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(54) **Title:** MULTI-ELEMENT COVER FOR A MULTI-CAMERA ENDOSCOPE

(57) **Abstract:** There is provided herein a tip section of a multi-camera endoscope, the tip section comprising: a front looking camera and a front discrete illuminator to essentially illuminate the Field Of View (FOV) of said front looking camera; a right side looking camera and a right discrete illuminator to essentially illuminate the FOV of said right side looking camera; a left side looking camera and a left discrete illuminator to essentially illuminate the FOV of said left side looking camera; and a multi component cover configured to cover and seal said tip section such as to essentially prevent entry of fluids from the environment of said endoscope to inner parts of said tip section.

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**MULTI-ELEMENT COVER FOR A MULTI-CAMERA ENDOSCOPE****FIELD OF THE INVENTION**

Embodiments of the disclosure relate to a multi element cover to a tip section of a multi-camera endoscope.

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**BACKGROUND**

Endoscopes have attained great acceptance within the medical community, since they provide a means for performing procedures with minimal patient trauma, while enabling the physician to view the internal anatomy of the patient. Over the years, numerous endoscopes have been developed and categorized according to specific applications, such as cystoscopy, colonoscopy, laparoscopy, upper GI endoscopy and others. Endoscopes may be inserted into the body's natural orifices or through an incision in the skin.

An endoscope is usually an elongated tubular shaft, rigid or flexible, having a video camera or a fiber optic lens assembly at its distal end. The shaft is connected to a handle, which sometimes includes an ocular for direct viewing. Viewing is also usually possible via an external screen. Various surgical tools may be inserted through a working channel in the endoscope for performing different surgical procedures.

Endoscopes, such as colonoscopes, that are currently being used, typically have a front camera for viewing the internal organ, such as the colon, an illuminator, a fluid injector for cleaning the camera lens and sometimes also the illuminator and a working channel for insertion of surgical tools, for example, for removing polyps found in the colon. Often, endoscopes also have fluid injectors ("jet") for cleaning a body cavity, such as the colon, into which they are inserted. The illuminators commonly used are fiber optics which transmit light, generated remotely, to the endoscope tip section. The use of light-emitting diodes (LEDs) for illumination is also known.

Among the disadvantages of such endoscopes, are their limited field of view and their complicated packing of all the required elements, such as electronics and

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fiber optics together with fluid carrying elements in the small sized endoscope tip section. Other problem of the existing endoscopes is the difficult assembling of the gentle electronic components, which are often damaged by the assembling process itself. Another problem of the existing endoscopes is the complicated sealing of the parts, specifically in the tip section of the endoscope. Sealing of the tip section remains a challenge particularly due to the complex environment in which the endoscope is intended to operate.

There is thus a need in the art for endoscopes, such as colonoscopes, that allow a broader field of view and also enable the efficient packing, assembling and sealing of all necessary elements in the tip section, while maintaining their function.

The foregoing examples of the related art and limitations related therewith are intended to be illustrative and not exclusive. Other limitations of the related art will become apparent to those of skill in the art upon a reading of the specification and a study of the figures.

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## SUMMARY

The following embodiments and aspects thereof are described and illustrated in conjunction with systems, tools and methods which are meant to be exemplary and illustrative, not limiting in scope.

According to some embodiments, there is provided a tip section of a multi-camera endoscope, the tip section comprising: a front-pointing camera and a discrete front illuminator associated therewith; one or more side-pointing cameras and one or more discrete side illuminators associated therewith; and a multi component cover configured to cover the inner parts of the tip section.

According to some embodiments, there is provided a tip section of a multi-camera endoscope, the tip section comprising: a front looking camera and a front discrete illuminator to essentially illuminate the Field Of View (FOV) of the front looking camera; a right side looking camera and a right discrete illuminator to essentially illuminate the FOV of the right side looking camera; a left side looking camera and a left discrete illuminator to essentially illuminate the FOV of the left side

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looking camera; and a multi component cover configured to cover and seal the tip section such as to essentially prevent entry of fluids from the environment of the endoscope to inner parts of the tip section.

According to some embodiments, the multi component cover comprises: a  
5 front-side component configured to cover a front part and a side part of the tip section; and a side component configured to cover another side part of the tip section, wherein the front-side component and the side component are configured to abut to cover the tip section. The front-side component may be configured to cover the front part and a right side part of the tip section and wherein the side component  
10 is configured to cover a left side part of the tip section. The front-side component may be configured to cover the front part and a left side part of the tip section and wherein the side component is configured to cover a right side part of the tip section.

According to some embodiments, the multi component cover comprises: a  
15 front component configured to cover a front part; a right side component configured to cover a right side part of the tip section; and a left side component configured to cover a left side part of the tip section; wherein the front, right side and left side components are configured to abut to cover the tip section.

According to some embodiments, the multi component cover comprises: a  
20 main component configured to cover the majority of the tip section; and a removable window component configured to cover a window opening located on the main component, wherein the removable window component is configured to allow access to an inner part of the tip section without removing the main component.

According to some embodiments, the multi component cover comprises: a  
25 distal component configured to cover a distal part of the tip section; and a proximal component configured to cover a proximal part of the tip section, wherein the distal component and the proximal component are configured to abut to cover the tip section. According to some embodiments, the distal component may have a shape of a cylinder having a side wall and a front face, the front face is configured to cover a front part of the tip section and the proximal component has a shape of a cylinder  
30 having a side wall. According to some embodiments, the distal component may be configured for assembling over an inner part of the tip section from a distal part of

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the tip section and wherein the proximal component is configured for assembling over the inner part of the tip section from a proximal part of the tip section, such that the distal component and the proximal component are configured to join each other along a connection line, (which may be essentially perpendicular to the length of the tip section, for example, along an imaginary line extended between the two side cameras), such that the assembling does not cause damage to the a right/left side looking cameras or optical assemblies thereof.

The multi component cover further comprises optical windows for one or more of: the front discrete illuminator, the right discrete illuminator, and the left discrete illuminator.

The multi component cover may further comprise openings for one or more of: the front looking camera and/or an optical assembly thereof, the right side looking camera and/or an optical assembly thereof, and the left side looking camera and/or an optical assembly thereof.

The multi component cover may further comprise a fluid channeling component adapted to channel fluid for insufflations and/or irrigation. The fluid channeling component may be a unitary component comprising a front fluid channel leading to a front opening at a distal end of the unitary fluid channeling component, for cleaning one or more front optical elements of the tip section, and a side fluid channel leading to a left side opening and to a right side opening in the unitary fluid channeling component, for cleaning side optical elements of the tip section. The unitary fluid channeling component further comprises a working channel adapted for the insertion of a medical tool. The unitary fluid channeling component further comprises a jet fluid channel adapted to clean a body cavity into which the endoscope is inserted.

According to some embodiments, the multi component cover may further include openings for one or more of: a front I/I injector and/or a nozzle thereof, a side I/I injector and/or a nozzle thereof, a jet fluid channel, and a working channel.

According to some embodiments, the front looking camera, the front discrete illuminator, the right side looking camera, the right discrete illuminator, the left side

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looking camera, and the left discrete illuminator are configured to be installed on a single electronic circuit board.

According to some embodiments, the tip section has a diameter of about 17 mm or less. According to some embodiments, the tip section has a diameter of about 12 mm or less. According to some embodiments, the tip section has a diameter of about 10 mm or less. According to some embodiments, the tip section has a diameter of about 7 mm or less.

According to some embodiments, there is provided a method for assembling a multi component cover on a tip section of a multi-camera endoscope, the method comprising: installing one or more optical windows on a first part of a multi component cover; installing the first part of an inner part of a tip section; installing one or more optical windows on a second part of the multi component cover; and installing the second part of the inner part of the tip section.

According to some embodiments, the first part of the multi component cover comprises: a front-side component configured to cover a front part and a side part of the tip section; and the second part of the multi component cover comprises: a side component configured to cover another side part of the tip section, wherein the front-side component and the side component are configured to abut to cover the tip section. The front-side component may be configured to cover the front part and a right side part of the tip section and wherein the side component is configured to cover a left side part of the tip section. The front-side component may be configured to cover the front part and a left side part of the tip section and wherein the side component is configured to cover a right side part of the tip section.

According to some embodiments, the first part of the multi component cover comprises a front component configured to cover a front part; wherein the second part of the multi component cover comprises a right side component configured to cover a right side part of the tip section; wherein the a third part of the multi component cover comprises a left side component configured to cover a left side part of the tip section; and wherein the front, right side and left side components are configured to abut to cover the tip section.

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According to some embodiments, the first part of the multi component cover comprises a main component configured to cover the majority of the tip section; and wherein the second part of the multi component cover comprises a removable window component configured to cover a window opening located on the main component, wherein the removable window component is configured to allow access to an inner part of the tip section without removing the main component.

According to some embodiments, the first part of the multi component cover comprises a distal component configured to cover a distal part of the tip section; and wherein the second part of the multi component cover comprises a proximal component configured to cover a proximal part of the tip section, wherein the distal component and the proximal component are configured to abut to cover the tip section. The distal component may have a shape of a cylinder having a side wall and a front face, the front face is configured to cover a front part of the tip section and the proximal component has a shape of a cylinder having a side wall.

According to some embodiments, any one of the parts (components) of the multi component cover may include a cannal/cavity, for example, along one or more edges of the part (component), on an external and/or internal part of the part (component). The cannal/cavity may be configured to contain one or more adhesives, such as glue, for connecting the parts (components) to each other and thus allowing better sealing of the tip cover.

According to some embodiments, there is provided herein an endoscope comprising the tip section as described herein. According to some embodiments, there is provided herein a colonoscope comprising the tip section as described herein.

According to some embodiments, there is provided herein a multi-camera endoscope, such as a colonoscope, comprising the tip section disclosed herein. According to some embodiments, the tip section of an endoscope (such a colonoscope) is the most distal part of the endoscope which terminates the endoscope. The tip section is turnable by way of a bending section connected thereto.

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More details and features of the current invention and its embodiments may be found in the description and the attached drawings.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, suitable methods and materials are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

## BRIEF DESCRIPTION OF THE FIGURES

Exemplary embodiments are illustrated in referenced figures. Dimensions of components and features shown in the figures are generally chosen for convenience and clarity of presentation and are not necessarily shown to scale. It is intended that the embodiments and figures disclosed herein are to be considered illustrative rather than restrictive. The figures are listed below:

Figure 1a schematically depicts an isometric view of a tip section of an endoscope (including an electronic circuit board carrying cameras and illumination sources, and fluid channeling component), having a multi component tip cover (shown in an exploded view), according to an exemplary embodiment of the current invention;

Figure 1b schematically depicts an isometric view of the tip section of Fig 1a, having an assembled multi component tip cover, according to some exemplary embodiment of the current invention;

Figure 2 schematically depicts an isometric view of a tip section of an endoscope (including an electronic circuit board carrying cameras and illumination sources, and a fluid channeling component), having a multi component tip cover (shown in an exploded view), according to an exemplary embodiment of the current invention;

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Figure 3 schematically depicts an exploded view of a multi component tip cover, according to an exemplary embodiment of the current invention;

Figure 4a schematically depicts an isometric view of a tip section of an endoscope (including an electronic circuit board carrying cameras and illumination sources, and a fluid channeling component), having a multi component tip cover (shown in an exploded view), according to an exemplary embodiment of the current invention;

Figure 4b schematically depicts an isometric view of the tip section of Fig. 4a, having a multi component tip cover (partially in an exploded view), according to an exemplary embodiment of the current invention; and

Figure 4c schematically depicts an isometric view of the tip section of Figs. 4a-b having an assembled multi component tip cover, according to an exemplary embodiment of the current invention.

### DETAILED DESCRIPTION

While a number of exemplary aspects and embodiments have been discussed above, those of skill in the art will recognize certain modifications, permutations, additions and sub-combinations thereof. It is therefore intended that the following appended claims and claims hereafter introduced be interpreted to include all such modifications, permutations, additions and sub-combinations as are within their true spirit and scope.

In the description and claims of the application, each of the words “comprise” “include” and “have”, and forms thereof, are not necessarily limited to members in a list with which the words may be associated.

Reference is now made to Fig. 1a, which schematically depicts an isometric view of a tip section of an endoscope (including an electronic circuit board carrying cameras and illumination sources, and a fluid channeling component), having a multi component tip cover (shown in an exploded view), according to an exemplary embodiment of the current invention and to Fig. 1b, which schematically depicts an

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isometric view of the tip section of Fig 1a, having an assembled multi component tip cover, according to some exemplary embodiment of the current invention.

Tip section 100 generally includes an inner part 110 which includes electronics (such as cameras, circuit board such as electronic circuit board 400, illumination sources, such as LEDs etc.), fluid channels (such as fluid channeling component 600) and a multi-element tip cover 700. Multi-element tip cover 700 is designed to fit over the inner parts of the tip section 100, and to provide protection to the internal components in the inner part. Multi-element tip cover 700 includes, according to this embodiment, three parts: a front component 710 configured to cover a front part of the tip section; a right side component 730 configured to cover a right side part of the tip section; and a left side component 750 configured to cover a left side part of the tip section, wherein the front, right side and left side components are configured to abut each other to cover the tip section, in such way that they cover essentially all inner parts of the tip section.

Front component 710 includes hole 736 configured to align with (and accommodate) front optical assembly 236 of forwards looking camera 116; optical windows 242a, 242b and 242c of LEDs 240a, 240b and 240c; distal opening 340 of a working channel (not shown); distal opening 344 of a jet fluid channel 644; and irrigation and insufflation (I/I) injector 346 having a nozzle 348 (aligning with opening 664 of fluid channeling component 600).

Left side component 750 includes hole 756b configured to align with (and accommodate) side optical assembly 256b of side looking cameras 220b; optical windows 252a and 252b of LEDs 250a and 250b on both sides of optical assembly 256b; side I/I injector 266b adapted to align with side I/I opening 666b of fluid component 600. Also seen in Figs. 1a and b are nozzles 267a and b for side I/I injectors 266a (not shown) and 266b.

Right side component 730 includes similar elements as left side component 720 (not shown).

Left side component 750 and right side component 730 are each in a shape of essentially half a cylinder (without top and bottom).

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Front component 710 has essentially a cup shape having two opposing arms 712 and 714 extending perpendicularly to the cup bottom (which may also be referred to as the cup's front face) and protruding from the cup edges. Upon assembling of the tip cover components, front component 710 may be installed first, and then the side components such that their long edges meet each other on both sides over arms 712 and 714 to assure sealing (Fig. 1b). Adhesives, such as glue, may be added, for example, in cavities 716 (along the external parts of the edges of component 710), 718 (along the internal edges of component 730) and 720 (along the internal edges of component 750) to allow complete sealing of tip section 100.

Multi-element tip covers according to embodiments of the invention, such as multi-element tip cover 700 or any other multi-element tip cover as disclosed herein, solves a significant problem that exists in the art when attempts are made to pack all necessary components into the small inner volume of an endoscope tip and to cover and seal these components. Regular cup shaped tip covers are used for standard tips having just one front camera. However, when standard cup shaped tip covers are used to cover the multi-camera tip, protruding inner tip elements, such as lenses or other parts of the side optical assemblies, are often damaged during the sliding of the cover over them. Using a multi-element tip cover may solve this problem. In addition, a multi-element tip cover assists in aiming its holes/openings/windows exactly at their right place over the corresponding tip inner elements. This is almost impossible using a unitary piece cover. Moreover, separately sealing each one of the elements of the multi-element tip cover improves the overall sealing of the tip due to better access to each element (for example an optical window) compared to the limited access of the same element in a unitary piece cover, such as a cup shaped cover. Separately sealing (and optionally checking for satisfactory sealing) of each one of the elements of the multi-element tip cover may be performed prior to assembling of the cover. This may also improve the sealing of the tip.

According to an embodiment of the current invention, tip section 100 of an endoscope comprises at least a forwards looking camera and at least one side looking camera. Tip section 100 is turnable by way of flexible shaft (not shown) which may also be referred to as a bending section, for example a vertebra mechanism).

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In some embodiments, the front-looking camera and/or any of the side-looking cameras comprises a Charge Coupled Device (CCD) or a Complementary Metal Oxide Semiconductor (CMOS) image sensor.

5 It is noted that the term "endoscope" as mentioned to herein may refer particularly to a colonoscope, according to some embodiments, but is not limited only to colonoscopes. The term "endoscope" may refer to any instrument used to examine the interior of a hollow organ or cavity of the body.

10 Tip section 100 may include front optical assembly 236 of forwards looking camera 116. Optical axis of forwards looking camera 116 is substantially directed along the long dimension of the endoscope. However, since forward looking camera 116 is typically a wide angle camera, its Field Of View (FOV) may include viewing directions at large angles to its optical axis. It should be noted that number of illumination sources such as LEDs used for illumination of the FOV may vary (for example, 1-5 LEDs may be used on a front face of tip section 100). Distal opening 15 340 of a working channel (not shown) is also located on the front face of tip section 100, such that a surgical tool inserted through working channel tube, and through the working channel in the endoscope's tip section 100 and deployed beyond the front face may be viewed by forwards looking camera 116.

20 Distal opening 344 of a jet fluid channel is also located on the front face of tip section 100. Distal opening 344 of a jet fluid channel may be used for providing high pressure jet of fluid such as water or saline for cleaning the walls of the body cavity.

25 Also located on the front face of tip section 100 is an irrigation and insufflation (I/I) injector 346 having a nozzle 348 aimed at front optical assembly 236. I/I injector 346 may be used for injecting fluid (liquid and/or gas) to wash contaminants such as blood, feces and other debris from front optical assembly 236 of forwards looking camera. Optionally the same injector is used for cleaning front optical assembly 236 and one two or all of optical windows 242a, 242b and 242c. I/I injector 346 may be fed by fluid such as water and/or gas which may be used for cleaning and/or inflating a body cavity.

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Visible on a left side of tip section 100 is the side camera (side looking camera) element 256b of side looking camera 220b and optical windows 252a and 252b of LEDs 250a and 250b for camera 220b. A second side looking camera 220a, is not shown in Fig.1a but can be similar to camera 220b. Optical axis of side looking camera 220a is substantially directed perpendicular to the long dimension of the endoscope. Optical axis of side looking camera 220b is substantially directed perpendicular to the long dimension of the endoscope. However, since side looking cameras 220a and 220b is typically a wide angle camera, its field of view may include viewing directions at large angles to its optical axis.

Side I/I injector 266b having a nozzle 267b aimed at side optical assembly 256b may be used for injecting fluid to wash contaminants such as blood, feces and other debris from side optical assembly 256b of side looking camera. The fluid may include gas which may be used for inflating a body cavity. Optionally the same injector is used for cleaning both side optical assembly 256b and optical windows 252a and/or 252b. It is noted that according to some embodiments, the tip may include more than one window and LEDs, on the side and more than one window and LEDs in the front (for example, 1-5 windows and two LEDs on the side). Similar configuration of I/I injector and nozzle exists for cleaning optical assembly 256a and optical windows 252a' and 252b' located on the other side of tip 100 (not shown). The I/I injectors are configured to clean all or a part of these windows/LEDs. Side I/I injectors 346 and 266 may be fed from same channel.

It is noted that the side wall 362 has a form of an essentially flat surface which assists in directing the cleaning fluid injected from side I/I injectors 266a (not shown) and 266b towards side optical assembly 256b and optical windows 252a and/or 252b. Lack of such flat surface may result in dripping of the cleaning fluid along the curved surface of tip section 100 of the endoscope without performing the desired cleaning action.

It should be noted that while only one side looking camera is seen in Figs. 1a and b, preferably at least two side looking cameras may be located within tip section 100. When two side looking cameras are used, the side looking cameras are preferably installed such that their field of views are substantially opposing.

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However, different configurations and number of side looking cameras are possible within the general scope of the current invention.

According to some embodiments, the circuit board used for carrying electronic components such as cameras and/or LEDs, may be a flexible circuit board that may consume less space and leaves more volume for additional necessary features. The flexibility of the board adds another dimension in space that can be used for components positioning.

The use of a flexible circuit board according to embodiments of the invention, can significantly increase reliability of the electric modules connection thereto as no wires are for components connectivity. In addition, according to some embodiments, the components assembly can be machined and automatic.

The use of a flexible circuit board according to embodiments of the invention, may also allow components (parts) movement and maneuverability during assembly of the camera head (tip of the endoscope) while maintaining high level of reliability. The use of the circuit board according to embodiments of the invention, may also simplify the (tip) assembling process.

According to some embodiments, a flexible circuit board may be connected to the control unit via multi wire cable; this cable may be welded on the board in a designated location freeing additional space within the tip assembly and adding flexibility to cable access. Assembling the multi wire cable directly to the electrical components was a major challenge which is mitigated by the use of the flexible board according to embodiments of the invention.

Reference is now made to Fig. 2, which schematically depicts an isometric view of a tip section of an endoscope (including an electronic circuit board carrying cameras and illumination sources, and a fluid channeling component), having a multi component tip cover (shown in an exploded view), according to an exemplary embodiment of the current invention. Tip section 200 generally includes an inner part 210 which may be similar to inner part 110 of tip section 100 of Fig. 1 a-b and a multi-element tip cover 800. Multi-element tip cover 800 is designed to fit over the inner parts of the tip section 200, and to provide protection to the internal

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components in the inner part. Multi-element tip cover 800 includes, according to this embodiment, a main component 830 configured to cover the majority of the tip section; and a removable window component 850 configured to cover a window opening 860 located on main component 830, such that removable window component 850 is configured to allow access to an inner part 210 of tip section 200 without removing main component 830. This may allow fixing or replacing one of the components of inner part 210 (such as a LED, an optical element or any other element) without removing main component 830 and damaging the packing and sealing of tip section 200.

Main component 830 has essentially a cup shape having a front face part configured to cover the front face of tip section 200 and cup edges configured to cover the side surface of tip section 200.

Main component 830 may further includes front and side holes, openings, windows and surfaces similar to those of multi-component cover 700 of Figs. 1a and b.

Reference is now made to Fig. 3, which schematically depicts an exploded view of a multi component tip cover, according to an exemplary embodiment of the current invention. Multi-element tip cover 900 is designed to fit over the inner part (not shown) of a tip section and to provide protection to the internal components in the inner part. Multi-element tip cover 900 includes, according to this embodiment, a front-side component 930 configured to cover a front part and a side part of the tip section and a side component 950 configured to cover another side part of the tip section, wherein front-side component 930 and side component 950 are configured to abut to cover the tip section.

Reference is now made to Figs. 4a-c. Fig 4a schematically depicts an isometric view of a tip section of an endoscope (including an electronic circuit board carrying cameras and illumination sources, an electronic circuit board holder, a fluid channeling component), having a multi component tip cover (shown in an exploded view), according to an exemplary embodiment of the current invention. Figure 4b schematically depicts an isometric view of the tip section of Fig. 4a, having a multi component tip cover (partially in an exploded view), according to an exemplary

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embodiment of the current invention. Figure 4c schematically depicts an isometric view of the tip section of Figs. 4a-b having a multi component tip cover, according to an exemplary embodiment of the current invention.

Tip section 1000 generally includes an inner part 1100 which includes  
5 electronics (such as cameras, circuit board, LEDs etc.), fluid channels (such as fluid channeling component 1600) and a multi-element tip cover 1010. Multi-element tip cover 1010 is designed to fit over the inner parts of the tip section 1000, and to provide protection to the internal components in the inner part. Multi-element tip cover 1010 includes, according to this embodiment, two parts: a distal component  
10 1050 configured to cover a distal part of the tip section and a proximal component 1030 configured to cover a proximal part of the tip section, wherein the distal component and the proximal component are configured to abut to cover the tip section. Distal component 1050 has a shape of a cylinder having a side wall 1052 and a front face 1054, front face 1054 is configured to cover a front part 1102 of  
15 inner part 1100 of tip section 1000 and proximal component 1030 has a shape of a cylinder having a side wall 1032 without a top or a bottom configured to cover a proximal part 1104 of inner part 1100 of tip section 1000.

Distal component 1050 includes on front face 1054 thereof hole 1056  
configured to align with front optical assembly 1236 of forwards looking camera  
20 1116; optical windows 1242a, 1242b and 1242c of LEDs 1240a, 1240b and 1240c; distal opening 1340 of a working channel (not shown); distal opening 1344 of a jet fluid channel 1644; and I/I injector 1346 (aligning with opening 1664 of Fluid channeling component 1600).

Distal component 1050 further includes on side wall 1052 thereof optical  
25 windows 1252a of LED 1250a and on an opposing side of side wall 1052 another optical window of another LED (not shown).

Distal component 1050 further includes on the edge of side wall 1052 thereof  
a recess 1756' (essentially in a shape of half a hole) configured to accommodate  
(along with a recess 1756'' on the edge of side wall 1032 of proximal component  
30 1030) optical assembly 1256b of side looking cameras 1220b. On an opposing side of side wall 1052 there may be a similar recess (not shown) to accommodate (along

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with another recess on the edge of side wall 1032 of proximal component 1030) optical assembly 1256a of side looking cameras 1220a located on the other side of inner part 1100 (not shown).

5 Proximal component 1030 includes on side wall 1032 thereof optical windows 1252b of LED 1250b and on an opposing side of side wall 1032 another optical window 1252a of another LED (not shown).

10 Proximal component 1030 further includes on the edge of side wall 1032 thereof a recess 1756" (essentially in a shape of half a hole) configured to accommodate (along with recess 1756' on the edge of side wall 1052 of distal component 1050) optical assembly 1256b of side looking cameras 220b. On an opposing side of side wall 1032 there is a similar recess 1756a" to accommodate (along with another recess on the edge of side wall 1032 of proximal component 1050) optical assembly 1256a of side looking cameras 1220a located on the other side of inner part 1100 (not shown).

15 Proximal component 1030 further includes side I/I injector 1266b adapted to align with side I/I opening 1666b.

Other parts of inner part 1100 of tip section 1000 may generally be similar to inner part 1100 of tip section 100 of Fig. 1 a-b.

20 The method of assembling tip section 1000 over inner part 1100 may include assembling distal component 1050 from the distal part of tip section 1000, assembling proximal component 1030 from the proximal part of tip section 1000 and joining distal component 1050 and proximal component 1030 along their edges (line 1500) such that none of the tip cover components slides over the optical assemblies of the side looking cameras.

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

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

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**CLAIMS****What we claim is:**

1. A tip section of a multi-camera endoscope, the tip section comprising:

5 a front looking camera and a front discrete illuminator to essentially illuminate the Field Of View (FOV) of said front looking camera;

a right side looking camera and a right discrete illuminator to essentially illuminate the FOV of said right side looking camera;

a left side looking camera and a left discrete illuminator to essentially illuminate the FOV of said left side looking camera; and

10 a multi component cover configured to cover and seal said tip section such as to essentially prevent entry of fluids from the environment of said endoscope to inner parts of said tip section.

2. The tip section of claim 1, wherein said multi component cover comprises:

15 a front-side component configured to cover a front part and a side part of said tip section; and

a side component configured to cover another side part of said tip section, wherein said front-side component and said side component are configured to abut to cover said tip section.

3. The tip section of claim 2, wherein said front-side component is configured  
20 to cover said front part and a right side part of said tip section and wherein said side component is configured to cover a left side part of said tip section.

4. The tip section of claim 2, wherein said front-side component is configured  
25 to cover said front part and a left side part of said tip section and wherein said side component is configured to cover a right side part of said tip section.

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5. The tip section of claim 1, wherein said multi component cover comprises:

a front component configured to cover a front part;

a right side component configured to cover a right side part of said tip section; and

5 a left side component configured to cover a left side part of said tip section,

wherein said front, right side and left side components are configured to abut to cover said tip section.

6. The tip section of claim 1, wherein said multi component cover comprises:

10 a main component configured to cover the majority of said tip section; and

a removable window component configured to cover a window opening located on said main component, wherein said removable window component is configured to allow access to an inner part of said tip section without removing said main component.

15

7. The tip section of claim 1, wherein said multi component cover comprises:

a distal component configured to cover a distal part of said tip section; and

a proximal component configured to cover a proximal part of said tip section, wherein said distal component and said proximal component are configured to abut to cover said tip section.

20

8. The tip section of claim 7, wherein said distal component has a shape of a cylinder having a side wall and a front face, said front face is configured to cover a front part of said tip section and said proximal component has a shape of a cylinder having a side wall.

25

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- 5 9. The tip section of claim 7, wherein said distal component is configured for assembling over an inner part of said tip section from a distal part of said tip section and wherein said proximal component is configured for assembling over said inner part of said tip section from a proximal part of said tip section, such that said distal component and said proximal component are configured to join each other along a connection line, such that the assembling does not cause damage to said a right/left side looking cameras or optical assemblies thereof.
- 10 10. The tip section of claim 1, wherein said multi component cover further comprises optical windows for one or more of:
- said front discrete illuminator;
  - said right discrete illuminator; and
  - said left discrete illuminator.
- 15 11. The tip section of claim 1, wherein said multi component cover further comprises openings for one or more of:
- said front looking camera and/or an optical assembly thereof,
  - said right side looking camera and/or an optical assembly thereof,
  - and
  - said left side looking camera and/or an optical assembly thereof.
- 20 12. The tip section of claim 1, further comprising a fluid channeling component adapted to channel fluid for insufflations and/or irrigation.
- 25 13. The tip section of claim 12, wherein said fluid channeling component is a unitary component comprising a front fluid channel leading to a front opening at a distal end of said unitary fluid channeling component, for cleaning one or more front optical elements of said tip section, and a side fluid channel leading to a left side opening and to a right side opening in

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said unitary fluid channeling component, for cleaning side optical elements of said tip section.

5 14. The tip section of claim 13, wherein said unitary fluid channeling component further comprises a working channel adapted for the insertion of a medical tool.

15. The tip section according to claim 14, wherein said unitary fluid channeling component further comprises a jet fluid channel adapted to clean a body cavity into which said endoscope is inserted.

10 16. The tip section of claim 1, wherein said multi component cover further comprises openings for one or more of:

a front I/I injector and/or a nozzle thereof;

a side I/I injector and/or a nozzle thereof;

a jet fluid channel; and

a working channel.

15 17. The tip section of claim 1, wherein said front looking camera, said front discrete illuminator, said right side looking camera, said right discrete illuminator, said left side looking camera, and said left discrete illuminator are configured to be installed on a single electronic circuit board.

18. The tip section of claim 1, having a diameter of about 17 mm or less.

20 19. The tip section according to claim 18, having a diameter of about 12 mm or less.

20. The tip section according to claim 19, having a diameter of about 10 mm or less.

25 21. A method for assembling a multi component cover on a tip section of a multi-camera endoscope, the method comprising:

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installing one or more optical windows on a first part of a multi component cover;

installing said first part of an inner part of a tip section;

installing one or more optical windows on a second part of said multi component cover; and

installing said second part of said inner part of said tip section.

22. The method of claim 21, wherein said first part of said multi component cover comprises:

a front-side component configured to cover a front part and a side part of said tip section; and said second part of said multi component cover comprises:

a side component configured to cover another side part of said tip section, wherein said front-side component and said side component are configured to abut to cover said tip section.

23. The method of claim 22, wherein said front-side component is configured to cover said front part and a right side part of said tip section and wherein said side component is configured to cover a left side part of said tip section.

24. The method of claim 22, wherein said front-side component is configured to cover said front part and a left side part of said tip section and wherein said side component is configured to cover a right side part of said tip section.

25. The method of claim 21, wherein said first part of said multi component cover comprises a front component configured to cover a front part;

wherein said second part of said multi component cover comprises a right side component configured to cover a right side part of said tip section;

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wherein said a third part of said multi component cover comprises a left side component configured to cover a left side part of said tip section; and wherein said front, right side and left side components are configured to abut to cover said tip section.

5 26. The method of claim 21, wherein said first part of said multi component cover comprises a main component configured to cover the majority of said tip section; and wherein said second part of said multi component cover comprises a removable window component configured to cover a window opening located on said main component, wherein said removable  
10 window component is configured to allow access to an inner part of said tip section without removing said main component.

15 27. The method of claim 21, wherein said first part of said multi component cover comprises a distal component configured to cover a distal part of said tip section; and wherein said second part of said multi component cover comprises a proximal component configured to cover a proximal part of said tip section, wherein said distal component and said proximal component are configured to abut to cover said tip section.

20 28. The method of claim 27, wherein said distal component has a shape of a cylinder having a side wall and a front face, said front face is configured to cover a front part of said tip section and said proximal component has a shape of a cylinder having a side wall.

29. An endoscope comprising the tip section of any one of claims 1-20.

30. A colonoscope comprising the tip section of any one of claims 1-20.



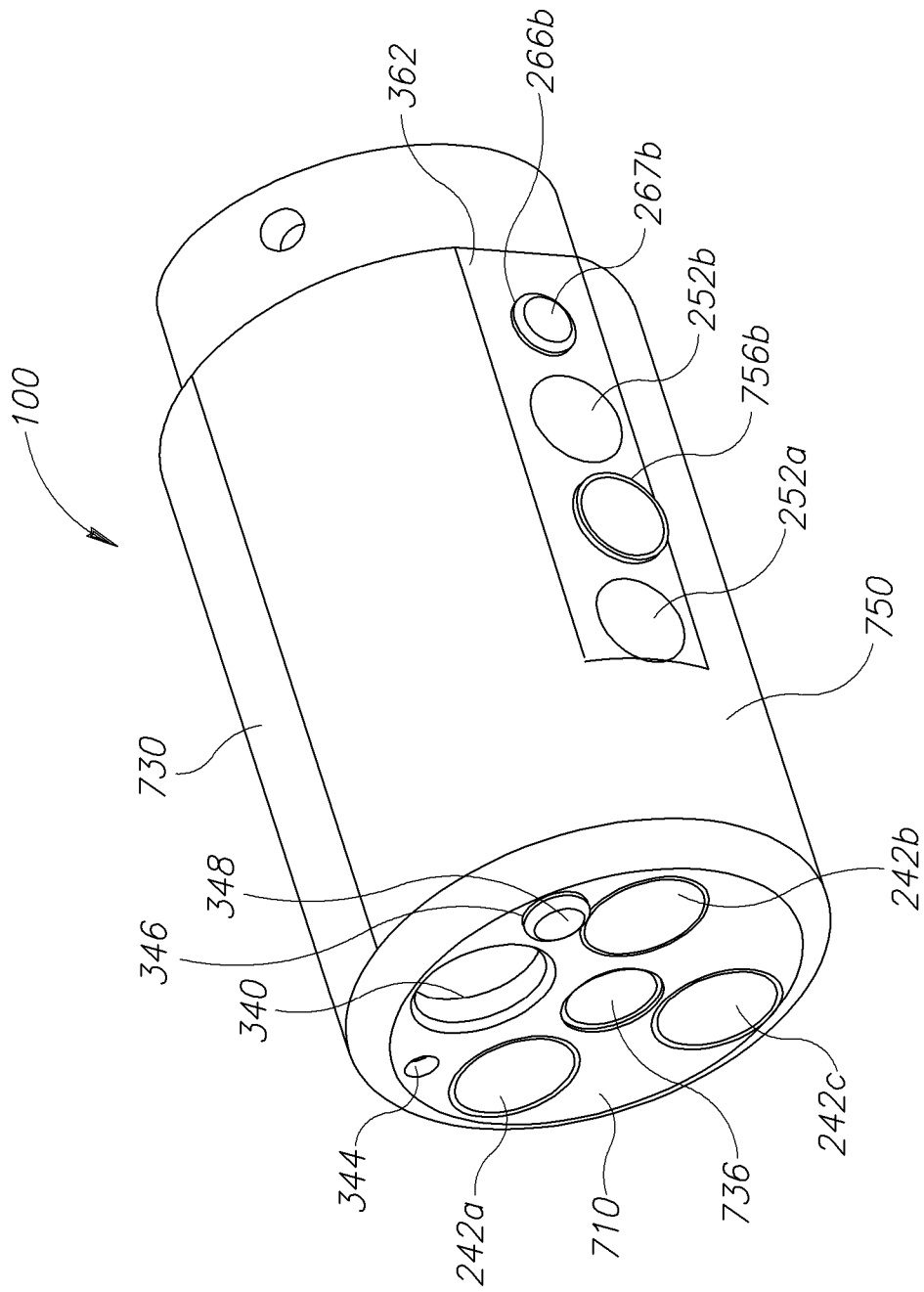


FIG. 1B

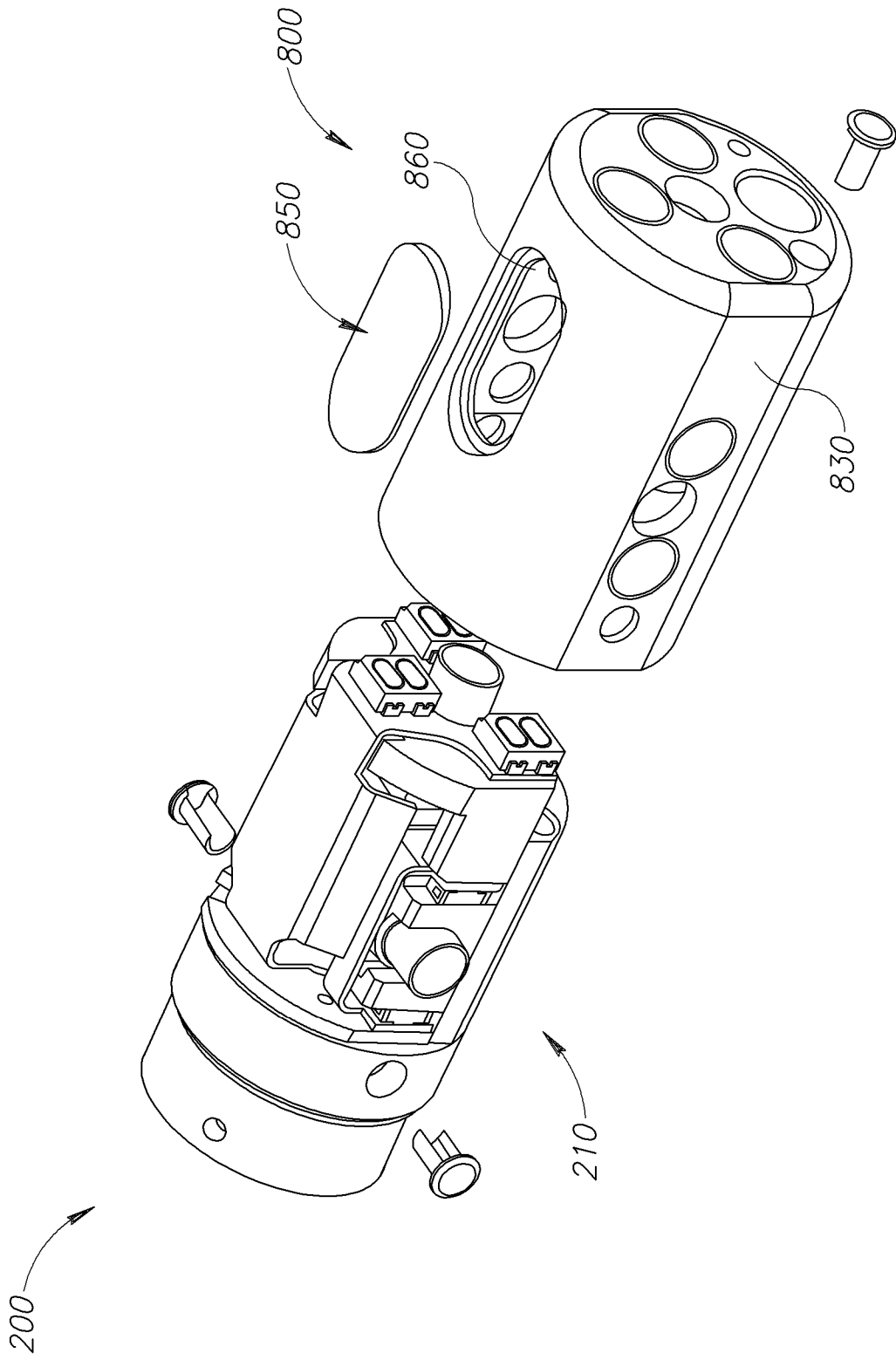


FIG.2

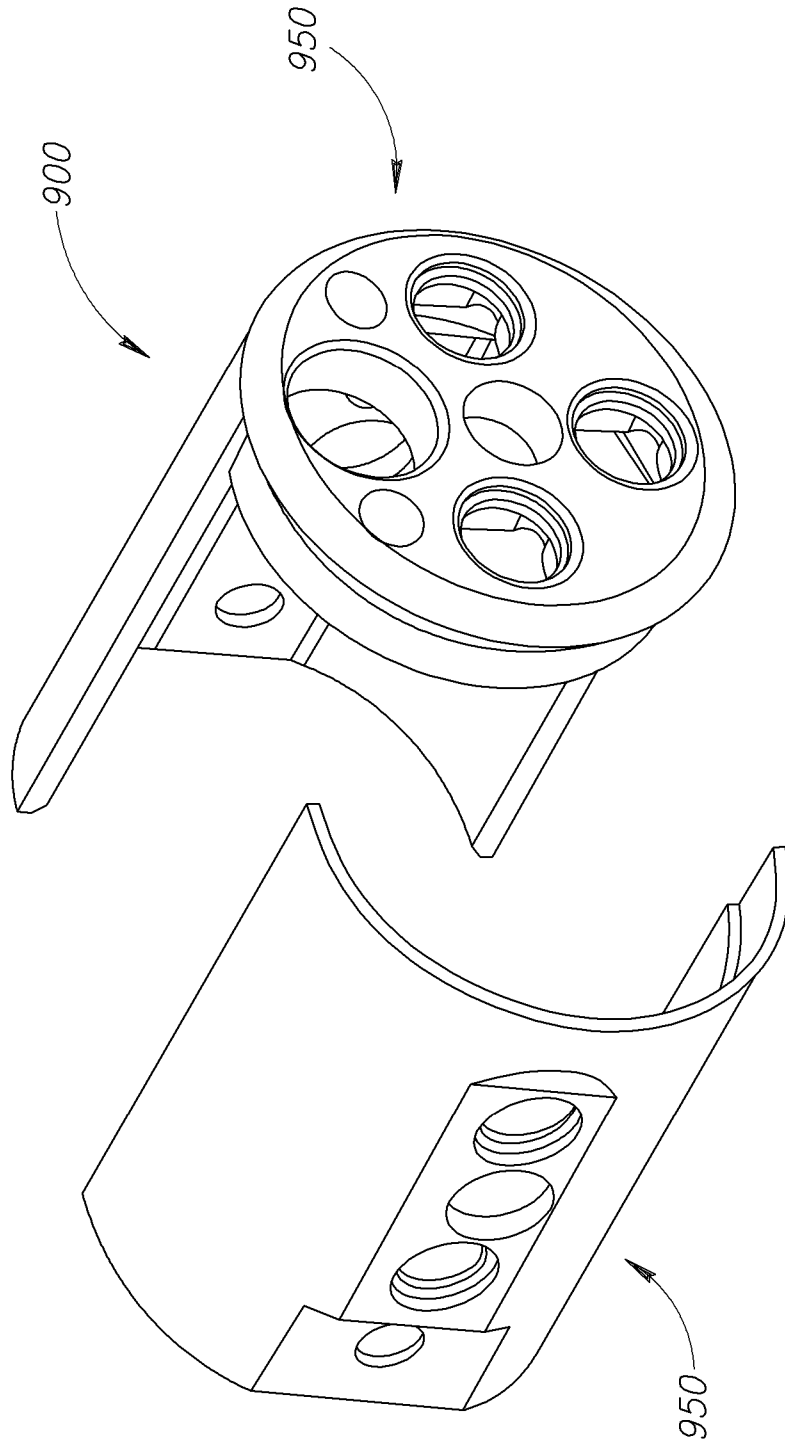


FIG. 3

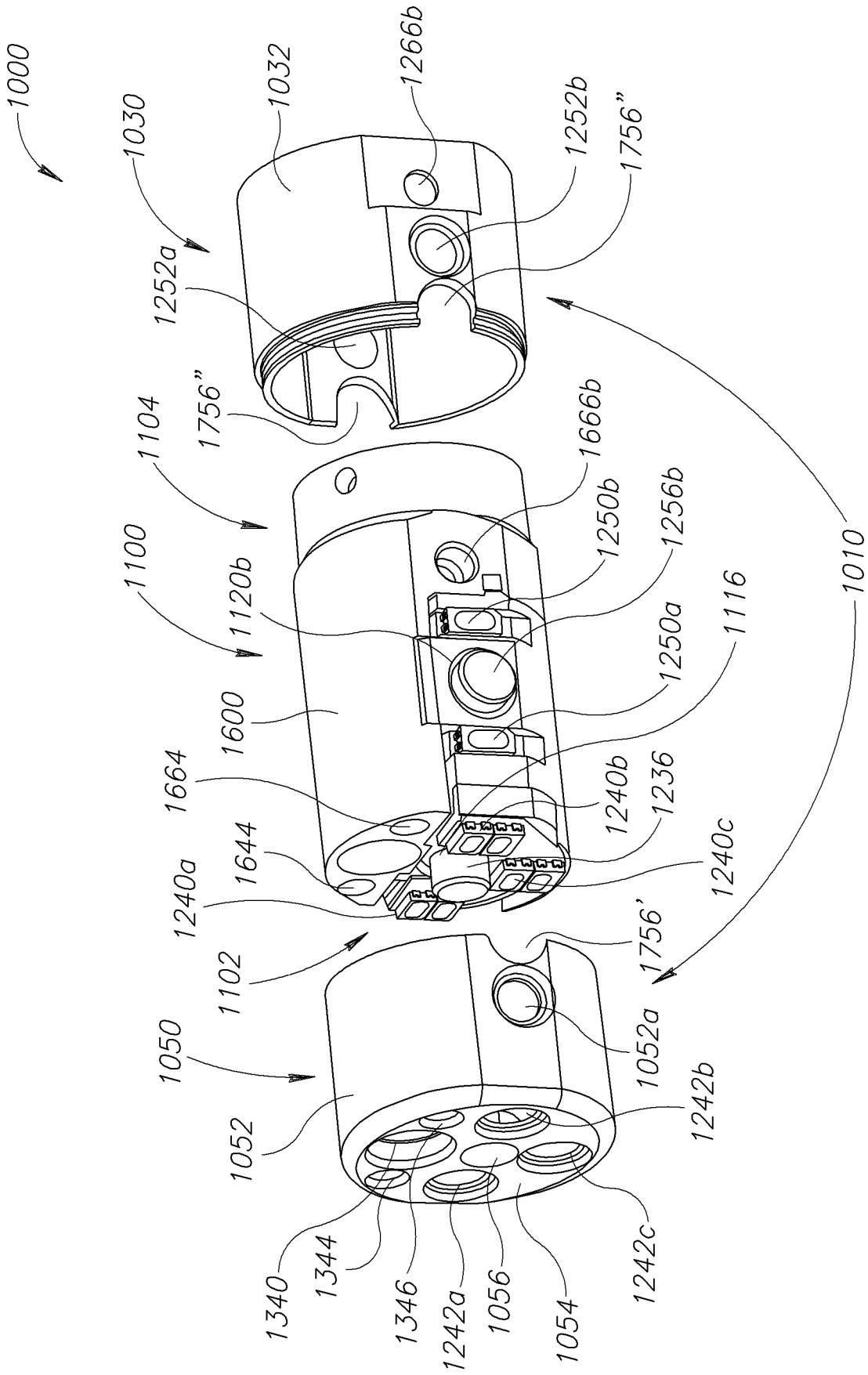


FIG. 4A



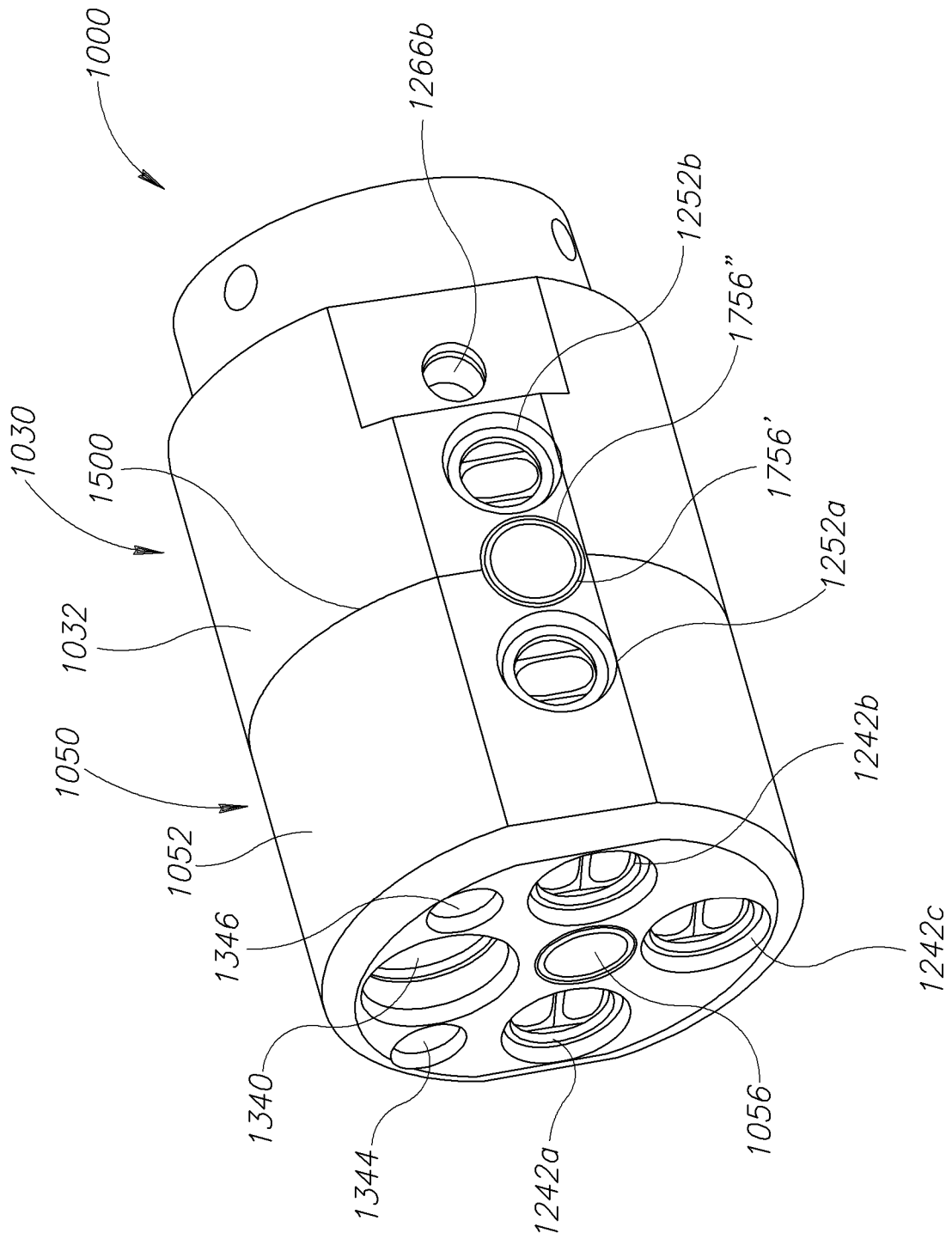


FIG. 4C

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL2012/050037

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(8) - A61B 1/05 (2012.01) USPC - 600/109 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC(8) - A61B 1/00, 1/05, 1/06, 1/12; G02B 6/06 (2012.01) USPC - 128/4, 6; 600/101, 109, 129, 158, 173; 348/65; 350/96.29 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatBase, Google Scholar		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,800,341 A (MCKENNA et al) 01 September 1998 (01.09.1998) entire document	1-30
A	US 2009/0306476 A1 (BANIK et al) 10 December 2009 (10.12.2009) entire document	1-30
A	US 4,699,463 A (D'AMELIO et al) 13 October 1987 (13.10.1987) entire document	1-30
A	US 4,846,154 A (MACANALLY et al) 11 July 1989 (11.07.1989) entire document	1-30
A	US 2004/0015049 A1 (ZAAR) 22 January 2004 (22.01.2004) entire document	1-30
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/>		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 22 May 2012		Date of mailing of the international search report <b>01 JUN 2012</b>
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201		Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774