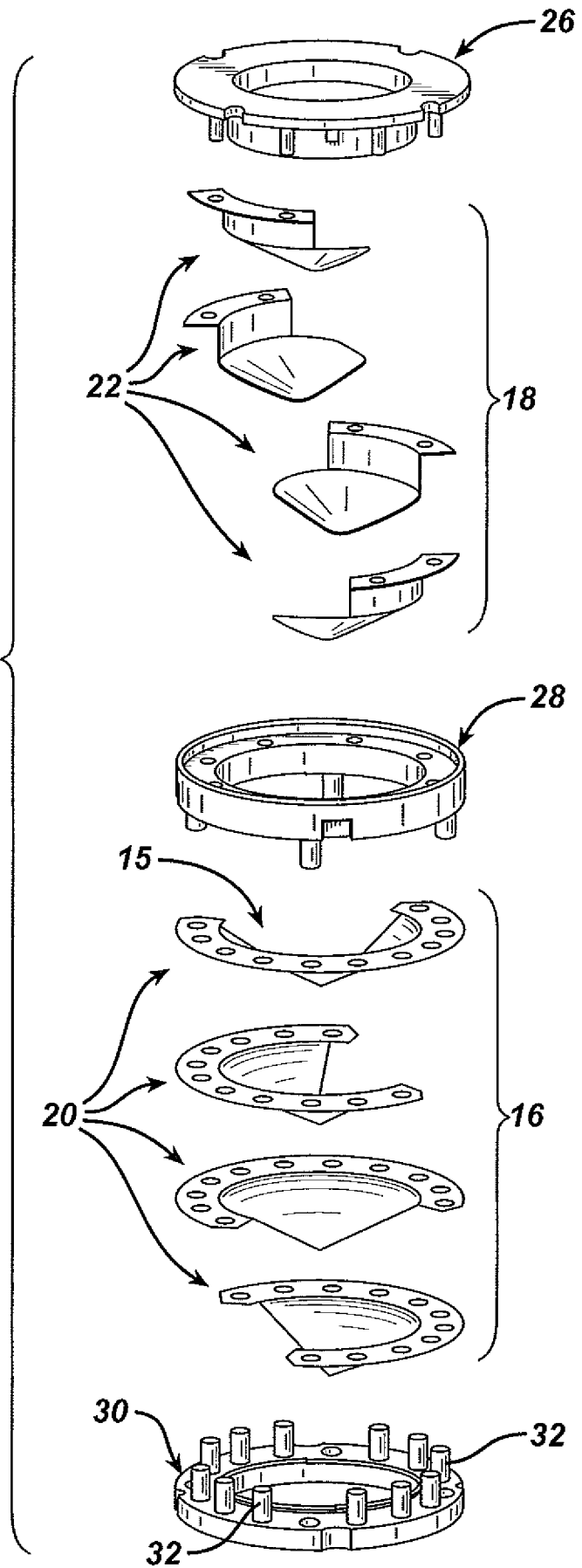


FIG. 1F

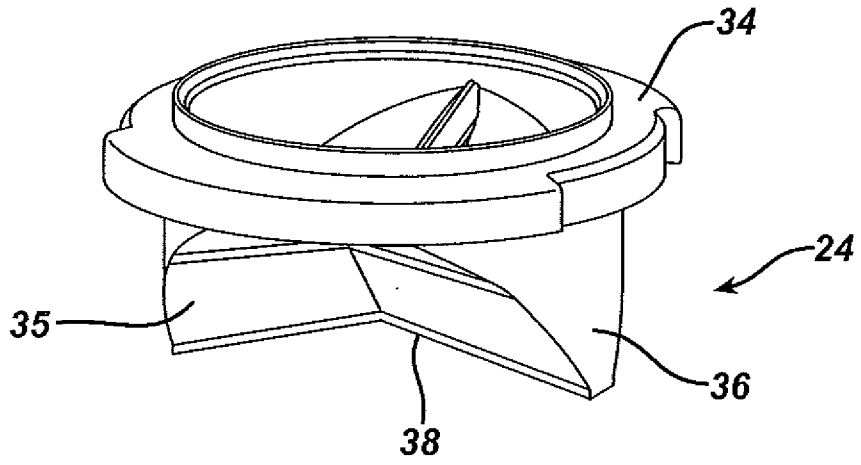


FIG. 1G

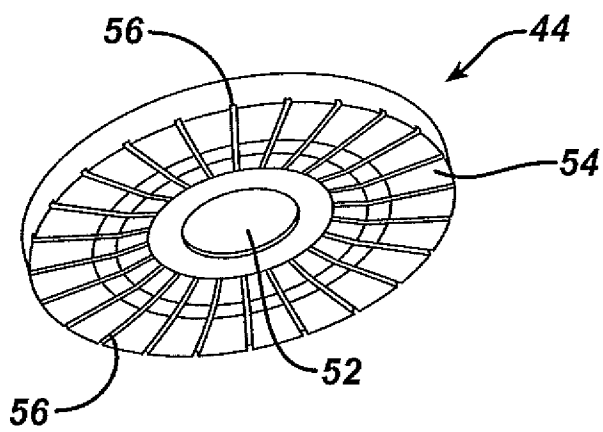


FIG. 1H

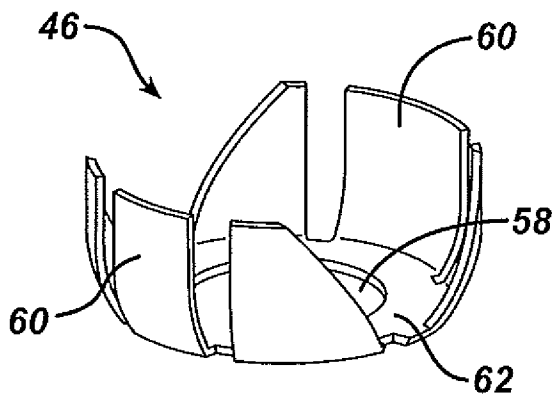


FIG. 1I

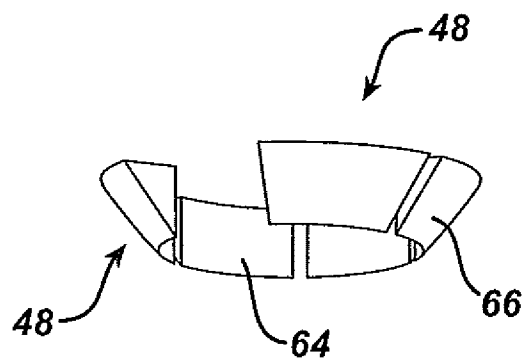


FIG. 1J

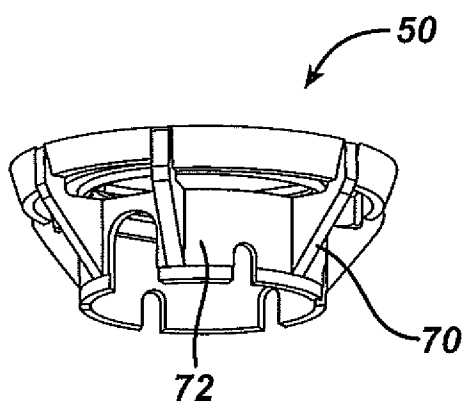
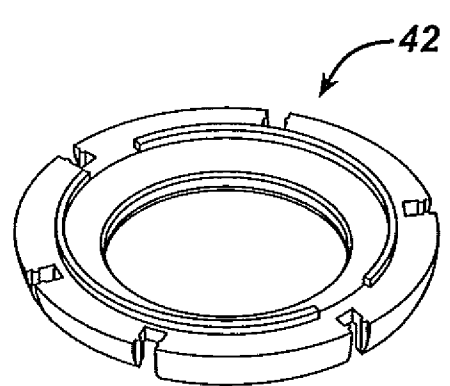


FIG. 1K



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FIG. 2A

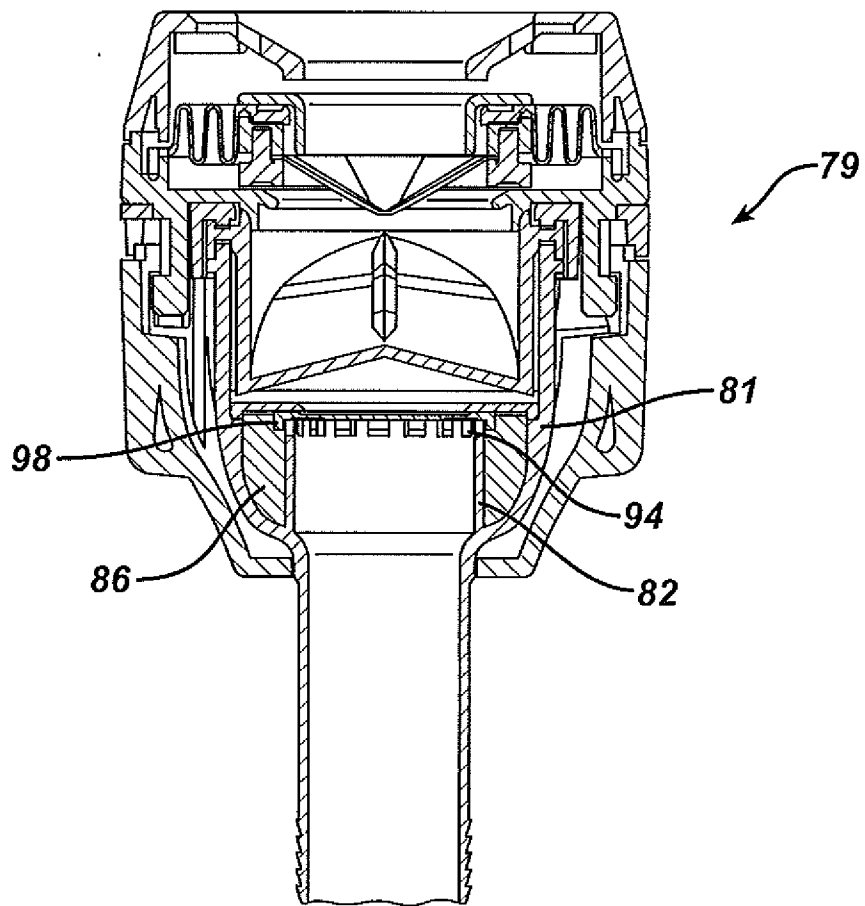


FIG. 2B

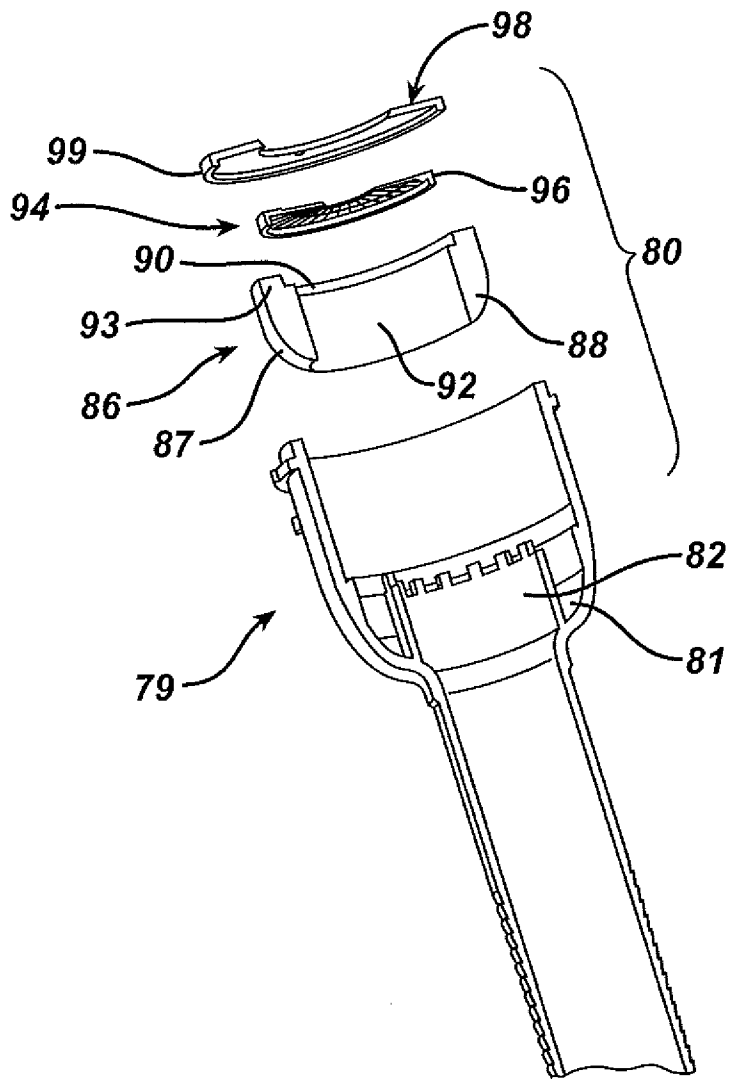


FIG. 3A

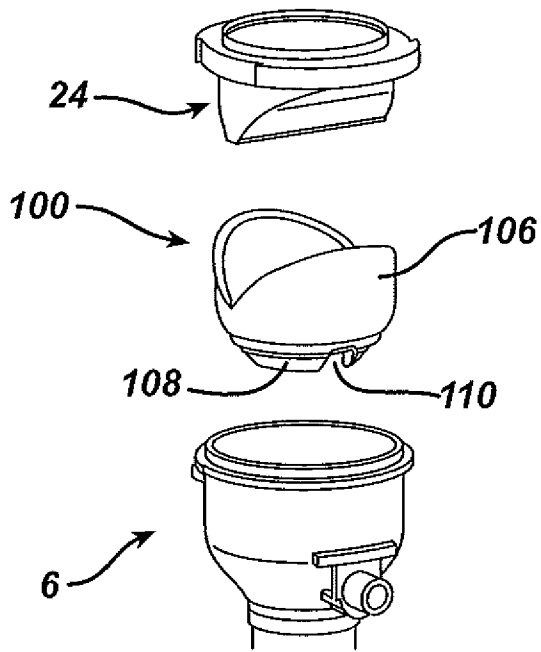


FIG. 3B

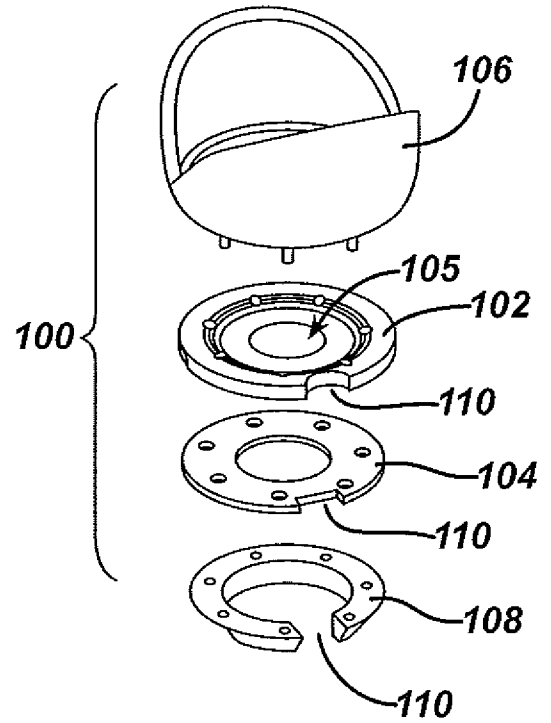


FIG. 3C

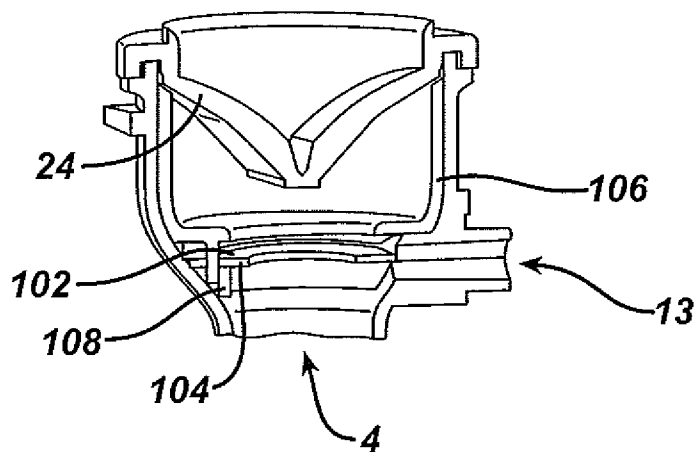


FIG. 4A

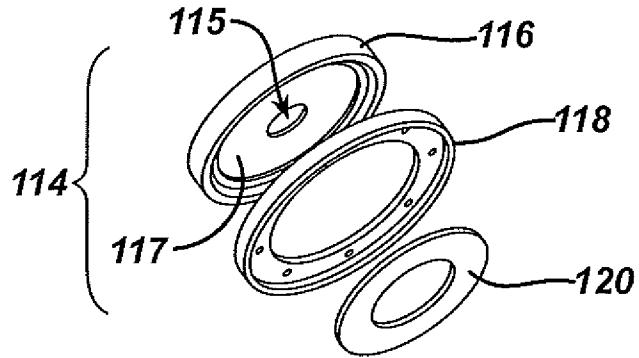


FIG. 4B

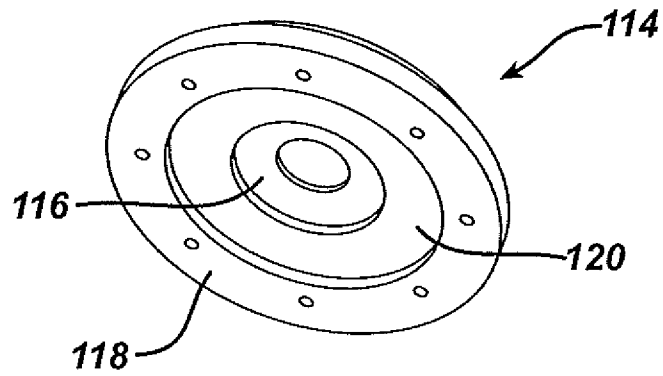


FIG. 4C

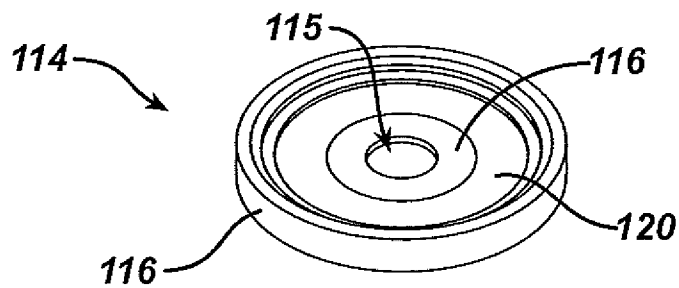


FIG. 5A

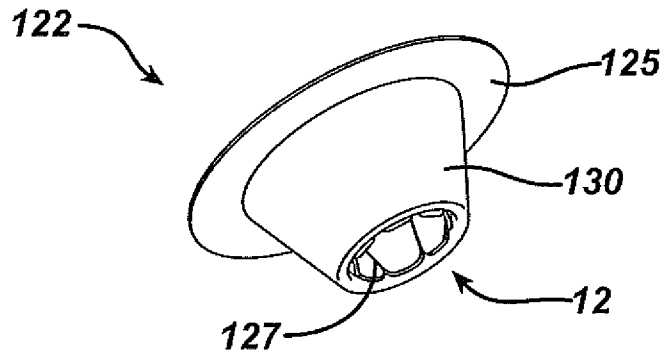


FIG. 5B

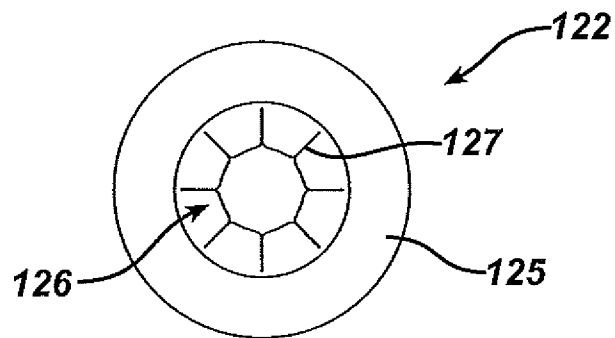


FIG. 5C

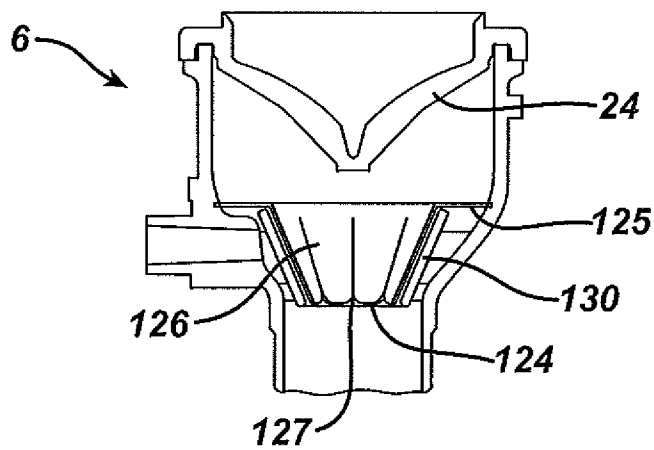


FIG. 6C

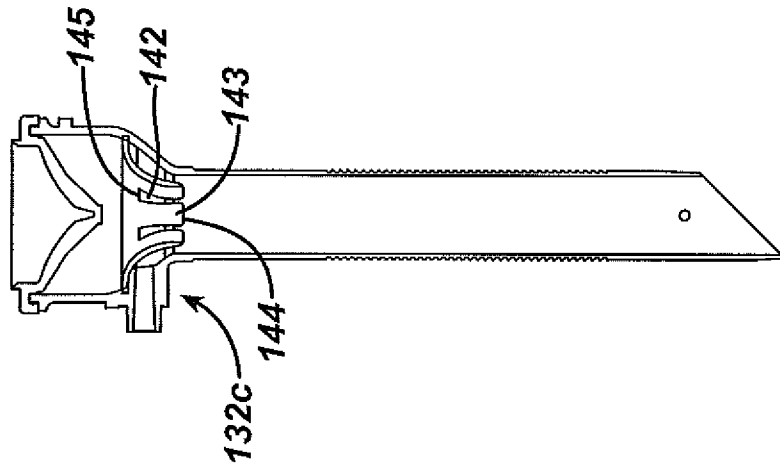


FIG. 6B

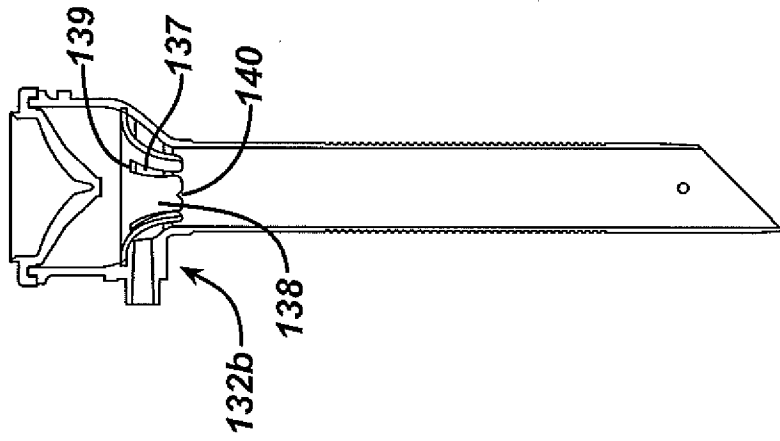


FIG. 6A

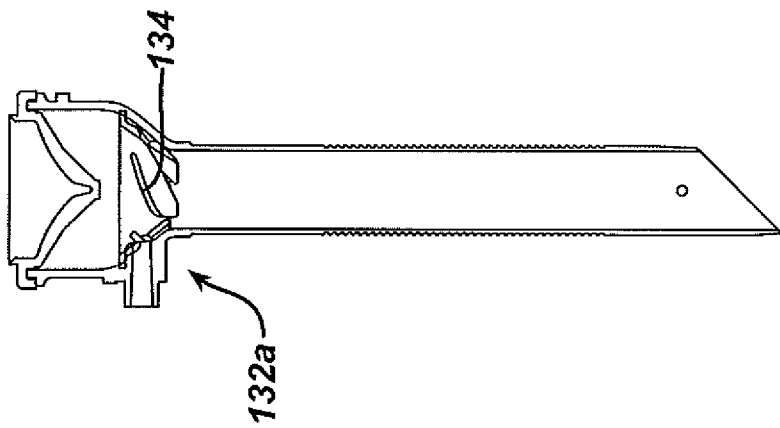


FIG. 7

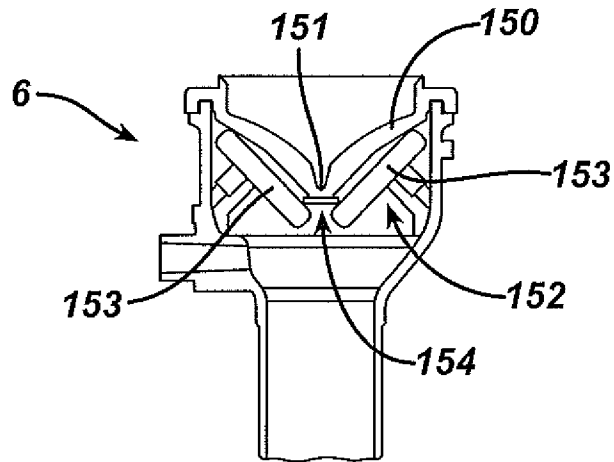


FIG. 8

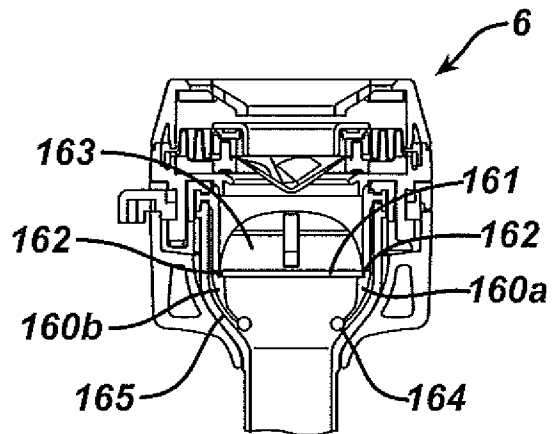


FIG. 9

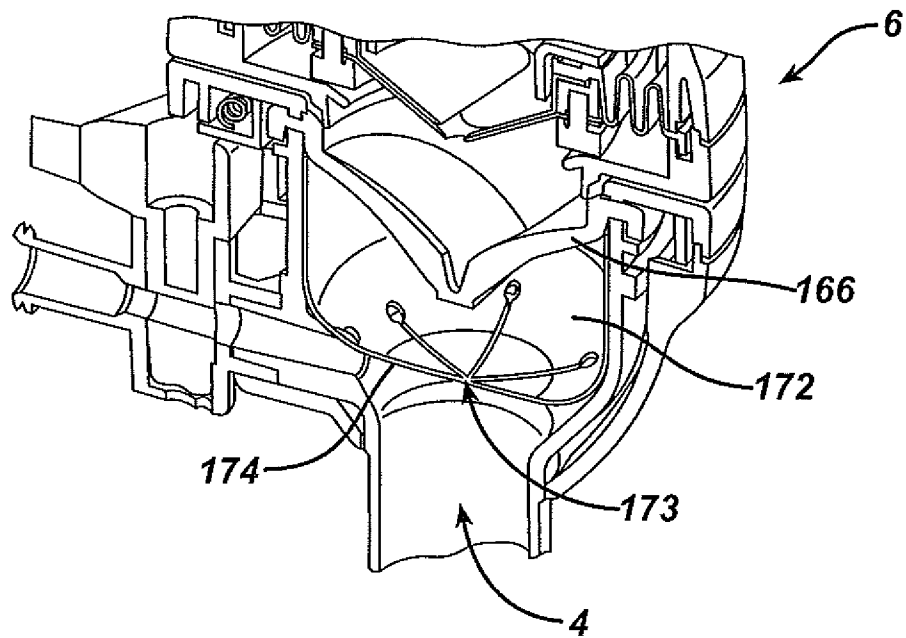


FIG. 10A

FIG. 10B

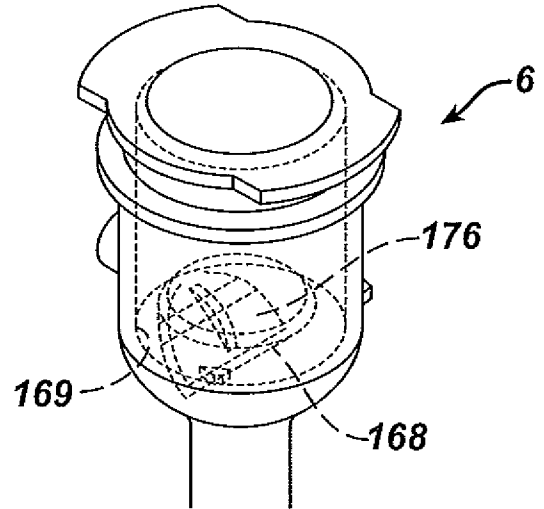
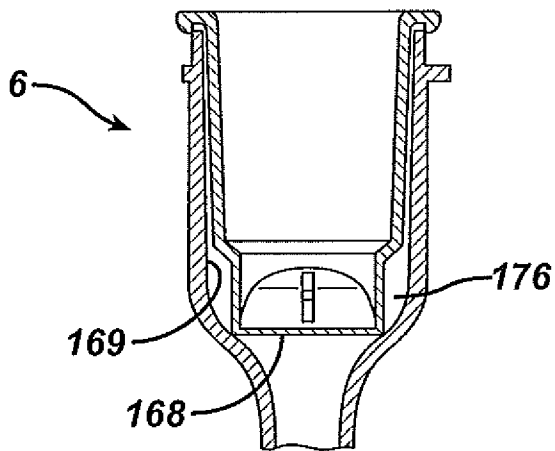


FIG. 11

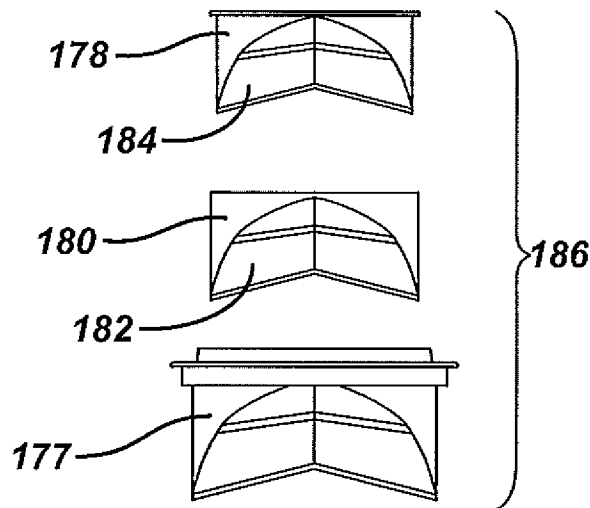


FIG. 12A

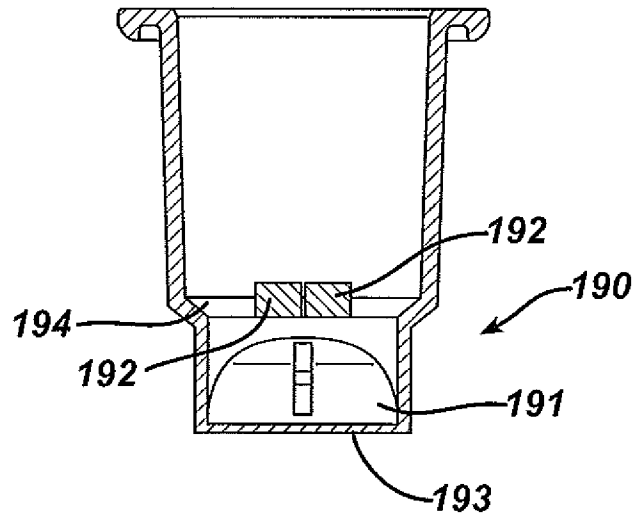


FIG. 12B

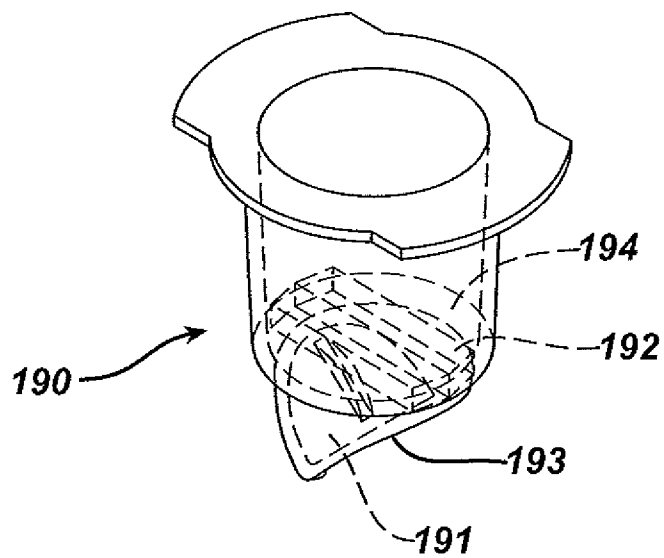


FIG. 13

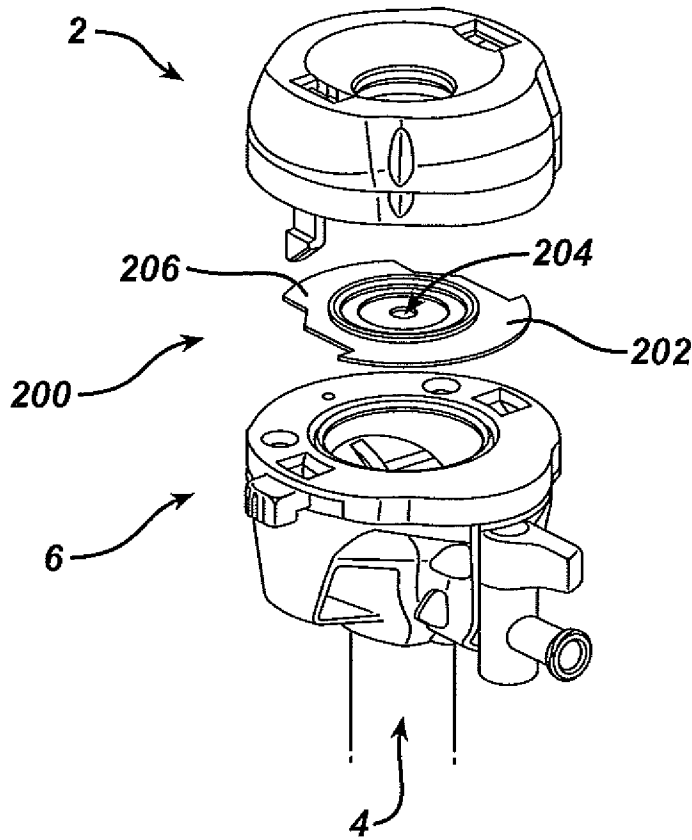


FIG. 14

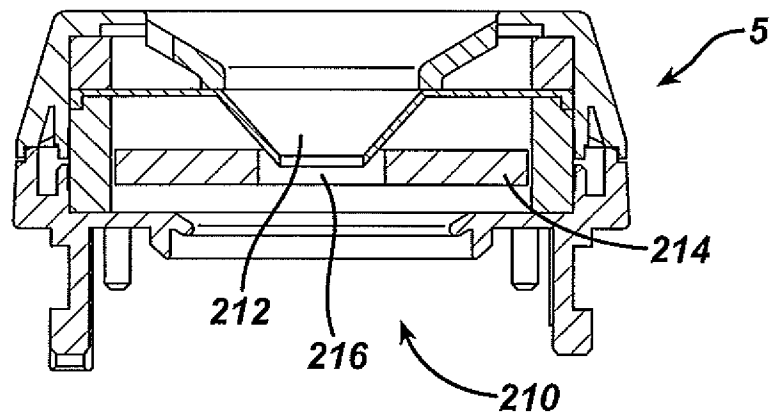


FIG. 15A

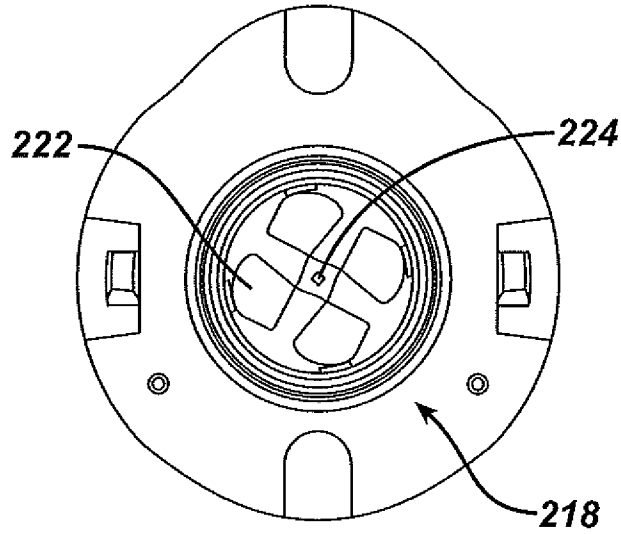


FIG. 15B

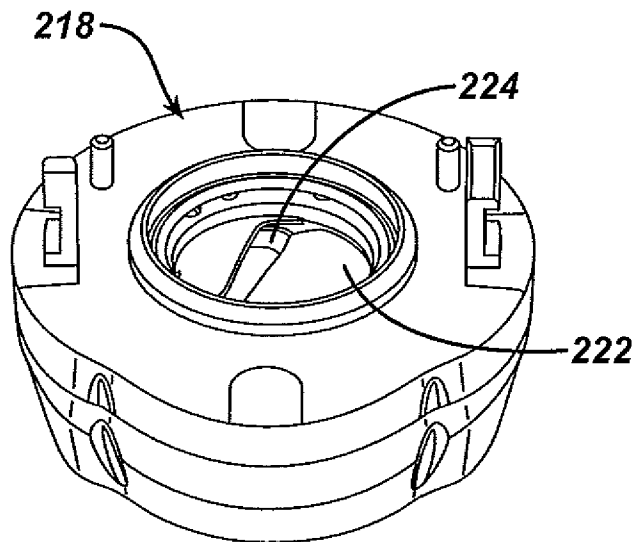


FIG. 16

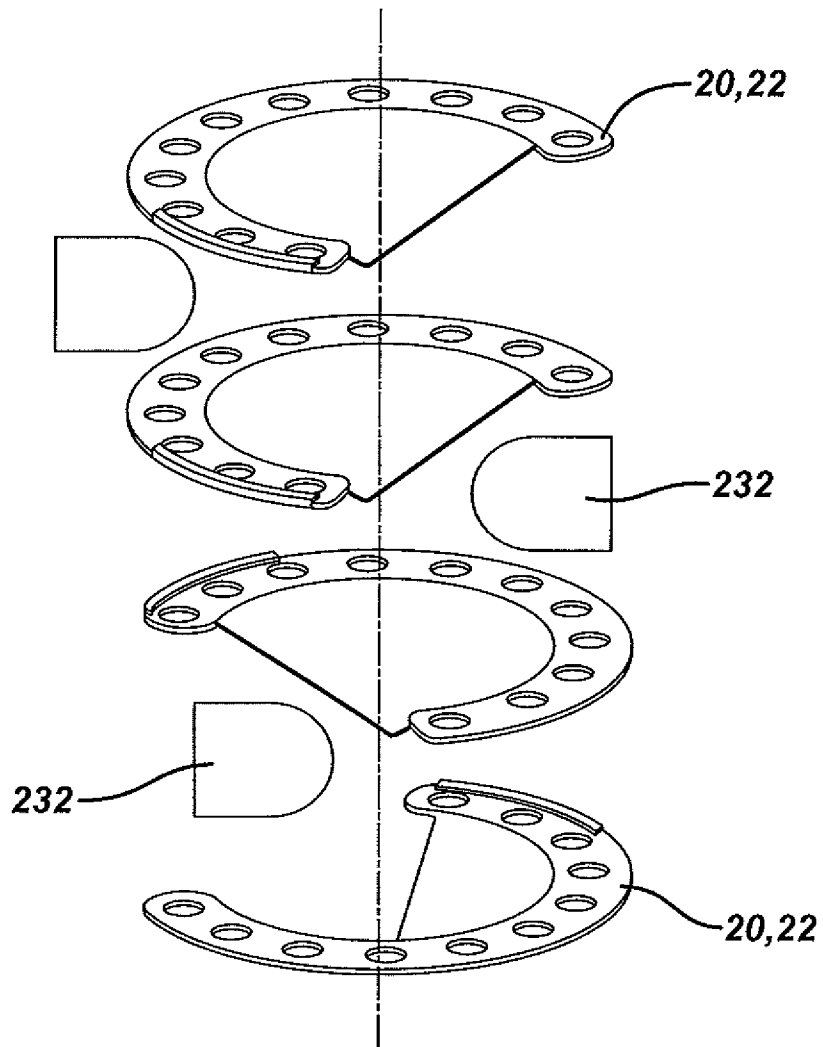


FIG. 17

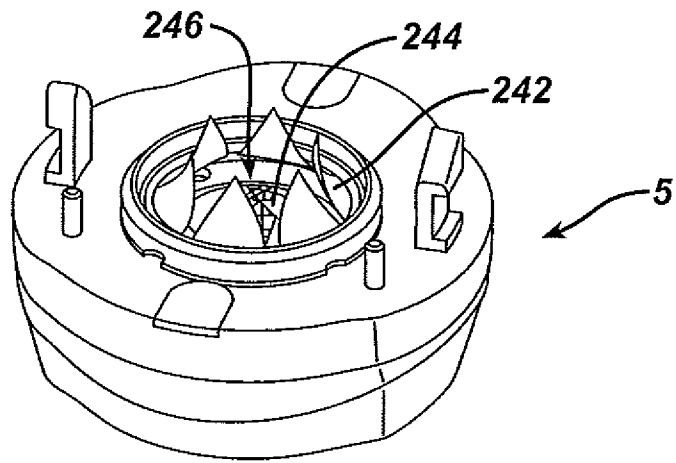


FIG. 18A

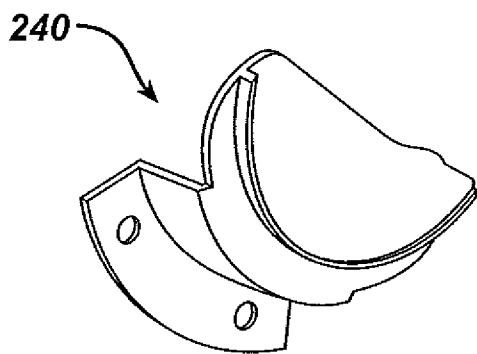


FIG. 18B

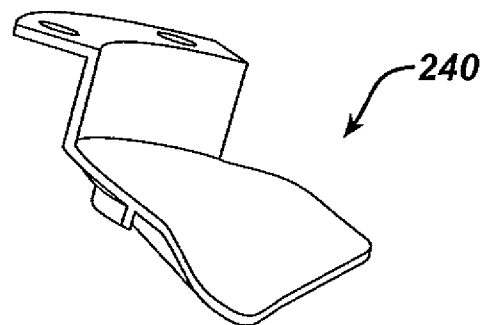


FIG. 19A

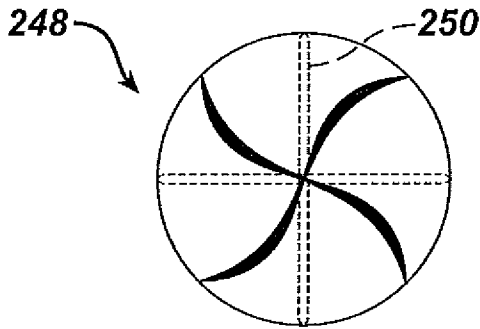


FIG. 19B

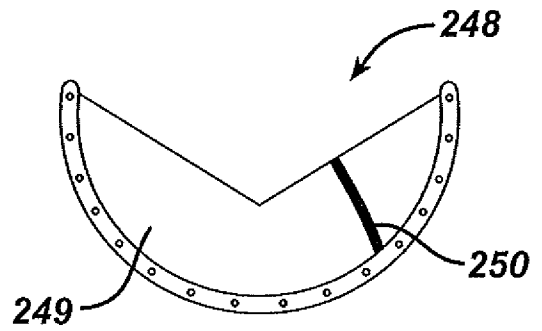


FIG. 20A

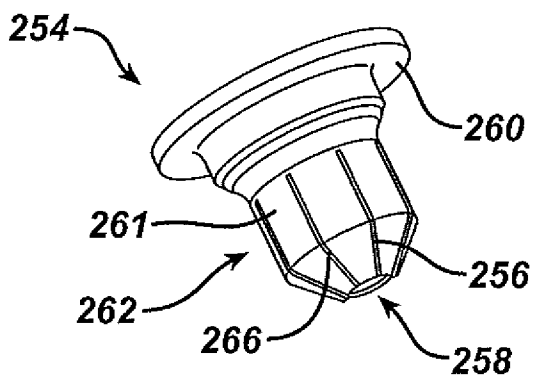


FIG. 20B

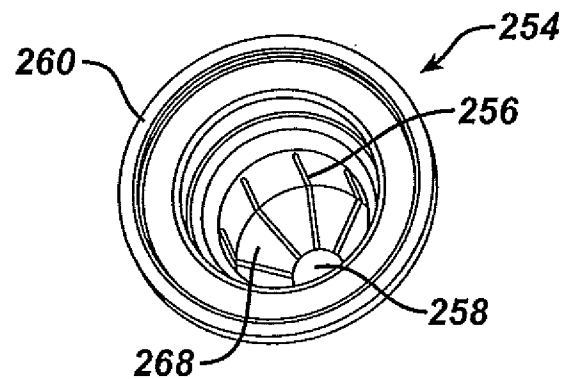


FIG. 21

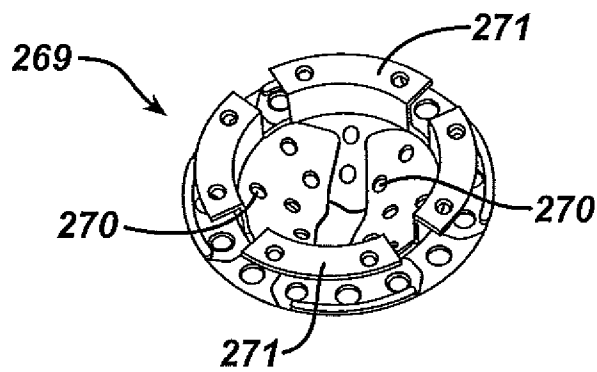


FIG. 22A

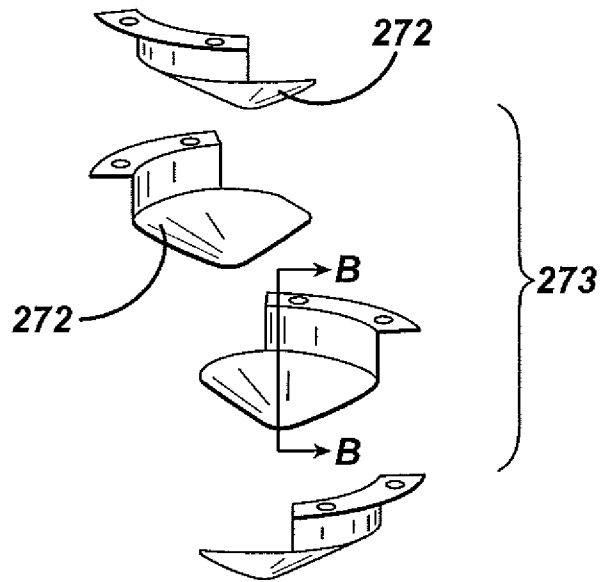


FIG. 22B

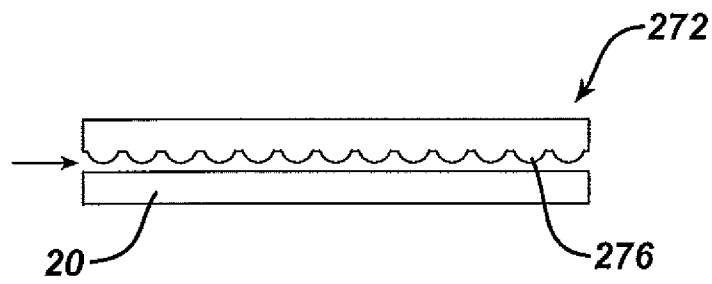


FIG. 23A

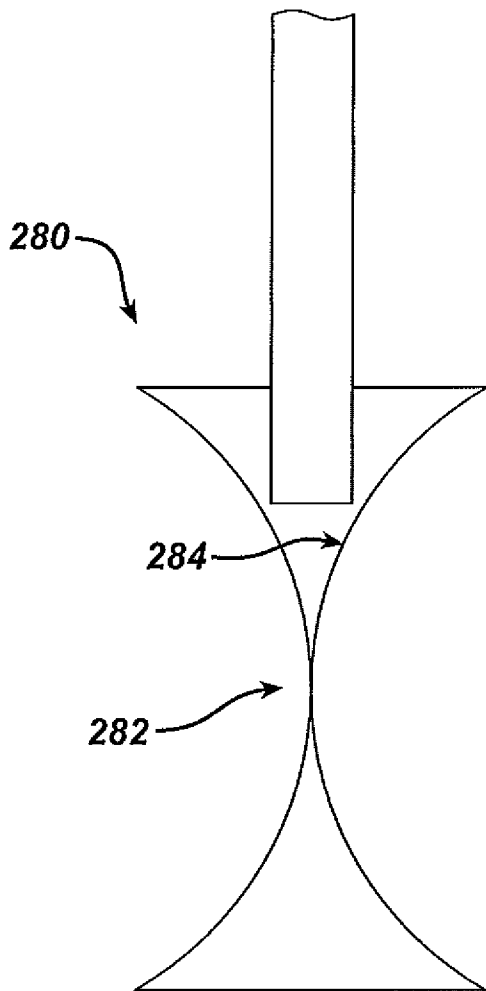


FIG. 23B

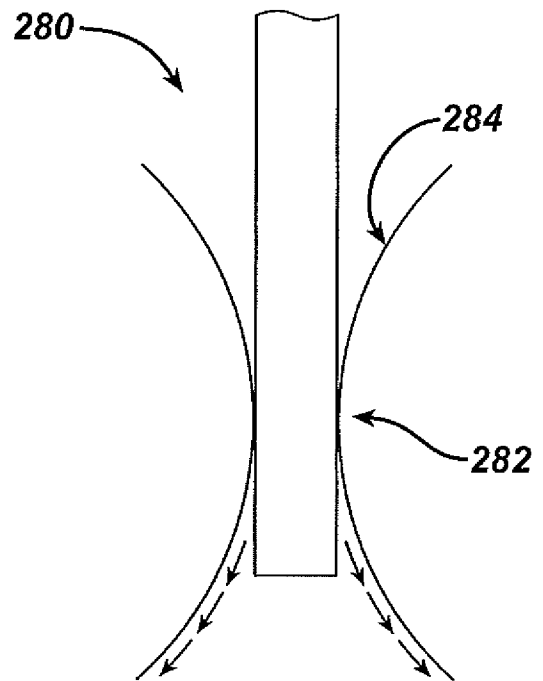


FIG. 24A

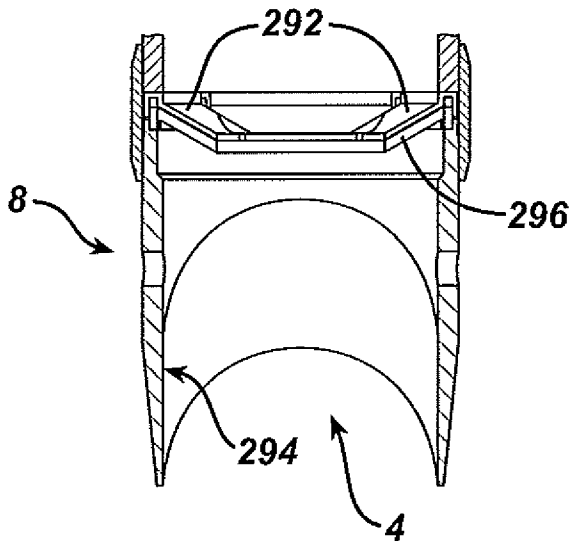


FIG. 24B

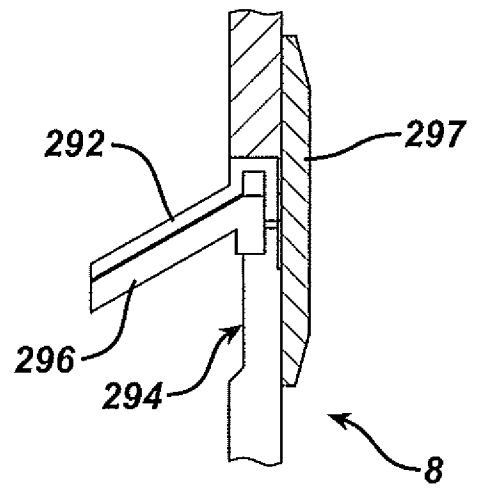


FIG. 25

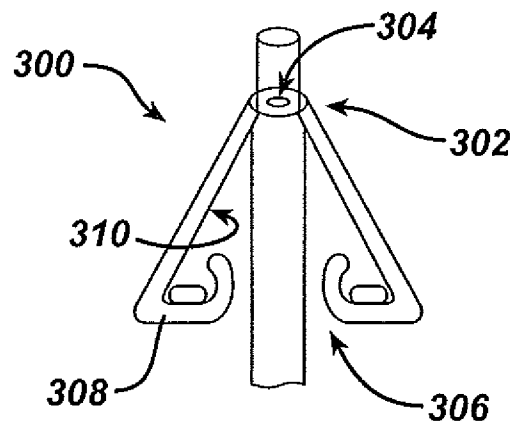


FIG. 26

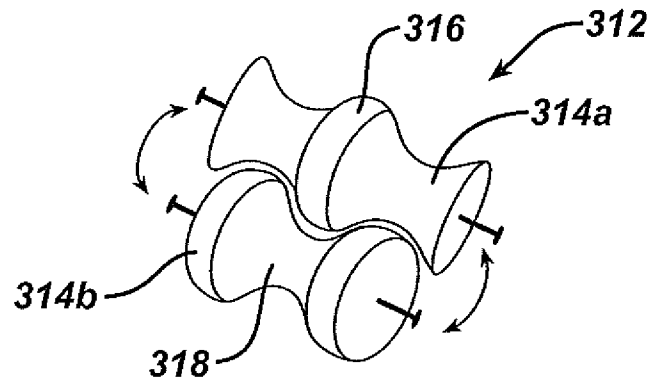


FIG. 27A

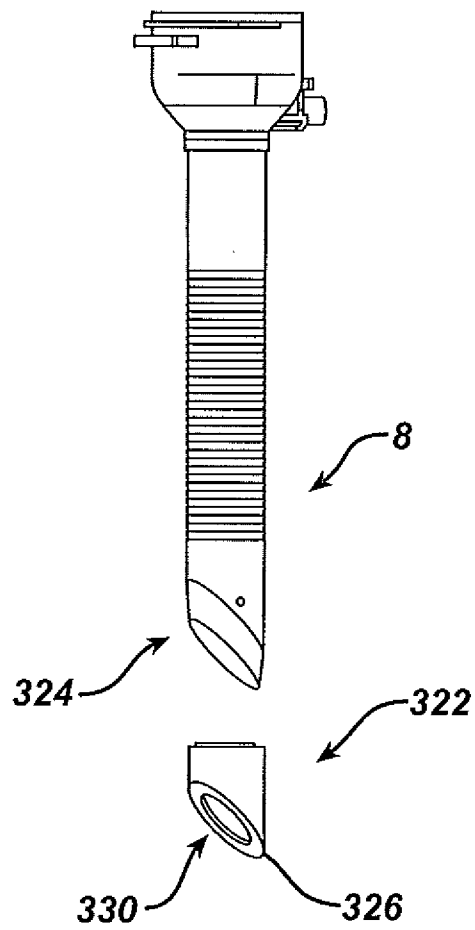


FIG. 27B

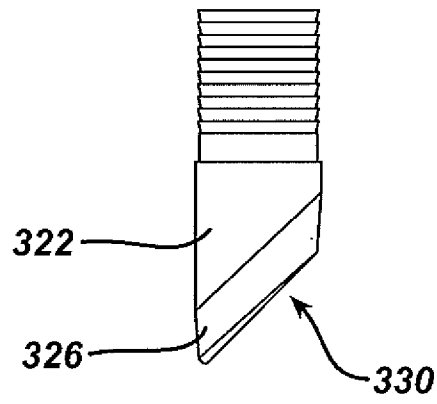
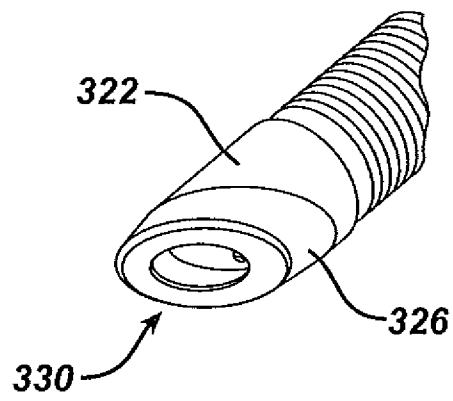


FIG. 27C



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FIG. 28

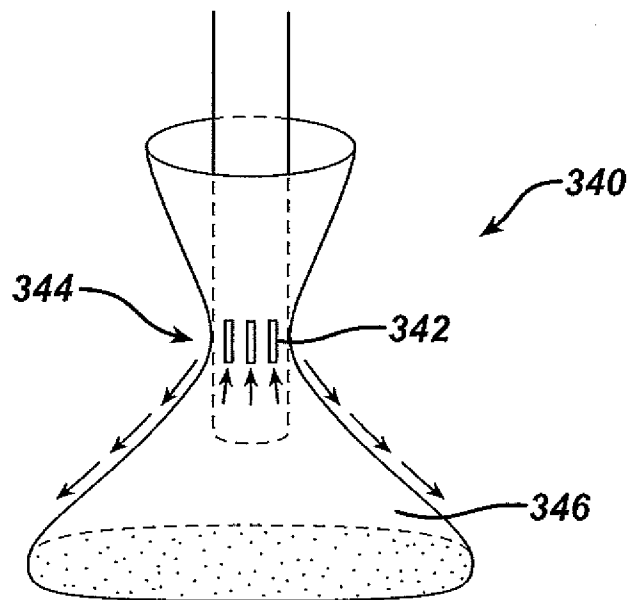


FIG. 29

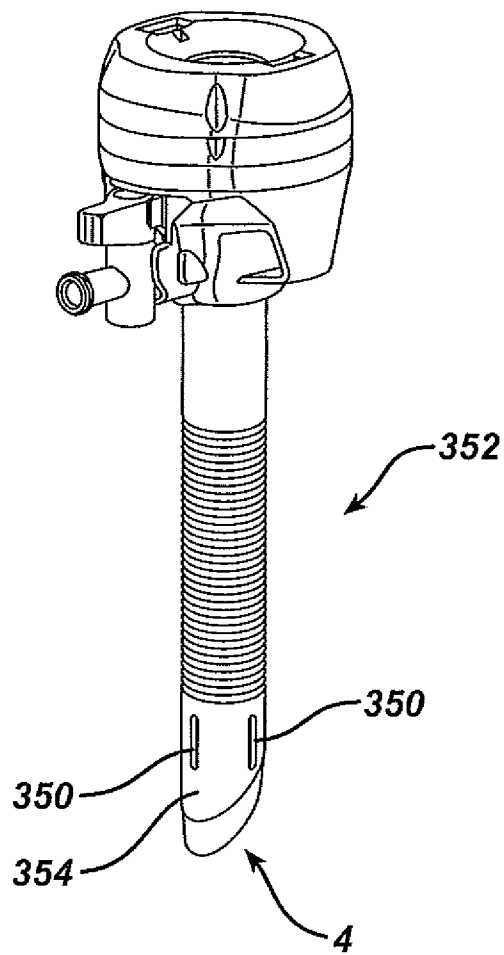


FIG. 30B

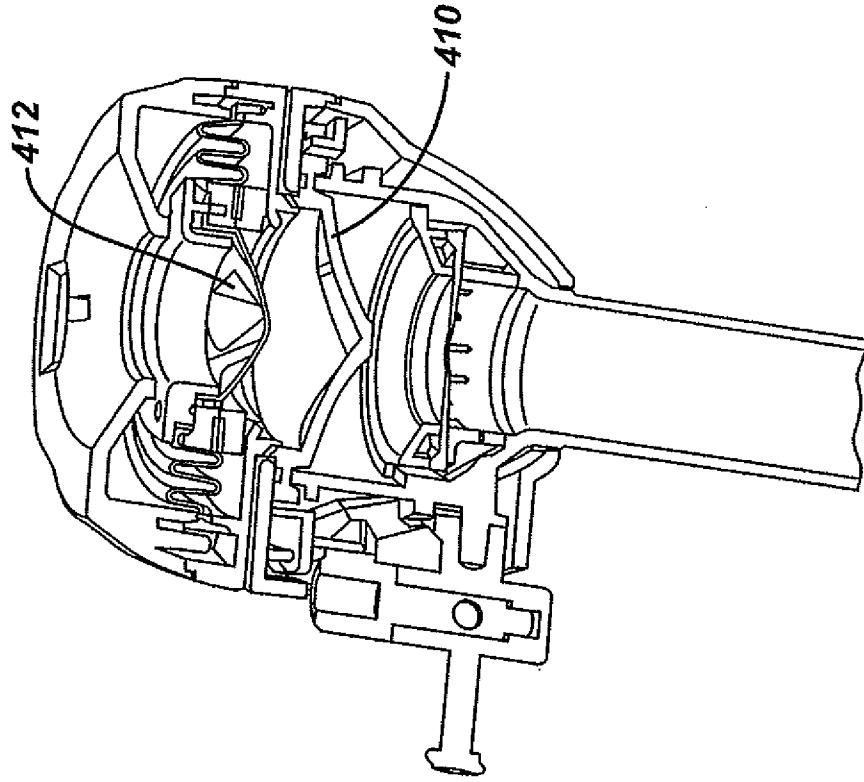


FIG. 30A

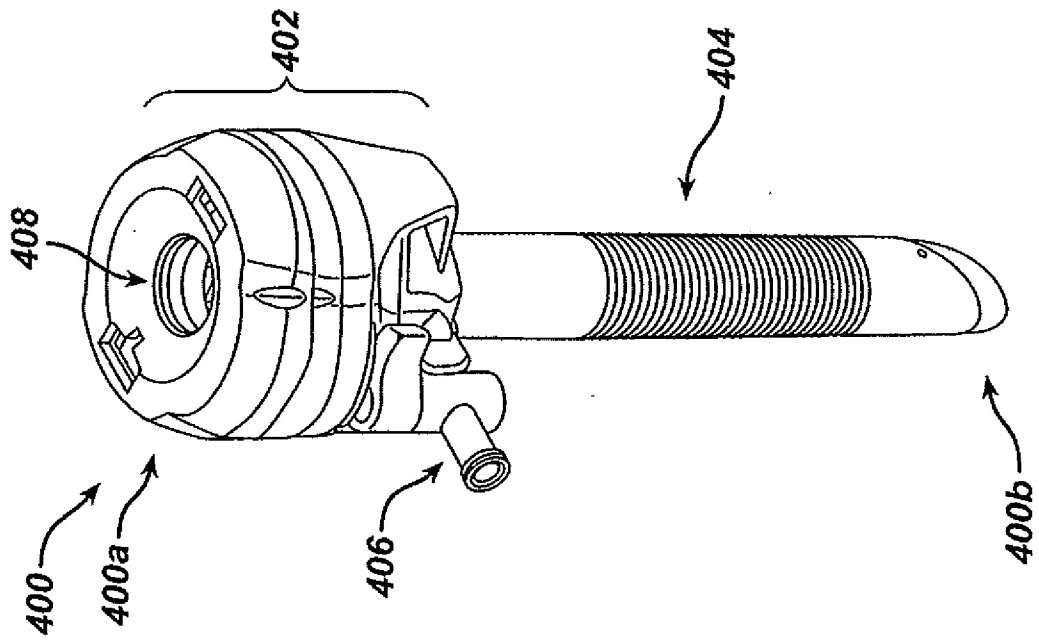


FIG. 30C

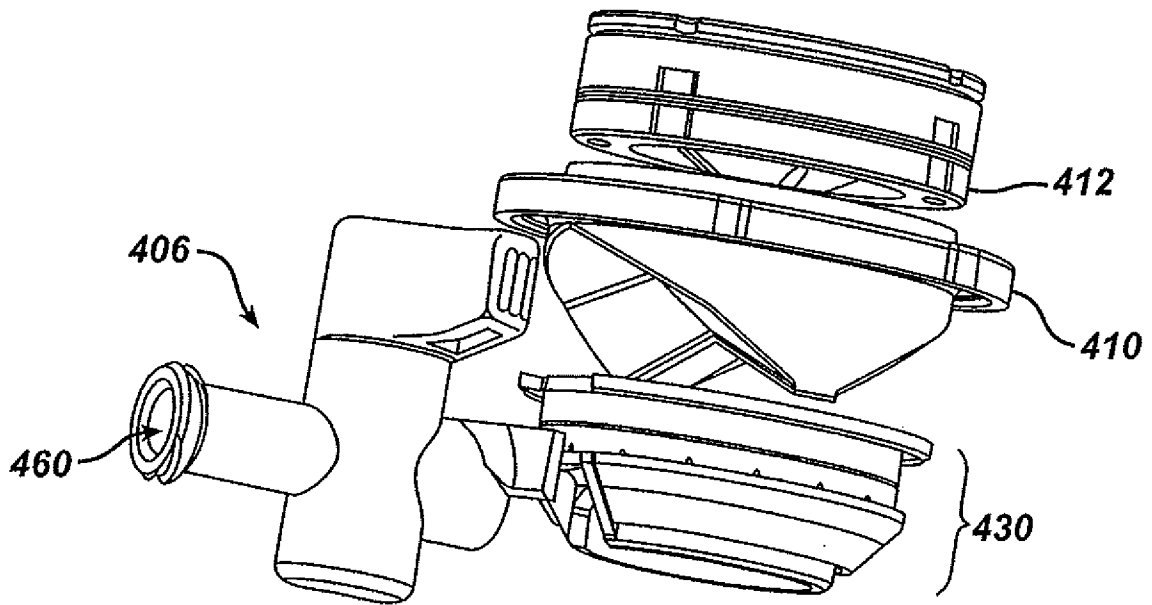


FIG. 30D

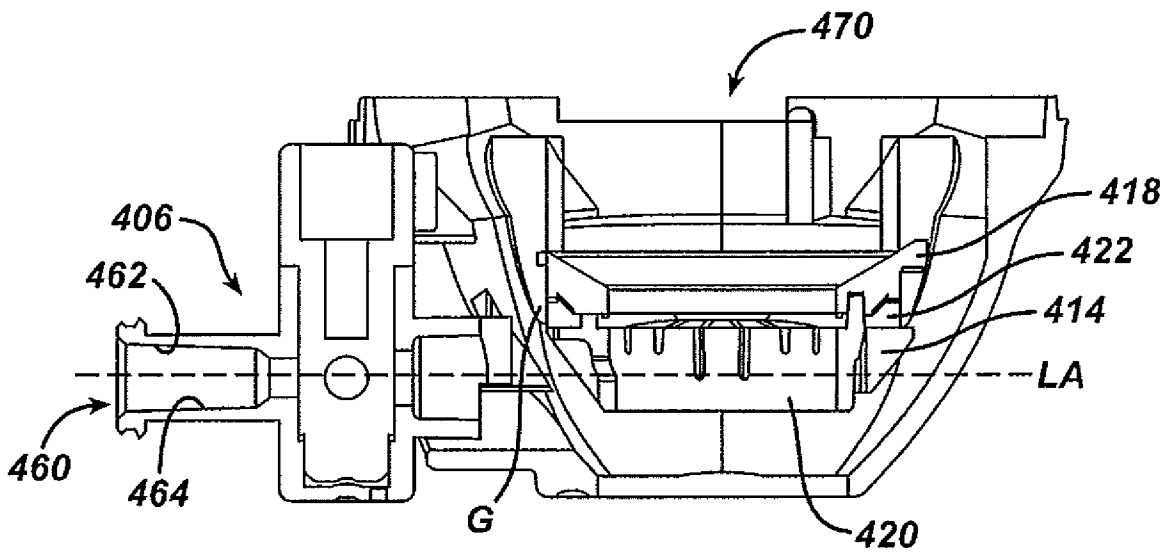


FIG. 30E

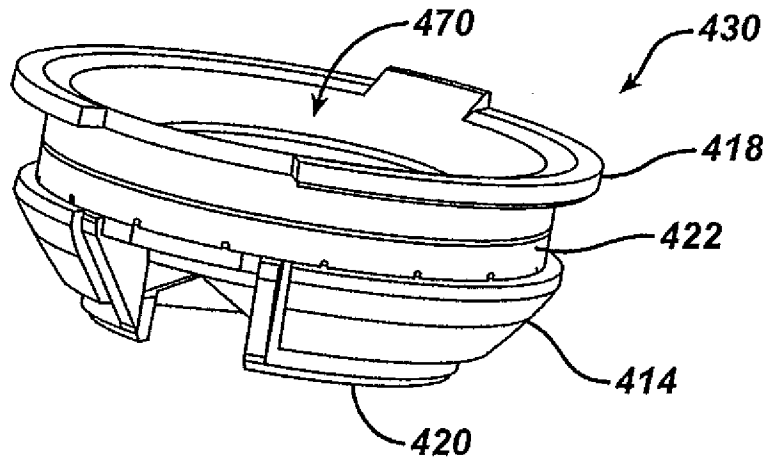


FIG. 30F

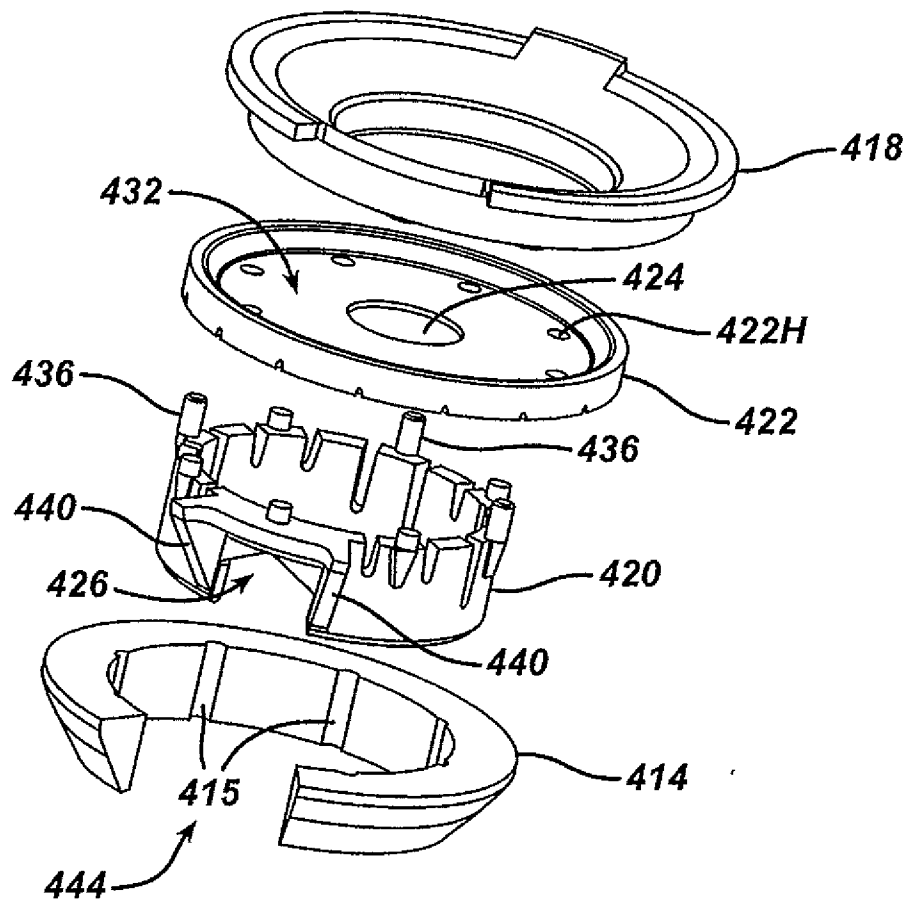


FIG. 30G

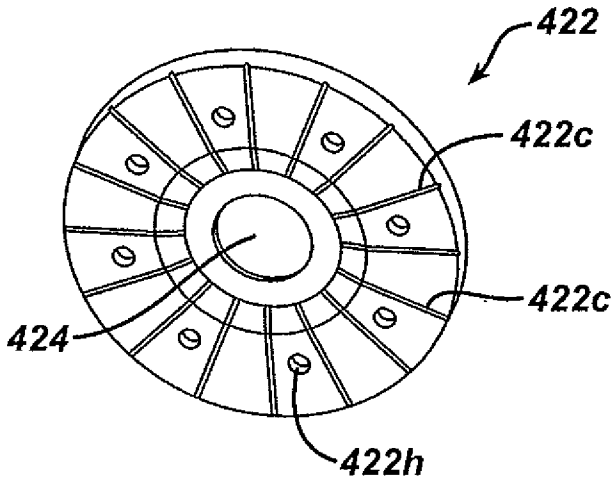


FIG. 30H

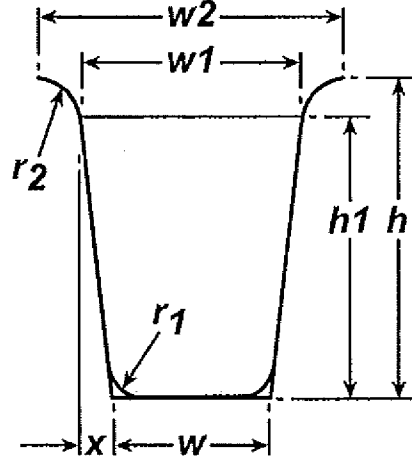


FIG. 30I

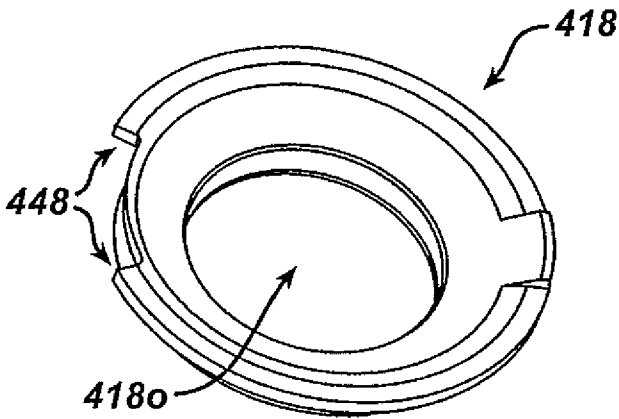


FIG. 30J

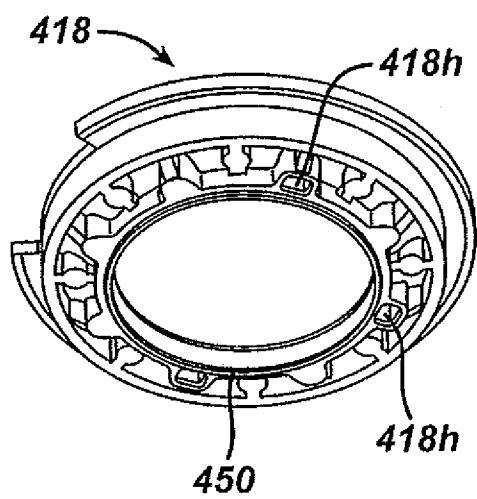


FIG. 31

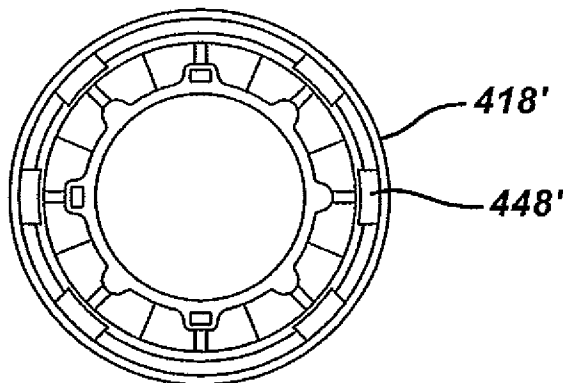


FIG. 32A

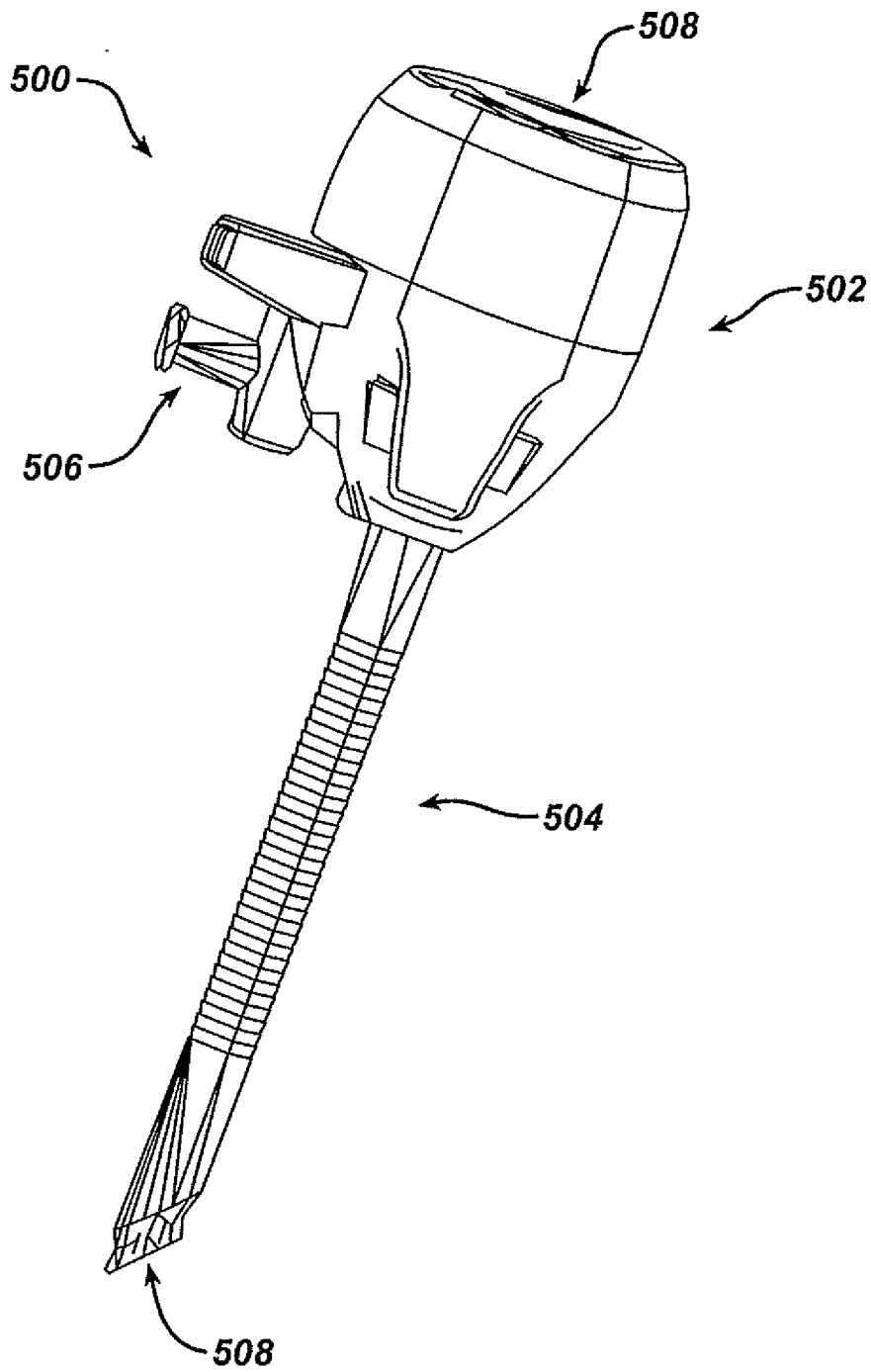


FIG. 32B

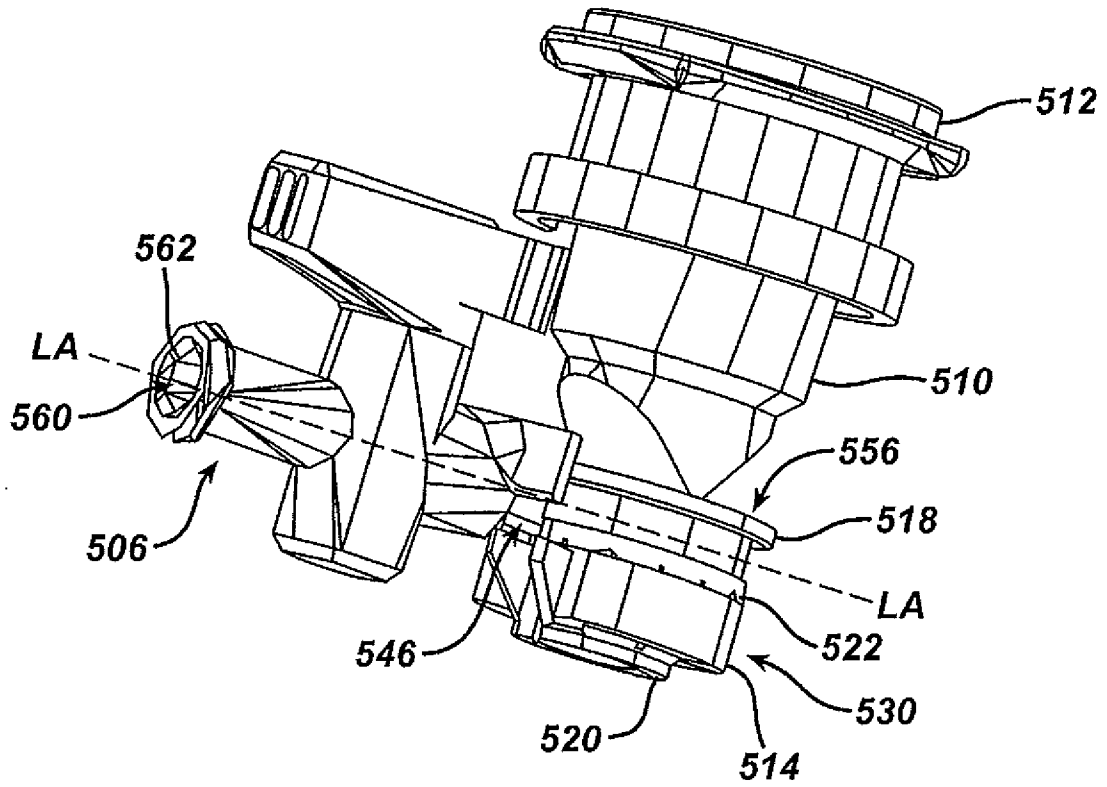


FIG. 32C

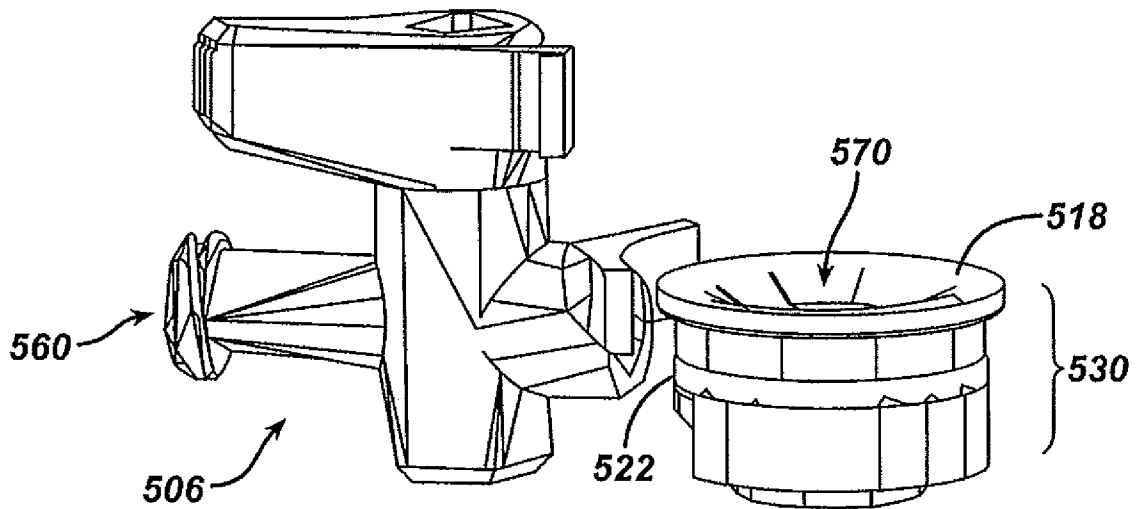
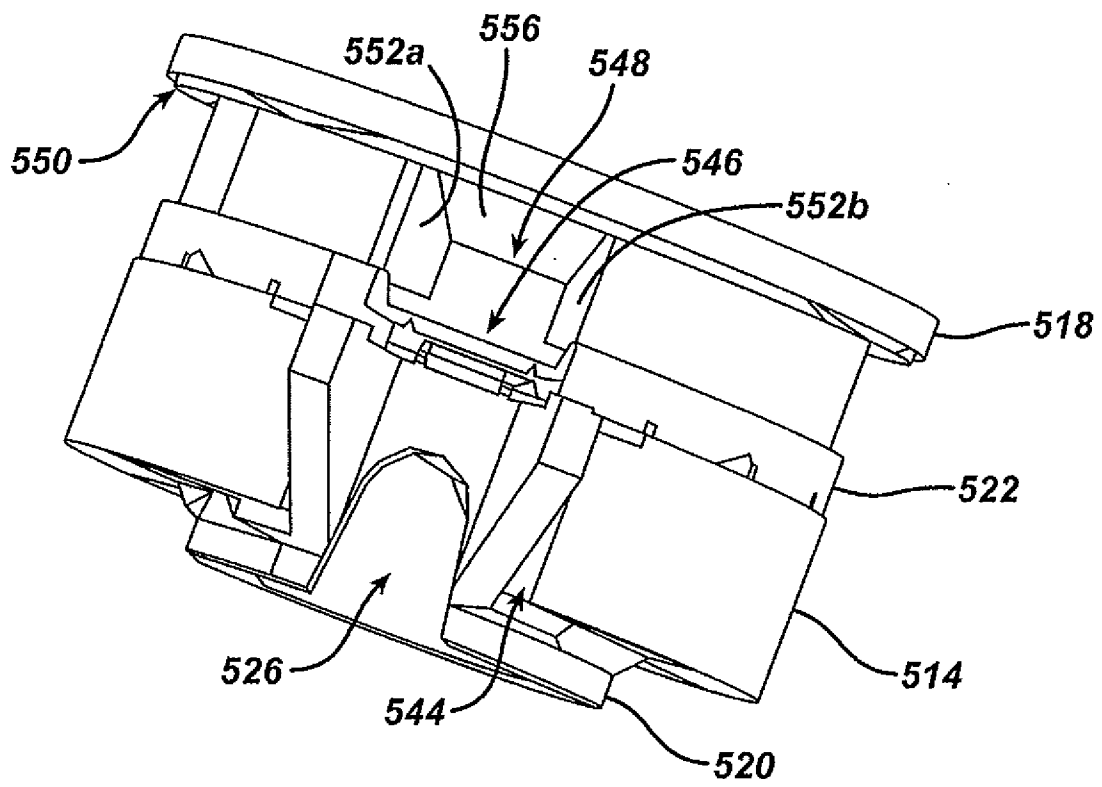


FIG. 32D



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/042765

A. CLASSIFICATION OF SUBJECT MATTER INV. A61B17/34 A61B19/00 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) A61B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 842 971 A (YOON INBAE [US]) 1 December 1998 (1998-12-01)	1-3, 9-14, 18-21, 25-41, 44
Y	column 6, lines 12-60; figures 12,3a,11	4-8, 15-17, 22-24, 42, 43, 45
Y	----- GB 2 298 906 A (MICROSURGICAL EQUIPMENT LTD [GB]) 18 September 1996 (1996-09-18)	4-8, 15-17, 22-24, 42, 43
A	page 4, lines 22-27; figures 2,3 ----- -/--	1-3, 9-14, 18-21, 25-41, 44, 45
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C.		
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Date of the actual completion of the international search	Date of mailing of the international search report	
4 October 2010	13/10/2010	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Lee, Ronan	

INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/165277 A1 (CARRILLO OSCAR R JR [US] ET AL CARRILLO JR OSCAR R [US] ET AL) 28 July 2005 (2005-07-28) figures 2-4	1-45
Y	EP 1 459 688 A1 (ETHICON ENDO SURGERY INC [US]) 22 September 2004 (2004-09-22)	45
A	figures 1,2,3,7	1-44

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Information on patent family members

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