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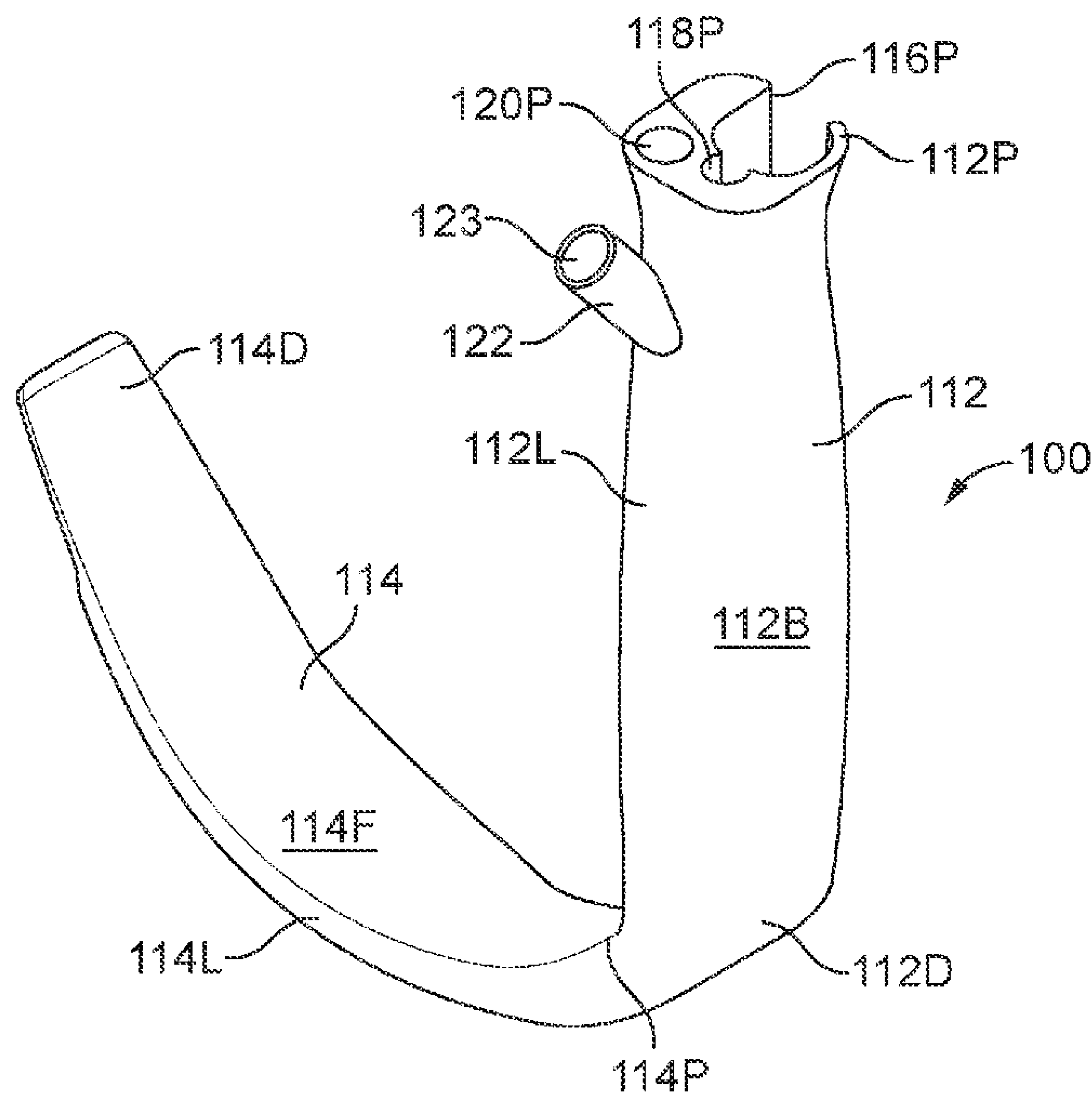
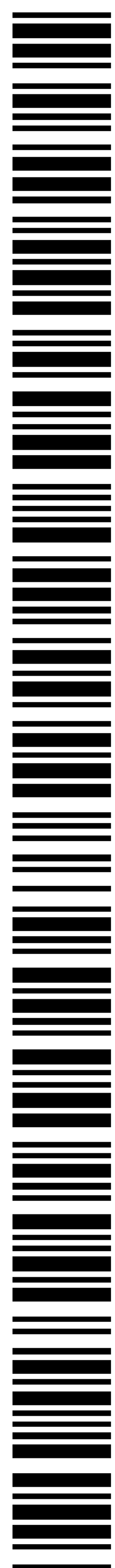


FIG. 10

(57) Abstract: In one aspect, this disclosure relates to a laryngoscope having a channel for delivering an endotracheal tube to the trachea and its placement under continuous visualization by a camera and with controlled suction. The laryngoscope may further comprise one or more additional channels, including a suction and camera channel. In another aspect, this disclosure relates to medical systems comprising one of laryngoscopes according to this disclosure and one or more of adapters, tools and/or cameras.



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LARYNGOSCOPE AND INTUBATION METHODS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to U.S. provisional patent application 63/090,560 filed October 12, 2020 and U.S. patent application 17/215,521 filed March 29, 2021, the entire disclosure of both applications is herein incorporated in its entirety by the reference.

TECHNICAL FIELD

[0002] This disclosure relates to the field of medical devices, including medical devices for managing a patient airway and intubation methods, including laryngoscopes containing a channel for delivering and positioning an endotracheal tube under continuous visualization, at least one camera/suction channel and/or at least one camera/tool channel.

BACKGROUND

[0003] A healthcare professional may use a laryngoscope for gaining access to patient's airway in medical emergency, e.g., a facial trauma, and/or in order to facilitate endotracheal intubation during certain surgical procedures, in general anesthesia and/or under other circumstances when a patient cannot breathe unassisted. Laryngoscopes known in the art comprise a handle attached to a blade. A healthcare professional may insert the blade into the oropharynx by manipulating the handle in order to obtain a view of the vocal cords and the glottis and while attempting to gain access to an airway and further in order to keep the airway accessible in order to position an endotracheal tube or some other airway device which will facilitate breathing and/or deliver a medication.

[0004] For proper placement of an endotracheal tube and in order to establish ventilation, it is particularly important for a healthcare professional to view the patient's larynx, including vocal cords. However, the airway may be obstructed with vomit, blood, and/or some other bodily secretion. A healthcare professional may use a suction tube in order to aspirate these bodily secretions. Various attempts have been made to combine a laryngoscope with a suction tube, including a suctioning laryngoscope blade to which a suction tube is coupled, as provided in US Patent 6,248,061 or a laryngoscope with integrated and controllable suction, as disclosed in US Patent Publication 2016/0345803.

[0005] Various attempts have been also made for adopting a blade of a laryngoscope to delivering an endotracheal tube. For example, U.S. Patent 8,529,442 provides laryngoscopes having an external centrally located channel. For proper placement of an endotracheal tube and in order to establish ventilation, it is particularly important for a healthcare professional to view the patient's larynx, including vocal cords. Certain video laryngoscopes are known in the art, including U.S. Patent 8,529,442 disclosing a video laryngoscope including a camera and lighting unit located beneath the external channel.

[0006] However, there remains a need in the field for a laryngoscope capable of assisting in accurate and expeditious placement of an endotracheal tube.

SUMMARY

[0007] This disclosure helps in addressing the need in the field for a laryngoscope that can reliably, expeditiously, and consistently deliver an endotracheal tube to a trachea under continuous visualization with a camera, including for patients who are difficult to intubate and/or under the circumstances when suction and/or ventilation may be needed during intubation.

[0008] In one embodiment, the present disclosure provides a laryngoscope comprising a handle and a blade,

wherein the handle has a body with a proximal end and a distal end and having a length between the proximal end and the distal end,

wherein the blade is curved and adopted to the contour of a human larynx and wherein the blade has a distal end, a proximal end, a front surface, a back surface, a left flanking surface and a right flanking surface, and

wherein the handle is attached at its distal end to the proximal end of the blade, and

wherein the laryngoscope comprises an endotracheal tube (ETT) channel having a passageway encircled by a wall in the body of at least a portion of the handle length, wherein the ETT channel has a proximal end opening located at or near the proximal end of the handle and wherein the ETT channel has a distal end opening, and

wherein the laryngoscope further comprises a suction/camera channel formed as a passageway in the body of the laryngoscope, wherein the suction/camera channel has a proximal end opening located at or near the proximal end of the handle and

wherein the suction/camera channel has a distal end opening located at or near the distal end of the blade and wherein the suction/camera channel has a diameter compatible for positioning a camera in the suction/camera channel.

[0009] The laryngoscope may have the blade which contains a protective flange extending distally from the distal end of the blade front surface and wherein the flange is distal to the distal end opening of the ETT channel.

[0010] Preferred embodiments of the laryngoscope include those wherein the ETT channel contains a slit opening the ETT channel onto at least one surface of the laryngoscope. In some preferred embodiments, the slit may open the ETT channel to the left flanking surface or to the right flanking surface of the laryngoscope.

[0011] In some embodiments, the ETT channel may open with its distal end proximally to or at the distal end of the handle. Some preferred embodiments include laryngoscopes wherein the ETT channel from the handle continues through at least a portion of the blade length and wherein the ETT channel opens with its distal end proximally to or at the distal end of the blade.

[0012] In some preferred embodiments, the laryngoscope may comprise one or more guide grooves formed as a recess in at least a portion of the wall of the ETT channel and/or one or more guide grooves formed as a recess in one or more external (the front (ventral) surface, the back (dorsal) surface, the left flank surface or the right flank surface) surfaces of the handle and/or the blade, and wherein a depth of the guide groove is compatible with placing a bougie in the guide groove.

[0013] Any of the laryngoscopes according to this disclosure may further comprise a connector extending from the body of the handle, the connector comprising a lumen enclosed by a wall, the lumen opening into the suction/camera channel, wherein the connector is a port for connecting the suction channel to an oxygen, suction and/or vacuum source. Some preferred embodiments include laryngoscopes, wherein the laryngoscope further comprises a suction control port located on the handle, wherein the suction control port is a lumen in the body of the handle and wherein the lumen is connected to the suction channel, and wherein the air pressure inside the suction lumen is controllable by opening and closing the suction control port. In some preferred embodiments, the suction control port may be located in a proximal portion of a front surface of the handle. In some preferred embodiments, the suction control port may be positioned on the front surface of the handle and proximally to the connector positioned on the left flanking surface or the right flanking surface.

[0014] Some preferred embodiments of laryngoscopes according to this disclosure include laryngoscopes, wherein the laryngoscope further comprises a cuff attached to the distal portion of the blade, wherein the cuff is located proximally to the distal end of the blade, and wherein the distal end opening for the channel and the distal end opening of the channel located distally to the cuff. The cuff may be inflatable and wherein the laryngoscope further contains a means for inflating the cuff.

[0015] In yet another aspect, the present disclosure provides a system comprising the laryngoscope according to this disclosure and wherein the system further comprises one or more of the following items:

a) a camera adapter, wherein the camera adapter is a substantially cylindrical body enclosing a lumen for housing a camera;
b) a channel adapter having a substantially conical body formed by a wall that encloses a lumen, the body having a distal end and a proximal end and a length between the distal end and a proximal end, wherein the conical body has a first diameter (d1) at the distal end and a second diameter (d2) at the proximal end, wherein the first diameter (d1) is smaller than the second diameter (d2), and wherein the first diameter (d1) is smaller than a diameter of the proximal end opening of the suction channel, and wherein the second diameter (d2) is larger than the diameter of the proximal end opening of the suction channel;
c) a bougie; and/or
d) a camera.

[0016] In yet another aspect, the present disclosure relates to an assembly comprising the laryngoscope according to this disclosure, a camera positioned in the suction/camera channel of the laryngoscope and an endotracheal tube positioned in the ETT channel of the laryngoscope.

[0017] In one further aspect, the present disclosure relates to method for treating a patient, the method comprising placing a camera into the suction channel of the laryngoscope according to this disclosure and introducing the assembly into patient's upper oral airway. The method may further include manipulating the laryngoscope with assistance by a bougie positioned in a guide groove.

[0018] The present disclosure further provides in one embodiment a laryngoscope containing at least one camera/suction channel and/or at least one camera/tool channel. In some embodiments, the laryngoscope may be combined with at least one camera insertable into and removable from the camera/suction channel, the camera providing continuous visualization during insertion and placement.

[0019] In one aspect, the present disclosure provides a laryngoscope comprising a camera/suction channel, a handle and a blade with a proximal end and a distal end, the handle comprising a body with a distal end and a proximal end, the body being attached at the distal end to the proximal end of the blade, wherein the blade has a back surface and a front surface, wherein the laryngoscope contains at least one camera/suction entry port located on the body of the handle, the camera/suction entry port opening into the camera/suction channel located inside the body of the handle, the camera/suction channel opening with a camera/suction port on the back surface of the blade. In some embodiments of the laryngoscope, the handle may be attached to the blade removably. In some preferred embodiments of the laryngoscope, the camera/suction channel may comprise a tube. In some preferred embodiments of the laryngoscope, the camera/suction channel may comprise a tube which insertable into and removable from the body of the handle. In some embodiments of the laryngoscope, the body of the handle may further comprise a suction control port. In some embodiments of the laryngoscope, the blade may be curved. In some embodiments, the laryngoscope may further comprise a camera sheath insertable and removable from the camera/suction channel. In some embodiments, the camera sheath may contain a sealed window at the distal end.

[0020] In some embodiments, the laryngoscope may further comprise a camera/tool channel attached to the surface of the body of the handle and/or the camera/tool channel comprises a groove shaped in the surface of the body of the handle, wherein the camera/tool channel has a distal end and a proximal end, and wherein the distal end of the camera/tool channel opens on the back surface of the blade or on the side of the back surface of the blade, and wherein the proximal end of the camera/tool channel is positioned on the body of the handle.

[0021] In some embodiments, the camera/tool channel may comprise a groove.

[0022] In some embodiments, the laryngoscope may further comprise an adaptor attached to the camera/suction entry port.

[0023] In some embodiments, the body of the handle may be substantially hollow.

[0024] In some preferred embodiments, the laryngoscope may further comprise a camera attached to a wand, the camera being insertable into and removable from the camera/suction

channel. The camera may be disposable or it can be reusable. In order to be reusable, the camera may be hosted inside a disposable sheath.

[0025] In another aspect, this disclosure relates to an airway management device comprising the laryngoscope according to this disclosure and one or more of the following: at least one camera insertable and removable from the camera/suction channel, at least one bougie and/or at least one stopper for closing the camera/suction entry port.

[0026] In yet another aspect, this disclosure relates to a system for endotracheal intubation, the system comprising the laryngoscope according to this disclosure attached to an air/vacuum/suction source and a camera inserted in the laryngoscope and capable of capturing images distally from the back surface of the blade.

[0027] In yet further aspect, this disclosure provides a method for managing patient's airway, the method comprising inserting a camera in the camera/suction channel of the laryngoscope according to this disclosure, inserting a bougie into the camera/tool channel, inserting the blade into the oropharynx by manipulating the handle and with assistance from the bougie under continuous visualization by the camera. Some embodiments of the method may further comprise connecting the laryngoscope to an air/suction/vacuum source and establishing suction through the camera/suction channel and aspirating bodily secretions through the camera/suction port. In some embodiments of the method, suction may be conducted under visualization by the camera. The methods may further comprise opening and/or closing the suction control port.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] **Fig. 1** is a perspective view of one embodiment of a laryngoscope according to this disclosure.

[0029] **Fig 2** is a perspective view of an embodiment of a laryngoscope according to this disclosure, including a camera inserted into the suction/camera channel and a bougie inserted into the camera/tool channel.

[0030] **Fig. 3** is a perspective view of an embodiment of a laryngoscope according to this disclosure and which can be combined with two cameras.

[0031] **Fig. 4** is a perspective view of the laryngoscope of **Fig. 3** with a first camera extending distally from the suction/camera channel and a second camera extending distally from the camera/tool channel.

[0032] **Fig. 5** is a perspective view of an embodiment of the laryngoscope of **Fig. 1** with a camera and an endotracheal tube.

[0033] **Fig. 6** depicts a portion of one embodiment for a laryngoscope handle with an adaptor and a camera being inserted into the suction/camera channel.

[0034] **Fig.** 7 depicts a portion of one embodiment for a laryngoscope handle with a camera being inserted into the suction/camera channel and camera's wand being secured in place.

[0035] **Fig. 8** depicts one embodiment of the laryngoscope of this disclosure in use and connected through a suction catheter to a suction/vacuum source (not shown).

[0036] **Fig. 9** depicts a proximal portion of the laryngoscope handle of **Fig. 8**, showing the adaptor being connected to a succession catheter.

[0037] **Fig. 10** depicts a perspective view of one embodiment of a laryngoscope according to this disclosure showing a front (ventral) surface of the blade.

[0038] **Fig 11** depicts another side perspective view of the laryngoscope of **Fig. 10**.

[0039] **Fig. 12** is a perspective view of another embodiment of a laryngoscope with a cuff according to this disclosure.

[0040] **Fig. 13** is another side perspective view of the laryngoscope of **Fig. 12**.

[0041] **Fig. 14** is a top-view of the back surface of the laryngoscope of **Fig. 10**.

[0042] **Fig. 15** is a side-view of the laryngoscope of **Fig. 10**.

[0043] **Fig. 16** is a cross-sectional view of the laryngoscope according to this disclosure taken through the handle from the front surface to the back surface and perpendicular to the proximal-distal **12P/12D** axis.

[0044] **Fig. 17** depicts the laryngoscope with a cuff of **Fig. 12** being assembled with an endotracheal tube, a bougie and a camera.

[0045] **Fig. 18** depicts a proximal region of the handle of the laryngoscope **100** according to this disclosure, a camera adapter and a camera.

[0046] **Fig. 19** depicts the camera of **Fig. 18** being placed into the laryngoscope of **Fig. 18** through the camera adapter of **Fig. 18**.

[0047] **Fig. 20** depicts a proximal region of the handle of the laryngoscope **100** with a bougie positioned in a guide groove.

[0048] **Fig. 21** depicts the assembly of **Fig. 20** and further depicting an endotracheal tube being guided with the bougie into an ETT channel.

[0049] **Fig. 22** depicts the assembly of **Fig. 21** after the endotracheal tube has been fully loaded into the ETT channel.

[0050] **Fig. 23** depicts a side perspective view of one embodiment of the laryngoscope according to this disclosure with an endotracheal tube positioned in the ETT channel and extending distally from the distal end of the laryngoscope.

[0051] **Fig. 24** depicts the endotracheal tube being separated from the laryngoscope through the slit in the ETT channel.

[0052] **Fig. 25** depicts one embodiment of an adapter.

[0053] **Fig. 26** depicts the adapter of **Fig. 25** being combined with a camera.

[0054] **Fig. 27** is a perspective view of an assembly of the laryngoscope of **Fig. 1** being assembled with a camera through the adapter of **Fig. 25**.

[0055] **Fig. 28** depicts an assembly of an endotracheal tube with a camera via the adapter of **Fig. 25.**

[0056] **Fig. 29** depicts another embodiment of a laryngoscope according to this disclosure in which an ETT channel is located in the handle.

[0057] **Fig. 30** is a perspective view of the laryngoscope of **Fig. 29**, showing the back surface of the blade.

[0058] **Fig. 31** depicts another embodiment of a laryngoscope according to this disclosure in which an ETT channel is located in the handle.

[0059] **Fig. 32** is a perspective view of the laryngoscope of **Fig. 31**, showing the back surface of the blade.

[0060] **Fig. 33** is a perspective view of another embodiment of a laryngoscope according to this disclosure.

[0061] **Fig. 34** depicts the laryngoscope of **Fig. 33** assembled with a bougie.

DETAILED DESCRIPTION

[0062] This disclosure relates to medical devices for examining and managing a patient airway, including examination, drug-delivery, intubation, ventilation and extubation. In one aspect, this disclosure relates to various embodiments of a laryngoscope, preferably containing an endotracheal tube (ETT) channel suitable for delivering and positioning an endotracheal tube (ETT) during intubation. Some preferred embodiments include means for ventilating a patient through the laryngoscope. In some preferred embodiments, the laryngoscope further

preferably comprises a suction channel which may also be used, in at least some embodiments, for housing a camera.

[0063] Laryngoscopes according to the present disclosure address certain previously unsolved technical problems, including these laryngoscopes provide a conduit for accurate and expeditious placement of an endotracheal tube wherein the insertion procedure can be performed under continuous visualization and a placement of the laryngoscope and/or the endotracheal tube can be visualized and verified with a camera. Other technical advantages include, but are not limited to, a means for controlling suction, performing suction and placement under continuous visualization, carrying out placement and examination wherein surrounding tissues can be manipulated with a guiding tool, such as for example, as a bougie. Because the laryngoscopes in this disclosure may be assembled with one or more tools, including, but are not limited to, a suction catheter, a camera, a guiding tool, and/or an endotracheal tube, one healthcare practitioner can perform various manipulations as the assembly can be held with one hand while the tools/devices in the assembly can be manipulated and controlled with another hand. The laryngoscopes according to this disclosure can be suitable for use under emergency circumstances and/or for patients who are difficult to intubate. Further embodiments include a laryngoscope containing at least one suction/camera channel and/or at least one camera/tool channel. The laryngoscope is compatible with a camera.

[0064] In this disclosure, the term "distal end" means the end which is introduced into a patient's oropharynx first during examination and/or in an intubation procedure. The "proximal end" is opposite to the distal end.

[0065] Referring to **Figs. 1-9**, certain embodiments of a laryngoscope according to this disclosure will now be described in more detail. **Fig. 1** depicts one embodiment of the laryngoscope, generally **10**. The laryngoscope **10** comprises a handle **12** and a blade **14**. In some embodiments, the handle **12** and the blade **14** are formed into a one-piece laryngoscope during manufacturing. For example, the handle **12** and the blade **14** can be molded together, and/or glued together, or otherwise be permanently attached during manufacturing.

[0066] In other embodiments, the handle **12** can be detachable from the blade **14**. In these embodiments, the handle **12** can be attached to the blade **14** prior to use, for example, by screwing the handle **12** onto the blade **14** and/or with any other fastener means.

[0067] The handle **12** comprises a body **16** with a distal end **16A** and a proximal end **16B**. It should be noted that while in one embodiment, the handle **12** comprises a substantially

tubal body, any other shapes typically used in handles can be also suitable. The shape and the length of the handle **12** can be adjusted as needed.

[0068] The blade **14** may be curved and is preferably adopted to the contour of a human larynx such that when the laryngoscope **10** is in use, the blade **14** can be used to lift the epiglottis and can be inserted into an airway by manipulating the handle **12** which remains extended out of the mouth.

[0069] The blade **14** has a distal end **14A** and a proximal end **14B**. The body **16** of the handle **12** is attached at its distal end **16A** to the proximal end **14B** of the blade **14**. In some embodiments, where the handle **12** is detachable from the blade **14**, the body **16** may contain a plurality of threads at or near the distal end **16A** for screwing the body **16** onto the proximal end **14B** of the blade **14**. In some embodiments, the blade **14** may comprise a plurality of threads at and/or near the proximal end **14B** for attachment to the handle **12**.

[0070] The blade **14** has a back surface **14C** and the opposite front surface **14D**. A healthcare professional may grasp the handle **12** and insert the blade **14** into the oropharynx of a patient by manipulating the handle **12** in order to obtain a view of the vocal cords and the glottis and while attempting to gain access to the patient's airway. After the positioning procedure is successfully completed, the front surface **14D** of the blade **14** is positioned toward the patient's front, while the back surface **14C** is positioned toward the patient's back.

[0071] The body **16** contains a suction/camera entry port **18** which is an opening on the body **16**. The suction/camera entry port **18** leads to at least one suction/suction channel **24** located inside the body **16** along the proximal-distal axis **16B/16A** at least for a portion of the length of the body **16**. The suction/camera channel **24** opens on the back surface **14C** of the blade **14** with at least one camera/suction port **20**.

[0072] In some embodiments, the suction/camera channel **24** comprises a passage inside the handle **12** located along the proximal-distal axis **16B/16A** for at least a portion of the body **16** length. In some embodiments, the suction/camera channel **24** may be continued further from the body **16** and inside the blade **14** and then open on the back surface **14C** of the blade **14** with at least one camera/suction port **20**. In at least some embodiments, the suction/camera channel **24**, for example as a tubing, may start at or near the camera/suction entry port **18**, located inside the body **16** and then be continued outside the blade **14** and in some embodiments, be continued outside and along at least a portion of the back surface **14C** of the blade **14.**

[0073] In some embodiments, the body **16** is hollow at least partially. This is one of the technical advantages of the laryngoscope according to this disclosure versus video

laryngoscopes known in the art. While handles in conventional laryngoscopes often host batteries, one or more power switches and other elements, making a conventional handle heavy and difficult to manipulate, the handle **12** in some preferred embodiments need not to include any such elements. In some preferred embodiments, the body **16** is substantially hollow (having a space inside), providing a space for the suction/camera channel **24**. In some other embodiments, the body **16** is not hollow and instead it can be made as a solid piece in which the suction/camera channel **24** may be bored through.

[0074] In some embodiments, the suction/camera channel **24** may comprise a tubing, a portion of which may protrude outside the camera/suction entry port **18**. This portion of the tubing protruding outside the camera/suction entry port **18** may be used as an adaptor **25**. The adaptor **25** can be used for connecting the laryngoscope **10** to an oxygen/suction/vacuum source (not shown). The adaptor **25** may further comprise a valve, e.g., a clip, which may regulate opening and closing of the camera/suction entry port **18**.

[0075] In some embodiments, the tubing which comprises the suction/camera channel **24** can slide proximally/distally. In some embodiments, the tubing can be insertable and removable from the laryngoscope **10**.

[0076] A camera **26** connected to a wire, a cable and/or a wand **27** can be placed through the camera/suction entry port **18** into the suction/camera channel **24** and then positioned at the camera/suction port **20**. In some embodiments, the camera **26** with the wand **27** can further comprise a sheath. In some embodiments, the sheath may comprise a sealed window at its distal end. The camera **26** with the wand **27** may be placed and in the sheath and removed from the sheath, as needed. The sheath protects the camera from exposure to bodily fluids. In embodiments, wherein the suction/camera channel **24** comprises a tubing, the tubing may serve as the sheath for the camera **26** and the wand **27** and/or the tubing.

[0077] In some embodiments and as is shown in **Fig. 2**, the camera **26** with the wand **27** can slide inside the suction/camera channel **24**. The camera **26** can extend distally from the camera/suction port **20**. This provides visualization of a patient's larynx and vocal cords in real time. The positioning of the camera **26** relative to the camera/suction port **20** can be adjusted as needed by manipulating the wand **27**.

[0078] As shown in **Fig. 5**, the camera **26** with the wand **27** can be removed from the suction/camera channel **24** through the camera/suction entry port **18** while the laryngoscope **10** remains positioned in a patient. This feature provides yet another technical advantage.

[0079] The camera **26** can be then used in combination with another medical device, for example, with an endotracheal tube **40**, as shown in **Fig. 5**.

[0080] In some embodiments and as is shown in **Figs. 1** and **2**, the laryngoscope **10** may further comprise at least one camera/tool channel **28** with a distal end **28A** and a proximal end **28B**. The camera/tool channel **28** is positioned outside the body **16**.

[0081] While the camera/tool channel **28** may be positioned anywhere on the surface of the body **16**, some preferred embodiments include those wherein the positioning of the camera/tool channel **28** relative to the back surface **14C** is such that the camera/tool channel **28** is adjacent to the surface **14C.** Preferably, the camera/tool channel **28** is positioned on the side of the back surface **14C.**

[0082] Preferably, the distal end **28A** of the camera/tool channel **28** is located on the back surface **14C** of the blade **14** or the distal end **28A** of the camera/tool channel **28** is located on the side of the back surface **14C**. Preferably, the proximal end **28B** is located on the surface of the body **16**.

[0083] In some embodiments, the camera/tool channel **28** may comprise a tube, a tube with a split, a groove, a set of clip-like holders or any combination therefor attached to the external surface of the body **16**. In other embodiments, the camera/tool channel **28** may be a groove or a channel shaped in the wall of the body **16**.

[0084] The camera/tool channel **28** can host a tool or a camera. For example, the camera/tool channel **28** can host a bougie **30**, as shown in **Fig. 2** or a second camera **26** as shown in **Figs. 3** and **4** or a suction tube (not shown).

[0085] As shown in **Fig. 2**, because the distal end **28A** of the camera/tool channel **28** opens on the back surface **14C** or on the side of the back surface **14C** of the blade **14**, the bougie **30** can extend distally from the camera/tool channel **28** and it can slide proximally/distally. The tip of the bougie **30** can be positioned distally relative to the camera **26** which is extending distally from the camera/suction port **20,** as shown in **Fig. 2**.

[0086] As shown in **Fig. 2**, a healthcare professional can adjust a relative position of the bougie **30** in the channel **28** and the camera **26** in the channel **24** such that the bougie **30** is manipulated in an oral airway under continuous visualization by the camera **26**. Because the bougie **30** is hosted in the camera/tool channel **28**, the bougie **30** can be removed, while the laryngoscope **10** remains positioned in a patient. Furthermore, because the camera **26** and the bougie **30** are held in place by the respective channels **24** and **28,** one healthcare professional can manipulate and adjust the camera **26**, the laryngoscope **10**, and the bougie **30**.

[0087] As is shown in **Figs. 6** and 7, the adaptor **25** may comprise a tube which may have a notch **25A** near the proximal end. The notch **25A** can be used for securing the wand **27** after the camera **26** has been inserted into the suction/camera channel **24**. The notch **25A** holds

the wand **27** in place and prevents it and the camera **26** from sliding distally and deeper into the laryngoscope **10**. Once the position of the camera **26** is adjusted and verified as being located distally from the camera/suction port **20**, the wand **27** can be secured in the notch **25A**. This provides yet another technical advantage as the laryngoscope **10** and the bougie **30** can be manipulated by one healthcare professional under continuous visualization from the camera **26**.

[0088] Yet another technical advantage of the laryngoscope according to this disclosure is that the camera/suction entry port **18** may be also used as a suction port. When suction is needed, for example, because an airway is obstructed with vomit, blood, and/or some other bodily secretion, a healthcare professional may remove the camera **26** from the suction/camera channel **24** and connect the adaptor **25** to a suction catheter **34**, one embodiment of which is shown in **Fig.** 9. In at least some other embodiments, the camera **26** need not be removed before suction can take place. In these embodiments, the camera **26** can remain placed in the channel **24** during suction through the channel **24**.

[0089] The suction catheter **34** may be connected to a suction/vacuum source (not shown). A bodily secretion is then aspirated into the camera/suction port **20** and suctioned out through the suction/camera channel **24** and removed from the camera/suction entry port **18**.

[0090] In some embodiments, the body **16** may comprise a suction control port **22** which opens inside the body **16**. The suction control port **22** is connected to the suction/camera channel **24**. When the suction control port **22** is open, it supplies air to the suction/camera channel **24**. Accordingly, vacuum in the suction/camera channel **24** is released at least partially through the suction control port **22** and suction through the suction/camera channel **24** is decreased at least partially. Thus, the suction control port **22** controls suction or it can be used to decrease suction through the suction/camera channel **24**.

[0091] As shown in **Fig. 8**, a healthcare professional may close the suction control port **22** with a finger, a piece of tape and/or a suction control port may be fitted with a stopper/plug/lid (not shown). If no suction is needed or only minimum suction is needed, the suction control port **22** may be kept open. In order to increase suction and aspiration of bodily secretions from the camera/suction port **20**, the suction control port **22** may be closed with a finger or with a stopper/plug/lid (not shown in **Fig. 8**).

[0092] As shown in **Fig. 8**, a camera **26** can be positioned in the camera/tool channel **28** and/or the camera **26** may remain positioned in the suction/camera channel **24** and accordingly, suction through the camera/suction port **20** can be conducted under continuous visualization from the camera **26** positioned in the camera/tool channel **28**. Because suction is conducted

under visualization with the camera **26**, a healthcare professional can monitor the process in real time and by applying only minimum vacuum as may be needed in order to prevent damage to the surrounding tissues.

[0093] The laryngoscopes of this disclosure provide several technical advantages, some of which are described in more detail below. If needed, a placement of the laryngoscope **10** can be assisted by a bougie **30** under continuous visualization with one or more cameras **26**. If needed, the camera **26** and/or the bougie **30** can be removed, while the laryngoscope **10** remains positioned in a patient. By monitoring the surrounding tissues in real time with one or more cameras **26**, a healthcare professional can complete laryngoscopy and/or endotracheal intubation in a shorter period of time. A correct placement can be verified in real time. If/when suction may be needed, a healthcare professional can initiate suction while still holding the laryngoscope **10**. One healthcare professional can operate the laryngoscope **10**, the suction catheter **34** and the camera **26** with one hand by simply holding the laryngoscope handle **12**.

[0094] Because the laryngoscope **10** and suction can be operated under continuous visualization, this may decrease a risk of trauma to patient's surrounding tissues and help with intubation of a difficult airway. The intubation can be completed faster and with fewer attempts. In some embodiments, the laryngoscope **10** may be made light in weight and portable as it does not need to include a battery and/or a power switch in the handle, lessening a burden on a healthcare professional handling the laryngoscope **10** during a procedure.

[0095] In another aspect, the present disclosure provides a system comprising the laryngoscope **10** and one or more of the following: at least one camera with a cable and/or wand, the camera insertable into and removable from the channel **24** and/or the channel **28**, and/or at least one bougie insertable into and removable from the channel **28**, and/or a stopper that can fit into the suction control port **22**; and/or suction tubing insertable into and removable from the port **18** and the port **20**; and/or an instruction manual.

[0096] Referring to **Figs. 10-32**, further embodiments of a laryngoscope according to this disclosure will now be described in more detail.

[0097] **Figs. 10**, **11, 14, 15, 16, 23, 24 and 27** depict various views of an alternative embodiment of the laryngoscope according to this disclosure, generally **100**. The laryngoscope **100** comprises a handle **112** attached to a blade **114**. In some embodiments, the handle **112** and the blade **114** are formed into a one-piece laryngoscope during manufacturing, for example by molding. In some embodiments, the handle **112** and the blade **114** can be molded together, and/or glued together, or otherwise be permanently attached during manufacturing. In other embodiments, the handle **112** can be detachable (not shown) from the blade **114**. In these

embodiments, the handle **112** can be attached to the blade **114** prior to use, for example, by screwing the handle **112** onto the blade **114** and/or with any other fastener means.

[0098] Preferably, the handle **112** has a substantially tubal body having a length between a proximal end **112P** and a distal end **112D**. It should be noted that while in one embodiment, the handle **112** has a substantially tubal body, any other shapes typically used for handles can be also suitable. The shape and the length of the handle **112** can be adjusted as needed in order to facilitate a sufficient grasp by a healthcare professional for manipulating the handle **112** during insertion and while conducting examination and/or intubation.

[0099] The handle **112** has a front surface **112F** and the opposite back surface **112B.** In this disclosure, the front surface can be alternatively referred to as "the ventral surface." In this disclosure, the back surface can be alternatively referred to as "the dorsal surface."

[00100] The handle **112** also has two flanking surfaces, the right flanking surface **112R** and the left flanking surface **112L**. As can be seen in the cross-sectional view of **Fig. 16**, the flanking surface **112L** is located between the front surface **112F** and the back surface **112B**, creating one flank and the flanking surface **112R** is located between the back surface **112B** and the front surface **112F**, creating the other flank.

[00101] In some embodiments, a width of the handle **112** which can be defined as the width of the front surface **112F** from the left flank **112L** to the right flank **112R** is substantially same as a width of the blade **114** which can be measured as the width of the blade front surface **114F** from the left flank **114L** to the right flank **114R** one embodiment of which is shown in **Fig. 10**. In other embodiments, the width of the handle **112** is less than the width of the blade **114** and the blade **114** is wider (broader)a than the handle **112**.

[00102] The blade **114** may be curved and is preferably adopted to fit with the contour of a human larynx such that when the laryngoscope **100** is in use, the blade **114** is insertable into the human larynx and the blade **114** can be used to lift the epiglottis. The blade **114** can be introduced into an oropharynx by manipulating the handle **112** which may remain substantially extended out of the mouth in some embodiments. In some preferred embodiments, the blade **114** is shaped such that it can extend to the hypopharynx and glottic structures. The blade **114** may be sufficiently rounded to pass over the patient's tongue.

[00103] The blade **114** has a distal end **114D** and a proximal end **114P**. The handle **112** is attached at its distal end **112D** to the proximal end **114P** of the blade **114**. In at least some embodiments, the blade **114** is attached to the handle **112** at an angle α such that the laryngoscope **100** is J-shaped. The angle α can be optimized as needed, and preferably it can be at any value between 30 and 150 degrees. Other values can be also suitable. The angle α is

optimized based on the angle needed for performing functions such as passing over the tongue and lifting the epiglottis with as little manipulation of the head and the neck as possible. In some embodiments, the blade **114** is wider (broader) than the handle **112**.

[00104] The blade **114** has a back (dorsal) surface **114B** and the opposite front (ventral) surface **114F**. A healthcare professional may grasp the handle **112** and introduce the blade **114** into the oropharynx of a patient by manipulating the handle **112** in order to obtain a view of the vocal cords and the glottis and while attempting to gain access to the patient's airway.

[00105] The blade **114** has two flanking surfaces, the right flanking surface **114R** and the left flanking surface **114L**. As can be seen for example in **Fig. 11**, the flanking surface **114L** is located between the front surface **114F** and the back surface **114B**, creating one flank. The opposite flank (not shown in **Fig. 11**, but the opposite flank can be seen in **Fig. 24**) has a flanking surface **114R** is located between the back surface **114B** and the front surface **114F** on the opposite site of the left flanking surface **114R**.

[00106] At its proximal end **114P**, the front surface **1114F** of the blade **114** is connected to the distal end **112D** of the front surface **112F** of the handle **112.** The front surface **114F** of the blade **114** and the front surface **112F** of the handle **112** can be collectively referred to in this disclosure as the front surface of the laryngoscope **110**.

[00107] At its proximal end **114P**, the back surface **114B** of the blade **114** is connected to the distal end **112D** of the back surface **112B** of the handle **112.** The back surface **114B** of the blade **114** and the back surface **1112B** of the handle **112** can be collectively referred to in this disclosure as the back surface of the laryngoscope **100**.

[00108] At its proximal end **114P**, the left flanking surface **114L** of the blade **114** is connected to the distal end **112D** of the left flanking surface **112L** of the handle **112.** The left flanking surface **114L** of the blade **114** and the left flanking surface **112L** of the handle **112** can be collectively referred to in this disclosure as the left flanking surface of the laryngoscope **100**.

[00109] At its proximal end **114P**, the right flanking surface **114R** of the blade **114** is connected to the distal end **112D** of the right flanking surface **112R** of the handle **112.** The right flanking surface **114R** of the blade **114** and the right flanking surface **112R** of the handle **112** can be collectively referred to as the right flanking surface of the laryngoscope **100**.

[00110] When a healthcare professional holds the laryngoscope **100** by the handle **112** and is looking at the blade front surface **114F** with the distal end **114D** pointing away from the healthcare professional, the blade right flanking surface **114R** is on the right from the healthcare professional.

[00111] In some embodiments, the blade **114** may contain a protective flange **115** extending distally from the distal end **114D** of the front surface **114F**. In some preferred embodiments, the protective flange **115** is the first area of the laryngoscope **100** that contacts the epiglottis during insertion. Accordingly, the protective flange **115** may be made in a shape and of a material facilitating insertion, e.g., aiding in lifting the epiglottis, while also protecting patient's tissues from injuries. Some preferred shapes for the protective flange **115** include, but are not limited to, a tongue-like shape tapered at its distal end. Suitable materials for making the flange **115** include plastic.

[00112] As can be seen for example in **Fig. 16**, which is a cross-sectional view, the handle **112** in some preferred embodiments can be made as a solid-piece body **113,** e.g., a plastic body, in which various channels, lumens and recesses, e.g., **116**, **118** and **120** are located, as discussed in more detail below. The blade **114** can be also made as a solid-piece body **117**, e.g., a plastic body, in which various channels are located. In this disclosure, the body **113** of the handle **112** together with the body **117** of the blade **114,** can be referred as the body of the laryngoscope **100.**

[00113] Some laryngoscopes according to this disclosure comprise a channel **116** suitable for carrying an endotracheal tube (ETT). The ETT channel **116** can be referred in this disclosure interchangeably as the ETT conduit or as the ETT channel because one of the functions for the ETT channel **116** is to guide an ETT during an intubation procedure. Insertion of an ETT can be guided and adjusted by manipulating the handle **112** of the laryngoscope **100** with one hand.

[00114] Unlike prior art laryngoscopes, where an endotracheal tube is typically positioned externally on the surface of a handle, the ETT channel **116** in preferred embodiments of the laryngoscopes according to this disclosure is a passageway (a lumen, channel or a groove) in the body of at least a portion of the handle length **112**, one embodiment of which can be seen in a cross-sectional view in Fig. **16**.

[00115] In some embodiments, the ETT channel **116** starts with an opening **116P** at or near the proximal end **112P** of the handle **112**. The opening **116P** leads into a passageway (lumen) in the body **113** of the handle **112**. In some embodiments, the ETT channel **116** can be extruded in the body of the laryngoscope **100.** In some embodiments, the laryngoscope **100** can be molded with the lumen for the ETT channel **116**. In some embodiments, the lumen of the ETT channel **116** is at least partially encircled by the wall of **109**.

[00116] Preferably, the ETT channel **116** continues through at least a portion or even all the length of the handle **112** along the proximal-distal axis **112P/112D**. The ETT channel **116**

may further preferably continue as a passageway in the body **117** through at least a portion of the length of the blade **114** along the proximal-distal axis **114P/114D**, as shown for example in **Fig. 11**. In other embodiments, the ETT channel **116** is located in the handle **112**.

[00117] In some preferred embodiments, the ETT channel **116** ends with an opening **116D** at or near the distal end **114D** of the blade **114**. A diameter of the ETT channel **116** may vary, but typically it is compatible with a diameter of an endotracheal tube such that an endotracheal tube, e.g., an endotracheal tube **406**, can be placed into the ETT channel **116** for example, as shown in **Fig. 23**, depicting the endotracheal tube **406** positioned in the ETT channel **116**.

[00118] As shown in **Fig. 23**, when the endotracheal tube **406** is placed in the ETT channel **116**, a distal end **406D** of the endotracheal tube **406** may extend distally out from the distal opening **116D** of the ETT channel **116**. The diameter of the ETT channel **116** is preferably larger than a diameter of an endotracheal tube such that an endotracheal tube can slide inside the ETT channel **116** along the proximal-distal axis **112P/114D** of the laryngoscope **100**. Endotracheal tubes include those suitable for infants, pediatric patients, adult female patients or adult male patients. Accordingly, the diameter of the ETT channel **116** can be adopted in order to carry an endotracheal tube with an ETT diameter of 3 mm as typically used in infants, of 6.0 to 6.5 mm as typically used in pediatric patients, or form an ETT with a larger diameter, e.g., 7.5 to 8.0 mm or even 8 to 8.5 mm as used for adult patients.

[00119] The endotracheal tube **406** may further extend distally from the distal end **114D** of the blade **114.** A proximal end **406P** of the endotracheal tube **406** may extend proximally from the proximal opening **116P** of the ETT channel **116**. In some embodiments, certain laryngoscopes according to this disclosure may serve as a conduit for delivering and positioning an endotracheal tube during intubation.

[00120] In some embodiments, the ETT channel **116** may comprise a slit **126** as shown in **Fig. 24.** In some embodiments, the slit **126** may be in a form of a groove. The slit **126** may be running for at least a portion of the length of the ETT channel **116**. The slit **126** opens the ETT channel **116** onto at least one of the surfaces of the laryngoscope **100**. In some preferred embodiments, the slit **126** opens the ETT channel **116** to one or more of the flanking surfaces **112L**, **114L**, **112R** and/or **114R**. Preferably, the slit **126** opens to the right flanking surfaces **112R** and **114R** or to the left flanking surfaces **112L** and **114L**.

[00121] As shown in **Fig. 24**, in one preferred embodiment, an endotracheal tube **406** can be positioned into the ETT channel **116** and removed from the ETT channel **116** through the slit **126** that opens the ETT channel **116** to the right flanking surfaces **112R** and/or **114R**. In alternative embodiments, an endotracheal tube **406** can be positioned into the ETT channel **116**

and removed from the ETT channel **116** through the slit **126** that opens the ETT channel **116** to the left flanking surfaces **112L** and/or **114L**. In yet another alternative embodiment, an endotracheal tube **406** can be positioned into the ETT channel **116** and removed from the ETT channel **116** through the slit **126** that opens the ETT channel **116** to the back surfaces **112B** and/or **114B**. In yet another alternative embodiment, an endotracheal tube **406** can be positioned into the ETT channel **116** and removed from the ETT channel **116** through the proximal end opening **116P.**

[00122] Some embodiments of the ETT channel **116** do not comprise the slit **126**. In some embodiments, the ETT channel **116** may be a lumen substantially enclosed by the wall **109** of the body **113** of the handle **112**. In some embodiments, the ETT channel **116** may continue as a lumen substantially enclosed by the wall **109** of the body **117** of the blade **114.** In other embodiments, the ETT channel **116** may run only through the handle **112** and open with the distal end opening **116D** at or near the distal end **112D** of the handle **112**, while the blade **114** does not contain the EET channel **116** located inside the body of the blade **114**.

[00123] It should be further noted that in yet some other embodiments, the ETT channel **116** may be formed, e.g., it may be extruded, as a groove, a trench or a recess in the body **113** of the handle **112** for at least a portion of the handle length along the proximal-distal axis **112P/112D** and then preferably continued as a groove, a trench, a recess or a lumen in the body **117** of the blade **114** for at least a portion of its length along the proximal-distal axis **114P/114D.** In any of these embodiments, the ETT channel **116** may open onto either the flanking surfaces, **112L** and/or **114L**, or **112R** and/or **114R**, or the back surfaces **112B** and/or **114B.** Embodiments wherein the ETT channel **116** is formed as a groove, a trench, a recess and/or the ETT channel contain the slit **126** facilitate removing an endotracheal tube from the ETT channel **116** after the intubation is completed.

[00124] The ETT channel **116** provides several technical advantages, some of which are outlined below. First, the endotracheal tube **406** when positioned in the ETT channel **116** moves together with the laryngoscope **100** and a health care practitioner can perform insertion with one hand by manipulating the handle **112**.

[00125] Second, as the ETT channel **116** is located inside the handle **112,** it is less likely that the endotracheal tube **406** will separate from the laryngoscope **100** during insertion.

[00126] In third, because the ETT channel **116** is located inside the handle **112,** the ETT channel **116** protects the ETT **406,** e.g., from involuntary bites, scratches and/or deformation during insertion.

[00127] In fourth, because the ETT channel **116** is located in the handle **112**, the shape of the handle **112** is not altered when the ETT **406** is loaded in the ETT channel **116**, making it easy for a healthcare practitioner to manipulate the laryngoscope **100** during insertion.

[00128] In fifth, after an endotracheal tube **406** has been positioned through the vocal cords, the laryngoscope **100** can be separated from the endotracheal tube **406** through the slit **126**. Thus, the laryngoscope **100** can be removed from a patient without disturbing the endotracheal tube **406** which may remain positioned as needed and may continue providing ventilation to the patient.

[00129] In sixth, it is possible to position the endotracheal tube **406** into the ETT channel **116** prior to inserting the laryngoscope into an oral cavity as the endotracheal tube **406** being positioned inside the ETT channel **116** does not interfere with using the laryngoscope for lifting the epiglottis.

[00130] In some preferred embodiments of the laryngoscope according to this disclosure, the ETT channel **116** may contain a guide groove **118**. When present in some preferred embodiments, the guide groove **118** is a groove or recess in the wall **109** of the ETT channel **116,** one embodiment of which can be seen in a cross-sectional view of **Fig. 16.** The guide groove **118**, when present, may start with an opening **118P** at or near the proximal end **112P** of the handle **112**. The guide groove **118** may continue through the length of at least a portion of the handle **112** and then in some embodiments, it may further continue through at least a portion of the length of the blade **114**, as shown for example in **Fig. 24**. The guide groove **118** in some preferred embodiments ends with an opening **118D** at or near the distal end **114D** of the blade **114**. A depth of the guide groove **118** may vary, but typically it is compatible with a diameter of a guide tool, e.g., a bougie **208** such as that the bougie **208** can be positioned in the guide groove **118**. The guide groove **118** may be formed in the wall of ETT channel **116** and accordingly, the guide groove **118** opens in some preferred embodiments into the lumen (the passageway) of ETT channel **116** such that the bougie **208** can be easily moved from the guide groove **118** into the lumen of the ETT channel **116** or the bougie **208** can be secured back in the guide groove **118**, as may be needed.

[00131] As is shown in **Fig. 20**, after the laryngoscope **100** has been placed in a patient and the larynx has been opened, a bougie **208** can be placed into an endotracheal tube **406**. The bougie **208** can be then extended distally from the distal end of the endotracheal tube **406.** The bougie **208** can then be placed in the guide groove **118** of the laryngoscope **100** and is used for guiding and docking the endotracheal tube **406** into ETT channel **116,** as shown for example, in **Figs. 21** and **22**. Thus, one of the functions for the guide groove **118** is to serve as a docking

means for delivering an endotracheal tube through ETT channel **116** and into a correct position in the trachea.

[00132] In the embodiments without the guide groove **118**, the guide tool, such as the bougie **208**, may be placed directly into ETT channel **116**.

[00133] Some preferred embodiments of the laryngoscope according to this disclosure include a suction/camera channel **120** which opens with a proximal end opening **120P** at or near the proximal end **112P** of the handle **112.** The suction/camera channel **120** can be referred in this disclosure as the suction channel **120** or simply as the channel **120**.

[00134] The proximal end opening **120P** leads into the channel **120** which is preferably a passageway formed in the body **113** of the handle **112**. The channel **120** may be continued as a passageway formed in the body **117** of the blade **114**. The suction channel **120** may open with a distal end opening **120D** at or near the distal end **114D** of the blade **114**. In some embodiments, the distal end opening **120D** of the suction channel **120** can open directly into the ETT channel **116.**

[00135] Preferably, the channel **120** has a diameter compatible with housing a camera such that a camera **210** can be positioned through the proximal opening **120P** into the channel **120**, as shown for example, in **Fig. 17**. The camera **210** can extend distally from the distal end opening **120D** of the channel **120**. Because a diameter of the suction channel **120** is larger than a diameter of the camera **210**, the camera **210** can slide in the suctions channel **120** along the proximal-distal **120P/120D** axis of the channel **120**.

[00136] The laryngoscopes according to this disclosure can be used with any cameras (videoscopes) **210** which are typically used in laryngoscopy and/or endoscopy. Suitable cameras include those which transmit real-time video images, preferably 2.0 megapixel or higher, including those with a WiFi capability and preferably compatible for wireless transmission to a smart phone, tablet and/or a computer. In alternative or in addition to wireless transmission, suitable cameras include those which can be connected to a monitor with a cable.

[00137] In some embodiments, a camera can be battery-operated. Suitable cameras include a charge-coupled device (CCD) located at the distal end, **211D**, of the scope (wand) **211** of the camera **210**. Suitable cameras also include fiberscopes and preferably fiberscopes with a probe of adjustable length.

[00138] A camera can be further equipped with a light source, the light intensity of which is preferably adjustable. When a camera is positioned in the channel **120**, it can provide real-time images of patient's glottis, larynx and/or vocal cords. Accordingly, placement of the

laryngoscope **100** as well as intubation with an endotracheal tube can be performed under continuous visualization.

[00139] As can be seen for example, in **Fig. 11** and **Fig. 15**, the flange **115** may extend distally over the distal end opening of the channel **120** at least in some preferred embodiments. The flange **115** may protect, if necessary, the camera **210** during insertion of the laryngoscope **100**. However, and if necessary, the camera **210** can be extended further from the distal end opening **120D** of the channel **120**. In some applications, the camera **210** can be extended distally to the flange **115**. Accordingly, the camera **210** can provide continuous visualization during insertion of the laryngoscope **100**. The camera **210** can slide distally and proximally in the channel **120**, providing visualization of the distal end **114D** of the blade **114.** The camera **210** can be also moved further distally to provide visualization of patient's tissues distally from the distal end **114D**.

[00140] As can be appreciated in **Figs. 11, 15** and **16,** the channel **120** is preferably positioned in the body of the laryngoscope **100** relative to the ETT channel **116** such that the camera **210,** when extending from the distal end opening **120D** of the channel **120** can visualize the distal end **406D** of the endotracheal tube **406** positioned in the ETT channel **116** with the distal end **406D** of the endotracheal tube **406** extending distally from the distal end **116D** of the ETT channel **116**.

[00141] In some embodiments, the channel **120** is positioned near or substantially near the mid-line of the body of the laryngoscope **100.** In some other embodiments, the channel **120** is positioned laterally to the mid-line of the body of the laryngoscope **100.**

[00142] Because of the preferred relative positioning of the ETT channel **116** and the channel **120** in the body of the laryngoscope **100** such that the distal end opening **120D** of the channel **120** is in the proximity to the distal end **116D** of the ETT channel **116**, both being located at or near the distal end **114D** of the blade **114**, manipulations with a bougie **208** and insertion of the endotracheal tube **406** can be conducted under continuous visualization by the camera **210** when the camera **210** is positioned in the channel **120**. It should be further noted that the ETT channel **116** can be also used for housing a camera. In some embodiments, the laryngoscope according to this disclosure can be used with two different cameras, one positioned in the channel **120** and another one positioned in the ETT channel **116**.

[00143] Because a camera can be positioned in the separate channel **120** separated by the wall from the ETT channel **116**, the camera can be removed from the laryngoscope **100** while the laryngoscope **100** and the endotracheal tube **406** remain positioned in a patient. In alternative, a camera can be re-introduced back into the channel **120** at any time during

examination and intubation and while the laryngoscope **100** remains positioned in a patient. There is no need to remove the laryngoscope assembly from the patient before a camera can be assembled with the laryngoscope.

[00144] At least in some preferred embodiments, the handle **112** may further comprise a connector **122** positioned on the handle **112.** The connector **122** is a conduit (a tube) extending from the body **113** and is attached to the body **113**. The connector **122** is preferably a tube having a wall which encloses a lumen **123** which opens through an opening in the body **113** into the channel **120**. The connector **122** can be used for connecting the laryngoscope **100** to an oxygen, suction and/or vacuum source. The connector **122** may comprise a valve or some other means, e.g., a cap, that can regulate opening and closing of the lumen **123** in the connector **122**.

[00145] When in operation with a vacuum source, the connector **122** can be used for aspirating bodily fluids (e.g., blood, vomit and/or mucous) through the channel **120**. This procedure can be conducted under continuous visualization by a camera positioned in the channel **120** and/or in the ETT channel **116**. Thus, at least in some preferred embodiments, the channel **120** has a dual function: it can carry a camera and it can also function as a suction channel.

[00146] In some embodiments, the handle **112** may comprise a suction control port **124** located on the handle **112,** preferably in the proximal portion of the handle **112** and even more preferably on the front surface **112F** in the proximal portion of the handle **112**. The suction control port **124** provides a lumen in the body **113** leading into the channel **120** such that air can enter the channel **120** through the suction control port **124**.

[00147] One of the functions for the suction control port **124** is to control the air pressure inside the suction lumen **122**. This function can be accomplished by opening and closing the suction control port **124**.

[00148] When suction is needed in order to clear an airway from bodily secretions, a suction catheter (not shown) may be connected to a suction/vacuum source (not shown) and to the laryngoscope **100** through the connector **122**. Secretions are then aspirated into the channel **120** from the distal end **120D** and removed from the channel **120** through the connector **122**.

[00149] When open, the suction control port **122** supplies air to the channel **120**. Accordingly, vacuum in the channel **120** is released at least partially through the suction control port **124**. This decreases suction through the channel **120** at least partially.

[00150] A healthcare professional may close the suction control port **124** with a finger, a piece of tape and/or a suction control port may be fitted with a stopper/plug/lid (not shown). If

no suction is needed or only if minimum suction is needed, the suction control port **122** may be kept open. In order to increase suction and aspiration of bodily secretions through the channel **120**, the suction control port **124** may be closed with a finger or with a stopper/plug/lid (not shown).

[00151] In some preferred embodiments, the suction control port **124** is positioned on the handle **112** proximally to the connector **122**. In some preferred embodiments, the suction control port **124** is positioned on the front surface **112F** of the handle **112** and proximally to the connector **122** positioned on the left flanking surface **112L** or the right flanking surface **112R.**

[00152] Referring to **Figs. 12, 13,** and **17**, it shows an alternative embodiment of a laryngoscope according to this disclosure, generally **200.** The laryngoscope **200** may have the same structure as the laryngoscope **100** and it may contain some of the same elements as were described in connection with the laryngoscope **100**.

[00153] The laryngoscope **200** comprises the handle **112** attached to the blade **114** as was described in connection with the embodiments of the laryngoscope **100.** However, the laryngoscope **200** further comprise a cuff **202** attached at the distal portion of the blade **114,** as can be best seen in the **Figs. 12** and **13.** In some embodiments, the cuff **202** is non-inflatable, while in some other embodiments, the cuff **202** is inflatable and can be inflated with means **204**.

[00154] As can be best seen in **Fig. 13**, the cuff **202** in some embodiments is attached to the blade **114** in its distal portion, wherein the cuff **202** is located proximally to the distal end **114D** of the blade **114** such that the distal end opening **116D** for the ETT channel **116** and the distal end opening **120D** of the channel **120** open distally to the cuff **202.**

[00155] In some embodiments where the slit **126** is present, the cuff **202** may be attached to the blade **114** such that the cuff **202** does not cover the slit **126.** In other embodiments, the cuff 202 may wrap around the blade **114** such that the cuff **202** also wraps around the slit **126**.

[00156] When in use, after the laryngoscope **200** has been positioned in a patient which can be conducted under continuous visualization with a camera positioned for example in channel **120**, the cuff **202** can be inflated and a patient can be ventilated while a healthcare practitioner is working for example on positioning an endotracheal tube and/or performing other tasks necessary for examining and managing an airway.

[00157] In yet another aspect, the present disclosure provides an embodiment for a camera adopter, generally **212**. As can be seen in **Fig. 17**, the camera adopter **212** is preferably a substantially cylindrical body, a wall of which is encircling a central lumen. The camera

adopter **212** is insertable into and removable from a lumen of the channel **120** through the proximal end opening **120P**. The camera adapter **212** has a distal end **212D** and a proximal end **212P** and a length between the distal end **212D** and the proximal end **212P**. The camera adapter **212** may have a sealed window located at the distal end **212D**. In some embodiments, the camera adapter **212** can fit over the camera **210** for example as shown in embodiments of **Figs. 17, 18** and **19**. The camera adapter **212** can be used for protecting the camera **210** from the exposure to bodily fluids and damage while the camera **210** is in use with any laryngoscope embodiments of this disclosure, e.g., **10**, **100**, **200, 500** or **700**.

[00158] In yet another embodiment and referring to **Figs. 25, 26, 27** and **28**, the present disclosure provides a channel adapter **300** having in some embodiments a substantially conical body **302** formed by a wall that encloses a lumen **303**. The body **302** has a distal end **302D** and a proximal end **302P** and a length between the distal end **302D** and the proximal end **302P.**

[00159] The body **302** has a first diameter (d1) at its distal end **302D** and the body **302** has a second diameter (d2) at its proximal end **302P,** wherein the first diameter (d1) is preferably smaller than the second diameter (d2), and wherein the first diameter (d1) is smaller than a diameter at the proximal end **120P** of the channel **120,** and wherein the second diameter (d2) is larger than the diameter of the proximal end **120P** of the channel **120**. Accordingly, a distal portion of the channel adapter **300** is insertable into the channel **120**. The distal portion of the channel adapter **300** fits tightly into the proximal opening **120P** of the channel **120**, but the proximal portion of the adapter **300** remains outside the channel **120,** as shown for example in **Fig. 27.** The lumen **303** of the adapter **300** is compatible with the camera **210**. The camera **210** can be placed into the lumen **303** of the adapter **300** and then assembled with a laryngoscope, for example, as shown in **Fig. 27**, or with an endotracheal tube **406** as shown, for example, in **Fig. 28** by inserting the distal end **302D** of the channel adaptor **300** into the opening **120P** of the channel **120**.

[00160] The channel adapter **300** may further contain at least one port **304** located on the wall of the body **302**. The port **304** serves as an ingress into the lumen **303**. One of the functions for the port **304** is to control air pressure in the channel **120** or in any other tube with which the channel adapter **300** is assembled. The channel adapter **300** may further comprise a conduit **306** formed as a hollow tube attached to and extending from the wall of the body **302**. The conduit **306** encloses a lumen **310** which connects with the lumen **303** through an opening in the wall of the body **302**. The conduit **306** can be used for connecting the channel adapter **300** to an air/vacuum source. When not in use, the lumen **310** of the conduit **306** can be closed

with a lid **308** which may be attached in some embodiments to the wall of the conduit **306** with a lid strap **309**.

[00161] Referring to **Figs. 29** and **30**, the present disclosure provides yet another embodiment for a laryngoscope, generally **500**. Just like other laryngoscopes of this disclosure, the laryngoscope **500** comprises the handle **512** attached to the blade **514**, as was described in connection with the embodiments of the laryngoscope **100.**

[00162] Preferably, the handle **512** has a substantially tubal body having a length between a proximal end **512P** and a distal end **512D**. It should be noted that while in one embodiment, the handle **512** has a substantially tubal body, any other shapes typically used for handles can be also suitable. The shape and the length of the handle **512** can be adjusted as needed in order to facilitate a sufficient grasp by a healthcare professional for manipulating the handle **512** during insertion and while conducting examination and/or intubation.

[00163] The handle **512** has a front surface **512F** and the opposite back surface **512B.** Between the front surface **512F** and the back surface **512B**, the handle **512** a flanking surface, the right flanking surface **512R** and it opposite, the left flanking surface **512L**.

[00164] In some embodiments, a width of the handle **512** which can be defined as the width of the front surface **512F** from the left flank **512L** to the right flank **512R** is substantially same as a width of the blade **514** which can be measured as the width of the blade front surface **514F** from the left flank **514L** to the right flank **514R**. In other embodiments, the width of the handle **512** is less than the width of the blade **514** and the blade **514** is wider (broader)a than the handle **512**.

[00165] The blade **514** may be curved and is preferably adopted to fit with the contour of a human larynx such that when the laryngoscope **500** is in use, the blade **514** is insertable into the human larynx and the blade **514** can be used to lift the epiglottis. The blade **514** can be introduced into an oropharynx by manipulating the handle **512** which remains substantially extended out of the mouth. The blade **514** is shaped such that it can extend to the hypopharynx and glottic structures. The blade **514** is sufficiently rounded to pass over the patient's tongue.

[00166] The blade **514** has a distal end **514D** and a proximal end **514P**. The handle **512** is attached at its distal end **512D** to the proximal end **514P** of the blade **514**. In at least some embodiments, the blade **514** is attached to the handle **512** at an angle α such that the laryngoscope **500** is J-shaped. The angle α can be optimized as needed, and preferably it can be at any value between 30 and 150 degrees. Other values can be also suitable. The angle α is optimized based on the angle needed for performing functions such as passing over the tongue

and lifting the epiglottis with as little manipulation of the head and the neck as possible. In some embodiments, the blade **514** is wider (broader) than the handle **512**.

[00167] The blade **514** has a back surface **514B** and the opposite front surface **514F**. A healthcare professional may grasp the handle **512** and introduce the blade **514** into the oropharynx of a patient by manipulating the handle **512** in order to obtain a view of the vocal cords and the glottis and while attempting to gain access to the patient's airway. After insertion is successfully completed, the front surface **514F** of the blade **514** is positioned toward the patient's front, while the back surface **514B** is positioned toward the patient's back.

[00168] Just like other laryngoscope embodiments in this disclosure, the laryngoscope **500** contains a suction/camera channel **520**, the structure and function of which is substantially similar to the channel **120**. The channel **520** is a passageway in the body of the handle **512** that is further continued through the blade **514**. The channel **520** starts with a proximal end opening **520P** at or near the proximal end **512P** of the handle **512**. The channel **520** ends with a distal end opening **520D** located at or near the distal end **514D** of the blade **514**. The channel **520** may further be connected to a connector **522.** Functions and a location of the connector **522** on the handle **512** are the substantially the same as for the connector **122** of the handle **112**. The handle **512** may further comprise a suction control port **524,** functions and a location of which are substantially the same as those for the suction control port **124** on the handle **112.** The suction control port **524** controls air pressure in the channel **520.** The channel **520** can be further used for housing a camera which can extend distally from the opening **520D** and collect images in real time distally to the distal end **514D** of the laryngoscope **500.**

[00169] The laryngoscope **500** contains an ETT channel **516,** the structure of which is different from the ETT channel **116.** The ETT channel **516** is a passageway in the body of the handle **512.** The ETT channel **516** starts with a proximal end **516D** located at or near the proximal end **512P** of the handle **512.** The ETT channel **516** ends with a distal end opening **516D** at or near the distal end **512D** of the handle **512.** In some alternative embodiments, the distal end opening **516D** may open the **ETT** channel **516** proximally to the distal end **512D** of the handle **512.** An endotracheal tube can be placed into the ETT channel **516.** A distal end of the endotracheal tube can extend from the distal end **516D** of the ETT channel **516**. In some preferred embodiments, the ETT channel **516** also contains a slit along at least a portion of its length such that an endotracheal tube can be placed and removed from the ETT channel **516** through the slit similarly as desribed in connection with the slit **126** shown in **Fig. 24.** Preferably, the ETT channel **516** ends proximally to the proximal end **514P** of the blade **514**. Accordingly, a distal portion of an endotracheal tube which is extending from the distal end

opening **516D** of the ETT channel **516** can be aligned over the back surface **514B** of the blade **514.** This allows for visualization of the endotracheal tube with a camera extending distally from the channel **520**. All procedures can be performed under continuous visualization and suction can be used on demand if/when needed by regulating a pressure through the suction control port **524**.

[00170] Because the ETT channel **516** is located in the body of the handle **512**, the shape of the handle is suitable for manipulations without concerns for damaging or dislocating an endotracheal tube as the ETT channel protects the endotracheal tube from damage and/or deformation. However, because there is no internal ETT channel present in the blade **514**, as the endotracheal tube extends out from the ETT channel **516** at or near the distal end **512D** of the handle **512**, the blade **514** can be made substantially flat or at least flatter than in conventional channel laryngoscopes. It is believed that reducing the thickness of the blade **514** may improve its function for lifting the epiglottis and protecting patient's tissues. In the laryngoscope embodiment **500**, the laryngoscope comprises a guide groove **518**, functions and a location of which are similar to those of the guide groove **118**. The guide groove **518** is preferrably a recess in the wall of the ETT channel **516** and then it may continue as a recess on the external wall of the channel **520** such as that a tool, such as a bougie, can be placed in the groove **518** for guiding an endotracheal tube placed in the ETT channel **516**.

[00171] Referring to **Figs. 31** and **32**, the present disclosure provides yet another embodiment for a laryngoscope, generally **700**. Just like other laryngoscopes of this disclosure, the laryngoscope **700** comprises the handle **712** attached to the blade **714**, as was described in connection with the embodiments of the laryngoscope **100** and/or **500. Fig. 31** depicts the back surface **712B** of the handle **712** and the front surface **714F** and the left flank **714L** of the blade **714**. **Fig. 32** depicts the front surface **712F** of the handle **712** and the back surface **714B** of the blade **714**.

[00172] An ETT channel **716** has substantially the same structure and functions as was described in connection with the ETT channel **516.** The channel **716** starts with a proximal end **716P** at or near the proximal end **712P** of the handle **712**. The channel **716** opens with a distal opening (not shown in **Figs. 31** or **32**) at or near the distal end **712D** of the handle **712.** In some preferred embodiments, the channel **716** can open with a distal end opening proximally to the distal end **712D** such that an endotracheal tube can be placed in the ETT channel **716** and aligned with the blade **714** wherein the ETT extends out the distal end 712D and is aligned externally to the blade **714**.

[00173] In the laryngoscope embodiment **700**, a suction/camera channel **720** has substantially the same structure and functions as was described in connection with the channel **520.** A distal end opening **720D** of the channel **720** is preferably located under the back surface **714B** of the blade **714.** Preferably, the channel **720** ends proximally to the distal end **714D** of the blade **714,** such as the thickness of the blade **714** at the distal end **714D** is as flat as possible and it serves as a flange protecting a camera when the camera is inserted into the channel **720** and the camera extends distally from the channel **720.**

[00174] The suction control port **724** has the same structure and functions as was described in connection with the suction control ports **124** and **524.** A connector **722** with a lumen **723** has substantially the same location, functions and structures as was described in connection with the connector **122.** Unlike the embodiment of laryngoscope **500**, the laryngoscope **700** does not contain a guide groove.

[00175] Referring to **Figs. 33** and **34**, they depict another embodiment for a laryngoscope according to this disclosure, generally **800**. Just like other laryngoscopes of this disclosure, the laryngoscope **800** comprises the handle **812** attached to the blade **814**, as was described in connection with the embodiments of the laryngoscope **100, 500** and **700. Fig. 33** depicts the back surface **812B** of the handle **812** and the front surface **814F** and the left flank **814L** of the blade **814**. **Fig. 34** depicts a bougie **208** assembled with the laryngoscope **800**.

[00176] The laryngoscope **800** contains an ETT channel **816,** the structure of which is similar to that of the **ETT** channels **516** and **716.** The channel **816** starts with a proximal end **816P** at or near the proximal end **812P** of the handle **812**. The channel **816** opens with a distal opening (not shown in **Figs. 33** or **34**) at or near the distal end **812D** of the handle **812.** In some preferred embodiments, the channel **816** can open with a distal end opening proximally to the distal end **812D** such that an endotracheal tube can be placed in the ETT channel **816** and aligned with the blade **814** wherein the ETT extends out the distal end **812D** and is aligned externally to the blade **814**.

[00177] In the laryngoscope embodiment **800**, a suction/camera channel **820** has substantially the same structure and functions as was described in connection with the channel **520.** A distal end opening **820D** of the channel **820** is preferably located under the back surface **814B** of the blade **814.** Preferably, the channel **820** ends proximally to the distal end **814D** of the blade **814,** such as the thickness of the blade **814** at the distal end **814D** is as flat as possible and it serves as a flange protecting a camera when the camera is inserted into the channel **820** and the camera extends distally from the channel **820.**

[00178] A connector **822** with a lumen has substantially the same location, functions and structures as was described in connection with the connector **122.**

[00179] Unlike other embodiments, the laryngoscope **800** contains a guide groove **818** formed as a recess (notch) on the surface for at least a portion of the handle **812** length. In the embodiment of **Fig. 33**, the guide groove **818** starts with a proximal end **818P** located at or near the proximal end **812P** of the handle **812**. In the embodiment of **Fig. 33**, the guide groove **818** is located on the front surface **812F** of the handle **812**. In other embodiments, the guide groove **818** may be located on the back surface **812B** or on one of the flank surfaces **812L** or **812R**.

[00180] In the embodiment of **Fig. 33**, the guide groove **818** continues as a recess (notch) on the front surface **814F** of the blade **814** for at least a portion of the blade **814** length. The guide groove **818** ends with a distal end **818D** located at or near the distal end **814D** of the blade **814**. In other embodiments, the guide groove **818** may be formed on the back surface **814B** of the blade **814** or in one of the flanks **814L** or **814R.**

[00181] A depth of the guide groove **818** is compatible with a bougie **208** which can be placed in the guide groove **818** as shown in **Fig. 34**.

[00182] In further embodiments, any of the laryngoscopes **100**, **200**, **500**, **700** or **800** may further comprise at least one camera/tool channel **28** as was discussed in connection with laryngoscope embodiment **10**.

[00183] In yet another aspect, the present disclosure provides methods for gaining access to patient's airway with the laryngoscope according to this disclosure, as may be needed in medical emergency and/or in order to facilitate endotracheal intubation during certain surgical procedures, in general anesthesia and/or under other circumstances when a patient cannot breathe unassisted or examination of patient's airway may be needed. In some of these methods, a healthcare professional may position at least one camera attached to a cable or wand, e.g., the camera **210**, in the suction/camera channel and/or the ETT channel of the laryngoscope **10**, **100**, **200, 500**, **700**, or **800** and then further optionally inserting a bougie, e.g., the bougie **208**, in the ETT channel and preferably, in the guide groove if present. Certain embodiments of the methods may further include positioning an endotracheal tube, e.g., the endotracheal tube **406**, in the ETT channel. Some of the technical advantages for the laryngoscopes according to this disclosure is that the ETT channel is located inside the laryngoscope handle, protecting an endotracheal tube from deformation and/or damage and providing the opportunity to assemble an endotracheal tube with the laryngoscope before a procedure starts.

[00184] A healthcare practitioner can then introduce the blade of the laryngoscope according to this disclosure into the oropharynx by manipulating the handle and the bougie **208**. The healthcare practitioner can then advance the blade into the hypopharynx and lift the epiglottis. All these procedures can be performed under continuous visualization, including real-time images of the upper airway, glottic aperture and vocal cords with the camera **210** preferably positioned in the suction/camera channel, e.g., **20** or **120,** and/or the ETT channel, e.g., **116** or **516.**

[00185] The methods may further comprise connecting any of the laryngoscopes to an air/suction/vacuum source through the conduit (connector) and aspirating bodily secretions through the connector. The methods may further comprise keeping the airway accessible with the laryngoscope, and then positioning an endotracheal tube, e.g., the endotracheal tube **406** through the vocal cords by extending the distal end **406D** of the endotracheal tube **406** from the distal end of the ETT channel. The placement of the endotracheal tube **406** can be conducted under continuous visualization by the camera **210** positioned preferably in the suction/camera channel. The placement can be guided with a bougie **208** positioned in the ETT channel. If it is necessary to aspirate body secretions at any time during any of these procedures, the laryngoscope can be connected to a suction/vacuum source through the suction connector and suction can take place without the need for inserting a separate suction catheter. Once the endotracheal tube **406** has been placed and its placement has been verified, the laryngoscope can be separated from the endotracheal tube **406** through the slit in the wall of the ETT channel. This separation step can be performed at the same time while the endotracheal tube **406** still remains positioned in place and providing ventilation to a patient.

[00186] In some embodiments of this disclosure, procedures can be conducted while the cuff **202** of the laryngoscope **200** is inflated. The laryngoscopes according to this disclosure can be used for various medical procedures, including, but are not limited to, conducting examination of an airway, gaining and maintaining access to an airway, assisting a patient with breathing, delivering a medication, and/or inserting an endotracheal tube.

[00187] In yet another aspect, the present disclosure provides methods for manufacturing the laryngoscopes according to this disclosure. The laryngoscope can be molded from one or more different plastic materials. In some embodiments, the handle and the blade can be made as two separate pieces which can be assembled together. In some embodiments, the handle may be attached detachably to the blade. The ETT channel, the suction/camera channel and any other channels, if present, can be designed in the mold and/or the channels can be extruded

from the body of the laryngoscope. In some preferred embodiments, the laryngoscopes according to this disclosure can be disposable. Suitable cameras can be disposable or reusable.

[00188] From the foregoing description, all objections of the present invention are realized. A laryngoscope containing an ETT channel and/or suction/camera channel, systems comprising the laryngoscope, methods of their use, and manufacturing methods have been described. Certain additional embodiments may include the following.

[00189] Embodiment 1. A laryngoscope comprising a suction/camera channel, a handle and a blade with a proximal end and a distal end, the handle comprising a body with a distal end and a proximal end, the body being attached at the distal end to the proximal end of the blade, wherein the blade has a back surface and a front surface, wherein the laryngoscope contains at least one camera/suction entry port located on the body of the handle, the camera/suction entry port opening into the suction/camera channel located inside the body of the handle, the suction/camera channel opening with a camera/suction port on the back surface of the blade.

[00190] Embodiment 2. The laryngoscope of embodiment 1, wherein the handle is attached to the blade removably.

[00191] Embodiment 3. The laryngoscope of embodiment 1 or 2, wherein the suction/camera channel comprises a tube.

[00192] Embodiment 4. The laryngoscope of embodiment 1, 2 or 3, wherein the suction/camera channel comprises a tube which insertable into and removable from the body of the handle.

[00193] Embodiment 5. The laryngoscope of any one of embodiments 1-4, wherein the body of the handle further comprises a suction control port.

[00194] Embodiment 6. The laryngoscope of any one of embodiments 1-5, wherein the blade is curved.

[00195] Embodiment 7. The laryngoscope of any one of embodiments 1-6, wherein the laryngoscope further comprises a camera sheath insertable and removable from the suction/camera channel.

[00196] Embodiment 8. The laryngoscope of embodiment 7, wherein the camera sheath contains a sealed window at the distal end.

[00197] Embodiment 9. The laryngoscope of any one of embodiments 1-8, wherein the laryngoscope further comprises a camera/tool channel attached to the surface of the body of the handle and/or the camera/tool channel comprises a groove shaped in the surface of the body of the handle, wherein the camera/tool channel has a distal end and a proximal end, and wherein

the distal end of the camera/tool channel opens on the back surface of the blade or on the side of the back surface of the blade, and wherein the proximal end of the camera/tool channel is positioned on the body of the handle.

[00198] Embodiment 10. The laryngoscope of any one of embodiments 1-9, wherein the camera/tool channel comprises a groove.

[00199] Embodiment 11. The laryngoscope of any one of embodiments 1-10, wherein the laryngoscope further comprises an adaptor attached to the camera/suction entry port.

[00200] Embodiment 12. The laryngoscope of any one of embodiments 1-11, wherein the body of the handle is substantially hollow.

[00201] Embodiment 13. The laryngoscope of any one of embodiments 1-12, wherein the laryngoscope further comprises a camera attached to a wand, the camera being insertable into and removable from the suction/camera channel.

[00202] Embodiment 14. An airway management device comprising the laryngoscope of any one of embodiments 1-13 and one or more of the following: at least one camera insertable and removable from the suction/camera channel, at least one bougie and/or at least one stopper for closing the camera/suction entry port.

[00203] Embodiment 15. A system for endotracheal intubation, the system comprising the laryngoscope according to any one of embodiments 1-13 attached to an air/vacuum/suction source and a camera inserted in the laryngoscope and capable of capturing images distally from the back surface of the blade.

[00204] Embodiment 16. A method for managing patient’s airway, the method comprising inserting a camera in the camera/suction channel of the laryngoscope according to any one of embodiments 1-13, inserting a bougie into the camera/tool channel, inserting the blade into the oropharynx by manipulating the handle and with assistance from the bougie under continuous visualization by the camera.

[00205] Embodiment 17. The method of embodiment 16, wherein the method further comprises connecting the laryngoscope to an air/suction/vacuum source and establishing suction through the suction/camera channel and aspirating bodily secretions through the camera/suction port.

[00206] Embodiment 18. The method of embodiment 16 or 17, wherein suction is conducted under visualization by the camera.

[00207] Embodiment 19. The method of embodiment 16, 17 or 18, wherein the method further comprises opening and/or closing the suction control port.

CLAIMS

What is claimed is:

1. A laryngoscope comprising a handle and a blade,

 wherein the handle has a body with a proximal end and a distal end and having a length between the proximal end and the distal end,

 wherein the blade is curved and adopted to the contour of a human larynx and wherein the blade has a distal end, a proximal end, a front surface, a back surface, a left flanking surface and a right flanking surface, and

 wherein the handle is attached at its distal end to the proximal end of the blade, and

 wherein the laryngoscope comprises an endotracheal tube (ETT) channel having a passageway encircled by a wall in the body of at least a portion of the handle length, wherein the ETT channel has a proximal end opening located at or near the proximal end of the handle and wherein the ETT channel has a distal end opening, and

 wherein the laryngoscope further comprises a suction/camera channel formed as a passageway in the body of the laryngoscope, wherein the suction/camera channel has a proximal end opening located at or near the proximal end of the handle and wherein the suction/camera channel has a distal end opening located at or near the distal end of the blade and wherein the suction/camera channel has a diameter compatible for positioning a camera in the suction/camera channel.

2. The laryngoscope of claim 1, wherein the blade contains a protective flange extending distally from the distal end of the blade front surface and wherein the flange is distal to the distal end opening of the ETT channel.

3. The laryngoscope of claim 1, wherein the ETT channel contains a slit opening the ETT channel onto at least one surface of the laryngoscope.

4. The laryngoscope of claim 3, wherein the slit opens the ETT channel to the left flanking surface or to the right flanking surface of the laryngoscope.

5. The laryngoscope of claim 1, wherein the ETT channel opens with its distal end proximally to or at the distal end of the handle.

6. The laryngoscope of claim 1, wherein the ETT channel from the handle continues through at least a portion of the blade length and wherein the ETT channel opens with its distal end proximally to or at the distal end of the blade.

7. The laryngoscope of claim 1, wherein the laryngoscope comprises one or more guide grooves formed as a recess in at least a portion of the wall of the ETT channel and/or one or more guide grooves formed as a recess in one or more external surfaces of the handle and/or the blade, and wherein a depth of the guide groove is compatible with placing a bougie in the guide groove.

8. The laryngoscope of claim 1, wherein the laryngoscope further comprises a connector extending from the body of the handle, the connector comprising a lumen enclosed by a wall, the lumen opening into the suction/camera channel, wherein the connector is a port for connecting the suction channel to an oxygen, suction and/or vacuum source.

9. The laryngoscope of claim 1, wherein the laryngoscope further comprises a suction control port located on the handle, wherein the suction control port is a lumen in the body of the handle and wherein the lumen is connected to the suction channel, and wherein the air pressure inside the suction lumen is controllable by opening and closing the suction control port.

10. The laryngoscope of claim 9, wherein the suction control port is located in a proximal portion of the front surface of the handle.

11. The laryngoscope of claim 9, wherein the suction control port is positioned on the front surface of the handle and proximally to the connector.

12. The laryngoscope of claim 1, wherein the laryngoscope further comprises a cuff attached to the distal portion of the blade, wherein the cuff is located proximally to the distal end of the blade, and wherein the distal end opening of the ETT channel and the distal end opening of the suction/camera channel are located distally to the cuff.

13. The laryngoscope of claim 12, wherein the cuff is inflatable and wherein the laryngoscope further contains a means for inflating the cuff.

14. A system comprising the laryngoscope of claim 1, the system further comprising one or more of the following items:

    a) a camera adapter, wherein the camera adapter is a substantially cylindrical body enclosing a lumen for housing a camera;
    b) a channel adapter having a substantially conical body formed by a wall that encloses a lumen, the body having a distal end and a proximal end and a length between the distal end and a proximal end, wherein the conical body has a first diameter (d1) at the distal end and a second diameter (d2) at the proximal end, wherein the first diameter (d1) is smaller than the second diameter (d2), and wherein the first diameter (d1) is smaller than a diameter of the proximal end opening of the suction channel, and wherein the second diameter (d2) is larger than the diameter of the proximal end opening of the suction channel;
    c) a bougie; and/or
    d) a camera.

15. An assembly comprising the laryngoscope of claim 1, a camera positioned in the suction/camera channel of the laryngoscope and an endotracheal tube positioned in the ETT channel of the laryngoscope.

16. A method for treating a patient, the method comprising placing a camera into the suction/camera channel of the laryngoscope according to claim 1 and introducing the assembly into patient’s upper oral airway.

17. The method of claim 16, wherein the method further comprises manipulating the laryngoscope with assistance of a bougie positioned in a guide groove of the laryngoscope.

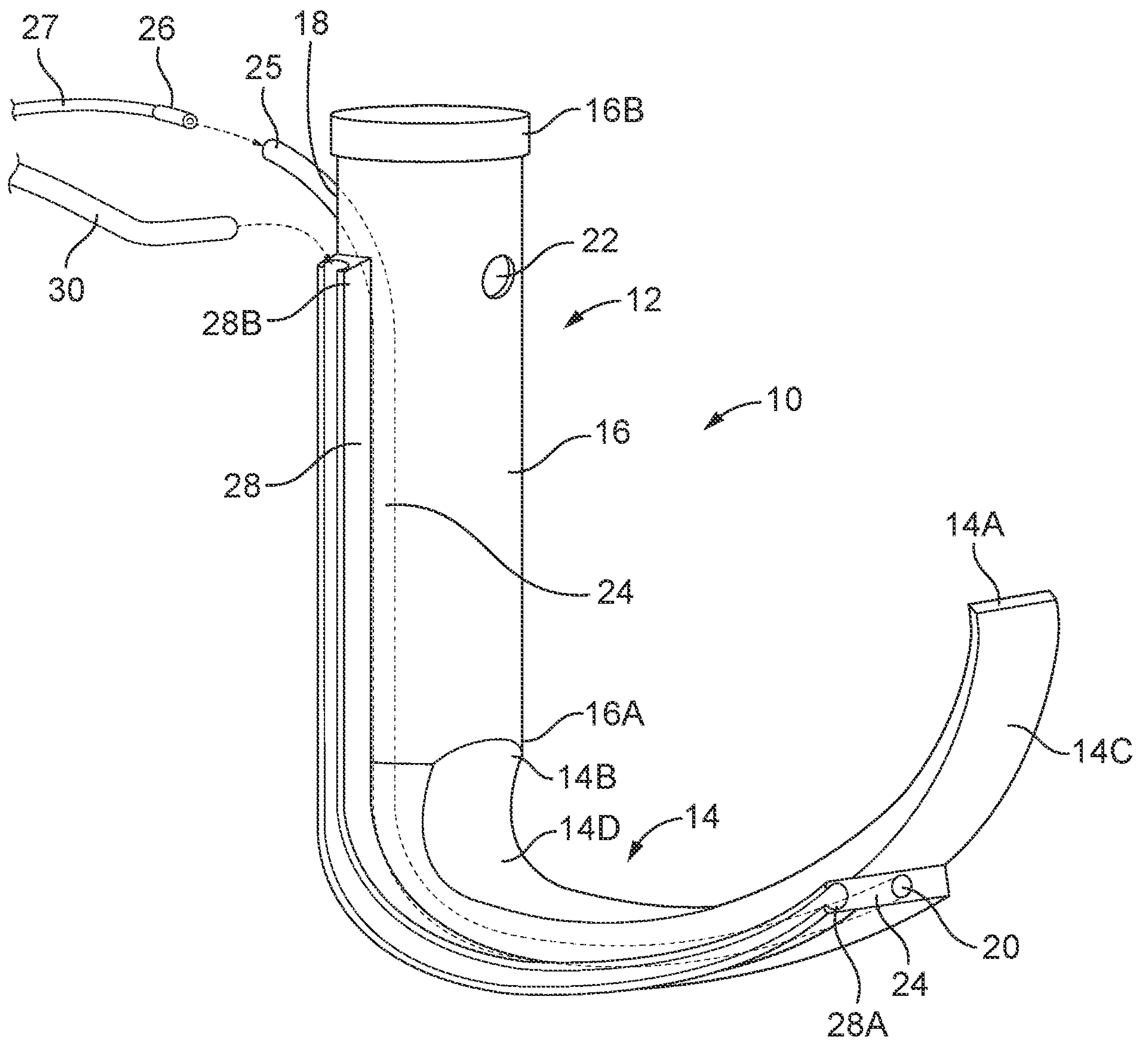

FIG. 1

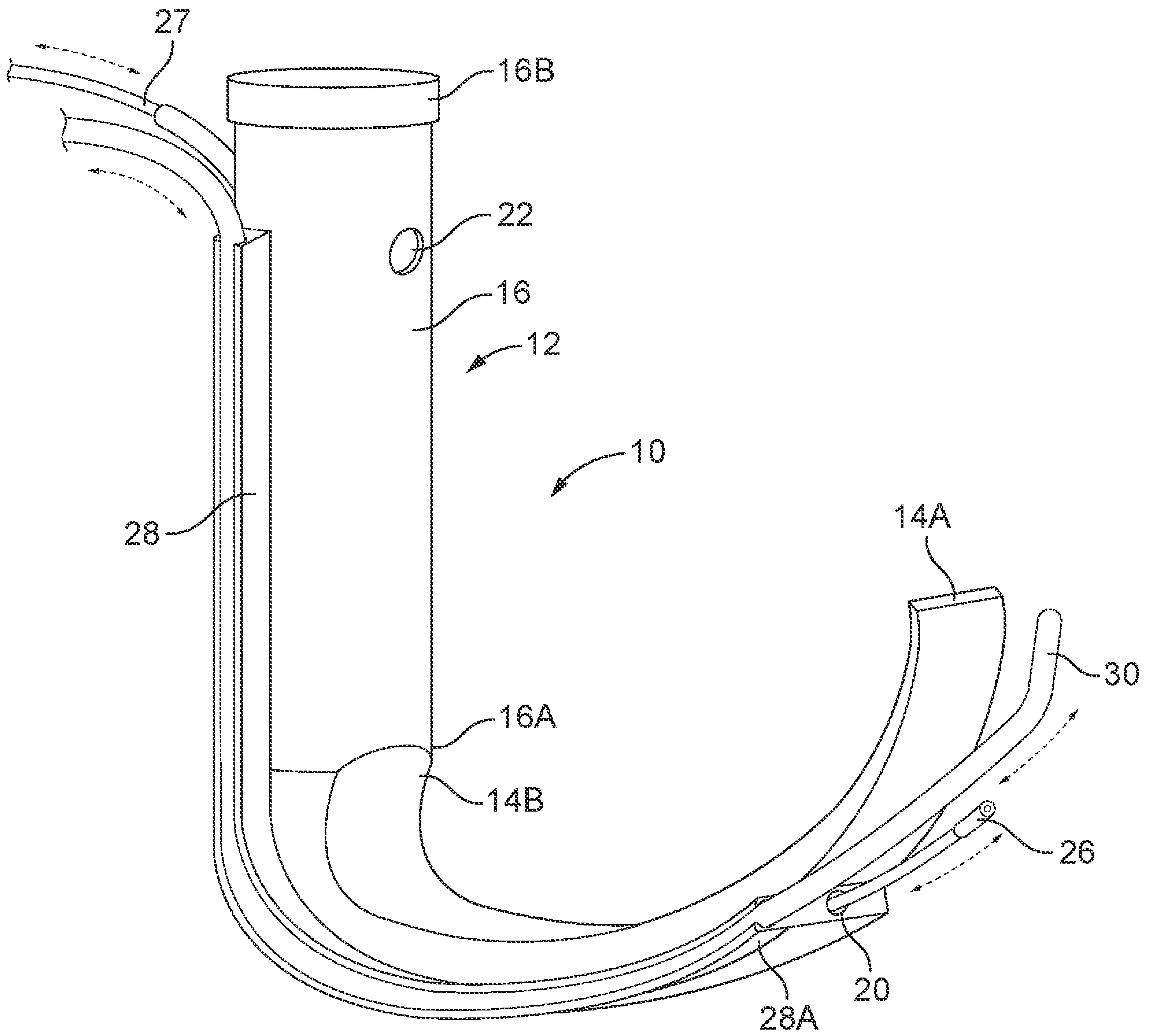

FIG. 2

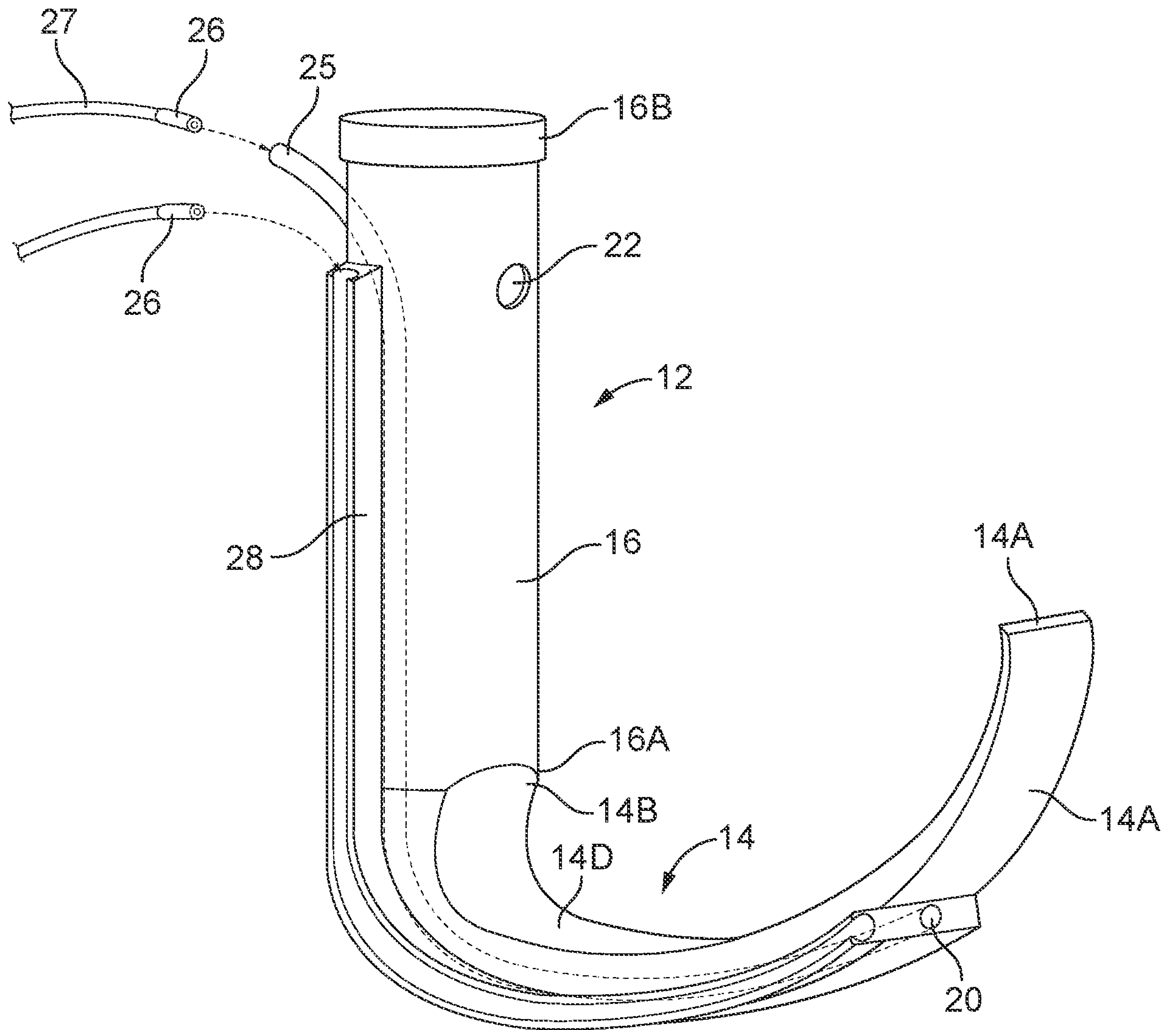

FIG. 3

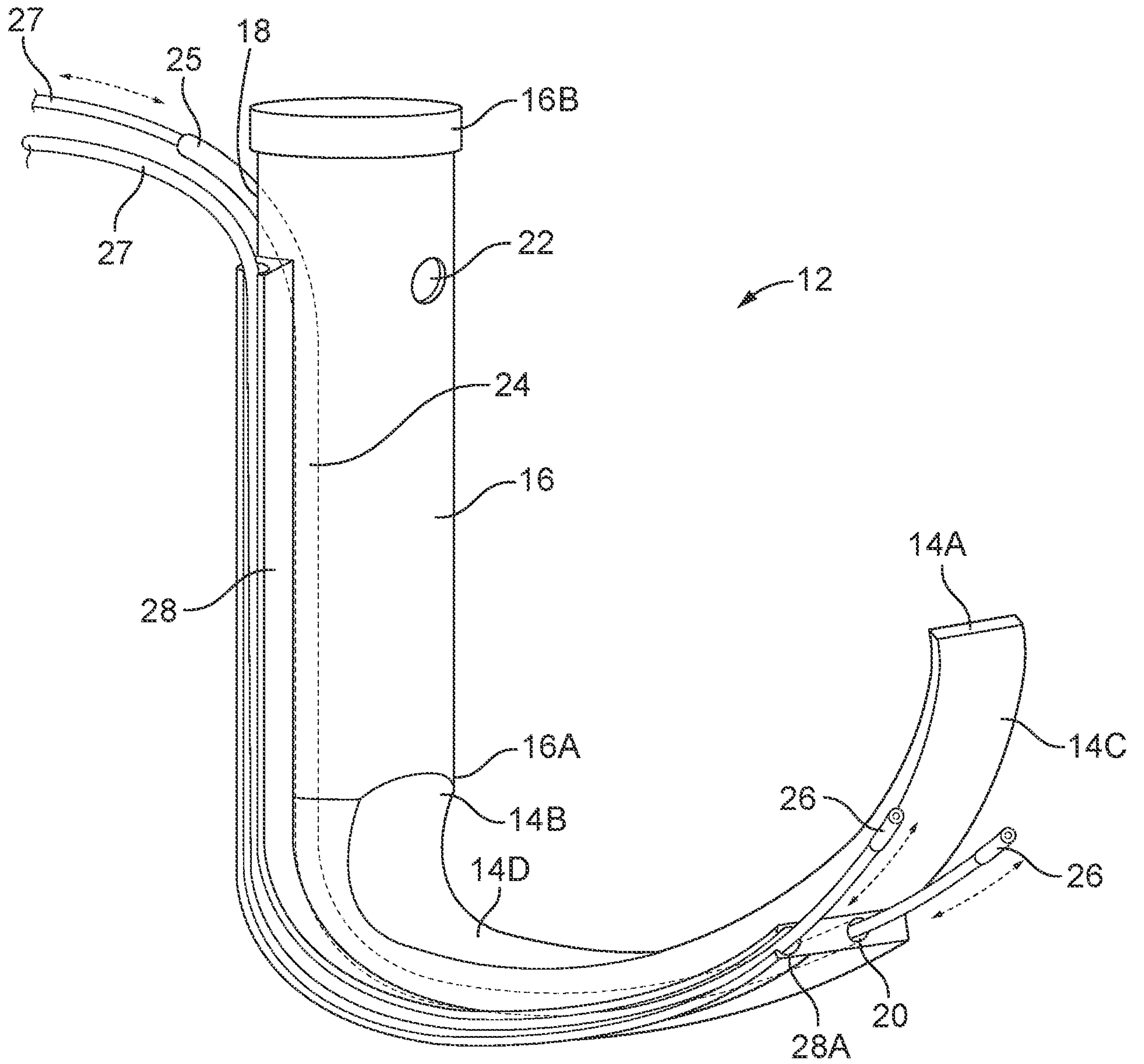

FIG. 4

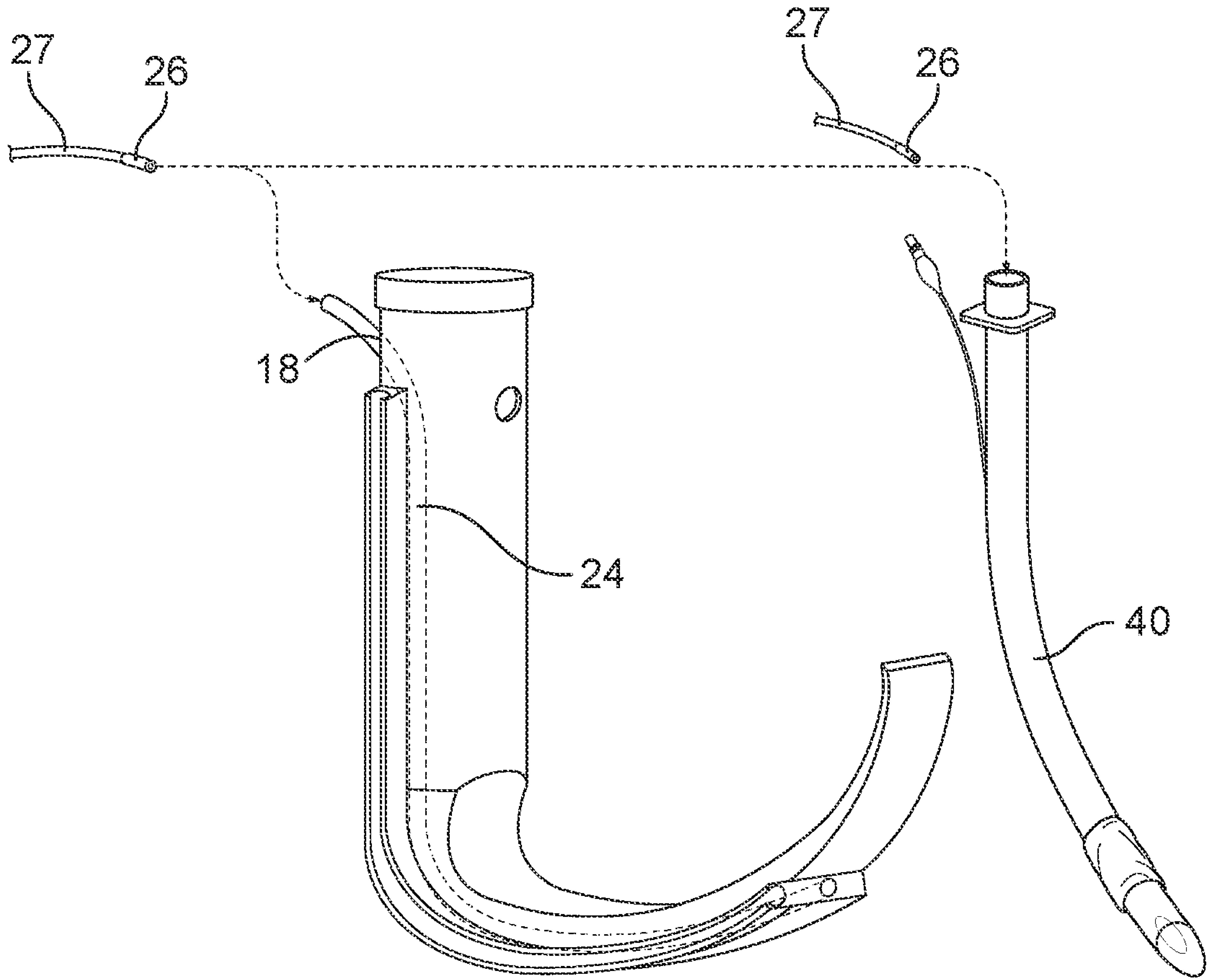

FIG. 5

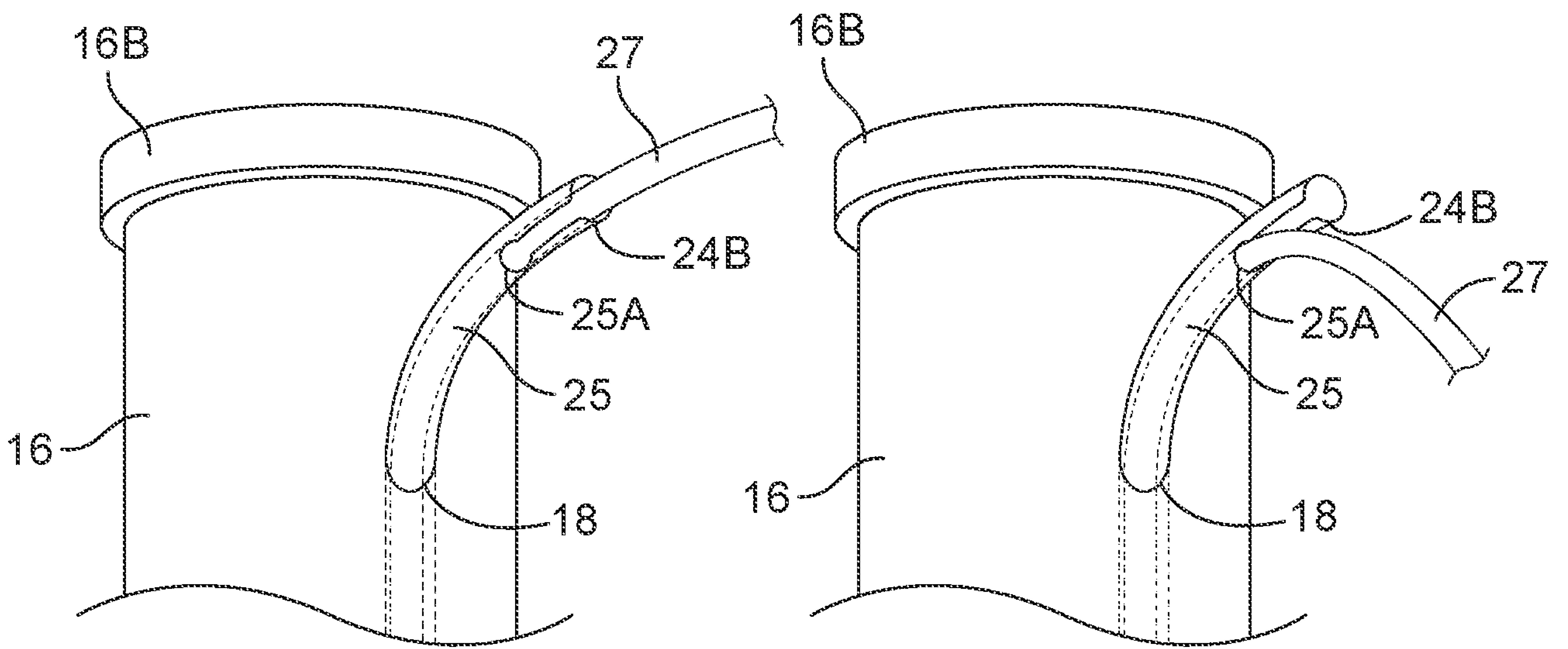

FIG. 6

FIG. 7

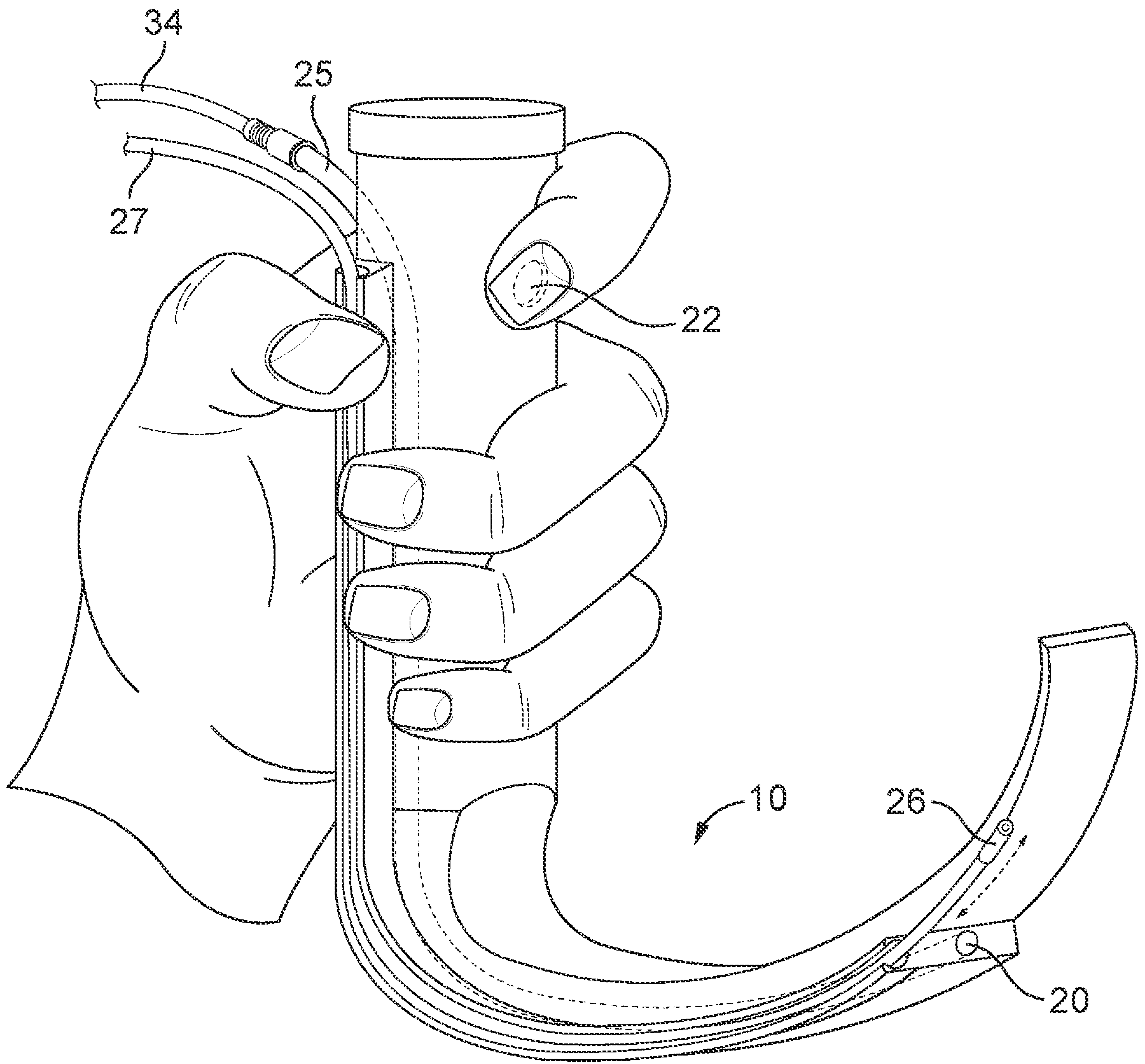

FIG. 8

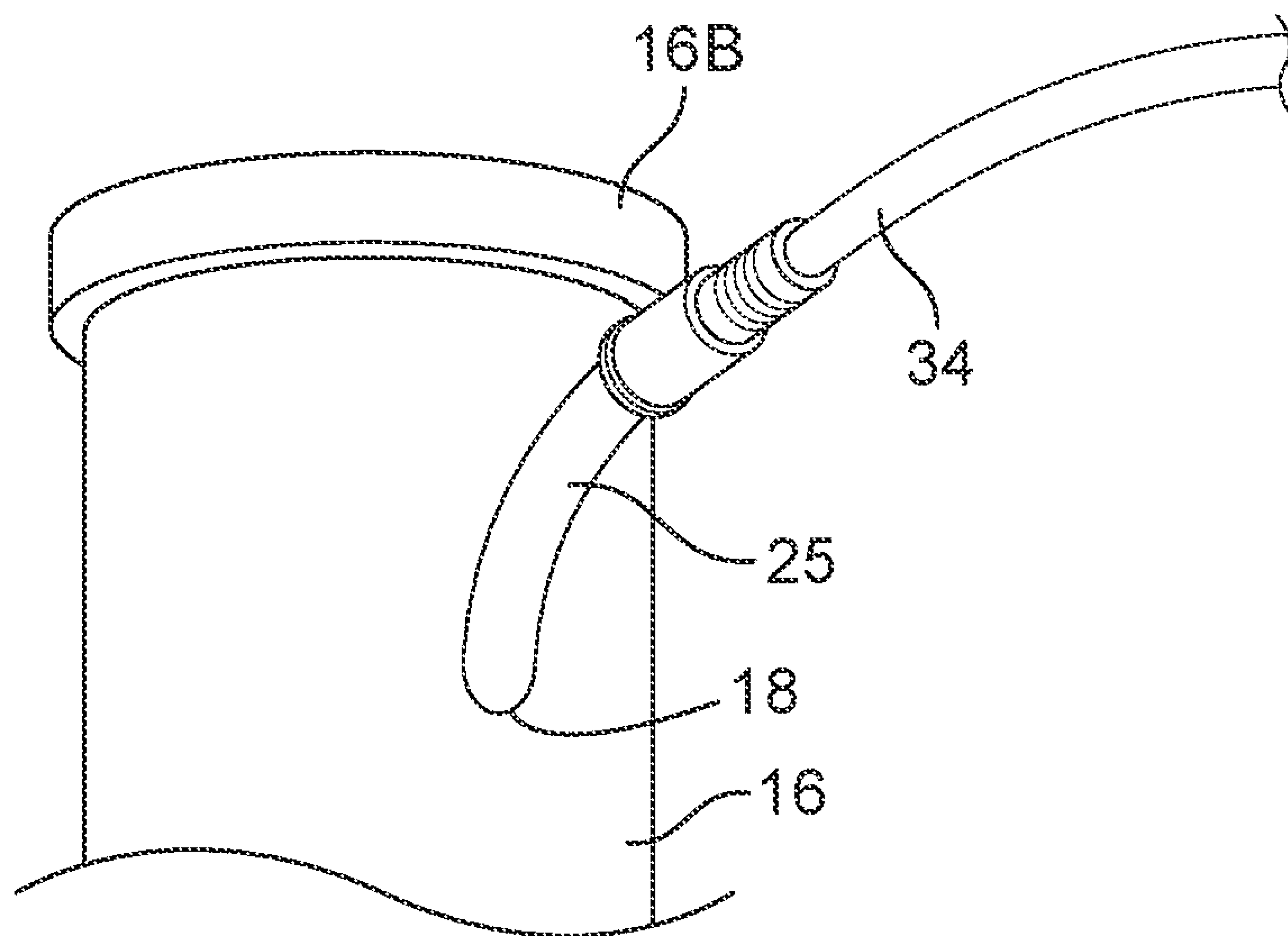

FIG. 9

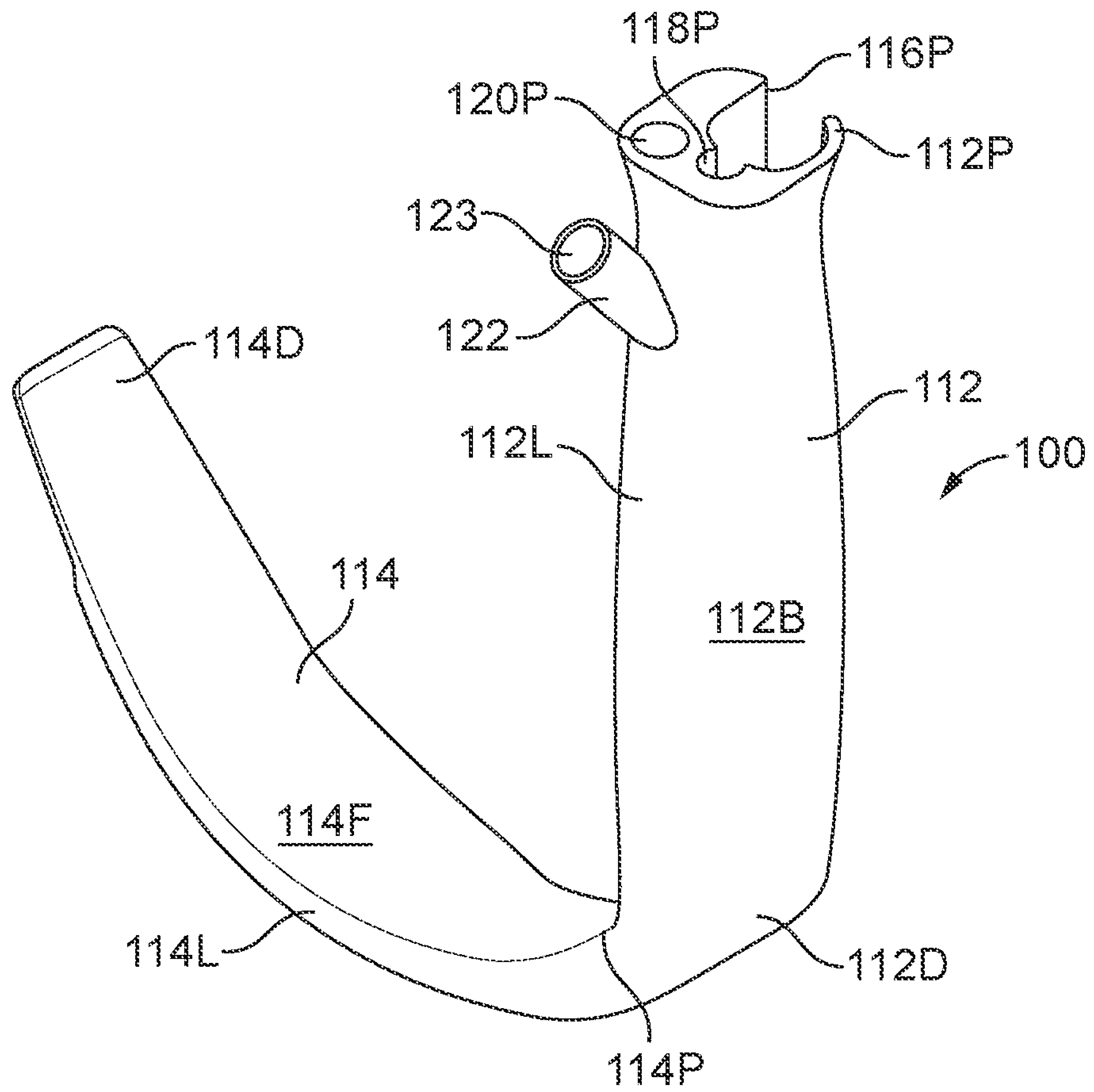

FIG. 10

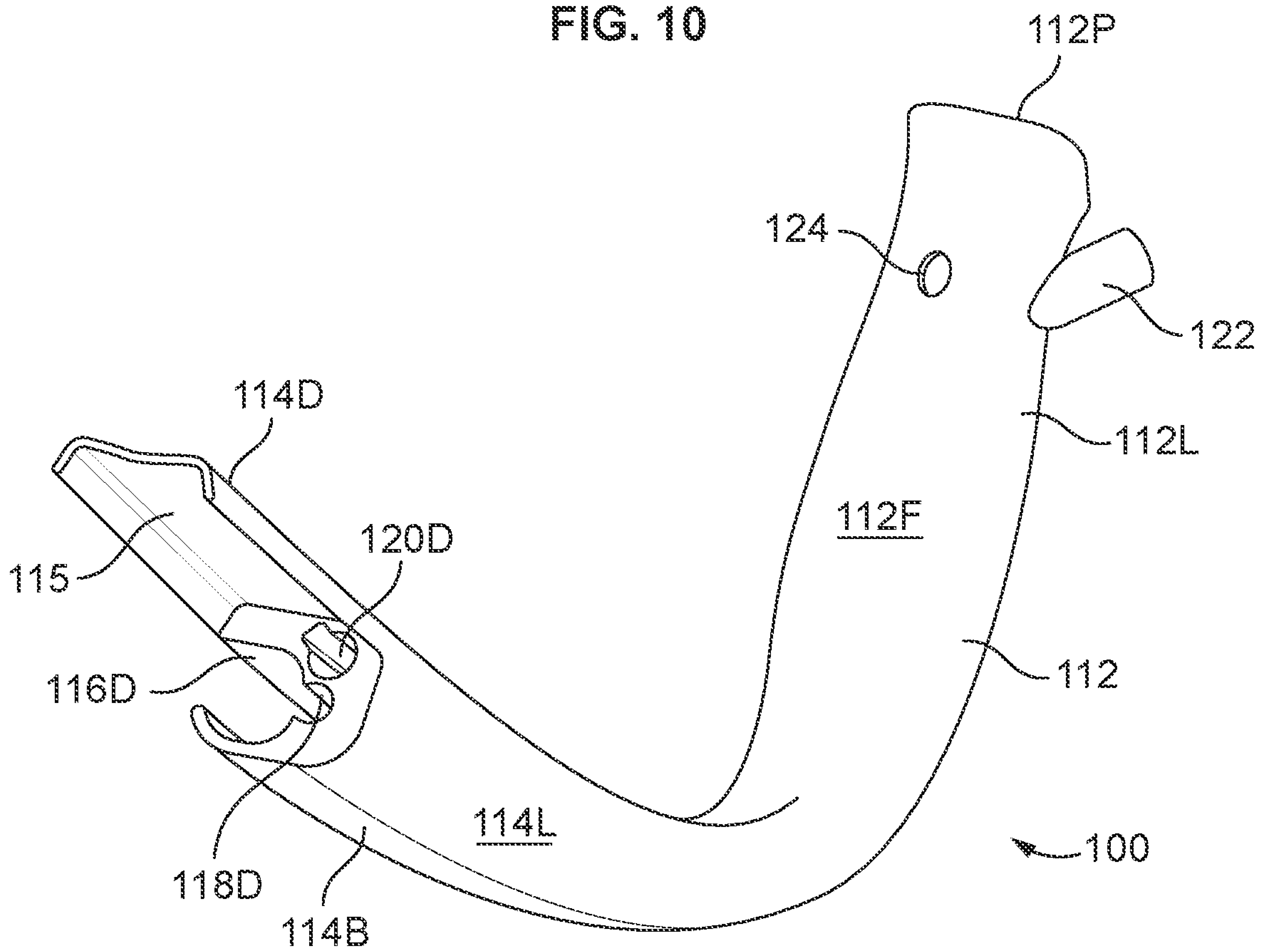

FIG. 11

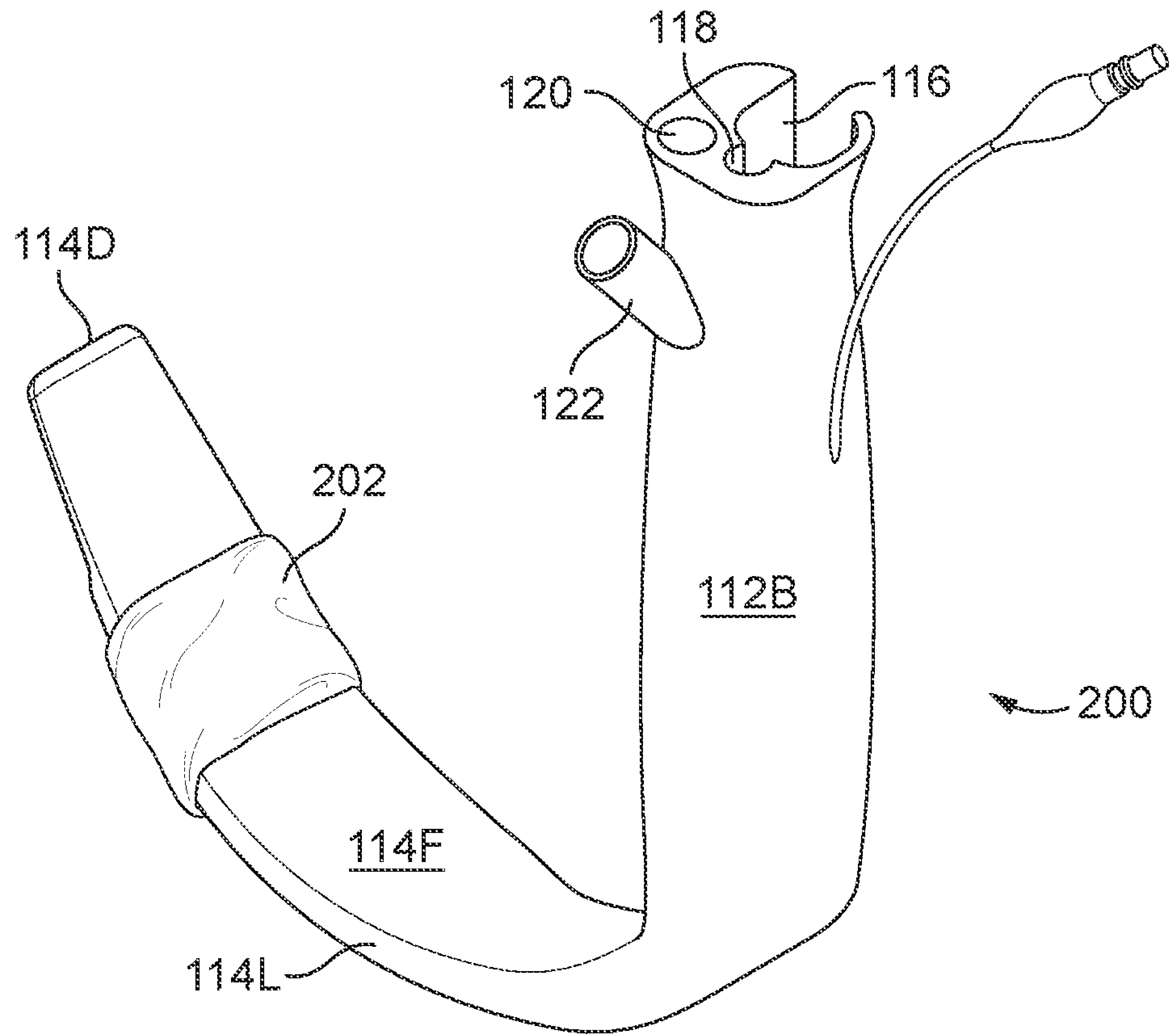

FIG. 12

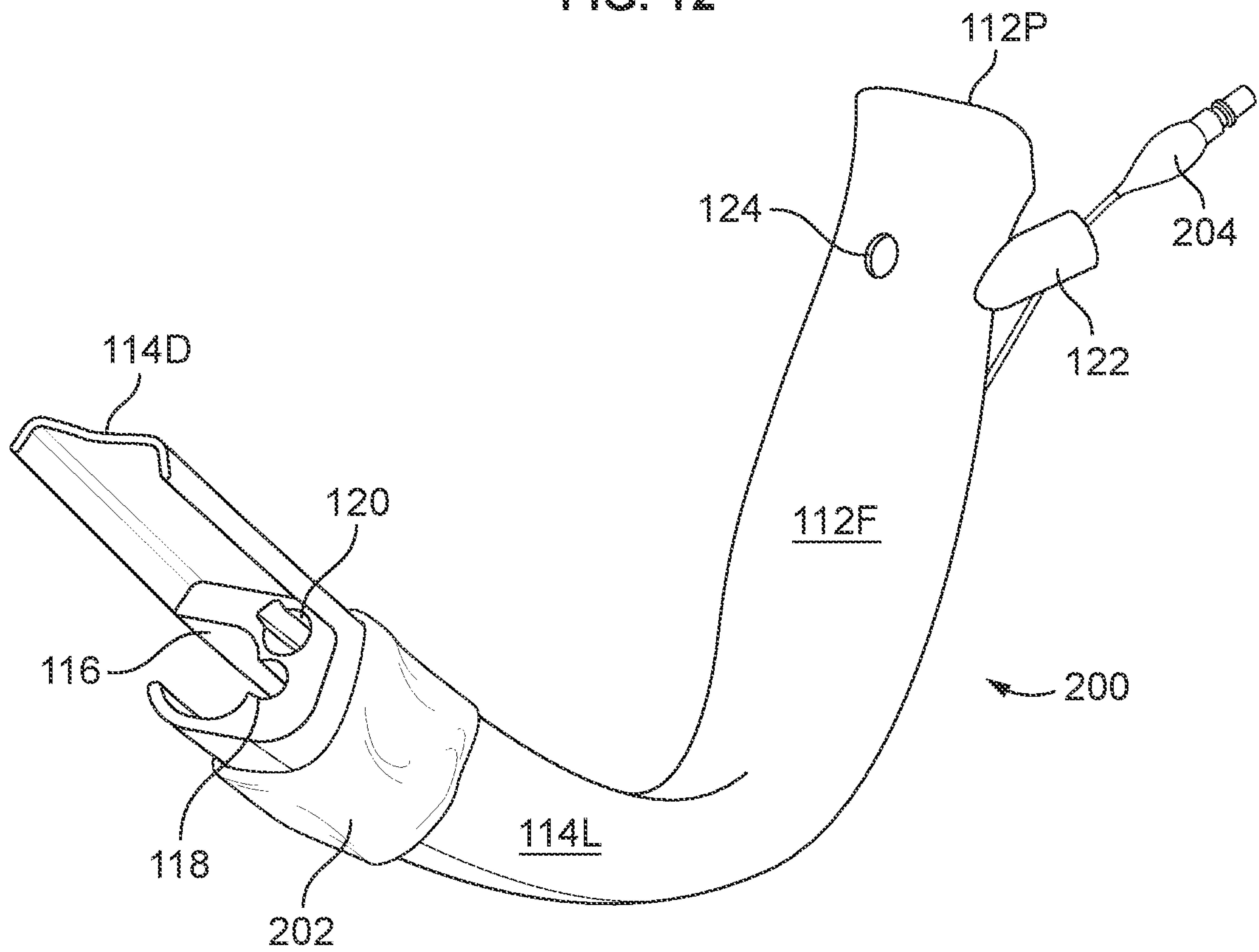

FIG. 13

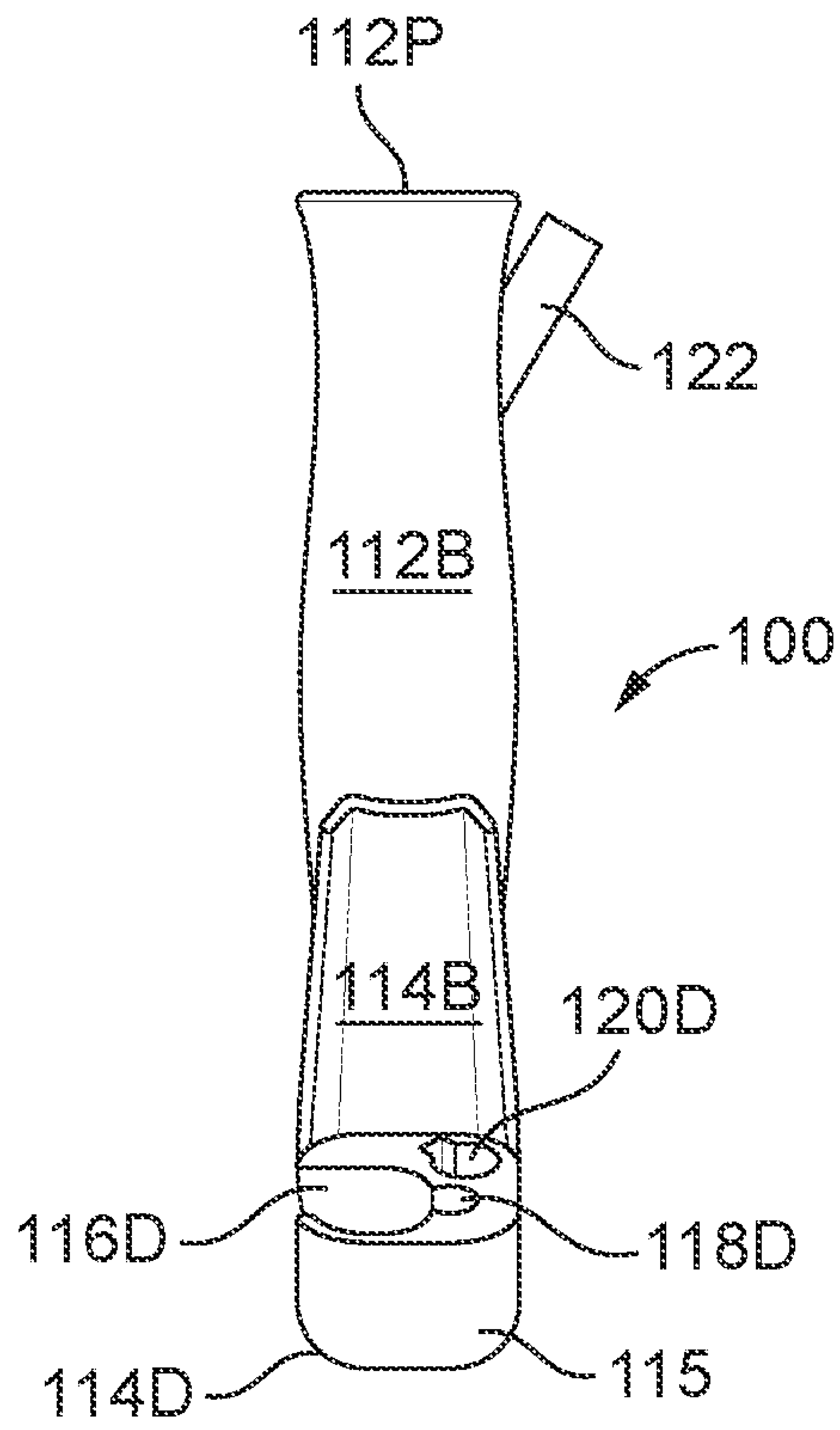

FIG. 14

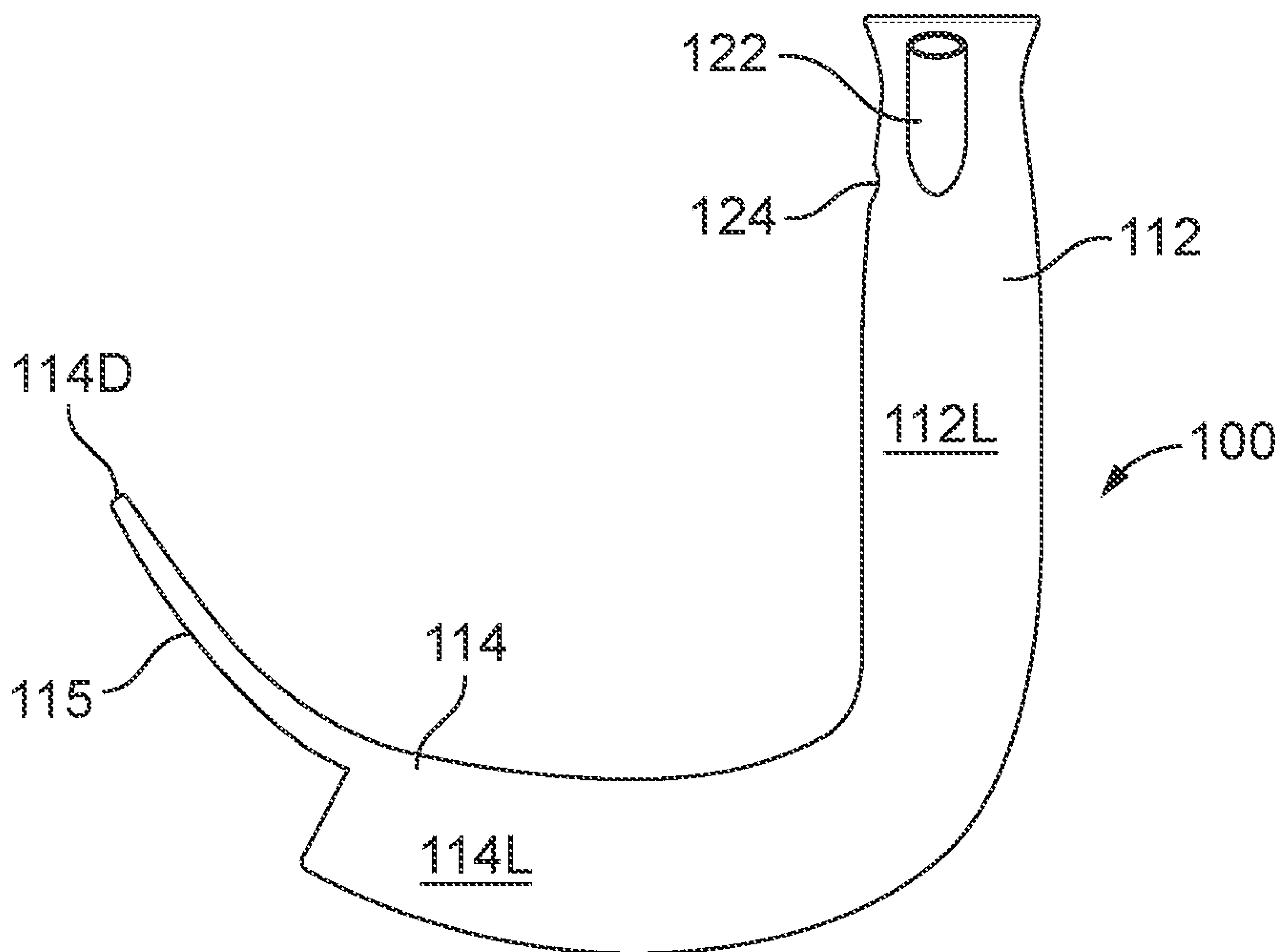

FIG. 15

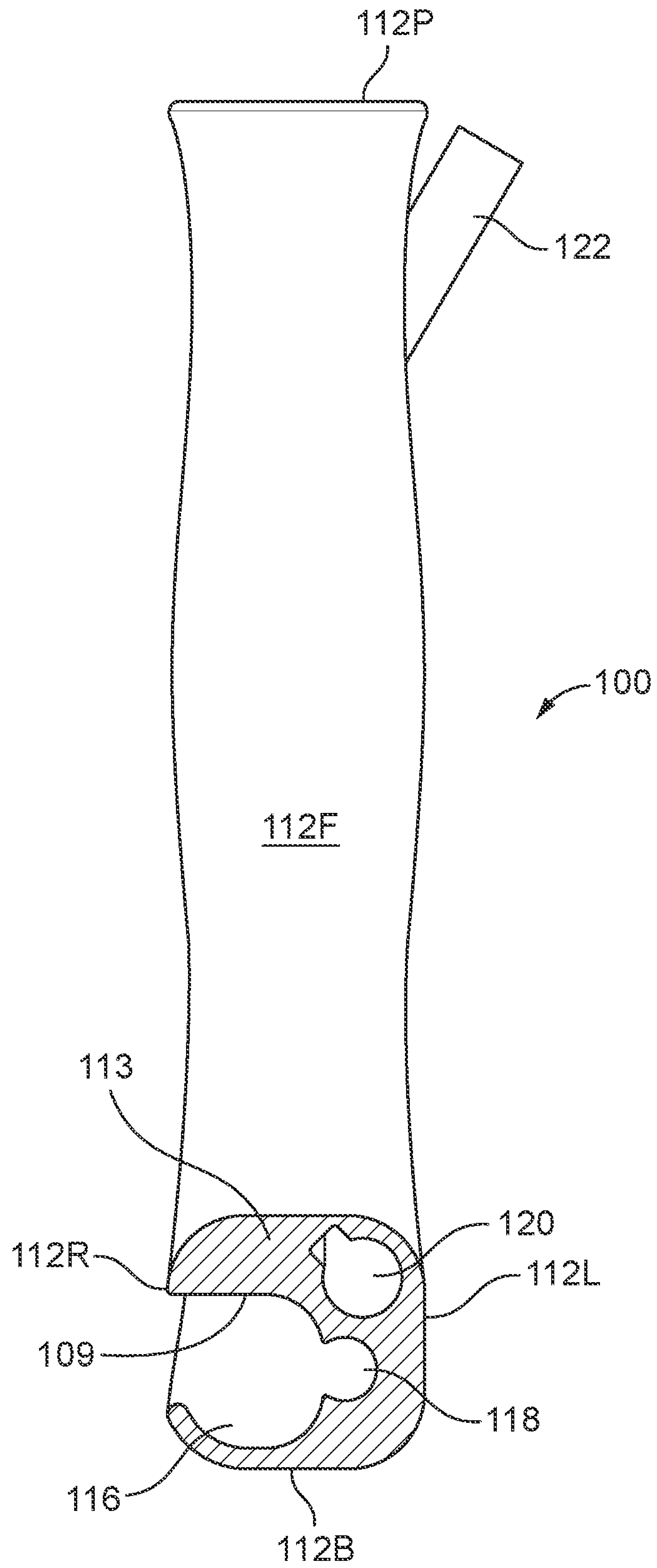

FIG. 16

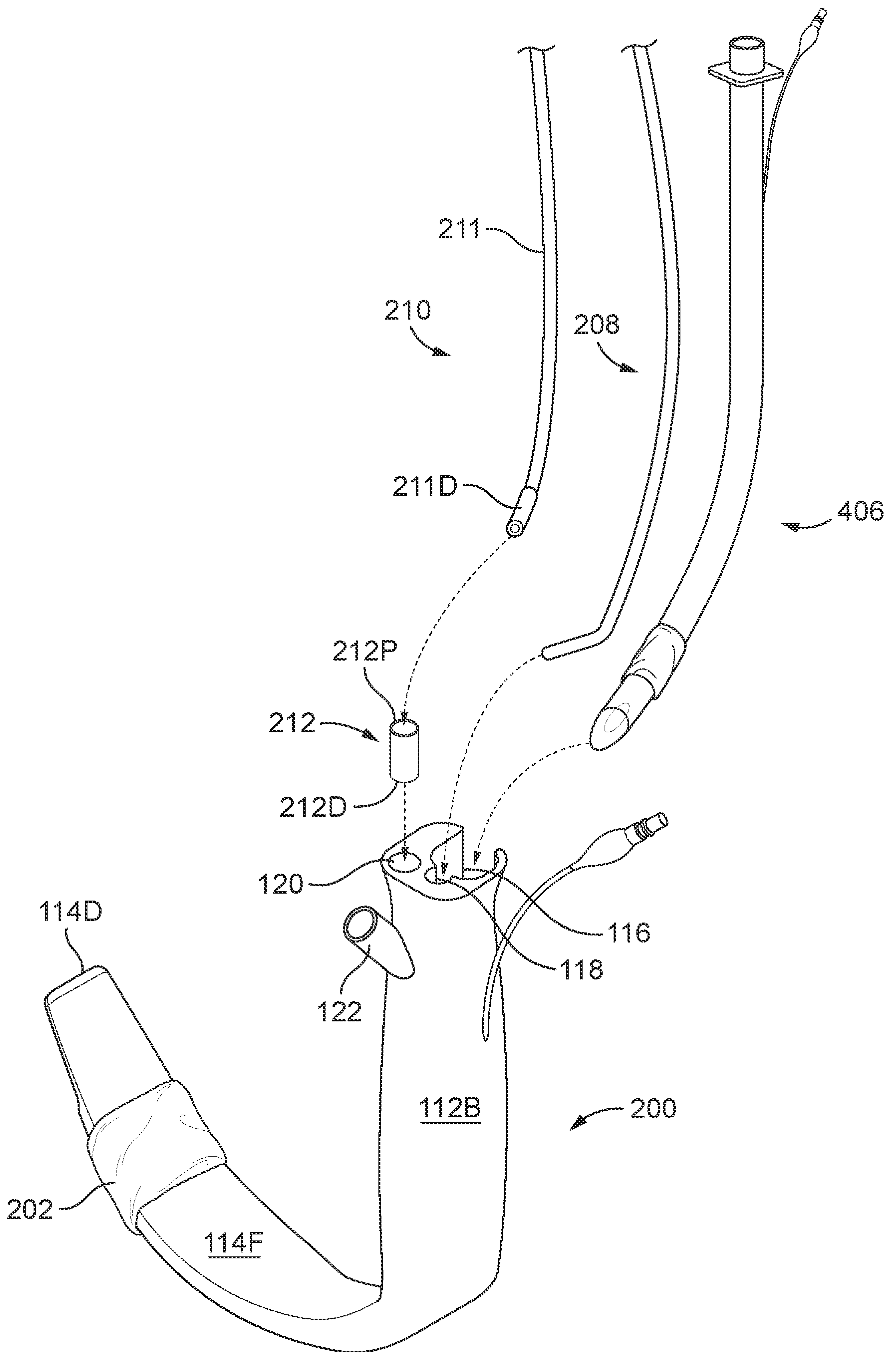

FIG. 17

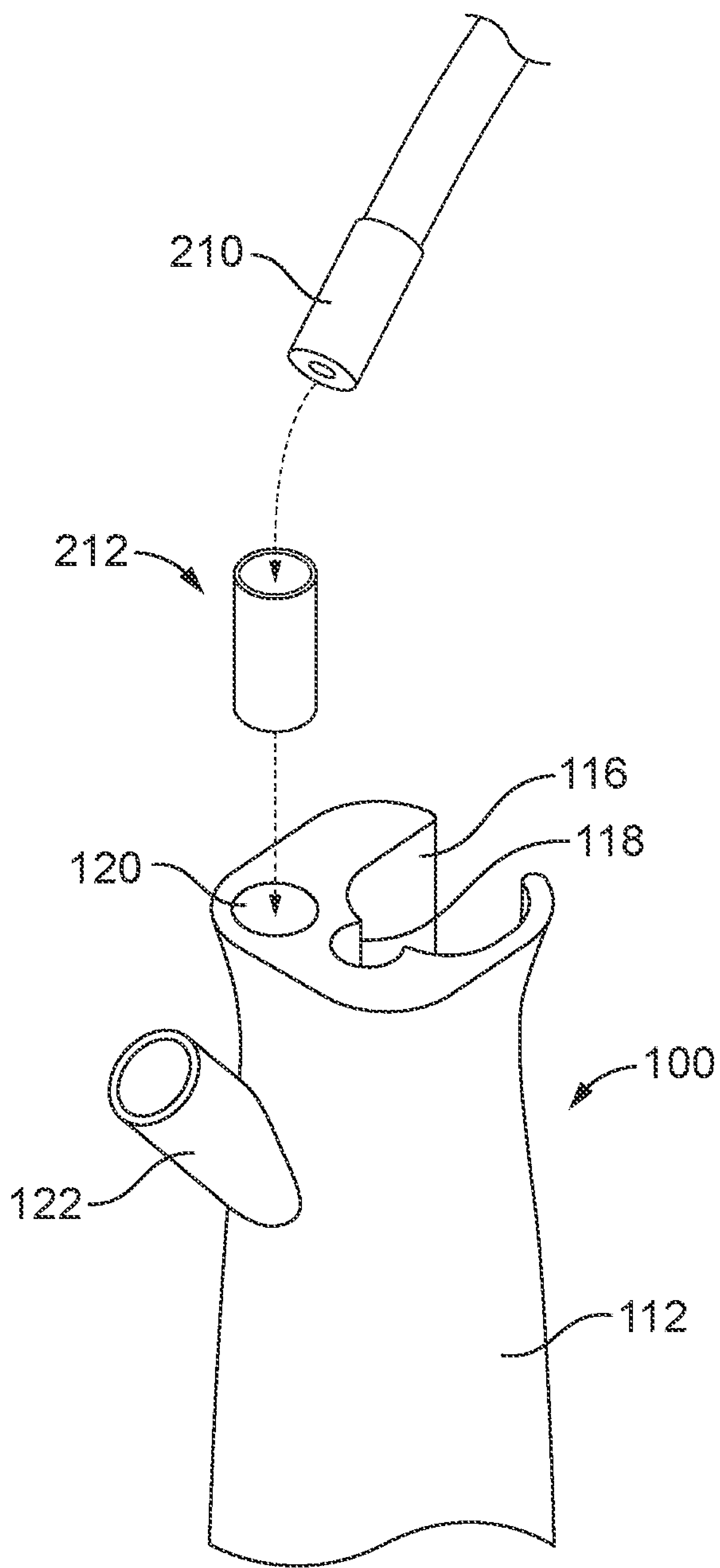

FIG. 18

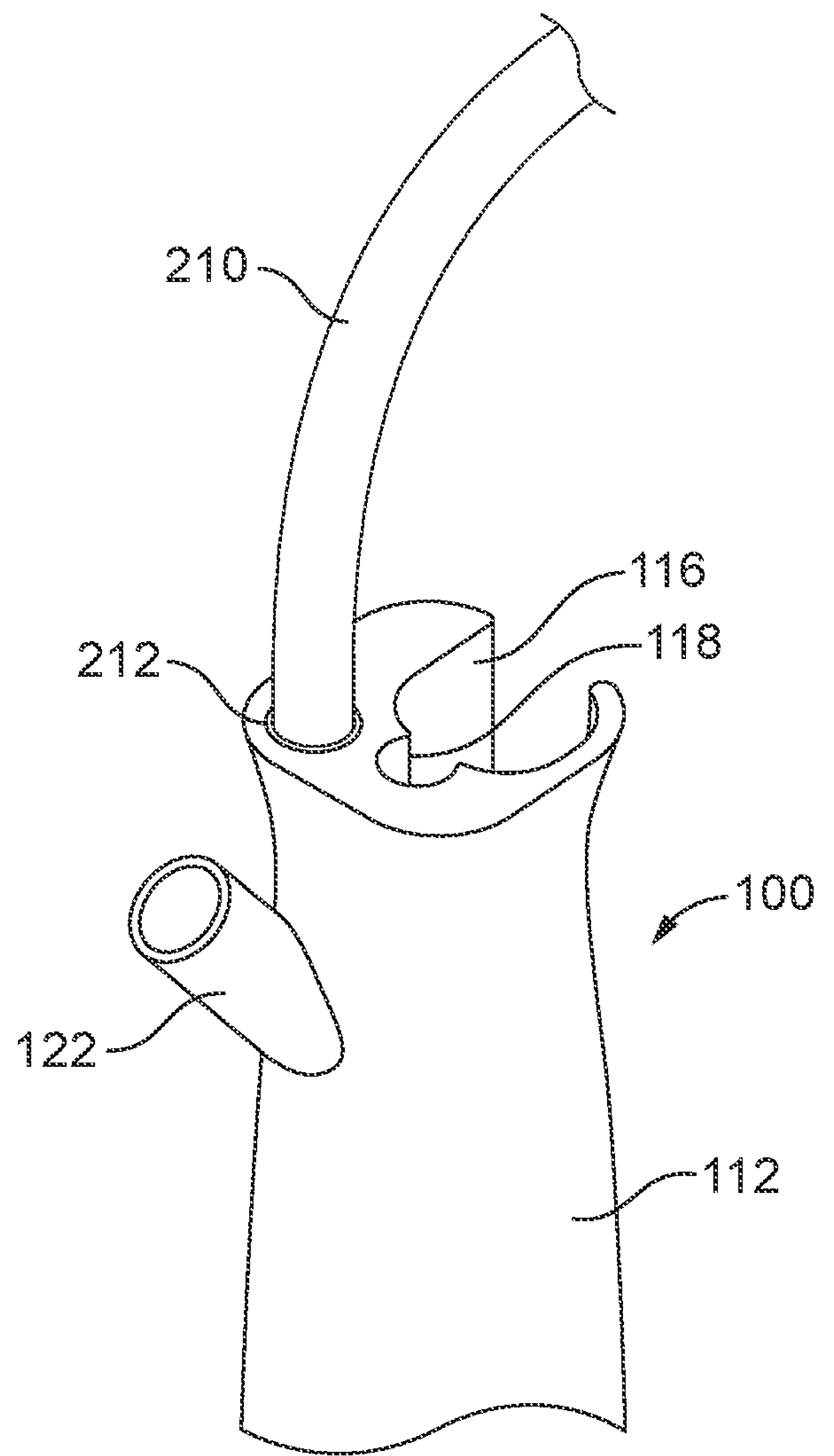

FIG. 19

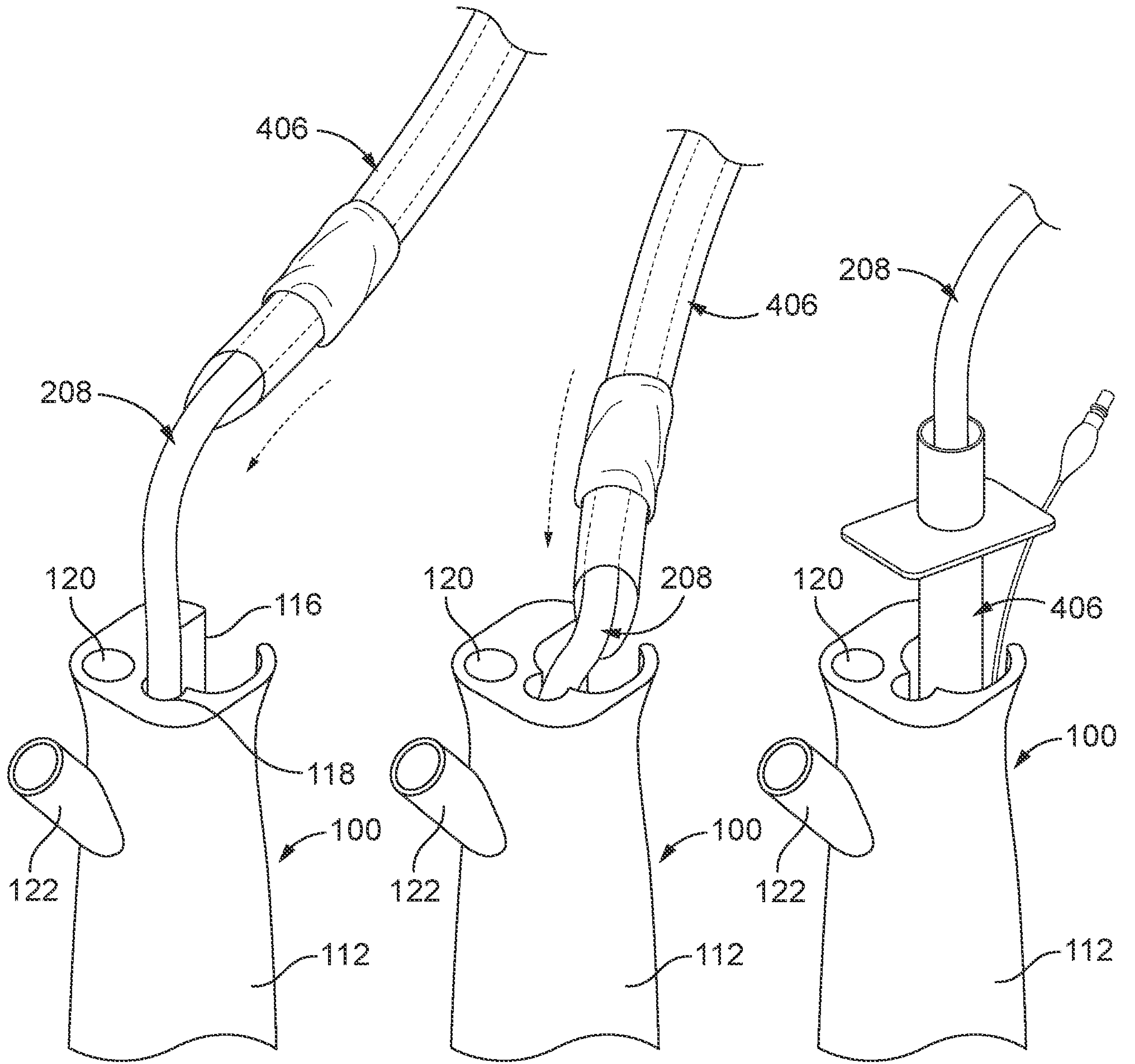

FIG. 20 FIG. 21 FIG. 22

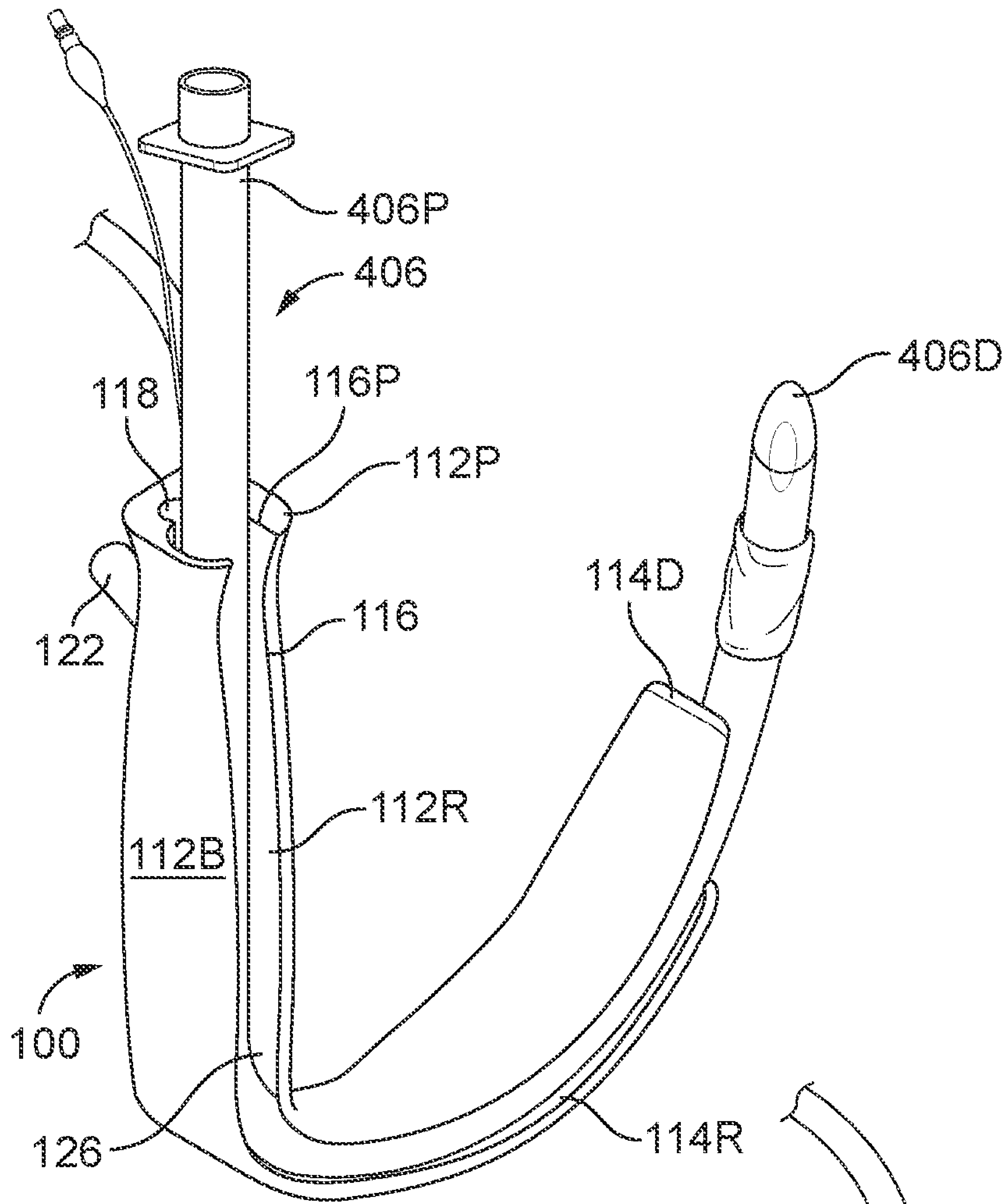

FIG. 23

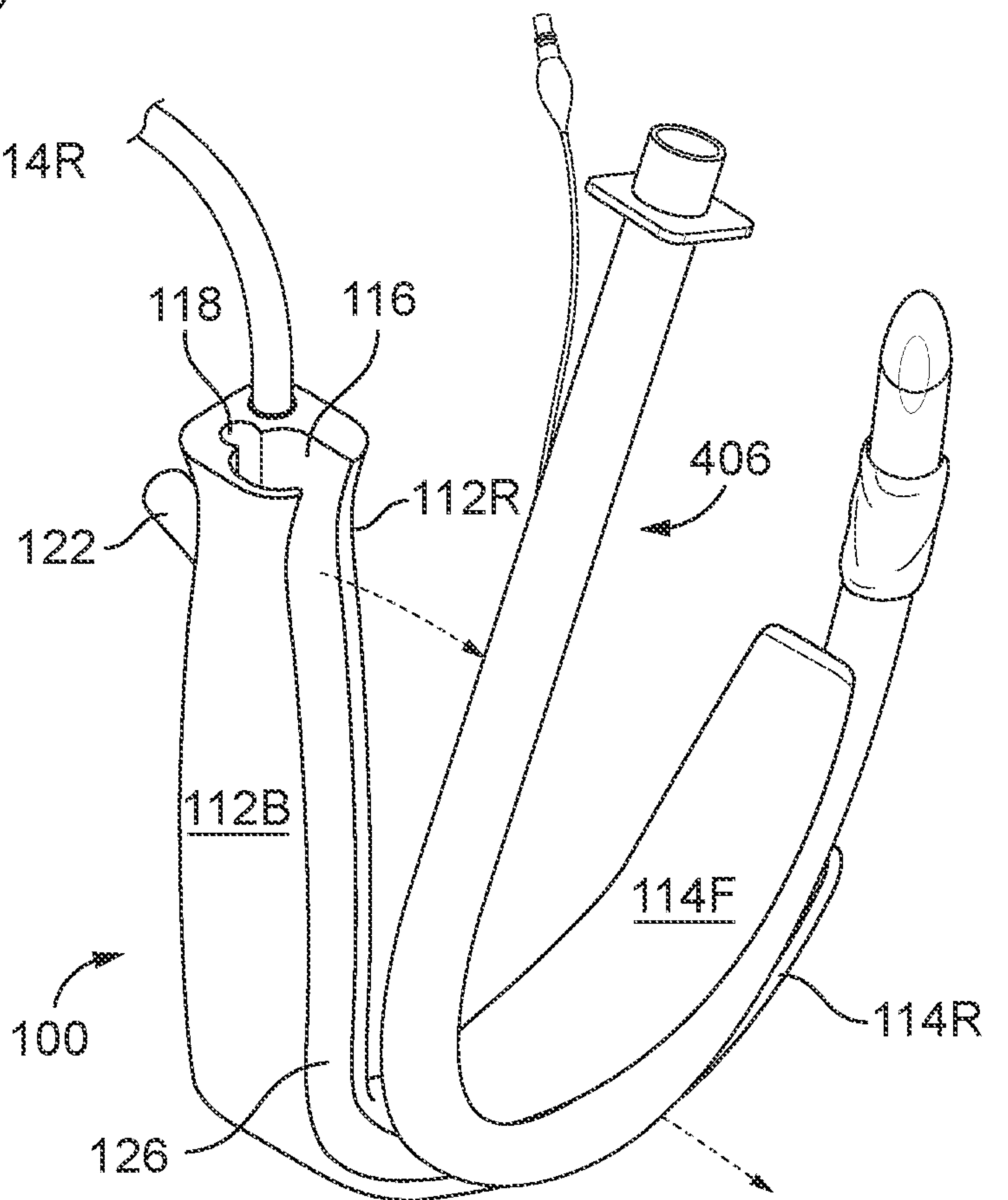

FIG. 24

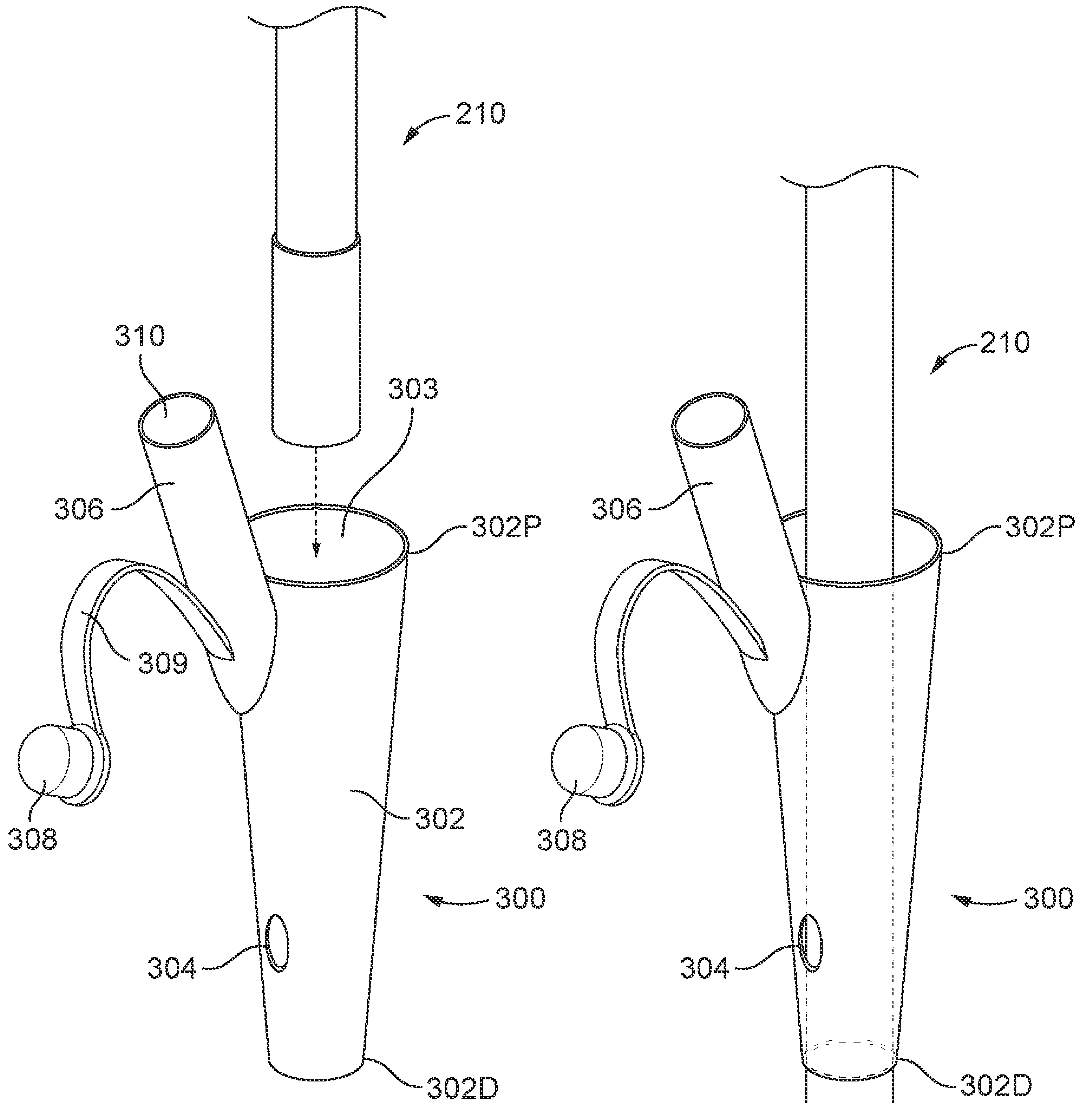

FIG. 25

FIG. 26

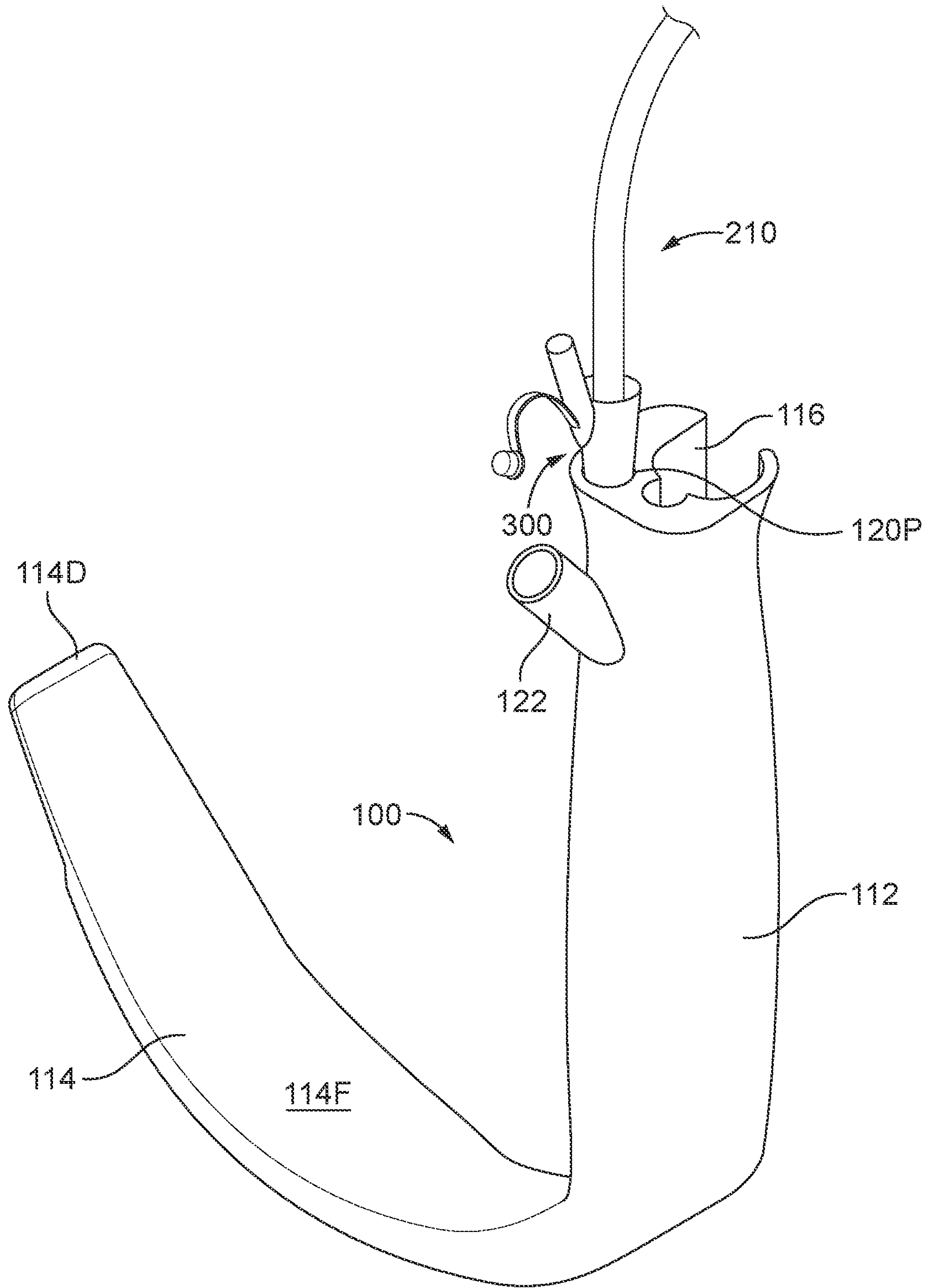

FIG. 27

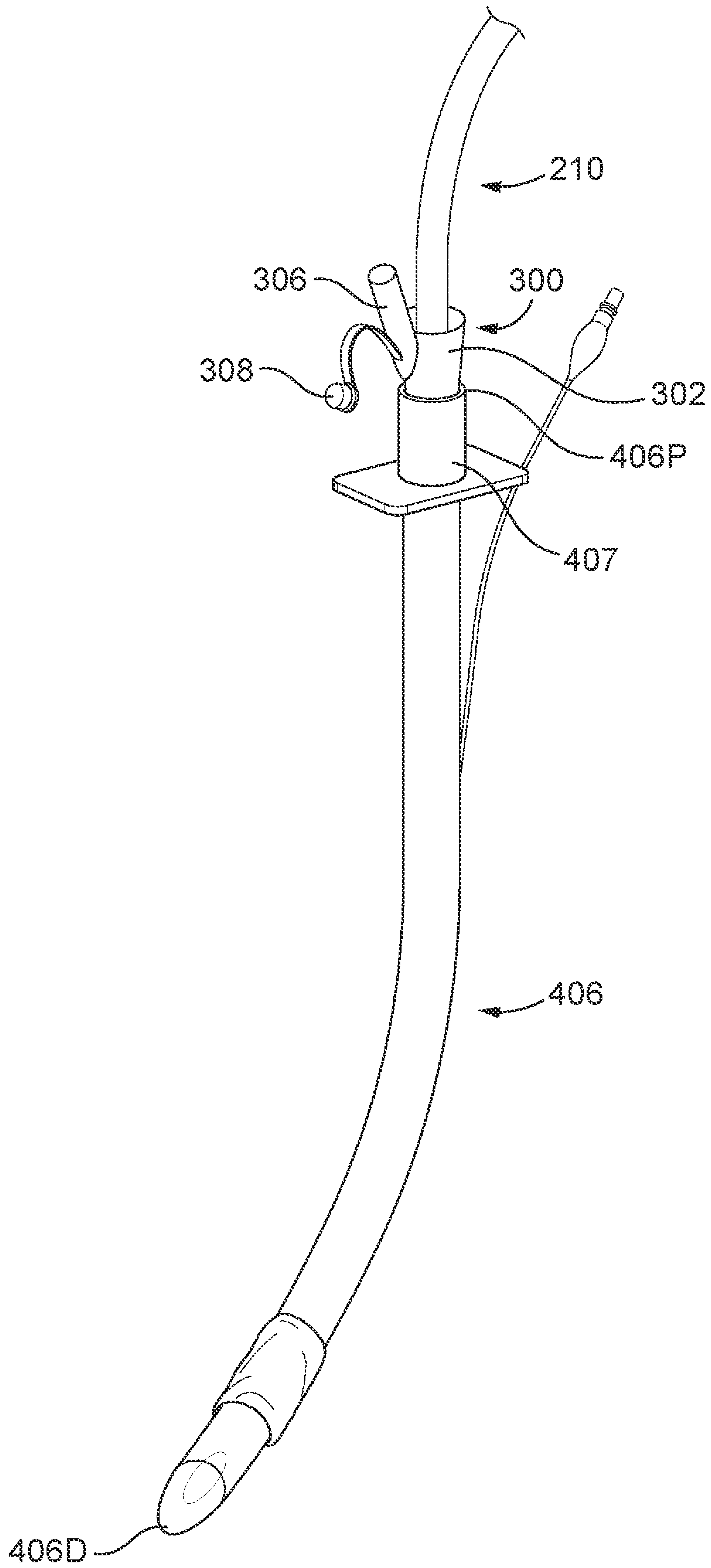

FIG. 28

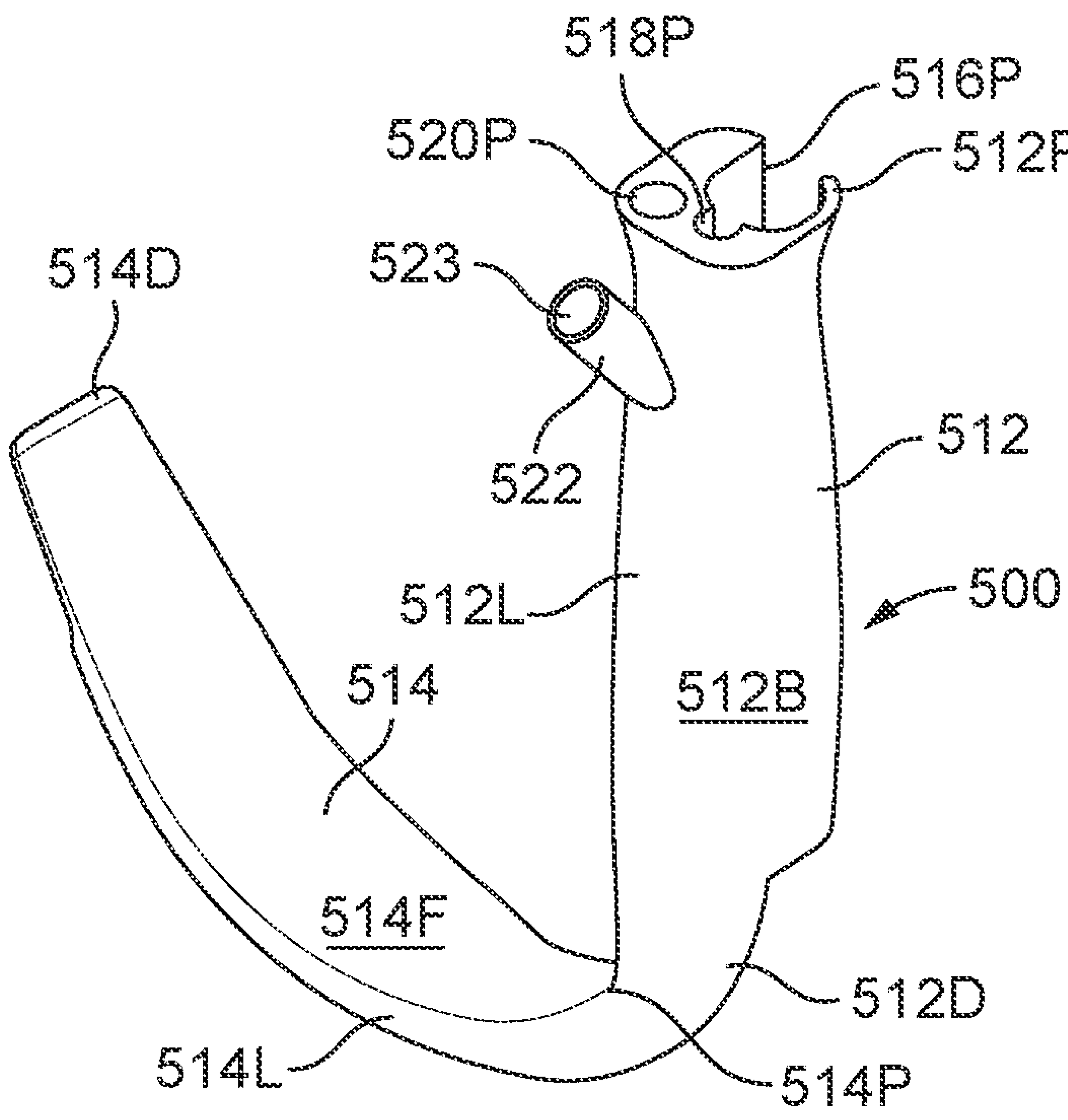

FIG. 29

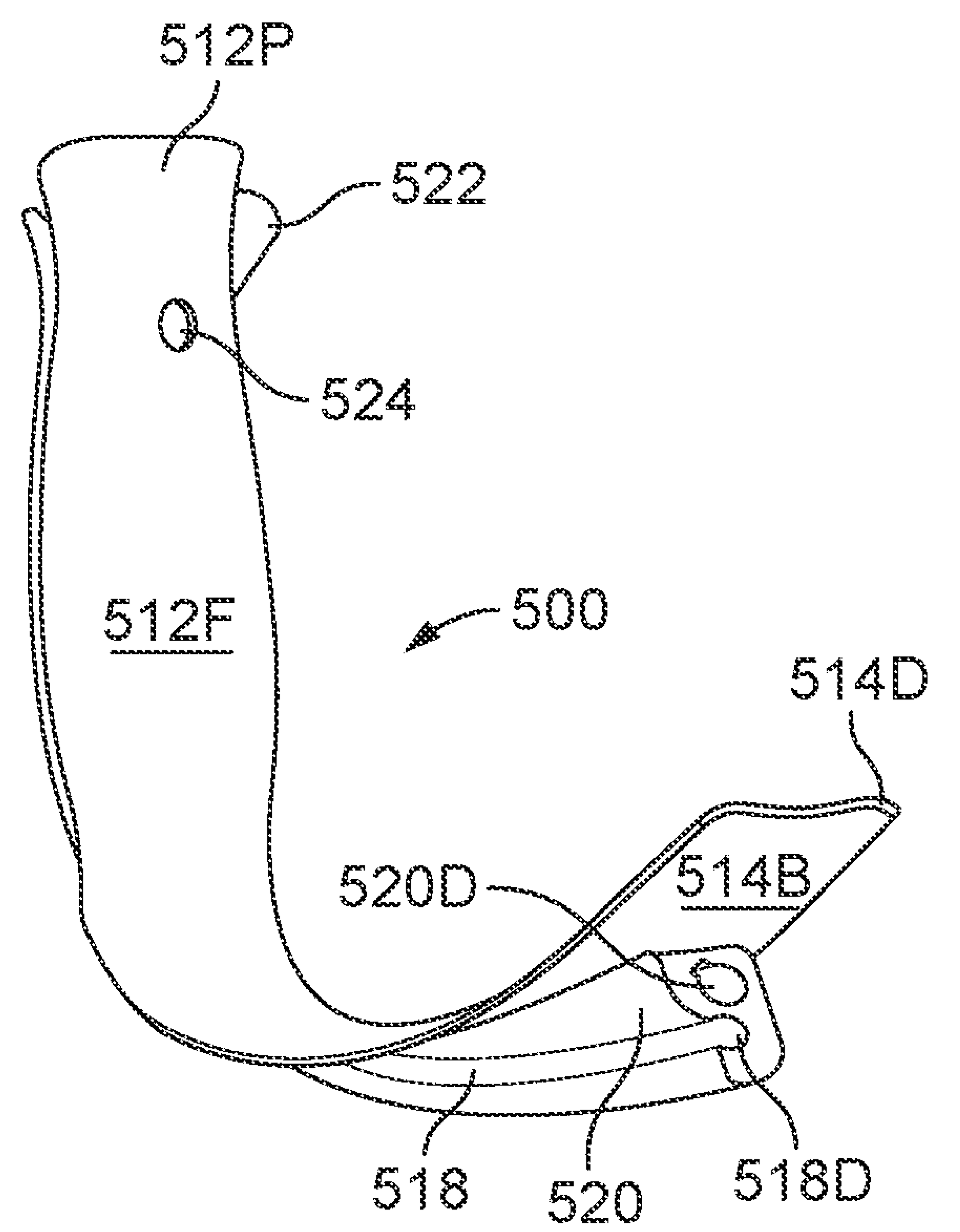

FIG. 30

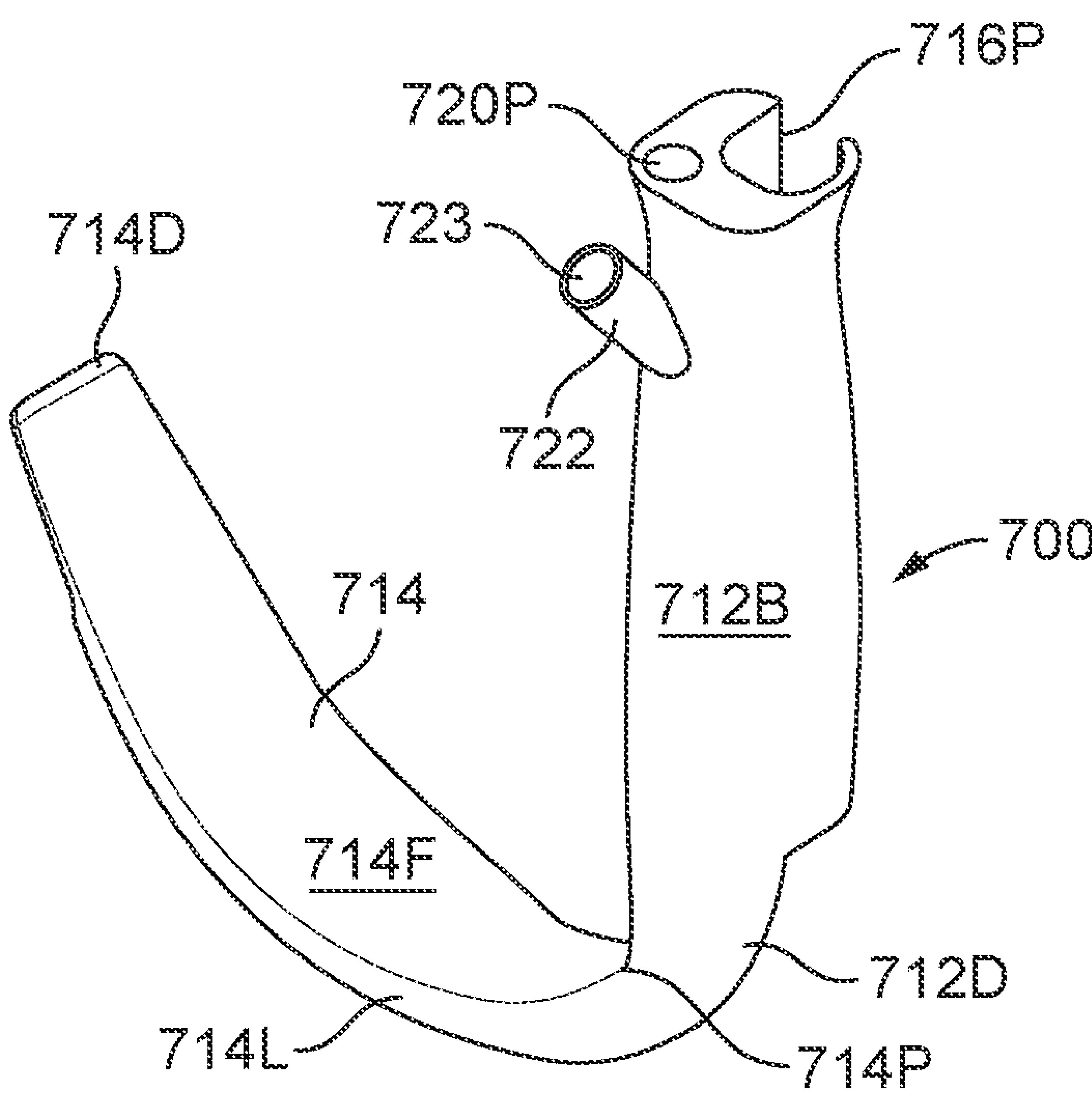

FIG. 31

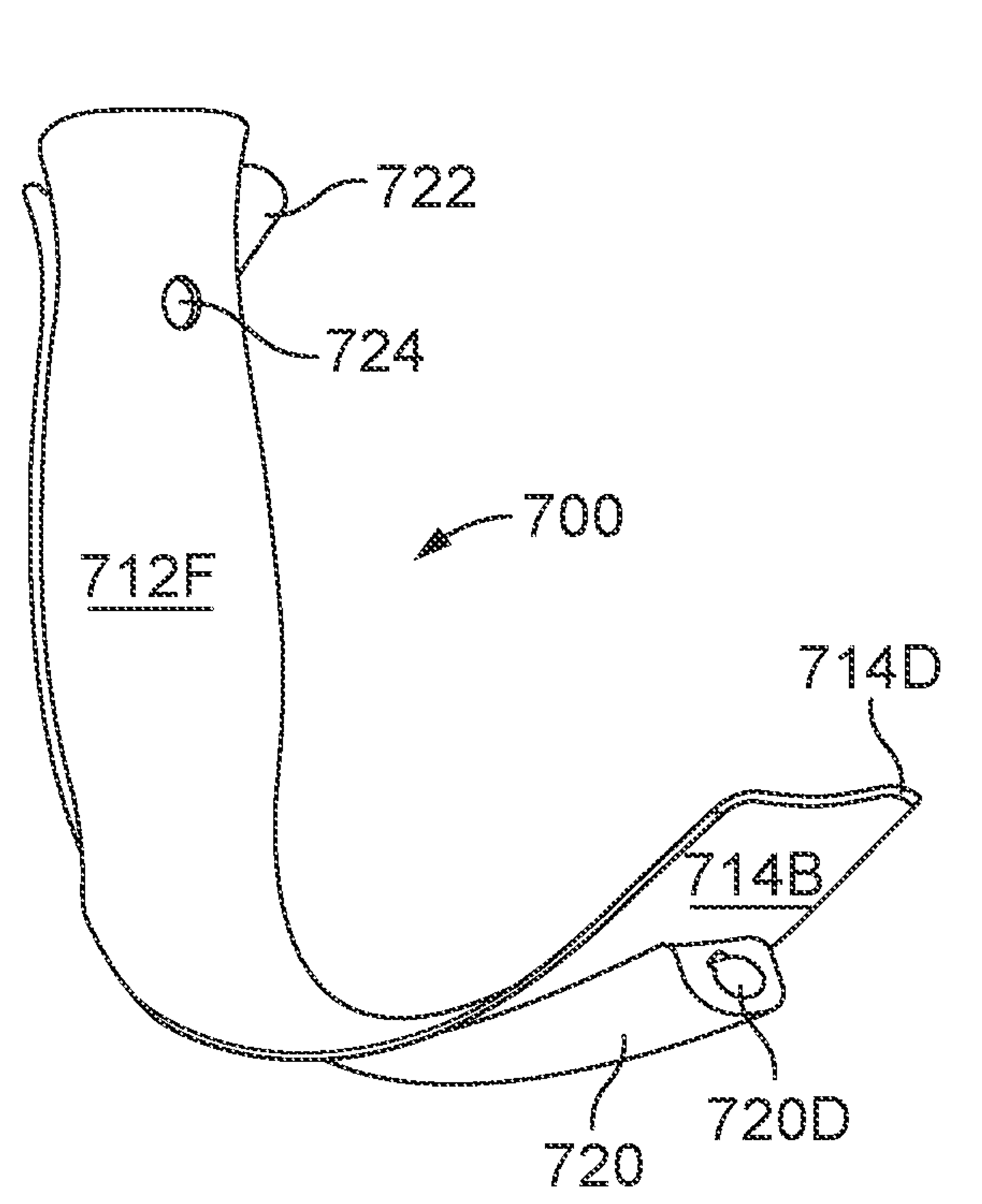

FIG. 32

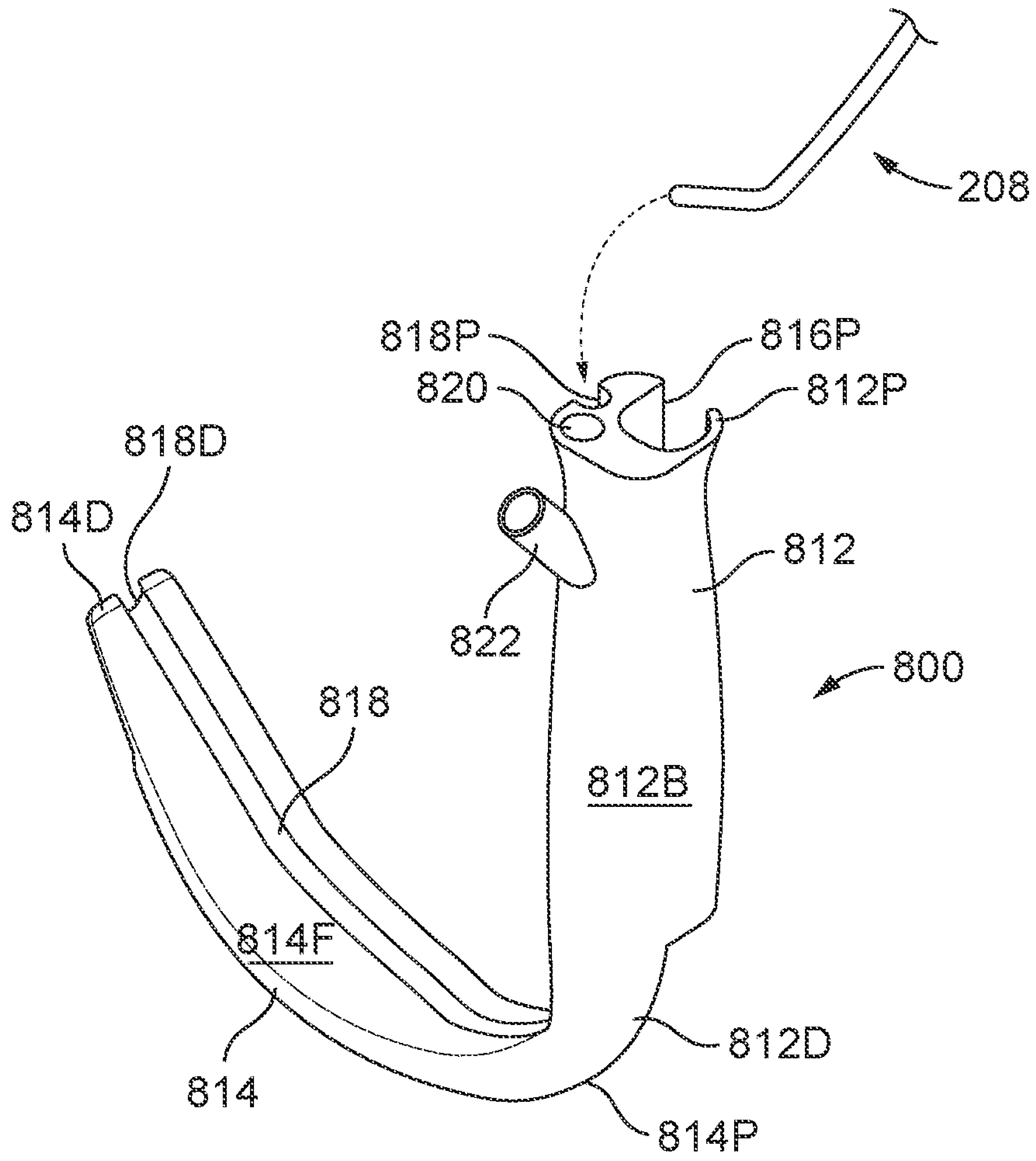

FIG. 33

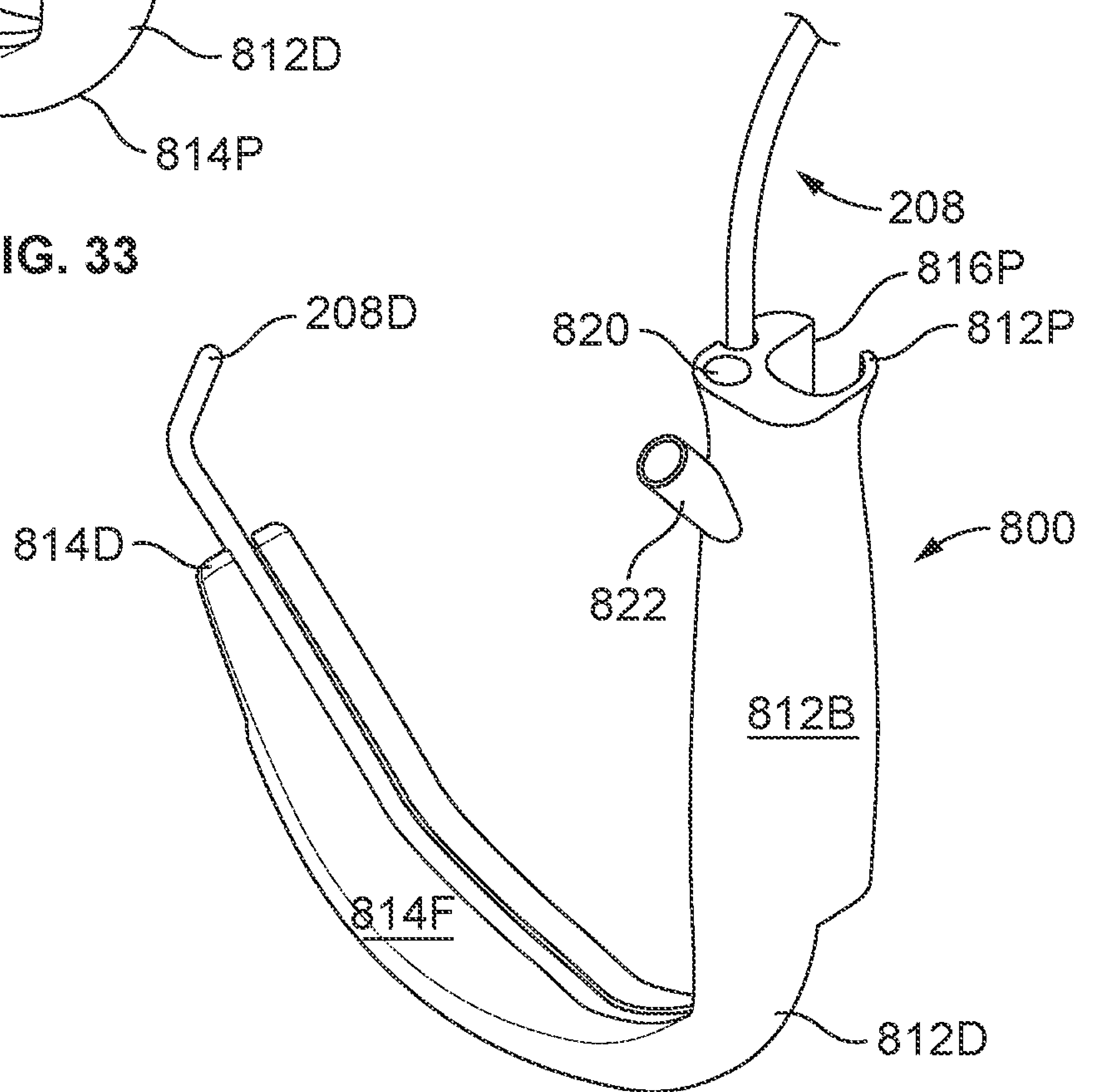

FIG. 34