A tubular organ traversing device includes a trailing inflatable radially expandable anchor member having a high restraint gripping periphery and leading inflatable advancing member with a radially expandable trailing section, having a surface engaging periphery of less restraint than that of the anchor member and longitudinally expandable leading section. A multilumen flexible tube is secured to and extends through the anchor member to a forward section of the advancing member through an elastomeric axial well in its rear. One lumen communicates with the anchor member and a second lumen to the advancing member and the two lumens are connected by way of a valve system to a pressurized fluid and exhaust and the valve system is controlled to sequentially first deflate both members, inflate the advancing member, deflate the anchor member, deflate the advancing member and then deflate the anchor member to commence the next cycle.

8 Claims, 6 Drawing Figures
SELF PROPELLED CONDUIT TRAVERSING
DEVICE

BACKGROUND OF THE INVENTION

The present invention relates generally to improvement in conduit traversing devices and it relates more particularly to an improved self propelling device for advancing a service member such as a tube functioning as a catheter or for other desirable purposes through a tubular organ.

It is frequently desirable and often necessary for a particular purpose to advance a service device which may be an implement, viewing device, camera, cleaning device or the like, to predetermined areas in a small bore conduit which extends along an irregular and often highly convoluted path. Thus, for example, when an obstruction occurs in the intestine, it is desirable to remove the waste materials that are being blocked, especially preceding surgery, to remove such obstruction. The conventional procedure for advancing a tube through the intestine is to insert the tube to a comfortable depth and permit the natural peristaltic movement of the intestine to advance the tube to the desired areas. However, by reason of the slow rate of advance effected by peristalsis, the procedure is highly time consuming, often requiring 18 or more hours. In many cases surgery must be performed under emergency conditions, and the time required to advance a tube through the intestine by peristalsis is excessive and may result in a dangerous and possibly fatal delay of surgery, so that the surgery is accordingly performed in the absence of the removal of the waste material and under correspondingly adverse conditions, with frequent highly undesirable consequences. Many devices and procedures have been heretofore proposed for advancing a tube or other implement along the intestine, independently of the peristalsis, but these devices possess numerous drawbacks and disadvantages. They are unreliable, slow, uncomfortable, require a high degree of skill, are complicated and of little versatility and adaptability, and otherwise leave much to be desired.

SUMMARY OF THE INVENTION

It is a principal object of the present invention to provide an improved conduit traversing device.

Another object of the present invention is to provide an improved self propelled convoluted tube traversing device.

Still another object of the present invention is to provide an improved self propelled device for traversing a tubular organ, such as the intestine, to advance therethrough a waste removal tube or other implement or device.

A further object of the present invention is to provide a device of the above nature characterized by its great reliability, ease and speed of operation, simplicity and ruggedness, and its great versatility and adaptability.

The above and other objects of the present invention will become apparent from a reading of the following description taken in conjunction with the accompanying drawing which illustrates a preferred embodiment thereof.

In a sense, the present invention contemplates the provision of an improved longitudinally extending tubular member, having first and second lumens, an inflatable transversely anchor member connected to the tubular member and communicating with the first lumens, an inflatable advancing member, connected to the tubular member and communicating with the second lumen and including a transversely expandable section and a longitudinally expandable section and means for connecting the first and second lumens to a source of pressurized fluid and exhaust in a predetermined sequence to correspondingly sequentially expand and deflate the anchor member and advancing member.

In the improved form of the preferred device, the tubular member consists of three joined lumen defining tubes, the first tube communicating with the anchor member through one, or more ports in the tube, the second tube communicating through ports therein with the advancing member and the third tube functioning as a service tube and extending forwardly of the inflatable members. The anchor member is a hollow cylinder formed of an elastomeric material and has bosses formed on its outer peripheral face. The advancing member is disposed forwardly of the anchor member and its rear anchor defining section is radially expandable relatively short member, having a curved smooth outer face and formed of an elastomeric material, and its forward section is provided with peripheral accordion pleats, so with inflation it extends and with deflation, it contracts. An elastomeric tube extends coaxially forwardly from the advancing section rear wall and joins the advancing member a short distance rearwardly of its front wall, so that the corresponding section of the tubular member advances with the front wall. The first and second tubes are connected by way of a timed valving system to pressure and exhaust to sequentially expand the anchor member, expand the advancing member, deflate the advancing member and deflate the anchor member.

The improved self propelled conduit traversing device is reliable, simple and rugged, rapid, easy to operate, and of great versatility and adaptability.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram and a longitudinal sectional view of a preferred embodiment of the present invention, shown in a deflated condition at a first step in its advancing cycle;

FIG. 2 is a side elevational view of the advancing assembly in the second step of the cycle;

FIG. 3 is a view similar to FIG. 2 illustrating the third cycle step;

FIG. 4 is a view similar to FIG. 2 illustrating the last cycle step;

FIG. 5 is an enlarged fragmentary medial longitudinal sectional view of the advancing member; and

FIG. 6 is a view similar to FIG. 5 of a modified form of the advancing member.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, particularly FIGS. 1 to 5 thereof, which illustrate a preferred embodiment of the present invention, the reference numeral 10 generally designates the improved device which includes an advancing section 11 joined by a luminal tubular member 12 to an activating section 13. The tubular member 12 is formed of three isolated tubes 14, 16 and 17 respectively, joined to each other or integrally formed as a unit of high flexibility and of suitable length, so as to extend from the activating section 13
to the desired area of the tubular organ and being capable of easily following the various curves and convolutions of the organ. The tubes 14 and 16 are sealed at their distal ends.

The advancing section 11 is mounted on the distal end of the tubular member 12 and includes a trailing inflatable anchor member 18 and a longitudinally spaced leading inflatable advancing member 19. The anchor member 18 is of tubular cylindrical configuration and formed of an elastomeric material and includes relatively heavy circular front and rear end walls 20 and 21 respectively, and a relatively thin cylindrical peripheral wall 22. Outwardly directed bosses or projections 23 are formed on the outside face of the peripheral wall 22. The tubular member 12 extends coaxially through anchor member 18 and is hermetically sealed to the end walls 20 and 21 and one or more ports 24 are formed in tube 14 between end walls 20 and 21 to provide fluid communication between the tube 14 and the anchor member 18.

The advancing member 19 is integrally formed unit which is mounted on the distal end of tubular member 12 forwardly of anchor member 18 and is of hollow tubular configuration and includes a radially expandable trailing portion 26 and a longitudinally expandable leading portion 27. The anchoring portion 26 is of an elastomeric material with a relatively thin outwardly convex peripheral wall and a relatively thick annular end wall 29, having a central opening of greater diameter than the maximum transverse dimension of tubular member 12.

The advancing portion 27 is in the shape of cylindrical bellows, including a relatively thick accordion pleated peripheral wall, the trailing edge of which joins the leading edge of the anchor portion wall 28. The leading edge of wall 30 is joined to the peripheral edge of an annular relatively thick end wall 32, whose central opening is hermetically sealed to the tubular member 12 proximate its distal end.

Projecting forwardly from and joined to the inside peripheral border of the central opening of rear end wall 29, is a thin walled elastomeric tube member 33, which may be peripherally reinforced by thick peripheral ribs which prevent the collapse of the tube member 33. The leading end of tube member 33 is hermetically joined to tube member 12 a short distance rearwardly of front wall 32, by a thick annulus 34. One or more ports 35 are formed in tube 16 between walls 32 and 34 to provide communication between tube 16 and advancing member 19. It should be noted that the dimensions and wall thicknesses of the advancing member 19 are such, as specified above, that upon the inflation thereof such as by the introduction of compressed air, the anchor portion 26 first expands radially and the advancing portion 27 then expands longitudinally with no significant radial expansion. Upon the reduction of the air pressure in advancing member 19 it radially and longitudinally returns to its normal contracted position under the elastomeric and resilient properties of the material forming the advancing member 19.

The activating section 13 includes a solenoid actuated valve system 36 of known construction having outlet ports connected to tubes 14 and 16 respectively, and a pair of inlet ports, one of which is connected to exhaust or suction, and the other of which is connected to a compressed air tank 37, which in turn is connected to the outlet of a compressed air pump 38. A sequenc-

ing timer 39 actuates the valve system 36 to sequentially connect the tubes 14 and 16 to exhaust, connects tube 16 to compressed air, connect tubes 14 and 16 to compressed air and then connects tube 16 to exhaust, the cycle being periodically repeated.

In the operation and application of the device 10 described above, the advancing section including the anchoring member 18 and the advancing member 19 is inserted into the tubular organ T, for example the intestine, as far as it can be conveniently, and comfortably be effected, with the members 18 and 19 being in deflated contracted condition as shown in FIG. 1. The timer 39 is then actuated to effect the repeated pressure and exhaust cycle specified above. First the advancing member 19 communicates with the compressed air to first radially expand anchoring portion 26 and anchor it to tubular wall T and then longitudinally expand the advancing portion 27 to advance walls 32 and 34 to pull tubular member 12 and anchor member 18 forwardly as shown in FIG. 2. Then anchor member 18 is inflated and expanded to firmly anchor it to wall T, as shown in FIG. 3. Thereafter advancing member 19 is deflated and contracted so that its rear portion advances forwardly, as shown in FIG. 4, by reason of the section of tube 12 between members 18 and 19 being anchored against movement by the expanded anchor member 18. Finally, anchor member 18 is deflated and contracted to return the section to its initial condition as shown in FIG. 1, and the cycle is periodically repeated to advance the section 11 by increments along the tubular organ T carrying with it the service tube 17 to the desired area of the tubular organ T, and the timer is then deactuated to stop the advance of the section 11. The area of the tubular organ T exposed to the distal end of tube 17 may now be treated in the desired manner. It should be noted that the tube 17 may be anchored in position by inflating and expanding at least anchor member 18 during treatment.

In FIG. 6 of the drawing there is illustrated another embodiment of the present invention which differs from that first described only in the construction of the outer peripheral wall of the advancing member. Specifically, the modified advancing member 40 includes an accordion pleated peripheral wall 41 which extends for the full length of the advancing member 40 and terminates in relatively thick front and rear end walls 42 and 43 respectively. The trailing portion 44 of the accordion pleated wall is relatively thin and the remaining portion 46 is relatively heavy. Thus, upon the inflation of advancing member 40 the trailing anchor defining portion first expands radially and then the remaining advancing portion expands longitudinally with little or no radial expansion. In all other respects and in its operation the device employing the advancing member 40 is similar to that first described.

While there have been described and illustrated preferred embodiments of the present invention, it is apparent that numerous alterations, omissions and additions may be made without departing from the spirit thereof.

I claim:

1. A self propelled conduit traversing device comprising a longitudinally extending flexible tubular member having first and second lumens, an inflatable transversely expandable anchor member connected to said tubular member and communicating with said first lumen, an inflatable advancing member connected to
said tubular member and communicating with said second lumen and including a transversely expandable section and a longitudinally expandable section, said advancing member including a front wall affixed to said tubular member and a rear wall having a central opening and an axially extending elastomeric tube having a rear end joined to the border of said opening and a front end secured to said tubular member proximate said front end wall, said elastomeric tube surrounding and being radially spaced from said tubular member, and acting means for connecting said first and second lumens to a source of pressurized fluid and exhaust in a predetermined sequence to expand and deflate said anchor member and advancing in accordance with said sequence.

2. The device of claim 1 wherein said tubular member includes a service third lumen projecting to the distal end of the forwardmost of said anchor and advancing members.

3. The device of claim 1 wherein said anchor and advancing members are longitudinally spaced along said tubular member, said advancing member being disposed forwardly of said anchor member.

4. The device of claim 3 wherein said actuating means is programmed to cyclically sequentially first deflate said anchor and advancing members, inflate said advancing member, then inflate said anchor member and then deflate said advancing member.

5. The device of claim 4 wherein said advancing member transversely expanding section first fully expands then said longitudinally extending section fully expands when said expanding member is pressurized.

6. The device of claim 1 wherein said longitudinally expanding section comprises an accordion pleated peripheral wall.

7. A self propelled conduit traversing device comprising a longitudinally extending flexible tubular member having first and second lumens, an inflatable transversely expandable anchor member connected to said tubular member and communicating with said first lumen, an inflatable advancing member connected to said tubular member and communicating with said second lumen and including a transversely expandable first section and a longitudinally expandable second section in free fluid communication with said first section and upon inflation of said advancing member, said second section expanding subsequent to the expansion of said first section, said advancing member including a front wall affixed to said tubular member and a rear wall having a central opening and an axially extending elastomeric tube having a rear end joined to the border of said opening and a front end secured to said tubular member proximate said front end wall, said elastomeric tube surrounding and being radially spaced from said tubular member, and actuating means for connecting said first and second lumens to a source of pressurized fluid and exhaust in a predetermined sequence to expand and deflate said anchor member, and advancing member in accordance with said sequence.

8. The device of claim 7 wherein the wall thickness of said transversely expandable section is less than the wall thickness of said longitudinally expandable section.

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