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(54) CANNULA ASSEMBLY KIT, TROCAR ASSEMBLY KIT AND MINIMALLY INVASIVE SURGERY SYSTEM

KANÜLENBAUSATZ, TROKARBAUSATZ UND MINIMAL-INVASIVES CHIRURGISCHES SYSTEM
KIT DE MONTAGE DE CANULE, KIT DE MONTAGE DE TROCART ET SYSTÈME DE CHIRURGIE
MINI-INVASIVE

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Description

TECHNICAL FIELD

[0001] The invention relates to a cannula assembly kit for a trocar suitable for use in minimally invasive surgery, a trocar assembly kit comprising such cannula assembly kit, a system comprising the cannula assembly kit and a sleeve assembly for such cannula assembly kit.

BACKGROUND ART

[0002] Minimally invasive surgery has been used increasingly in recent years due to the benefits compared to conventional open surgery as it reduces the trauma to the patient tissue, leaves smaller scars, minimizes post-surgical pain and enables a faster recovery of the patient.

[0003] For example, in laparoscopic surgery which is a typical form of minimally invasive surgery the surgeon accesses a body cavity, such as the abdominal or pelvic cavity, through a series of small incisions. A laparoscope is inserted through an incision, and conventionally connected to a monitor, thereby enabling the surgeon to see the inside of the abdominal or pelvic cavity. In order to perform the surgical procedure, surgical instruments are inserted through other incisions. In addition, the body cavity around the surgical site is inflated with a fluid, preferably gas e.g. carbon dioxide in order to create an 'air' space within the cavity to make space for the surgeon to view the surgical site and move the laparoscopic instruments.

[0004] Invasive surgeries are generally performed through rather small openings in a patient's skin and the surgical site is visualized for the surgeon by inserting a camera, such as an endoscope into the body cavity and displaying the images on a screen.

[0005] For illuminating the body cavity it has been suggested to include illuminating optic in the cannula. US 2014/0107417 discloses a cannula assembly with an illumination component and an imaging component. The cannula assembly includes a tubular element forming a lumen, a deployable portion of the tubular element, and an electronic component mounted to the deployable portion of the tubular element. The tubular element has a proximal end and a distal end adapted to be inserted into a body cavity. The deployable portion of the tubular element is engaged near the distal end of the tubular element so as to transition between a closed position and an open position. The electronic component is at least partially disposed in the lumen when the deployable portion is in the closed position.

[0006] WO95/10218 discloses a visualization system for minimally invasive surgery. The visualization system comprises a cannula. The cannula may have bundle(s) of fibers guiding light to the distal end of the cannula for illumination of the cavity.

[0007] WO2009/134634 discloses a removable and pluggable illumination module that can be coupled to the

distal end or housed within the body of a single use removable body of a minimally invasive surgery tool, for example a cannula.

[0008] WO2009/116969 discloses an illumination system comprising a surgical tool and an attachable cannula or sheath comprising a transparent or semitransparent material capable of carrying light from the proximal end of the cannula to the distal end of the cannula, thereby illuminating the surgical field.

[0009] US2011/0282160 discloses a cannula system having a housing, a first lumen, a second lumen, and a port capable of fluid communication with the first lumen. The second lumen configured to receive fluid from the first lumen and to direct the fluid to a surgical site. A light emitting diode light source is positionable within the housing and configured to direct light through the second lumen to illuminating the surgical site.

[0010] US 2008/0058989 discloses a miniature camera robot which can be placed entirely within an open space such as an abdominal cavity. The instant camera robot has pan and tilt capabilities, an adjustable focus camera, and a support means for supporting the robot body. In particular embodiments, the camera robot further contains a light source for illumination and a handle to position the camera robot.

[0011] In order to improve the vision for surgeon, in particular to make it easier for the surgeon to determine the sizes of various organs, tissues, and other structures in a surgical site, several in-situ surgical metrology methods have been provided in the prior art. Different types of optical systems have been applied to provide an improved vision of the surgical site, which is approaching a 3D vision.

[0012] US2014276097 describes a system and method for performing optical measurements within a body cavity during minimal surgery. The system comprises a light source configured to emit a light beam, a first pattern generator defining a first longitudinal axis and configured to project a first generated pattern, and a second pattern generator defining a second longitudinal axis and configured to project a second generated pattern. The first and second generated patterns have different angular divergences. The first pattern generator is a diffractive circle pattern generator, whereas the second pattern generator is a diffractive cross pattern generator. Adjustment of the first and second generated patterns with respect to each other causes the system to serve as an optical ruler for performing the optical measurements when the first and second generate patterns overlap or coincide with each other at certain points.

[0013] EP 2630915 describes a light instrument for use in minimally invasive surgery, where the instrument includes an elongate tubular member and a metrology system mounted on the elongate tubular member. The metrology system includes a mask, a zoom lens assembly and a light element arranged such that the light element propagates light beams through the mask and the zoom lens assembly to project the patterns of the mask onto

the surgical site of interest to provide markings as references used for measuring by the surgeon.

[0014] US 2013/0296712 describes an apparatus for determining endoscopic dimensional measurements, including a light source for projecting light patterns on a surgical sight including shapes with actual dimensional measurements and fiducials, and means for analyzing the projecting light patterns on the surgical site by comparing the actual dimensional measurements of the projected light patterns to the surgical site.

[0015] WO 2013/163391 describes a system for generating an image, which the surgeon can use for measuring the size of or distance between structures in the surgical field by using an invisible light for marking a pattern to the surgical field.

[0016] The system comprises a first camera; a second camera; a light source producing light at a frequency invisible to human eye; a dispersion unit projecting a predetermined pattern of light from the invisible light source; an instrument projecting the predetermined pattern of invisible light onto a target area; a band pass filter directing visible light to the first camera and the predetermined pattern of invisible light to the second camera; wherein the second camera images the target area and predetermined pattern of invisible light, and computes a three-dimensional image.

DISCLOSURE OF INVENTION

[0017] The object of the present invention is to provide a solution for providing good visibility of a body cavity during minimally invasive surgery in particular with respect to providing good visual information to the surgeon about the position of the surgical instrument relative to the surgical site.

[0018] Also it is an object of an embodiment of the invention to provide a tool for use in minimally invasive surgery, which tool can increase the visibility of a body cavity to thereby make it simpler for a surgeon to determine the position of a surgical instrument relative to the surgical site and thereby to increase the surgeon's control of movements of the surgical instrument relative to the surgical site.

[0019] Further it is an object of an embodiment of the invention to provide a tool for providing an increased visibility of the position of a surgical instrument relative to the surgical site, which tool is simple to use and can be produced at an adequate cost.

[0020] These and other objects have been solved by the invention or embodiments thereof as defined in the claims and as described herein below.

[0021] It has been found that the invention or embodiments thereof have a number of additional advantages, which will be clear to the skilled person from the following description.

[0022] It has been found that by using a cannula assembly kit of the invention a surgeon can obtain a very good or even excellent visibility of the position of a sur-

gical instrument relative to the surgical site which thereby results in an increased control of the instrument, which both reduce the risk of making mistakes during the surgery and at the same time may reduce the required time for a minimal surgery procedure.

[0023] In order to an operator to move a surgical instrument in a relatively gentle way, it is standard to provide a cannula (sometimes also called a sleeve) to provide an access port through the incision. The cannula functions as a portal for the subsequent placement of a surgical instrument, such as graspers, scissors, staplers, etc. Usually the cannula is inserted through the incision by using an obturator which is temporarily inserted through the access port of the cannula. A set comprising an obturator and a cannula is called a trocar. The obturator may be a metal or plastic sharpened or non-bladed tip. Where the obturator comprises a sharp tip, the tip may be used by the operator to make the incision. Where the obturator is of the non-bladed tip type, the operator uses a scalpel to cut through at least a skin top layer where after the trocar can be pressed through the incision. When the trocar has been pressed through the incision, the obturator is removed and the cannula now forms an access port. The cannula usually comprises one or more seals to seal against gas slip-out and to accommodate an instrument.

[0024] The cannula assembly kit of the invention advantageously comprises one or more seals e.g. such as the seals described in the article "Trends in Laparoscopy: Sealing Technology" Posted on Medical Device And Diagnostic Industry www.mddionline.com by mddiadmin on August 1, 2009.

[0025] The terms distal and proximal should be interpreted in relation to the orientation of the cannula.

[0026] The phrase "distal to" means "arranged at a position in distal direction to". The phrase "distally arranged" means arranged distally to the distal end of the surgical instrument.

[0027] The term "substantially" should herein be taken to mean that ordinary product variances and tolerances are comprised.

[0028] The term "about" is generally used to ensure that what is within measurement uncertainties are included. The term "about" when used in ranges, should herein be taken to mean that what is within measurement uncertainties are included in the range.

[0029] The phrase "real time" is herein used to mean the time it requires the computer to receive and process constantly changing data optionally in combination with other data, such as predetermined data, reference data, estimated data which may be non-real time data such as constant data or data changing with a frequency of above 1 minute to return the real time information to the operator. "Real time" may include a short delay, such as up to 5 seconds, preferably within 1 second, more preferably within 0.1 second of an occurrence.

[0030] The Term "operator" is used to designate a surgeon or a robotic surgeon i.e. a robot programmed to

perform a laparoscopic procedure on a patient.

[0031] The term "surgical instrument" means herein a laparoscopic tool comprising a surgical tool adapted for performing surgery onto the tissue within the surgery cavity e.g. a grasper, a suture grasper, a cutter, a sealer, a stapler, a clip applier, a dissector, scissors, shears, a suction instrument, a clamp instrument, an electrode, a coagulation device, a curette, ablaters, scalpels, a needle holder, a needle driver, a spatula, forceps, a biopsy and retractor instrument or a combination thereof.

[0032] It should be emphasized that the term "comprises/comprising" when used herein is to be interpreted as an open term, i.e. it should be taken to specify the presence of specifically stated feature(s), such as element(s), unit(s), integer(s), step(s) component(s) and combination(s) thereof, but does not preclude the presence or addition of one or more other stated features.

[0033] Throughout the description or claims, the singular encompasses the plural unless otherwise specified or required by the context.

[0034] In an embodiment the cannula assembly kit of the invention is adapted to constitute a part of a trocar suitable for use in minimally invasive surgery. The cannula assembly kit comprises a cannula and a pattern generating member. The cannula has a distal end and a proximal end and comprises an elongate cannula shaft portion extending from the proximal end to the distal end and an access port through said elongate cannula shaft portion, such that a surgical tool of a surgical instrument can be inserted through the access port.

[0035] Advantageously the cannula assembly kit comprises a flange portion at its proximal end for holding the cannula assembly kit in position after it has been inserted through an incision.

[0036] In use the distal end of the cannula shaft portion is inserted through the incision e.g. together with a distal end of an obturator and the proximal end optionally comprising a flange portion remains outside the incision to ensure a safe positioning of the cannula. The flange portion may have any shape or size. The cannula shaft portion may have any cross-sectional shapes e.g. round, oval or angular for example as the cross-sectional shapes of prior art cannulas.

[0037] In the following the cannula assembly kit is described with a flange portion at its proximal end, however it should be understood that such flange portion may be omitted, in particular where the cannula assembly kit is part of or adapted to be handled by a robot as described below.

[0038] The pattern generating member comprises a pattern light source and a projector, wherein the pattern light source is operatively connected to the projector for projecting a light pattern. At least the projector of the pattern generating member is configured to be at least temporarily fixed to the cannula shaft portion of said cannula. Preferably at least the projector of the pattern generating member is configured to be fixed to the cannula shaft portion of said cannula to form a substantially rigid con-

nection between said projector and said cannula shaft portion.

[0039] The term "access port" means a port through which a surgical instrument can be inserted. The access port may comprise a seal or an insulation, a lid and/or similar which fully or partly locks or fills out the access port when the surgical instrument is not inserted in the access port. The seal, insulation and/or seal ensure that undesired amounts of gasses do not escape and deflate the body cavity. When a surgical instrument is not inserted in the access port, the seal or the insulation advantageously seals against undesired outslip of gas.

[0040] The term "rigid connection" means a connection which ensures that the relative position between rigidly connected elements is substantially constant during normal use.

[0041] Although the assembly kits of the invention are mainly described in an unassembled state, the invention should be interpreted to also include the assembled corresponding version(s) of the assembly kits.

[0042] In use the projector will be moved in a correlated way with at least some of the movement of a surgical instrument inserted through the access port of the cannula shaft portion and thereby images of the projected light pattern from the projector will change, thereby providing the operator with visual information about the position of the surgical instrument relative to the surgical site.

[0043] Advantageously at least the projector of the pattern generating member is configured to be at least temporarily fixed to the cannula shaft portion of the cannula, such that any lateral movement of a surgical tool of a surgical instrument inserted through the access port results in a correlated movement of the projector and thereby a correlated change of the reflections of the projected light pattern which can be imaged onto a screen via a camera e.g. of a scope, such as an endoscope. The change of the reflected pattern is herein also referred to as the recorded or recordable pattern.

[0044] The phrase "a correlated change" or "a correlated movement" means a change or movement which corresponds to the lateral movements of the surgical instrument such that a given lateral movement of the surgical instrument results in a given and/or corresponding change or movement of respectively the projected light pattern and the projector. In an embodiment the movement of the surgical instrument may result in a gearing of the change or movement of respectively the projected light pattern and the projector. A change of the projected light pattern is herein used to mean a change of reflections of the projected light seen on a surface arranged distal to the cannula.

[0045] The pattern will reach an inner wall of a body cavity in which the minimally invasive surgery is performed - herein also referred to as the surgical site.

[0046] The surgical site often comprises a very curved and uneven surface, which will be visible from the shape of the pattern as it is reflected on the surgical site. The

projector will project the light pattern on an area of the surgical site such that the contours and/or the topography of the surgical site and the position of the surgical instrument can be deduced by the operator based on indirect vision of the light pattern.

[0047] In an embodiment at least the projector of the pattern generating member is configured to be at least temporarily fixed to the cannula shaft portion of the cannula, such that any tilting movements of the cannula result in a correlated movement of the projector and thereby a correlated change of the reflections of the projected light pattern. In an embodiment the reflections of the projected light pattern is received by a camera. The camera may in an embodiment be mounted to or form part of the cannula. The camera may optionally be mounted at the distal end of the cannula arranged for monitoring reflected light. By having the camera fixed to the cannula or integrated with the cannula any risk of damaging tissue by the camera may be reduced. Further the camera need not be held by the operator or an assisting operator. In an embodiment the camera is mounted to be pivotally moved relative to the shaft portion of the cannula. Thereby the operator can angle the camera in any desired direction.

[0048] In an embodiment the camera is mounted to a scope, such as an endoscope. The camera may transmit the recorded signal to a screen and/or transmit the recorded signal to a robot configured for maneuvering the surgical instrument. In an embodiment the camera forms part of a robot configured for maneuvering the surgical instrument. The recorded signal may preferably be transmitted in real life speed to ensure that the time delay becomes as small as possibly.

[0049] In an embodiment the camera is configured for transmitting the recorded signal in real life to a screen which is visible to a surgeon or an observer of the minimally invasive surgery.

[0050] In an embodiment the projector of the pattern generating member is configured to be at least temporarily fixed to the cannula shaft portion of the cannula such that at least a portion of the light pattern is projected in a distal direction.

[0051] Distal direction means herein in a direction, which is parallel with or up to 90 degrees in any direction relative to a center axis of the access port or - where the center axis is not straight - relative to tangent to the center axis at the access port exit. In an embodiment the term "distal direction is used to mean a direction, which is parallel with or up to 90 degrees in any direction relative to a center axis of the access port or - where the center axis is not straight - relative to tangent to the center axis at the access port exit. Advantageously at least a portion of the light pattern is projected in a direction which is parallel with or up to 30 degree relative to a direction parallel with the center axis of the access port or relative to tangent to the center axis of the access port at the access port exit and preferably at least a portion of the light pattern is projected in a direction which is parallel

with or up to 15 degree relative to a direction parallel with the center axis of the access port or tangent to the center axis at the access port exit, such as up to 10 degree relative to a direction parallel with the center axis of the access port or tangent to the center axis at the access port exit.

[0052] The access port exit is the exit of the access port at the distal end of the cannula shaft portion.

[0053] As it will be further explained below, in an embodiment the cannula is bendable and/or bent and in such situations the distal direction should be determined in respect to the distal end of the cannula. For certain surgical procedures it is desired that the cannula is bent or bendable to a very high degree e.g. up to 180 degrees, such as up to about 90 degrees. The distal direction is determined as the direction parallel to tangent to the center axis of the access port at the access port exit $\pm$ up to 45 degrees, such as $\pm$ up to 30 degrees, such as $\pm$ up to 15 degrees. Where the cannula is bendable and/or bent and at the same time straight in an end section comprising the access port exit, the tangent to the center axis of the access port at the access port exit is identical to the center axis at the end section comprising the access port exit.

[0054] In an embodiment the projector of the pattern generating member is configured to be at least temporarily fixed to the cannula shaft portion of the cannula such that at least a portion of the light pattern is projected in a proximal direction, such as in a direction opposite to a distal direction. This embodiment is in particular advantageous where the target of the surgical site is laterally positioned relative to a surgical instrument inserted through the access port.

[0055] In an embodiment the projector of the pattern generating member is configured to be at least temporarily fixed at the distal end of the cannula shaft portion.

[0056] Advantageously the distal end of the cannula shaft portion has a distal access port exit and comprises an end edge in the vicinity of the distal access port exit. The end edge optionally frames the distal access port exit. The projector of the pattern generating member is configured to be at least temporarily fixed at the end edge, preferably to form a rigid connection thereto. The projector is preferably arranged for projecting the light pattern in a distal direction, preferably such that at least a portion of the light pattern is projected in a direction which is parallel with or up to 45 degrees relative to a direction parallel with the center axis of the access port. In an embodiment the projector is arranged for projecting the light pattern in a distal direction, which is parallel with or up to 30 degrees relative to a direction parallel with the center axis of the access port, such as in a direction which is parallel with or up to 15 degrees relative to a direction parallel with the center axis of the access port, such as in a direction which is parallel with or up to 10 degrees relative to a direction parallel with the center axis of the access port.

[0057] In an embodiment at least a portion of the light

pattern is projected in a direction which is parallel with or up to 45 degrees relative to a direction parallel with tangent to the center axis of the access port at the access port exit. In an embodiment the projector is arranged for projecting the light pattern in a distal direction, which is parallel with or up to 30 degrees relative to tangent to the center axis of the access port at the access port exit, such as in a direction which is parallel with or up to 15 degrees relative to tangent to the center axis of the access port at the access port exit, such as in a direction which is parallel with or up to 10 degrees relative to tangent to the center axis of the access port at the access port exit.

[0058] The end edge is advantageously an edge extending between an inner surface defining the access port and an outer surface of the cannula shaft portion at the distal end of the cannula shaft portion. In an embodiment the end edge is substantially orthogonal to the center axis of the access port and/or to tangent to the access port at the access port exit. In an embodiment the end edge has an angle of larger than 90 degrees to the center axis and/or to tangent to the access port at the access port exit, such as an angle of from 100 to 125 degrees to the center axis and/or to tangent to the access port at the access port exit.

[0059] The cannula assembly kit may comprise several projectors and/or several pattern generating members.

[0060] In an embodiment the pattern generating member comprises two or more projectors wherein the pattern light source is operatively connected to the projectors for projecting light patterns. At least the projectors of the pattern generating member are configured to be at least temporarily fixed to the cannula shaft portion of the cannula, preferably at a distance from each other, such as at the end edge at diagonal sides of the distal access port exit.

[0061] The pattern light source may comprise a splitter and/or a filter splitting and or filtering the light into two or more fractions for said respective projectors, where said two or more light portions may be equal or different e.g. with respect to power, wavelengths, wavelength profiles. The two or more projectors may be equal or different from each other e.g. with respect to pattern shape or size.

[0062] In an embodiment the cannula assembly kit comprises two or more pattern generating members. The two or more pattern generating members may be equal or different from each other e.g. with respect to power, wavelengths, wavelength profiles pattern shape or size.

[0063] In an embodiment the cannula shaft portion comprises an access section adapted to be inserted through a surgical incision for allowing a surgical instrument to be inserted through the access port, wherein the access section is at least partially rigid, preferably the entire access section of the cannula shaft portion or the entire cannula shaft portion is substantially rigid. The rigidity of the cannula shaft portion ensures that when the cannula shaft portion is subjected to a tilting movement - e.g. by tilting of an instrument inserted into the access

port - the projector will be moved in a correlated way and thereby resulting in a correlated change of the reflections of the projected light pattern which can be imaged onto a screen or transmitted to a robot via a camera e.g. mounted to or integrated with the cannula and/or a camera of a scope.

[0064] The recorded signal may preferably be transmitted in real life speed to ensure that the time delay becomes as small as possibly.

[0065] The term "access section" is used to denote the length section of the cannula shaft portion, which is adapted to be fully or partly inserted into the incision. It should be noted that a rigid section may comprise one or more layers, e.g. seals of non-rigid material.

[0066] In an embodiment at least the access section is collapsible by comprising a seal and or an isolation which collapses when the access port is free of an inserted instrument, to thereby prevent gas escape via the access port and thus prevent deflation of the abdominal or other surgical cavity inside the patient.

[0067] In an embodiment at least the access section is collapsible by being of a collapsible material, such as at least at the access section is at least partly collapsed when the access port is free of an inserted instrument.

[0068] In an embodiment the cannula shaft portion comprises an access section adapted to be inserted through a surgical incision for allowing a surgical instrument to be inserted through the access port, wherein the access section is collapsible. Advantageously at least the access section of the cannula shaft portion is of a non-rigid material, such as an elastomer e.g. rubber.

[0069] The rigidity is determined at 25 °C.

[0070] In principle the cannula shaft portion may be straight or bent. Where the cannula shaft portion is substantially rigid, it is desired that the cannula shaft portion is relatively straight or optionally bent in a relatively soft curve.

[0071] Where the cannula shaft portion is straight, the access port will usually be straight as well.

[0072] In an embodiment the pattern generating member is detachable from the cannula shaft portion.

[0073] Preferably at least the projector of the pattern generating member is configured to be temporarily fixed to the cannula shaft portion by a click lock, a sleeve lock, a screw lock, a turn lock, a wedge lock or combinations thereof.

[0074] Advantageously the pattern light source is not fixed or adapted to be fixed to the cannula shaft portion. In an embodiment the pattern light source is fixed or adapted to be fixed to the flange portion of the cannula. The operative connection can in principle be any kind of wave guiding element or elements, such as an optical fiber, one or more lenses, mirrors, splitters, collimators, amplifiers or any other suitable optical element. The optical connection between the pattern light source and the projector is preferably provided by an optical fiber.

[0075] Where only the projector is mounted to the cannula shaft portion, the remaining part of the pattern gen-

erating member including the pattern light source may be reused without requiring sterilization.

[0076] In an embodiment at least the projector and the pattern light source of the pattern generating member are temporarily fixed to the cannula by a sleeve.

[0077] In an embodiment all elements of the pattern generating member are temporarily fixed to the sleeve. The elements of the pattern generating member comprise the projector and the pattern light source and optional power source and/or one or more controlling elements such as the pattern light source control unit described below.

[0078] In an embodiment at least the projector of the pattern generating member is permanently fixed to the cannula.

[0079] In an embodiment the pattern light source and an optional battery are fixed or adapted to be fixed to the cannula shaft portion.

[0080] In an embodiment the pattern light source and an optional battery are arranged in an external light source unit and are optically connected to the projector e.g. via an optical fiber, directly connected or by use of free space optics.

[0081] In an embodiment the pattern light source is adapted to be arranged at a distance to the projector, the pattern light source is preferably incorporated into a pattern light source housing arranged to be positioned at a distance to the cannula and advantageously connected to the projector via connection means comprising an optical fiber, preferably the optical fiber is protected by a polymer cover.

[0082] In an embodiment at least the projector of the pattern generating member is incorporated in or mounted to a sleeve. The sleeve preferably comprises a sleeve end edge portion comprising the projector. The sleeve is configured to be mounted onto the cannula shaft portion. Optionally the sleeve constitutes an outer and/or an inner seal for minimizing undesired gas leak. The sleeve is advantageously fixed or fixable to the flange portion. In an embodiment the pattern light source is incorporated in or mounted to a sleeve at its proximal end where the sleeve is mounted to the flange portion.

[0083] The sleeve may comprise any material including polymer material and/or metal. Preferably the sleeve has an outer surface which is hydrophilic and advantageously has a low friction. In an embodiment the sleeve comprises a coating for reducing friction e.g. a coating of PTFE or parylene. In an embodiment the surface of the sleeve has been subjected to a plasma treatment and/or chlorination.

[0084] Advantageously the sleeve is of elastomer, such as one more thermoplastic elastomers, rubber and/or silicone. Preferred materials comprise polyisoprene, silicone, butyl-ethylene propylene (diene) polymer and/or styrene butadiene rubber.

[0085] In an embodiment the cannula comprises a mounting through hole for mounting the projector, preferably the mounting through hole extends through the

cannula shaft portion such that the projector can be mounted at or adjacent to the distal end of the cannula shaft portion. Thereby the projector can be mounted via said mounting through hole after the cannula has been inserted through a surgical incision.

[0086] In an embodiment the sleeve comprises a mounting through hole for mounting the projector prior to or after the cannula has been inserted through a surgical incision.

[0087] In an embodiment at least the projector of the pattern generating member is permanently fixed to the cannula shaft portion, preferably the projector is integrated with the cannula to form an integrated cannula assembly.

[0088] The pattern light source can in principle be any kind of light source capable of providing a desired pattern. The light source may be a coherent light source or an incoherent light source.

[0089] The term "coherent light" is herein used to denote laser light whereas "incoherent light" includes any non-laser light irrespectively of its degree of coherence. Incoherent light with a relatively high degree of coherence (sometimes called partially coherent light) is often preferred because the coherent light provides a highly bright pattern, while the incoherent light source generally can be obtained at a much lower cost than coherent light.

[0090] In an embodiment the pattern light source is a coherent light source, such as a semiconductor light source, such as a laser diode and/or a VCSEL light source.

[0091] In an embodiment the pattern light source is an incoherent light source, preferably the light source is a semiconductor light source, such as a light emitting diode (LED).

[0092] Advantageously, the light pattern is generated by at least one laser and/or LED. Lasers and LEDs (light emitting diodes) are advantageous as they can generate light patterns that are well defined and it is possible to choose the wavelength and thus color such that the pattern is enhanced in the remote vision, for example such that the light pattern is clearly visible and enhanced on the monitor and/or easily detectable for computer recognition, decoding and/or vision procession.

[0093] The pattern light source advantageously has a relatively narrow band width thereby providing a bright light in the narrow bandwidth, while simultaneously emitting a relatively low light energy. It is advantageous both to avoid undesired heating of the surgical target site and simultaneously have low risk of blinding and/or result in undesired side or error reflections which may distort the recording by the camera.

[0094] In an embodiment the pattern light source has a band width (full width at half maximum -FWHM) of up to about 50 nm, such as from 1 nm to about 40 nm. Preferably the narrow band width of the pattern light source is about 25 nm or less, such as about 10 nm or less.

[0095] In an embodiment the pattern light source is a broad band light source such as a supercontinuum light

source e.g. spanning at least an octave within the bandwidth range from 400 nm to 2600 nm. Above 2600 nm light transmitted in a silica fiber will be strongly attenuated.

[0096] In an embodiment the pattern light source is configured for emitting at least one electromagnetic wavelength within the UV range of from about 10 nm to about 400 nm, such as from about 200 to about 400 nm.

[0097] In an embodiment the pattern light source is configured for emitting at least one electromagnetic wavelength within the visible range of from about 400 nm to about 700 nm, such as from about 500 to about 600 nm.

[0098] In an embodiment the pattern light source is configured for emitting at least one electromagnetic wavelength within the IR range of from about 700 nm to about 1mm, such as from about 800 to about 2500 nm.

[0099] In an embodiment the pattern light source is configured for emitting two or more distinguished wavelengths or wavelength bandwidths and advantageously the pattern light source is configured for switching between said distinguished wavelengths or wavelength bandwidths.

[0100] Light in the lower wavelengths e.g. below 600 nm requires relatively high power in order to be visually distinguished from illuminating light emitted to light up the area under surgery - usually emitted from a scope, such as an endoscope.

[0101] In an embodiment the pattern light source comprises at least one wavelength within the visible range.

[0102] In an embodiment the pattern light source comprises at least one wavelength within the invisible range, such as the UV or the IR range. Where the pattern light source comprises wavelengths in the invisible range, such wavelengths are advantageously detected by the camera system and converted to a visible wavelength for displaying to the operator e.g. by digital processing.

[0103] In an embodiment the pattern generating member comprises two or more pattern light sources having equal or different bandwidths, wherein the two or more pattern light sources preferably are operatively connected to the projector.

- the two or more pattern light sources can be operated independently of each other i.e. they can independently be switched on and off e.g. using a non-hand held unit or by a unit incorporated into the flange portion.

[0104] In an embodiment the two or more pattern light sources can be connected to separate projectors.

[0105] Generally it is desired that the pattern light source (or sources) can be switched on and off and optionally be modified in wavelengths and/or intensity, using a pattern light source control unit. In an embodiment the pattern light source control unit is a non-hand held unit, such as a pedal or a voice activated control unit - thereby in a simple manner the operator can control the light pattern. In an embodiment the pattern light source

control unit is incorporated into the flange portion.

[0106] In an embodiment the pattern light source (or sources) is controlled by a robot - e.g. by being part of the robot. The pattern light source control unit may advantageously be computer controlled.

[0107] Advantageously the pattern light source is arranged to provide a pattern output power which is sufficient to generate a visible pattern, but not too high such that an undesired amount of heat may be generated. Preferably the pattern light source is arranged to provide a pattern output power up to about 100 mW such as at least about 0.1 mW, such as from about 1 to about 100 mW, such as from about 3 mW to about 50 mW. Preferably the pattern output power is adjustable. The pattern output power is determined as the output power of the projector.

[0108] Advantageously the pattern light source is tunable in wavelength and/or power and the cannula assembly kit comprises a regulator for tuning the pattern light source, preferably such that movements of a surgical instrument inserted through the access port trigger the regulator to a coordinated tuning of the pattern generating member. The tuning is advantageously performed such that movements in the distal towards proximal direction or vice versa of a surgical instrument inserted through the access port trigger the regulator to a coordinated tuning of the pattern generating member. In an embodiment the regulator is a tunable button arranged at an inner wall of the cannula shaft portion such that movement of a surgical instrument in the distal towards proximal direction or vice versa tunes the light intensity of the pattern light source up and down and/or changes the wavelengths of the pattern light source. In an embodiment where the pattern light source (or sources) is controlled by a robot the robot may advantageously control or comprise the surgical instrument inserted through the access port and the regulator for tuning the pattern light source may advantageously also be part of or at least controlled by the robot.

[0109] The projector of the pattern generating member comprises a phase optic element, a spatial light modulator, a multi-order diffractive lens, a holographic lens, a computer regulated optical element, and/or a computer regulated mechanically optical element e.g. a mems (micro-electro-mechanical) element. The projector of the pattern generating member may comprise a mirror arrangement. The phase optic element may advantageously be a diffractive optic element (DOE).

[0110] In an embodiment the phase optics element is capable of producing an image having periodic intensity distribution.

[0111] Diffractive optic elements are well known in the art and may for example utilize a surface with a complex microstructure for its optical function. The micro-structured surface relief profile has two or more surface levels. The surface structures are either etched in fused silica or other glass types, or embossed in various polymer materials. Additionally, diffractive optics can realize almost the same optical functions as refractive optics such

as lenses, prisms or aspheres, but they are much smaller and lighter. DOEs are not limited to laser applications; partially coherent light from LEDs or other light sources can also be modulated.

[0112] In an embodiment the DOE is as described in US 2013/0038836 e.g. as shown in Fig. 1 and/or as described in section [0015] of US 2013/0038836.

[0113] In an embodiment the diffractive optic elements comprise a "multi-order diffractive" lens, such as a conventional diffractive-optic lens utilizing a single diffraction order in which the optical power of the lens is directly proportional to the wavelength of light.

[0114] In an embodiment the projector comprises a spatial light modulator. The spatial light modulator is configured for modulating the light pattern for example by modulating the transparency of a pattern cover e.g. by a computer modulation. In an embodiment the spatial light modulator is arranged for modulating the intensity and/or the phase of the light from the pattern light source to thereby modulate the emitted light pattern.

[0115] In order to ensure that the cannula can be inserted through a desired small incision it is generally desired that the part of the pattern generating member to be mounted to the cannula shaft portion prior to insertion into an incision is relatively small.

[0116] Advantageously the projector of the pattern generating member has a maximally extending area perpendicular to the center axis of the access port when the pattern generating member is fixed to the cannula shaft portion, which maximally extending area is up to about 8 cm², such as up to about 4 cm², such as up to about 2 cm², such as from about 0.01 to about 1 cm², such as from about 0.1 to about 0.5 cm². Preferably the projector of the pattern generating member is configured to be at least temporarily fixed at the end edge in the vicinity of the distal access port exit and the projector is preferably shaped such that the projector does not extend laterally beyond the end edge or up to 5 mm laterally beyond the end edge.

[0117] In an embodiment the projector of the pattern generating member has a projector face from where the light is to be emitted and the projector is pivotable, so it can be pivotally unfolded from a first folded position where the projector face is not facing in the distal direction to a second position where the projector face is facing in the distal direction. Thereby the cannula can be inserted into an incision when the projector is in a first folded position and there after the projector can be unfolded to its second position. Optionally the unfolding can be provided by triggering a release button at the inner wall of the cannula shaft portion e.g. by the surgical instrument - e.g. by a tilting of the surgical instrument - after the cannula has been inserted through the incision such that the projector is unfolded to its second position e.g. by a spring mechanism.

[0118] The pattern may have any desired shape.

[0119] In an embodiment the projector is fixed or adapted to be fixed to the cannula shaft portion such that the

pattern remains substantially stationary when the surgical instrument is subjected exclusively to a circumferential movement with the longitudinal axis of the surgical instrument.

[0120] In an embodiment the projector when fixed to the cannula shaft portion is configured to emitting a pattern, which pattern when projected to a surface orthogonal to the center axis of the access port has at most 10 fold rotational symmetry, preferably the pattern has at most 8 fold rotational symmetry.

[0121] Such pattern which is not fully rotational symmetrical but has up to 10 fold rotational symmetry gives the user an even better visual information about the position of the surgical instrument relative to the surgical site.

[0122] The projector of the pattern generating member is configured to emit a pattern comprising an arch shape, ring or semi-ring shaped lines, a plurality of angled lines and/or a coded structured light configuration. In an embodiment the pattern comprises a grid of lines, e.g. a crosshatched pattern optionally comprising substantially parallel lines when emitted to a planar surface.

[0123] The changes in the grid lines due to lateral movements of the surgical instrument can for example be used to deduce the contours of the body cavity such as projected surface and/or the contours and/or topographic shape of the surgical field. The changes in the angle and distance between crossing and/or parallel grid lines during movement(s) of the surgical instrument can for example be used to determine the orientation of the surgical instrument.

[0124] The phrases "surgical field", "surgical site" and "surgery target site" are herein used interchangeably.

[0125] In an embodiment the light pattern comprises a plurality of light dots. When the surgical instrument is moved, the position and/or the distance between the dots will change, which enhances the operator's ability even further to deduce the position of the surgical instrument and the area contours of the surgical field.

[0126] In an embodiment of the pattern generating member is configured to emit a pattern comprising a coded structured light configuration comprising a plurality of light dots with different shapes and/or sizes arranged in a preselected configuration. The pattern comprising a coded structured light configuration is in particular suitable for determining a topographic shape of the target surface.

[0127] Patterns comprising coded structured light configurations are for example described in "Pattern codification strategies in structured light systems" by Salvi et al. Pattern Recognition, Volume 37, Issue 4, April 2004, Pages 827-849.

[0128] In an embodiment the projector fixed to the cannula shaft portion is configured to emit a pattern which pattern, when projected to a surface perpendicular to the longitudinal axis of the body portion of the surgical instrument, comprises a plurality of angled lines. Advantageously the pattern comprises a grid of lines, such as a

grid comprising one or more sets of parallel lines.

[0129] Where the pattern has an angled lines when projected to a surface orthogonal to the center axis of the access port, a tilting of the surgical instrument inserted into the access port can for example be observed by a change of such angled lines e.g. by a deformation of one or more of the lines, by change of line angles and/or by change of distance between lines.

[0130] The pattern is advantageously sufficiently large to ensure good visual perception of the surgical instrument and movement thereof.

[0131] At the same time, since the projector is fixed to the cannula shaft portion the risk of direct contact between the projector and tissue during surgery is relatively small and it has been found that for most procedures the projector requires less cleaning during minimally invasive surgery than an endoscope.

[0132] In an embodiment the projector of the pattern generating member is configured to emit a pattern, which pattern when emitted towards a plane surface at a distance of about 80 mm from the distal end of the cannula shaft portion and normal to a center axis of the cannula shaft portion, has a grid area of up to about 225 cm², such as of up to about 100 cm², such as of up to about 9 cm².

[0133] The flange portion comprises a handle part, the flange portion comprising means for being temporally fixed to an obturator.

[0134] In an embodiment the cannula comprises two or more access ports through the flange portion and the cannula shaft portion. Thereby several surgical instruments can be inserted simultaneously.

[0135] In an embodiment the cannula comprises two or more cannula shaft portions and an access ports through the flange portion and the cannula shaft portions suitable for inserting a surgical instrument through each of the respective access ports.

[0136] In an embodiment the cannula assembly kit comprises a cleaning element for cleaning the projector. In an embodiment the cleaning element is in the form of a wiping element arranged for wiping and/or washing the projector. In an embodiment the cleaning element is in the form of a spray element arranged for spraying and/or blowing the projector with a fluid such as gas or liquid. An example of a suitable cleaning element is as the cleaning device described in US 8,397,335.

[0137] In an embodiment the cannula is adapted for being handled by a surgeon - i.e. to be mounted in an incision of a patient to provide the access port to the surgical site.

[0138] In an embodiment the cannula is adapted for being maneuvered by a robot - i.e. to be mounted in an incision of a patient using a robot to provide the access port to the surgical site.

[0139] In an embodiment the cannula is a part of the robot.

[0140] The invention also comprises a trocar assembly kit for use in minimally invasive surgery. The trocar as-

sembly kit comprises a cannula assembly as described above and an obturator. The obturator may in principle be any kind of obturator configured to be used with a cannula.

[0141] The obturator has a distal end and a proximal end and comprises a head portion at its proximal end, a tip portion at its distal end and a rigid obturator shaft portion extending between the head portion and the tip portion, wherein the cannula and the obturator are correlated to each other such that the tip portion of the obturator can be instead through the access port of the cannula and the head portion of the obturator can be temporally fixed to the flange portion of the cannula, preferably such that a seal is formed in the access opening between the cannula and the obturator.

[0142] Advantageously the obturator comprises a projector protection arrangement correlated with the projector of the cannula assembly kit to at least partly cover the projector when the cannula assembly kit and the obturator are in an assembled state. Thereby the projector can be protected by the projector protection arrangement during insertion of the trocar assembly through an incision. The projector protection arrangement is advantageously arranged to be at least partly passed into a cavity of the obturator upon withdrawing of the obturator from said cannula access port.

[0143] The cannula assembly kit and the obturator are in an assembled state when the tip portion of the obturator is inserted substantially fully through the access port of the cannula shaft portion, and the cannula assembly kit and the obturator are disassembled upon withdrawing of the obturator from said cannula access port.

[0144] In an embodiment the projector protection arrangement is arranged to be pivotally folded from a first position where it , at least partly covers the projector to a second position where it at least partly is passed into a cavity of the obturator. The folding from the second position to the first position may for example be performed manually after having inserted the tip portion of the obturator substantially fully through the access port of the cannula shaft portion and the folding from the first position to the second position may for example be performed simply by withdrawing the obturator from the access port and/or by releasing a holding mechanism temporarily holding the projector protection arrangement in the first position.

[0145] In an embodiment the projector protection arrangement is arranged to be radially displaced from a first position where it , at least partly covers the projector to a second position where it at least partly is passed into a cavity of the obturator. The radial displacement may for example be provided by a spring arrangement and/or a holding mechanism temporarily holding the projector protection arrangement in one of the first position and the second positions.

[0146] A sleeve assembly suitable for a cannula assembly kit as described above may be provided. The sleeve assembly comprises a sleeve and a pattern gen-

erating member. The pattern generating member comprises a pattern light source and a projector, wherein the pattern light source is operatively connected to the projector for projecting a light pattern. At least the projector of the pattern generating member is configured to be at least temporarily and rigidly fixed to the sleeve, the sleeve preferably comprises a sleeve end edge portion comprising the projector.

[0147] The sleeve may advantageously be as described above.

[0148] In an embodiment the sleeve is configured to substantially fully cover at least a cannula shaft portion of a cannula. In an embodiment the sleeve is configured to cover at least a part of a cannula flange portion of the cannula.

[0149] The invention also relates to a minimally invasive surgery system comprising a cannula assembly kit as described above, a surgical instrument, a camera and a computer system.

[0150] The camera may be a mono camera or a stereo camera. In an embodiment the minimally invasive surgery system comprises two or more camera adapted for recording image data. The minimally invasive surgery system may be configured to combining or multiplexing said image data.

[0151] In an embodiment the camera is mounted to or integrated with the cannula e.g. as described above.

[0152] The camera may advantageously comprise a charge-coupled device (CDD) image sensor, or a complementary metal-oxide-semiconductor (CMOS) image sensor.

[0153] In an embodiment the camera is mounted to a scope. A Scope is herein used to mean any suitable scope, such as an endoscope, a laparoscope anarthroscope, a thoracoscope, a gastroscope, a colonoscope, a laryngoscope, a bronchoscope, a cystoscope or a combination thereof. In an embodiment the scope is an endoscope. In an embodiment the scope is a laparoscope.

[0154] In an embodiment the minimally invasive surgery system comprises two or more cameras, such as at least one camera mounted to or integrated with the cannula and at least one camera mounted to or integrated with a scope.

[0155] The minimally invasive surgery system may further comprise one or more illuminating element, such as an illuminating element mounted to or integrated with the scope.

[0156] The minimally invasive surgery system may additionally comprise one or more sensors which may be used in the generation of minimally invasive surgery data and/or performing a minimally invasive surgery. Such one or more sensors may include light emitting based sensors, mechanical sensors, electrical sensors and etc. In an embodiment the one or more sensors comprises position tracking sensor(s), accelerometer(s), gyroscope(s) and/or other motion-sensing devices.

[0157] It is advantageous that the projected light pattern of the cannula assembly kit comprises at least one

wavelength not comprised by the optional other illuminating light sources and/or sensor light sources.

[0158] The surgical instrument of the minimally invasive surgery system is advantageously selected from a grasper, a suture grasper, a cutter, a sealer, a stapler, a clip applier, a dissector, scissors, shears, a suction instrument, a clamp instrument, an electrode, a coagulation device, a curette, ablaters, scalpels, a needle holder, a needle driver, a spatula, forceps, a biopsy and retractor instrument or a combination thereof.

[0159] The computer system may comprise hardware and software for collecting minimally invasive surgery data and/or for performing minimally invasive surgery.

[0160] The computer system may comprise one or more hardware elements which are or are adapted to be in data communication.

[0161] In an embodiment the computer system is in data communication with the camera to receive image data from the camera. The computer system is programmed to determining real time position data of the surgical instrument, to determining real time topography data of a surface reflecting the light pattern emitted by the cannula assembly kit and/or to determining real time contours of a surface reflecting the light pattern emitted by the cannula assembly kit.

[0162] In an embodiment the computer system is configured to transmitting the determined data to a robot, a database and/or a monitor for being displayed.

[0163] In an embodiment the surgical instrument forms part of the robot or is adapted for being maneuvered by the robot. The computer system is preferably configured to transmitting the determined data to the robot. In an embodiment the computer system or at least a part of the computer system forms part of the robot.

[0164] In an embodiment the cannula assembly kit is adapted for being controlled by a computer or forms part of the computer.

[0165] The cannula assembly kit of the invention may be used in a method of performing a minimal invasive surgery of a target surgical site in an internal body structure below a skin area of a patient. In an example the method comprises,

- providing an access port to the surgery target site comprising providing an incision through the skin area inserting a cannula assembly kit as described above,
- inserting a surgical instrument through the access port,
- inserting a camera element through the access port or through an additional access port to the surgery target site,
- providing that the projector if the cannula assembly kit is emitting a light pattern,
- recording image data of the light pattern reflected from the surgery target site by the camera, and
- moving the surgical instrument for performing the minimal invasive surgery while simultaneously re-

ceiving feedback based on the recorded image data.

[0166] In an example the method comprises,

- providing an access port to the surgery target site comprising providing an incision through the skin area inserting a cannula assembly kit with a camera as described above, 5
- inserting a surgical instrument through the access port, 10
- providing that the projector if the cannula assembly kit is emitting a light pattern,
- recording image data of the light pattern reflected from the surgery target site by the camera, and 15
- moving the surgical instrument for performing the minimal invasive surgery while simultaneously receiving feedback based on the recorded image data.

[0167] In an example the method comprises performing the minimally invasive surgery by using the minimally invasive surgery system as described above. 20

[0168] The method of performing a minimal invasive surgery may be performed by an operator i.e. a surgeon and/or a robot.

[0169] For example a surgeon may be performing an incision and inserting the cannula assembly kit and a robot is performing the remaining method steps. 25

[0170] In an embodiment the entire method of performing a minimal invasive surgery is performed by a robot. The recorded image data may simultaneously be transmitted to a monitor for being displaced such than an observer, such as a supervisor, a surgeon and/or a trainee can observe the minimally invasive surgery performed by the robot. 30

[0171] All features of the inventions including ranges and preferred ranges can be combined in various ways within the scope of the invention, unless there are specific reasons not to combine such features. 35

BRIEF DESCRIPTION OF EXAMPLES 40

[0172] Preferred embodiments of the invention will be further described with reference to the drawings.

Fig. 1a is a schematic view of an embodiment of a cannula assembly kit. 45

Fig. 1b is a schematic view of an embodiment of an obturator adapted to be used together with the cannula assembly kit of Fig. 1a. 50

Figs. 1c and Fig. 1d are schematic views of a trocar assembly kit comprising the cannula assembly kit of Fig. 1 and the obturator of Fig. 2 is partly or fully in an assembled state. 55

Fig. 2 is a schematic view of an embodiment of a cannula assembly kit, where the shaft portion of the

cannula comprises a mounting through hole through which the projector has been mounted.

Fig. 3 is a schematic view of an embodiment of a cannula assembly kit comprising a sleeve.

Fig. 4 is a schematic view of an embodiment of a cannula assembly kit with a relatively large flange portion for comprising the pattern light source.

Fig. 5 is a schematic view of a distal end portion of an assembled trocar assembly kit, where the obturator comprises a projector protection arrangement.

Fig. 6 is a schematic view of an embodiment of a cannula assembly kit during use in a surgical procedure seen from outside the body cavity.

Fig. 7 is a schematic view of an embodiment of a cannula assembly kit during use in a surgical procedure seen in a cross-sectional view through the body cavity.

Fig. 8 is a schematic view of an embodiment of a cannula assembly kit configured for emitting a bullseye shaped pattern.

Fig. 9 is a schematic view of an embodiment of a cannula assembly kit with a bent cannula shaft portion.

Fig. 10 is a schematic view of an embodiment of a cannula assembly kit where the cannula comprises two cannula shaft portions and one cannula flange portion.

Fig. 11 is a schematic view of another cannula assembly kit where the cannula comprises two cannula shaft portions and one cannula flange portion.

Fig. 12 is a schematic view of an embodiment of a cannula assembly kit where the cannula comprises two cannula flange portions and one cannula shaft portion.

Fig. 13 is a schematic illustration of an embodiment of a minimally invasive surgery system of the invention where the projected light pattern comprises a coded structured light configuration comprising a plurality of light dots with different sizes.

Fig. 14 is a schematic illustration of an embodiment of a minimally invasive surgery system of the invention where the projected light pattern comprises a coded structured light configuration comprising a plurality of light dots with different shapes and sizes.

Fig. 15 is a schematic illustration of an embodiment

of a minimally invasive surgery system of the invention where the projected light pattern comprises a crosshatched pattern

[0173] The figures are schematic and are not drawn to scale and may be simplified for clarity. Throughout, the same reference numerals are used for identical or corresponding parts.

[0174] Fig. 1a illustrates an embodiment of a cannula assembly kit of the invention. The cannula assembly kit comprises a cannula 1 and a pattern generating member wherein only the projector 2 is shown. The cannula has a distal end D and a proximal end P and comprises a flange portion 4 at its proximal end and an elongate cannula shaft portion 3 extending from the flange portion 4 to its distal D end and an access port A through the flange portion 4 and the elongate cannula shaft portion 3, such that a surgical tool of a surgical instrument can be inserted through the access port. The pattern generating member comprises a not shown pattern light source and a projector 2 at least temporarily fixed to the cannula shaft portion 3 of the cannula. The cannula flange portion 4 comprises an insufflation port 5 for insufflating the body cavity.

[0175] The obturator and the cannula assembly kit of Fig. 1 are correlated to each other. The obturator 9 shown in Fig. 1b has a distal end D and a proximal end P and comprises a head portion 6 at its proximal end, a tip portion 8 at its distal end and a rigid obturator shaft portion 7 extending between said head portion 6 and said tip portion 8. The tip portion can be bladed or non-bladed.

[0176] The obturator of Fig. 1b and the cannula assembly kit of Fig. 1 are correlated to each other such that the obturator can be inserted into the access port A of the cannula 1. In Fig. 1c the obturator 9 is partly inserted into the access port A of the cannula 1. In Fig. 1d the obturator 9 is fully inserted into the access port A of the cannula 1 to thereby assemble the trocar assembly kit.

[0177] The cannula assembly kit shown in Fig. 2 comprises a cannula and a pattern generating member wherein only the projector 12 is shown. The cannula comprises a flange portion 14 and an elongate cannula shaft portion 13 extending from the flange portion 14 to its distal end and an access port A. At its distal end the cannula shaft portion 13 has an access port exit 13a and comprises an end edge 13b in the vicinity of said distal access port exit 13a.

[0178] The shaft portion 13 of the cannula comprises a mounting through hole 12a indicated on the drawing with dotted lines. The projector 12 has been mounted via the mounting through hole 12a and a not shown optical fiber extends through the mounting through hole 12a for transmitting light to the projector 12.

[0179] The cannula assembly kit shown in Fig. 3 comprises a cannula and a pattern generating member wherein only the projector 22 is shown. The cannula comprises a flange portion 24 and an elongate cannula shaft portion 23 extending from the flange portion 24 to its distal

end and an access port A. The shaft portion 23 and the flange portion 24 are covered by a sleeve 26 which is mounted to the cannula. The projector 22 is mounted to or integrated in the sleeve 26 and the sleeve also comprises a fiber covering line 22a comprising a not shown optical fiber arranged for transmitting light to the projector 22.

[0180] The cannula assembly kits shown in Fig. 4 comprises a flange portion 34 and an elongate cannula shaft portion 33 extending from the flange portion 34 to its distal end and an access port A. The cannula assembly kit also comprises a not shown pattern generating member. The rays R indicate that the not shown projector is positioned at the distal end of the cannula shaft portion 33. The cannula flange portion 34 is relatively large such that a not shown light source and/or battery can be incorporated into the cannula flange portion 34.

[0181] The distal end portion of an assembled trocar assembly kit shown in Fig. 5 comprises distal end portions of the correlated cannula assembly kit and obturator. The cannula assembly kit comprises a cannula shaft portion 43 and a projector 42 arranged for projecting a light pattern. The obturator comprises a rigid obturator shaft portion 47 and a tip portion 48. The obturator further comprises a projector protection arrangement 47a correlated with the projector 42 of the cannula assembly kit to at least partly cover the projector 42, such that the projector is at least partly projected during the insertion during surgery. In a not shown modified embodiment the projector protection arrangement is shaped to align with the shape of the tip portion of the obturator such that there will be a more gradually increase of the diameter of the assembled trocar assembly kit from the tip portion of the obturator to the cannula shaft portion of the cannula assembly kit.

[0182] When the obturator is withdrawn from the access port of the cannula assembly kit, the projector protection arrangement 47a will at least partly be passed into a cavity of the obturator, such that the projector protection arrangement 47a is not blocking for the withdrawal. The projector protection arrangement 47a may for example be pivotally folded into a cavity of the obturator, by folding towards the tip portion 48.

[0183] Fig. 6 and Fig. 7 show a cannula assembly kit in use during a surgical procedure. The figures show a body part of a patient in surgery, where an incision I is made through the skin 50 of the patient, the cannula assembly kit comprises a shaft portion 53 and a flange portion 54, and the shaft portion 53 is inserted through the incision I. The cannula assembly kit comprises a pattern generating member comprising a projector from where a light pattern P in the form of rays R of light is emitted.

[0184] A surgical instrument comprising a handle portion 56, a body portion 57 and a surgical tool 58 is inserted through the access port of the cannula assembly kit and the pattern P is projected onto a surgical site 60.

[0185] It can be seen that when the surgical tool 58 of surgical instrument is subjected to a lateral movement

and/or tilting movement the pattern will be moved in a correlated way, thereby providing information to the operator.

[0186] The pattern can for example be recorded by an image recorder on a scope inserted via the same or another incision through the skin.

[0187] The cannula assembly kit 61 shown in fig. 8 comprises a not shown projector operatively connected to a light source and configured for emitting light rays R arranged to form a bullseye shaped pattern P. The various rings of the bullseye shaped pattern P could for example have different wavelength profile.

[0188] The cannula assembly kit shown in Fig. 9 comprises a cannula and a pattern generating member wherein only the projector 72 is shown. The cannula comprises a flange portion 74 and an elongate cannula shaft portion 73 extending from the flange portion 74 to its distal end and an access port A. The cannula shaft portion 73 is bent in a soft curve to thereby make it easier for an operator to insert the cannula shaft portion 73 through an incision of a patient. The cannula shaft portion 73 is for example pre-bent to the shown bending curve and is further bendable or flexible i.e. in unloaded condition the cannula shaft portion 73 is bent. In another embodiment the cannula shaft portion 73 is substantially rigid in the bent position.

[0189] At its distal end the cannula shaft portion 73 comprises an end edge 73b and the projector 72 is mounted at the end edge 73b and a not shown optical fiber is arranged to guide light along a channel 72a in the wall of the cannula shaft portion 73.

[0190] The cannula assembly kit shown in Fig. 10 comprises a cannula and at least one pattern generating member wherein only the two projectors 82 are shown. The two projectors 82 can be of a common pattern generating member or they can be of separate pattern generating members.

[0191] The cannula comprises a flange portion 84 and a double cannula shaft portion 83, 83a, 83b. The double cannula shaft portion 83, 83a, 83b comprises a common shaft portion section 83 and two branch shaft portion sections 83a and 83b each comprising a distal access port section A, such that the cannula has a common access port section through the flange portion 84 and through the common shaft portion section 83 and two separate distal access port sections through said respective branch shaft portion sections 83a and 83b.

[0192] The cannula assembly kit shown in Fig. 11 comprises a cannula and at least one pattern generating member wherein only the two projectors 92 are shown. The two projectors 92 can be of a common pattern generating member or they can be of separate pattern generating members.

[0193] The cannula comprises a flange portion 94 and two cannula shaft portions 93a, 93b providing two access ports through the cannula flange portion 94.

[0194] The cannula assembly kit shown in Fig. 12 comprises a cannula and at least one pattern generating

member wherein only the projector 102 is shown. The cannula comprises two flange portions 104a, 104b and a double cannula shaft portion 104, 104a, 104b. The double cannula shaft portion 104, 104a, 104b comprises a common shaft portion section 104 and two branch shaft portion sections 104a and 104b. The respective branch shaft portion sections 104a and 104b are connected to the respective flange portions 104a, 104b and are merged in the common shaft portion section 104 in the distal end section of the cannula.

[0195] The minimally invasive surgery system shown in the respective Figs. 13, 14, 15 and 16 comprises a cannula assembly kit 110, a surgical instrument 115, a camera 116 and a computer system 118.

[0196] The cannula assembly kit 110 comprises a flange portion 114, an elongate cannula shaft portion 117 and a projector 112 for projecting a light pattern at its distal end. An access port is provided via the cannula shaft portion 117.

[0197] The surgical instrument 115 comprises its actual operation tool 115a at its distal end. The distal end comprising the operation tool 115a is inserted through the access port of the cannula assembly kit 110.

[0198] The projector 112 projects a light pattern towards a distally arranged surface 111 and the reflected light pattern 113 is recorded by the camera 116. In use this distally arranged surface 111 will be a surgery site which may be very uneven as described above.

[0199] As the surgical instrument 115 is moved the cannula assembly kit will be moved accordingly and thereby also the projector 112 will be moved and the reflected pattern 113 will change accordingly at least when the surgical instrument 115 is subjected to tilting movements.

[0200] The camera records the reflected light and generates recorded image data. The recorded image data is transmitted to the computer system 118.

[0201] In the shown embodiment the computer system comprises a calibration unit for calibration of the camera, a processing unit comprising algorithms for 3D data set generation and decoding of the recorded and calibrated image data, a processing unit for determine topography data in real time and a PC for storing and/or displaying the determined topography data. The various units of the computer system 118 may be integrated in a common hardware box.

[0202] As described above the surgical instrument 115 may advantageously form part of a robot for performing the minimally invasive surgery and the computer system may provide feedback to the robot and/or at least a part of the computer system may be an integrated part of the robot.

[0203] In Fig. 17 the projected light pattern comprises a coded structured light configuration comprising a plurality of light dots with different sizes.

[0204] In Fig. 14 the projected light pattern comprises a coded structured light configuration comprising a plurality of light dots with different shapes and sizes.

[0205] In Fig. 15 the projected light pattern comprises crosshatched pattern

Claims

1. A cannula assembly kit for a trocar suitable for use in minimally invasive surgery, said cannula assembly kit comprising a cannula (1) having a distal end (D) and a proximal end (P) and an elongate cannula shaft portion (3, 13, 23, 33, 43, 53, 73) extending from said proximal end (P) to said distal end (D) and an access port (A) through said elongate cannula shaft portion (3, 13, 23, 33, 43, 53, 73), such that a surgical tool of a surgical instrument can be inserted through the access port (A), **characterised in that** the cannula assembly kit comprises a pattern generating member, said pattern generating member comprises a pattern light source and a projector (2, 12, 22, 42, 72, 82), wherein the pattern light source is operatively connected to the projector (2, 12, 22, 42, 72, 82) for supplying light to the projector and the projector comprises a phase optic element, a spatial light modulator, a multi-order diffractive lens, a holographic lens and/or a computer regulated mechanical optical element for emitting a light pattern comprising a plurality of light dots, an arch shape, ring or semi-ring shaped lines, a plurality of angled lines and/or a coded structured light configuration, at least said projector (2, 12, 22, 42, 72, 82) of said pattern generating member is configured for being at least temporarily fixed to said cannula shaft portion (3, 13, 23, 33, 43, 53, 73) of said cannula, at least said projector (2, 12, 22, 42, 72, 82) of said pattern generating member is configured for being fixed to said cannula shaft portion (3, 13, 23, 33, 43, 53, 73) of said cannula to form a substantially rigid connection between said projector and said cannula shaft portion (3, 13, 23, 33, 43, 53, 73), said cannula preferably comprises a flange portion (4, 14, 24, 34, 54, 74) at its proximal end, preferably at least said projector (2, 12, 22, 42, 72, 82) of said pattern generating member is configured for being at least temporarily fixed to said cannula shaft portion (3, 13, 23, 33, 43, 53, 73) of said cannula, such that any tilting movements of the cannula result in a correlated movement of said projector (2, 12, 22, 42, 72, 82).
2. The cannula assembly kit of any one of the preceding claims, wherein said projector (2, 12, 22, 42, 72, 82) of said pattern generating member is configured for being at least temporarily fixed to said cannula shaft portion (3, 13, 23, 33, 43, 53, 73) of said cannula such that at least a portion of said light pattern is projected in a distal direction, said projector (2, 12, 22, 42, 72, 82) of said pattern generating member is preferably configured for being at least temporarily fixed at the distal end (D) of said cannula shaft portion (3, 13, 23, 33, 43, 53, 73), optionally said cannula also comprises a camera (116), such as a camera at the distal end of the cannula arranged for monitoring reflected light (113).
3. The cannula assembly kit of any one of the preceding claims, wherein said distal end (D) of said cannula shaft portion (13, 73) has a distal access port exit (13a) and comprises an end edge (13b, 73b) in the vicinity of said distal access port exit (13a), said end edge (13b, 73b) optionally frames said distal access port exit (13a), said projector (12) of said pattern generating member is configured for being at least temporarily fixed at said end edge (13b, 73b), preferably arranged for projecting said light pattern in a distal direction, preferably such that at least a portion of the light pattern is projected in a direction which is parallel with or up to 90 degrees relative to a direction parallel with the center axis of the access port and/or relative to tangent to the center axis at the access port exit, such as in a direction which is parallel with or up to 45 degrees relative to a direction parallel with the center axis of the access port and/or relative to tangent to the center axis at the access port exit, such as in a direction which is parallel with or up to 30 degrees relative to a direction parallel with the center axis of the access port and/or relative to tangent to the center axis at the access port exit, such as in a direction which is parallel with or up to 15 degrees relative to a direction parallel with the center axis of the access port and/or relative to tangent to the center axis at the access port exit, such as in a direction which is parallel with or up to 10 degrees relative to a direction parallel with the center axis of the access port and/or relative to tangent to the center axis at the access port exit.
4. The cannula assembly kit of any one of the preceding claims, wherein said cannula assembly kit comprises two or more pattern generating members, preferably said pattern generating member comprises two or more projectors (42, 82, 92) wherein the pattern light source is operatively connected to said projectors for projecting light patterns, at least said projectors (42, 82, 92) of said pattern generating member are configured for being at least temporarily fixed to said cannula shaft portion (43, 83a, 83b, 93a, 93b) of said cannula, preferably at a distance from each other, such as at the end edge at diagonal sides of the distal access port exit.
5. The cannula assembly kit of any one of the preceding claims, wherein said pattern generating member is detachable from said cannula shaft portion (3, 13, 23, 33, 43, 53, 73), preferably at least said projector (2, 12, 22, 42, 72, 82) of said pattern generating member being configured for being temporarily fixed to said cannula shaft portion (3, 13, 23, 33, 43, 53,

- 73) by a click lock, a sleeve lock, a screw lock, a turn lock, a wedge lock or combinations thereof, more preferably said projector of said pattern generating member is incorporated in or mounted to a sleeve (26), preferably comprising a sleeve end edge portion comprising said projector (22), said sleeve (26) being configured for being mounted onto said cannula shaft portion (23), optionally said sleeve constitutes an outer and/or an inner seal for minimizing undesired gas leak, said sleeve optionally being fixed or fixable to said flange portion.
6. The cannula assembly kit of any one of the preceding claims, wherein said projector (2, 12, 22, 42, 72, 82) of said pattern generating member comprises a diffractive optic element (DOE).
 7. The cannula assembly kit of any one of the preceding claims, wherein said projector (2, 12, 22, 42, 72, 82) of said pattern generating member has a projector face from where the light is to be emitted, said projector is pivotable, so it can be pivotally unfolded from a first folded position where the projector face is not facing in distal direction to a second position where the projector face is facing in distal direction.
 8. The cannula assembly kit of any one of the preceding claims, wherein said projector of said pattern generating member is configured for emitting a pattern comprising a grid of lines, e.g. a crosshatched pattern optionally comprising substantially parallel lines when emitted to a planar surface.
 9. The cannula assembly kit of any one of the preceding claims, wherein said cannula assembly kit comprises a cleaning element for cleaning said projector, said cleaning element is preferably in the form of a wiping element arranged for wiping and/or washing the projector or a spray element arranged for spraying or blowing the projector with a fluid such as gas and/or liquid.
 10. A trocar assembly kit for use in minimally invasive surgery, said trocar assembly kit comprising a cannula assembly kit (10) according to any one of the preceding claims comprising the flange portion, and an obturator (9), said obturator has a distal end (D) and a proximal end (P) and comprises a head portion (6) at its proximal end (P), a tip portion (8, 48) at its distal end (P) and a rigid obturator shaft portion (7, 47) extending between said head portion (6) and said tip portion (8, 48), wherein said cannula (1) and said obturator (9) are correlated to each other such that said tip portion (8, 48) can be inserted through the access port (A) and said head portion (6) can be temporally fixed to said flange portion, preferably such that a seal is formed in said access opening between the cannula (1) and the obturator (9).
 11. The trocar assembly kit of claim 10, wherein said obturator (9) comprises a projector protection arrangement correlated with the projector of the cannula assembly kit (47a) to at least partly cover the projector when the cannula assembly kit and the obturator are in an assembled state comprising that the tip portion (48) of the obturator is inserted substantially fully through the access port of the cannula shaft portion (43), and wherein projector protection arrangement is arranged to be at least partly passed into a cavity of the obturator (9) upon withdrawing of said obturator from said cannula access port, preferably said projector protection arrangement is arranged to be pivotally folded from a first position where it is at least partly covering the projector to a second position where it at least partly is passed into a cavity of the obturator or said projector protection arrangement is arranged to be radially displaced from a first position where it is at least partly covers the projector to a second position where it at least partly is passed into a cavity of the obturator.
 12. A minimally invasive surgery system comprising a cannula assembly kit (110) of any one of the preceding claims 1-9, a surgical instrument (115), a camera (116) and a computer system (118), preferably the cannula comprises said camera and/or the system comprises a scope comprising said or an additional camera (116), said scope preferably being selected from an endoscope, a laparoscope, anarthroscope, a thoracoscope, a gastroscope, a colonoscope, a laryngoscope, a bronchoscope, a cystoscope or a combination thereof, wherein the minimally invasive surgery system preferably further comprises an illuminating element mounted to or integrated with the scope.
 13. The minimally invasive surgery system of claim 12, wherein the surgical instrument is a grasper, a suture grasper, a cutter, a sealer, a stapler, a clip applier, a dissector, scissors, shears, a suction instrument, a clamp instrument, an electrode, a coagulation device, a curette, ablaters, scalpels, a needle holder, a needle driver, a spatula, forceps, a biopsy and retractor instrument or a combination thereof.
 14. The minimally invasive surgery system of any one of the claims 12-13 wherein the computer system (118) is in data communication with said camera (116) to receive image data from said camera (116), said computer system (118) is programmed to determining real time position data of said surgical instrument (115), to determining real time topography data of a surface (111) reflecting the light pattern (113) emitted by the cannula assembly kit (110) and/or to determining real time contours of a surface (111) reflecting the light pattern (113) emitted by the cannula assembly kit.

15. The minimally invasive surgery system of any one of the claims 12-14 wherein the computer system (118) is configured to transmitting the determined data to a robot, a database and/or a monitor for being displayed.
16. The minimally invasive surgery system of any one of the claims 12-15 wherein the surgical instrument (115) forms part of a robot or is adapted for being maneuvered by a robot, the computer system (118) is configured to transmitting the determined data to said robot, preferably the computer system (118) or at least a part of the computer system (118) forms part of the robot.

Patentansprüche

1. Kanülenbausatz für einen Trokar geeignet zur Verwendung in der minimalinvasiven Chirurgie, wobei der Kanülenbausatz eine Kanüle (1) aufweist, die ein distales Ende (D) und ein proximales Ende (P) und einen länglichen Kanülenschaftabschnitt (3, 13, 23, 33, 43, 53, 73), der sich vom proximalen Ende (P) zum distalen Ende (D) erstreckt, und eine Zugangsöffnung (A) durch den länglichen Kanülenschaftabschnitt (3, 13, 23, 33, 43, 53, 73) hat, so dass ein chirurgisches Werkzeug eines chirurgischen Instruments durch die Zugangsöffnung (A) eingeführt werden kann, **dadurch gekennzeichnet, dass** der Kanülenbausatz ein Mustererzeugungselement aufweist, wobei das Mustererzeugungselement eine Musterlichtquelle und einen Projektor (2, 12, 22, 42, 72, 82) aufweist, wobei die Musterlichtquelle operativ mit dem Projektor (2, 12, 22, 42, 72, 82) verbunden ist, um dem Projektor Licht zuzuführen, und der Projektor ein Phasenoptikelement, einen räumlichen Lichtmodulator, eine diffraktive Mehrfachordnungslinse, eine holographische Linse und/oder ein computergesteuertes mechanisches Optikelement zum Emittieren eines Lichtmusters aufweist, das eine Vielzahl von Lichtpunkten, eine Bogenform, ring- oder halbringförmige Linien, eine Vielzahl von verwinkelten Linien und/oder eine codierte strukturierte Lichtkonfiguration aufweist, wobei mindestens der Projektor (2, 12, 22, 42, 72, 82) des Mustererzeugungselements so konfiguriert ist, dass er mindestens zeitweise am Kanülenschaftabschnitt (3, 13, 23, 33, 43, 53, 73) der Kanüle fixiert ist, und mindestens der Projektor (2, 12, 22, 42, 72, 82) des Mustererzeugungselements so konfiguriert ist, dass er am Kanülenschaftabschnitt (3, 13, 23, 33, 43, 53, 73) der Kanüle fixiert ist, um eine im Wesentlichen starre Verbindung zwischen dem Projektor und dem Kanülenschaftabschnitt (3, 13, 23, 33, 43, 53, 73) zu bilden, wobei die Kanüle vorzugsweise an ihrem proximalen Ende einen Flanschabschnitt (4, 14, 24, 34, 54, 74) aufweist, wobei vorzugsweise

mindestens der Projektor (2, 12, 22, 42, 72, 82) des Mustererzeugungselements so konfiguriert ist, dass er mindestens zeitweise am Kanülenschaftabschnitt (3, 13, 23, 33, 43, 53, 73) der Kanüle fixiert ist, so dass jegliche Kippbewegung der Kanüle zu einer korrelierten Bewegung des Projektors (2, 12, 22, 42, 72, 82) führt.

2. Kanülenbausatz nach einem der vorhergehenden Ansprüche, wobei der Projektor (2, 12, 22, 42, 72, 82) des Mustererzeugungselements so konfiguriert ist, dass er mindestens zeitweise am Kanülenschaftabschnitt (3, 13, 23, 33, 43, 53, 73) der Kanüle derart fixiert ist, dass mindestens ein Teil des Lichtmusters in eine distale Richtung projiziert wird, wobei der Projektor (2, 12, 22, 42, 72, 82) des Mustererzeugungselements vorzugsweise so konfiguriert ist, dass er mindestens zeitweise am distalen Ende (D) des Kanülenschaftabschnitts (3, 13, 23, 33, 43, 53, 73) fixiert ist, wobei gegebenenfalls die Kanüle auch eine Kamera (116) aufweist, so dass eine Kamera am distalen Ende der Kanüle zum Überwachen des reflektierten Lichts (113) angeordnet ist.
3. Kanülenbausatz nach einem der vorhergehenden Ansprüche, wobei das distale Ende (D) des Kanülenschaftabschnitts (13, 73) einen distalen Zugangsöffnungsausgang (13a) hat und eine Endkante (13b, 73b) in der Nähe des distalen Zugangsöffnungsausgangs (13a) aufweist, wobei die Endkante (13b, 73b) gegebenenfalls den distalen Zugangsöffnungsausgang (13a) umrahmt, und der Projektor (12) des Mustererzeugungselements so konfiguriert ist, dass er mindestens zeitweise an der Endkante (13b, 73b) fixiert ist, vorzugsweise angeordnet zum Projizieren des Lichtmusters in eine distale Richtung, vorzugsweise derart, dass mindestens ein Teil des Lichtmusters in eine Richtung projiziert wird, die parallel zu oder bis zu 90 Grad relativ zu einer Richtung parallel zur Mittelachse der Zugangsöffnung und/oder relativ zur Tangente zur Mittelachse am Ausgang der Zugangsöffnung ist, beispielsweise in einer Richtung, die parallel zu oder bis zu 45 Grad relativ zu einer Richtung parallel zur Mittelachse der Zugangsöffnung und/oder relativ zur Tangente zur Mittelachse am Ausgang der Zugangsöffnung ist, beispielsweise in einer Richtung, die parallel zu oder bis zu 30 Grad relativ zu einer Richtung parallel zur Mittelachse der Zugangsöffnung und/oder relativ zur Tangente zur Mittelachse am Ausgang der Zugangsöffnung ist, beispielsweise in einer Richtung, die parallel zu oder bis zu 15 Grad relativ zu einer Richtung parallel zur Mittelachse der Zugangsöffnung und/oder relativ zur Tangente zur Mittelachse am Ausgang der Zugangsöffnung ist, beispielsweise in einer Richtung, die parallel zu oder bis zu 10 Grad relativ zu einer Richtung parallel zur Mittelachse der Zugangsöffnung und/oder relativ zur Tangente zur

Mittelachse am Ausgang der Zugangsöffnung ist.

4. Kanülenbausatz nach einem der vorhergehenden Ansprüche, wobei der Kanülenbausatz zwei oder mehr Mustererzeugungselemente aufweist, wobei das Mustererzeugungselement vorzugsweise zwei oder mehr Projektoren (42, 82, 92) aufweist, wobei die Musterlichtquelle mit den Projektoren zum Projizieren der Lichtmuster operativ verbunden ist, wobei mindestens die Projektoren (42, 82, 92) des Mustererzeugungselements so konfiguriert sind, dass sie mindestens zeitweise am Kanülenschaftabschnitt (43, 83a, 83b, 93a, 93b) der Kanüle fixiert sind, vorzugsweise in einem Abstand voneinander, beispielsweise an der Endkante an diagonalen Seiten des distalen Zugangsöffnungsausgangs.
5. Kanülenbausatz nach einem der vorhergehenden Ansprüche, wobei das Mustererzeugungselement vom Kanülenschaftabschnitt (3, 13, 23, 33, 43, 53, 73) abnehmbar ist, wobei vorzugsweise mindestens der Projektor (2, 12, 22, 42, 72, 82) des Mustererzeugungselements konfiguriert ist, um zeitweise am Kanülenschaftabschnitt (3, 13, 23, 33, 43, 53, 73) durch eine Klickverriegelung, eine Hülsenverriegelung, eine Schraubverriegelung, eine Drehverriegelung, eine Keilverriegelung oder Kombinationen davon fixiert zu sein, wobei der Projektor des Mustererzeugungselements bevorzugter in eine Hülse (26) eingebaut oder an dieser angebracht ist, die vorzugsweise einen Hülsenendkantenabschnitt aufweist, der den Projektor (22) aufweist, wobei die Hülse (26) konfiguriert ist, um auf dem Kanülenschaftabschnitt (23) angebracht zu sein, wobei die Hülse gegebenenfalls eine äußere und/oder eine innere Dichtung zur Minimierung eines unerwünschten Gaslecks bildet, wobei die Hülse gegebenenfalls an dem Flanschabschnitt fixiert oder fixierbar ist.
6. Kanülenbausatz nach einem der vorhergehenden Ansprüche, wobei der Projektor (2, 12, 22, 42, 72, 82) des Mustererzeugungselements ein diffraktives optisches Element (DOE) aufweist.
7. Kanülenbausatz nach einem der vorhergehenden Ansprüche, wobei der Projektor (2, 12, 22, 42, 72, 82) des Mustererzeugungselements eine Projektorfläche hat, von der das Licht emittiert werden soll, wobei der Projektor schwenkbar ist, so dass er von einer ersten gefalteten Position, in der die Projektorfläche nicht in distale Richtung weist, in eine zweite Position, in der die Projektorfläche in distale Richtung weist, schwenkbar entfaltet werden kann.
8. Kanülenbausatz nach einem der vorhergehenden Ansprüche, wobei der Projektor des Mustererzeugungselements zum Emittieren eines Musters konfiguriert ist, das ein Liniengitter aufweist, beispielsweise

weise ein schraffiertes Muster, das gegebenenfalls im Wesentlichen parallele Linien aufweist, wenn es zu einer ebenen Oberfläche emittiert wird.

9. Kanülenbausatz nach einem der vorhergehenden Ansprüche, wobei der Kanülenbausatz ein Reinigungselement zum Reinigen des Projektors aufweist, wobei das Reinigungselement vorzugsweise in Form eines Wischelements angeordnet ist, das zum Abwischen und/oder Waschen des Projektors angeordnet ist, oder eines Sprühelements angeordnet ist, das zum Besprühen oder Anpusten des Projektors mit einem Fluid wie etwa Gas und/oder Flüssigkeit angeordnet ist.
10. Trokarbausatz zur Verwendung in der minimalinvasiven Chirurgie, wobei der Trokarbausatz einen Kanülenbausatz (10) nach einem der vorhergehenden Ansprüche, der den Flanschabschnitt aufweist, und ein Dichtungsmittel (9) aufweist, wobei das Dichtungsmittel ein distales Ende (D) und ein proximales Ende (P) hat und einen Kopfabschnitt (6) an seinem proximalen Ende (P), einen Spitzenabschnitt (8, 48) an seinem distalen Ende (P) und einen starren Dichtungsmittelschaftabschnitt (7, 47) aufweist, der sich zwischen dem Kopfabschnitt (6) und dem Spitzenabschnitt (8, 48) erstreckt, wobei die Kanüle (1) und das Dichtungsmittel (9) so miteinander korreliert sind, dass der Spitzenabschnitt (8, 48) durch die Zugangsöffnung (A) eingeführt werden kann und der Kopfabschnitt (6) zeitweise am Flanschabschnitt fixiert werden kann, vorzugsweise derart, dass eine Dichtung in der Zugangsöffnung zwischen der Kanüle (1) und dem Dichtungsmittel (9) ausgebildet ist.
11. Trokarbausatz nach Anspruch 10, wobei das Dichtungsmittel (9) eine Projektorschutzanordnung aufweist, die mit dem Projektor des Kanülenbausatzes (47a) korreliert ist, um den Projektor mindestens teilweise abzudecken, wenn der Kanülenbausatz und das Dichtungsmittel in zusammengebauten Zustand vorliegen, der umfasst, dass der Spitzenabschnitt (48) des Dichtungsmittels im Wesentlichen vollständig durch die Zugangsöffnung des Kanülenschaftabschnitts (43) eingeführt ist, und wobei die Projektorschutzanordnung so angeordnet ist, dass sie nach Zurückziehen des Dichtungsmittels aus der Kanülenzugangsöffnung mindestens teilweise in einen Hohlraum des Dichtungsmittels (9) geführt ist, wobei vorzugsweise die Projektorschutzanordnung so angeordnet ist, dass sie von einer ersten Position, in der sie den Projektor mindestens teilweise bedeckt, in eine zweite Position, in der sie mindestens teilweise in einen Hohlraum des Dichtungsmittels geführt ist, schwenkbar ist, oder wobei die Projektorschutzanordnung so angeordnet ist, dass sie von einer ersten Position, in der sie den Projektor mindestens teilweise bedeckt, in eine zweite Position,

in der sie mindestens teilweise in einen Hohlraum des Dichtungsmittels geführt ist, radial versetzt wird.

12. Minimalinvasives Chirurgiesystem, das einen Kanülenbausatz (110) nach einem der vorhergehenden Ansprüche 1 bis 9, ein chirurgisches Instrument (115), eine Kamera (116) und ein Computersystem (118) aufweist, wobei vorzugsweise die Kanüle die Kamera aufweist und/oder das System eine Beobachtungsvorrichtung aufweist, die die oder eine zusätzliche Kamera (116) aufweist, wobei die Beobachtungsvorrichtung vorzugsweise ausgewählt ist aus einem Endoskop, einem Laparoskop, einem Anarthroskop, einem Thorakoskop, einem Gastroskop, einem Koloskop, einem Laryngoskop, einem Bronchoskop, einem Zystoskop oder einer Kombination davon, wobei das minimalinvasive Chirurgiesystem vorzugsweise ferner ein Beleuchtungselement aufweist, das an der Beobachtungsvorrichtung angebracht oder in dieser integriert ist.
13. Minimalinvasives Chirurgiesystem nach Anspruch 12, wobei das chirurgische Instrument ein Greifer, ein Nahtgreifer, ein Schneider, ein Versiegeler, ein Hefter, ein Klammeranbringer, ein Dissektor, eine Schere, eine Schere, ein Sauginstrument, ein Klammerinstrument, eine Elektrode, eine Koagulationsvorrichtung, eine Kürette, Ablatoren, Skalpelle, ein Nadelhalter, ein Nadelführer, ein Spatel, eine Zange, ein Biopsie- und Retraktorinstrument oder eine Kombination davon ist.
14. Minimalinvasives Chirurgiesystem nach einem der Ansprüche 12 bis 13, wobei das Computersystem (118) in Datenkommunikation mit der Kamera (116) steht, um Bilddaten von der Kamera (116) zu empfangen, wobei das Computersystem (118) programmiert ist, um Echtzeit-Positionsdaten des chirurgischen Instruments (115) zu ermitteln, Echtzeit-Topografiedaten einer Oberfläche (111) zu ermitteln, die das von dem Kanülenbausatz (110) emittierte Lichtmuster (113) reflektiert, und/oder um Echtzeitkonturen einer Oberfläche (111) zu ermitteln, die das von dem Kanülenbausatz emittierte Lichtmuster (113) reflektiert.
15. Minimalinvasives Chirurgiesystem nach einem der Ansprüche 12 bis 14, wobei das Computersystem (118) konfiguriert ist, um die ermittelten Daten an einen Roboter, eine Datenbank und/oder einen Monitor zum Anzeigen zu übertragen.
16. Minimalinvasives Chirurgiesystem nach einem der Ansprüche 12 bis 15, wobei das chirurgische Instrument (115) einen Teil eines Roboters bildet oder dazu angepasst ist, von einem Roboter manövriert zu werden, wobei das Computersystem (118) konfiguriert ist, um die ermittelten Daten an den Roboter zu

übertragen, wobei vorzugsweise das Computersystem (118) oder mindestens ein Teil des Computersystems (118) einen Teil des Roboters bilden.

Revendications

1. Kit d'assemblage de canule pour un trocart pouvant être utilisé en chirurgie mini-invasive, ledit kit d'assemblage de canule comprenant une canule (1) ayant une extrémité distale (D) et une extrémité proximale (P) et une partie de tige de canule allongée (3, 13, 23, 33, 43, 53, 73) s'étendant depuis ladite extrémité proximale (P) jusqu'à ladite extrémité distale (P) et un orifice d'accès (A) traversant ladite partie de tige de canule allongée (3, 13, 23, 33, 43, 53, 73), de telle sorte qu'un outil chirurgical d'un instrument chirurgical puisse être inséré dans l'orifice d'accès (A), **caractérisé en ce que** le kit d'assemblage de canule comprend un élément générateur de motif, ledit élément générateur de motif comprend une source lumineuse de motif et un projecteur (2, 12, 22, 42, 72, 82), la source lumineuse de motif est raccordée de manière fonctionnelle au projecteur (2, 12, 22, 42, 72, 82) pour acheminer la lumière vers le projecteur et le projecteur comprend un élément optique de phase, un modulateur de lumière spatial, une lentille diffractive multi-ordre, une lentille holographique et/ou un élément optique mécanique régulé par ordinateur pour émettre un motif lumineux comprenant une pluralité de points lumineux, une forme arquée, des lignes de forme annulaire ou semi-annulaire, une pluralité de lignes angulaires et/ou une configuration lumineuse structurée codée, au moins ledit projecteur (2, 12, 22, 42, 72, 82) dudit élément générateur de motif étant configuré pour être au moins fixé temporairement à ladite partie de tige de canule (3, 13, 23, 33, 43, 53, 73) de ladite canule, au moins ledit projecteur (2, 12, 22, 42, 72, 82) dudit élément générateur de motif étant configuré pour être fixé à ladite partie de tige de canule (3, 13, 23, 33, 43, 53, 73) de ladite canule pour former un raccord sensiblement rigide entre ledit projecteur et ladite partie de tige de canule (3, 13, 23, 33, 43, 53, 73), ladite canule comprenant de préférence une partie de bride (4, 14, 24, 34, 54, 74) à son extrémité proximale, de préférence au moins ledit projecteur (2, 12, 22, 42, 72, 82) dudit élément générateur de motif étant configuré pour être au moins fixé temporairement à ladite partie de tige de canule (3, 13, 23, 33, 43, 53, 73) de ladite canule, de telle sorte que tout mouvement d'inclinaison de la canule résulte en un mouvement corrélé dudit projecteur (2, 12, 22, 42, 72, 82) .
2. Kit d'assemblage de canule selon l'une quelconque des revendications précédentes, dans lequel ledit projecteur (2, 12, 22, 42, 72, 82) dudit élément gé-

nérateur de motif est configuré pour être au moins fixé temporairement à ladite partie de tige de canule (3, 13, 23, 33, 43, 53, 73), de telle sorte qu'au moins une partie dudit motif lumineux soit projeté dans la direction distale, ledit projecteur (2, 12, 22, 42, 72, 82) dudit élément générateur de motif étant de préférence configuré pour être au moins fixé temporairement à l'extrémité distale (D) de ladite partie de tige de canule (3, 13, 23, 33, 43, 53, 73), facultativement ladite canule comprenant également une caméra (116), par exemple une caméra à l'extrémité distale de la canule agencée pour contrôler la lumière réfléchie (113).

3. Kit d'assemblage de canule selon l'une quelconque des revendications précédentes, dans lequel ladite extrémité distale (D) de ladite partie de tige de canule (13, 73) a une sortie d'orifice d'accès distal (13a) et comprend un bord d'extrémité (13b, 73b) à proximité de ladite sortie d'orifice d'accès distal (13a), ledit bord d'extrémité (13b, 73b) encadre facultativement ladite sortie d'orifice d'accès distal (13a), ledit projecteur (12) dudit élément générateur de motif est configuré pour être au moins fixé temporairement audit bord d'extrémité (13b, 73b), de préférence agencé pour projeter ledit motif lumineux dans la direction distale, de préférence de telle sorte qu'au moins une partie du motif lumineux soit projetée dans une direction qui est parallèle à ou jusqu'à 90 degrés par rapport à une direction parallèle à l'axe central de l'orifice d'accès et/ou par rapport à la tangente à l'axe central au niveau de la sortie d'orifice d'accès, par exemple dans une direction qui est parallèle à ou jusqu'à 45 degrés par rapport à une direction parallèle à l'axe central de l'orifice d'accès et/ou par rapport à la tangente à l'axe central au niveau de la sortie d'orifice d'accès, par exemple dans une direction qui est parallèle à ou jusqu'à 30 degrés par rapport à une direction parallèle à l'axe central de l'orifice d'accès et/ou par rapport à la tangente à l'axe central au niveau de la sortie d'orifice d'accès, par exemple dans une direction qui est parallèle à ou jusqu'à 15 degrés par rapport à une direction parallèle à l'axe central de l'orifice d'accès et/ou par rapport à la tangente à l'axe central au niveau de la sortie d'orifice d'accès, par exemple dans une direction qui est parallèle à ou jusqu'à 10 degrés par rapport à une direction parallèle à l'axe central de l'orifice d'accès et/ou par rapport à la tangente à l'axe central au niveau de la sortie de l'orifice d'accès.
4. Kit d'assemblage de canule selon l'une quelconque des revendications précédentes, dans lequel ledit kit d'assemblage de canule comprend deux éléments générateurs de motif ou plus, de préférence ledit élément générateur de motif comprenant deux projecteurs (42, 82, 92) ou plus dans lesquels la source lumineuse de motif est raccordée de manière fonc-

tionnelle auxdits projecteurs pour projeter des motifs lumineux, au moins lesdits projecteurs (42, 82, 92) dudit élément générateur de motif étant configurés pour être au moins fixés temporairement à ladite partie de tige de canule (43, 83a, 83b, 93a, 93b) de ladite canule, de préférence à distance l'un de l'autre, par exemple sur le bord d'extrémité au niveau des diagonales de la sortie d'orifice d'accès distal.

5. Kit d'assemblage de canule selon l'une quelconque des revendications précédentes, dans lequel ledit élément générateur de motif est détachable de ladite partie de tige de canule (3, 13, 23, 33, 43, 53, 73), de préférence au moins ledit projecteur (2, 12, 22, 42, 72, 82) dudit élément générateur de motif étant configuré pour être fixé temporairement à ladite partie de tige de canule (3, 13, 23, 33, 43, 53, 73) par verrouillage à encliquetage, verrouillage à manchon, verrouillage à vis, verrouillage rotatif, verrouillage à clavette ou des combinaisons de ceux-ci, de manière davantage préférée, ledit projecteur dudit élément générateur de motif étant incorporé dans ou monté sur un manchon (26), comprenant de préférence une partie de bord d'extrémité de manchon comprenant ledit projecteur (22), ledit manchon (26) étant configuré pour être monté sur ladite partie de tige de canule (23), facultativement ledit manchon constituant un joint étanche extérieur et/ou intérieur pour minimiser les fuites de gaz indésirables, ledit manchon étant fixé ou fixable facultativement sur ladite partie de bride.
6. Kit d'assemblage de canule selon l'une quelconque des revendications précédentes, dans lequel ledit projecteur (2, 12, 22, 42, 72, 82) dudit élément générateur de motif comprend un élément optique diffractif (EOD).
7. Kit d'assemblage de canule selon l'une quelconque des revendications précédentes, dans lequel ledit projecteur (2, 12, 22, 42, 72, 82) dudit élément générateur de motif a une face de projecteur d'où la lumière est émise, ledit projecteur étant pivotable de manière à pouvoir être déployé de manière pivotante d'une première position repliée dans laquelle la face de projecteur n'est pas tournée dans la direction distale jusqu'à une seconde position dans laquelle la face de projecteur est tournée dans la direction distale.
8. Kit d'assemblage de canule selon l'une quelconque des revendications précédentes, dans lequel ledit projecteur dudit élément générateur de motif est configuré pour émettre un motif comprenant une grille de lignes, par exemple un motif hachuré comprenant sensiblement, et facultativement, des lignes sensiblement parallèles lorsqu'il est émis sur une surface plane.

9. Kit d'assemblage de canule selon l'une quelconque des revendications précédentes, dans lequel ledit kit d'assemblage de canule comprend un élément nettoyant pour nettoyer ledit projecteur, ledit élément nettoyant étant de préférence sous la forme d'un élément d'essuyage agencé pour essuyer et/ou laver le projecteur ou un élément de pulvérisation agencé pour pulvériser ou souffler sur le projecteur un fluide tel qu'un gaz et/ou un liquide.
10. kit d'assemblage de trocart destiné à être utilisé en chirurgie mini-invasive, ledit kit d'assemblage de trocart comprenant un kit d'assemblage de canule (10) selon l'une quelconque des revendications précédentes, comprenant la partie de bride, et un obturateur (9), ledit obturateur ayant une extrémité distale (D) et une extrémité proximale (P) et comprenant une partie de tête (6) à son extrémité proximale (P), une partie de pointe (8, 48) à son extrémité distale (P) et une partie de tige d'obturateur rigide (7, 47) s'étendant entre ladite partie de tête (6) et ladite partie de pointe (8, 48), ladite canule (1) et ledit obturateur (9) étant corrélés l'un avec l'autre, de telle sorte que ladite partie de pointe (8, 48) puisse être insérée dans l'orifice d'accès (A) et ladite partie de tête (6) puisse être fixée temporairement à ladite partie de bride, de préférence de telle sorte qu'un joint étanche soit formé dans ledit orifice d'accès entre la canule (1) et l'obturateur (9).
11. Kit d'assemblage de trocart selon la revendication 10, dans lequel ledit obturateur (9) comprend un agencement de protection de projecteur corrélé avec le projecteur du kit d'assemblage de canule (47a) afin de couvrir au moins partiellement le projecteur lorsque le kit d'assemblage de canule et l'obturateur sont à l'état assemblé comprenant le fait que la partie de pointe (48) de l'obturateur est insérée sensiblement dans sa totalité dans l'orifice d'accès de la partie de tige de canule (43), et l'agencement de protection de projecteur étant agencé pour être au moins partiellement inséré dans une cavité de l'obturateur (9) lors du retrait dudit obturateur dudit orifice d'accès de canule, ledit agencement de protection de projecteur étant agencé pour être replié de manière pivotante d'une première position dans laquelle il recouvre au moins partiellement le projecteur dans une seconde position dans laquelle il est au moins partiellement inséré dans une cavité de l'obturateur ou ledit agencement de protection de projecteur étant agencé pour être déplacé radialement d'une première position dans laquelle il recouvre au moins le projecteur dans une seconde position dans laquelle il est au moins partiellement inséré dans une cavité de l'obturateur.
12. Système de chirurgie mini-invasive comprenant un kit d'assemblage de canule (110) selon l'une quelconque des revendications précédentes 1 à 9, un instrument chirurgical (115), une caméra (116) et un système informatique (118), de préférence la canule comprenant ladite caméra et/ou le système comprenant un scope comprenant ladite caméra ou une caméra additionnelle (116), ledit scope étant de préférence sélectionné parmi un endoscope, un laparoscope, un arthroscope, un thoracoscope, un gastroscope, un colonoscope, un laryngoscope, un bronchoscope, un cystoscope ou une combinaison de ceux-ci, le système de chirurgie mini-invasive comprenant de préférence un élément éclairant monté ou intégré dans le scope.
13. Système de chirurgie mini-invasive selon la revendication 12, dans lequel l'instrument chirurgical est un préhenseur, un préhenseur à sutures, une lame, un dispositif de ligature, un dispositif d'agrafage, un applicateur de clip, un dissecteur, des ciseaux, des cisailles, un instrument d'aspiration, un instrument de clamage, une électrode, un dispositif de coagulation, une curette, un dispositif d'ablation, un scalpel, un porte-aiguille, une spatule, des forceps, un instrument à biopsie et un écarteur ou une combinaison de ceux-ci.
14. Système de chirurgie mini-invasive selon l'une quelconque des revendications 12 à 13, dans lequel le système informatique (118) est en communication de données avec ladite caméra (116) pour recevoir des données d'image de ladite caméra (116), ledit système informatique (118) est programmé pour déterminer les données de position en temps réel dudit instrument chirurgical (115), pour déterminer les données topographiques en temps réel d'une surface (111) réfléchissant le motif lumineux (113) émis par le kit d'assemblage de canule (110) et/ou pour déterminer les contours en temps réel d'une surface (111) réfléchissant le motif lumineux (113) émis par le kit d'assemblage de canule.
15. Système de chirurgie mini-invasive selon l'une quelconque des revendications 12 à 14, dans lequel le système informatique (118) est configuré pour transmettre les données déterminées à un robot, une base de données et/ou un moniteur pour les afficher.
16. Système de chirurgie mini-invasive selon l'une quelconque des revendications 12 à 15, dans lequel l'instrument chirurgical (115) forme une partie d'un robot ou est adapté pour être manœuvré par un robot, le système informatique (118) étant configuré pour transmettre les données déterminées audit robot, de préférence le système informatique (118) ou au moins une partie du système informatique (118) faisant partie du robot.

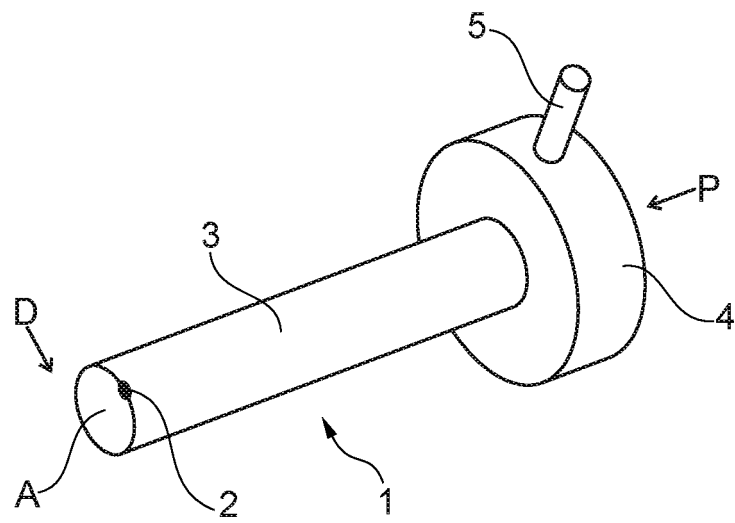


Fig. 1a

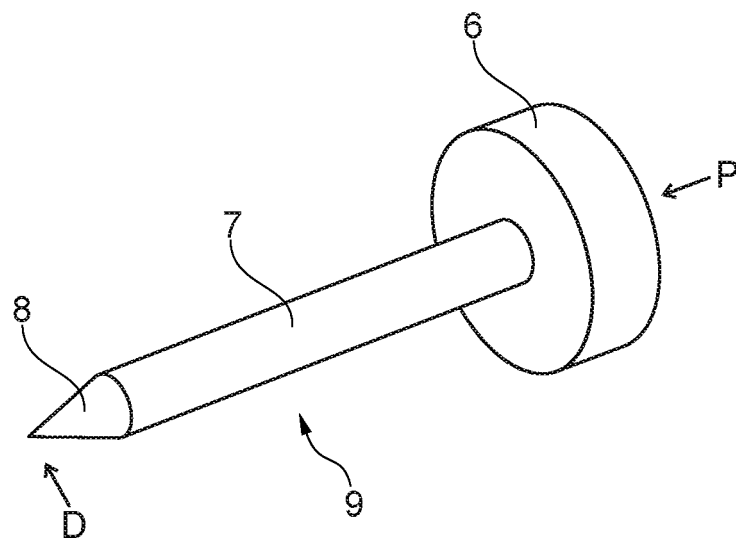


Fig. 1b

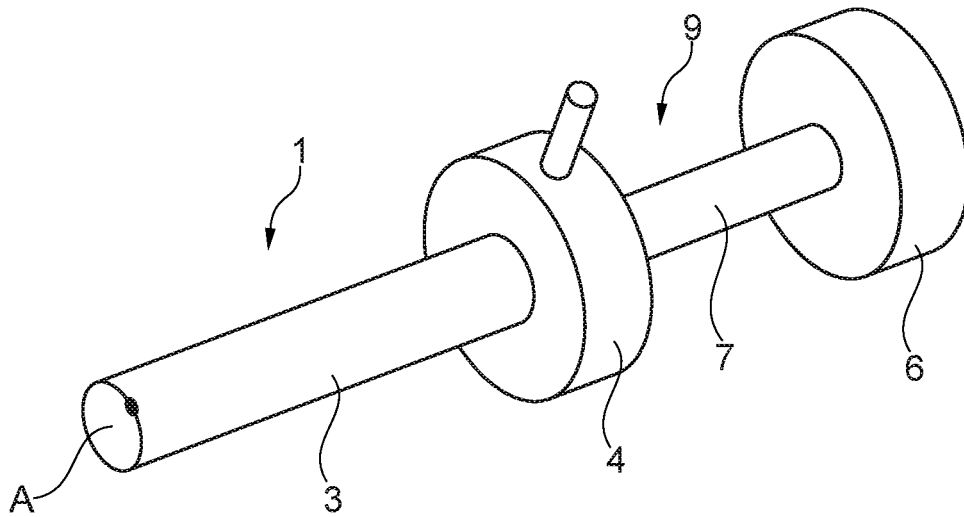


Fig. 1c

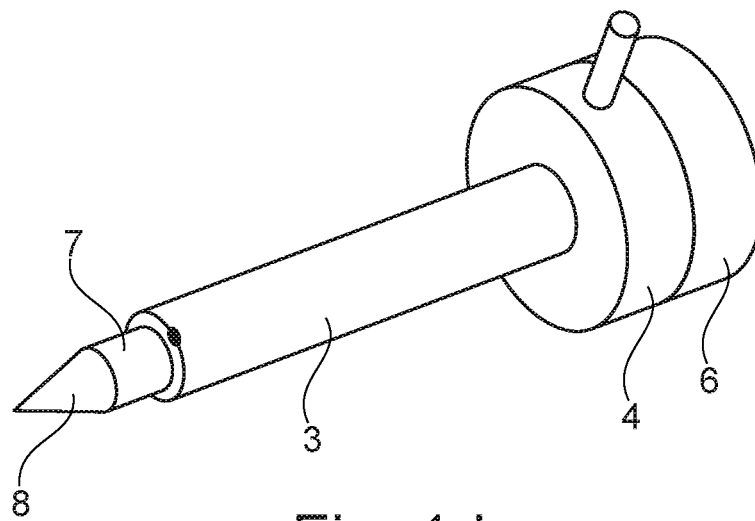


Fig. 1d

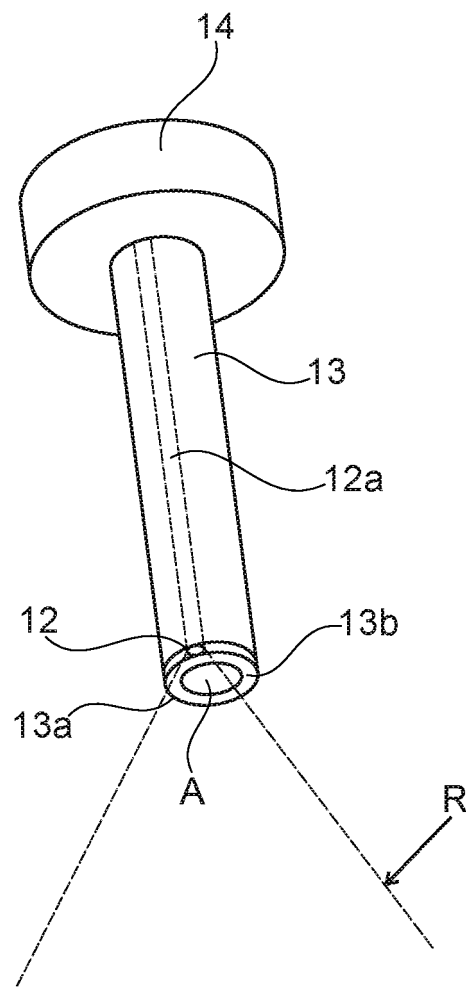


Fig. 2

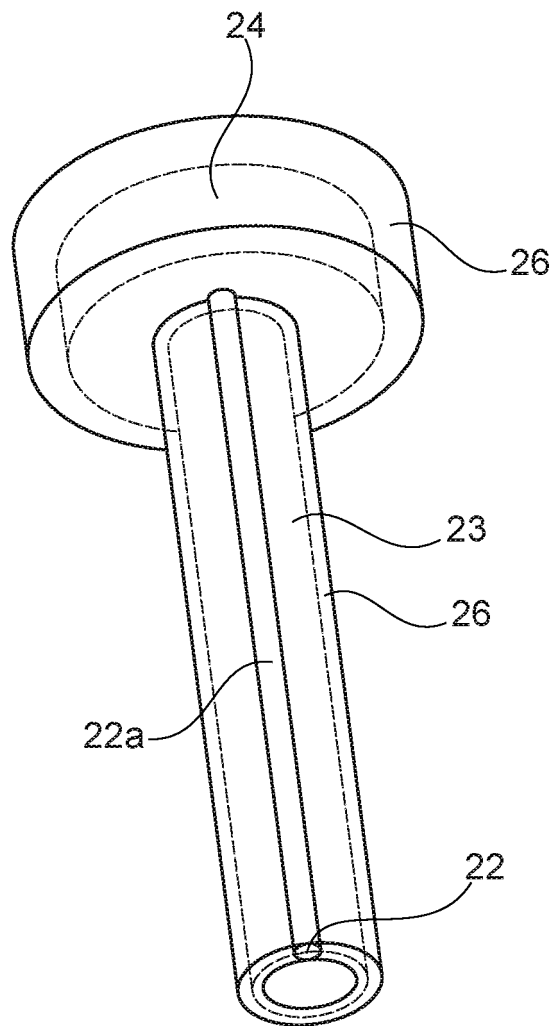


Fig. 3

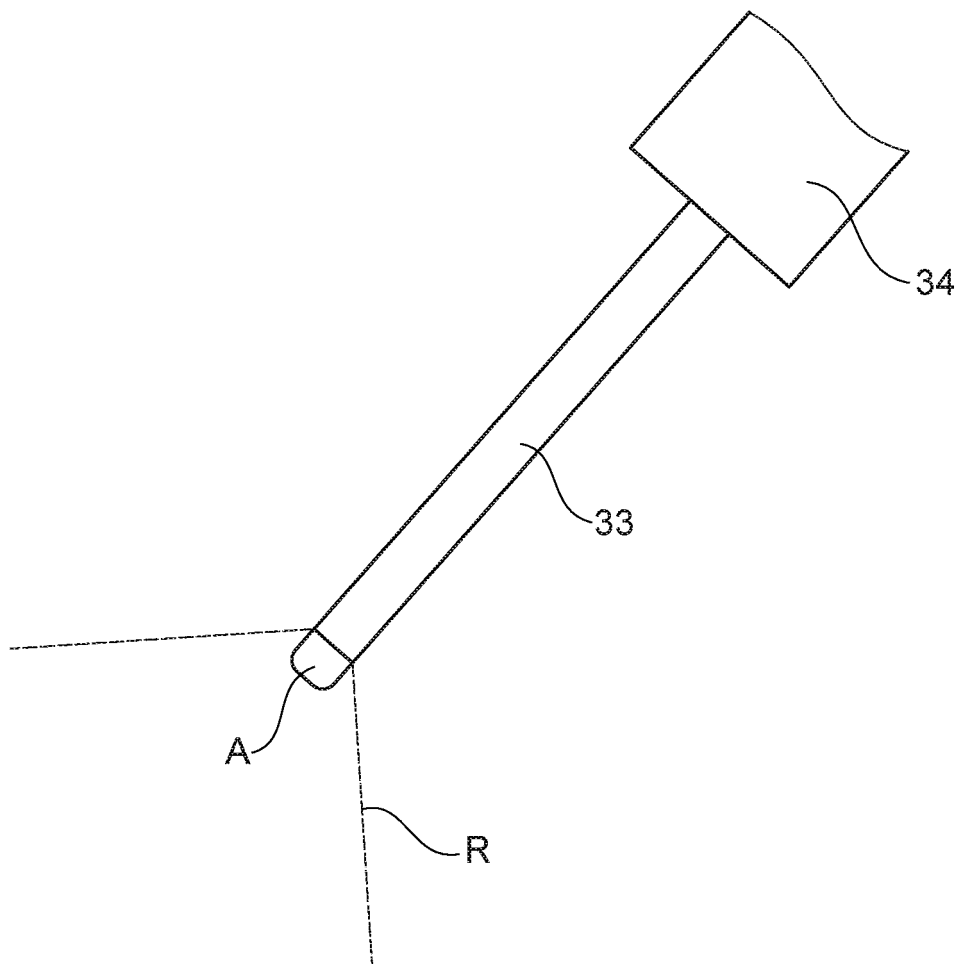


Fig. 4

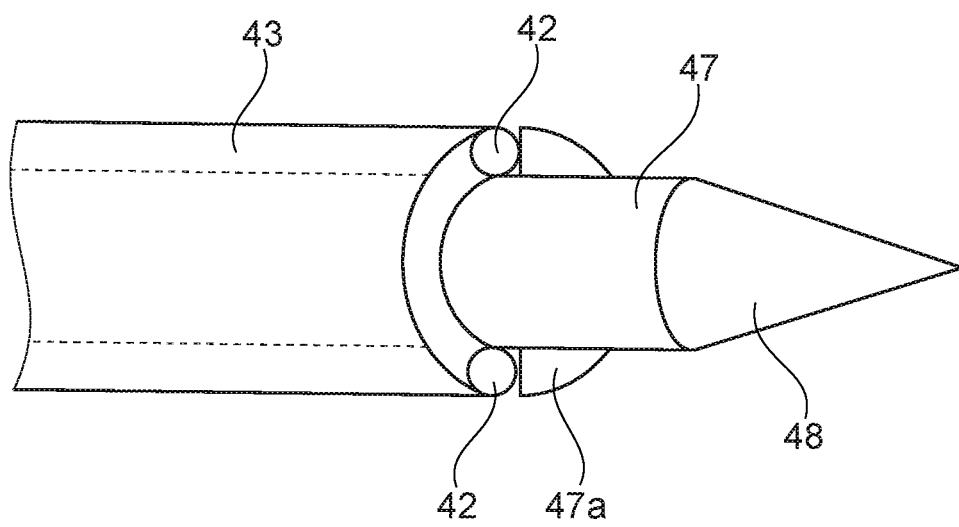


Fig. 5

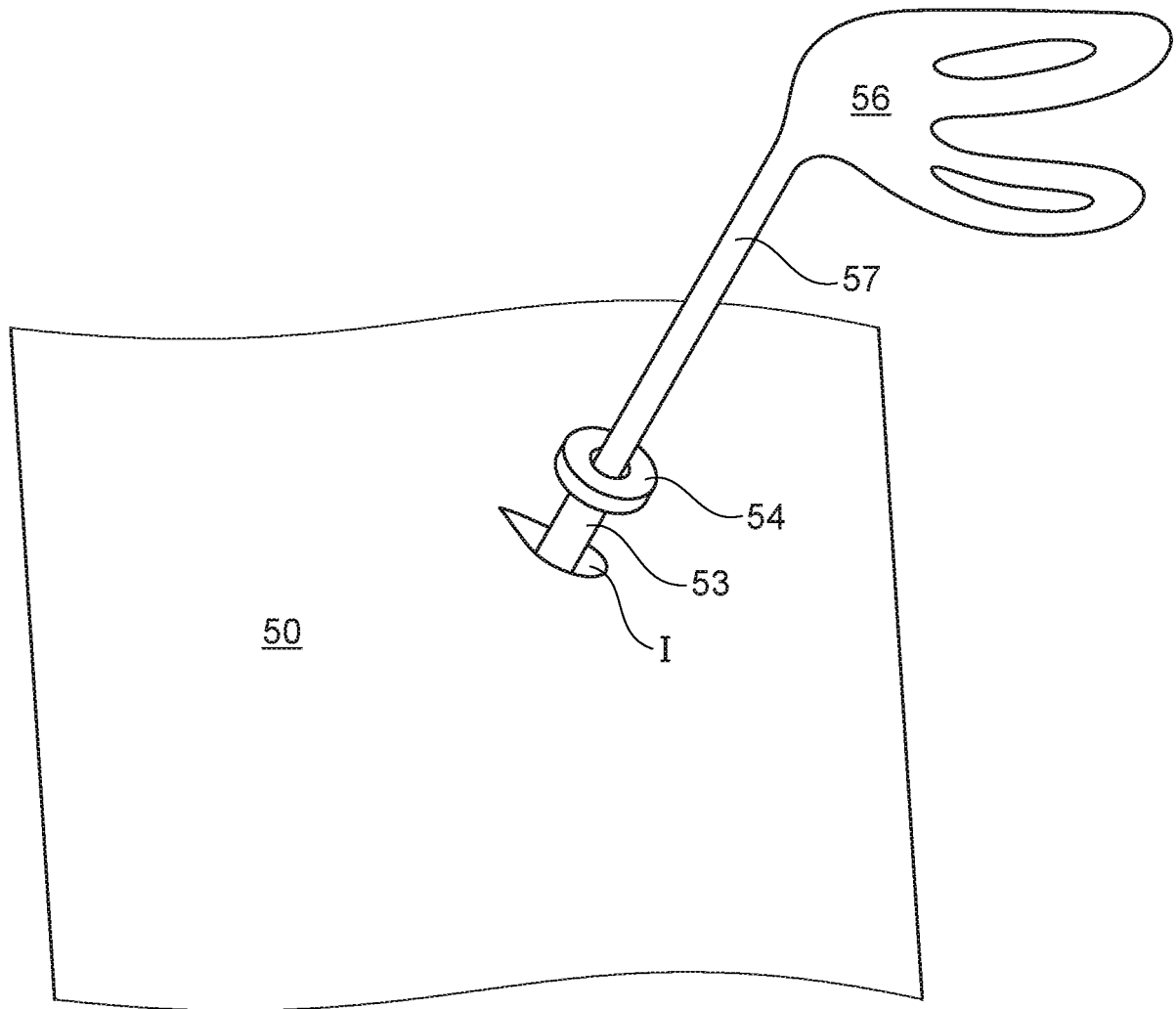


Fig. 6

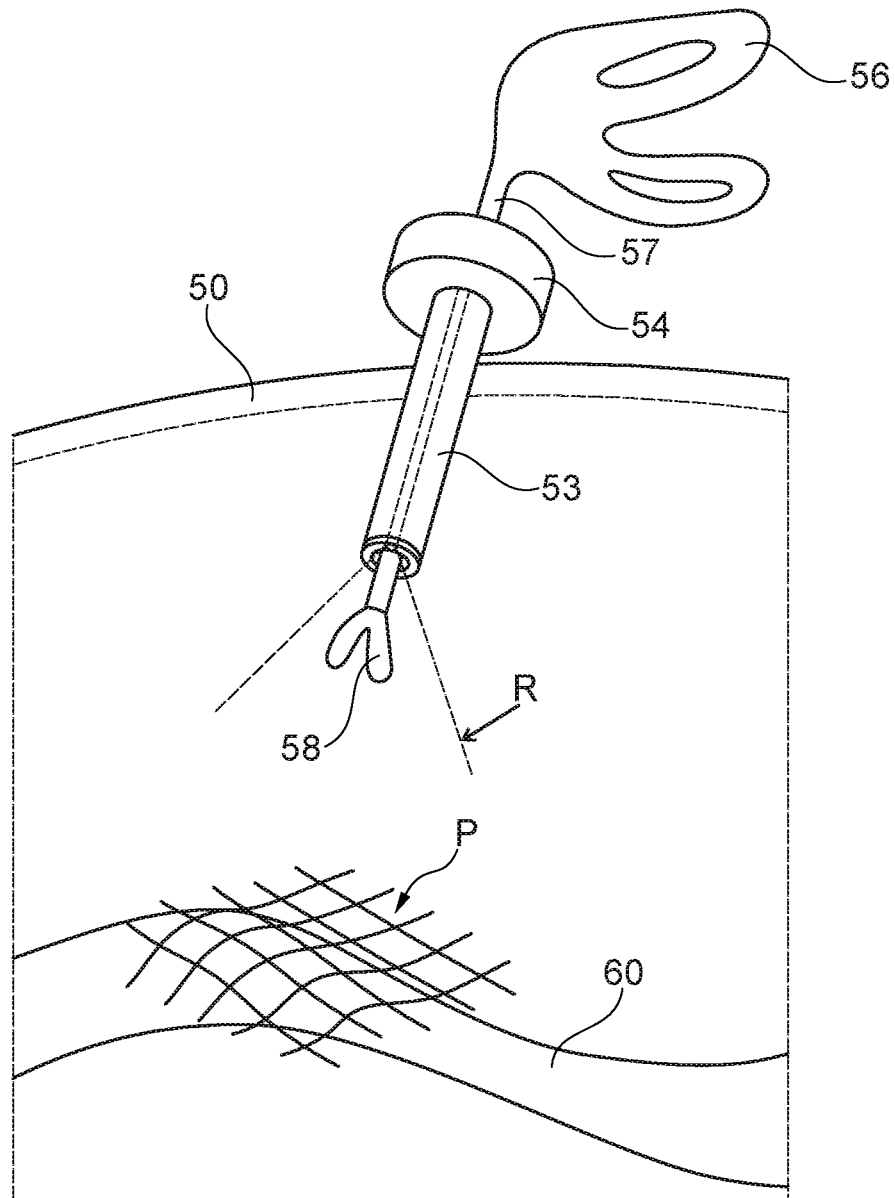


Fig. 7

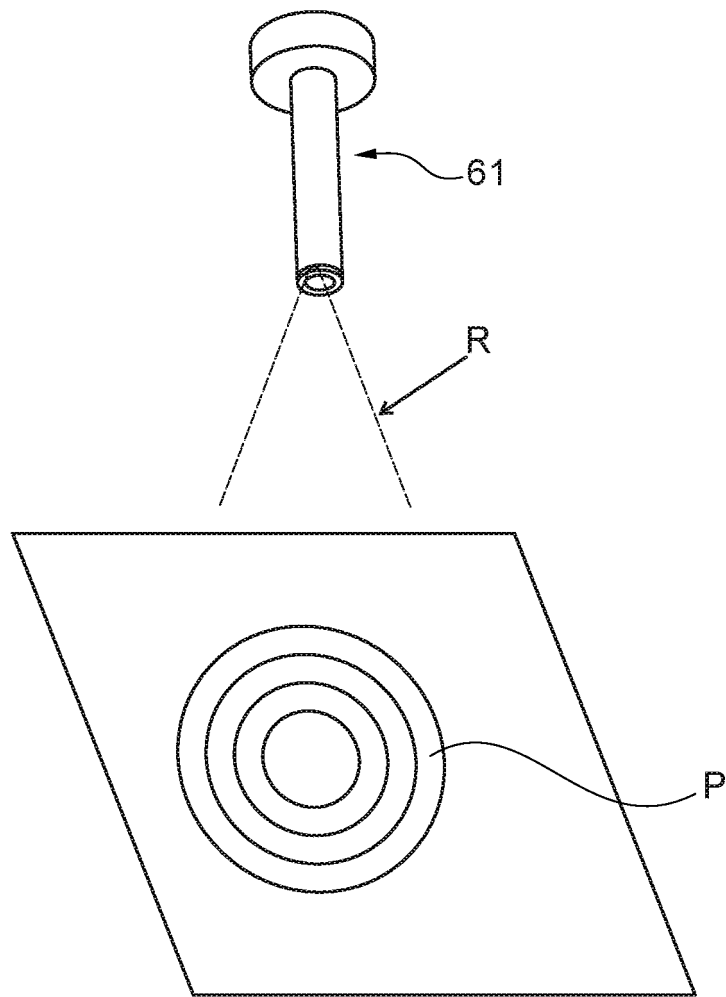


Fig. 8

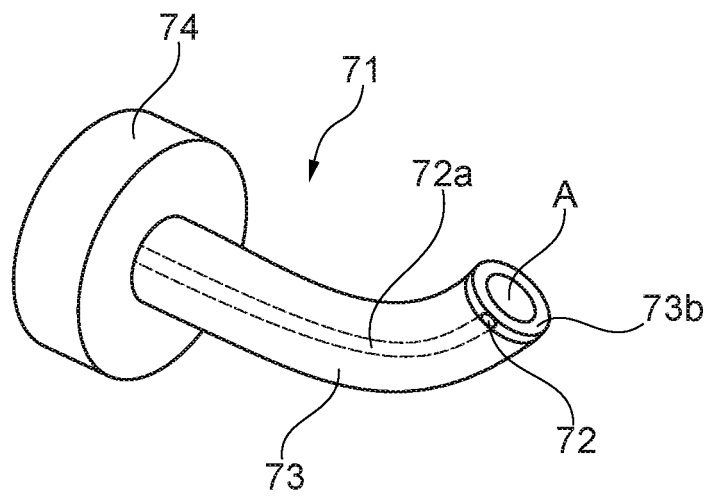


Fig. 9

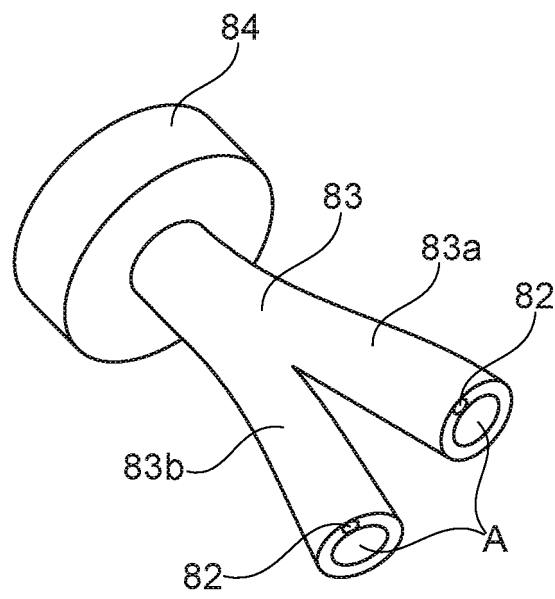


Fig. 10

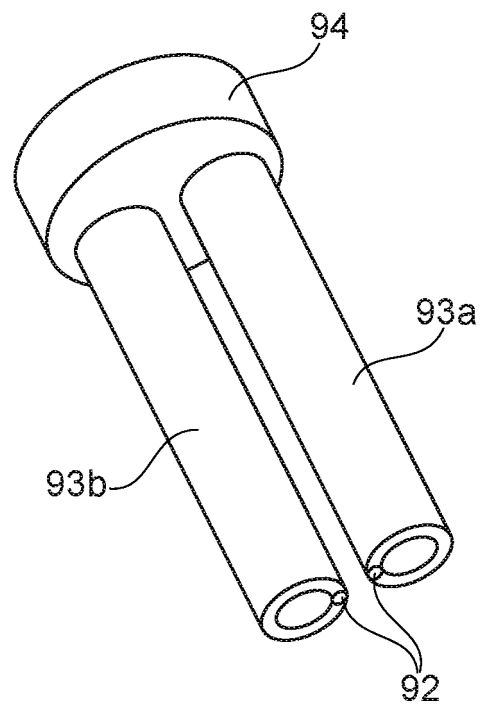


Fig. 11

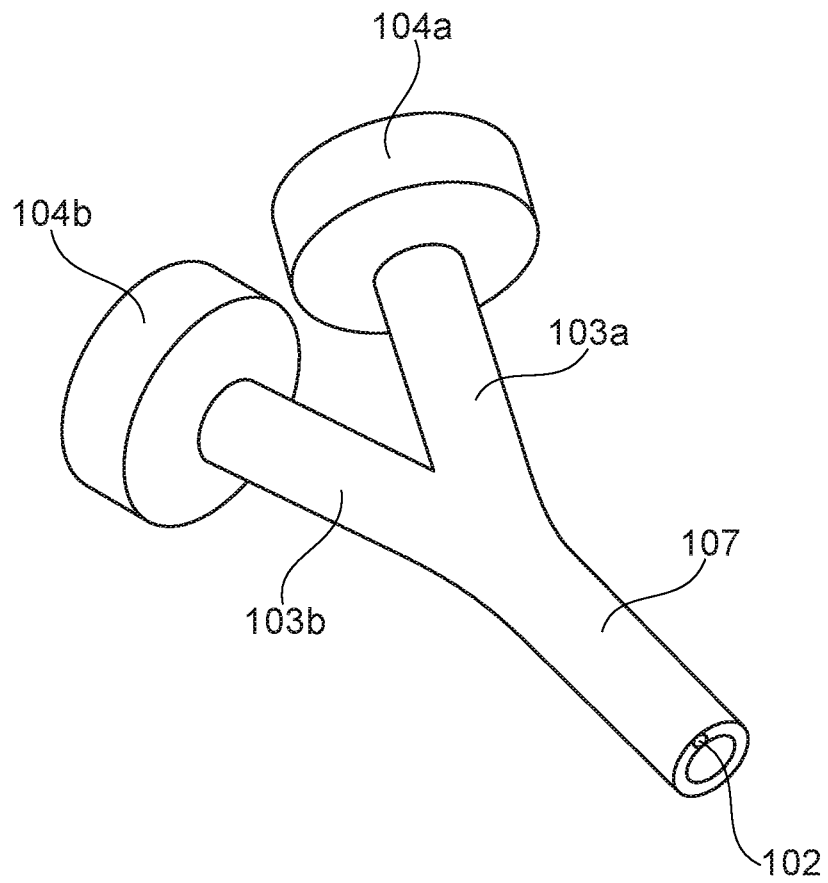


Fig. 12

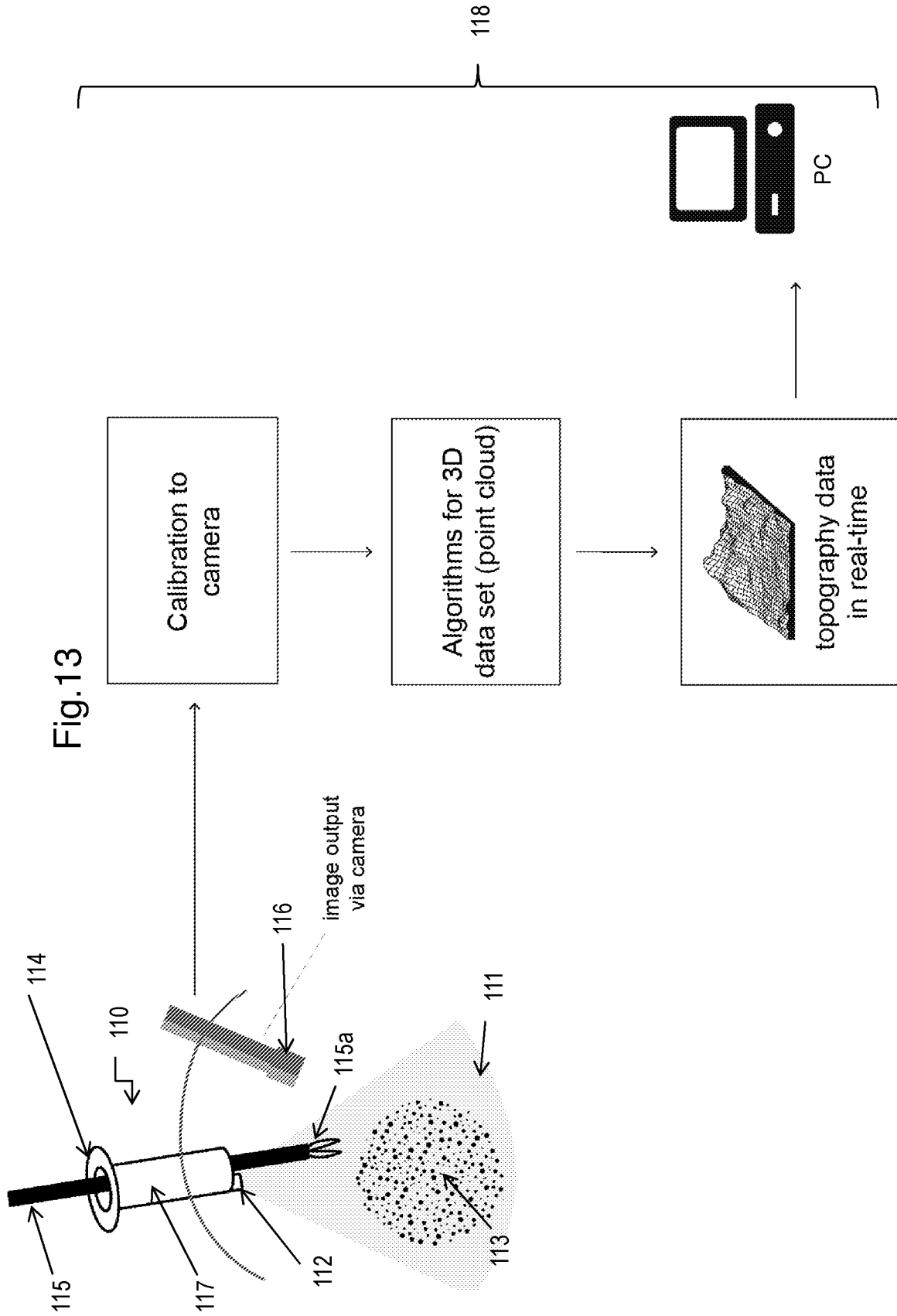


Fig.14

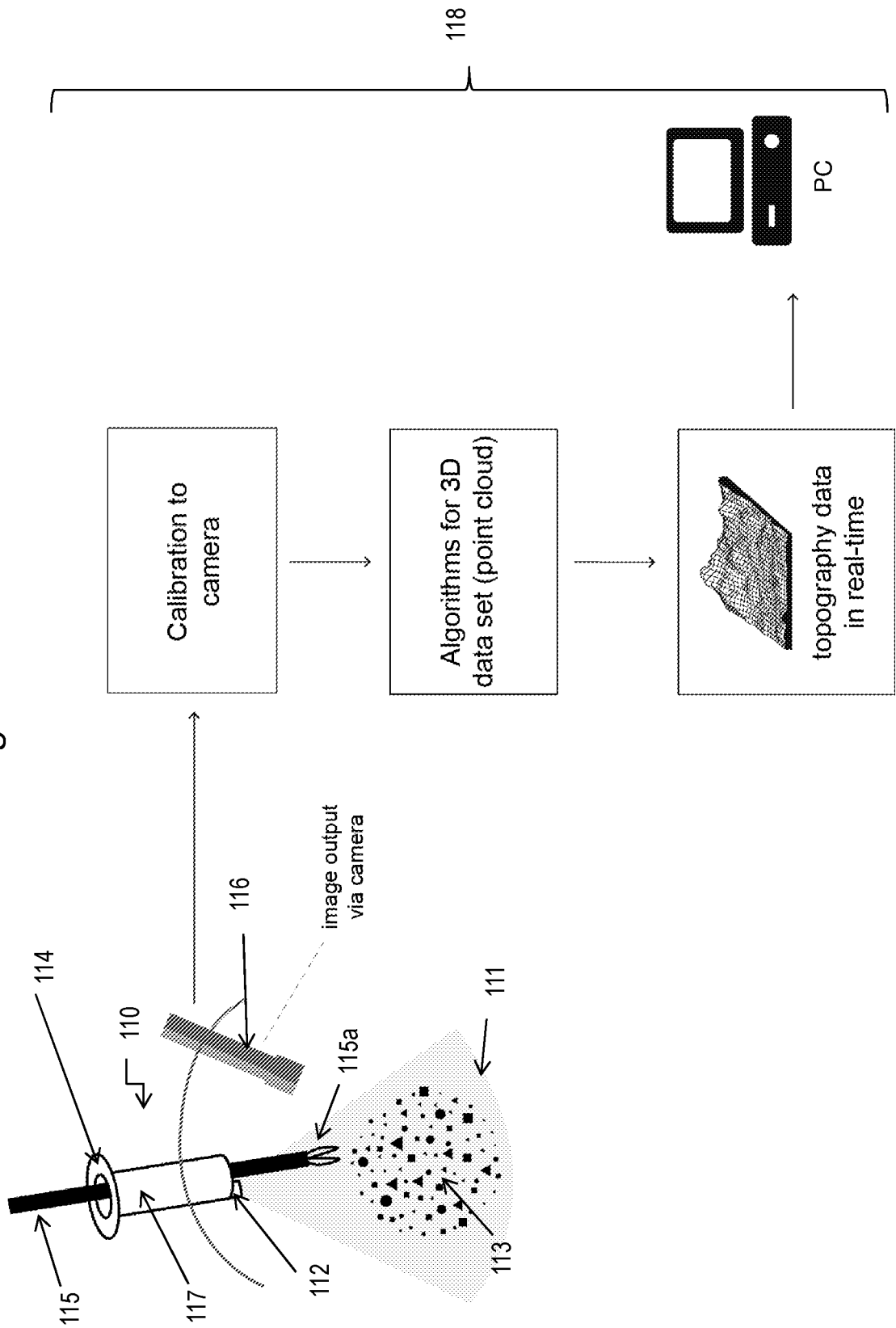


Fig.15

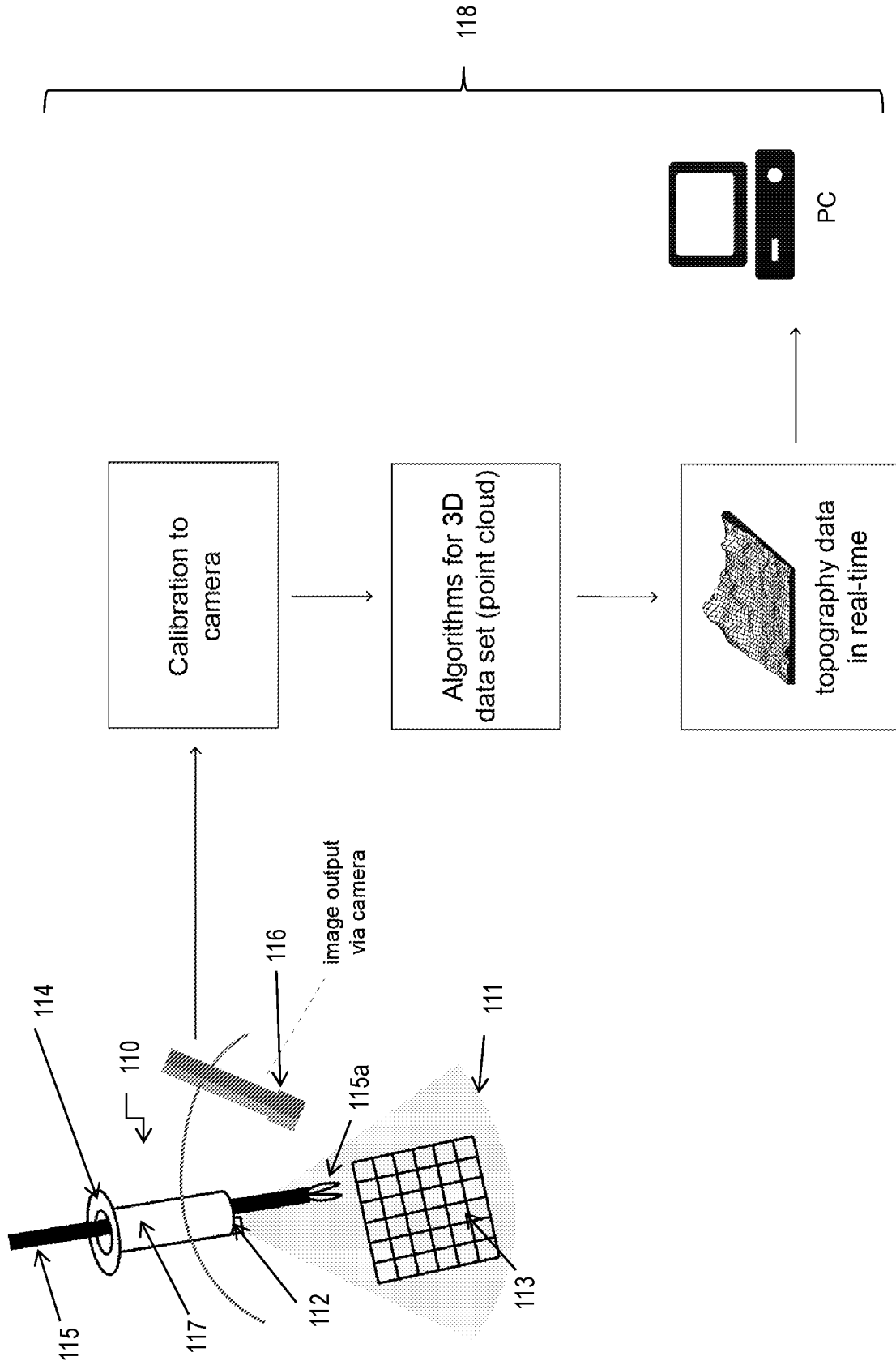
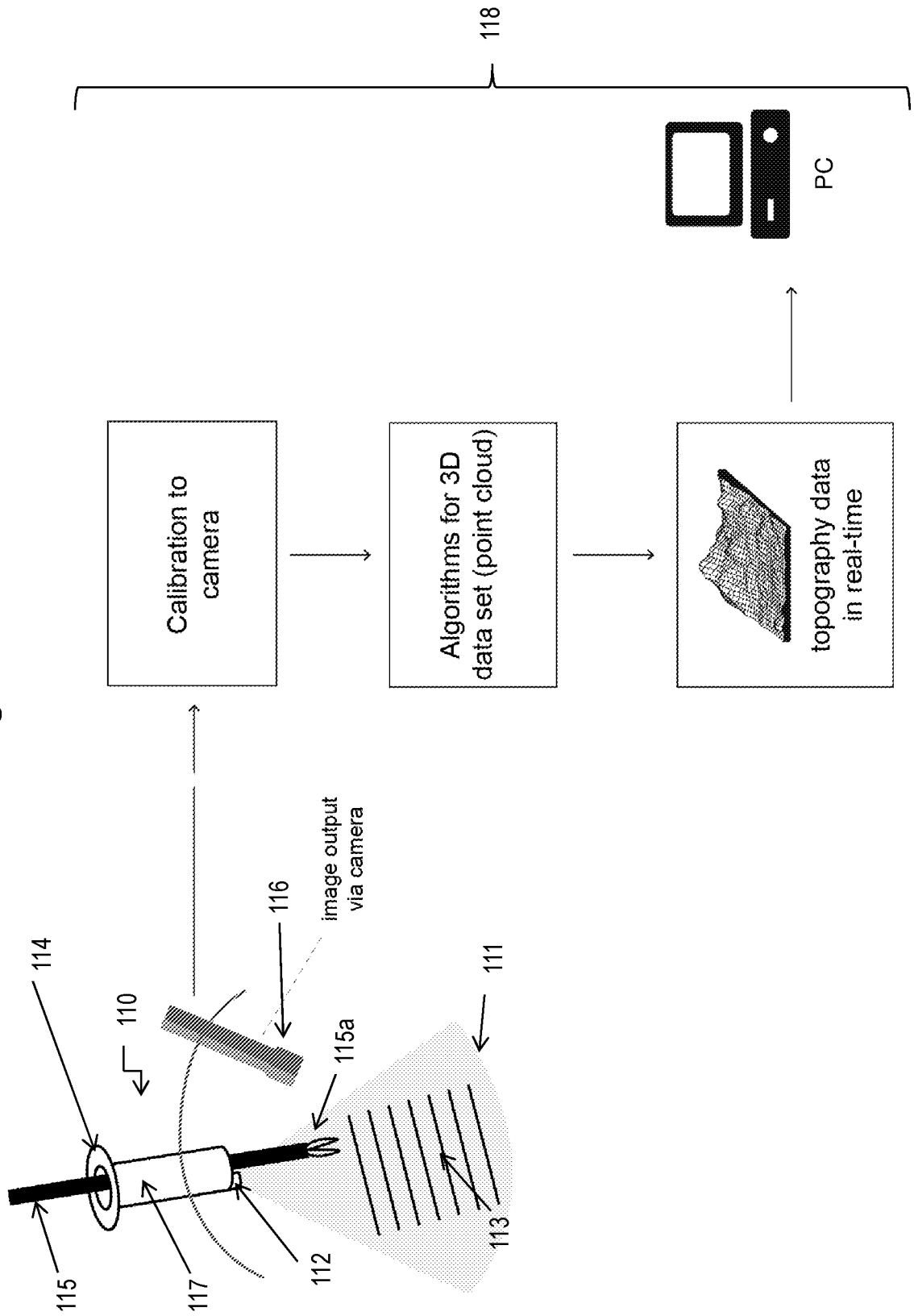


Fig.16



REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	针头套件，TROCARK套件和微创手术系统		
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申请号	EP2016781653	申请日	2016-07-01
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申请(专利权)人(译)	3DINTEGRATED APS		
当前申请(专利权)人(译)	3DINTEGRATED APS		
[标]发明人	HANSEN STEEN MLLER KIRKEGAARD HENRIETTE SCHULTZ		
发明人	HANSEN, STEEN MØLLER KIRKEGAARD, HENRIETTE SCHULTZ		
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CPC分类号	A61B1/05 A61B1/06 A61B1/313 A61B17/3421 A61B90/30 A61B90/37 A61B2017/3445 A61B2017/3447 A61B2017/3449 A61B2034/2065 A61B2034/302 A61B2090/306 A61B2090/309 A61B2090/373 A61B1/04		
优先权	201570483 2015-07-21 DK		
其他公开文献	EP3145419A4 EP3145419A1		
外部链接	Espacenet		

摘要(译)

本发明包括适用于微创手术的用于套管针的套管组装套件。套管组装套件包括套管和图案产生构件。套管具有远端和近端，并且包括在其近端处的凸缘部分和从所述凸缘部分延伸到其远端的细长套管轴部分以及通过凸缘部分和细长套管轴部分的进入端口，例如手术器械的手术工具可以通过进入端口插入。图案产生构件包括图案光源和投影仪，该投影仪布置成使得图案光源可操作地连接到投影仪以投影光图案。图案产生构件的至少投影仪被配置为至少临时固定到套管的套管轴部。

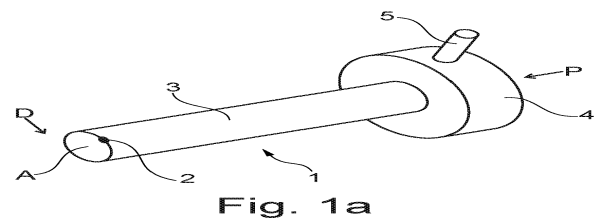


Fig. 1a

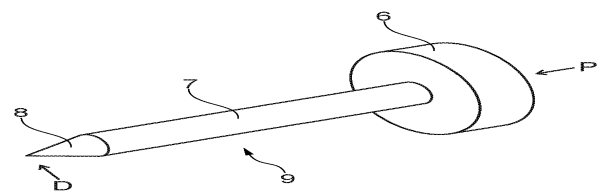


Fig. 1b