

[54] FLEXIBLE AND EXPANDABLE  
ESOPHAGOSCOPE[76] Inventor: Sung Soo Kim, 4724 Imperial Pk.  
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[51] Int. Cl. .... A61b 1/06

[58] Field of Search ..... 128/3, 4-11,  
128/341, 343; 138/118, 119, 120, 129, 134[56] References Cited  
UNITED STATES PATENTS

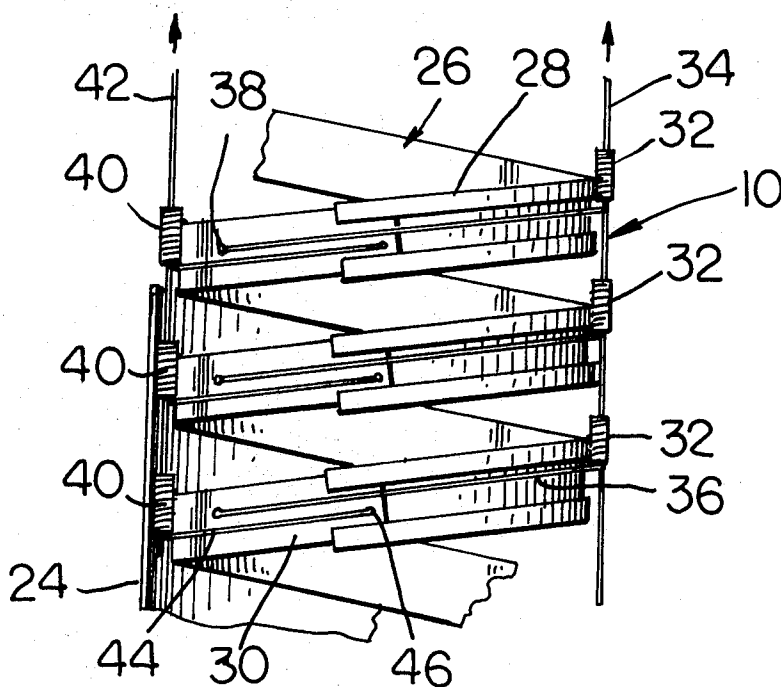
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|-----------|---------|-----------------------|-------|
| 3,190,286 | 6/1965  | Stokes.....           | 128/6 |
| 3,572,325 | 3/1971  | Bazell et al. ....    | 128/6 |
| 3,610,231 | 10/1971 | Takahashi et al. .... | 128/6 |
| 3,739,770 | 6/1973  | Mori .....            | 128/6 |

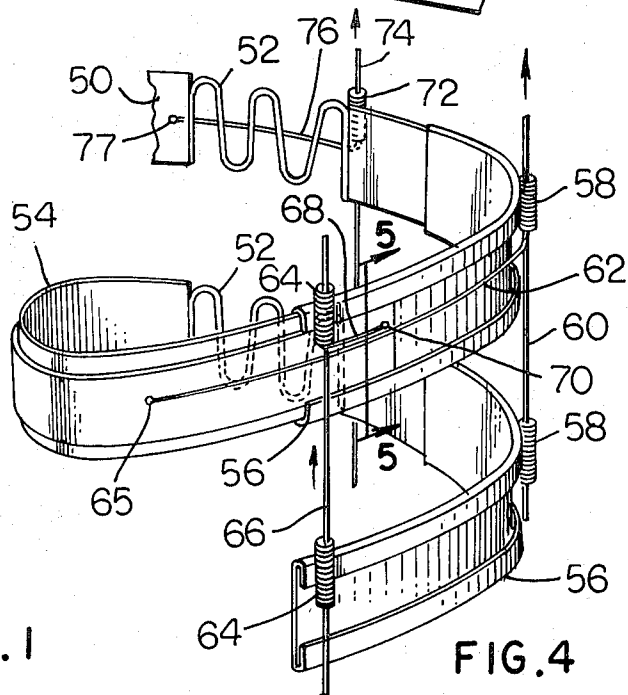
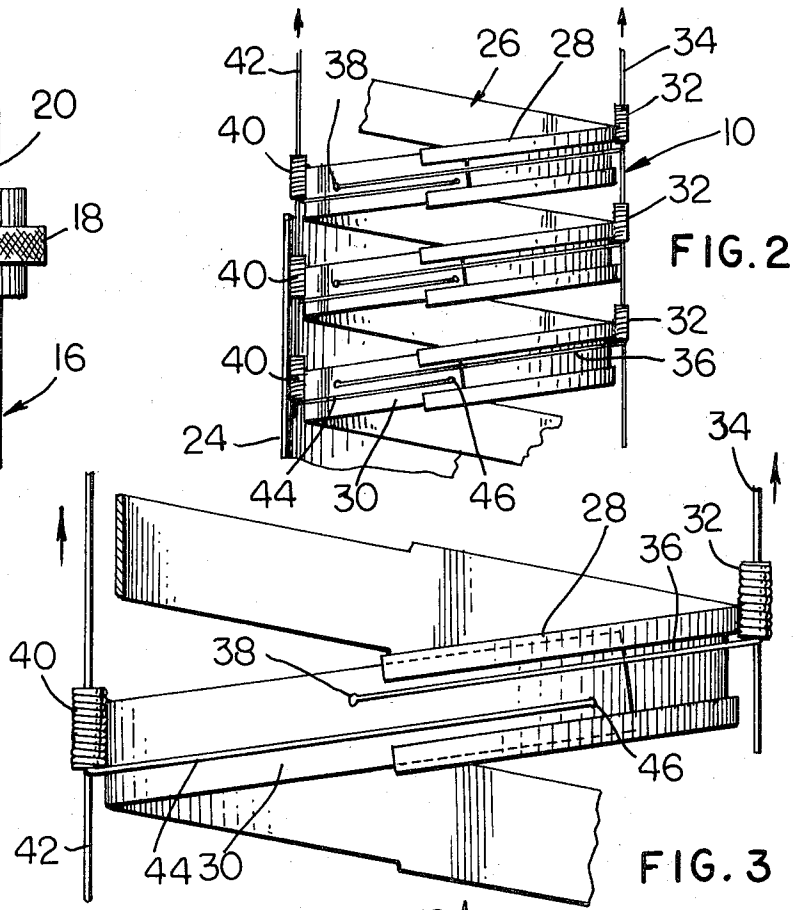
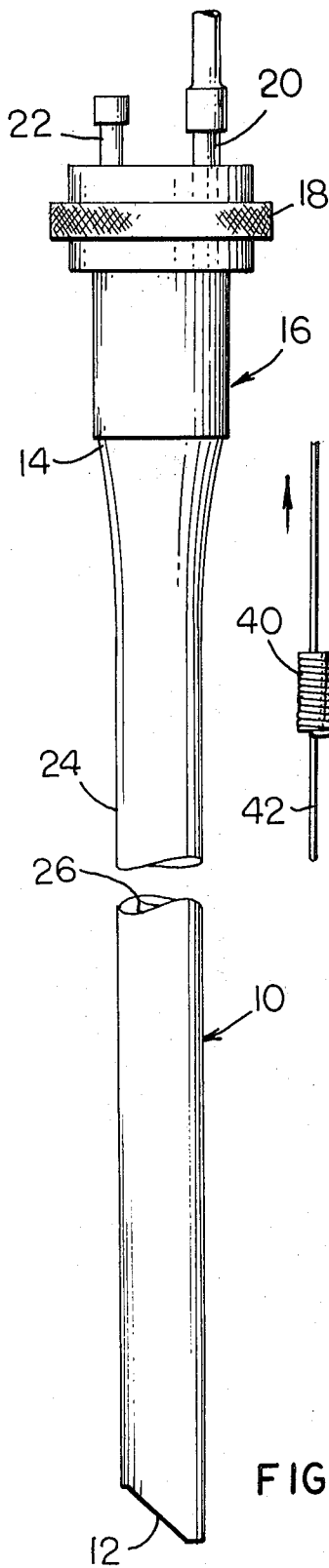
Primary Examiner—Lucie H. Laudenslager  
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## [57] ABSTRACT

An elongated flexible tubular element for use as an esophagoscope and the like and an arrangement for selectively expanding and contracting the tubular element. The flexible tubular element is adapted to have associated therewith or to receive therein a suction tube and/or a fiber optical bundle for illumination of the region at the inner end of the tubular element, and another optical element for checking or photographing the region at the inner end of the tubular element can also be introduced through the tubular element if so desired. A control box at the outer end of the tubular element is provided for controlling the expansion and contraction thereof.

19 Claims, 17 Drawing Figures





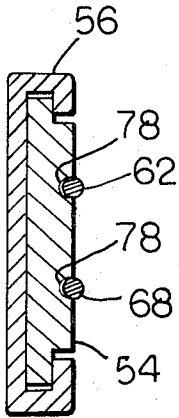


FIG. 5

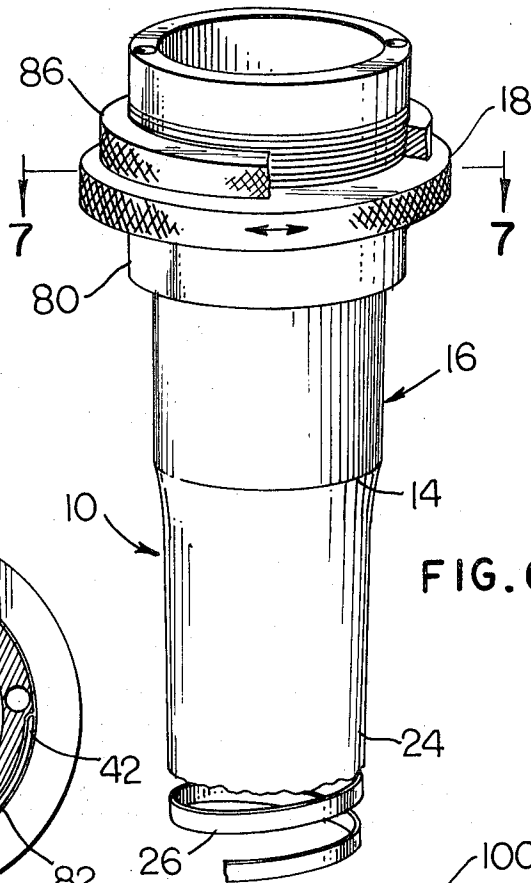


FIG. 6

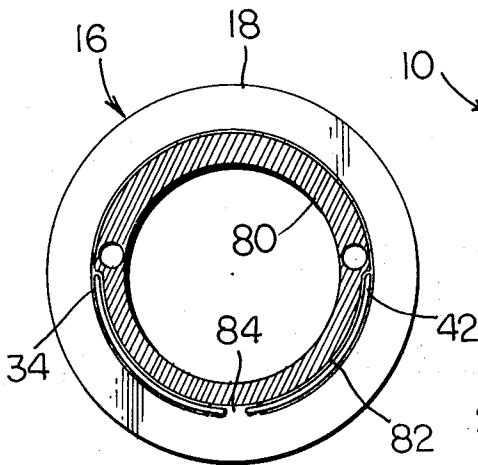


FIG. 7

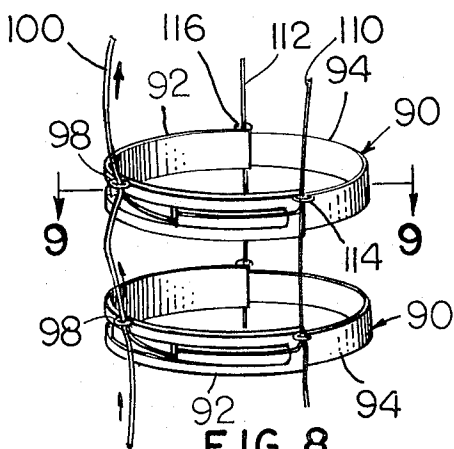


FIG. 8

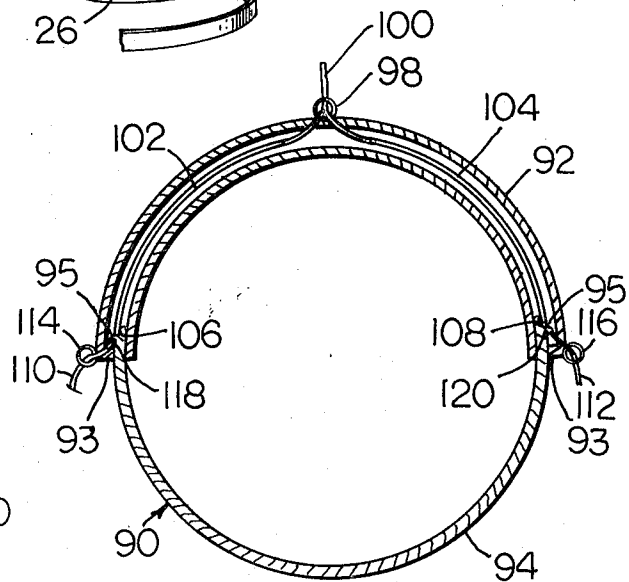
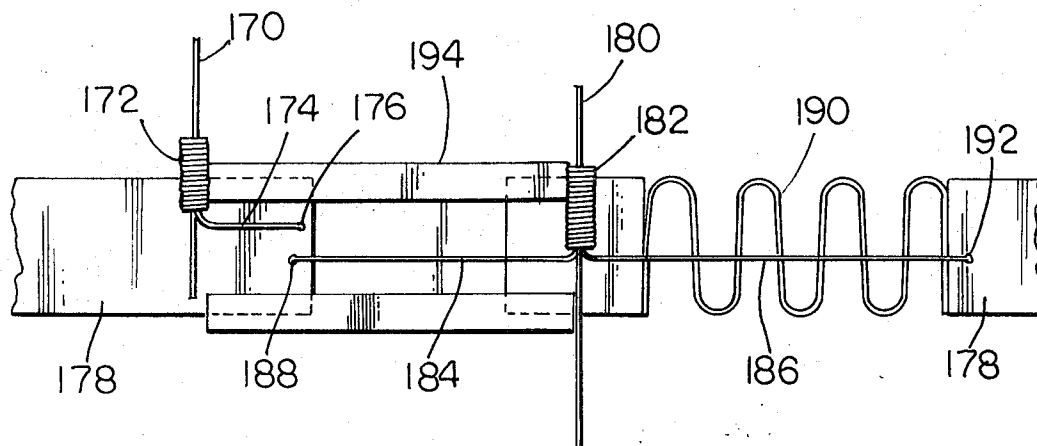
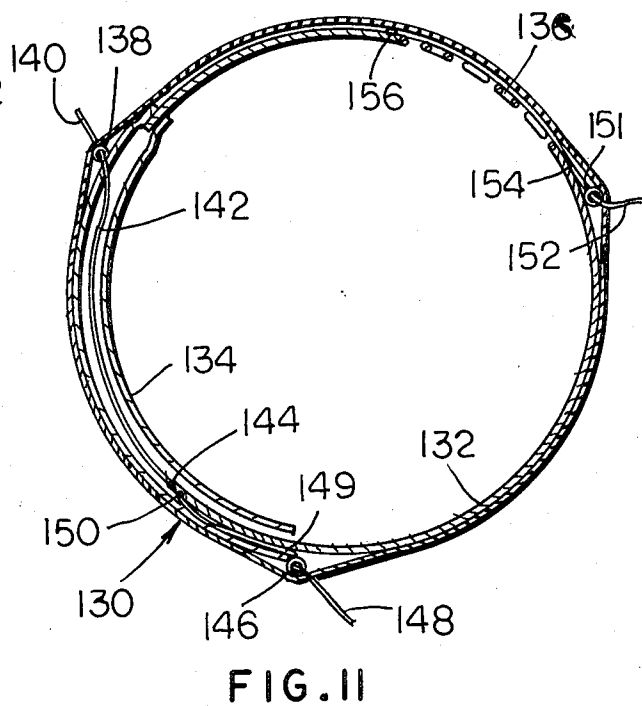
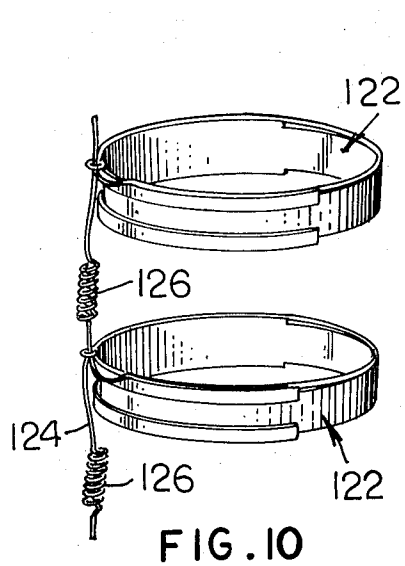


FIG. 9



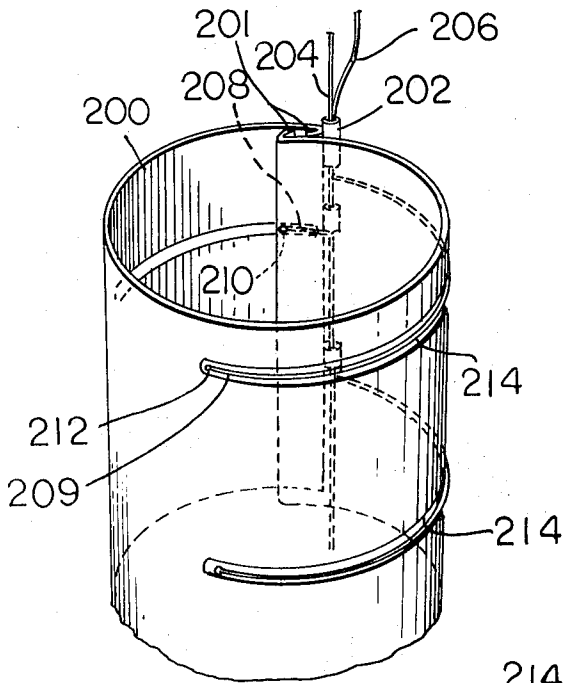


FIG. 13

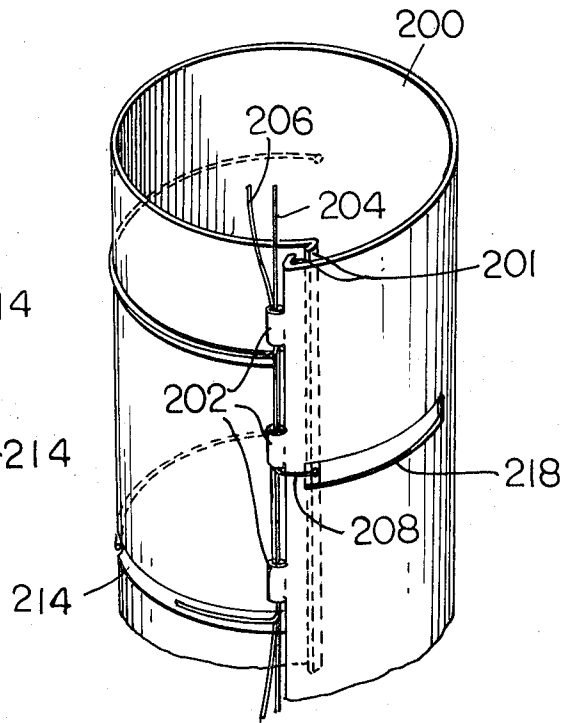


FIG. 14

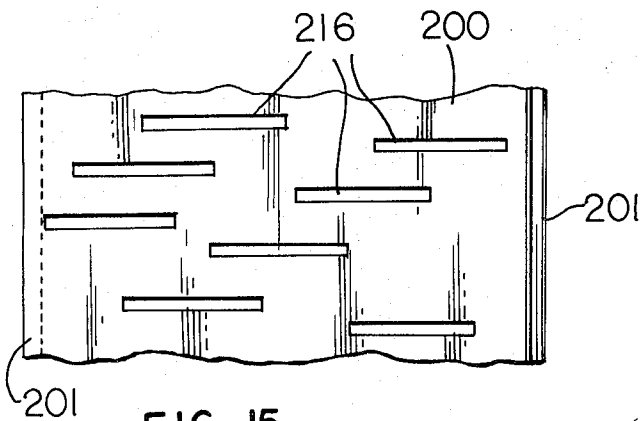


FIG. 15

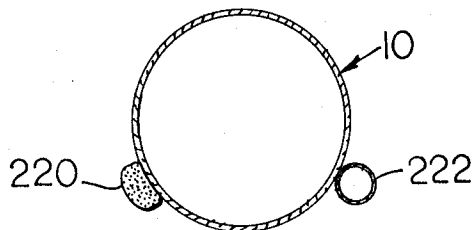


FIG. 16

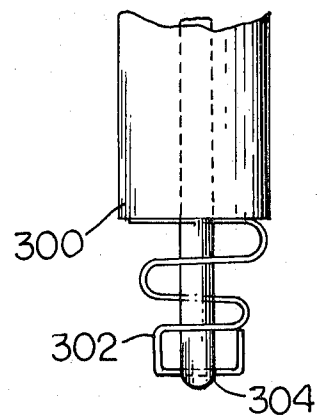


FIG. 17

## FLEXIBLE AND EXPANDABLE ESOPHAGOSCOPE

### BACKGROUND OF INVENTION

The present invention relates to a device for use particularly for the esophagoscope and pertains, in particular, to an elongated flexible tubular element which can be expanded and contracted.

A tubular element is introduced into the esophagus, and regions of the esophagus can then be inspected for disease or injury or for other reasons requiring inspection of the esophagus in order to make a reliable diagnosis.

It is also required at times to dilate the esophagus in the event, in particular, of a structure therein.

Esophagoscopy is a procedure requiring specially trained personnel and, even when specially trained, highly competent personnel are employed, complications can arise, for example, as by perforation of the esophagus.

Dilation of the esophagus is also done by a trained specialist, and this operation can also be accompanied by the complication of perforation of the esophagus.

Conventionally, an esophagoscope is made of a rigid metal tube of relatively large diameter, say, about 12 millimeters in diameter. Esophageal dilators may consist of a series of tubes of the nature referred to of respectively different diameters. In any case, the use of an esophagoscope or an esophageal dilator requires great skill and can create substantial problems.

With the foregoing in mind, the primary objective of the present invention is the provision of a tubular element for use in the practice of esophagoscope or esophageal dilation which can be handled by any physician without occurrence of the problems above referred to.

Still another object is the provision of such a tubular element that can be introduced into the esophagus by the patient.

Another object is the provision of a tubular element of the nature referred to which is selectively expansible and contractable.

Still another object is the provision of a tubular element of the nature referred to which is selectively expansible and contractable and which is also somewhat flexible in the lateral direction.

A still further object is the provision of a tubular element of the nature referred to which can be employed not only for viewing the esophagus but also as an esophageal dilator.

A particular object of the present invention is the provision of a tubular element of the nature referred to which, in contracted condition, is small enough to be easily manipulated by the patient and swallowed by the patient into the desired location, whereupon the tubular element can be expanded for use.

The foregoing objects as well as other objects and advantages of the present invention will become more apparent upon reference to the following detailed specification taken in connection with the accompanying drawings in which:

FIG. 1 is a schematic view of the device according to the present invention.

FIG. 2 is a fragmentary view showing a portion of the device of FIG. 1 with the cover cut away to expose the inside thereof.

FIG. 3 is a fragmentary view drawn at somewhat enlarged scale and showing a single convolution of the device of FIG. 2.

FIG. 4 is a somewhat schematic perspective view showing a modification of the device of FIG. 2.

FIG. 5 is a sectional view indicated by line V—V on FIG. 4 showing disposition of the string-like control elements in grooves formed in a part of the device.

FIG. 6 is a perspective view showing the control box at the outer end of the tubular element in the string-like elements which effect control of the expansion and contraction of the tubular element.

FIG. 7 is a sectional view indicated by line VII—VII on FIG. 6.

FIG. 8 is a schematic view showing another form which the device can take in which the tubular element is made up of a series of axially related expansible and contractable rings.

FIG. 9 is a plan sectional view indicated by line IX—IX on FIG. 8.

FIG. 10 is a somewhat schematic view showing a modification of the FIGS. 8 and 9 arrangement.

FIG. 11 is a schematic sectional view similar to FIG. 9 but showing a modified arrangement.

FIG. 12 is a developed view of a typical expansible and contractable ring similar to that of FIG. 11.

FIG. 13 shows a modification in which a tubular member is formed of a rolled sheet.

FIG. 14 is a view like FIG. 13 looking in at the tubular member from the opposite side.

FIG. 15 is a developed view showing how the sheet of FIGS. 13 and 14 is provided with slits to impart flexibility thereto.

FIG. 16 is a schematic plan section showing how an optical element and/or a suction tube could be used with the tubular member.

FIG. 17 is a view showing how the inner end of the optical element could be supported on the tubular member.

### BRIEF SUMMARY OF THE INVENTION

According to the present invention, an elongated flexible tubular element is made up of a series of expansible and contractable axially distributed rings, or by a helical element, the individual convolutions of which can selectively be expanded and contracted. The flexible tubular element comprises a fluid impervious flexible outer sleeve portion. Teflon, or a rubber-like material, for example, and at one end of the element, namely, the outer end, is a control box having a ring which is rotatable to effect expansion or contraction of the flexible tubular element.

The tubular element may comprise a fiber optical bundle carried thereby with the inner end of the optical bundle supported and with the outer end adapted for being connected to a source of illumination so that the region at the inner end of the tubular element, namely, the end thereof opposite the control box, can be illuminated.

Expansion and contraction of the tubular element is preferably accomplished by strings or string-like elements extending longitudinally along the tubular element and branching off at each ring, or at each of the aforementioned helical convolutions, and so connected to the rings and convolutions that pulling on one string will cause contraction of the tubular element while

pulling on another thereof will cause expansion of the element.

### DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings somewhat more in detail, the device according to the present invention comprises an elongated flexible tubular element 10 having an inner end 12 and an outer end 14. The tubular element, at the outer end 14, carries a control head, or box, generally designated 16 and which includes a rotatable control ring 18 by means of which the flexible tubular element 10 can be caused to expand and contract.

The flexible tubular element is adapted to carry or have introduced therethrough a suction tube as at 20 and a flexible fiber optical bundle as at 22. The suction tube is, of course, connected to a source of suction and the optical bundle at 22 is connected to a source of illumination.

The flexible tubular element 10 has a thin outer sleeve-like member mounted thereon which may be of rubber or rubber-like material or may be a freely expandable and contractable textile material suitably sealed as by the application of a fluid impervious sealant, such as Teflon. The sleeve-like member is fluid impervious and is removeable for inspection or repair of the portions of the tubular element disposed therein.

The device inside the outer sleeve may be formed of expansible and contractable rings, preferably thin stainless steel rings, or may consist of a helix, or strip of ribbon-like material, again, preferably stainless steel, and with the individual convolutions of the helical member being expansible and contractable.

FIG. 2 shows an arrangement wherein, inside the flexible fluid impervious outer sleeve-like member 24, there is a somewhat ribbon-like helical member 26, each convolution of which is selectively expandable and contractable.

FIG. 3 is a somewhat enlarged view of a convolution of the helical member of FIG. 2 and will show that each convolution comprises a female portion 28 at one end and a male portion 30 at the other end telescopically engaging the female portion. The male portion of each convolution, as will be seen in FIG. 3, engages the female portion on the next adjacent convolution.

By varying the degree of telescopic engagement of the said portions, the respective convolutions made up by the portions can be expanded and contracted. FIG. 3 shows that there is an eyelet arrangement 32 connected to the female portion through which a string or cord-like element 34 is entrained which extends longitudinally along the tubular member. String-like element 34 is connected to another string 36 which extends circumferentially about the helical element and is connected to the male portion 30 at 38. It will be apparent that by pulling on string-like element 34 in the direction of the arrow adjacent thereto, the male portion 30 will be pulled into the female portion and the respective convolution will contract.

A similar eyelet arrangement 40 is connected to the male portion and another string or cord-like element 42 extending longitudinally along the tubular element is entrained therethrough. String-like element 42 is connected to another string-like member or cord 44 that extends circumferentially about the male member and is connected thereto at 46. At this point, it will be evident that pulling on cord-like element 42 in the di-

rection of the arrow adjacent thereto will cause the male portion to be drawn out from the female portion and the respective convolution will thereby be expanded. Hooks, or the like, (not shown), are provided on the ends of the male and female portions to prevent disengagement thereof in a position of maximum expansion.

FIG. 4 shows a modification of the arrangement of FIG. 3 in which the male portion, indicated at 50, has interposed therein a flat compression spring 52.

The male portion of the next adjacent convolution is indicated at 54 and telescopically engages the female portion 56 which pertains to the first mentioned male portion 50 and the compression spring 52. The convolution of FIG. 4 is also adapted for expansion and contraction by cord elements. In FIG. 4, a first eyelet arrangement at 58 is connected to the female portion 56 and has a string 60 entrained therethrough which has a branch 62 extending about and connected to the male member at 65.

Another eyelet at 64 is connected to the extreme end of the female member and has a string 66 entrained therethrough with a branch string 68 leading about the male member and connected thereto at 70. It will be apparent that movement of cord 60 in the direction of the arrow will cause contraction of the convolution while pulling of string 66 in the direction of the arrow will cause expansion thereof.

Furthermore, an additional eyelet 72 is provided at one side of spring 52 and a cord 74 extends there-through and longitudinally of the tubular member and has a branch cord 76 connected thereto and leading across the gap in the male member which is spanned by the compression spring. Cord 76 is connected to male portion 50 at 77. Movement of cord 74 in the direction of the arrow simultaneously with movement of string 60 in the direction of the arrow will cause contraction of the convolution on both sides thereof.

As will be seen in FIG. 5, the cords or strings extending about the male member in both of the arrangements of FIGS. 3 and 4 can be disposed in grooves formed therein. In FIG. 5, the grooves are indicated at 78 with the branch cords 62 and 68 disposed therein.

FIG. 6 shows that the control box 16 at the outer end 14 of the tubular element consists of a body part 80 mounted on the outer end 14 of the tubular element 10. Body part 80 is tubular so that instruments and the like can be introduced into the tubular element and be withdrawn therefrom. Control ring 18 is rotatably mounted on body part 80 and connected to the control ring are the cords or strings which cause expansion and contraction of the tubular element.

For example, the modification of FIG. 3 has two substantially diametrically opposed strings 34 and 42 and these strings extend through respective passages in the tubular body part 80 to an arcuate recess 82 formed in the body part and extend about the recess and are connected together as shown in FIG. 7. The control ring 18 is connected to the interconnected strings in recess 82 at 84 so that rotation of ring 18 will move the strings in the axial direction of the tubular element in respectively opposite directions.

Any suitable means may be provided for locking control ring 18 in adjusted positions thereof, or it may merely be frictionally fitted to body part 80 so as to remain in adjusted positions thereon. If positive locking of the rotatable control ring in adjusted positions is de-

sired, body part 80 may have a clamp nut 86 threaded thereon axially adjacent control ring 18 so that the ring can be clamped in its respective adjusted positions.

FIGS. 8 and 9 show a modification in which the tubular member is made up of an axially distributed series of expansible and contractable annular rings 90. Each such ring may comprise a female portion 92 and a male portion 94 telescopically engaging the female portion.

As will be seen in FIG. 9, the female portion 92 may be so arranged that the male portion 94 telescopes into both ends thereof. The ends of the female portion 92 and the male portion 94 include hook means 93 and 95 which prevent the portions from becoming disengaged when in maximum expanded position.

Eyelet means 98 mounted in about the middle of the arcuate length of the female portion 92 receives a pull cord 100 having branches 102 and 104 at each ring which extend circumferentially and are connected to the tip ends of the male portion at 106 and 108. Pulling axially on cord 100 will draw the tip ends of the male portion 94 completely into the female portion 92 thereby substantially reducing the diameter of the respective ring to about one-half its expanded diameter.

Expansion of the ring is accomplished by two pull cords 110 and 112 running through eyelet means 114 and 116 and having branch cords leading inwardly and connected to the tip ends of the male portion 94 of the ring at 118 and 120. It will be evident that the ring can be expanded from its collapsed or retracted position by pulling upwardly on cords 110 and 112, while simultaneously relaxing cord 100. The cords 110 and 112 are substantially diametrically opposed on the tubular elements and both lead into the control head and are manipulated by rotation of the control ring thereon.

FIG. 10 shows a modification in which the spring element connecting the rings has coiled portions between the rings. In FIG. 10, the rings are generally indicated at 122 and the spring which supports the rings in axially spaced relation is indicated at 124 and will be seen to have coiled portions 126 therein between adjacent ones of the rings 122.

FIG. 11 shows a modification of an expansible and contractable ring that could be employed in either of the modifications of FIGS. 8 or 10. In FIG. 11 the ring, generally indicated at 130, comprises a male portion 132 telescopically engaging a female portion 134. About diametrically opposite the point of engagement of the male portion with the female portion, the male portion is interrupted by an undulating compression spring 136. Eyelet means 138 carried on the female portion receives a pull cord 140 with a branch 142 at the level of each ring which leads around the female portion and is connected to the tip end of the male portion at 144.

Other eyelet means at 146 receive a pull cord 148, and pull cord 148 has a branch 149 at the level of each ring leading about the female portion and connected to the tip end of the male portion at 150. Pulling axially on cord 140, while relaxing cord 148 will cause contraction of the respective ring; while pulling axially on cord 148, while relaxing cord 140 will cause expansion of the respective ring.

On one side of the gap bridged by spring 136 is a further eyelet means 151 on each ring and through which eyelet means the pull cord 152 is entrained which, at

the level of each ring, has a branch cord 154 spanning the gap in which spring 136 is placed and connected to the ring at 156 on the opposite side of the gap. Pulling axially on cord 152 will cause collapsing of the spring, while releasing the cord will permit the spring to expand.

As shown in FIG. 12, which is a developed view of the ring of FIG. 11, expansion of the ring can be accomplished by a pull cord 170 passing through eyelet means 172 and having a branch 174 extending about and connected at 176 to the tip end of the male portion 178 of the ring. Contraction of the ring can be accomplished by pulling axially on another pull cord 180 passing through eyelet means 182 and having two branches 184 and 186 at the level of each ring. Branch 184 leads to the tip end of the male portion 178 and is connected thereto at 188 while branch 186 spans the gap in which the spring 190 is located and is connected to the ring at 192.

In FIG. 12, both of the eyelet means at 172 and 182 are mounted on the female portion 194, of the ring, and may be substantially diametrically opposed about the ring. The advantage of the FIG. 12 arrangement is that only two adjusting cords are required to effect expansion and contraction of the ring at two spaced points thereabout.

FIG. 13, 14 and 15 schematically illustrate another modification of the invention.

In these Figures, a thin sheet of material, stainless steel, for example, is wrapped into a cylindrical form and is indicated at 200. The ends of the sheet overlap and on the tip edge of the outer layer, there is arranged the eyelet means 202 through which are entrained two pull cords 204 and 206. Pull cord 204 has branch cords 208 extending inside the outer layer of the sheet and connected to the tip end of the inner layer as at 210. Cord 206, on the other hand, has branch cords 209 extending about the outside of the tubular element and connected thereto at 212. It will be evident that pulling of the cord 206 will cause the tubular element to contract while pulling of cord 204 will open the element up from a retracted position. The tubular element may be grooved to receive the cords as shown at 214 in FIG. 14.

The edges of the rolled up sheet have hook elements 201 formed thereon which prevent the edges from separating when the tubular member is in a position of maximum expansion.

As will be seen in FIG. 15, which is a developed view of sheet 200, the sheet may be provided with a multiplicity of transversely extending slits 216 advantageously arranged in staggered relation and which impart flexibility to the sheet when it is rolled up into tubular form.

As will be seen in FIGS. 13 and 14, certain ones of the said slits, indicated at 218, may be availed of for receiving the branch cords 208, which are employed during expanding of the tubular element.

As shown in FIG. 16, an elongated tubular element according to any of the modifications of the present invention, may have mounted thereon and extending the length thereof, the optical fiber bundle 220 by means of which the region at the inner end of the tubular element can be illuminated. This optical bundle can also be passed down the hollow interior of the tubular element together with any other optical device, desired. Also, a suction tube 222 can extend along the tubular

element either outside or inside, as may be preferred for applying suction to the region at the inner end of the tubular element.

In every case, the tubular element is completely enclosed within a fluid impervious highly flexible elastic shield or sleeve which, as mentioned, can be made of any suitable elastomeric material, either of plastic or natural rubber, or any combination thereof. Also, a suitably flexible textile material can be employed and impregnated with an elastic fluid impervious material, such as teflon, if so desired.

FIG. 17 is a fragmentary view of the inner end of the tubular member showing how the spring connecting the axially distributed expansible and contractable elements, as in the modifications of FIGS. 8 and 10, can have an end part at 300 extended at the inner end of the tubular element and forming a holder 302 for the light emitting inner end of the optical element 304 carried by the tubular element.

The hook elements described for limiting the expanding movement of the rings, or convolutions, of the flexible tubular member, may be provided in the case of each of the illustrated modifications. Other means for limiting the expanding movement of the tubular member will also suggest themselves.

Modifications may be made within the scope of the appended claims.

What is claimed is:

1. A device especially adapted for insertion into the esophagus and comprising; an elongated tubular member, said member comprising a plurality of substantially cylindrical circular means extending axially along said member and adjustable in diameter, adjusting means connected to said circular means and moveable for adjusting the diameter of the circular means, adjustable means at one end of said member connected to said adjusting means for the movement thereof for the selective expansion and contraction of said circular means, and a resilient fluid impervious sleeve member extending along and enclosing said circular means.

2. A device according to claim 1 in which said circular means comprises axially distributed elements tiltable relative to one another whereby said tubular member is laterally flexible.

3. A device according to claim 2 which includes at least one flexible optical element extending along said tubular member from end to end.

4. A device according to claim 3 in which said optical element is adapted to supply light to the vicinity of the end of said tubular member opposite said adjustable means, said tubular member being hollow from end to end so as to be adapted to have a further element introduced therethrough.

5. A device according to claim 1 in which said circular means comprises a plurality of axially distributed circular elements, each circular element being resilient, said adjusting means comprising string means connected to circumferential points of each circular element and operable when moved to adjust the circumferential points on the respective circular element relatively, means on said circular elements forming deviation points about which said string means are entrained, and axial strings connected to said string means on the opposite side of said deviation points from said circular elements and extending along said tubular element to said adjustable means for movement thereby.

6. A device according to claim 5 which includes means for arresting said adjustable means in adjusted positions thereof.

7. A device according to claim 1 in which said circular means comprises a helical member, and each individual convolution of said helical member being expandable and contractable.

8. A device according to claim 7 in which each said convolution has one end in the form of a male member and the other end in the form of a female member, each end of each convolution telescopically interfitting with the adjacent end of the next adjacent convolution.

9. A device according to claim 8 in which each of said male and female members include means at the ends which are interengageable to limit the expanding movement of said convolutions and which prevent said members from becoming disengaged.

10. A device according to claim 7 in which each said convolution in the region thereof intermediate the ends is circumferentially flexible.

11. A device according to claim 10 in which said adjusting means comprises string-like means extending circumferentially of each said convolution and having ends connected to circumferentially spaced points of the respective convolution, flexible inextensible string-like elements extending axially along the outside of said convolutions and connected to said string-like means, eyelet means on said convolutions through which said string-like elements pass and which form deviating points for said string-like means, said string-like elements extending to and being connected to said adjustable means for axial movement of the string-like elements by said adjustable means with simultaneous circumferential movement of said string-like means to adjust said convolutions radially.

12. A device according to claim 1 in which said circular means is in the form of individual rings variable in diameter, and a helical spring extending along said tubular member and having a portion of each convolution connected to a respective ring.

13. A device according to claim 12 in which the portion of said spring between adjacent ones of said rings include a flexible coiled region.

14. A device according to claim 12 in which each ring includes interfitting male and female portions in adjustable telescopic relation whereby the diameter of each ring can be varied by varying the degree of telescopic engagement of said portions.

15. A device according to claim 14 which includes string-like elements extending circumferentially of said rings and connected thereto, pull strings extending axially along said rings and connected to said string-like elements, eyelet means connected to said rings through which said pull strings extend and which form deviation points for said string-like elements, said pull strings being connected to said adjustable means for movement thereby.

16. A device according to claim 15 which includes a flexible optical element extending the length of said tubular member and having a light emitting end portion disposed outwardly beyond the range of the ring most remote from said adjustable means, said helical spring having an end region supportingly connected to said end portion of said optical element.

17. A device according to claim 1 in which said circular means comprises a rolled strip of thin material with the edges in overlapping relation.

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18. A device according to claim 17 in which said strip comprises lateral slit-like perforations distributed thereover to impart flexibility to said circular means.

19. A device according to claim 17 which includes eyelet means on the radially outer edge of said strip, axial string means passing through said eyelet means, and branch strings connected to said string means at

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axially spaced points therealong and leading circumferentially about said circular means and connected to spaced points thereabout, whereby axial movement of said string means will cause circumferential movement of said branch strips and expansion and contraction of said circular means.

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