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(54) **UTERINE MANIPULATOR INCLUDING POSITION SENSOR**

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See application file for complete search history.

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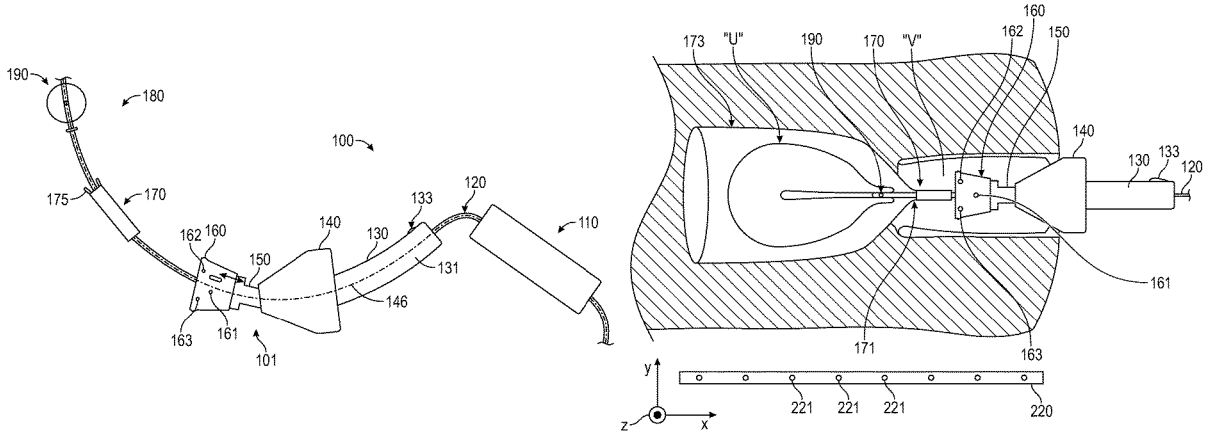
(57) **ABSTRACT**

A uterine manipulator includes a housing and a shaft extending distally from the housing. An end effector assembly is disposed at a distal end portion of the shaft. The end effector assembly includes a cervical cup and a uterine manipulating tip portion extending distally from the cervical cup. A position sensor is supported by the cervical cup. The position sensor is configured to identify a location of the cervical cup.

20 Claims, 7 Drawing Sheets



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A61B 17/00	(2006.01)
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A61B 17/42	(2006.01)
A61B 34/00	(2016.01)
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A61B 34/37	(2016.01)
A61B 90/00	(2016.01)
A61B 90/50	(2016.01)

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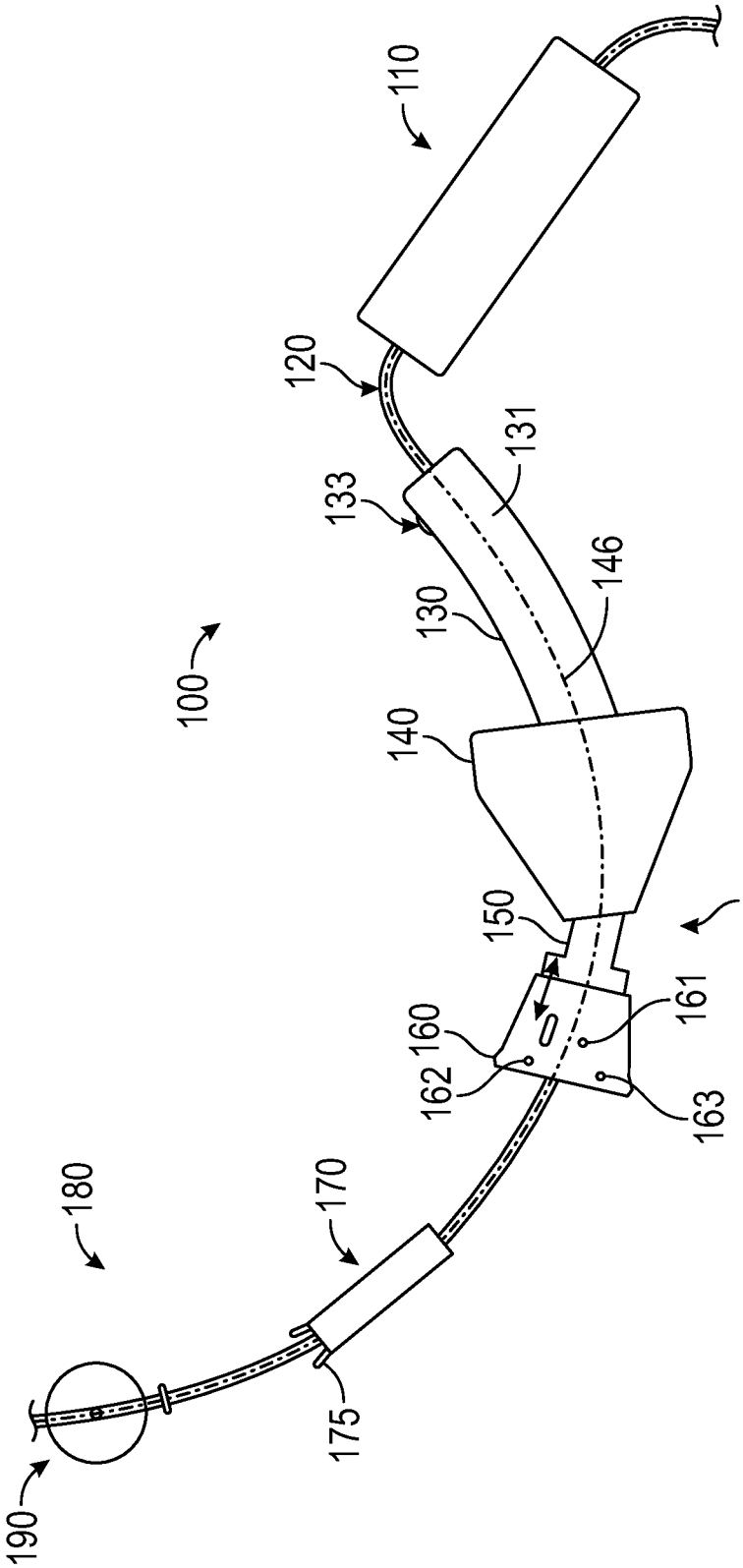
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120
131
133
146
130
100
140
150
101
161
160
162
163
180
170
175
190

FIG. 1

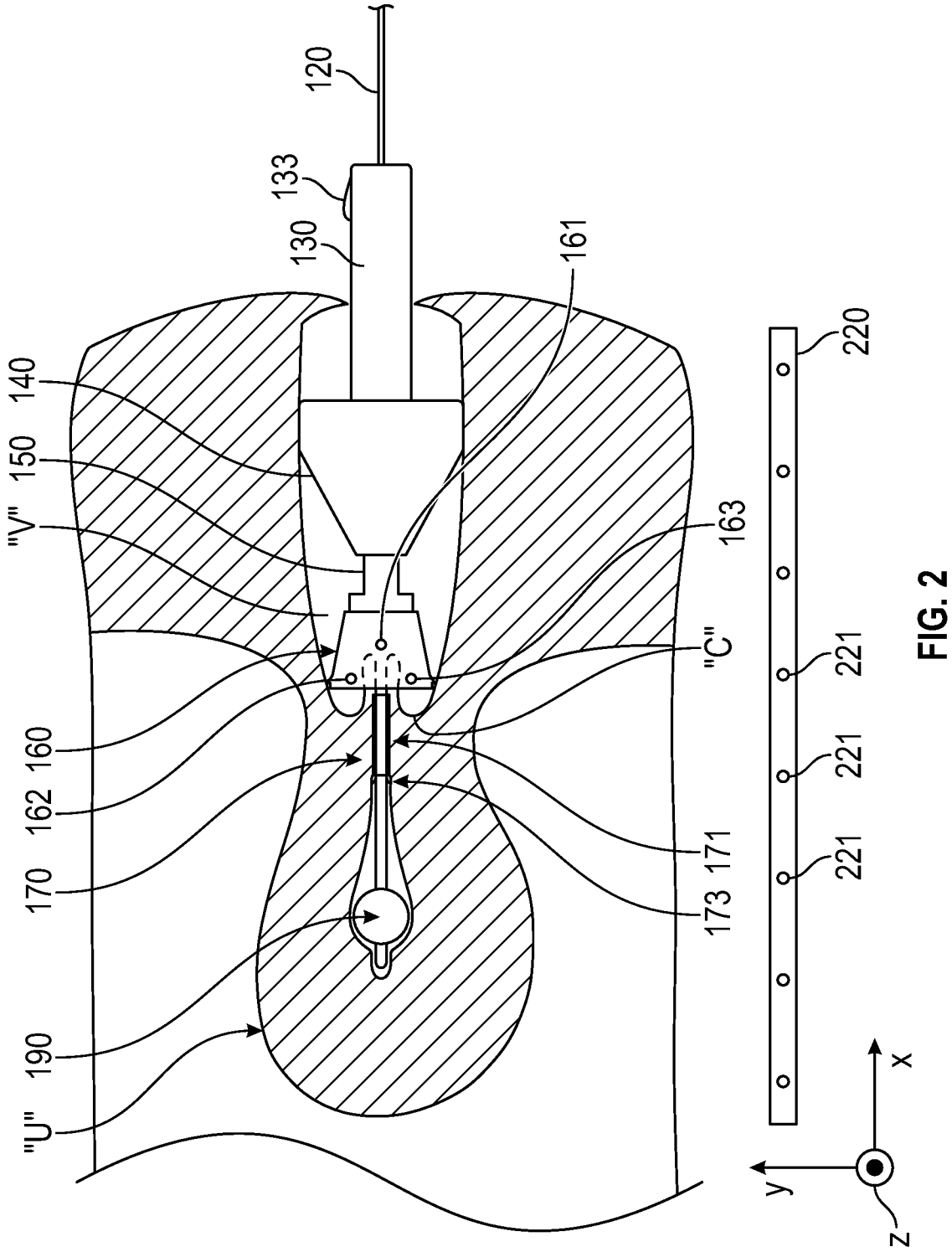
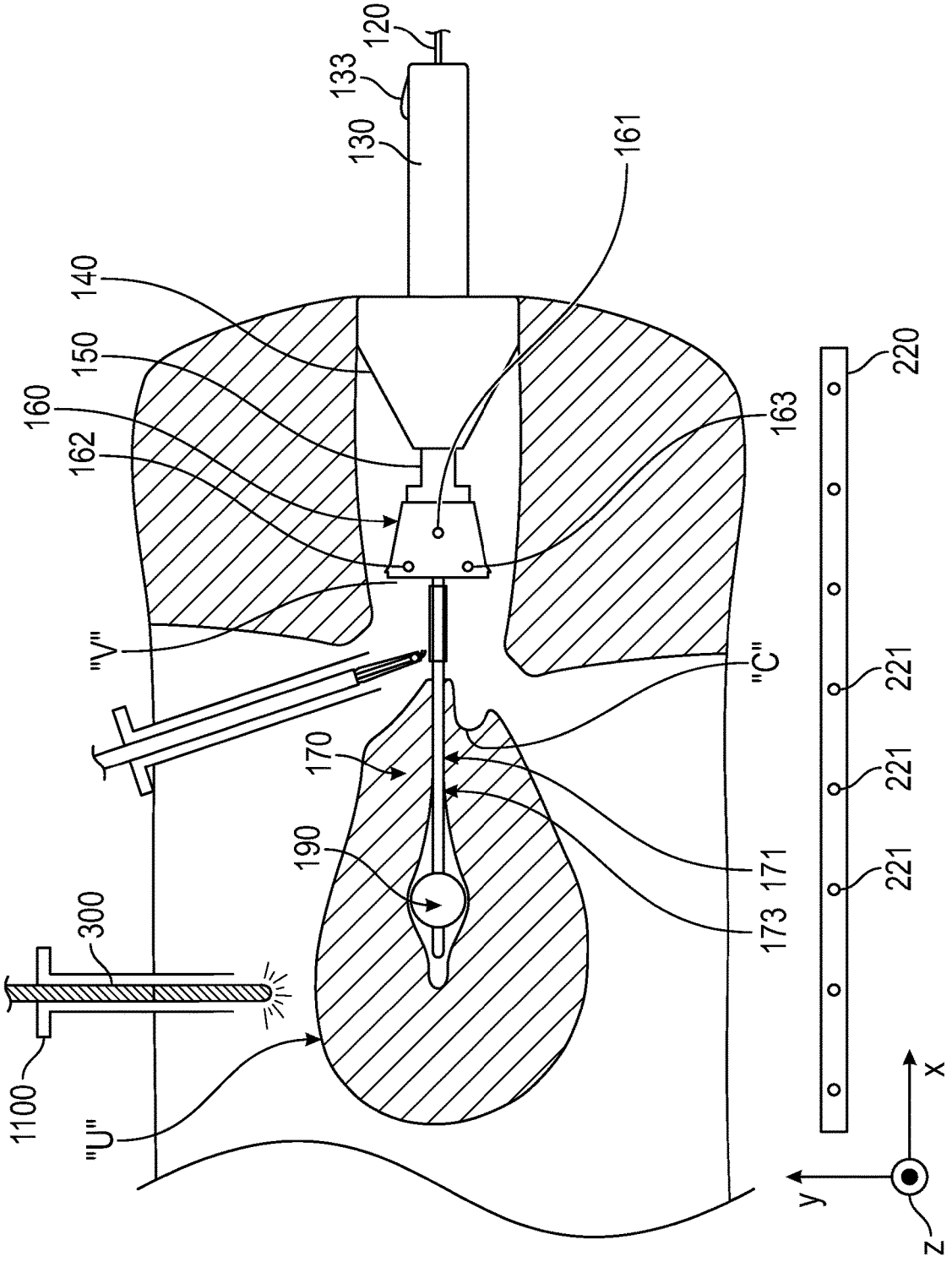

120
133
130
161
140
150
"V"
163
"C"
160
162
170
171
173
190
"U"
220
221
221
221
x
y
z

FIG. 2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133
130
161
140
150
160
162
163
220
"V"
"C"
221
221
221
170
190
171
173
300
1100
"U"
x
y
z

FIG. 3

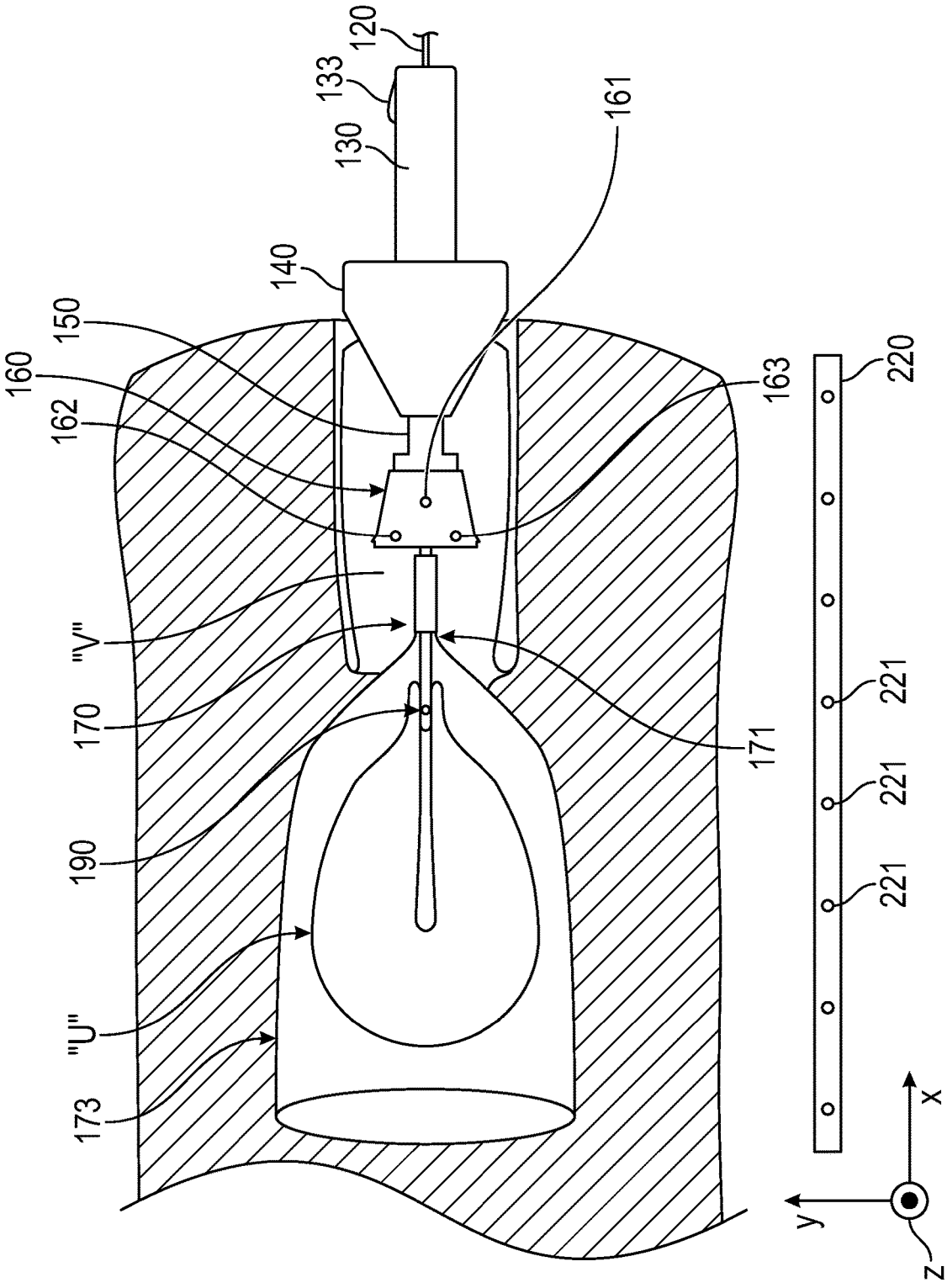
120
133
130
161
140
150
160
162
163
220
"V"
170
171
221
221
221
190
"U"
173
x
y
z

FIG. 4

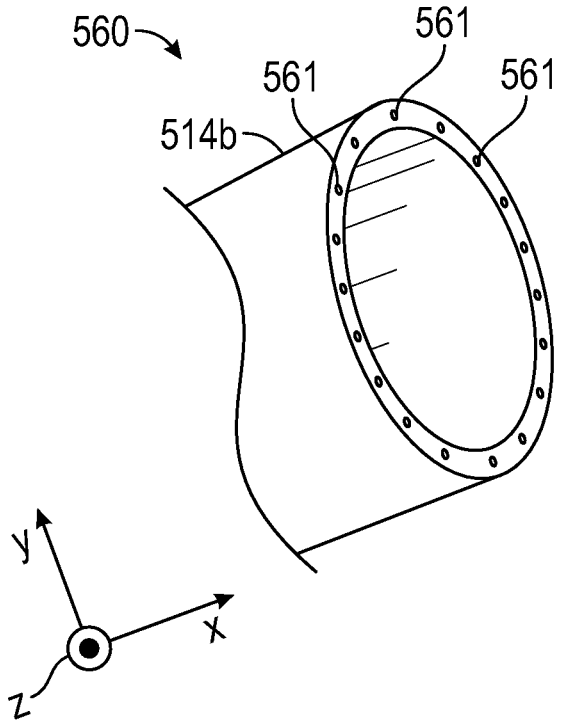

FIG. 5

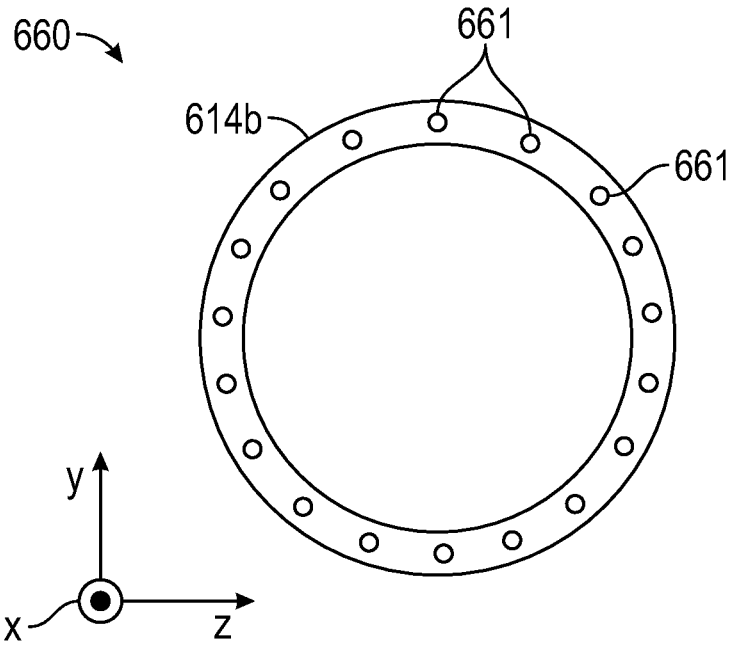

FIG. 6

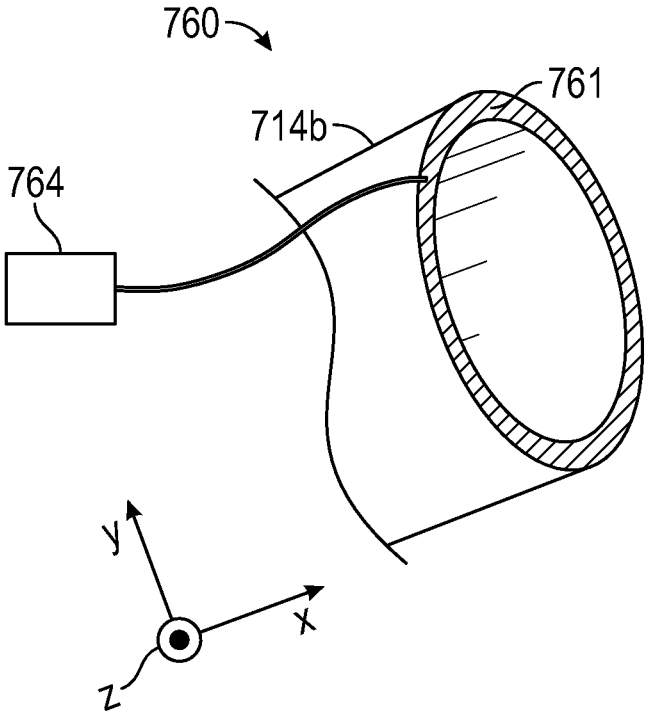

FIG. 7

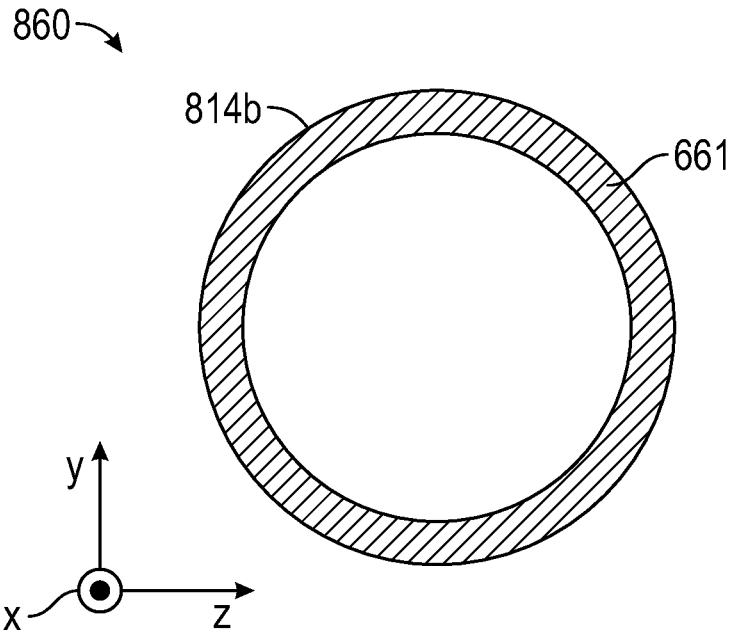

FIG. 8

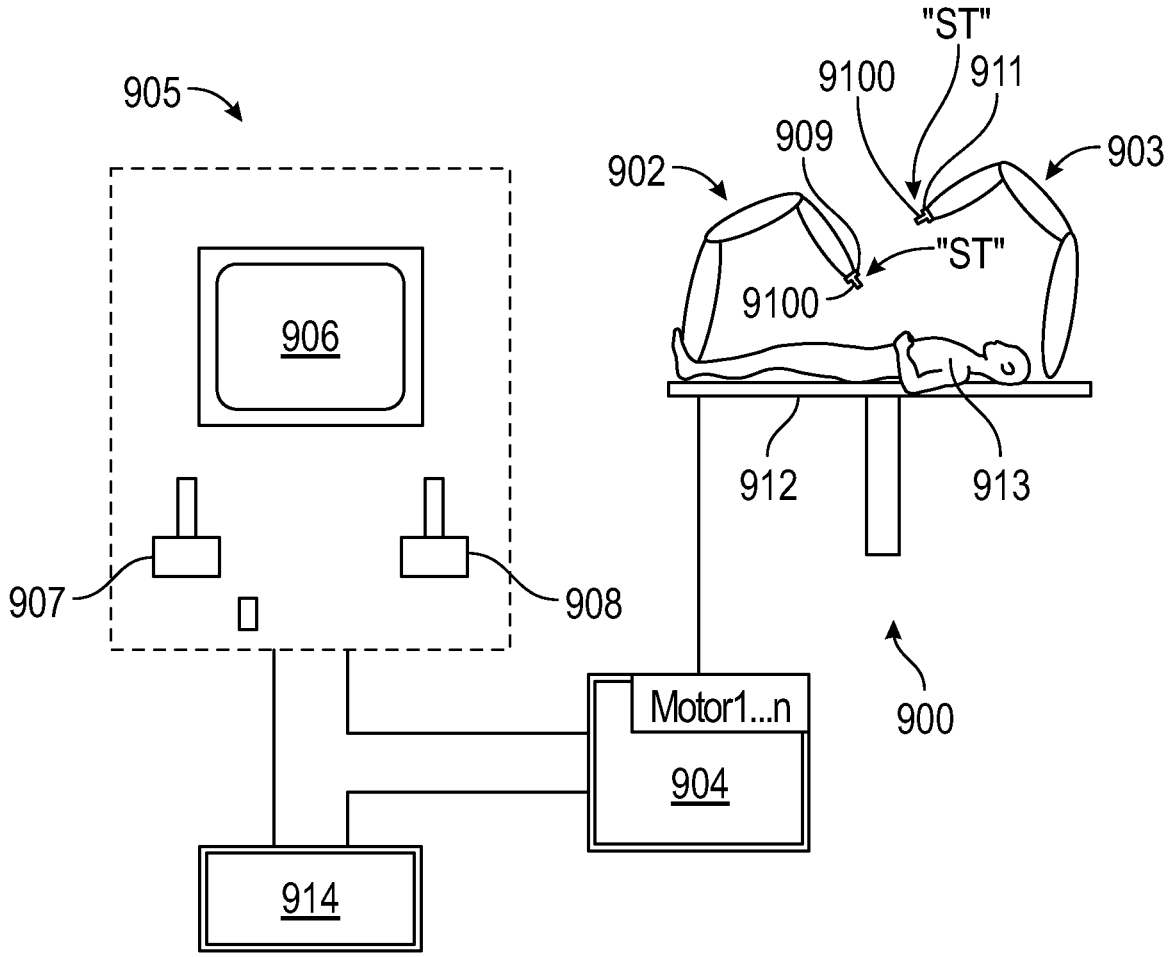
905
906
907
908
914
Motor1...n
904
900
902
903
909
9100
911
"ST"
"ST"
9100
912
913

FIG. 9

UTERINE MANIPULATOR INCLUDING POSITION SENSOR

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of and priority to U.S. Provisional Patent Application No. 62/986,021, filed on Mar. 6, 2020, the entire content of which is incorporated by reference.

FIELD

The present disclosure relates to a uterine manipulator and, more particularly, to a uterine manipulator including a position sensor.

BACKGROUND

One of the final steps in a laparoscopic hysterectomy is a colpotomy, which requires making a circular incision in vaginal tissue to separate the uterus from the vagina. This incision is typically performed with the aid of a uterine manipulator. Uterine manipulators are conventionally used to position the vagina and the cervix to enable removal of the uterus or other tissue specimens after the colpotomy. Typically, uterine manipulators include a handle and a shaft extending distally from the handle that includes a cervical cup and an inflatable balloon. In use, the inflatable balloon is advanced through the vagina and cervix and is positioned within the uterus in a deflated position. Once positioned within the uterus, the inflatable balloon is inflated to secure the uterine manipulator within the uterus and the cervical cup is positioned about the cervix for effectuating the colpotomy.

During a colpotomy procedure, a sufficient distal force must be exerted on the uterine manipulator to mobilize the cervix away from the ureters such that the colpotomy incision can be performed. Applying insufficient force may allow the cervix to return to its anatomical position adjacent to the ureters, which may result in injury to the ureters during the colpotomy.

SUMMARY

In aspects of the disclosure, a uterine manipulator includes a housing and a shaft extending distally from the housing. An end effector assembly is disposed at a distal end portion of the shaft. The end effector assembly includes a cervical cup and a uterine manipulating tip portion extending distally from the cervical cup. A position sensor is supported by the cervical cup. The position sensor is configured to identify a location of the cervical cup.

In some aspects of the disclosure, at least one magnet is supported by the cervical cup as an alternative or in addition to the position sensor. The at least one magnet is configured to attract a metal surgical tool to identify the location of the cervical cup.

In some aspects of the disclosure, a vibrating element is supported by the cervical cup as an alternative or in addition to the position sensor and/or the at least one magnet. The vibrating element is configured to initiate ureter peristalsis.

In some aspects of the disclosure, a plurality of position sensors are arranged at a distal end portion of the cervical cup. The position sensors are arranged circumferentially around the distal end portion of the cervical cup.

In some aspects of the disclosure, the position sensors are arranged on a distal-facing surface of the cervical cup.

In some aspects of the disclosure, a fluorescent tag is supported by the cervical cup as an alternative or in addition to the position sensor, the at least one magnet, and/or the vibrating element. The fluorescent tag is configured to emit light to identify a location of the cervical cup.

In some aspects of the disclosure, the emitted light is non-visible to humans.

In some aspects of the disclosure, the fluorescent tag is supported on a distal-facing surface of the cervical cup.

In some aspects of the disclosure, the fluorescent tag is arranged circumferentially around a distal-end portion of the cervical cup.

In some aspects of the disclosure, the fluorescent tag is passively fluorescent.

In some aspects of the disclosure, the fluorescent tag is reactively fluorescent.

In some aspects of the disclosure, the fluorescent tag includes a power source configured to activate the fluorescent tag.

In aspects of the disclosure, a robotic system for operating a uterine manipulator includes at least one robot arm that operates the uterine manipulator. A display device displays images of a patient's anatomy overlaid with images of a position of the uterine manipulator relative to the patient's anatomy.

In some aspects of the disclosure, a pad includes a plurality of external position sensors. The pad is configured to be positioned under the patient. The pad is configured to detect a location of the position sensor supported by the cervical cup.

In some aspects of the disclosure, the images of the patient's anatomy are CT scan images.

In some aspects of the disclosure, a surgical grasping tool supports a second position sensor. The second position sensor is configured to identify a location of the surgical grasping tool.

In some aspects of the disclosure, a position sensing scope is configured to detect a position of the positon sensor supported by the cervical cup.

Other features of the disclosure will be appreciated from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate aspects and features of the disclosure and, together with the detailed description below, serve to further explain the disclosure, in which:

FIG. **1** is a side view of a uterine manipulator in accordance with the aspects and features of present disclosure;

FIG. **2** is a schematic diagram of a distal end portion of the uterine manipulator of FIG. **1** disposed within a vaginal cavity of a patient and engaged with a cervix of the patient;

FIG. **3** is a schematic diagram of the distal end portion of the uterine manipulator of FIG. **2** disposed within the vaginal cavity and a surgical grasping tool inserted adjacent the cervix of the patient;

FIG. **4** is a schematic diagram of the distal end portion of the uterine manipulator of FIG. **3** disposed within the vaginal cavity with a specimen bag in a deployed position around a transected uterus;

FIG. **5** is a perspective view of a cervical cup supporting positon sensors in accordance with the aspects and features of present disclosure;

FIG. **6** is an end view of another cervical cup supporting position sensors in accordance with the aspects and features of present disclosure;

FIG. **7** is a perspective view of a cervical cup supporting a fluorescent tag in accordance with the aspects and features of present disclosure;

FIG. **8** is an end view of another cervical cup supporting a fluorescent tag in accordance with the aspects and features of present disclosure; and

FIG. **9** is a schematic illustration of a robotic surgical system configured for use in accordance with the present disclosure.

DETAILED DESCRIPTION

During procedures employing a uterine manipulator (UM), a surgeon may rely on visual cues of anatomy to ascertain where in the UM is positioned with respect to a patient's anatomy. When visual cues cannot be used, the surgeon may rely on tactile feedback between a laparoscopic tool and the UM to determine if the UM is in a desired location (e.g., with a cervical cup of the UM engaged with the patient's cervix). According to aspects of the present disclosure, position sensors are utilized to determine a location of the UM within the anatomy of the patient. Position sensors may be used to identify a location of laparoscopic tools, a cervical cup, and any other element of the UM. The locations of each of the above-noted elements can be overlaid with CT scan or MRI images of the patient's anatomy in real-time as a single image or video feed on a display. Additionally, electromagnetic navigation and/or fluoroscopic imaging can be employed to assist with navigating the UM to a desired position and/or manipulating the UM in order to perform a surgical task, e.g., a colpotomy.

As used herein, the term "distal" refers to the portion that is being described which is farther from a user, while the term "proximal" refers to the portion that is being described which is closer to a user. Further, to the extent consistent, any of the aspects and features detailed herein may be used in conjunction with any or all of the other aspects and features detailed herein.

Exemplary axes or directions such as an X-axis direction, a Y-axis direction and a Z-axis direction may be illustrated in the accompanying drawings and/or described herein. As an example, the X-axis direction may perpendicular to the Y-axis direction, and the Z-axis direction may be orthogonal to the X-axis direction and the Y-axis direction.

Descriptions of technical features or aspects of an exemplary embodiment of the disclosure should typically be considered as available and applicable to other similar features or aspects in another exemplary embodiment of the disclosure. Accordingly, technical features described herein according to one exemplary embodiment of the disclosure may be applicable to other exemplary embodiments of the disclosure, and thus duplicative descriptions may be omitted herein.

Aspects of the disclosure will be described more fully below (e.g., with reference to the accompanying drawings). Like reference numerals may refer to like elements throughout the specification and drawings.

Referring to FIGS. **1-4**, a uterine manipulator is shown and generally identified by reference numeral **100**. Uterine manipulator **100** is generally configured for insertion through the vaginal cavity "V" and into the uterus "U" and is used to mobilize and/or position the uterus "U" during surgical procedures (see FIGS. **2-4**). Uterine manipulator **100** generally includes a housing **110** and a shaft **120** extending from housing **110**. The housing **110** may include a handle configured for human operation of the uterine manipulator **100**, or the housing **110** may be secured to a robotic arm for robotic operation of the uterine manipulator **100**. In some aspects, shaft **120** supports one or more of a slidable occluder shaft **130**, an occluder **140**, a shuttle **150**, a cervical cup **160**, a specimen containment system **170**, and a uterine manipulating tip portion **180** including an inflatable balloon **190**. Depending upon the desired configuration, uterine manipulator **100** may include some or all of these features or may include additional or alternative features suitable for use with a uterine manipulator **100**.

Housing **110** of uterine manipulator **100** is configured to enable gripping and manipulation of uterine manipulator **100** (e.g. by a human hand or a robotic arm). Movement (e.g., axial, pivoting, rotation, etc.) of housing **110** causes uterine manipulating tip portion **180** to move for moving and/or positioning the uterus "U" (FIGS. **2-4**), for example, for retroversion and anteversion of the uterus "U" (FIGS. **2-4**).

In one aspect, at least one position sensor **161** is supported by the cervical cup **160**. The position sensor **161** is configured to identify a location of the cervical cup **160**. As an example, the at least one position sensor **161** may be supported at a distal end portion of the cervical cup **160**. However, multiple positon sensors **161** may be arranged at various locations about the cervical cup **160**. For example, a first position sensor **161** may be arranged at a proximal end portion of the cervical cup **160** while a second position sensor **161** is arranged at the distal end portion of the cervical cup **161**. Multiple position sensors **161** spaced-apart on the cervical cup **160** enable triangulation and, thus, three-dimensional position and orientation determination for the cervical cup **160**.

In some aspects, at least one magnet **162** is supported by the cervical cup **160**. The at least one magnet **162** is configured to attract a metal surgical tool (e.g., grasping device **200** of FIG. **3**) to identify the location of the cervical cup **160**. When the metal surgical tool is in relatively close proximity to the at least one magnet **162**, an operator of the metal surgical tool may feel the attractive force between the metal surgical tool and the at least one magnet **162**. This can be used to confirm that the cervical cup **160** supporting the at least one magnet **162** is in a desired location (e.g., engaged with the patient's cervix "C") and/or that the metal surgical tool is in proper position relative to the cervical cup **160**.

In some aspects, a vibrating element **163** is supported by the cervical cup **160**. The vibrating element **163** is configured to initiate ureter peristalsis. The occurrence of ureter peristalsis can be used to confirm that the cervical cup **160** is in contact with a ureter of the patient to determine a location of the cervical cup **160**.

Referring to FIG. **5**, a plurality of position sensors **561** are arranged at a distal end portion **514***b* of the cervical cup **560**. The position sensors **561** are arranged circumferentially around the distal end portion **514***b* of the cervical cup **560**, e.g., about an outwardly-facing surface thereof. The position sensors **561** may be intermittently spaced apart from each other around the distal end portion **514***b* of the cervical cup **560**. This allows visualization of a directional orientation of the distal end portion **514***b* of the cervical cup **560** to determine if the cervical cup **560** is engaged with the patient's cervix "C" or otherwise positioned.

Referring to FIG. **6**, a plurality of positon sensors **661** are arranged on a distal-facing surface **614***b* of the cervical cup **660**, e.g., about an distal rim thereof. The position sensors **661** may be intermittently spaced apart from each other and

arranged circumferentially around the distal facing surface **614***b* of the cervical cup **660**.

Referring to FIGS. **7** and **8**, cervical cups **760**, **860** support fluorescent tags **761**, **861**, respectively. The fluorescent tags **761**, **861** are configured to emit light (e.g., light non-visible to humans) to identify a location of the cervical cups **760**, **860**.

The fluorescent tags **761**, **861** of cervical cups **760**, **860** may be passively fluorescent. For example, a distal end portion **714***b* (FIG. **7**) or a distal-facing surface **814***b* (FIG. **8**) of the cervical cups **760**, **780**, respectively, includes a material with fluorescent properties. The material may be a polymer impregnated with one or more fluorescent agents or a fluorescent agent may be applied as a surface treatment. When non-visible light from a surgical imaging system excites the fluorescent agent, the fluorescent agent fluoresces and is visible by a surgical imaging system. The fluorescent agent may be visible through tissue, and thus emitted light may be detected across a patient's cervix, such as by a position sensing scope **300** (FIG. **3**). The position sensing scope **300** (FIG. **3**) may be a camera configured to detect a corresponding wavelength of light emitted by the fluorescent agent.

The cervical cups **760**, **860** may be reactively fluorescent. For example, a reaction occurs before or during a surgical procedure that causes the fluorescent agent to emit light (e.g., non-visible light to humans) without excitation from a surgical system. As an example, an external light source may emit light onto the cervical cups **760**, **860** to activate the fluorescent agent.

The cervical cups **760**, **860** may include a chamber with multiple chemical agents not in direct contact with each other in a first configuration, and when agitated or otherwise mixed the chemical agents combine to react and emit light.

The cervical cups **760**, **860** may include a temperature-activated fluorescent agent that emits light when placed in contact with a patient's body to expose the fluorescent agent to physiological temperatures.

The cervical cups **760**, **860** may include an air-activated fluorescent agent. In a first configuration, the air-activated fluorescent agent is covered, and in a second configuration the air-activated fluorescent agent is exposed to air to cause the air-activated fluorescent agent to emit light.

The cervical cups **760**, **860** may include a water-activated or saline-activated fluorescent agent.

The cervical cups **760**, **860** may include a fluorescent agent activated by a power source **764** (e.g., a battery).

As an example, the cervical cups **760**, **860** may be coated with indocyanine green (ICG) dye for use with fluoroscopic imaging of the cervical cups **760**, **860**. Infrared (IR) light of a predetermined wavelength (e.g., 785 nm) may be employed for activating the ICG dye to visualize a position of the instrument (e.g., via an infrared camera inserted through the first access cannula **1100** (FIG. **3**)).

Referring particularly to FIG. **7**, the fluorescent tag **761** is supported on a distal-end portion **714***b* of the cervical cup **760**. The fluorescent tag **761** may extend circumferentially around an outwardly-facing surface at the distal-end portion **714***b*.

Referring particularly to FIG. **8**, the fluorescent tag **861** is arranged circumferentially around a distal-facing portion **814***b* of the cervical cup **860**.

FIG. **9** illustrates a robotic surgical system shown generally as system **900** and generally may include a plurality of robot arms **902**, **903** configured to operate surgical tools "ST"; a control device **904**; and an operating console **905** coupled with control device **904**. Operating console **905** may include a display device **906**, which may be set up in particular to display three-dimensional images; and manual input devices **907**, **908**, by means of which a person (not shown), for example a surgeon, may be able to telemanipulate robot arms **902**, **903** in a first operating mode.

Each of the robot arms **902**, **903** may include a plurality of members, which are connected through joints, and an attaching device **909**, **911**, to which may be attached, for example, the surgical tool "ST" supporting an end effector **9100**, e.g., uterine manipulator **100** (FIG. **1**) and the end effector components thereof.

Robot arms **902**, **903** may be driven by electric drives (not shown) that are connected to control device **904**. Control device **904** (e.g., a computer) may be set up to activate the drives, in particular by means of a computer program, in such a way that robot arms **902**, **903**, their attaching devices **909**, **911** and thus the surgical tool "ST" (including end effector **9100**) execute a desired movement according to a movement defined by means of manual input devices **907**, **908**. Control device **904** may also be set up in such a way that it regulates the movement of robot arms **902**, **903** and/or of the drives.

System **900** may be configured for use on a patient **913** lying on a patient table **912** to be treated in a minimally invasive manner by means of end effector **9100**. System **900** may also include more than two robot arms **902**, **903**, the additional robot arms likewise being connected to control device **904** and being telemanipulatable by means of operating console **905**. A medical instrument or surgical tool "ST" (including an end effector **9100**) may also be attached to the additional robot arm. System **900** may include a database **914**, in particular coupled to with control device **904**, in which are stored, for example, pre-operative data from patient/living being **913** and/or anatomical atlases.

Referring to FIGS. **1-4** and **9**, a robotic system for operating the uterine manipulator **100**, more specifically, includes the system **900** including the control device **904** and plurality of robot arms **902**, **903**. The robot arms **902**, **903** can be employed to operate the uterine manipulator **100**. The display device **906** displays images of a patient's anatomy overlaid with images of a position of the uterine manipulator **100** relative to the patient's anatomy. The images of the patient's anatomy may be derived from computed tomography (CT) images, magnetic resonance imaging (MRI) images, and/or fluoroscopic images.

In some aspects, a reference pad **220** (FIGS. **2-4**) includes a plurality of external position sensors **221** configured to generate an electromagnetic field. The reference pad **221** is configured to be positioned under the patient. The reference pad **221** is configured to detect a location of the position sensors (e.g., sensors **161**) supported by the cervical cup (e.g., cervical cup **160**) and/or any other position sensor(s) within the field of the reference pad **220** (e.g., position sensor **211** at a distal end of surgical grasping device **200**). The reference pad **220** may be an electromagnetic filed transmitter positioned beneath the patient such that positions of any position sensors within the electromagnetic field can be determined by the reference pad **220**.

In some aspects, navigation of the medical instruments described herein is achieved by use of an electromagnetic navigation (EMN) system. In general, the EMN system is configured to identify a location and/or an orientation of a medical device being navigated toward a target location within the patient's body by using, among other things, an antenna assembly that generates one or more electromagnetic fields that are sensed by a sensor affixed to the medical device. In some cases, the EMN system is further configured

to augment computed tomography (CT) images, magnetic resonance imaging (MRI) images, and/or fluoroscopic images employed during navigation of the medical device through the patient's body toward a target of interest.

Referring again to FIG. **3**, the first access cannula **1100** may be inserted into the uterus "U" and the position sensing scope **300** may be inserted through the first access cannula **1100**. The position sensing scope **300** may emit a signal (e.g., an audio signal or an infrared signal) to any of the position sensors described herein and receives a reply signal useable for determining the position of the position sensor. A second access cannula **2100** may be inserted into the vagina "V" and the surgical grasping device **200** may be inserted through the second access cannula **2100**. Alternatively, each of the first access cannula **1100** and the second access cannula **2100** may be inserted into the uterus "U."

Referring again to FIGS. **1-4**, in some aspects, uterine manipulator **100** includes specimen containment system **170** or other deployable system incorporated thereon. Specimen containment system **170** includes a sleeve **171** supported on shaft **120** of uterine manipulator **100**. Sleeve **171** generally defines an elongate tubular shape and is configured to extend through the vaginal cavity "V" (FIGS. **2-4**). Sleeve **171** may be movable along shaft **120** or may be fixed relative thereto. Sleeve **171** may be formed from any suitable material such as stainless steel, plastic, titanium, or the like.

A specimen containment bag **173** is disposed within sleeve **171**. Specimen containment bag **173** may be formed from any suitable material. In particular, specimen containment bag **173** may be formed from a transparent, tear-resistant, and/or stretchable material to enable visualization into specimen containment bag **173** from the exterior thereof, inhibit tearing, and/or facilitate manipulation of specimen containment bag **173**, tissue specimen(s), and/or surgical instrumentation during use.

With the uterus "U" separated from the vagina "V," e.g., after performing a colpotomy, the uterine manipulator **100** may be positioned such that the specimen containment system **170** is located proximally of the uterus "U." The clinician may then insert a grasping device **200** including a pair of jaws **210** through a separate port or incision (FIG. **3**) to grasp and pull the rim **175** of the specimen containment bag **173** out of the sleeve **171** such that the specimen containment bag **173** moves from the initial position (FIG. **3**) to the deployed position (FIG. **4**) to surround the uterus "U." Additionally or alternatively, housing **110** may be manipulated to move shaft **120** proximally and/or distally such that the uterus "U" provides counter-traction against the specimen containment system **170** to cause specimen bag **173** of specimen containment system **170** to deploy from sleeve **171**. Rim **175** of specimen containment bag **173** causes specimen containment bag **173** to expand outwardly once removed or deployed from sleeve **171**. As an alternative to manual deployment, an actuation shaft (not shown) may be translated relative to shaft **120**, specimen containment bag **173**, and/or sleeve **171** to deploy specimen containment bag **173** therefrom, as noted above.

Once the specimen containment bag **173** is deployed above the uterus "U," uterine manipulator **100** may be withdrawn from the vaginal cavity "V," leaving specimen containment bag **173** in place around the transected uterus "U." Alternatively, in aspects where sleeve **171** is fixedly attached to specimen bag **173**, the combination of sleeve **171** and specimen bag **173** may remain in the vaginal cavity "V" as the remainder of the uterine manipulator **100** is withdrawn from the vaginal cavity "V." One or both ends of the specimen containment bag **173** may then be closed and/or externalized. The transected uterus "U" can then be morcellated from within the specimen containment bag **173**, if needed, and remaining end(s) of the specimen containment bag **173** may then be closed and/or externalized. Because the tissue specimen is contained within the specimen bag **173** during morcellation, the seeding of cancer cells is prevented. Finally, the specimen containment bag **173** is removed. As can be appreciated, the various sensors, magnets, and/or tags detailed herein may be utilized to facilitate the colpotomy, containment, morcellation, and/or extraction detailed above, or any other suitable surgical task, using containment system **170** disposed on the uterine manipulator **100** as detailed above or using any other suitable instruments/systems coupled to or separate from uterine manipulator **100**.

From the foregoing and with reference to the various figure drawings, those skilled in the art will appreciate that certain modifications can also be made to the disclosure without departing from the scope of the same. While several embodiments of the disclosure have been shown in the drawings, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of particular embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.

What is claimed is:

1. A uterine manipulator, comprising:
- a housing;
- a shaft extending distally from the housing;
- an end effector assembly disposed at a distal end portion of the shaft, the end effector assembly including a cervical cup and a uterine manipulating tip portion extending distally from the cervical cup;
- a position sensor supported by the cervical cup, the position sensor configured to identify a location of the cervical cup; and
- at least one magnet supported by the cervical cup, the at least one magnet configured to attract a metal surgical tool to identify the location of the cervical cup.

2. The uterine manipulator of claim **1**, further including a vibrating element supported by the cervical cup, the vibrating element configured to initiate ureter peristalsis.

3. The uterine manipulator of claim **1**, further including a plurality of position sensors arranged at a distal end portion of the cervical cup.

4. The uterine manipulator of claim **3**, wherein the position sensors of the plurality of position sensors are arranged circumferentially around the distal end portion of the cervical cup.

5. The uterine manipulator of claim **3**, wherein the position sensors of the plurality of position sensors are arranged on a distal-facing surface of the cervical cup.

6. A uterine manipulator, comprising:
- a housing;
- a shaft extending distally from the housing;
- an end effector assembly disposed at a distal end portion of the shaft, the end effector assembly including a cervical cup and a uterine manipulating tip portion extending distally from the cervical cup,
- a fluorescent tag supported by the cervical cup, the fluorescent tag configured to emit light to identify a location of the cervical cup; and
- a vibrating element supported by the cervical cup.

7. The uterine manipulator of claim **6**, wherein the emitted light is non-visible to humans.

8. The uterine manipulator of claim 6, wherein the fluorescent tag is supported on a distal-facing surface of the cervical cup.

9. The uterine manipulator of claim 6, wherein the fluorescent tag is arranged circumferentially around a distal-end portion of the cervical cup.

10. The uterine manipulator of claim 6, wherein the fluorescent tag is passively fluorescent.

11. The uterine manipulator of claim 6, wherein the fluorescent tag is reactively fluorescent.

12. The uterine manipulator of claim 6, wherein the fluorescent tag includes a power source configured to activate the fluorescent tag.

13. A robotic system for operating a uterine manipulator, comprising:

at least one robot arm configured to operate a uterine manipulator; and

a display device configured to display images of a patient's anatomy overlaid with images of a position of the uterine manipulator relative to the patient's anatomy,

wherein the uterine manipulator includes:

a housing;

a shaft extending distally from the housing;

an end effector assembly disposed at a distal end portion of the shaft, the end effector assembly including a cervical cup and a uterine manipulating tip portion extending distally from the cervical cup; and

a position sensor supported by the cervical cup, the position sensor configured to identify a location of the cervical cup;

a pad including a plurality of external position sensors, the pad configured to be positioned under the patient, and the pad configured to detect a location of the position sensor supported by the cervical cup.

14. The system of claim 13, wherein the images of the patient's anatomy are CT scan images.

15. The system of claim 13, further including a surgical grasping tool supporting a second position sensor, the second position sensor configured to identify a location of the surgical grasping tool.

16. The system of claim 13, further including a position sensing scope configured to detect a position of the position sensor supported by the cervical cup.

17. The uterine manipulator of claim 13, further including at least one magnet supported by the cervical cup.

18. A uterine manipulator, comprising:

a housing;

a shaft extending distally from the housing;

an end effector assembly disposed at a distal end portion of the shaft, the end effector assembly including a cervical cup and a uterine manipulating tip portion extending distally from the cervical cup;

a position sensor supported by the cervical cup, the position sensor configured to identify a location of the cervical cup; and

a vibrating element supported by the cervical cup, the vibrating element configured to initiate ureter peristalsis.

19. A robotic system for operating a uterine manipulator, comprising:

at least one robot arm configured to operate a uterine manipulator;

a display device configured to display images of a patient's anatomy overlaid with images of a position of the uterine manipulator relative to the patient's anatomy,

wherein the uterine manipulator includes:

a housing;

a shaft extending distally from the housing;

an end effector assembly disposed at a distal end portion of the shaft, the end effector assembly including a cervical cup and a uterine manipulating tip portion extending distally from the cervical cup; and

a position sensor supported by the cervical cup, the position sensor configured to identify a location of the cervical cup; and

a surgical grasping tool supporting a second position sensor, the second position sensor configured to identify a location of the surgical grasping tool.

20. A robotic system for operating a uterine manipulator, comprising:

at least one robot arm configured to operate a uterine manipulator;

a display device configured to display images of a patient's anatomy overlaid with images of a position of the uterine manipulator relative to the patient's anatomy,

wherein the uterine manipulator includes:

a housing;

a shaft extending distally from the housing;

an end effector assembly disposed at a distal end portion of the shaft, the end effector assembly including a cervical cup and a uterine manipulating tip portion extending distally from the cervical cup; and

a position sensor supported by the cervical cup, the position sensor configured to identify a location of the cervical cup; and

at least one magnet supported by the cervical cup.

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