(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 July 2011 (28.07.2011)

PCT

(10) International Publication Number
WO 2011/089565 A1

(51) International Patent Classification:
A61B 17/00 (2006.01)

(21) International Application Number:
PCT/IB2011/050264

(22) International Filing Date:
20 January 2011 (20.01.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/296,485 20 January 2010 (20.01.2010) US
61/384,288 19 September 2010 (19.09.2010) US

(71) Applicant *(for all designated States except US)*: **EON SURGICAL LTD.** [IL/IL]; 27 Ha-Barzel St., 69710 Tel-Aviv (IL).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **FARIN, Danny** [IL/IL]; Hod-Hasharon (IL). **BACHAR, Yehuda** [IL/IL]; Givat-Shmuel (IL). **WINSHTEIN, Ronny** [IL/IL]; 18 Tabenkin Street, 52302 Ramat-Gan (IL). **SHOHAT, Shaul** [IL/IL]; HaGiva 69, 73134 Kfar HaOranim (IL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) **Title**: SYSTEM OF DEPLOYING AN ELONGATE UNIT IN A BODY CAVITY

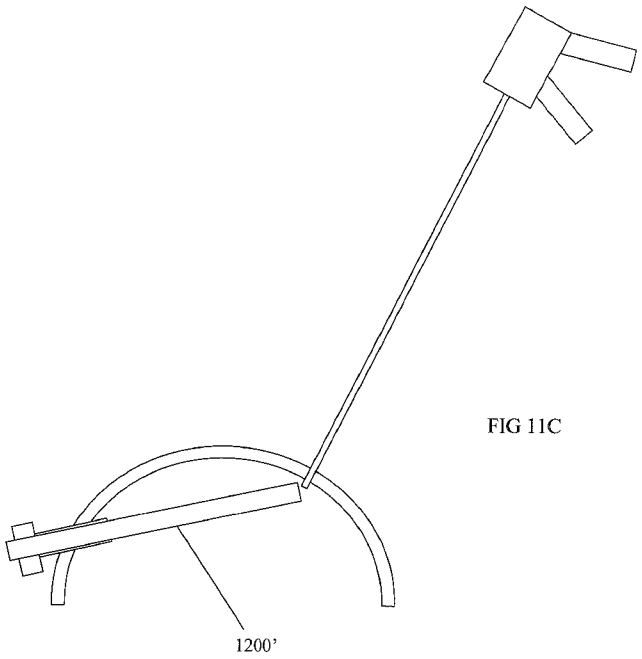


FIG 11C

(57) **Abstract**: A system and method are disclosed for deploying an elongated unit in a body cavity, for introducing an interchangeable tool to a slender shaft having a distal end. The system comprising: an elongated unit comprising a longitudinal axis and a distal portion arranged to protrude through a first port into the body cavity. At least one maneuvering unit connected to the elongated unit for maneuvering the distal portion of the elongated unit in a 3D coordinate system to a determined depth and orientation in the body cavity. The at least one maneuvering unit is arranged to selectively deploy the distal portion of the elongated unit at the determined depth and orientation at a distance with respect to the distal end of the slender shaft and selectively align the longitudinal axis thereof with a longitudinal axis of the slender shaft. The elongated unit and/or the slender shaft is arranged advanceable relative each other, such that once the distal portion of the elongated unit is deployed the distal portion of the elongated unit reaches and/or captures the distal end of the slender shaft.

WO 2011/089565 A1

Title: SYSTEM OF DEPLOYING AN ELONGATE UNIT IN A BODY CAVITY

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention generally relates to surgical methods and devices, and more specifically to laparoscopic and/or any endoscopic related surgical interventions. More particularly, the invention pertains to a system and/or method for deploying an elongated unit in a body cavity.

DESCRIPTION OF PRIOR ART

Laparoscopic or minimally invasive surgery includes the use of several relatively small ports into the abdomen by which different types of instrumentation and accessories are introduced and used for different surgical interventions (usually performed under endoscopic vision). Although usually considered superior in several aspects to open surgery, the use of plurality of 5 to 15 mm ports still leads to local pain, scars, and possibly port related complications such as hernia in scars and the need for one or two assistants in addition to the surgeon. Laparoscopic methods and surgical device are described, for example, in US patents Nos. 5,980,493, 7,593,777 and 7,316,699, the disclosures of which are fully incorporated herein by reference.

In past years, new versions of laparoscopic systems and approaches were introduced to overcome several of the "classic" laparoscopy disadvantages, mainly the Single-Port Access (SPA) and the Needlescopy approaches. In SPA the surgeon operates almost exclusively through a single entry point, typically through the patient's navel, using access ports and hand instrument. Highly experienced and skilled physicians may still use standard laparoscopic hand instruments, although the use of a single port access decreases its triangulation and complicates maneuverability. The use of special-purpose articulating instrumentation was introduced to overcome this difficulty, although it is considered very expensive, necessitates special training and still involves complex surgical maneuverability.

Minilaparoscopy/needelscopic laparoscopy is intended to overcome the problems encountered in single port access surgery. While the advantages of SPA includes improved cosmetic, less abdominal wall pain and less incision related complications, this surgical approach has its disadvantages. The vision is partially obscured by the paralleled inserted instruments; there is minimal triangulation and limited maneuverability of the surgical instruments. Minilaparoscopy maintains the same mode of surgery as standard laparoscopy however there is only one trocar and all the rest of the instruments are connected to needle like shafts which are inserted with no trocar and therefore provide comparable cosmetic and painless results as SPA.

In needlescopy, the laparoscopic ports are replaced with small incisions, usually between 2 to 3 mm in diameter. The surgery is performed by inserting narrow guide tubes into the small incisions and then passing tiny instruments through the tubes, while using a small television camera for guidance. The small instruments have very slender tips which make dissection and tissue maneuvration very difficult. Furthermore the instrument tips may have a greater tendency to break and their removal may be cumbersome and difficult.

In order to avoid such difficulties while maintaining small incision porting, it has been advised to combine the single-port and the needlescopic approaches. This is achieved by first inserting regular-sized interchangeable end-effectors through a regular size single port access and then detachably attaching them to corresponding distal portions of needle-sized manipulators. The manipulators are protruding into abdomen cavity via miniature needlescopic type incisions. The concept and several device derivatives were described in the following patents, the disclosures of which are fully incorporated herein by reference.

US patent No. 5,352,219 to Reddy describes a two-part modular tool and method for use thereof in conjunction with laparoscopic techniques enhances such techniques by enabling tools to be manipulated within a body cavity through small needle holes. The tool has an instrument head initially inserted through a laparoscopic port and an acuminate shaft which intracorporeally attaches to the instrument head. The instrument head is then manipulable through the needle hole at the site of desired use. The instrument head may be any tool configuration useful in surgical procedures which can be miniaturized to pass through a laparoscopic port.

US patent No. 5,441,059 to Dannan describes a method of conducting minimally invasive surgery that includes the steps of making a primary incision; importing at least one surgical instrument head through the primary incision; making at least one secondary incision, smaller than the primary incision and the cross-section of the surgical instrument head, for a handle; extending the distal end of the handle through each secondary incision; attaching one of the surgical instrument heads to the distal end of the handle; manipulating the surgical instrument head with the handle to which it is attached; detaching the surgical instrument head from the handle; removing the surgical instrument head through the primary incision; and withdrawing the distal end of the handle from the secondary incision.

US patent No. 6,723,043 to Kleeman et al. describes a surgical instrument assembly that includes an operative element and an insertion instrument removably engageable to the operative element. The insertion instrument is positionable in a patient with the operative element engaged thereto to position the operative element at an operative site in the patient. A transfer instrument is removably engageable to the operative element when the operative instrument is located at the

operative site. The insertion instrument can then be removed. Methods for using the surgical instrument assembly are also disclosed.

However, patient safety of the aforementioned prior art devices, systems and methods may be improved as navigation precision is not optimal as organs may unintentionally be injured.

Hence, an improved system and/or method would be advantageous, and in particular allowing for increased patient safety would be advantageous.

SUMMARY OF THE INVENTION

Accordingly, embodiments of the present invention preferably seek to mitigate, alleviate or eliminate one or more deficiencies, disadvantages or issues in the art, such as the above-identified, singly or in any combination by providing a system and/or a method according to the appended patent claims.

In a broad aspect of some embodiments there is provided a laparoscopic system applicable for delivering, guiding and/or coupling an interchangeable laparoscopic end-effector (e.g., surgical tool) to a distal portion of a tool manipulator in a body cavity. Appropriately utilizing the system may constitute a shorter duration, reduced uncertainty and improved safety of procedure preparation and initiation.

In some embodiments, the interchangeable surgical tools are of regular laparoscopic size and are sequentially deliverable though a single regular laparoscopic port (usually between 5 and 10 mm in diameter). Once delivered into body cavity, each surgical tool may then be connected to a slender shaft manipulator having a diameter of 5mm or less, optionally about 2mm or less. The surgical tool may be connected to the manipulator distal end by a variety of interlocking means, including snap-lock mechanisms.

Optionally, a tool introducer may be used to position the interchangeable surgical tool in a chosen operation site within body before coupling to a tool manipulator. The introducer or manipulator distal end may have a pivoting connection to the surgical tool. An introducer pivoting distal end may be selectively angled by remote manipulation.

In some embodiments, at least one endoscope and/or camera may be introduced via the laparoscopic port to monitor surgical procedure and/or tool guidance and transfer between introducer and manipulator. An endoscope may have an angled or beveled tip for viewing the process of connecting between tool and manipulator. An endoscope/camera may be inserted through the port/trocar any time before or after the tool introducer is positioned there. In some embodiments, the laparoscopic system includes a special purpose monitoring endoscope: besides using a camera to monitor procedure as custom in laparoscopic procedures, a special purpose endoscope (which may be a standard/commercially available or specially designed endoscope) may be advanced via an

introducer inner lumen for monitoring adaptor/interlocking operation. In some embodiments, a detachable mini-camera optionally in the form of a capsule or an end-effector is percutaneously introduced into the body cavity in a minimally invasive technique (e.g., using a tool introducer), and connected to a previously introduced tool holders (e.g., a distal end of a tool manipulator).

In some embodiments, the laparoscopic system includes an external guiding template indicating specific insertion ports for trocar and/or manipulators. Optionally, each port is specifically designed to guide a manipulator to a specific orientation within body for a rapid and accurate in-vivo coupling to an interchangeable end-effector. The operator may selectively choose between a fixed manipulator guiding, that is relevant for manipulator introduction into body and engaging with the effector, and a free manipulator movement, relevant for proper surgical intervention. A template frame may be procedure-specific and/or patient-specific (and allow all possible relevant ports) or adjustable according to need. It may be operated manually and/or remotely. Beneath or included in the template frame, there may be an adhesive sealant cloth and/or pad that provides adequate sealing around port/incision to avoid contamination and CO2 leakage.

In some embodiments, the laparoscopic system includes a needlescopic manipulator supporting mechanism capable of setting a specific chosen position of a miniature element (e.g., effector or camera) within body. The supporting mechanism may be operated manually or robotically, and allow fixedly 3D orientation change of the miniature element manipulator/holder (slender shaft/handle). The supporting mechanism may be a truss-based mechanism or a ball-socket mechanism; may include a ratchet mechanism and may be implemented in the external guiding template, for example in or in association to at least one of its ports.

In some embodiments, the laparoscopic system includes a surgical tool vectoring mechanism selectively and/or automatically altering introducer distal end when/after the effector is protruding into body through the trocar, in order to facilitate accurate and rapid engagement with manipulator distal end. The vectoring mechanism may allow an accurate, timely direction shift of the surgical tool/effector with respect to tool-holder longitudinal axis. Optionally, the tool is detachable from the introducing tool holder, and is further connectable to a second tool holder (e.g., a manipulator) that is substantially parallel and/or collinear and/or concentric with respect to a receiving portion of the tool/adaptor after the said direction shift. The vectoring mechanism may be passive (e.g., using a spring/nitinol set to shift the tool to a predetermined direction), or active/adjustable (e.g., either mechanically – for example by maneuvering the introducing tool holder along the trocar path, or electronically/robotically – after the tool is completely protruding through the trocar).

Optionally, an end-effector may be coupled to manipulator using rapid interlocking means (e.g., snap locking means). In some embodiments, the laparoscopic system includes a "handoff" coupling mechanism, i.e., a double-action locking mechanism allowing secure passing between two end-portions of laparoscopic slender shafts (e.g., trocars, manipulators, introducers, etc.) whereby the effector is released from introducer only after interlocking with manipulator and vice versa. Optionally, a special tool removal device may be used for detaching an effector to/from a manipulator, or this may be performed by the tool introducer itself.

According to an aspect of some embodiments there is provided a system for deploying an elongated unit in a body cavity for introducing an interchangeable tool to a slender shaft having a distal end, the system comprising:

an elongated unit comprising a longitudinal axis and a distal portion arranged to protrude through a first port into the body cavity; and

at least one maneuvering unit connected to the elongated unit for maneuvering the distal portion of the elongated unit in a 3D coordinate system to a determined depth and orientation in the body cavity, and the at least one maneuvering unit is arranged to selectively deploy the distal portion of the elongated unit at the determined depth and orientation at a distance with respect to the distal end of the slender shaft and selectively align the longitudinal axis thereof with a longitudinal axis of the slender shaft;

wherein the elongated unit and/or the slender shaft is arranged advanceable relative each other, such that once the distal portion of the elongated unit is deployed the distal portion of the elongated unit reaches and/or captures the distal end of the slender shaft.

In some embodiments, the distal portion of the elongated unit is deployed to reach and/or to capture the distal en of the slender shaft adjacent an entry point of the slender shaft, and wherein the entry point is located at a periphery of the body cavity.

In some embodiments, the at least one maneuvering unit comprising a trocar or an elongated trocar.

In some embodiments, the system according to any preceding claims, wherein the elongated unit comprising a elongated channel, such as an elongated trocar, or an elongated tool introducer having an operative length, such as at least 10 cm, such as at least 20 cm. Alternatively and/or additionally, the operative length is the distance from an entry point to an distal end of the distal portion.

In some embodiments, the slender shaft having a maximal diameter of less than 3 mm.

In some embodiments, the elongated unit comprising a tubular section. Alternatively and/or additionally, the tubular section comprising a deployable endoscope. Alternatively and/or additionally,

the tubular section comprising a window for enabling endoscopic visualization by the deployable endoscope. Alternatively and/or additionally, the endoscope deployed in the tubular section of the elongated unit is arranged for monitoring the deployment and/or the advancement and/or the reach and/or capture.

In some embodiments, the at least one maneuvering unit comprising a pivotally connection between the longitudinal axis and the distal portion of the elongated unit, and wherein the pivotally connection is arranged for allowing angular positioning of a interchangeable tool after the distal portion of the elongated unit is deployed adjacent to the distal end of the slender shaft.

In some embodiments, the distal portion of the elongated unit is a tool holder, such as a cartridge, comprising an interchangeable tool.

In some embodiments, the angular positioning is predetermined, or constant, or selectively determined after the distal portion of the elongated unit is deployed.

In some embodiments, the angular positioning positions an inner passage of the interchangeable tool with respect to the distal end of the slender shaft. Alternatively and/or additionally, the inner passage is concentrically arranged with respect to the distal portion of slender shaft after the angular positioning.

In some embodiments, the interchangeable tool comprises one of the group consisting of a grasper, a dissectors, a needle holder, a pair of scissors, a camera, a endoscope, a heat source, a sensing probe, a cryogenic probe, a dissector, a biopsy probes, a cutting tools, a laser source, an IR source, a light source, an illumination source, an ultrasound probe, an electrocautery device, a drug delivery device and combinations thereof.

In some embodiments, the maneuvering unit further comprising an external guiding device for maneuvering the elongated unit and the slender shaft, wherein the external guiding device comprising:

a center guide comprising a first opening;

an adjustable peripheral guide comprising a proximate end connected to the center guide and a distal part comprising at least one second opening;

wherein the elongated unit is distally connected to the distal portion of the elongated unit and readily deployed in the body cavity through the first opening; and

the adjustable peripheral guide and the at least second opening is arranged to adjustably advance the slender shaft to be reached and/or captured by the distal portion of the elongated unit.

In some embodiments, the external guiding device is further adapted to guide the distal end of the slender shaft to a determined orientation and/or depth in the body cavity. Alternatively and/or

additionally, the external guiding device is arranged to selectively lock the distal end of the slender shaft in the orientation and/or depth.

In some embodiments, the at least one second opening includes a longitudinal axis that is angled towards the center guide in at least one dimension.

In some embodiments, the adjustable peripheral guide is adjustable by at least one of: lengthening, bending, tilting, rotating, deforming and/or any combination thereof.

In some embodiments, the system further comprising an external frame comprising at least one of the external guiding device.

According to an aspect of some embodiments there is provided a method for deploying an elongated unit in a body cavity in a body cavity for introducing an interchangeable tool reversibly connectable to a distal end of a slender shaft, the method comprising the steps of:

protruding an elongated unit into the body cavity through a port being arranged in direct communication with the body cavity;

connecting the elongated unit to at least one maneuvering unit for maneuvering a distal end of the elongated unit in a 3D coordinate system to a determined depth and orientation in the body cavity;

utilizing the maneuvering unit for deploying the distal portion of the elongated unit at the determined depth and orientation at a distance with respect to the distal end of the slender shaft and selectively aligning the longitudinal axis thereof with a longitudinal axis of the slender shaft;

the distal portion of the elongated unit reaching and/or capturing the distal end of the slender shaft, when the distal portion of the elongated unit is deployed; and

introducing the interchangeable tool being connectable to the distal end of the slender shaft.

Alternatively and/or additionally, the method further comprising the step of:

advancing the elongated unit and/or the slender shaft relative each other. Alternatively and/or additionally, the method further comprising the step of:

reversibly connecting the interchangeable tool to the distal end of the slender shaft after introducing the interchangeable tool utilizing the elongated unit.

In some embodiments, the method comprising utilizing the elongated unit for reaching and/or capturing the distal end of the slender shaft is performed at an entry point of the slender shaft at a location where the distal end of the slender shaft emerges into the body cavity and before the distal end of the slender shaft moves substantially into the body cavity.

In some embodiments, the method comprising utilizing a endoscope situated in a tubular section of the elongated unit for monitoring the protruding, and/or the advancing, and/or the deployment, and/or the reaching and/or capturing, and/or the introducing of the interchangeable tool.

In some embodiments, the maneuvering further comprising the step of:

positioning the distal portion of the elongated unit including a interchangeable tool eccentrically to the longitudinal axis, wherein the interchangeable tool comprising a inner passage, and the inner passage is being angled towards the distal end of the slender shaft.

In some embodiments, the inner passage of the interchangeable tool is concentric to the distal portion of the tool manipulator after the positioning. Alternatively and/or additionally, the method comprising automatically executing the positioning when the interchangeable tool is introduced utilizing the elongated unit. Alternatively and/or additionally, the method comprising selectively executing the positioning by an operator.

In some embodiments, the method comprising predetermining an angle for the positioning of the interchangeable tool. Alternatively and/or additionally, the method comprising using a constant angle for the positioning of the interchangeable tool. Alternatively and/or additionally, the method comprising selectively determining an angle for the positioning of the interchangeable tool after introducing the interchangeable tool.

In some embodiments, the maneuvering and/ advancing is performed by means of an external guiding apparatus.

In some embodiments, the method comprising housing the interchangeable tool, such as a cartridge.

In some embodiments, the first lumen is a laparoscopic port having a diameter that is equal or more than 5mm. In some embodiments, the second lumen is a needlescopic port having a diameter that is equal or less than 3mm. Optionally, the second lumen includes a longitudinal axis that is angled towards the center guide in at least one dimension. Optionally, the adjustable peripheral guide is adjustable by at least one of: lengthening, bending, tilting, rotating, deforming and/or any combination thereof. Optionally, the interchangeable tool is tilted with respect to the tool introducer.

Further embodiments of the invention are defined in the dependent claims, wherein features for the second and subsequent aspects of the invention are as for the first aspect mutatis mutandis.

BRIEF DESCRIPTION OF THE DRAWINGS

Some embodiments of the invention are herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is

stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the invention. In this regard, the description taken with the drawings makes apparent to those skilled in the art how embodiments of the invention may be practiced.

In the drawings:

FIGS. 1A-B illustrate rapid laparoscopy system in operation, and a corresponding zoom-in portion, in accordance with an exemplary embodiment of the present invention;

FIG. 2 illustrates a rapid-laparoscopy external template, in accordance with an exemplary embodiment of the present invention;

FIGS. 3A-H illustrate several deployment possibilities of a rapid-laparoscopy external template, in accordance with an exemplary embodiment of the present invention;

FIGS. 4A-B illustrate exemplary prior-art and an optional laparoscopic ports schemes, in accordance with an exemplary embodiment of the present invention;

FIGS. 5A-F illustrate an exemplary interchangeable tools insertion system and steps of introduction thereof, in accordance with an exemplary embodiment of the present invention;

FIGS. 6A-B illustrate a side view and a corresponding top cut-view of a tool nested in an introduced cartridge, in accordance with an exemplary embodiment of the present invention;

FIGS. 7A-C illustrate several interlocking possibilities to a tool, in accordance with an exemplary embodiment of the present invention;

FIG. 8 illustrates a side view of a tool connected to manipulator, in accordance with an exemplary embodiment of the present invention;

FIG. 9 illustrates a side view of a tool connected to a manipulator pressed against a tool cartridge, in accordance with an exemplary embodiment of the present invention;

FIGS. 10A-F illustrate several regular and cut views of tool interlocking with a cartridge and release from a manipulator, in accordance with an exemplary embodiment of the present invention; and

FIGS. 11A-C illustrate two alternative ways of positioning a trocar and a tool-introducer inside the body cavity for safely connecting an interchangeable tool to a manipulator, in accordance with an exemplary embodiment of the present invention.

DETAILED DESCRIPTIONS OF EXEMPLARY EMBODIMENTS

Specific embodiments of the invention now will be described with reference to the accompanying drawings. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. The terminology used in the detailed description of the

embodiments illustrated in the accompanying drawings is not intended to be limiting of the invention. In the drawings, like numbers refer to like elements.

(a) Exemplary rapid laparoscopy system

FIGS. 1 illustrate an exemplary rapid laparoscopy system **100** deployed in patient body **200** (shown in a "sliced" proportion for demonstrative purposes), the system includes an introducing sleeve **110** and at least one tool manipulator **140**. In some embodiments, sleeve **110** is a trocar having a tubular body **112** and a substantially sharp or blunt distal end that is capable of channeling a surgical tool **130** into a cavity within body **200** using a tool introducer **120**. Sleeve **110** may be of any preferred size, and usually between 3 to 20mm in diameter, optionally 5 to 10mm (e.g., similar in size to regular laparoscopic port). Sleeve **110** may be sized (e.g., smallest cross section) to accommodate a largest of tools **130** in a specific tool kit. In some embodiments, system **100** includes a single regular-sized laparoscopic port that may be utilized for tool(s) **130** insertion into body and/or connection to manipulator(s) **140**.

Tool **130** may be any operational element (e.g., a probe or an instrument) deployable within a body, including but not limited to: surgical tools, grasping elements, dissectors, needle holders, clippers, scissors, connecting (e.g., stapling) elements, biopsy related instruments, sensor elements, imaging elements, clamping or grasping devices, heat generating probes (including RF, laser, IR, light, etc.), cryogenic probes, cutting and dissecting devices or energy sources, ultrasound probes, etc. In some embodiments, tool **130** is interchangeable and may be releasably attached to a distal tip **146** of manipulator **140**, as shown in FIG. 1B. In some embodiments, tool **130** includes a tool head or effector **132** (e.g., grasping means as presently illustrated), a body **134** and an inner passage **136** for accommodating a manipulator distal tip **146**. In some embodiments, tool **130** further includes locking mechanism (not shown) that allows safe coupling to manipulator **140**.

In some embodiments, introducer **120** includes a tubular body **122**, with an optional distal projection (optionally, tail-like), that is associated with (e.g., connected to, for example by using a Babcock grasper) tool **130**. In some embodiments, tool introducer **120** is releasably connected to tool **130** and/or to any sort of adapter or cartridge **124** (shown in FIGs. 5) that may be associated with (e.g., connect to or contain) tool **130** until deployment and/or operation. In some embodiments, introducer **120** allows a defined 3D orientation of tool **130** within body, thus providing a simpler and a potentially rapid approach for engaging manipulator **140** with inner passage **136** of tool **130**. Optionally, tool **130** orientation is selectively chosen, optionally adequately accurate. Optionally, tool **130** is oriented to a specific predefined position, for example by using a pivoting mechanism that combines spring energy and motion limiting (not shown). Alternatively or additionally, tool orientation is achieved by manual or

computerized operation, either remotely or at site. In some embodiments, introducer **120** and/or any associated tool holder, adapter or cartridge, further includes a safe tool passing mechanism (not shown), optionally a "handoff" type mechanism, which allows release of tool **130** only after the latter is safely interlocked with manipulator **140**, and optionally vice versa.

In some embodiments, manipulator **140** includes a shaft **142**, distal tip **146** and a tool operating handle **144**. Shaft **142** and tip **146** largest cross section may be 0.5 to 5mm in diameter, optionally 1 to 2.5mm, optionally about 1mm, about 1.5mm or about 2mm or higher or lower or intermediate. Tip **146** is optionally sharp and/or pointed in order to allow at least one of tissue penetration and easier engagement into tool inner passage **136**. Optionally, tip **146** is a Veres needle which optionally permits penetration through skin and abdominal wall tissue while preventing injury of internal organs (e.g., bowels), when not "armed". Optionally, tip **146** includes interlocking means, e.g., threading or a groove for snap-locking (not shown), for firmly connecting with tool **130**. Handle **144** may be any manually operated type laparoscopic instrumentation handle or may be replaced with any robotic or other non-manually operated arm. In some embodiments, handle **144** includes mechanisms which operates tool **130** and/or their association (e.g., locking or releasing modes or operations).

At least part of the instruments are made from rigid biocompatible materials as known to a person skilled in the art, and may include stainless steel, optionally hardened or reinforced by carbon coating or fibers, ceramic materials, plastic/polymeric materials (e.g., PEEK), composite materials (e.g., carbon-epoxy), or any combination thereof.

In some embodiments, rapid laparoscopy system **100** further includes at least one, and preferably at least two, intraoperative imaging devices (e.g., microcameras and/or endoscopes), at least one of which can be used to monitor tool **130** transfer, locking and/or handoff from introducer **120** to manipulator **140**, and optionally vice versa. Optionally, tool handoff monitor is an endoscope **128** (as shown in FIGs. 5) located within or adjacent to trocar **110** and/or introducer **120**. Additionally or alternatively, a grasped microcamera is transferred into body via trocar **110** using introducer **120** and then handed over to one of manipulators **140** which locates it in a preferred position to monitor the surgical operation. Other microcameras and/or endoscopes may be deployed in other locations using different manipulators.

In some embodiments, manipulator **140** is supported with an external holding device **150** which allows selective locking of manipulator in a certain positioning. This may be especially advantageous for example when a physician chooses to fixate a tool (e.g., a grasper) in a certain position while avoiding any unnecessary movements for a chosen period of time, and/or when he needs to occupy his hands with other manipulator(s). Holding device **150** may use a manipulator shaft grasper associated

with a locking and/or guiding elements (not shown), thereby allowing selective alternating between a free movement mode and a position locking/guiding mode.

Reference is now made to FIG. 2 showing patient body **200** setting prior to a rapid laparoscopy procedure using an exemplary external holding device **150** in a form of template. In some embodiments, device **150** includes a template frame **154**, a single tool introducer opening **156** and a plurality of manipulators openings **158**. Frame **154** includes several extensions upon which laparoscopic instrumentation may be supported, the extensions may be provided in a predefined design according to a specific instrumentation allocation pattern (as derived from a specific surgical method) or may be assembled or manipulated (e.g., manually, electronically or other) to a different chosen arrangement.

Frame **154** may have a curved base for improved fitting over patient body **200** and/or may include fastening elements (not shown), such as fastening belts, for a firmer connection to patient body **200**. Frame **154** may be made from any rigid or semi-rigid material, including metals, plastics and polymers.

External holding device **150** may include introducer-manipulators coordinating means which allow accurate manipulator engagement with a tool-head within body by guiding the manipulator in a specific correlated angle, plane and/or depth with respect to the tool head.

Exemplary holding device **150**, as specifically illustrated in FIG. 2, is adapted for a single-port micro-laparoscopic procedure in which a single regular-sized laparoscopic port is used for delivering regular-sized laparoscopic instrumentation into body to be assembled to and operated with micro-sized, "needlescopic", manipulators. Accordingly, in some embodiments, tool introducer opening **156** is approximately 5 to 15 mm in diameter (although it may be changed to or replaced with to different sizes according to need) in order to allow regular sized tools and endoscope(s) as accustomed in "classic" laparoscopy approaches. Furthermore, in some embodiments, manipulators openings **158** are approximately 1 to 2.5 mm in diameter in order to allow needlescopic manipulation of tools within body with substantially lessened scarring effect of body **200**.

Exemplary holding device **150** may include or be provided with a sealing pad or sheath **152** that may be especially useful in order to seal any entrapped gaseous substances (e.g., CO_2) within cavity of body **200**, and/or for protecting against any potential contamination as may be resulted in case of directly communicating with open air. Sealing pad **152** may be made from any relatively pliant or elastic material such as soft polymer or silicone, while maintaining re-sealing capabilities when pierced with a micro-sized element, such as a needle (similarly to a septum seal).

Device **150** may serve as a needle introducer template using specific pre-set orientation means. This may be advantageous especially for rapid location and handoff of tool **130** from introducer **120** to manipulator **140**, as device **150** may be used to guide manipulator distal tip **146** adequately accurately towards tool inner passage **136**. An exemplary pre-set orientation means are illustrated in FIGs. 3A-B, in which tool manipulator **140** is operated through manipulator opening **158** and a portion of sealing pad **152**. As shown in FIG. 3A, a needle guiding element **148** is placed over a portion of shaft **142** and maintains a specific orientation according to a preformed design of opening **158**. Optionally, guiding element **148** is a sleeve, optionally a splitting sleeve, and is made of a relatively rigid material, such as metal, plastic or polymer. After tool **130** is connected to manipulator distal end **136** and released from introducer **120**, guiding element **148** may be removed and manipulator can be freely maneuverable as illustrated in FIG. 3B. FIG. 3C illustrates a different type of an exemplary external supporting and/or guiding mechanism for manipulator **140** that includes a socket and a ball **151** design. Manipulator shaft **142** is passed through a lumen in ball joint **151** and allowed to freely move. Manipulator shaft **142** may be selectively paused in a specific orientation by deploying ball-joint lock **153**.

Reference is now made to FIGs. 3D-H schematically illustrating possible applications of external holding device **150** having a template arm **155**. In some embodiments, template arm **155** is applied for coordinating a rapid and accurate engagement of manipulator shaft **142** distal end and a tool coupled to cartridge or any other coupling element **124** that is angularly connected to introducer body **122**. In some embodiments, the engagement coordination includes guiding at least two members in body to a specific point and a specific angle in a 3D coordinate system within body **200** in order to allow the rapid and accurate engagement. In some embodiments, template arm **155** includes at least one introducer path **156** and at least one manipulator path **158** that are located in the same plane, optionally a perpendicular plane (e.g., a sagittal plane or a transverse plane) of patient body **200**, optionally an anterior or a posterior plane. In some embodiments, at least one of introducer path(s) and manipulator(s) path(s) are at least partially circular thereby allowing a relative rotation of circular shaft therein. Additionally or alternatively, at least one of the paths includes a specific mating pattern (not shown), for example a recess, a protrusion or any non-axisymmetrical shape, thereby allowing sliding of a shaft therein, the shaft having a mating cross section in a specific predetermined sliding plane into body.

FIG. 3D illustrates a template arm **155** having a single introducer path **156** and a single manipulator path **158**, that are angled one with respect to the other in a same plane. In some embodiments, trocar body **112** is inserted through introducer path **156** thereby channeling introducer

body **122** into patient body **200**. In some embodiments, introducer body **122** is coupled to an interchangeable tool (not shown) via a tool coupling element **124** that takes an angular orientation with respect to introducer body **122** when it is completely emerged in body **200** through trocar body **122**. In some embodiments, manipulator shaft **142** is inserted through manipulator path **158** and travels into body **200** in an angled orientation towards coupling element **124**. In some embodiments, coupling element **124** (and/or a tool coupled to and/or an inner passage of the tool) are in same angle and same plane as manipulator shaft **142** when are inserted through paths **156** and **158**, respectively, of template frame **155**. In some embodiments, at least one of paths **156** and **158** includes a guiding slot, recess, projection, etc. (not shown) that necessitates tool-manipulator engagement in same point and/or angle and/or plane within body **200**. Additionally or alternatively, markings are used to allow instruments manipulation within body to the desired tool-manipulator orientation.

In some embodiments, template arm **155** is rotational around path **156** in order to allow penetration points of same or different manipulator(s) shaft(s) **142** around said rotational axis. FIGs. 3E-3G suggest different template arms **155a**, **155b** and **155c**, which further allow penetration ports at different lengths along its longitudinal axis. In this way, an operator may use a single template arm to insert a plurality of manipulators at different penetration ports (e.g., as illustrated in FIG. 4B) which are located in different angles and lengths with respect to tool introducing port **210b**.

FIG. 3E illustrates a template arm **155a** having a single introducer path **156** and a plurality of manipulator paths, in this case three manipulator paths **158a**, **158b** and **158c**. In some embodiments, at least some of the manipulator paths are angled in such a way that manipulator passing therethrough will engage a tool in the same depth but in a different angle (so at least two paths will have different angles) or in a different depth but in the same angle (so at least two paths will have same angles), or any combination thereof. FIG. 3F illustrates a template arm **155b** having a single introducer path **156** and at least one, optionally a single, manipulator path **158**. In some embodiments, template arm **155b** has at least two pats, a first part that includes path **156** and a second part that includes path **158**, that are telescopically connected, thereby allowing a selective distance alternation between the two paths.

FIG. 3G illustrates a template arm **155c** having a similar approach to arm **155b**, but uses at least two members jointly coupled to allow a selective distance alternation between introducer path **156** and manipulator path **158**.

In some embodiments, for example when a template arm having a single manipulator path **158** is used, an operator may still choose a path angle. In some embodiments, path **158** is angled, either automatically or manually, using a mechanism (not shown) which correlates the distance between paths **156** and **158** and/or the depth of tool coupling element **124** and/or the angle of coupling element

124. Alternatively or additionally, manipulator insertion angle may be altered while using a constant manipulator path **158** angle, using angle adaptors **143** that are assembled (permanently or detachably) to a portion of manipulator shaft **142** (as illustrated in FIG. 3H).

(b) Exemplary micro-laparoscopy approach

The present invention will provide descriptions for laparoscopic cholecystectomy procedures, although it should be clear that the proposed treatment and medical tools can be applied in many different minimally invasive and/or anterior and/or endoscopic surgical procedures.

FIG. 4A illustrates a prior-art laparoscopic cholecystectomy procedure which utilizes a minimal sum of four laparoscopic ports:

(1) An endoscope port **210a** of approximately 10mm in diameter, usually located at patient's umbilicus. Port **210a** allows insertion of a trocar by which an endoscope may be inserted into body;

(2) A main operating port **220a**, approximately 10mm in diameter, usually located below the sternum. Port **220a** allows insertion of different types of surgical and other instruments, for example tools for suction, clipping, dissecting, cutting and hooking;

(3) Two graspers ports **230b**, approximately 5mm in diameter each, usually located adjacently below the right-lateral ribs. Commonly, two graspers are delivered through ports **230b** to grasp and hold the gall bladder in a certain position prior to executing surgical intervention steps.

In a normal laparoscopic cholecystectomy, the abdomen is first inflated with CO_2 via a 2.5mm special-purpose Veres-needle, followed by opening of ports **210a**, **220a** and **230a**. An endoscope is then inserted through port **210a**. After the abdomen is thoroughly scanned, graspers are introduced through ports **230a**. A first grasper grasps the gall bladder at the Fundus region and then stretches and pushes it over the liver. A second grasper grasps the gall bladder at the Infundibulum region to maneuver it laterally towards abdomen walls, thereby uncovering the cystic duct and the cystic artery. Several surgical instruments are then serially introduced via port **220a**. At first, a dissector is used to separate between the cystic duct and artery, a clipper is then introduced to block inflow of duct and artery, later to be both cut by scissors. Finally, the gall balder is separated using hooks or scissors and removed from patient body through port **210a** (either as a whole or in pieces).

The use of a combined single-port laparoscopy and needlescopy approaches, allows the surgeon more flexibility in choosing a laparoscopic ports scheme that may be procedure-specific and/or patient-specific. For example, the use of slender manipulators allows more flexibility in choosing a number of manipulators and associated tools to be applied simultaneously or in sequence while optionally covering larger or smaller operated regions. Furthermore, more imaging and/or illumination sources may be introduced and operated at different regions within abdomen, thus allowing improved

visual monitoring of procedure and tool handling within body. Once a camera is situated within body (e.g., via a needlescopic port) and abdomen cavity is adequately monitored, an endoscope may be considered unnecessary or be pulled in and out the single laparoscopic port for sequential tools introductions into the abdomen through this port.

FIG. 4B illustrates an optional exemplary porting scheme for laparoscopic cholecystectomy, which may be advantageously utilized using a rapid micro-laparoscopy approach of the present invention:

(1) A tools introducing port **210b** of approximately 10mm in diameter, usually located at patient's umbilicus. Port **210b** allows insertion of a trocar by which tools (e.g., tools **130**) may be sequentially inserted into body optionally followed by an endoscope. The 10 mm port may serve to introduce regular size instruments such as clippers, Ligasure/harmonic scalpel, suction, electrosurgical hook, etc.;

(2) At least one camera port **220b** of approximately 1mm in diameter, usually located adjacently below the left-lateral ribs. A micro-camera (sized 1 to 10mm in diameter) may be inserted though port **210b** using a tool introducer (e.g., introducer **120**) and transferred to a manipulator that is operated and/or protruding through port **220b**. Alternatively or additionally, an even smaller camera (sized 1mm or less) may be delivered into body directly though the 1mm incision of port **220b**;

(3) At least two graspers' ports **230b** of approximately 2mm in diameter each, usually located adjacently below the right-lateral ribs. Similarly to the micro-camera, the graspers may be delivered through port **210b** and connected to manipulators protruding through ports **230b**.

(4) Optionally one or more illuminator ports **240b** for holding illumination source, such as LED illumination, IR light, regular light, fiber optics etc. Port **240b** is approximately 1mm in diameter and located adjacently to port **220b**, also below the left-lateral ribs. This may be especially useful in case that the mini-camera does not include indigenous illumination capabilities, for example in view of the importance to minimize its size.

In some embodiments, similarly to normal laparoscopic cholecystectomy, the abdomen is first inflated with CO_2 using a 2.5mm special-purpose Veres-needle. Camera and illumination manipulators are then introduced through 1mm incisions made as ports **220b** and **240b**, respectively. Port **210b** is then opened and a trocar is introduced. An interchangeable mini-camera and illumination are then introduced via the trocar at port **210b** and connected to corresponding manipulators distal ends protruding at ports **220b** and **240b**. Two 5mm sized interchangeable graspers may then be introduced via port **210b** and connected to corresponding manipulators distal ends protruding at ports **230b**. The rest of the surgical procedure steps may be carried out as in the prior art approach previously

described, while "regular" laparoscopy instruments are inserted to abdomen and manipulated via port **210b**. Alternatively, at least one interchangeable surgical tool replaces a "regular" laparoscopy instrument and delivered to abdomen cavity later to be connected to a corresponding needlescopic manipulator that is located at a special purpose port (not shown) according to need and/or surgeon choice.

In some embodiments, an external holding device or template **150** is used for any of the purposes previously described, whereas a specific template frame **154** design and/or template frame **155** are chosen and/or assembled at-site according to the requested laparoscopic porting scheme.

(c) Exemplary deployment of a rapid micro-laparoscopy system

Reference is now made to FIGS. 5A-F illustrating an exemplary rapid micro-laparoscopy system **100** and steps of introduction of tools therethrough. For demonstrative purposes, in FIGS. 5A-C a tool itself is not illustrated.

In some embodiments, after deployment of system **100** as previously described, a trocar **110**, having a tubular body **112** of about 10mm in diameter, is introduced through port **210b** thereby allowing a safe passage of laparoscopic tools and instrumentation into body. Optionally, an introducer **120** having a body **122** of about 5 to 9mm in diameter is inserted through trocar **110**. Optionally, body **122** is tubular with an inner diameter of equal or less than 8mm, optionally about 5mm, allowing insertion therethrough of endoscope **128** which is about 8mm or less in diameter. In some embodiments, endoscope **128** is a side-vision endoscope having a lens **129** projected through a special lateral opening **127**, and can provide monitoring for the tool exchange within body via lateral window(s) **125** of body **122**. Body **122** includes a distal end **126** that is pivotally connected to tool cartridge **124** currently illustrated without a tool for demonstrative purposes.

Phase A of a tool delivery is illustrated in FIG. 5A where an assembly of introducer body **122**, endoscope **128** and cartridge **124** are traveled within trocar body **112** lumen towards abdomen cavity.

Phase B of tool delivery is illustrated in FIG. 5B where cartridge **124** almost entirely protrudes out of trocar **110** lumen. Tool introducer distal end **126** including lateral window **125** also protrudes, so endoscope monitoring may be initiated.

In Phase C (FIG. 5C), cartridge **124** is oriented with respect to the longitudinal axis of trocar-introducer assembly after entirely protruded into body cavity. In some embodiments, a released potential energy based device (e.g., a released spring motion; not shown) is used for a passive cartridge **124** altering to a specific, optionally predefined orientation, optionally further using any orientation control mechanism (such as a motion limiter, a designated cam, an electronic control element, etc.). Alternatively or additionally, cartridge **124** alternation is actively performed either

manually or remotely via a robotic arm. In some embodiments, cartridge **124** and/or the encapsulated tool longitudinal axis are substantially parallel or concentric to manipulator shaft **146**, thereby allowing a rapid engagement and connecting therebetween, as suggested in phase D (FIG. 5D).

The last delivery phase E (FIG. 5E) takes place once or after tool **130** is appropriately connected to manipulator shaft **146**. In a first embodiment, two distinct locking mechanisms (not shown) are situated in cartridge **124** and/or tool **130** and are used for locking the tool to cartridge **124** and to manipulator shaft **146**, respectively. In a second embodiment, the two locking mechanisms are interrelated in a way that when a first lock is in locked mode the second lock is in released mode, and vice versa, thus allowing a "handoff" passing of the tool in a secure way.

Once phase E is complete, and tool **130** is connected to manipulator **140** and disconnected from introducer **120**, the tool may be utilized to its designated task. In case that an external template **150** is used for guiding manipulator shaft **146** towards tool **130**, the guiding element (e.g., guiding sleeve **148**) may be released or removed, thereby allowing relatively free movement of manipulator shaft **146**.

(d) Exemplary tool handoff delivery

Reference is now made to FIGS. 6 that illustrate a side view and a corresponding top cut-view of an exemplary tool **1300** nested in an exemplary cartridge **1240** that is connected and/or part of an exemplary tool introducer **1200** having a body **1220**. An exemplary needlescopic manipulator shaft **1400** is proximately distant and optionally concentric to tool **1300** suggesting an initial pre-connecting phase (e.g., phase C as previously described).

In some embodiments, cartridge **1240** is pivotally connected to introducer body **1220** with a pivot **1210** thereby allowing at least partial rotation around pivot **1210** axis. Optionally, cartridge **1240** rotation is accomplished using a spring mechanism (not shown) or by any other means known to art. Optionally, a desired 3D cartridge/tool orientation is accomplished by maneuvering cartridge **1240** from outside patient body, either manually or remotely.

In some embodiments, tool **1300** is an interchangeable grasper having a head **1320**, body **1340** and an inner passage **1360** capable of telescopically accommodating a distal tip of manipulator **1400**. Optionally, grasper **1300** is approximately 5mm in diameter. In some embodiments, for example as illustrated in FIGS. 6, only grasper head **1320** is encapsulated by cartridge **1240**, within cartridge tool head housing **1242**, whereas at least part of grasper body **1340**, optionally most or all its length, extends outwardly within body cavity. Cartridge **1240** may further include a tool grasper **1270** for locking grasper head **1320** within housing **1242** or selectively releasing it when deployed.

Reference is now made to FIG. 7A illustrating a top cut-view of grasper **1300**, having a tubular frame **1342**, nested in cartridge **1240** while interlocked with a manipulator distal tip **1460**. Optionally, tool **1300** includes a beveled tool opening **1362** for an easier accommodation of manipulator distal tip **1460**. In some embodiments, tool **1300** includes a manipulator tip lock **1370** situated along a portion of inner passage **1360**, for snap-locking to a distal tip of manipulator **1400**, using a lock beveled opening **1372** and a lock narrow section **1374** which is designed to mate with a corresponding recess **1462** located proximally to manipulator tip **1460**. In some embodiments, tip lock **1370** is connected at its proximal side to a tool inner shaft **1380** and is blocked from moving distally by a releasing mechanism lock widener **1394** shown in FIG. 7 in a locking position. In some embodiments, lock widener **1394** has a rounded portion **1396** for an optional selective smoother proximal travel within lock beveled opening **1374**. In some embodiments, lock widener is coupled to a releasing mechanism outer sleeve **1392** that is rotatable around tool body tubular frame **1342**.

When locked to manipulator **1400**, grasper **1300** may now be released from tool cartridge **1240** as illustrated in FIG. 8. In some embodiments, when grasper **1300** is distally pulled (e.g., by manipulator **1400**) it easily disconnects from cartridge **1240** by laterally widening cartridge tool grasper **1270** during pullout. Optionally, a threshold force is required for achieving disconnection in order to avoid unintentional tool escapes from cartridge grasping.

Additionally or alternatively, grasper release is achieved by unlocking a second locking mechanism that releasably holds it within cartridge housing **1242**. FIGs. 7B and 7C illustrate another exemplary design for manipulator **1400** in unlocked and locked modes, respectively. In some embodiments, manipulator **1400** includes an inner shaft **1422** having a distally pointed end **1460**, an intermediate sleeve **1466** having a distal compressible portion **1464** and optionally maintains substantially same outer diameter with shaft **1422** maximal diameter, and an outer sleeve **1424**. In some embodiments, compressible portion **1464** expands and/or send arms when compressed, thereby produced interlocking when engaged into a recess in a smaller diameter lumen. Optionally, compressible portion **1464** includes a tubular portion that is elastic and/or braided and/or slitted and/or bellowed (i.e., includes bellows). Optionally, compressible **1464** includes a stent-like design, optionally a cage-like design, optionally includes at least one strip that is bendable to an arch. Optionally, outer sleeve **1424** is connectible to tool **1300** and allows rotatability to an inner rotatable part and/or a sliding movement of an inner slidable part of tool **1300**. Optionally, outer sleeve rotates and/or slides with respect to shaft **1422** and/or intermediate sleeve **1466** thereby allowing operation of tool **1300** and/or locking/unlocking modes shift. Optionally, locking and unlocking are achieved by relative movement of shaft **1422** and intermediate sleeve **1466** (e.g., by pulling or pushing sleeve **1466** proximal end).

(e) Exemplary tool removal

In some embodiments, after final utilization of a tool and/or at procedure termination the tool should be disconnected from its corresponding manipulator **1400** and be safely removed from body via tool introducing port **210b**. Optionally, special removing device and/or tool grasping cartridge are used (not shown). Alternatively, same instrumentation is used in a substantially reverse order for tool(s) removal. Reference is now made to FIG. 9 illustrating a side view of grasper **1300** connected to manipulator **1400** while pressed against cartridge **1240**. In some embodiments, cartridge tool grasper **1270** includes a tool opening teeth **1272** including beveled end portions **1274** allowing tool grasper widening when grasper head **1320** is pressed against it with a force that exceeds a defined threshold force.

Now that grasper **1300** is re-nested in cartridge **1240** a second mechanism is operated for releasing the grasping of manipulator tip **1460** and disconnecting from manipulator **1400**, as illustrated FIGS. 10. In some embodiments, releasing mechanism outer sleeve **1392** includes a diagonal slot **1397** that is engaged with a pin **1398** laterally projecting from tool body inner shaft **1380**. Optionally, outer sleeve **1392** and inner shaft **1380** can slide and/or rotate one with respect to the other, so that pin **1398** travel from a first corner (position I1 in FIG. 10C) to a second corner (position I2 in FIG. 10D) of diagonal slot **1397** is accomplished by a proximal partial sliding of inner shaft 1380 and its rotation counter-clockwise partial rotation with respect to outer sleeve 1392.

In some embodiments, tool body tubular frame **1342** includes an L-slot **1344** that is engaged with a pin **1382** laterally projecting from tool body inner shaft **1380**. Optionally, tubular frame **1342** and inner shaft **1380** can slide and/or rotate one with respect to the other, so that pin **1382** travel from a first corner (position J1 in FIG. 10C) to a second corner (position J2 in FIG. 10D) of L-slot **1344** is accomplished by a proximal partial sliding of inner shaft **1380** and its rotation counter-clockwise partial rotation with respect to tubular frame **1342**.

Since that pin **1398** and pin **1382** are both projections of inner shaft **1380**, a counter-clockwise rotation of the inner shaft promotes a relative inward motion between tool frame **1342** and outer sleeve **1392**. Referring back to FIG. 7A, releasing mechanism lock widener **1394** is situated with respect to lock beveled opening **1372** in a manner that corresponds to positions I1/J1 (FIG. 10C). In some embodiments, lock widener **1394** is firmly connected to outer sleeve **1392** in a manner that denies lengthwise movement between them, so that when frame **1342** and outer sleeve **1392** are moving inwardly, lock beveled opening **1372** and lock widener **1394** are moving inwardly as well, resulting in widening of opening **1372** by widener **1394**. This allows manipulator tip **1460** removal from tool inner

passage **1360**, so that tool **1300** may be removed from body via port **210b**. FIG. 10E illustrates the widening of opening **1372** by widener **1394** in a manner that corresponds to positions I2/J2 (FIG. 10D).

In some embodiments, the lengthwise and/or rotational movement of inner shaft **1380** (hence of pins **1398** and **1382**) is executed by a corresponding motion of a manipulator body **1420**. As shown in FIG. 10F, body **1420** comprises a shaft **1422** and an outer sleeve **1424**, optionally capable of relative rotation. In some embodiments, tool inner passage **1360** includes at least one tenon **1364** which engages corresponding recesses or slots (not shown) on manipulator outer sleeve **1424**, thereby denying rotational movement between them. Hence, in some embodiments, when manipulator **1400** is traveled inward and/or counter-clockwise rotated, tool inner shaft **1380** follows the same movement and consequently manipulator **1400** is disconnected from tool **1300** and may be easily pulled out.

(f) Other exemplary embodiments

In some embodiments, the system is connectible and/or is part of a surgical robotic system and/or a telesurgery system. In an exemplary embodiment, at least one of: introducer, tool, tool-cartridge, manipulator, template, template arm, are controlled and/or operated robotically and/or remotely.

In some embodiments, the system includes at least partial fail-proof locking mechanisms, for example between the tool and the tool-cartridge and/or between the tool-cartridge and the introducer and/or between the tool and the manipulator distal end. In an exemplary embodiment, a locking mechanism is normally opened, hence in a fail-mode will resume unlocked mode, or vice versa.

In some embodiments, a system locking mechanism includes pneumatic and/or hydraulic and/or electronic components. Optionally the locking mechanism includes sensors which detect connection and/or disconnections of two elements (e.g., tool and cartridge, tool and manipulator, cartridge and introducer, etc.). Optionally, in a fail-mode situation, a passive locking mechanism may be bypassed with a different active locking mechanism (e.g., remotely manually operated), and vice versa.

In some embodiments, the system is designed to allow only a specific sequence of steps. One of many sequences may include the step of connecting and/or deploying a template arm in a specific manner; followed by the step of introducing an introducer into body and pivoting cartridge to a predetermined orientation in body; followed by the step of introducing a manipulator shaft using the template arm to directly engage and connect to the tool nested or connected to the cartridge; followed by the step of releasing the tool from the cartridge. In some embodiments, this "one-way" sequence may be applied by using a control mechanism that allows a proper utilization of a second locking element only after a first locking element was properly utilized, and vice versa.

(g) Exemplary positioning of the tool-introducer

System 1000 is deployed prior to utilization in a body cavity, for example, an abdominal cavity **2000**. System **1000** includes a laparoscopic working channel or port, referred to here as, but not limited to, a trocar **1100**, and at least one handheld micro-laparoscopic manipulator referred to as tool manipulator **1400**. Tool manipulator **1400** includes a shaft **1420** and an operation handle **1440**. Shaft **1420**, such as a slender shaft, is configured to be attached at its distal end to a detachable and/or an interchangeable surgical end-effector or tool (not shown). In some embodiments, the tool manipulator could be configured as described herein in respect to Fig. 6-10.

In Fig. 11A, trocar **1100** and tool manipulator **1400** are positioned after insertion into abdominal cavity **2000** and prior to attachment of a tool. Optionally, trocar **1100** may be housing an endoscope (not shown). In order to attached the tool to the distal end of shaft **1420**, the surgeon needs to position it adjacent to the lumen of trocar **1100** by aiming towards the endoscope lens (or "towards his eye" as seen in the monitor). Optionally, the endoscope is then withdrawn from trocar **1100**. A tool introducer then introduces a tool through the path of the trocar **1100**. In some embodiments the endoscope is deployed in the tool introducer. In some further embodiments the introduction of a tool and the transfer of the tool between a tool introducer and the shaft **1420** could be performed according to any of the methods described herein.

A tool may be any operational element (e.g., a probe or an instrument) deployable within a body, including but not limited to: surgical tools, grasping elements, dissectors, needle holders, clippers, scissors, connecting (e.g., stapling) elements, biopsy related instruments, sensor elements, imaging elements, clamping, clipping elements or grasping devices, heat generating probes (including RF, laser, IR, light, etc.), cryogenic probes, illuminating elements cutting and dissecting devices or energy sources, ultrasound probes, camera or other imaging probes, lenses, lenses tubes, or any other optical instruments, etc.

Trocar **1100** may be of any preferred size, and usually between 3 mm to 20 mm in diameter, optionally about 10 mm or 12 mm (e.g., similar in size to regular laparoscopic port). Trocar **1100** may be sized (e.g., smallest cross section) to accommodate a largest of a surgical tool in a specific tool kit. In some embodiments, system **1000** includes a single regular-sized laparoscopic port that may be utilized for tool(s) insertion into the body and/or connection to the tool manipulator **1400**.

In some embodiments, shaft **1420** includes a distal tip. The largest cross section of the shaft and tip may be 0.5 mm to 5 mm in diameter, optionally 1 to 2.5 mm, optionally about 1 mm, about 1.5 mm or about 2 mm or higher or lower or intermediate. The shaft tip is optionally sharp and/or pointed in order to allow at least one of tissue penetration and easier engagement with a tool. Optionally, the shaft

tip is a Veres needle which optionally permits penetration through skin and abdominal wall tissue while preventing injury of internal organs (e.g., bowels) when not "armed". Optionally, shaft **1420** includes interlocking means, e.g., threading or a groove for snap-locking (not shown), for firmly connecting with the tool, or alternatively by any means of friction, pressure or other means known to the art. Handle **1440** may be any manually operated type laparoscopic instrumentation handle or may be replaced with any robotic or other non-manually operated arm. In some embodiments, handle **1440** includes mechanisms which operate the introduced tool(s) and/or their association (e.g., locking or releasing modes or operations).

At least part of the instruments are made from rigid biocompatible materials as known to a person skilled in the art, and may include stainless steel, optionally hardened or reinforced by carbon coating or fibers, ceramic materials, plastic/polymeric materials (e.g., PEEK), composite materials (e.g., carbon-epoxy), or any combination thereof.

In some situations, the process of maneuvering the tool manipulator **1400** until locating the trocar **1100** may be difficult, time consuming and/or unsafe, due to the possibility that the shaft **1420** may harm adjacent tissues. Reference is now made to Figs. 11B-C, illustrating different (partial) deployment stages of a second schematically illustrated exemplary micro-laparoscopic system, in accordance with an exemplary embodiment of the invention. This embodiment comprises an elongated tool introducer **1200** (as shown in Figs.) and/or an elongated trocar **1100** (not shown). An elongated tool introducer **1200** assists in locating and guiding distal end of shaft **1420** before transferring the tool to the shaft **1420**. The elongated tool introducer **1200** is introduced via trocar **1100**, and travels into the abdominal cavity **2000** until it is adjacent the distal end of shaft **1420** (as shown in Fig. 11B). In this embodiment, an endoscope (not shown) may be placed inside the elongated tool introducer **1200**. Additionally and/or alternatively an elongated trocar **1100** could be used to locate and guide the distal end of shaft **1420** before introducing the tool introducer **1200** into the lumen of the trocar **1100**. If an elongated trocar **1100** is utilized an endoscope could in some embodiments be placed inside the trocar **1100.**

Additionally or alternatively to using an elongated trocar **1100** and/or an elongated tool introducer **1200**, other locating and/or guiding and/or grasping/connecting devices (not shown) may be used to locate and/or guide and/or grasp shaft **1420** in the abdominal cavity **2000** and assist in transferring and engaging the interchangeable tool.

Fig. 11C suggests a slightly different approach using a substantially longer or more distally advanceable elongated tool introducer **1200'** (shown) and/or elongated trocar **1100** (not shown), which is sized and/or configured to advance towards and to reach at and/or capture the inlet/incision or a

position adjacent to the inlet/incision of manipulator **1400** through and into abdominal cavity **2000**, so the tip of the shaft **1420** may be captured at the entry of the abdominal cavity **2000**, located at the periphery of the abdominal cavity **2000**. In some instances it will be preferable to use this approach, as may be important not only to prevent injury to organs but also to prevent working against the direction of viewing which may be considered cumbersome.

In some embodiments the release, transfer and engagement of the interchangeable tool could then be performed according to any of the methods described herein. Alternatively, such release, transfer and engagement maybe performed in other methods known to the art.

(h) Other alternatives of exemplary embodiments

According to an aspect of some embodiments, a system may be provided for positioning an interchangeable tool in a body cavity, the system comprising:

a channel comprising a lumen in direct communication with the body cavity;

a tool introducer comprising a longitudinal axis and a distal end, the tool introducer is capable of traveling through the channel lumen; and

a tool holder covering at least a portion of the interchangeable tool, the tool holder is pivotally connected to the tool introducer distal end, thereby allowing angular positioning of the interchangeable tool after the tool holder emerges from the channel into the body cavity.

In some embodiments, the angular positioning may be predetermined.

In some embodiments, the angular positioning may be constant.

In some embodiments, the angular positioning may be selectively chosen after the tool holder emergence into the body cavity.

In some embodiments, the interchangeable tool may includes a passage for accommodating a distal portion of a tool manipulator.

In some embodiments the angular positioning may positions the passage with respect to the distal portion of the tool manipulator.

In some embodiments, the passage may be concentric to the distal portion of the tool manipulator after the angular positioning.

In some embodiments, the interchangeable tool may comprising one of the group consisting of a grasper, a dissector, a needle holder, scissors, a camera, an endoscope, a heat source, a sensing probe, a cryogenic probe, a dissector, a biopsy probe, a cutting tool, a laser source, an IR source, a light source, an illumination source, an ultrasound probe, an electrocautery device, a drug delivery device and combinations thereof.

In some embodiments, the system may further comprising an external guiding device configured to guide a tool manipulator to engage the interchangeable tool in the body cavity, wherein the guiding device comprises:

a center guide comprising a first lumen adapted to accommodate the channel;

an adjustable peripheral guide having a proximal end connected to the center guide and a distal end incorporating a second lumen;

wherein: the tool introducer is distally connected to the interchangeable tool and readily deployed in the body cavity through the channel accommodated in the first lumen of the center guide; and

the adjustable peripheral guide is adjusted to guide the tool manipulator through the second lumen to engage the interchangeable tool.

In some embodiments, the external guiding device may be further adapted to guide a distal portion of the tool manipulator in a defined orientation and/or depth in the body cavity.

In some embodiments, the external guiding device may be adapted to selectively lock the distal portion of the tool manipulator in the orientation and/or depth.

In some embodiments, the distal portion of the tool manipulator may be concentric to an inner passage of the interchangeable tool.

In some embodiments, the second lumen includes a longitudinal axis that may be angled towards the center guide in at least one dimension.

In some embodiments, the adjustable peripheral guide may be adjustable by at least one of: lengthening, bending, tilting, rotating, deforming and/or any combination thereof.

In some embodiments, the interchangeable tool may be tilted with respect to the tool introducer.

In some embodiments, the system may further comprising an external frame comprising at least one external guiding device.

In some embodiments, the tool holder may be a tool cartridge.

In some embodiments, the tool introducer may comprises a tubular section.

In some embodiments, the system may further comprising an endoscope deployable in the tubular section.

In some embodiments, the tubular section may includes a window, thereby enabling endoscopic visualization by the endoscope.

According to an aspect of some embodiments a method may be provided for engaging an interchangeable tool, the tool having an inner passage, with a distal portion of a tool manipulator in a body cavity, the method comprising the steps of:

inserting a tool introducer into a channel, the channel comprising a lumen providing direct communication into the body cavity and wherein a proximal end of the interchangeable tool is reversibly connected to a distal end of the tool introducer;

orienting the distal portion of the tool manipulator in the body cavity;

emerging the interchangeable tool from the channel into the body cavity; and

positioning the interchangeable tool eccentrically to the lumen of the channel wherein the inner passage of the interchangeable tool is angled towards the distal portion of the tool manipulator.

In some embodiments, the positioning may be automatically executed once the interchangeable tool entirely emerges from the channel.

In some embodiments, the positioning may be selectively executed by an operator.

In some embodiments, the method may further comprising predetermining an angle of the positioning of the interchangeable tool.

In some embodiments, the method may comprising using a constant angle for the positioning of the interchangeable tool.

In some embodiments, the method may further comprising selectively choosing an angle of the positioning of the interchangeable tool after emerging the interchangeable tool.

In some embodiments, the inner passage of the interchangeable tool may be concentric to the distal portion of the tool manipulator after the positioning.

In some embodiments, the orientating step may be accomplished by means of an external guiding device.

In some embodiments, the method may further comprising the steps:

advancing the distal portion of the tool manipulator to engage with the inner passage of the interchangeable tool; and

engaging the distal portion of the tool manipulator with the inner passage of the interchangeable tool.

In some embodiments, The method may further comprising the steps of locating the distal end of the tool manipulator before introducing the interchangeable tool by:

introducing an elongated tool introducer through the lumen into the body cavity and moving the distal end of the tool introducer into a position adjacent to a position to which the distal portion of the

tool manipulator is oriented and guiding the distal end of the tool manipulator to engage with the inner passage when the interchangeable tool is emerged into the body cavity

and/or

introducing an elongated channel, the channel comprising a lumen, into the body cavity and moving the distal end of the elongated channel into a position in the body cavity adjacent to a position to which the distal portion of the tool manipulator is oriented and guiding the distal end of the tool manipulator to engage with the inner passage when the interchangeable tool is emerged into the body cavity; and

advancing the distal portion of tool manipulator to engage with the inner passage.

In some embodiments, The method may further comprising the step of capturing the distal end of the tool manipulator at an entry point of the tool manipulator as the distal end of the tool manipulator emerges into the body cavity and before the distal end of the tool manipulator moves substantially into the body cavity by utilizing the elongated tool introducer and/or the elongated channel having a lumen.

In some embodiments, The method may comprising monitoring the engaging procedure via an endoscope situated in a tubular section of the tool introducer.

In some embodiments, the interchangeable tool may be housed in a tool holder.

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

All publications, patents and patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention. To the extent that section headings are used, they should not be construed as necessarily limiting.

CLAIMS

1. A system for deploying an elongated unit in a body cavity for introducing an interchangeable tool to a slender shaft having a distal end, the system comprising:

an elongated unit comprising a longitudinal axis and a distal portion arranged to protrude through a first port into said body cavity; and

at least one maneuvering unit connected to said elongated unit for maneuvering said distal portion of said elongated unit in a 3D coordinate system to a determined depth and orientation in said body cavity, and said at least one maneuvering unit is arranged to selectively deploy said distal portion of said elongated unit at said determined depth and orientation at a distance with respect to said distal end of said slender shaft and selectively align said longitudinal axis thereof with a longitudinal axis of said slender shaft;

wherein said elongated unit and/or said slender shaft is arranged advanceable relative each other, such that once said distal portion of said elongated unit is deployed said distal portion of said elongated unit reaches and/or captures said distal end of said slender shaft.

2. The system according to claim 1, wherein said distal portion of said elongated unit is deployed to reach and/or to capture said distal en of said slender shaft adjacent an entry point of said slender shaft, and wherein said entry point is located at a periphery of said body cavity.

3. The system according to claim 1 or 2, wherein said at least one maneuvering unit comprising a trocar or an elongated trocar.

4. The system according to any preceding claims, wherein said elongated unit comprising a elongated channel, such as an elongated trocar, or an elongated tool introducer having an operative length, such as at least 10 cm, such as at least 20 cm.

5. The system according to claim 4, wherein said operative length is the distance from an entry point to an distal end of said distal portion.

6. The system according to any preceding claims, wherein said slender shaft having a maximal diameter of less than 3 mm.

7. The system according to any preceding claims, wherein said elongated unit comprising a tubular section.

8. The system according to claim 7, wherein said tubular section comprising a deployable endoscope.

9. The system according to claims 7 or 8, wherein said tubular section comprising a window for enabling endoscopic visualization by said deployable endoscope.

10. The system according to claims 8 or 9, wherein said endoscope deployed in said tubular section of said elongated unit is arranged for monitoring said deployment and/or said advancement and/or said reach and/or capture.

11. The system according to any preceding claims, wherein said at least one maneuvering unit comprising a pivotally connection between said longitudinal axis and said distal portion of said elongated unit, and wherein said pivotally connection is arranged for allowing angular positioning of a interchangeable tool after said distal portion of said elongated unit is deployed adjacent to said distal end of said slender shaft.

12. The system according to claim 11, wherein said distal portion of said elongated unit is a tool holder, such as a cartridge, comprising an interchangeable tool.

13. The system according to claim 11 or 12, wherein said angular positioning is predetermined, or constant, or selectively determined after said distal portion of said elongated unit is deployed.

14. The system according to any of claims 11 to 13, wherein said angular positioning positions an inner passage of said interchangeable tool with respect to said distal end of said slender shaft.

15. The system according to claim 14, wherein said inner passage is concentrically arranged with respect to said distal portion of slender shaft after said angular positioning.

16. The system according to any preceding claims, wherein said interchangeable tool comprises one of the group consisting of a grasper, a dissectors, a needle holder, a pair of scissors, a camera, a endoscope, a heat source, a sensing probe, a cryogenic probe, a dissector, a biopsy probes, a cutting tools, a laser source, an IR source, a light source, an illumination source, an ultrasound probe, an electrocautery device, a drug delivery device and combinations thereof.

17. The system according to any preceding claims, wherein said maneuvering unit further comprising an external guiding device for maneuvering said elongated unit and said slender shaft, wherein said external guiding device comprising:

a center guide comprising a first opening;

an adjustable peripheral guide comprising a proximate end connected to said center guide and a distal part comprising at least one second opening;

wherein said elongated unit is distally connected to said distal portion of said elongated unit and readily deployed in said body cavity through said first opening; and

said adjustable peripheral guide and said at least second opening is arranged to adjustably advance said slender shaft to be reached and/or captured by said distal portion of said elongated unit.

18. The system according to claim 17, wherein said external guiding device is further adapted to guide said distal end of said slender shaft to a determined orientation and/or depth in said body cavity.

19. The system according to claims 18, wherein said external guiding device is arranged to selectively lock said distal end of said slender shaft in said orientation and/or depth.

20. The system according to any of claims 17 to 19, wherein said at least one second opening includes a longitudinal axis that is angled towards said center guide in at least one dimension.

21. The system according to any of claims 17 to 20, wherein said adjustable peripheral guide is adjustable by at least one of: lengthening, bending, tilting, rotating, deforming and/or any combination thereof.

22. The system according to claim 1 and 18, further comprising an external frame comprising at least one of said external guiding device.

23. A method for deploying an elongated unit in a body cavity in a body cavity for introducing an interchangeable tool reversibly connectable to a distal end of a slender shaft, said method comprising the steps of:

protruding an elongated unit into said body cavity through a port being arranged in direct communication with said body cavity;

connecting said elongated unit to at least one maneuvering unit for maneuvering a distal end of said elongated unit in a 3D coordinate system to a determined depth and orientation in said body cavity;

utilizing said maneuvering unit for deploying said distal portion of said elongated unit at said determined depth and orientation at a distance with respect to said distal end of said slender shaft and selectively aligning said longitudinal axis thereof with a longitudinal axis of said slender shaft;

said distal portion of said elongated unit reaching and/or capturing said distal end of said slender shaft, when said distal portion of said elongated unit is deployed; and

introducing said interchangeable tool being connectable to said distal end of said slender shaft.

24. The method according to claim 23, further comprising the step of:

advancing said elongated unit and/or said slender shaft relative each other.

25. The method according to claim 23 or 24, further comprising the step of:

reversibly connecting said interchangeable tool to said distal end of said slender shaft after introducing said interchangeable tool utilizing said elongated unit.

26. The method according to any of claim 23 to 25, comprising utilizing said elongated unit for reaching and/or capturing said distal end of said slender shaft is performed at an entry point of said slender shaft at a location where said distal end of said slender shaft emerges into said body cavity and before said distal end of said slender shaft moves substantially into said body cavity.

27. The method according to any of claims 23 to 26, comprising utilizing a endoscope situated in a tubular section of said elongated unit for monitoring said protruding, and/or said advancing, and/or said deployment, and/or said reaching and/or capturing, and/or said introducing of said interchangeable tool.

28. The method according to any of claims 23 to 27, wherein said maneuvering further comprising the step of:

positioning said distal portion of said elongated unit including a interchangeable tool eccentrically to said longitudinal axis, wherein said interchangeable tool comprising a inner passage, and said inner passage is being angled towards said distal end of said slender shaft.

29. The method according to claim 28, wherein said inner passage of said interchangeable tool is concentric to said distal portion of said tool manipulator after said positioning.

30. The method according to claim 28 or 29, comprising automatically executing said positioning when said interchangeable tool is introduced utilizing said elongated unit.

31. The method according to claim claims 28 or 29, comprising selectively executing said positioning by an operator.

32. The method according to any of claims 28 to 31, comprising predetermining an angle for said positioning of said interchangeable tool.

33. The method according to any of claims 28 to 31, comprising using a constant angle for said positioning of said interchangeable tool.

34. The method according to any of claims 28 to 31, comprising selectively determining an angle for said positioning of said interchangeable tool after introducing said interchangeable tool.

35. A method according to any of claims 23 or 24, wherein said maneuvering and/ advancing is performed by means of an external guiding apparatus.

36. A method according to any of claims 23 to 42, comprising housing said interchangeable tool, such as a cartridge.

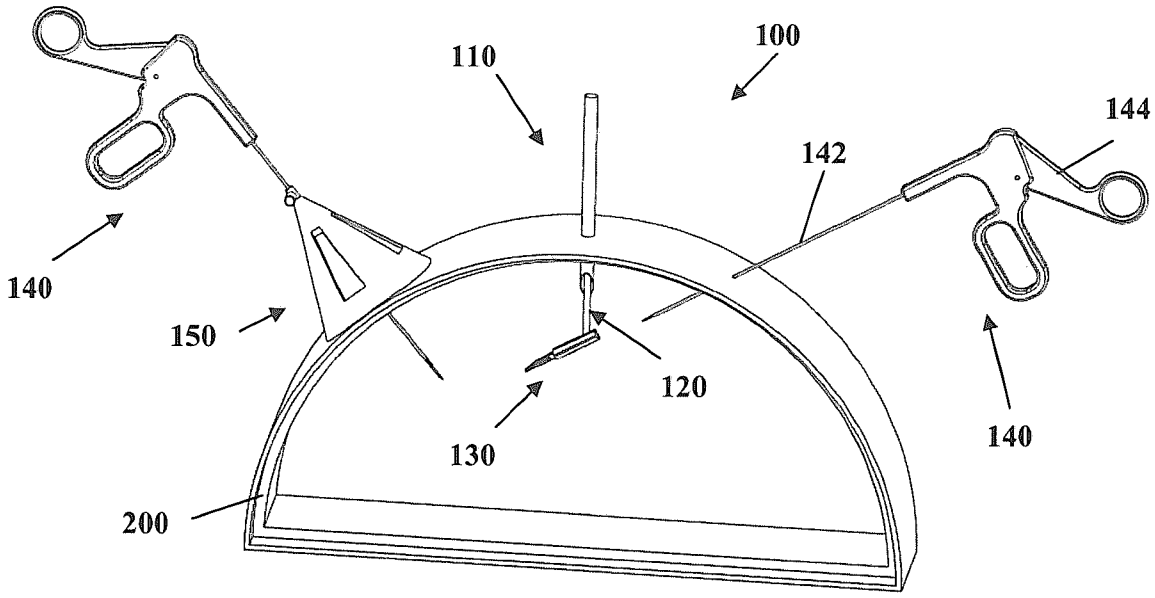

100
110
144
142
140
150
120
130
140
200

FIG. 1A

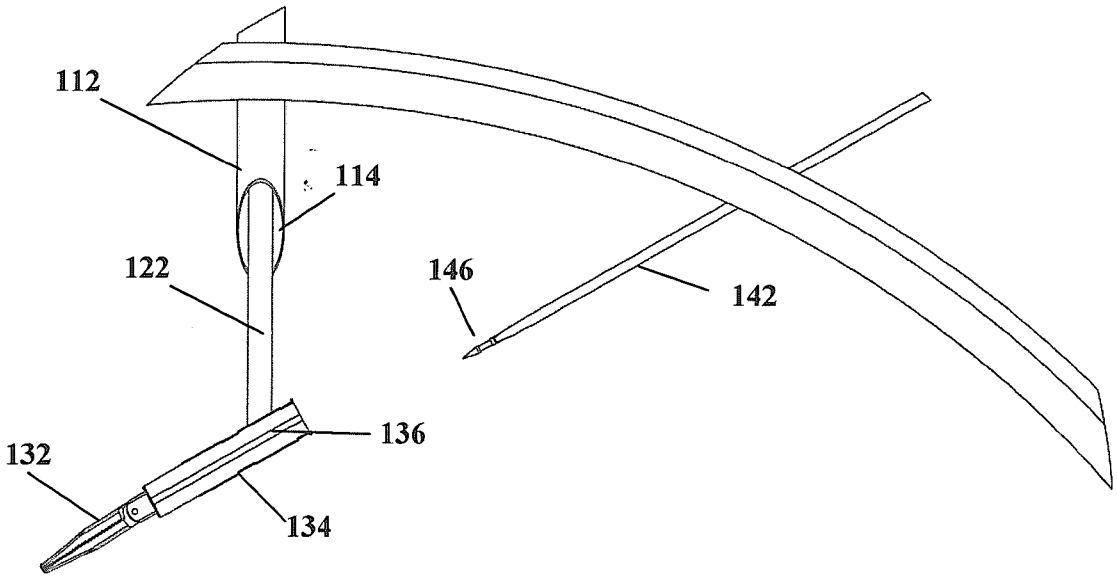

112
114
122
146
142
136
132
134

FIG. 1B

FIG. 2

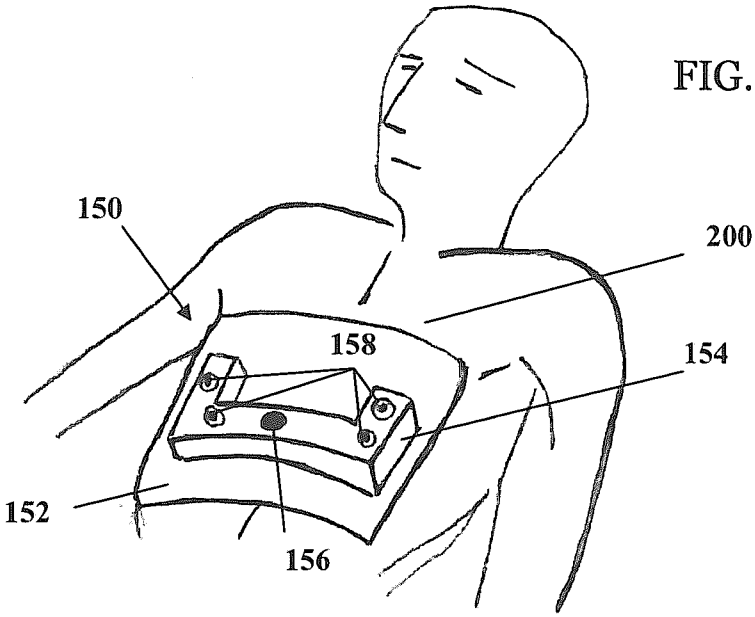


FIG. 3A

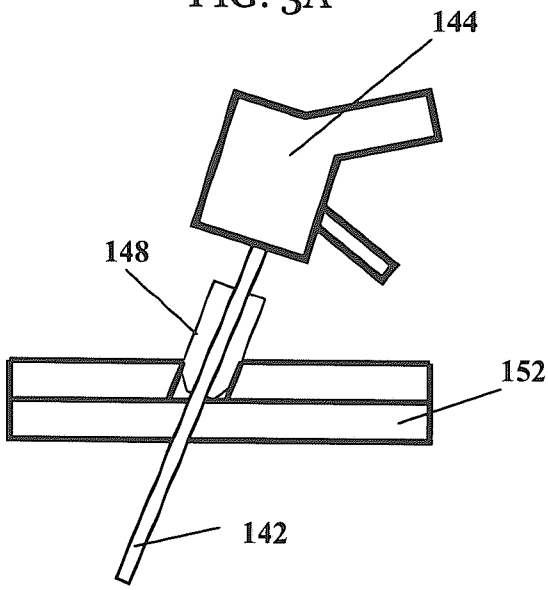


FIG. 3B

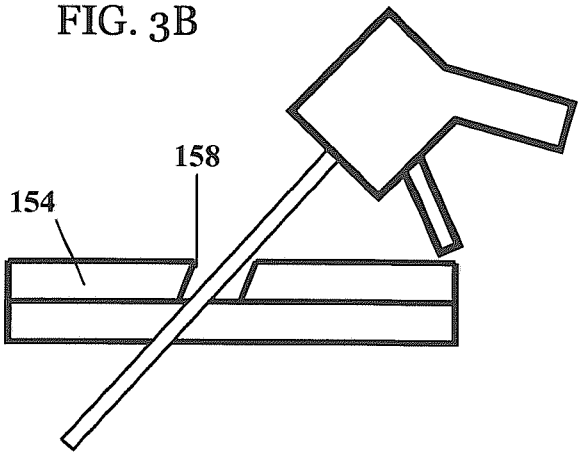
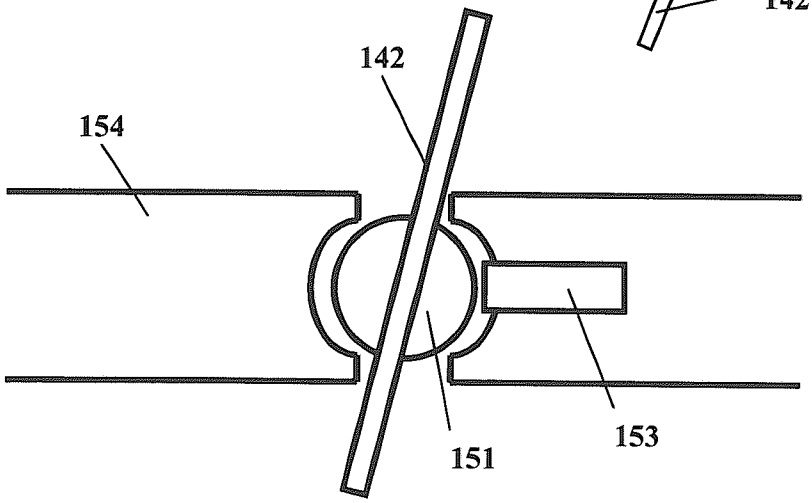


FIG. 3C



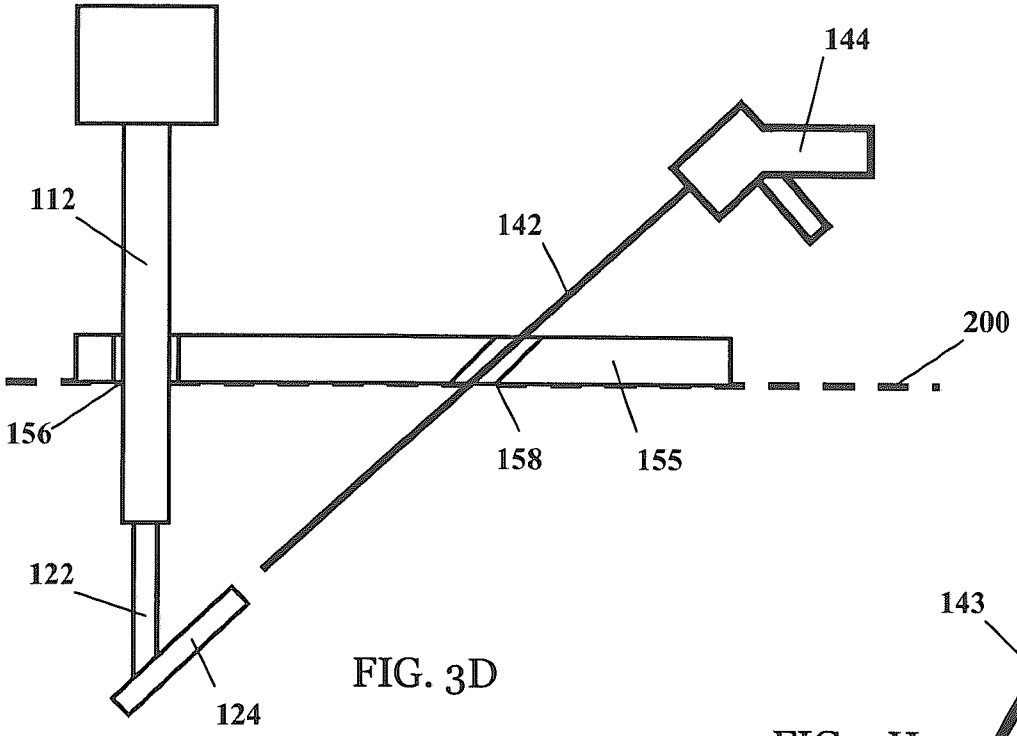


FIG. 3D

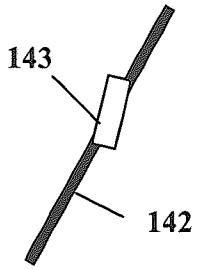


FIG. 3H

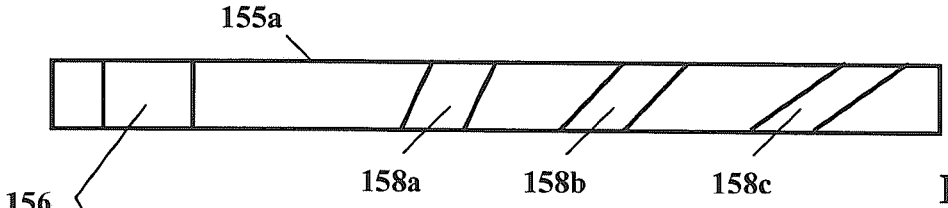


FIG. 3E

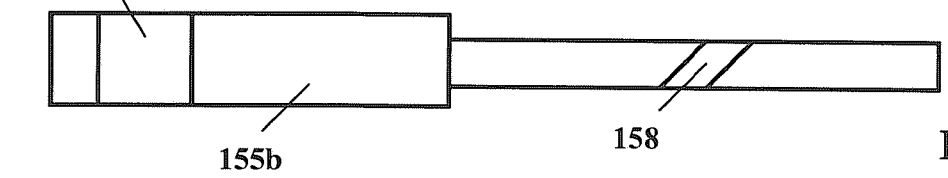


FIG. 3F

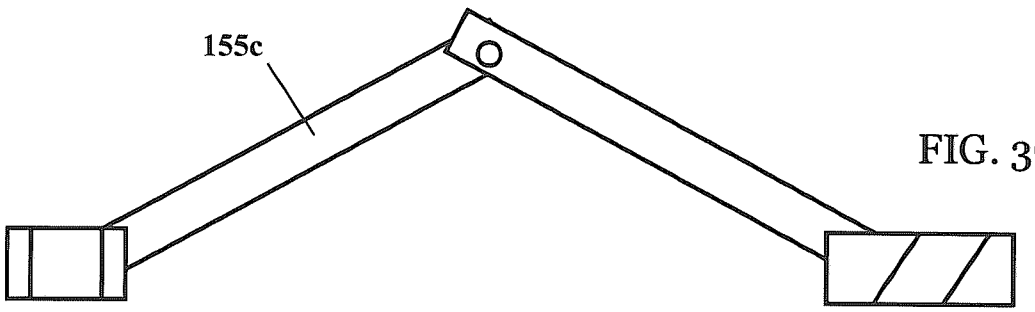


FIG. 3G

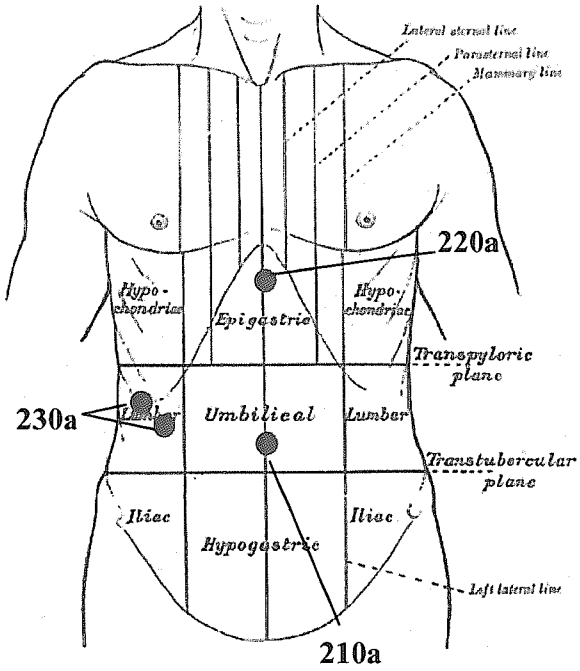


FIG.4A
(Prior Art)

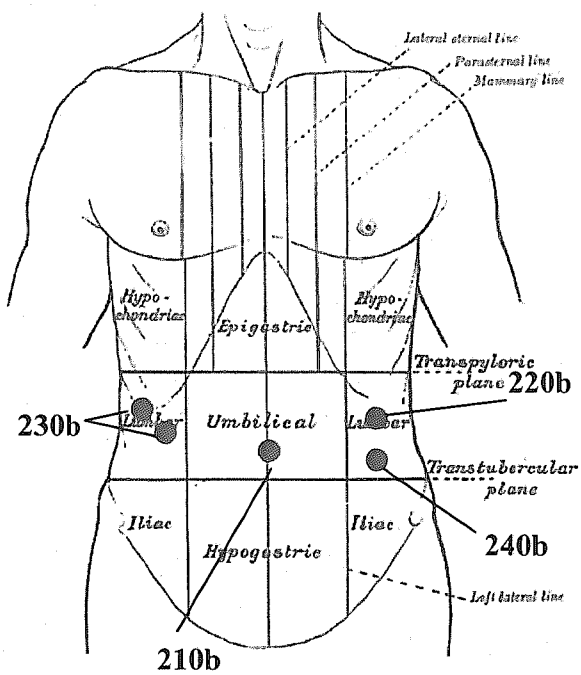


FIG. 4B

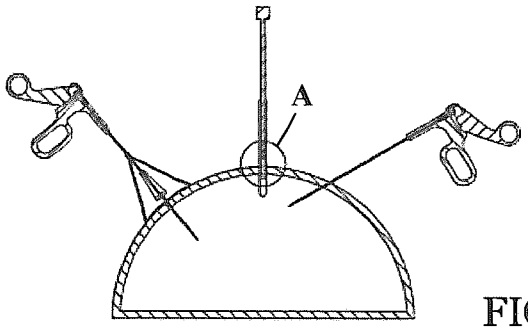
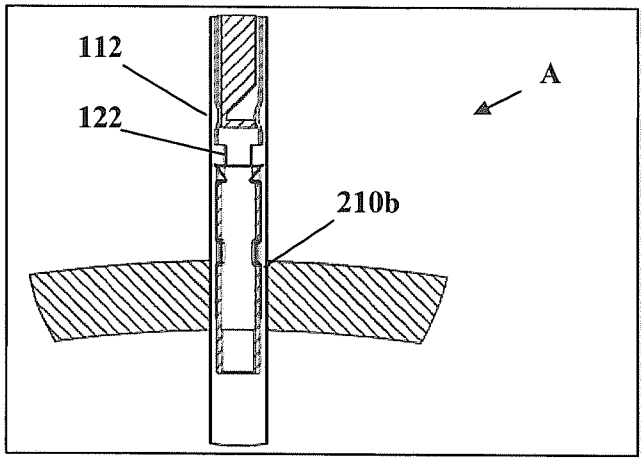


FIG. 5A



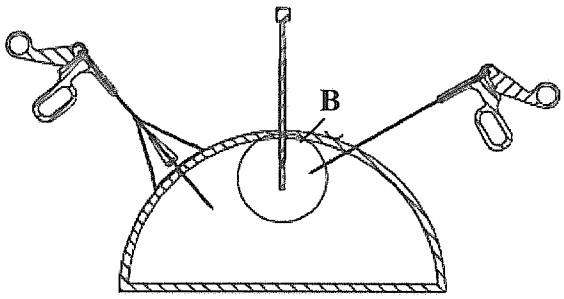
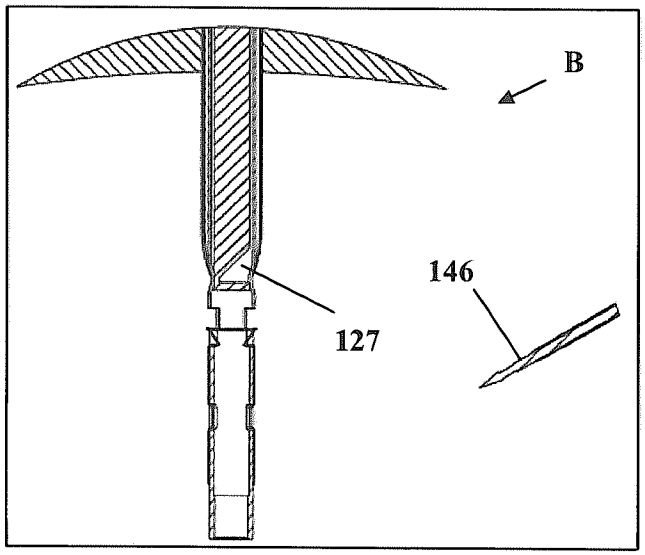


FIG. 5B



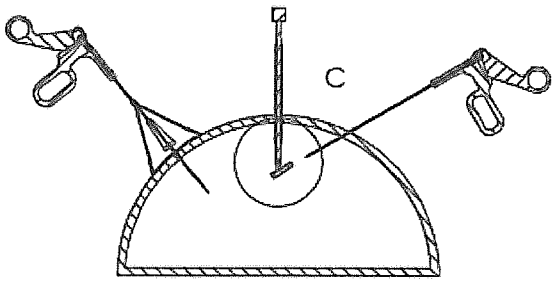
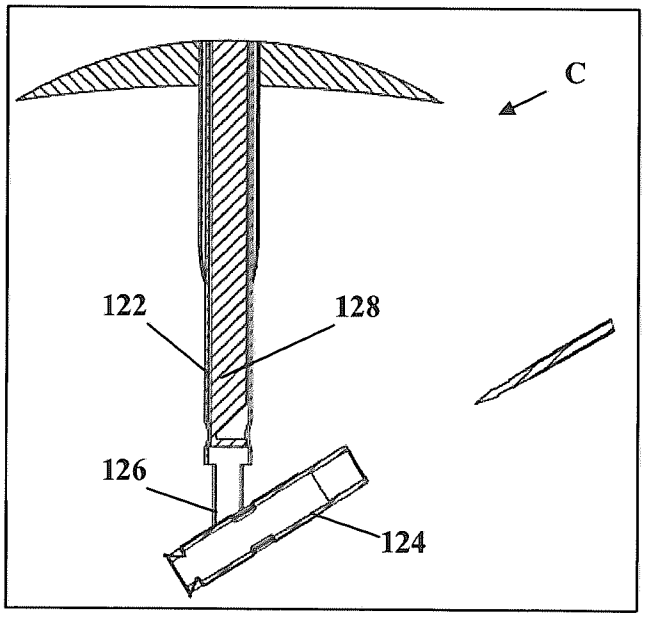


FIG. 5C



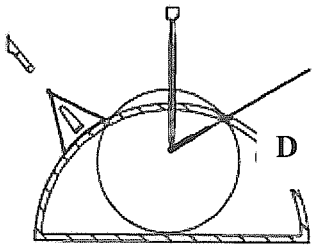


FIG. 5D

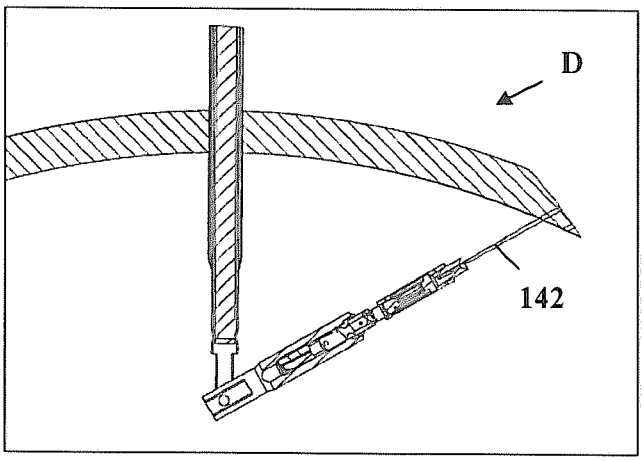
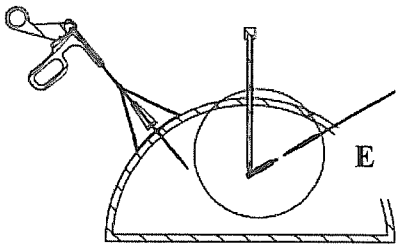
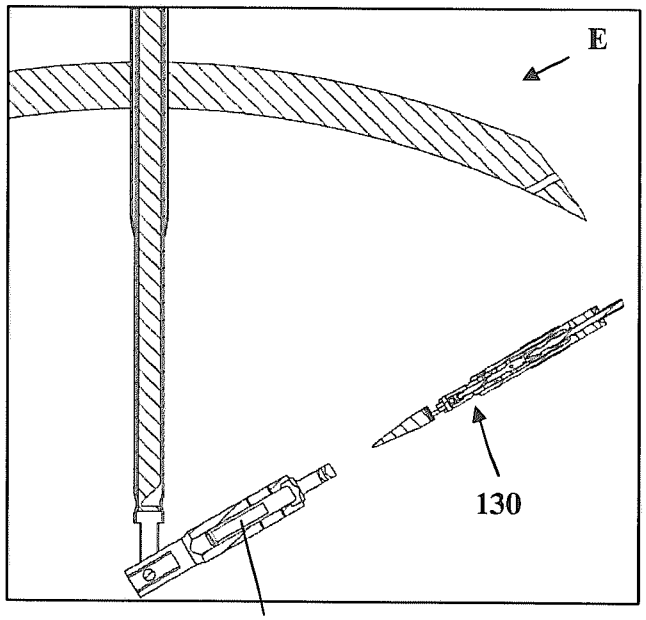


FIG. 5E





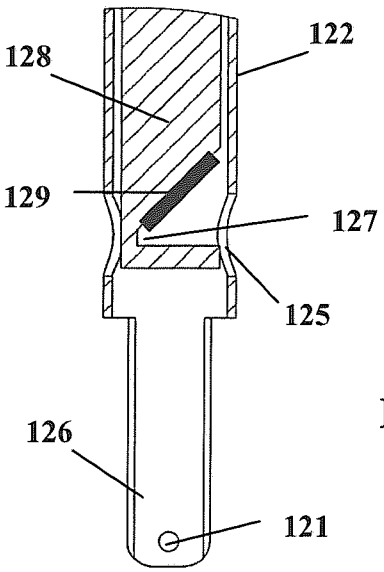


FIG. 5F

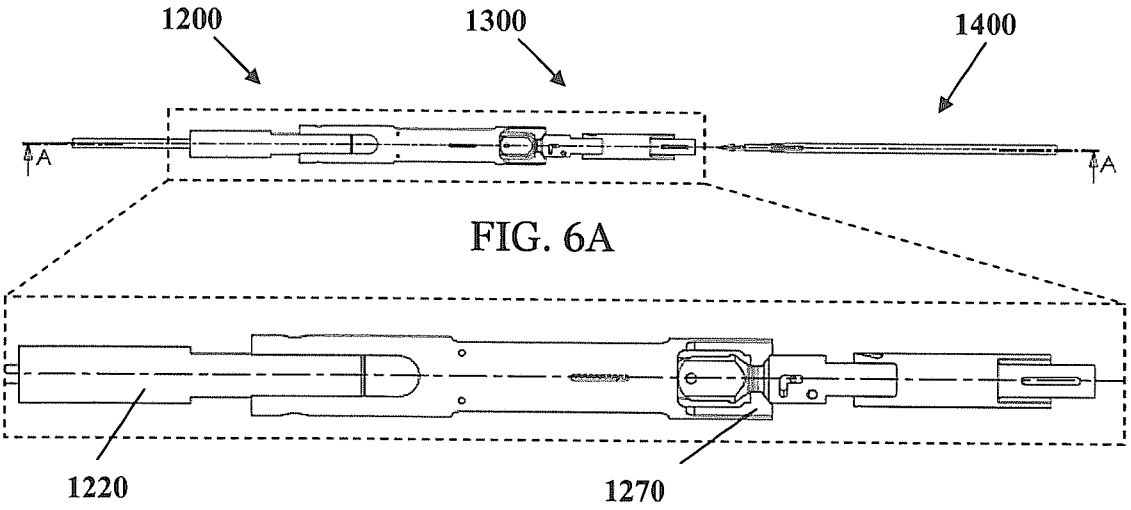
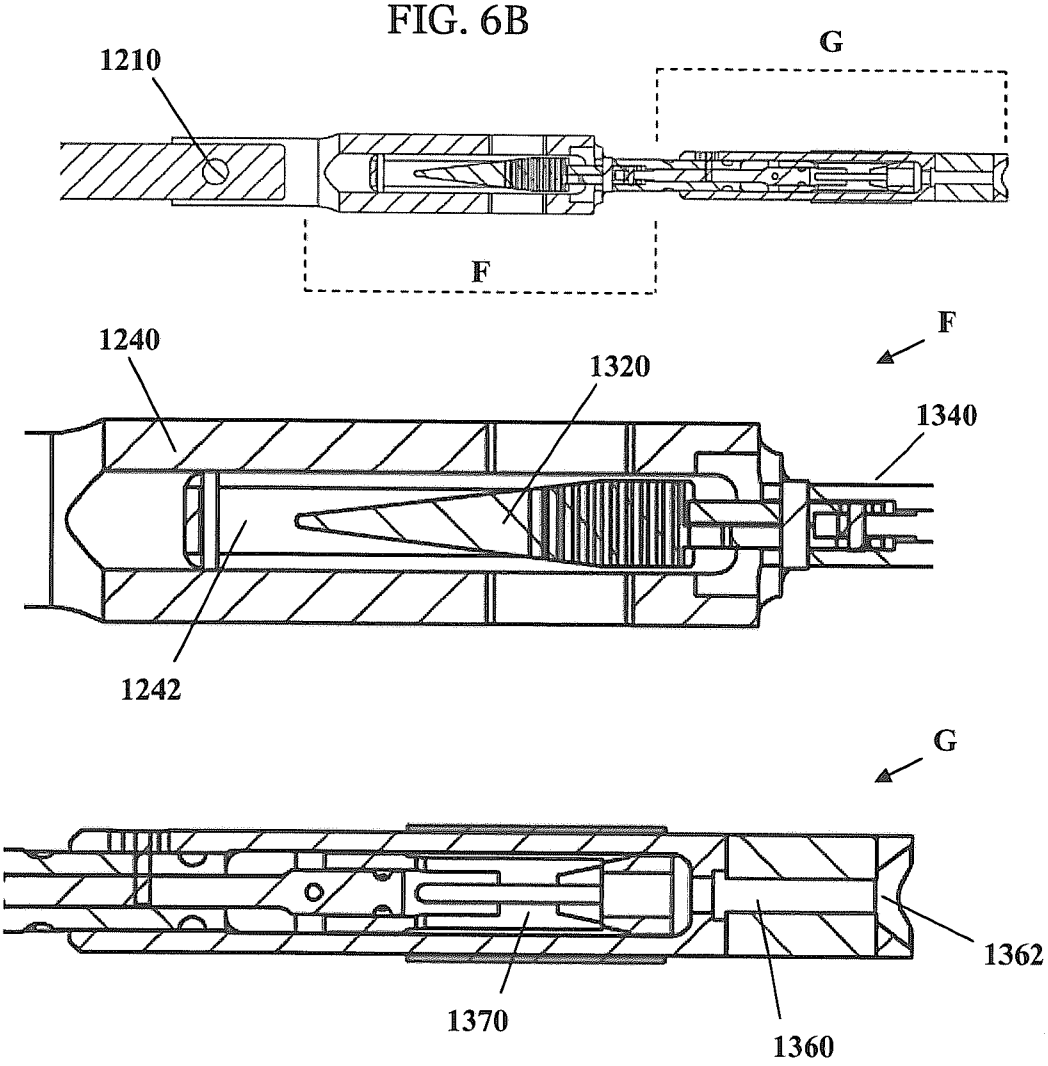

1200
1300
1400
A
A
1220
1270

FIG. 6A

FIG. 6B


1210
G
F
1240
1320
F
1340
1242
G
1362
1370
1360

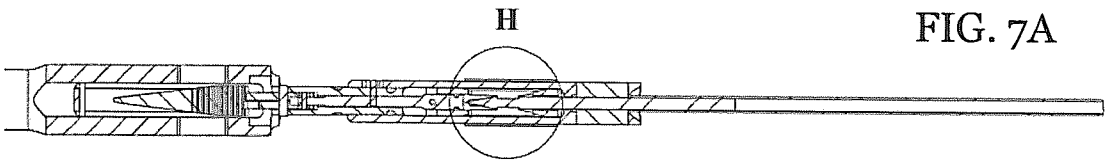


FIG. 7A

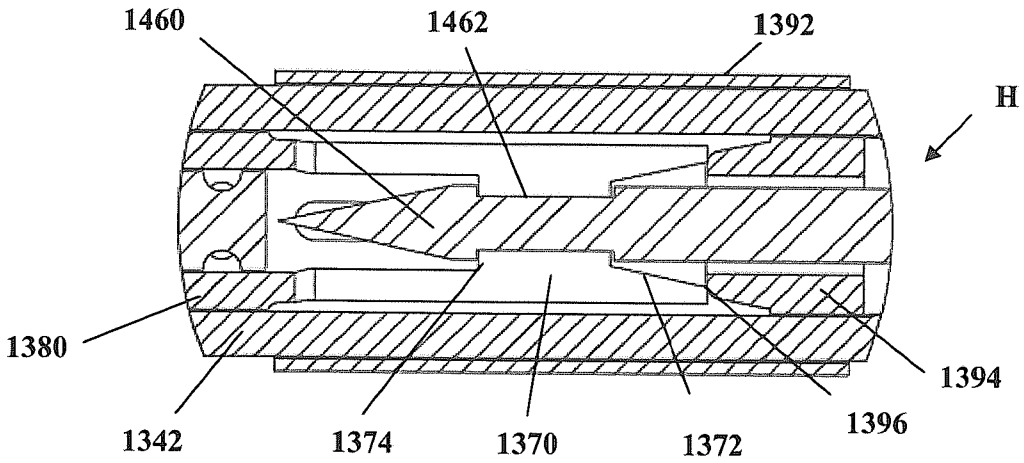
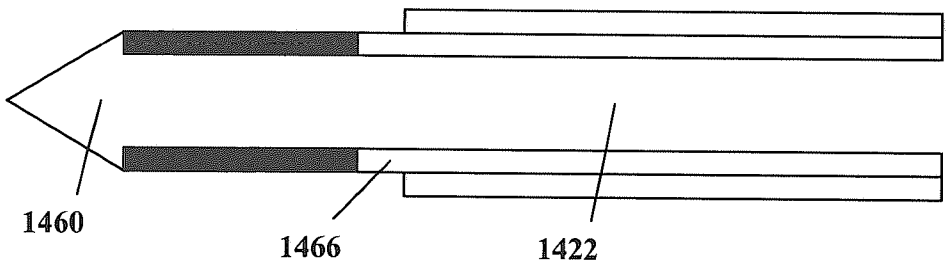


FIG. 7B



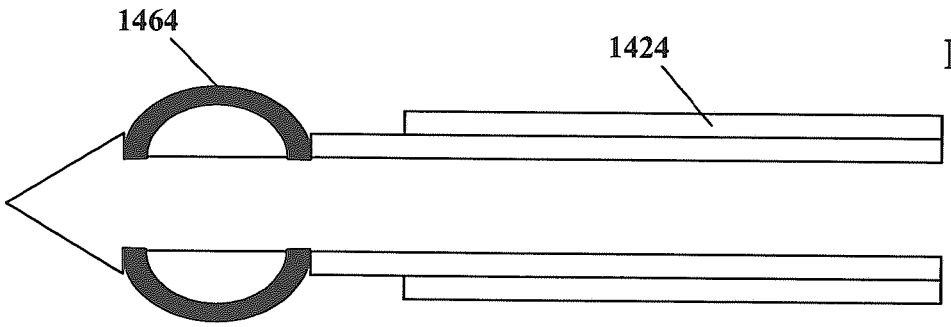


FIG. 7C

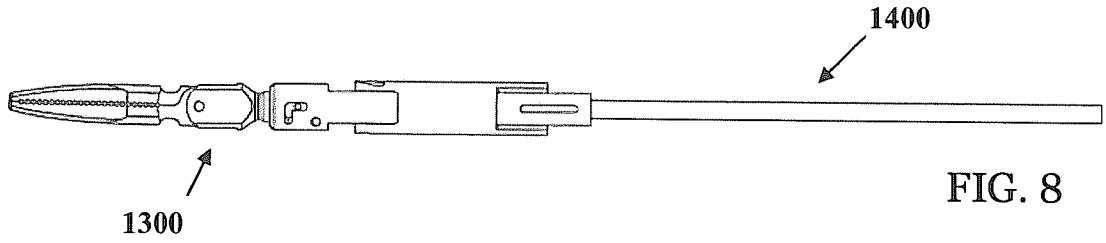


FIG. 8

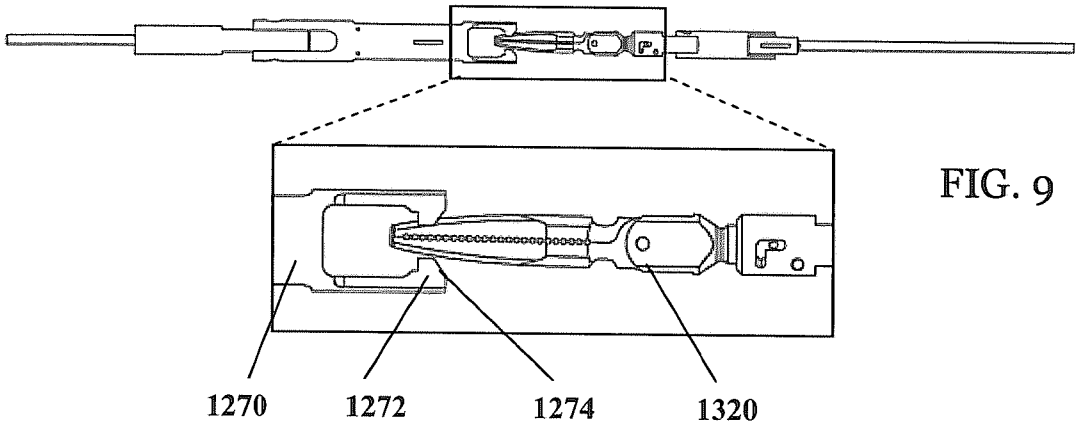


FIG. 9

FIG. 10A

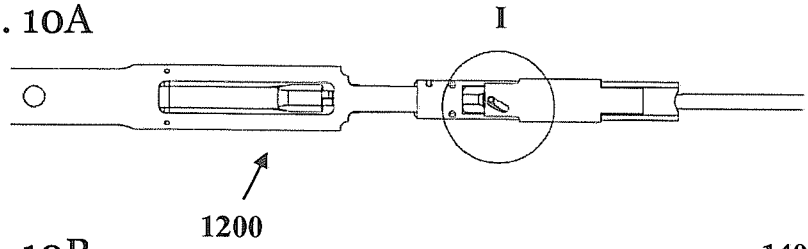


FIG. 10B

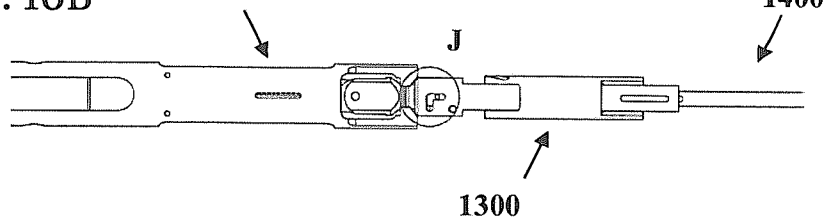


FIG. 10C

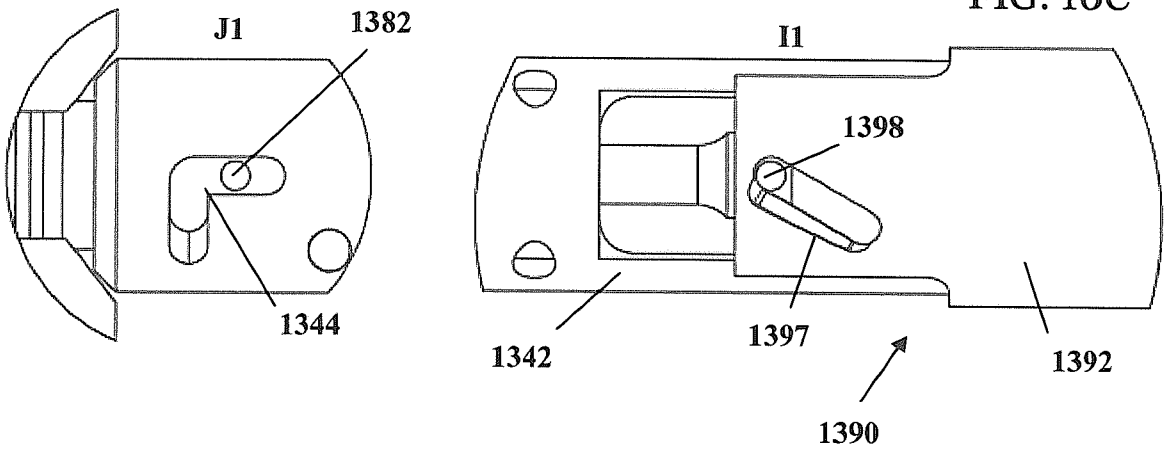
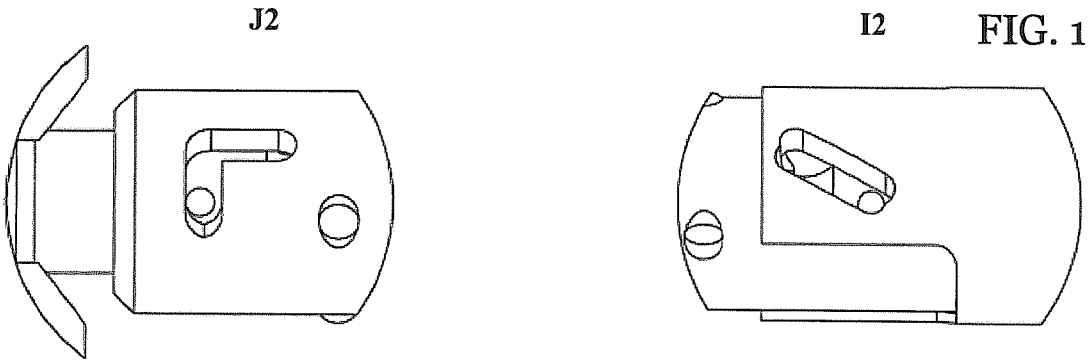


FIG. 10D



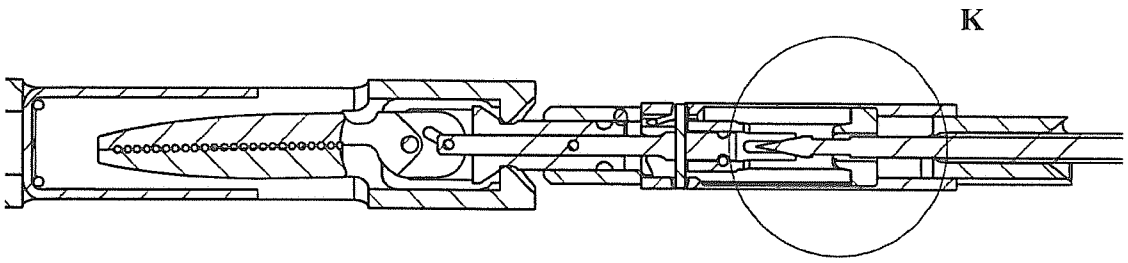
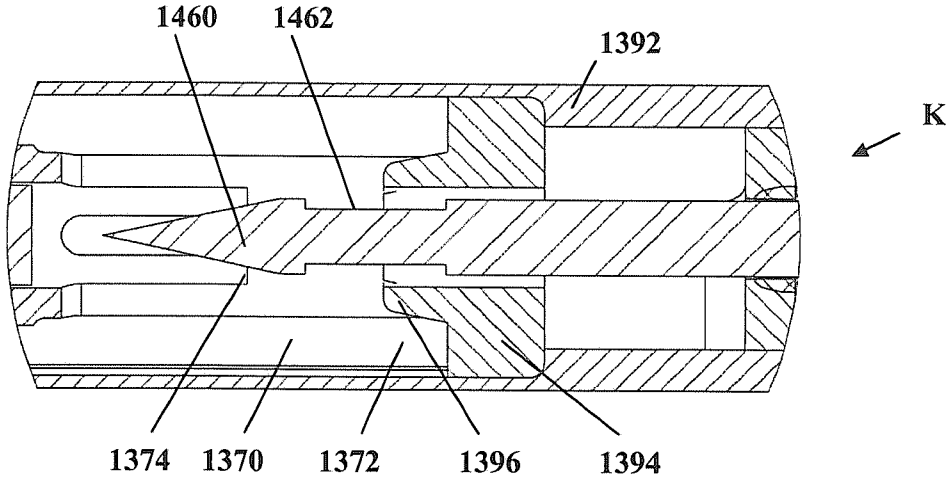


FIG. 10E



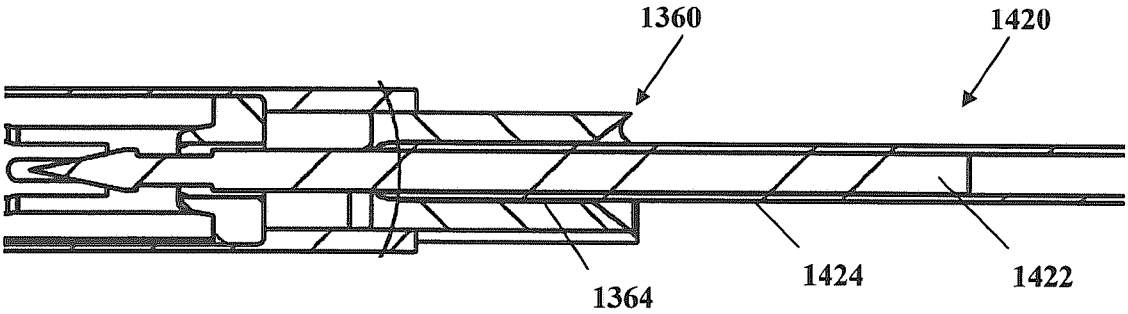


FIG. 10F

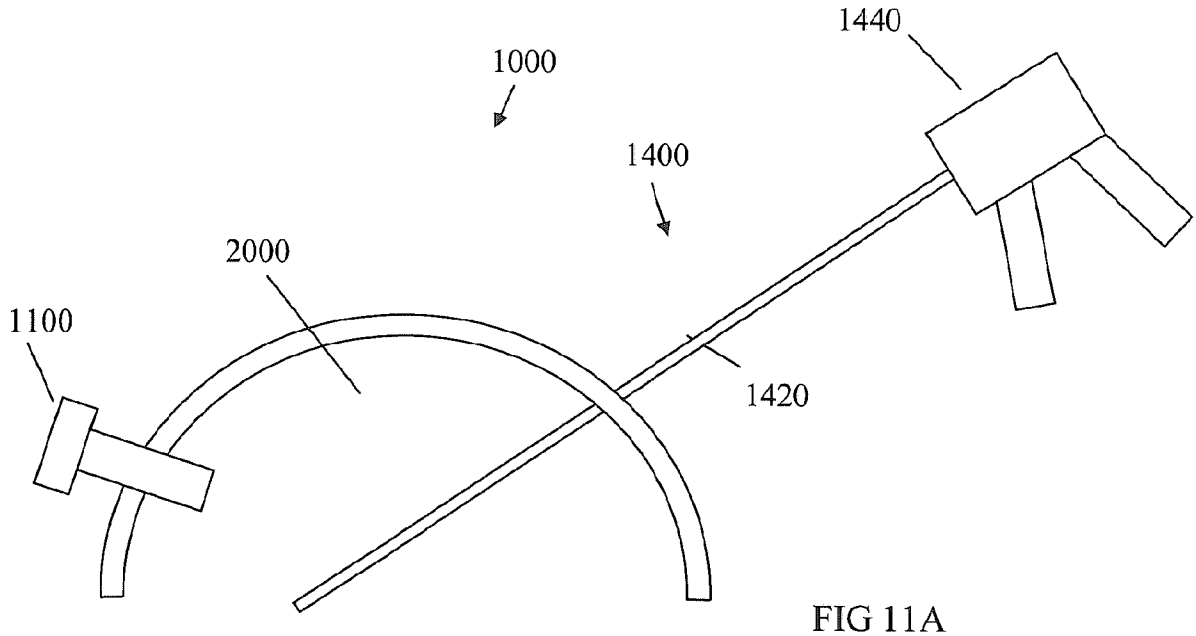


FIG 11A

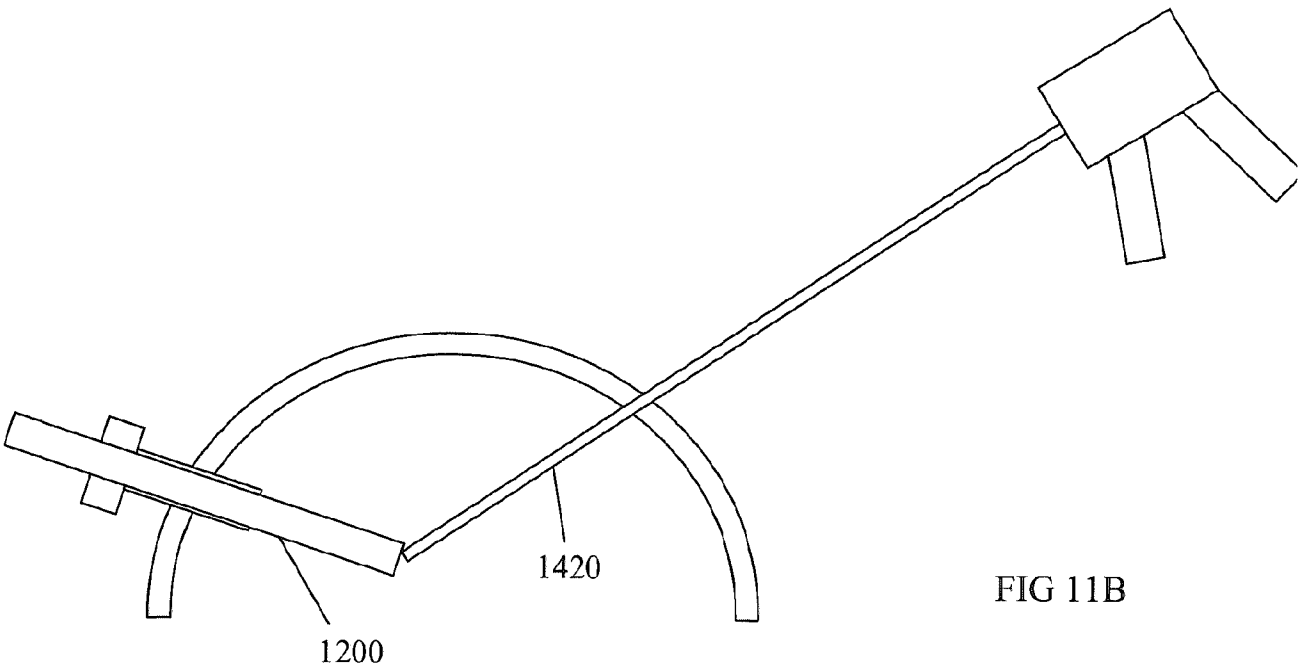


FIG 11B

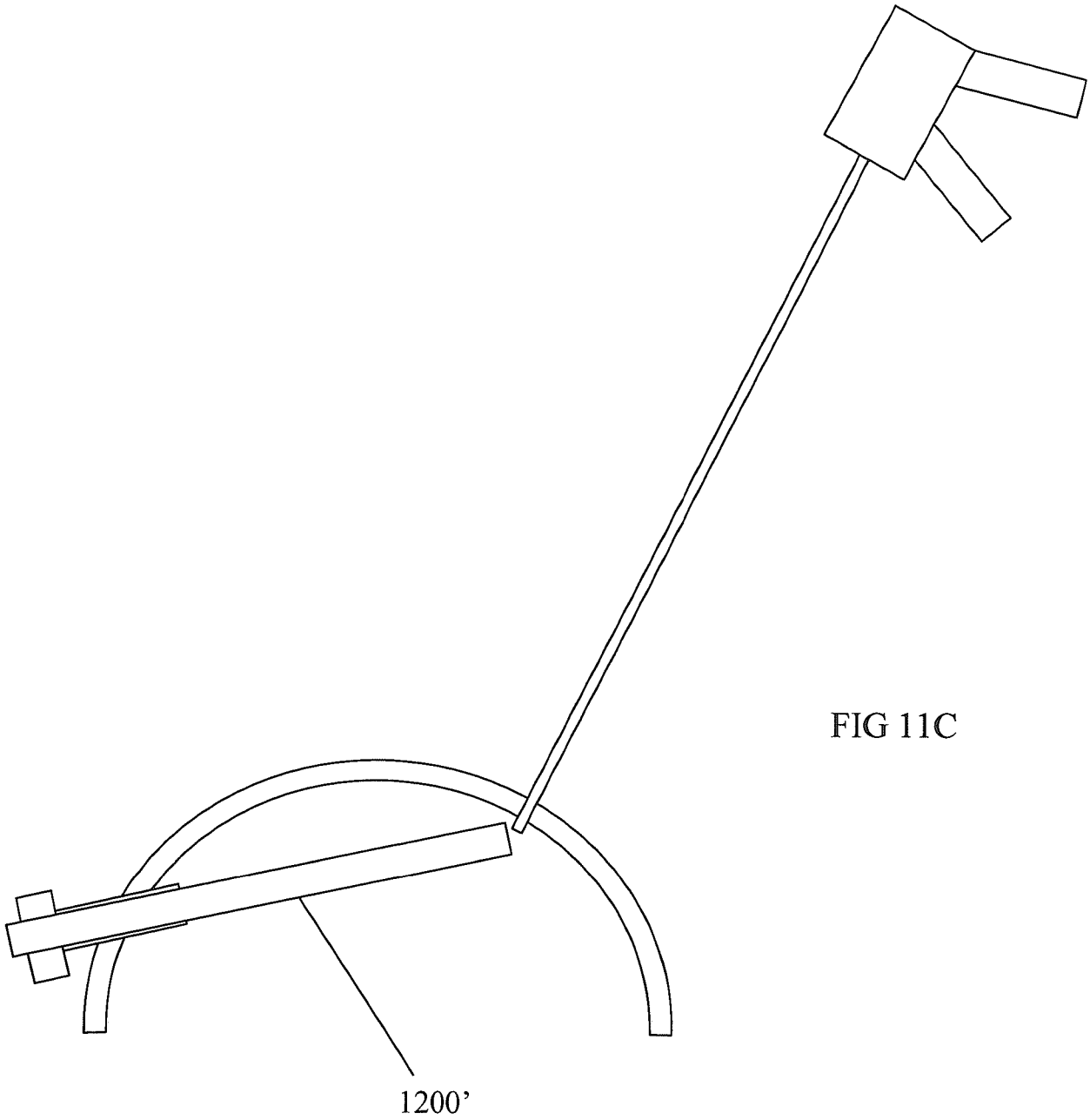


FIG 11C

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2011/050264

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/00
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 2008/287926 A1 (ABOU EL KHEIR TAREK AHMED NABIL [US]) 20 November 2008 (2008-11-20) pages 10-15; claim 1; figures 1,2,11,12	1-22
X	US 2003/060687 A1 (KLEEMAN THOMAS J [US] ET AL) 27 March 2003 (2003-03-27) paragraphs [0028] - [0042]; figure 1	1-5, 7-13,15, 16
X	US 5 441 059 A (DANNAN PATRICK A [US]) 15 August 1995 (1995-08-15) columns 3-5; claims 1-11; figures 1,2	1-7, 12-15
X	US 5 352 219 A (REDDY PRATAP K [US]) 4 October 1994 (1994-10-04)	1,2,4,6
A	columns 5-6	3,5,7-22

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 May 2011	18/05/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Chopinaud, Marjorie

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2011/050264

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 2010/114634 A1 (UNIV LELAND STANFORD JUNIOR [US]; CHAO KEVIN ZI JUN [US]; ROOP JOHN AV) 7 October 2010 (2010-10-07) the whole document	1-5,7,12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2011/050264

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 23-36
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 23-36

Claims 23-36 disclose a method of treatment by surgery practised on the human body contrary to Rule 39.1(iv) PCT. Claims 23-36 pertain to a method for deploying an elongated unit in a body cavity comprising the step of manoeuvring an elongated unit and of introducing an interchangeable tool obviously forming part of a surgical procedure. The Authority is therefore not required to carry out international search preliminary examination.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2011/050264

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008287926 A1	20-11-2008	WO 2010016824 A1	11-02-2010
US 2003060687 A1	27-03-2003	AT 301967 T	15-09-2005
		CA 2461636 A1	03-04-2003
		DE 60205644 D1	22-09-2005
		DE 60205644 T2	08-06-2006
		EP 1435845 A1	14-07-2004
		ES 2247419 T3	01-03-2006
		JP 4330443 B2	16-09-2009
		JP 2005503859 T	10-02-2005
		WO 03026513 A1	03-04-2003
US 5441059 A	15-08-1995	AU 1869295 A	04-09-1995
		WO 9522298 A1	24-08-1995
US 5352219 A	04-10-1994	NONE	
WO 2010114634 A1	07-10-2010	NONE	