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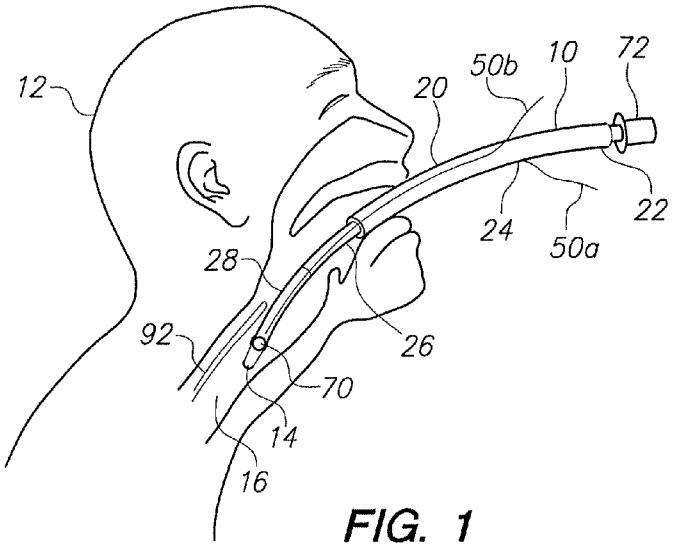

FIG. 1

(57) Abstract: An extendable intubation device is disclosed that includes a tube assembly having a plurality of elongated tubes. Within the assembly, a base tube is coupled with an extension tube to maintain a continuous fluid pathway along the tube assembly during a fore-and-aft movement of the extension tube relative to the base tube. For example, a portion of the extension tube can be co-axially mounted within the lumen of the base tube. Additional extension tubes can be included. The length and curvature of the extendable intubation device can be manually adjusted by a control unit having at least one control wire. The control wire(s) are attached to the distal end of the most distal extension tube and can be employed to reciprocally move one or more of the extension tubes in a fore-and-aft movement relative to the base tube and / or selectively bend the tube assembly.

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TELESCOPIC INTUBATION TUBE

This application claims the benefit of U.S. Patent Application Serial No. 13/549,218, filed July 13, 2012, which is currently pending. The entire contents of Application Serial No. 13/549,218 are hereby incorporated by reference herein.

FIELD OF THE INVENTION

The present invention pertains generally to medical devices. More particularly, the present invention pertains to tracheal intubation tubes. The present invention is particularly, but not exclusively, useful as an extendable and steerable intubation tube assembly that can be guided within the respiratory tract and into a patient's trachea.

BACKGROUND OF THE INVENTION

Intubation is a medical procedure that is used to establish and maintain the patency of a patient's airway. In nearly all cases, the procedure is performed by inserting the distal end of an intubation tube into the patient's upper respiratory tract and then carefully advancing the tube through the larynx and into the patient's trachea. Although tracheal intubation is typically performed through the mouth (orotracheal intubation), it can also be performed through the nose (nasotracheal intubation).

Tracheal intubation is often employed in emergency rooms under circumstances which require a physician to intubate a difficult patient quickly and without complication. This is no easy task. For one, it is generally desirable to use a large diameter tube to provide as much airflow as possible.

This requirement for a relatively large tube can compound the difficulties associated with trying to guide the intubation tube through the twists and turns within the respiratory tract necessary to reach the trachea.

As indicated above, during an intubation procedure, a relatively large diameter tube must be passed through the somewhat fragile larynx and into the trachea. This procedure must be performed delicately as undesirable complications can result if the airway is scraped or scratched. Generally, during advancement of the intubation tube, certain anatomical features must be identified to avoid entry into the esophagus and establish a correct pathway into the trachea. In fact, one of the biggest complications associated with these procedures is the failure to properly intubate the patient. Once the correct path is identified, it is not always easy to coax a flexible tube onto a desired pathway leading into the trachea.

In addition to the concerns cited above, substantial differences in the length and shape of the path that must be navigated by the intubation tube exist across the general patient population due to differences in patient height, weight, oral anatomy and age. In this regard, there is rarely time in the emergency room setting to identify and find a preformed intubation tube having a shape and size that perfectly matches a patient.

In light of the above, it is an object of the present invention to provide an extendable intubation tube that can be controllably guided through the respiratory system and into the trachea. Another object of the present invention is to provide an intubation device having a system to visually assist the user in guiding the device into the trachea. Still another object of the present invention is to provide an extendable intubation tube that can fit a relatively large portion of the general patient population and provide an optimal airway for all patients. Yet another object of the present invention is to provide a Telescopic Intubation Tube and corresponding methods of use which are easy to use, relatively simple to implement, and comparatively cost effective.

SUMMARY OF THE INVENTION

In accordance with the present invention, an extendable intubation device includes a tube assembly having a plurality of elongated tubes. For the intubation device, each tube has a proximal end, a distal end and is formed with a lumen extending between the tube's distal and proximal ends. Within the assembly, a first tube (base tube) is coupled with an adjacent second tube (extension tube) to maintain a continuous fluid pathway along the tube assembly during a fore-and-aft movement of the extension tube relative to the base tube. For example, in one embodiment, the proximal end of the extension tube can be co-axially mounted within the lumen of the base tube at the base tube's distal end. On the other hand, when base tubes having relatively small lumens are used (for example, for infants), the extension tube(s) may be mounted, e.g. clipped on, the external surface of the base tube. When an additional tube (e.g. a second extension tube) is included in the assembly, the second extension tube can be coupled with the first extension tube to maintain a continuous fluid pathway along the tube assembly during a fore-and-aft movement of the second extension tube relative to the first extension tube.

With the tubes assembled, the length of the extendable intubation device can be manually adjusted by a control unit. In more structural detail, the control unit can include at least one control wire(s). The control wire (or each wire when more than one is used) has an end that is attached to the distal end of the most distal extension tube. For the control unit, the wire(s) are sized to be long enough to ensure that the proximal end of each wire remains at an extracorporeal location throughout the intubation procedure. With this arrangement, the control unit can be employed to reciprocally move one or more of the extension tubes in a fore-and-aft movement relative to the base tube.

For the intubation device, one, some or all of the tubes in the tube assembly can be of a flexible construction such that the flexible tube(s) can bend under the influence of the control unit. With this structure, one or more of the control wire(s) can be manipulated to bend the distal end of the tube assembly and steer the intubation device into a patient's trachea. For example, a three wire or a four wire configuration may be used. For these configurations, the attachment points for the wires at the distal end of the tube assembly are typically uniformly spaced around the distal tube.

Also for the present invention, structures can be formed in the tubes to limit, and in some cases prevent, a relative rotation between adjacent tubes in the tube assembly. These structures, or additional structures, can also be used to limit the distal travel of one tube relative to another (i.e. an adjacent, more proximal tube).

The intubation device can also include an optical assembly to allow a user (e.g. physician) to visually monitor the advancement of the distal end of the tube assembly into the trachea of the patient. For this purpose, the optical assembly can include an optical fiber that extends through the tube assembly. For the optical assembly, the optical fiber has an end that is attached to the distal end of the most distal extension tube. The other end (i.e. the proximal end) of the fiber can be attached to an eyepiece, which remains at an extracorporeal location throughout the intubation procedure. In some implementations, a light source can be provided to introduce light into the optical fiber and illuminate the anatomical portions of the body near the distal end of the tube assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features of this invention, as well as the invention itself, both as to its structure and its operation, will be best understood from the accompanying drawings, taken in conjunction with the accompanying

description, in which similar reference characters refer to similar parts, and in which:

Fig. 1 is a perspective view of a patient with portions removed to expose the patients upper respiratory tract; shown intubated with an extendable intubation device in accordance with the present invention;

Fig. 2 is a perspective view of a tube assembly and control unit for use in the extendable intubation device shown in Fig. 1;

Fig. 3 is a cross sectional view of the tube assembly shown in Fig. 2 as seen along line 3-3 in Fig. 2;

Fig.4 is a perspective view of a tube with portions removed to reveal the inner tube wall which includes a keyway formed thereon;

Fig 5 is a perspective view of a tube showing a key extending from the outer tube surface for cooperation with the keyway shown in Fig. 4;

Fig. 6 is a schematic view of an optical assembly having a light, eyepiece and optical fiber;

Fig. 7 is a perspective view of another embodiment of an intubation device having a base tube and three extension tubes in accordance with the present invention;

Fig. 8 is a cross sectional view of an intubation device as seen along line 8-8 in Fig 7 but having a base tube and two extension tubes, shown in the non-extended configuration;

Fig. 9 is a perspective view of another embodiment of an intubation device having a pre-bent base tube and with the extension tubes in a non-extended configuration; and

Fig. 10 is a perspective view of intubation device shown in Fig. 9 illustrating various positions of the extension tubes.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to Fig. 1, an extendable intubation device 10 is shown positioned within a patient 12 after an orotracheal intubation of the patient 12.

As shown, the distal end 14 of the device 10 has been positioned in the trachea 16 of the patient. Fig. 1 further shows that the device 10 includes a tube assembly 20 that extends from the distal end 14 of the device 10 to a proximal end 22 of the device which remains at an extracorporeal location throughout the intubation procedure.

Figs. 2 and 3 show the tube assembly 20 in greater detail. As shown there, the tube assembly can include an elongated base tube 24 and elongated extension tubes 26, 28. Although the device 10 that is shown in Figs. 1-3 is illustrated as having three tubes, it is to be appreciated that more than three tubes and as few as two tubes (i.e. a base tube and one extension tube) may be used for the extendable intubation device described herein.

Figs. 2 and 3 further show that the base tube 24 has a proximal end 30, a distal end 32 and is formed with a lumen 34 extending between the distal end 32 and proximal end 30. Similarly, extension tube 26 has a proximal end 36, a distal end 38 and is formed with a lumen 40 extending between the distal end 38 and proximal end 36 and extension tube 28 has a proximal end 42, a distal end 44 and is formed with a lumen 46 extending between the distal end 44 and proximal end 42.

Continuing with reference to Figs. 2 and 3, it can be seen that the tubes 24, 26, 28 in the tube assembly 20 are telescopically arranged. Specifically, as shown, tubes 24, 26, 28 are each cylindrically shaped and are each centered on common axis 48 with the proximal end 42 of the extension tube 28 co-axially mounted within the lumen 40 of extension tube 26 at the distal end 38 of extension tube 26. Similarly, the proximal end 36 of the extension tube 26 is co-axially mounted within the lumen 34 of base tube 24 at the distal end 32 of base tube 24.

Figs. 1-3 also show that the distal most tube (i.e. tube 28) is typically formed with a beveled tip making it easier to pass through the vocal cords. Each tube in the tube assembly 20 can be made of the same material and wall thickness, or, the tube thickness and tube material may vary among the tubes. For example, one or more of the extension tubes 26, 28 may be more

flexible than the base tube 24, either by material selection, wall thickness or both. In one arrangement, the base tube 24 is made to be rigid enough to allow the user to insert the tube through the mouth / nose and into the larynx while the extension tube(s) are flexible. For some implementations, the length of each extension tube 26, 28 may be in the range of about 3-5cm. Generally, the base tube 24 may be longer than the extension tubes 26, 28, as shown in Fig. 1. Tube materials can include but are not necessarily limited to polyvinyl chloride, silicone rubber, latex rubber or a metal such as stainless steel. In some cases, one or more of the tubes may be armored to give it strength and flexibility, for example, a spiral of wire may be embedded into the wall of the tube. For some applications, the tube assembly 20 can include a standard cuff, such as a balloon (not shown) affixed to the distal extension tube 28.

Figs. 1-3 show that the overall length of the tube assembly 20 can be manually adjusted by a control unit having one or more control wires 50a-e. Although embodiments are shown having two wires (Fig. 1) and four wires (Figs. 2 and 3), it to be appreciated that more than four and as few as one control wire may be used in the extendable intubation devices disclosed herein. For the embodiments shown, the control wires 50a-e can be relatively stiff and made of a metal such as stainless steel.

As best seen in Fig. 3, each control wire 50d,e has a respective end 52a,b that is attached to the distal end 44 of the most distal extension tube 28. Typically, as shown, the attachment points for the wires 50d,e at the distal end 44 of the tube 28 are uniformly spaced around the extension tube 28.

Additionally, a wire (not shown) may be attached to the distal end 38 of the intermediate extension tube 28. For the present invention, the technique used to affix the control wire 50d,e to the extension tube 28 can be any technique known in the pertinent art for attaching a control wire to a plastic or metal tube such as adhesive bonding, brazing or a mechanical attachment. It can also be seen that the wires 50d,e are sized to be long enough to ensure that the proximal end 54a,b of each wire 50d,e remains at an extracorporeal

location throughout the intubation procedure. These proximal ends 54a,b can be left free for manipulation by the user.

Although the control wires 50d,e are shown positioned externally to the tube assembly 20, it is to be appreciated that portions (or all) of each wire may be located within the tube assembly 20 (i.e. the wires 50d,e may pass through in the lumens 34, 40, 46 of the tubes 24, 26, 28). For example, this may allow the extension tube(s) and wires to be extubated while leaving the base tube 24 positioned in the patient. Moreover, as shown, wire guides 56a,b may be employed to constrain lateral wire movement. Although one guide 56a,b is shown for each wire 50d,e, it is to be appreciated that more than one guide 56a,b per wire 50d,e may be employed and that guides 56a,b may be employed on extension tubes 26, 28, or internally when the wires 50d,e are passed within the tube assembly 20.

With the arrangement described above, the control wires 50d,e can be employed to reciprocally move one or more of the extension tubes 26, 28 in a fore-and-aft movement relative to the base tube 24. As indicated above, one, some or all of the tubes 24, 26, 28 in the tube assembly 20 can be of a flexible construction such that the flexible tube(s) can bend under the influence of the control wires 50d,e. With reference to Fig. 1, it can be seen one or more of the control wires 50a,b, can be manipulated to bend the distal end 14 of the device 10 and steer the distal end 14 into the patient's trachea 16.

Referring now to Figs. 3-5, it can be seen that structures can be provided to limit, and in some cases prevent, a relative rotation between adjacent tubes 24, 26, 28 in the tube assembly 20 and / or limit the distal travel of an extension tube 26, 28. In greater detail, Fig. 4 shows a base tube 24 having a keyway 58 formed on the inner wall 60 of the base tube 24. As shown, the keyway 58 may extend from the proximal end 30 of the extension tube 26 to an end 62 located at a distance from the distal edge 64 of the base tube 24. Also, Fig. 5 shows an extension tube 26 having a key 66, complementary to the keyway 58 shown in Fig. 4, formed on the outer wall 68 of the extension tube 26, for example, near the proximal end 36 of extension

tube 26. In use, the key 66 may be slid into the keyway 58 when the tubes 24, 26 are assembled together. The size and positions / length of the key 66 and keyway 58 may be designed to selectively limit relative rotation and / or distal travel of the extension tube 26 relative to the base tube 24. A similar key / keyway system may be used to limit relative rotation and / or distal travel of the extension tube 28 relative to the extension tube 26.

Cross referencing Figs. 1 and 6, it can be seen that the intubation device 10 can also include an optical assembly 69 to allow a user (e.g. physician) to visually monitor the advancement of the distal end 14 of the device 10 into the trachea 16 of the patient 12. As shown, the optical assembly 69 can include an optical fiber 70 that extends through the tube assembly 20 from the distal end 14 to an eyepiece 72 which remains at an extracorporeal location throughout the intubation procedure. Fig. 6 shows that a light source 74 can be spliced together with the eyepiece 72 to introduce light into the optical fiber 70 and illuminate the anatomical portions of the body near the distal end 14 of the device 10.

Figs. 7 and 8 show another embodiment of an intubation device 10' having an optical assembly 69' to allow a user (e.g. physician) to visually monitor the advancement of the distal end 14' of the device 10' into the trachea of the patient. As shown, the optical assembly 69' can include a flexible optical fiber 70' that is coiled within the lumens of the tubes 24', 26', 28' and can straighten when the tubes 26', 28' are extended from the base tube 24'. As shown, the optical assembly also includes a distal lens 76 and a fiber-optic view finder 78 at the proximal end. Also shown, the distal end of the optical fiber 70' can be affixed to the distal end of the distal most extension tube (i.e. tube 28') using a mounting bracket 80.

Fig. 8 also shows that the tubes 24', 26', 28' may be tapered, with each tube 24', 26', 28' having a conical shape with a relatively smaller distal diameter and a relatively larger proximal diameter. Fig. 7 further shows that the proximal end of each control wire 50' can include an end cap ferrule 82 and can be placed inside a control unit 84 as shown. Typically, the extension

tubes 26', 28' are straight when in a relaxed state. As a consequence, the ferrule 82 on each wire 50' is biased toward the control unit 84 and is pulled from the control unit 84 to selectively retract or bend an extension tube 26', 28'. For the embodiment shown in Fig. 7, the base tube 24' is rigid and pre-bent into a desired configuration, and can be formed with a handle 86 having one or more grips 88 to facilitate insertion into the upper respiratory tract of the patient.

Fig. 9 shows another embodiment of an intubation device 10" having rigid, pre-bent base tube 24" and handle 86'. Fig. 9 also shows that the device 10" can include an extension tube 26" and indicates, via arrows 90 the movements of the extension tube 26" that are possible including extension, rotation and bending movements. Fig. 10 illustrates different shapes of the extension tube 26" that are possible.

The operation of the device 10 can best be appreciated with reference to Fig. 1. First, the device 10 is sterilized and assembled as described above. Next, the distal end 14 of the device 10 is inserted into a patient's nose or mouth and advanced through the upper respiratory tract. In some cases, this advancement can be with the assistance of a conventional laryngoscope (not shown). In other cases, the device is made with a rigid proximal portion 24 to anatomically fill the upper airway. Once in the upper respiratory tract, the optical assembly 69 can be used to visually monitor the advancement of the distal end 14 and identify certain anatomical features to ensure that the device 10 is steered into the trachea 16 rather than the esophagus 92. These anatomical features can include the vocal chords and / or tracheal rings. Once the correct path is identified, one or more of the control wires 50a,b can be manipulated to bend the distal end 14 of the device 10 and steer the intubation device 10 into a patient's trachea 16. The device can then be secured to the patient 12 using customary techniques.

While the particular telescopic intubation tube and corresponding methods of use as herein shown and disclosed in detail are fully capable of obtaining the objects and providing the advantages herein before stated, it is to be understood that they are merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the details of construction or design herein shown other than as described in the appended claims.

What is claimed is:

1. A telescopic intubator which comprises:

an endotracheal tube having a proximal end and a distal end, and formed with a lumen extending between the proximal end and the distal end thereof;

an extension tube having a proximal end and a distal end and mounted on the endotracheal tube for a fore-and-aft movement therewith, wherein the extension tube is positioned to selectively extend the distal end of the extension tube beyond the distal end of the endotracheal tube;

a control unit for reciprocally moving the extension tube fore-and-aft relates to the endotracheal tube, and for selectively bending the extension tube to advance the endotracheal tube into the trachea of a patient;

an eyepiece mounted on the proximal end of the endotracheal tube; and

an optical fiber extending from the eyepiece to the distal end of the extension tube for visually monitoring an advancement of the intubator into the trachea of the patient.

2. A telescopic intubator as recited in claim 1 wherein the extension tube is a first extension tube and the telescopic intubator further comprises a second extension tube, wherein the second extension tube has a proximal end and a distal end and is mounted in the lumen of the first extension tube for a fore-and-aft movement therein to selectively extend the distal end of the second extension tube beyond the distal end of the first extension tube.

3. A telescopic intubator as recited in claim 1 wherein the control unit comprises a plurality of control wires, each control wire having a distal end attached to the distal end of the extension tube.

4. A telescopic intubator as recited in claim 1 further comprising a light source positioned to introduce light into the optical fiber.

5. A telescopic intubator as recited in claim 1 further comprising a means for limiting relative rotation between the endotracheal tube and the extension tube and for limiting distal travel of the extension tube relative to the endotracheal tube.

6. An extendable intubation device comprising:

a tube assembly having a first tube and a second tube, each tube having a proximal end and a distal end and formed with a lumen, the second tube being coupled with the first tube to maintain a continuous fluid pathway along and within the tube assembly during a fore-and-aft movement of the second tube relative to the first tube;

a control unit for reciprocally moving the second tube fore-and-aft relative to the first tube, and for selectively bending the tube assembly to advance a distal end of the tube assembly into the trachea of a patient; and

an optical assembly having an eyepiece and an optical fiber, the fiber extending through the tube assembly for visually monitoring an advancement of the distal end of the tube assembly into the trachea of the patient.

7. An extendable intubation device as recited in claim 6 further comprising a third tube having a proximal end and a distal end and formed with a lumen, the third tube coupled with the second tube to maintain a continuous fluid pathway along and within the tube assembly during a fore-and-aft movement of the third tube relative to the second tube.

8. An extendable intubation device as recited in claim 6 wherein the control unit comprises a plurality of control wires, each control wire having a distal end attached to the distal end of the tube assembly.

9. An extendable intubation device as recited in claim 8 wherein the control wires are attached at locations at the distal end of the tube assembly that are uniformly spaced around one of the tubes.

10. An extendable intubation device as recited in claim 8 wherein the plurality of control wires is three control wires.

11. An extendable intubation device as recited in claim 8 wherein the plurality of control wires is four control wires.

12. An extendable intubation device as recited in claim 6 wherein the optical assembly further comprises a light source positioned to introduce light into the optical fiber.

13. An extendable intubation device as recited in claim 6 further comprising a means for preventing relative rotation between the first and second tubes.

14. An extendable intubation device as recited in claim 6 further comprising a means for limiting distal travel of the second tube relative to the first tube.

15. A method for intubating a patient, the method comprising the steps of:

inserting a distal end of a tube assembly into a natural opening of the patient, the tube assembly having a first tube and a second tube with each tube having a proximal end and a distal end and formed with a lumen, the second tube coupled with the first tube to maintain a continuous fluid pathway along and within the tube assembly during a fore-and-aft movement of the second tube relative to the first tube;

reciprocally moving the second tube fore-and-aft relative to the first tube;

selectively bending the tube assembly to advance a distal end of the tube assembly into the trachea of a patient; and

visually monitoring an advancement of the distal end of the tube assembly into the trachea of the patient using an optical assembly having an eyepiece and an optical fiber.

16. A method as recited in claim 15 wherein the opening is a mouth.

17. A method as recited in claim 15 wherein the opening is a nose.

18. A method as recited in claim 15 wherein the tube assembly further comprises a third tube having a proximal end and a distal end and formed with a lumen, the third tube coupled with the second tube to maintain a continuous fluid pathway along and within the tube assembly during a fore-and-aft movement of the third tube relative to the second tube.

19. A method as recited in claim 15 wherein the reciprocally moving step is accomplished using a plurality of control wires, each control wire having a distal end attached to the distal end of the tube assembly.

20. A method as recited in claim 15 further comprising the step of directing light into the optical fiber.

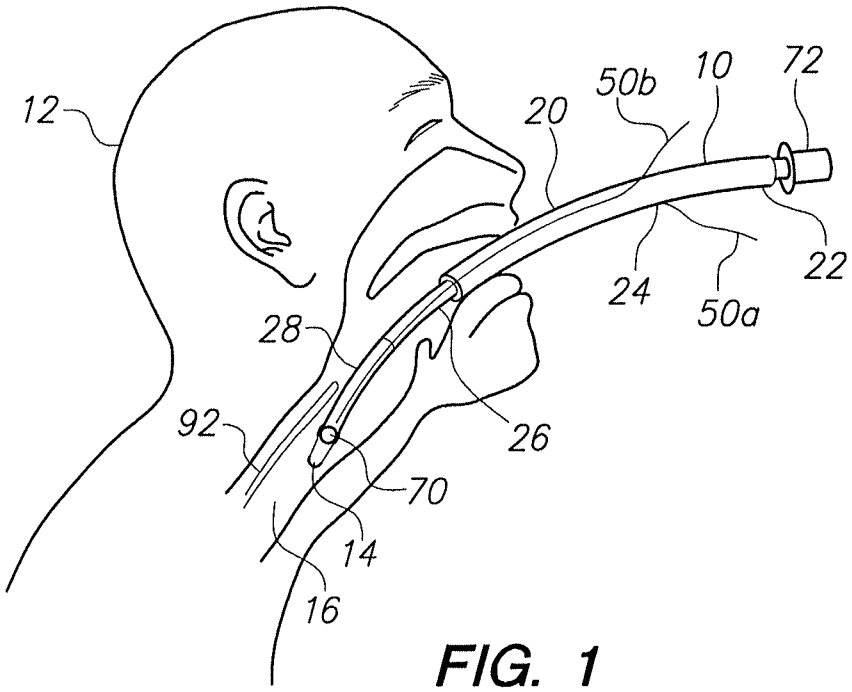

FIG. 1

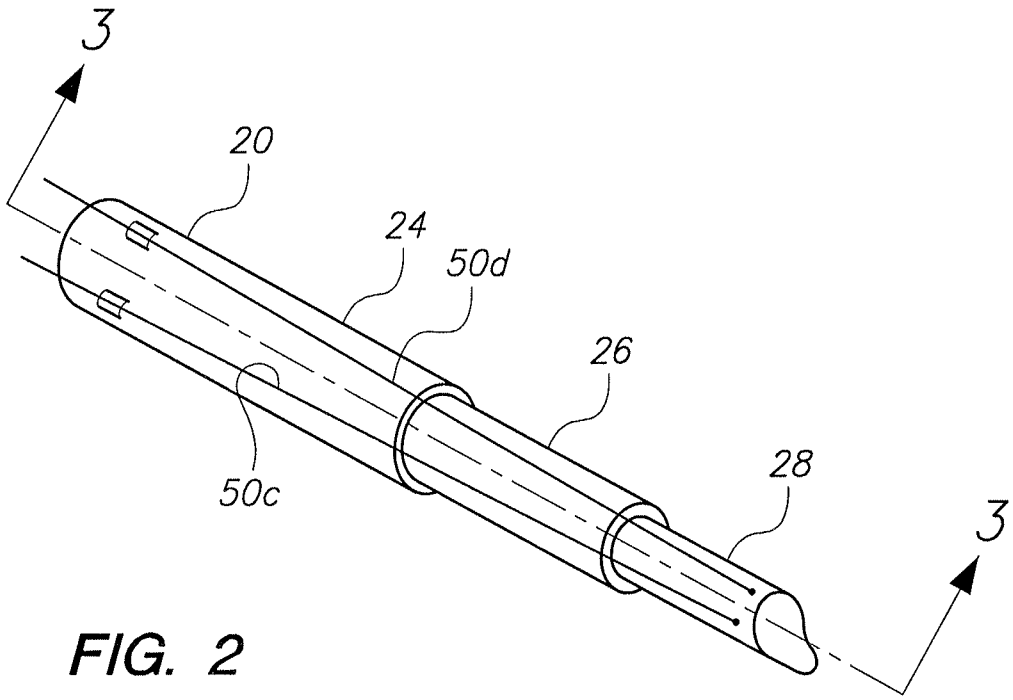

FIG. 2

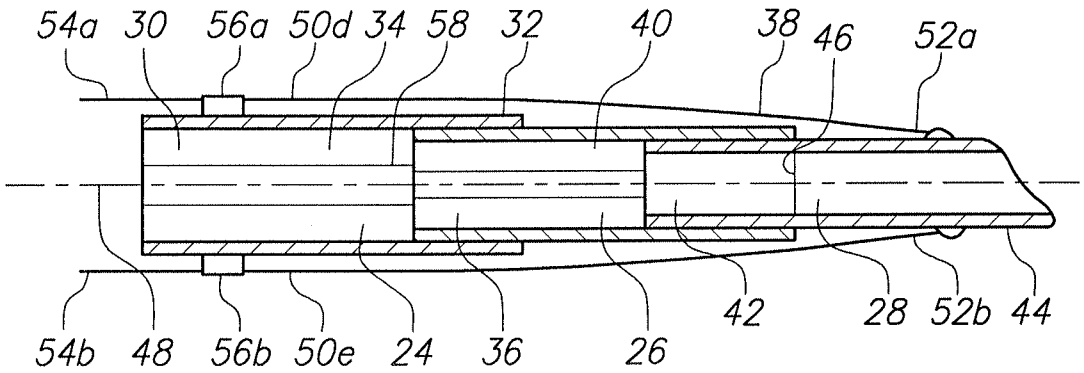

FIG. 3

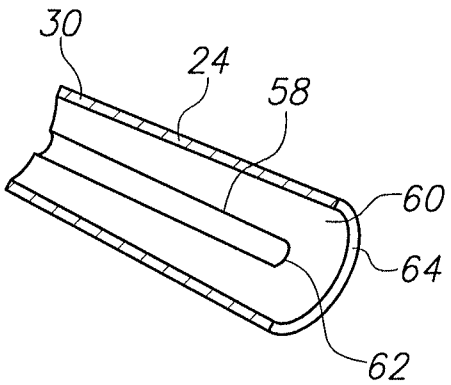

FIG. 4

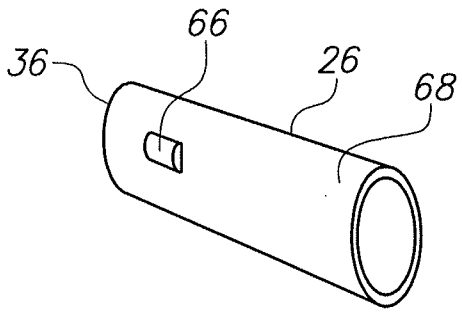

FIG. 5

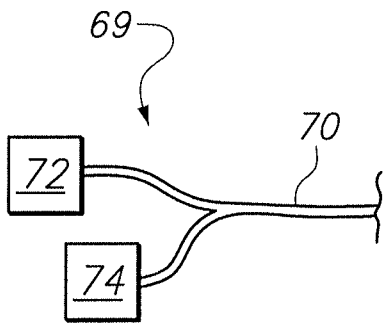

FIG. 6

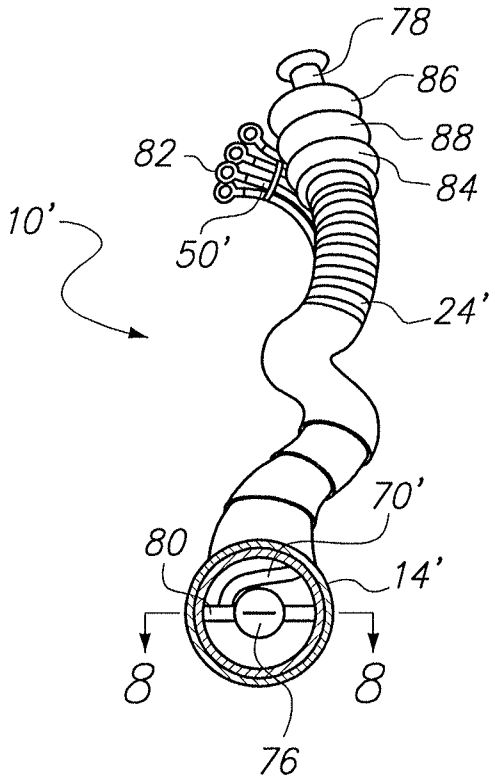

FIG. 7

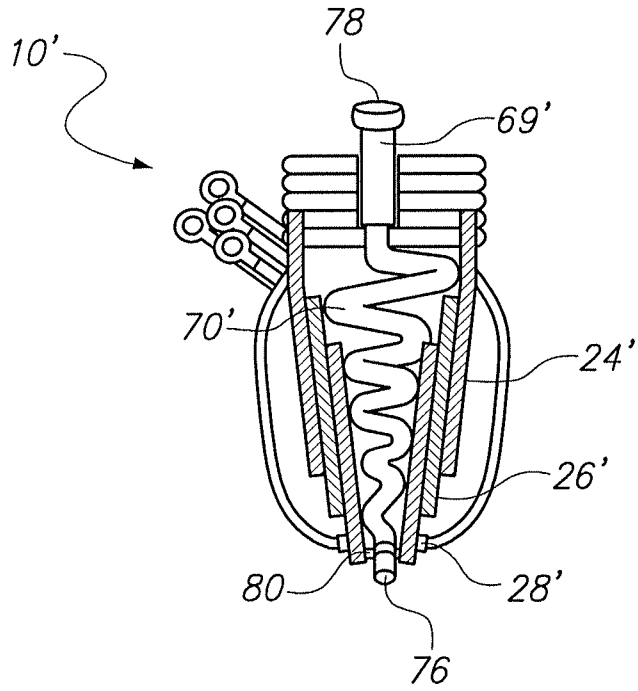

FIG. 8

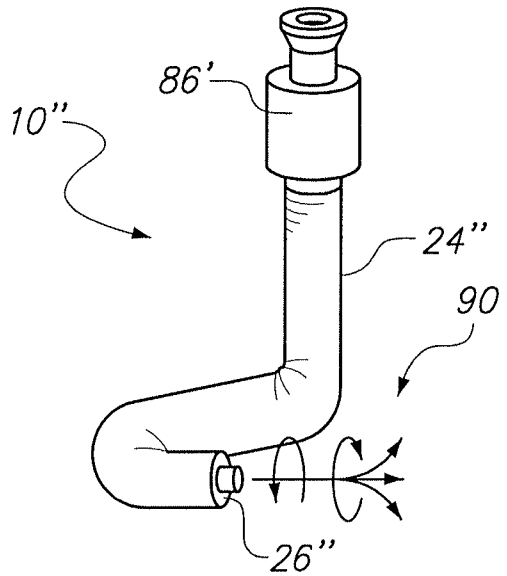

FIG. 9

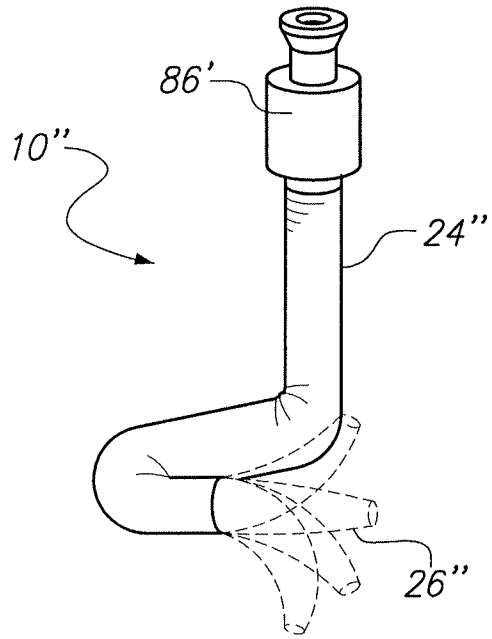

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US13/49548

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61B 1/00, 1/06, 1/32, 1/267; A61M 16/00, 16/04 (2013.01)
USPC - 128/200.26; 600/120, 141, 143, 160, 162, 204, 245
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8): A61B 1/00, 1/06, 1/32, 1/267; A61M 16/00, 16/04 (2013.01)
USPC: 128/200.26; 600/120, 141, 143, 160, 162, 204, 245

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); Google/Google Scholar; DialogPro; Pubmed/Medline: intubation, endotracheal, trachea, mouth, nose, larynx, telescopic, extend, retract, collapse, extensible, control wire, cable, lumen, optical fiber, lens, eyepiece

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US 5733242 A (RAYBURN, RL et al.) March 31, 1998; figures 1-2 and 6; column 4, lines 18-29; column 6, lines 1-6, 16-39; column 7, lines 1-17, 63-67; column 8, lines 1-6, 16-29	1-2, 4-7, 12-16, 18, 20 ---------- 3, 8-11, 17, 19
Y	US 5800342 A (LEE, JS, et al.) September 1, 1998; figures 23-24; column 1, lines 52-62; column 19, lines 31-67; column 20, lines 1-17	3, 8-11, 17, 19
A	US 2008/0308098 A1 (SCHWARTZ, J et al.) December 18, 2008; figure 1; paragraphs [0060], [0064]-[0066]	1
A	US 5263472 A (OUGH, YD) November 23, 1993; figures 9-10; column 5, lines 11-52	1

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 October 2013 (09.10.2013)	18 OCT 2013
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774