

May 12, 1970

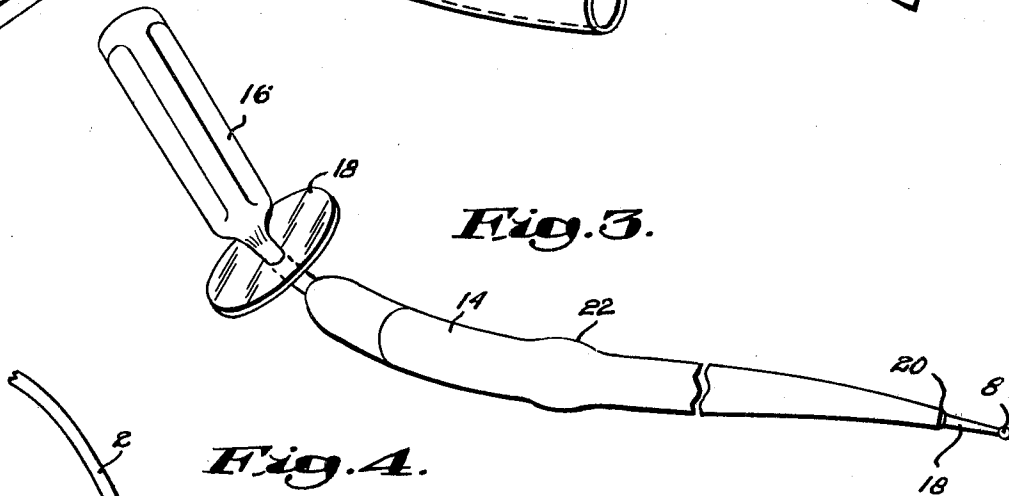
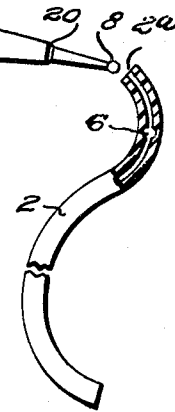
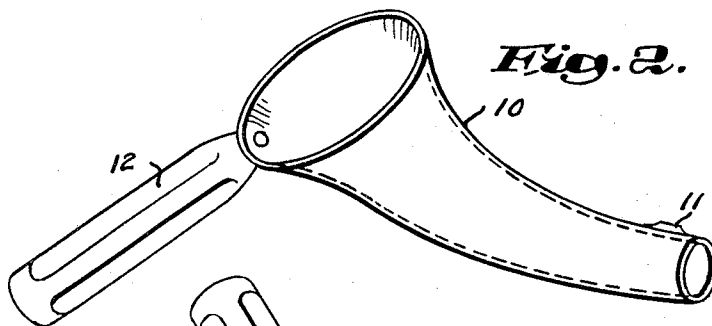
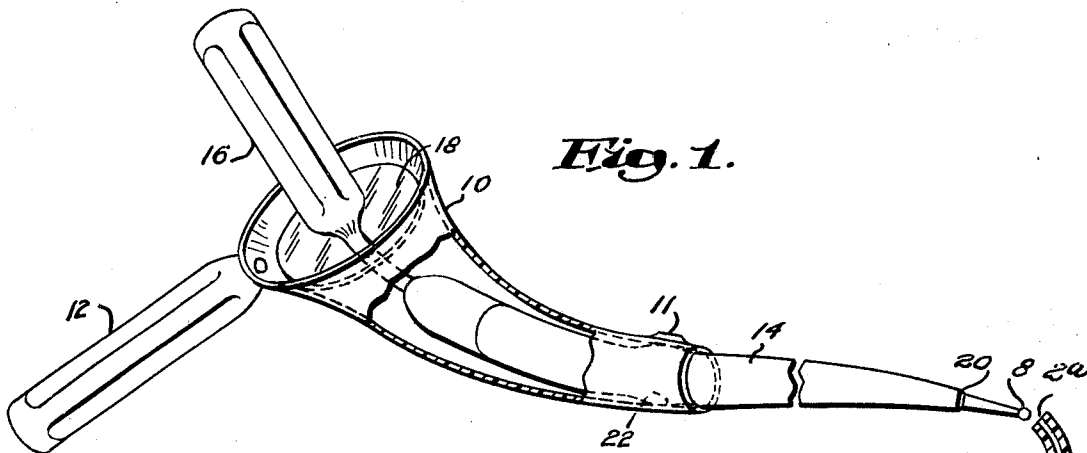
F. J. TOY

3,511,243

APPARATUS FOR PROVIDING A BREATHING CONDUIT COMMUNICATING
WITH THE TRACHEA AT THE BASE OF THE NECK

Filed July 18, 1967

5 Sheets-Sheet 1



Inventor:
Frederic J. Toy,
by *Wm. D. Hamill*
Attorney

May 12, 1970

F. J. TOY

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5 Sheets-Sheet 2

Fig. 5.

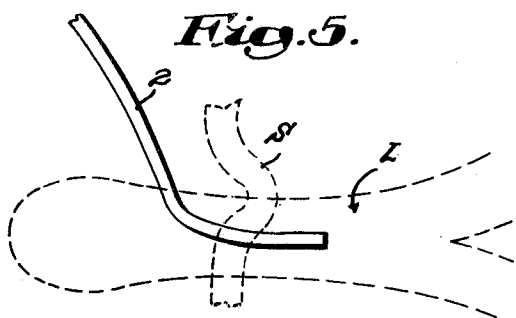


Fig. 6.

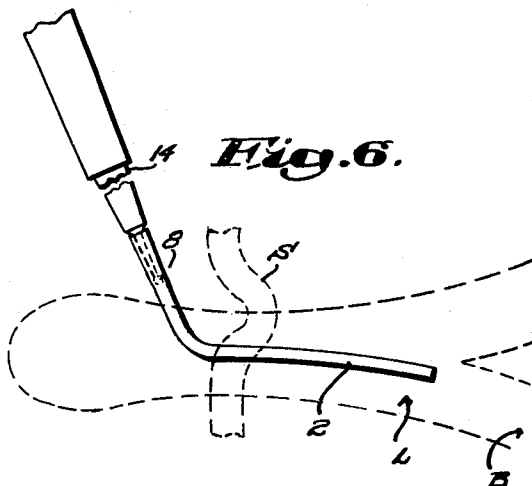


Fig. 7.

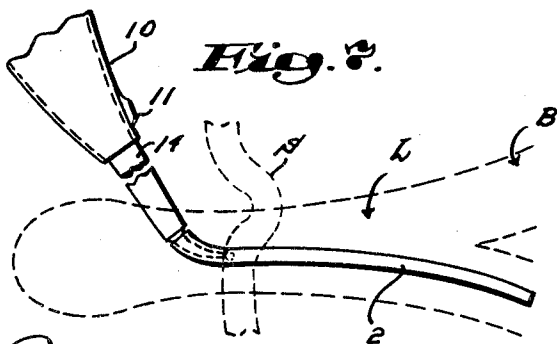


Fig. 9.

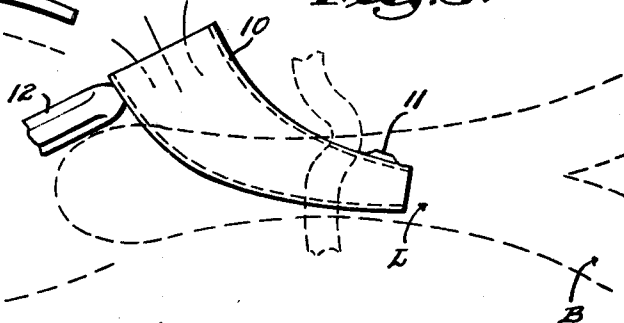


Fig. 8.

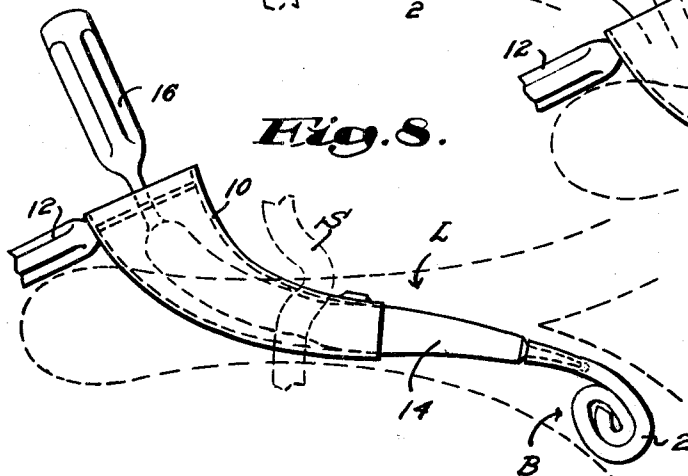


Fig. 10.

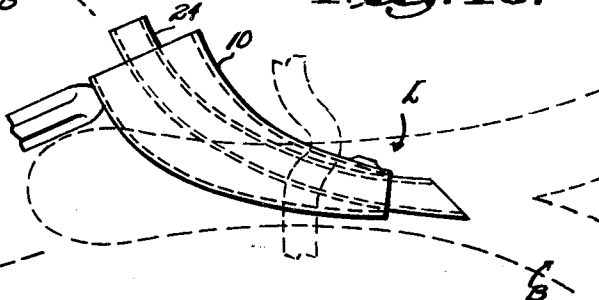
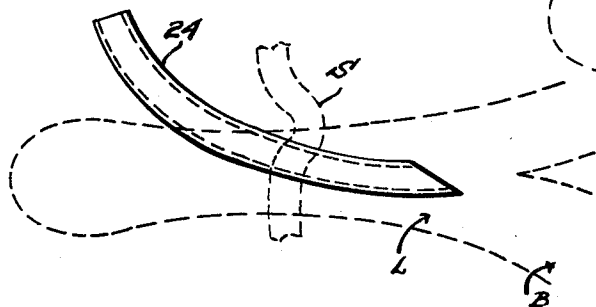


Fig. 11.



Inventor:
Frederic J. Toy,
by *Monroe A. Hamilton*
Attorney

May 12, 1970

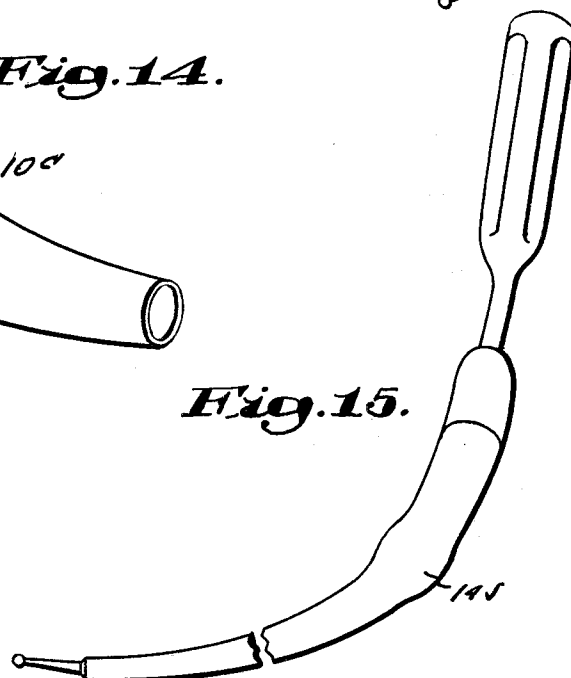
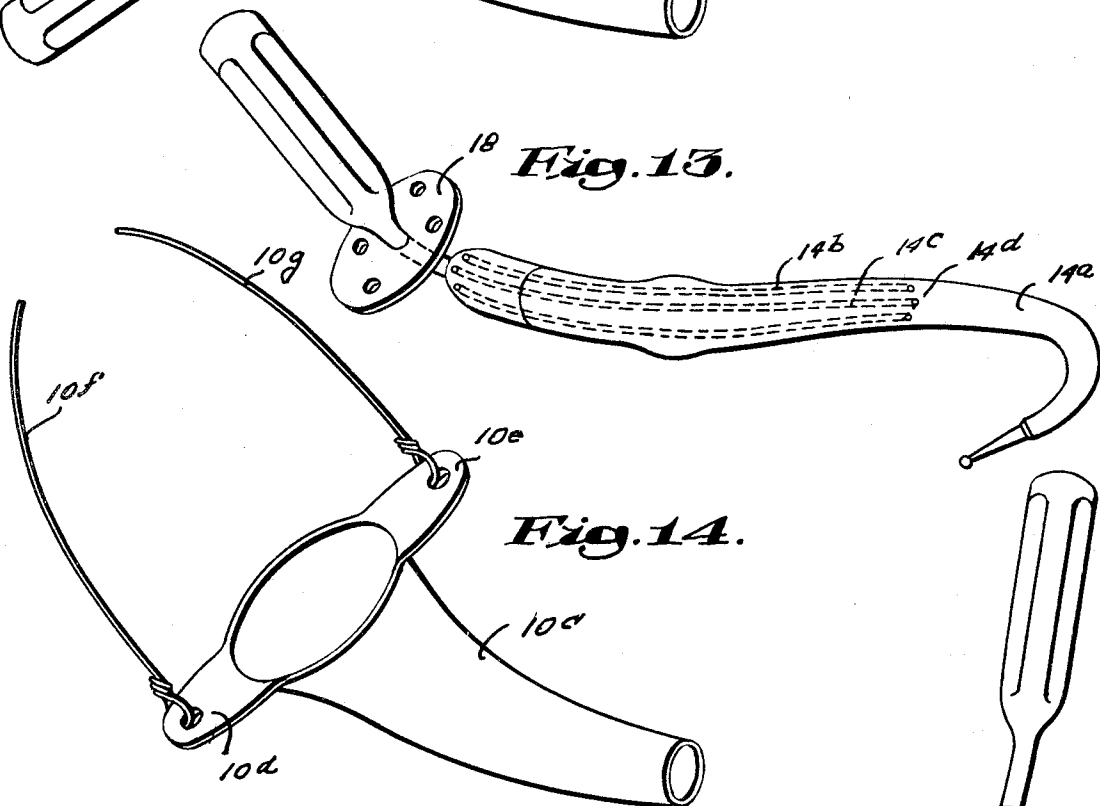
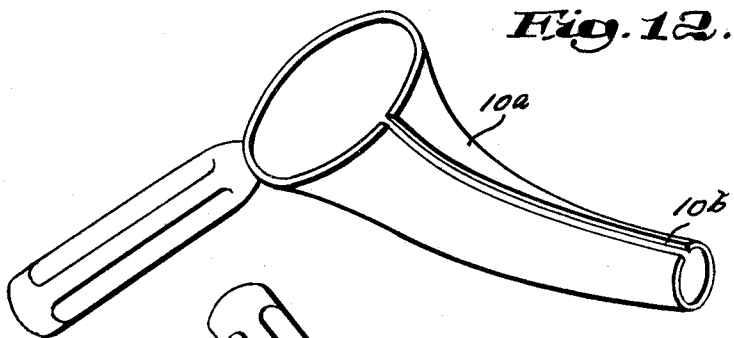
F. J. TOY

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5 Sheets-Sheet 3



Inventor:
Frederic J. Toy,
by *Munro H. Hamilton*
Attorney

May 12, 1970

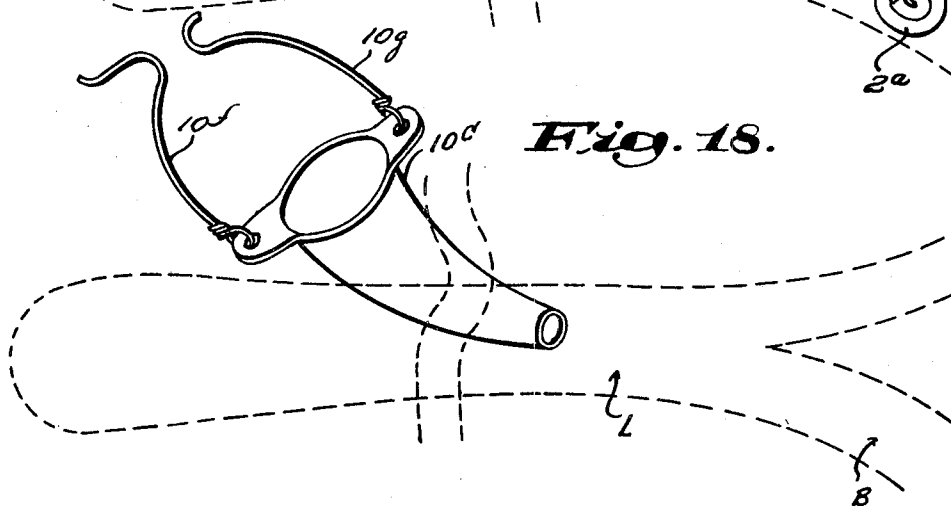
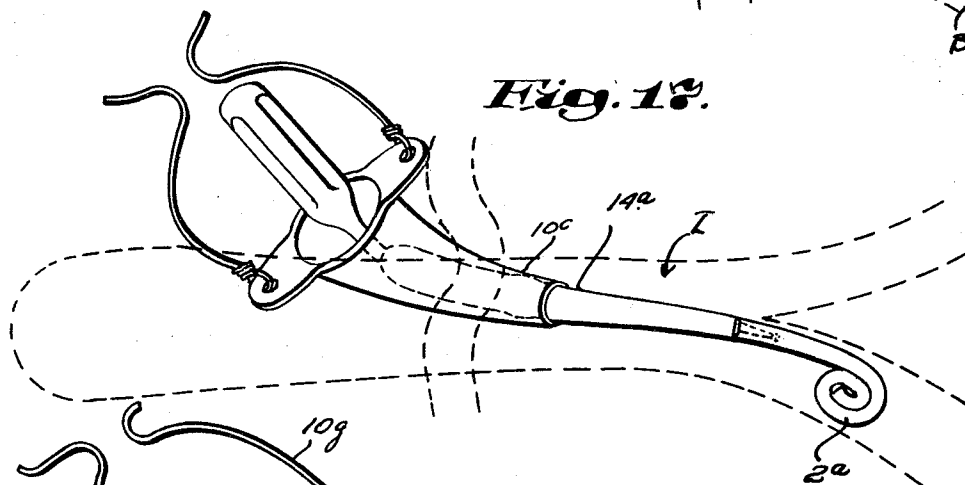
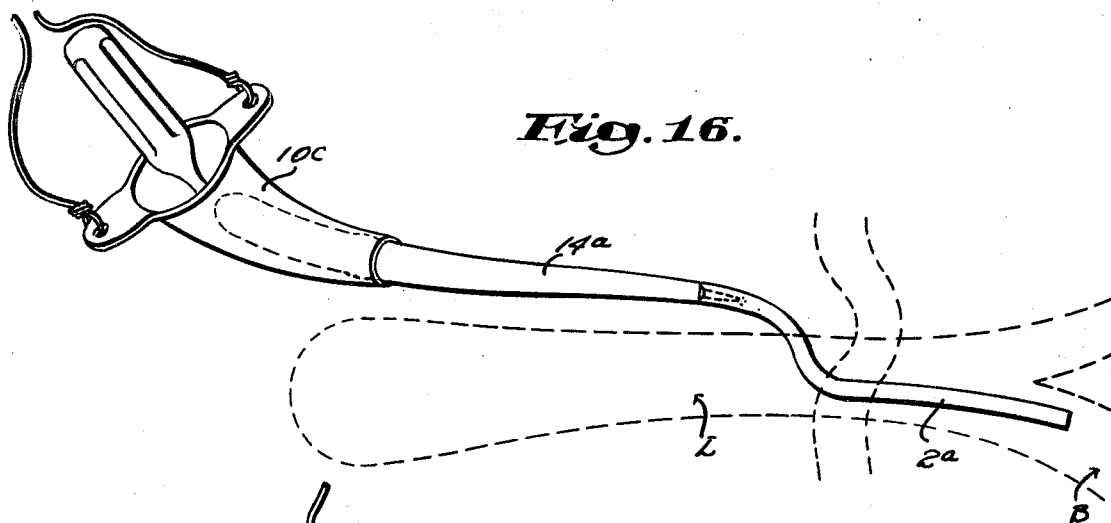
F. J. TOY

3,511,243

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5 Sheets-Sheet 4



Inventor:
Frederic J. Toy,
by *Marion H. Hamilton*
Attorney

May 12, 1970

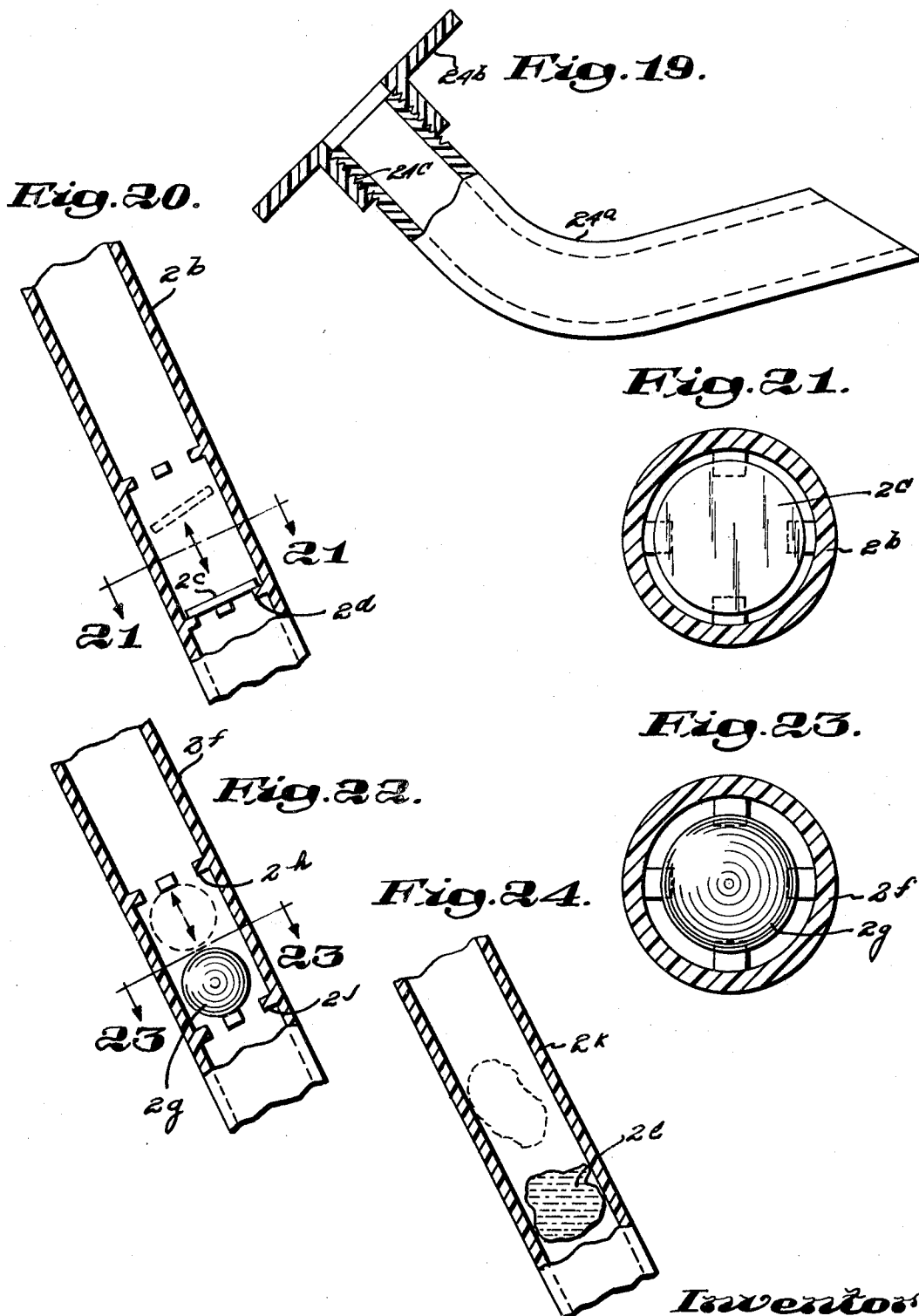
F. J. TOY

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5 Sheets-Sheet 5



Inventor:
Frederic J. Toy,
by *Monroe H. Hamilton*
Attorney

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APPARATUS FOR PROVIDING A BREATHING CONDUIT COMMUNICATING WITH THE TRACHEA AT THE BASE OF THE NECK

Frederic J. Toy, 404 Verona Ave.,

Elizabeth, N.J. 07208

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5 Claims

ABSTRACT OF THE DISCLOSURE

Emergency tracheotomy is carried out by locating a flexible leader through a hollow needle inserted in the base of the neck for extending into the trachea. The leader is attachable to an expanding adapter apparatus which includes a curved relatively rigid outer tubular guide conduit and a relatively flexible inner tapered adapter element detachably fitted within the small tapered end of the guide conduit. The adapter element is designed to project from the guide conduit a short distance generally corresponding to the length of the tracheal lumen.

The inner adapter element and the outer guide conduit held together as one are simultaneously forced into the tracheal lumen with the flexible leader serving as a guide and becoming coiled upon itself when fully extended into one of the bronchi. Thus the needle incision is progressively enlarged first by the small tapered end of the adapter element and then by the relatively large tapered end of the guide conduit.

With the guide conduit in a fully advanced position and held stationary by means of a handle, the inner tapered adapter element and attached leader member are disengaged and withdrawn, at which point the outer guide conduit constitutes a breathing passageway of appreciable magnitude. A length of tubular material of a desired size is then inserted through the outer guide conduit and into the tracheal lumen to form a breathing conduit whereupon the guide conduit in turn is withdrawn.

This invention relates to both a method and apparatus for use in emergency tracheotomy to provide for quickly locating a temporary breathing passageway through the base of the neck in communication with the trachea lumen.

It is a chief object of the invention to provide an improved method and surgical apparatus for use in tracheotomy and, more especially, to devise a method and means for rapidly locating temporary breathing conduit means through the base of the neck in communication with the trachea lumen in such position as to provide for respiratory functioning in emergency situations.

Another specific object of the invention is to devise a method which includes a series of progressive steps which can be carried out in rapid succession to provide a safe and efficient tracheotomy technique of relatively simplified nature.

Another object of the invention is to provide a novel combination of inner and outer guide components designed to be used in telescoping relationship so that the two components make possible a gradual expansion of a tracheal incision with subsequent retraction of the components after a breathing conduit of a suitable size has been inserted.

Still another object of the invention is to provide a leader and expanding adapter which can be instantly guided into a suitable position in the tracheal lumen when a tracheotomy incision is being enlarged.

Still another object is to provide in a tracheotomy apparatus of the class described, means for visually indicating when an air passageway has been initially established

through the trachea at the base of the neck. It is still another object to provide means for conveniently securing a breathing conduit in a fixed position when a suitable location of the breathing conduit has been effected.

A further object of the invention is to provide a novel combination of inner and outer guide components designed to fit one inside the other and being releasably secured together so that the inner component forms a smoothly contoured and tapered extension of the larger component and the two may thus be advanced through an incision while held together with a gradual expansion of the tracheal incision being realized.

The nature of the invention and its other objects and novel features will be more fully understood and appreciated from the following description of preferred embodiments selected for purposes of illustration and shown in the accompanying drawings in which:

FIG. 1 is a perspective view of an expanding adapter apparatus of the invention for use in tracheotomy;

FIG. 2 is a perspective view illustrating an outer guide conduit component of the apparatus shown in FIG. 1;

FIG. 3 illustrates an inner expanding adapter of generally tapered construction removed from the outer guide conduit shown in FIG. 2;

FIG. 4 is a diagrammatic view illustrating a trachea in cross section and indicating a first step in the method of the invention in which a hollow needle is located through the trachea at the base of the neck. This figure also illustrates the step of introducing a leader member through the hollow needle after penetration into the trachea lumen has occurred;

FIG. 5 is another diagrammatic view showing in dotted lines the trachea with the leader of FIG. 4 remaining in place and the hollow needle having been removed;

FIG. 6 is a diagrammatic view illustrating attachment of the leader to the expanding adapter illustrated in FIGS. 1 and 3;

FIG. 7 is a diagrammatic view illustrating the trachea with the leader and a portion of the expanding adapter having been advanced into the trachea lumen;

FIG. 8 is a diagrammatic view illustrating the entire adapter apparatus including the outer guide conduit advanced into the trachea lumen and with the leader becoming coiled up upon itself at a lower section of the trachea;

FIG. 9 illustrates the step of removal of the leader and expanding adapter through the outer guide conduit with the latter member held in the position shown;

FIG. 10 illustrates the step of introducing a breathing tube through the guide conduit into communication with the trachea lumen;

FIG. 11 illustrates removal of the outer guide conduit to leave the breathing tube in a suitably fixed position for respiratory purposes in the trachea lumen;

FIG. 12 is a detail view of a slightly modified form of guide conduit;

FIG. 13 illustrates a modified form of expanding adapter in which special air passageways are provided;

FIG. 14 is a perspective view illustrating the outer guide conduit in a modified form which includes means for securing this member temporarily in an operative position;

FIG. 15 is a perspective view of another form of expanding adapter;

FIGS. 16, 17 and 18 illustrate a modified method of providing a breathing conduit in which the expanding adapter apparatus is inserted in a trachea and the outer guide conduit is utilized as the breathing conduit itself;

FIG. 19 illustrates a modified form of breathing tube having a threaded outer end and threaded retainer cap for more precisely locating the breathing tube in a suitable position;

FIG. 20 is an enlarged fragmentary cross sectional view of a tubular leader member having a displaceable disc arrangement for indicating visually when release of air through the trachea takes place;

FIG. 21 is a cross section taken on the line 21—21 of FIG. 20;

FIG. 22 illustrates another tubular leader with visual indicating means comprising a floating ball assembly for indicating when air is exhaled;

FIG. 23 is a cross section taken on the line 23—23 of FIG. 22; and

FIG. 24 is a cross sectional view showing still another visual indication means in a tubular breathing device.

In carrying out a tracheotomy it is necessary to make an initial incision at the base of the neck communicating with the tracheal lumen. This incision may be made with various well-known surgical instruments such as a hollow needle for example.

Novel surgical instrument means employed in carrying out the method of the invention may include a flexible leader which can be introduced into the incision preferably through a hollow needle of the class noted above, and expanding adapter apparatus which when detachably secured to the flexible leader can be forced into the trachea. The adapter apparatus is made up of two parts and serves to progressively enlarge the initial incision made at the base of the neck, as well as providing an enlarged air passageway. A breathing tube, in a preferred form of the invention, is also utilized and may be introduced through the expanding adapter apparatus to take its place in forming a more effective breathing passageway.

It should be understood that the several parts described may be made of varying sizes specifically chosen with reference to the dimensional characteristics of the trachea, the trachea lumen, and the bronchi with which the trachea communicates. In general the length of the trachea in an adult may be in the neighborhood of from three to four inches and approximately one inch in diameter. Likewise, the thickness of the trachea and neck tissue may be approximately one-half to one inch. These dimensions are of relatively lesser magnitude in the case of children.

For use with dimensions of the size indicated for adults, for example, a flexible tubular leader may have an outer diameter of .125 inch, an inner diameter of .062 inch and a length of from three to six inches. Similarly, the adapter apparatus may range in tapered outer diameter from .125 inch up to one and one-half to two inches and the length of this apparatus may range from three to six inches. It is intended that these dimensions are to be taken as illustrative only and the invention is not intended to be limited to these or any other particular dimensions.

Considering the apparatus in greater detail, attention is directed to FIGS. 1-3 inclusive wherein I have illustrated a flexible leader denoted by the reference character 2. This member is designed to be used with a hollow needle 4 of the class commonly employed by surgeons for effecting a puncture or incision in a trachea as indicated diagrammatically in FIG. 4, the flexible leader may be comprised by a solid rubber-like material, if desired, but in a preferred form may be comprised by a rubber-like tube of small inner diameter as suggested diagrammatically in cross section in FIG. 1. The leader 2 may also be provided with some form of attaching means for releasably attaching the leader to the expanding adapter apparatus earlier noted. As illustrative of one desirable form of attaching means, I may form the tubular leader 2 with an inner ball socket 6 which is adapted to receive and releasably hold a ball tip 8 of the expander apparatus shown at the left hand side of FIG. 1.

This expanding adapter apparatus is made up of two parts which are further shown in separated relationship in FIGS. 2 and 3. As illustrated in FIG. 2, numeral 10 denotes one part consisting of a tapered outer guide conduit which is provided at its upper end with a handle member 12 extending substantially at right angles there-

to. The guide conduit 10 is further formed with a curved shape which is specially designed to be passed through an incision in the base of the neck and to allow a lower tapered extremity thereof to extend downwardly for a short distance into the tracheal lumen.

As illustrative of suitable dimensions for this member, which are not to be taken in a limited sense, I may form the member 10 with an over-all length of approximately five to six inches. The smaller extremity of member 10 may have an outer diameter of for example one-half inch and the larger extremity of member 10 may have an outer diameter of from one to one and one-half inches. There is thus provided a gradually tapering passageway through this member which is made use of as hereinafter described.

The second part of the expanding adapter apparatus noted consists in an inner expanding adapter element indicated by the numeral 14 more clearly illustrated in FIG. 3. This expanding adapter element may be formed of a compressible plastic or rubber material and is designed to be telescopically arranged in the outer guide conduit 10 to constitute an extension thereof for entering and initially enlarging an incision through the base of the neck. For this purpose the expanding adapter element while having some degree of flexibility is intended to be of sufficient rigidity so that it will not readily fold up upon itself and may be employed when attached to the flexible leader 2 to force the leader into and downwardly through the tracheal lumen.

For the functions noted the member 14 is tapered and provided with an intermediate body portion of an outer diameter generally somewhat less than the inner diameter of the guide conduit 10. A handle 16 is connected at one end of this adapter element and may, if desired, be separated from the body portion by a guide disc 18 adapted to be engaged within the outer guide conduit 10 as suggested in FIG. 1. This guide disc tends to function as a guide member in carrying out a thrusting action of the adapter element through the conduit 10.

As shown in FIGS. 1 and 3 the adapter element has a very small ball tip 8 connected to a relatively small tapering end 18. This provides for the ball tip 8 being forced into the flexible leader 2 for an appreciable distance before becoming attached in the ball socket 6. The end 2a of the flexible tubing 2 in a fully engaged position is brought into abutting relationship to a shouldered portion 20 of the adapter element as indicated in FIGS. 6 and 7. It will be apparent that by means of this arrangement the flexible leader and adapter element may be releasably secured together to resist accidental separation when in use and yet when desired, by the use of a sufficient pulling force, the two members may be separated at will.

The adapter element is further provided at an intermediate part thereof with an enlarged portion 22. This enlarged peripheral dimension is chosen of a size such that it gradually increases from an outer diameter which is of a value less than the inner diameter of the small extremity of member 10, to a diameter greater than the inner diameter of the extremity, and thereafter decreases to a smaller diameter.

This enlarged portion 22 constitutes an important feature of the invention and has been found to be an effective means of releasably attaching the adapter element inside of the guide conduit so that the two members may be moved as one. To provide for engagement in a position such as shown in FIG. 1 the adapter element 14 is located through the guide conduit 10 and the operator gripping the handle 16 compressibly forces the adapter element into a position such that the intermediate enlarged section 22 becomes compressibly held in the small end of the guide conduit 10.

When thus secured together the members 10 and 14 may be attached to the flexible leader 2 inserted in the trachea T. The two members are then progressively

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forced through an incision in the base of the neck and then downwardly into the tracheal lumen being guided by the flexible leader 2. It is pointed out that the tapered contour of the member 14 gradually merges with the tapered contour of the member 10 so that in effect these two parts are used as one and a gradual enlargement of the incision is accomplished to permit the guide conduit 10 to not only enter into the tracheal lumen but to extend downwardly therein for a short distance.

The method of the invention employing the apparatus described is illustrated in somewhat further detail in FIGS. 4 to 11 inclusive. As indicated therein FIGS. 4 and 5 illustrate the step of introducing the leader 2 through a hollow needle into the tracheal lumen L at approximately the base of the neck as indicated by the bone structure S. In FIG. 5 the hollow needle 4, shown in FIG. 4, has been removed with the leader 2 held in a fixed position.

In FIG. 6 the leader 2 is shown attached to the adapter apparatus and further advanced into the tracheal lumen passageway in a position to guide the expander element 14 into the needle incision.

FIG. 7 illustrates diagrammatically the leader 2 beginning to enter a bronchi passageway B with the adapter element 14 entering into the tracheal lumen and enlarging the needle incision.

FIG. 8 illustrates diagrammatically the leader 2 fully advanced into a bronchi passage in a substantially folded over or coiled position and this figure also illustrates diagrammatically the member 14 completely engaged in the tracheal lumen, together with a lower end of the outer guide conduit 10.

FIG. 9 illustrates the step of removing the inner component 14 of the expanding adapter apparatus together with the flexible leader 2 leaving the guide conduit 10 in a fully engaged position so that a substantial breathing passageway is established.

FIG. 10 illustrates the step of introducing a breathing tube 24 through the guide conduit 10 to communicate with the tracheal lumen and FIG. 11 illustrates diagrammatically removal of the guide conduit 10 to leave the breathing tube 24 in an operative position in the tracheal lumen.

The apparatus described may be varied in several respects and may be employed in other ways for some cases. The member 10 may, for example, be provided with a cutting edge 11 arranged at a lower end thereof to carry out a cutting action when member 10 is advanced and an incision already made.

Attention is directed to FIG. 12 in which I have illustrated a guide conduit member 10a which is similar in all respects to the guide conduit 10 except that it is formed with an expanding slot 10b. This slot may be employed to hold a tube or other instrument in place while the member 10a is removed.

In FIG. 13, I have illustrated a modified form of expanding adapter element 14a which also corresponds in all respects to the expanding adapter element 14 with the sole exception that there are provided in this member a plurality of air passageways 14b, 14c, 14d, etc., which are devised to provide for more immediate remedy in the case of an acute tracheal block where an air passageway must be established as promptly as possible. By locating the air passageways 14b, 14c, 14d, etc. in the manner shown throughout a substantial length of the adapter element it becomes possible to produce a breathing passageway quickly.

In FIG. 14, I have illustrated a guide conduit member 10c which is designed to be used as a breathing tube in place of the smaller breathing tube 24 shown in FIGS. 10 and 11. In this modified form of guide conduit, I have provided retainer flanges 10d and 10e extending outwardly from the larger end of this conduit member and having attached thereto fastening means as cords 10f and 10g.

These cords may be employed to secure the guide conduit

against the base of the neck by passing the cords around the neck and securing them in place.

In FIG. 15, I have illustrated a form of adapter element which is not employed with the disc 18 and which may be employed in the manner already described.

FIGS. 16 to 18 inclusive are intended to be illustrative of a slightly modified method of the invention where in the member 10c of FIG. 14 is employed as a breathing tube in place of the breathing tube 24 shown in FIGS. 10 and 11. In these FIGS. 16, 17 and 18, the same general procedure is followed, that is, a leader 2a is attached to an adapter element 14a after having been inserted through a hollow needle and the entire apparatus is then engaged in the tracheal lumen L as suggested in FIG. 17. Thereafter the member 14a and the leader 2a are withdrawn and the member 10c is secured in a fixed position by means of the cords 10f and 10g.

For some purposes a breathing tube corresponding to the breathing tube 24 may be desired to be employed with a protective cap or flange and in FIG. 19, I have illustrated a breathing tube 24a having a cap 24b which is in threaded engagement with a similarly threaded portion 24c formed at the end of the tube 24a. It will be apparent that this cap serves to seat the tube firmly against the base of the neck in an operative position.

In FIGS. 20 to 24 inclusive, I have further illustrated a method and means for facilitating the use of a flexible leader tube corresponding to the leader tube 2 already described. It will be appreciated that the technique of forming a needle incision through the base of the neck and communicating with the tracheal lumen is an operation requiring some skill and rather precise placement of the inner extremity of the needle employed to make the incision. Inasmuch as a partially blocked trachea may result in improper respiration, the point at which a correct penetration is reached will result in air being exhaled or expelled and an indication of this appearance can be very helpful in carrying out the tracheotomy method of the invention.

For this purpose I have provided a modified form of flexible leader 2b which may be formed of a rubber-like material which is of translucent character and which has secured therein a displaceable disc 2c normally supported on a flange portion 2d. In the event of air pressure being exerted in this leader 2b, the disc 2c will be displaced into a position such as that suggested in dotted lines in FIG. 20, thus indicating that a passageway has been established.

In place of the disc member 2c, I may also provide in a leader 2f a ball member 2g loosely contained between seating portions 2h and 2j. The ball may also serve to indicate when an air passageway has been established. Also in FIG. 24, I have illustrated a leader tube 2k in which a fluid material 2m is held by capillarity and is susceptible to air pressure to be displaced and also indicate when a passageway has been effected.

From the foregoing disclosure of the invention, it will be seen that I have provided a rapid and efficient method and apparatus for performing a tracheotomy and establishing a breathing passageway through the base of the neck in communication with the tracheal lumen. The progressive steps of entering the tracheal, enlargement of the needle incision and general location of a usable breathing tube are all of a simple nature susceptible of being carried out quickly and accurately with a minimum of danger. The adapter apparatus comprises a novel combination of parts which may be used in any one of several different ways and provides for a constant communicating passageway with the trachea lumen.

This method of entry into the trachea may be used also for entry into other areas of the body, for example, the bladder, the peritoneum or the chest.

Also the part 10 described in FIG. 1 may be constructed of fibroscopic material, that is, of light reflecting material which conducts light rays around corners such that an image can be seen periscopically. Also, this

part 10 is meant to supply a temporary opening into an organ for the purpose of visualizing and/or removing tissue, foreign material, or applying medication.

While I have shown and described preferred embodiments of the invention, it will be understood that changes and modifications of further variation may be practiced within the scope of the appended claims.

I claim

1. Apparatus for use in emergency tracheotomy comprising a flexible leader member for insertion through a hollow needle into the tracheal lumen, an expanding adapter apparatus detachably engaging one end of the leader member, said expanding adapter apparatus including an outer tapered guide conduit and an inner expanding adapter element telescopically arranged in the outer guide conduit to extend outwardly therefrom, a cutting edge extending rearwardly from the outer guide conduit extremity, and said outer guide conduit being formed with a progressively increasing diameter beginning at a point proximal to the cutting edge, thereby to dilate and compress cut tissue.

2. A structure according to claim 1 in which the flexible leader comprises a tubular member having an air passageway therein.

3. A structure according to claim 1 in which the flexible leader comprises a tubular member and means in the tubular member displaceable by flow of air through the tubular member to indicate exhalation through the tracheal lumen.

4. Surgical instrument means for use in emergency tracheotomy in which an incision is formed to communicate with the tracheal lumen and bronchi through the base of the neck, said surgical instrument means including an expanding adapter apparatus comprising a outer curved tapered guide conduit formed of a length to engage through the base of the neck and enter into the tracheal lumen, an inner expanding adapter element telescopically arranged in the outer guide conduit to constitute an extension thereof for entering and enlarging the said incision prior to engagement thereof by the tapered conduit, said inner expanding adapter element being formed with an intermediate engaging portion of short axial length, said intermediate engaging portion having an outer diameter which first increases in value from a size less than the inner diameter of the guide conduit at its lower end to a size greater than said inner diameter, and then decreasing to a size less than said inner diameter whereby said adapter element may be compressively forced through the guide conduit into a temporarily secured position and subsequently retracted while the guide conduit is received in the said tracheal lumen, said inner expanding adapter element including a relatively small flexible leader member releasably secured at an end thereof, and said flexible leader being of a length and diameter to enter into the bronchi in coiled relationship when the outer guide conduit is in a fully advanced position in the incision.

5. A structure according to claim 4 including a flexible leader comprising a tubular member formed with fitting means which is detachably engaged with a complementary portion of the said expanding adapter element.

6. Surgical instrument means for use in emergency tracheotomy in which an incision is formed to communicate with the tracheal lumen and bronchi through the base of the neck, said surgical instrument means including an expanding adapter apparatus comprising an outer curved tapered guide conduit formed of a length to engage through the base of the neck and enter into the tracheal lumen, an inner expanding adapter element telescopically arranged in the outer guide conduit to constitute an extension thereof for entering and enlarging the said incision prior to engagement thereof by the tapered conduit, said inner expanding adapter element being formed with an intermediate engaging portion of short axial length, said intermediate engaging portion having an outer diameter which first increases in value from a size less than the inner diameter of the guide conduit at its lower end to a size greater than said inner diameter, and then decreasing to a size less than said inner diameter whereby said adapter element may be compressively forced through the guide conduit into a temporarily secured position and subsequently retracted while the guide conduit is received in the said tracheal lumen, said outer guide conduit being provided at one side thereof with a cutting edge for enlarging the said incision when the guide conduit is advanced through the said incision, said cutting edge being located at the extremity of the outer guide conduit and said outer guide conduit being formed with a progressively increasing diameter proximal to the blade to dilate and compress cut edges of tissue.

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DALTON L. TRULUCK, Primary Examiner

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