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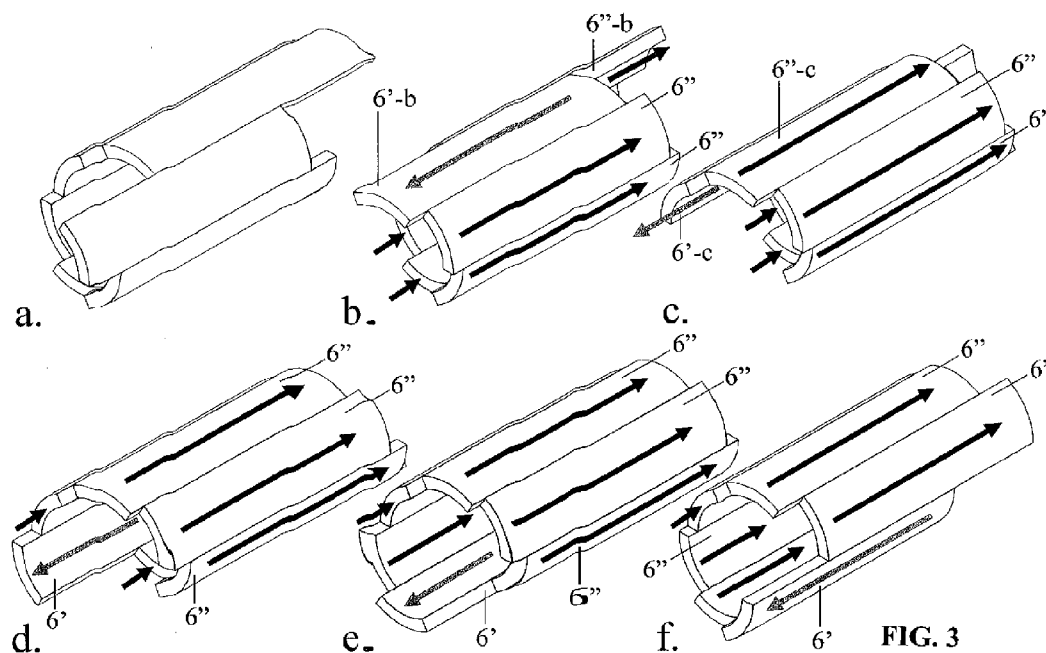
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(54) Title: TISSUE TRANSFER DEVICE



(57) Abstract: Tissue transfer device (1) comprising a tubular structure (2) with a lumen (3), wherein the lumen (3) is arranged between a proximal end (5) and a distal end (4) of the device (1), and wherein tissue is transportable between the distal end (4) and the proximal end (5), wherein the tubular structure (2) comprises longitudinally movable wall sections (6), and that said wall sections (6) are individually back and forth movable in the longitudinal direction of the device (1), wherein the device (1) is arranged such that during transport of tissue between the distal end (4) and the proximal end (5), first wall sections (6) assume a repetitious cycle of longitudinally moving in the direction of the proximal end (5) and back, and second wall sections (6) assume a repetitious shifted cycle with reference to the motions of the first wall sections (6) such that while the first wall sections (6) move in the direction of the proximal end (5) and back, the second wall sections (6) longitudinally move in the direction of the distal end (4) and forth, wherein the first wall sections (6)

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Tissue transfer device

The invention relates to a tissue transfer device comprising a tubular structure with a lumen, wherein the lumen is arranged between a proximal end and a distal end of the device, and wherein tissue is transportable between the distal end and the proximal end.

Such a tissue transfer device is known from US2010/331883, wherein within the tubular structure one or more wires with tissue adhering material attached thereto or formed therein may be preloaded, and withdrawn one by one during the procedure to remove tissue as it is cut.

US2015/0223787 discloses a distant transport trough for tissue, wherein the trough is provided with an extension, and wherein proximally the extension can be rolled to move the trough with the tissue.

Generally speaking a tissue transfer device is particularly applicable in combination with and during or after medical surgery, such as for instance when performing a hysterectomy. In a hysterectomy, but also in other surgery wherein tissue is to be removed from a patient's body, use can be made of a morcellator. In order to initiate tissue transport out and away from the patient's body, it is also known to use suction or a grasper. There are several problems when suction is used on the lumen of the morcellator's cutting blade as a driving force for moving the tissue through said lumen of the morcellator. The problems relate to obstructions hindering the tissue removal from the patient's body, due to

- diameter expansion of the tissue after resection
- accumulated friction within the hollow cutting blade
- jamming of tissue
- coagulation, etc.

It is furthermore a problem that the length of the lumen, that is the length of the hollow cutting blade and/or any longitudinal tube connected thereto for further transporting the tissue, restricts the possibilities to remove tissue, since the differential pressure between the proximal end and the distal end is limited to the barometric pressure. This aspect also restricts miniaturization of the known device and does not allow

sufficient length of the device in some applications.

It is an object of the invention to resolve these problems of the prior art and to provide a tissue transfer device which can be well handled, and which is equipped to transport removed tissue over extended distances.

According to the invention a tissue transfer device is proposed in accordance with one or more of the appended claims.

In a first aspect of the invention the tubular structure of the tissue transfer device is provided with longitudinally movable wall sections, and that said wall sections are individually back and forth movable in the longitudinal direction of the device, wherein the device is arranged such that during transport of tissue between the distal end and the proximal end, first wall sections assume a repetitious cycle of longitudinally moving in the direction of the proximal end and back, and second wall sections assume a repetitious shifted cycle with reference to the motions of the first wall sections such that while the first wall sections move in the direction of the proximal end and back, the second wall sections longitudinally move in the direction of the distal end and forth, wherein the first wall sections and the second wall sections exert in absolute terms mutually different frictional forces on the tissue. This provides the effect that the frictional forces exerted by the first wall sections and the second wall sections in combination result in a net frictional force acting on the tissue pointing in an intended direction towards one of the proximal end and the distal end, which will cause the tissue to move in such intended direction.

With the construction of the tissue transfer device of the invention the need to use suction or a grasper is avoided, and the tissue transport is not adversely affected by the slenderness of the construction of the device. The tissue transfer device of the invention can be used on a very broad range of tissue types, including bone and fat tissue. It is even possible to construe the longitudinally movable wall sections of the device to make it flexible and capable to follow bends. It is also possible to make the device steerable.

One of the niceties of the invention is that the design of the tissue transfer device is highly versatile, which follows from the many optional embodiments that are feasible as men-

tioned hereinafter.

Suitably the wall sections are selected from the group comprising cables, rods, tubes, glassfibres or combinations thereof. Since the group is not limited also other embodiments are feasible.

Also suitably the wall sections are provided with one or more shapes selected from the group comprising round, square, rectangular, or triangular or combinations thereof. Since also this group is not limited other shapes are feasible as well.

In a first preferable embodiment the first and second wall sections have mutually different dimensions to provide that, because of the different dimensions which imply different contact areas with the tissue, these wall sections will exert mutually different frictional forces on the tissue.

In a second preferable embodiment which may be applied in combination with or separate from the first embodiment, at their side facing the lumen the first and second wall sections have mutually different surface properties or claddings or structures to provide that these wall sections exert mutually different frictional forces on the tissue.

In a third preferable embodiment which may be applied in combination with or separate from the first and/or second embodiment, the first and second wall sections move at mutually different speeds and/or accelerations, which will then affect the frictional forces that will be applied on the tissue by the respective first and second wall sections.

In a fourth preferable embodiment which may be applied in combination with or separate from the first embodiment, or in combination with or separate from the second embodiment, or in combination with or separate from the third embodiment, or in any other suitable permutation of combinations with a selection or with all of said other embodiments, the first wall sections and the second wall sections differ in number.

In the case of the fourth embodiment it is preferred that a preselected first number of wall sections cyclically moves in the direction of the proximal end and back, and a preselected second number of wall sections longitudinally moves in the direction of the distal end and forth, wherein the first number is higher than the second number in case it is desired that the tissue moves towards the proximal end and lower in case

it is desired that the tissue moves towards the distal end.

When the first number of the longitudinally movable wall sections that move in the direction of the proximal end is higher than the second number of the longitudinally movable wall sections that move in the direction of the distal end, this provides the effect that the combined frictional forces applying to the tissue to be transported will cause the tissue to move towards the proximal end. Conversely when the first number of the longitudinally movable wall sections that move in the direction of the proximal end is lower than the second number of the longitudinally movable wall sections that move in the direction of the distal end, this provides the effect that the combined frictional forces applying to the tissue to be transported will cause the tissue to move towards the distal end.

A straightforward and relatively simple sub-embodiment of the fourth embodiment is that when the wall sections are mutually identical the first number and the second number add up to a total of at least three longitudinally movable wall sections.

An advantage of this sub-embodiment of the fourth embodiment is that it is already possible to provide an effective transfer device by arranging that the first number and the second number of the longitudinally movable wall sections add up to a total of at least three. In a preferable further developed embodiment the first number is four and the second number is two, so the total number of movable wall sections is then six.

In all embodiments it is preferred, that means that it is not a requirement, that the tubular structure comprises an outer tube wherein the longitudinally movable wall sections are at least in part contained. In this manner interference of the longitudinally movable wall sections with the tissue remaining in the patient's body can be effectively avoided.

The tissue transfer device of the invention is suitably embodied such that the device comprises a motor drive at the proximal end for individually driving the longitudinally movable wall sections. Of course this is only an option (correspondingly it is part of a dependent claim) and the device could well function when it would be manually driven as can be noted from the main claim which does not specify how the wall sections are driven.

The invention will hereinafter be further elucidated with reference to the drawing of an exemplary embodiment of a tissue transfer device according to the invention that is not limiting as to the appended claims. For the purpose of this explanation and for reasons of simplicity reference is made to the above-mentioned fourth embodiment.

In the drawing:

-figure 1 shows a perspective view at a tissue transport device according to the invention in an experimental setup;

-figure 2 shows a side view of the tissue transport device according to figure 1;

-figure 3 shows a sequence of events in a first embodiment of the tissue transfer device of figure 1; and

-figure 4 shows a sequence of events in a second embodiment of the tissue transfer device of figure 1.

Whenever in the figures the same reference numerals are applied, these numerals refer to the same parts.

Figure 1 shows an experimental setup of a tissue transport device 1 according to a fourth embodiment of the invention. This tissue transport device 1 comprises a tubular structure 2 with a lumen 3. The lumen 3 is arranged between a proximal end 5 and a distal end 4 of the device 1 which may be better seen in figure 2. The distal end 4 is during use located in the patient's body for picking up the tissue to be removed.

The device 1 according to this fourth embodiment is designed to transport tissue from the distal end 4 to the proximal end 5, and for this purpose the tubular structure 2 comprises longitudinally movable wall sections 6. Said wall sections 6 are individually back and forth movable in the longitudinal direction of the device 1, such that during transport of tissue from the distal end 4 to the proximal end 5, at any instance during the transport a preselected first number of wall sections longitudinally moves in the direction of the proximal end 5, and a preselected second number of wall sections 6 stands still or longitudinally moves in the direction of the distal end 4, wherein the first number is higher than the second number. In this manner the frictional forces applying to the tissue to be transported through the lumen 3 cause that the tissue moves in the direction of the proximal end 5. In order to arrange for a

continuous movement of the tissue, the longitudinally movable wall sections 6 are back and forth movable or reciprocating in order to entertain indeed a continuous movement of the tissue from the distal end 4 to the proximal end 5 of the device 1.

5 It is found beneficial that the first number and the second number add up to a total of at least three longitudinally movable wall sections 6. Preferably the first number is four and the second number is two, so that the total number of longitudinally movable wall sections 6 counts six. This is depicted in
10 figure 1 that shows four wall sections of a first group indicated with reference 6' that may act on the tissue to be transported by moving towards the distal end 4, whilst in a mode shifted with reference to said first group a second and larger group of wall sections indicated with reference 6'' that stands still or
15 moves in the direction of the proximal end 5. The resulting force acting on the tissue is that the forces applied by the wall sections 6'' of the second group will be higher than the forces applied by the wall sections 6' of the first group, which will cause the tissue to move towards the proximal end 5.

20 A detailed illustration of possible movements of the wall sections 6' of the first group and the wall sections 6'' of the second group is provided by figure 3, in which each time a single wall section 6' (see f.i. fig. 3b) moves towards the distal end 4, and the remaining five wall sections 6'' move in a
25 mutually shifted phase towards the proximal end 5. At the time the wall section 6''-b that is closest to the proximal end 5 has reached its farthest position, it stops and changes direction and becomes the next single wall section 6'-c (see fig. 3c) to move towards the distal end 4, whereas the previous wall section
30 6'-b that moved towards the distal end 4 has stopped and has started to move towards the proximal end 5 as shown in fig. 3c with reference 6''-c. This cycle repeats to give all wall sections a turn in acting as the single wall section 6' to move towards the distal end 4, while the remainder of the wall sections
35 6'' moves towards the proximal end 5.

Figure 4 shows an alternative embodiment wherein two pairs of wall sections 6'' move towards the proximal end 5 while one pair of wall sections 6' moves towards the distal end 4. In such a situation, the friction exerted upon the tissue by the
40 wall sections 6'' is twice as large as the friction exerted by

the wall sections 6'. In an effort to reduce the effect of instrument orientation, the wall sections belonging to the same pair oppose each other so that the (small) forces of gravity and the amount of surface contact of the wall sections with irregularly shaped pieces of transportable tissue affect each pair of wall sections equally.

Figure 1 further clearly shows a preferable arrangement wherein the tubular structure 2 comprises an outer tube 7 wherein the longitudinally movable wall sections 6 are at least in part contained.

In figure 2 it is shown that the device 1 preferably comprises a motor drive 8 at the proximal end 5 for individually driving the longitudinally movable wall sections 6.

Although the invention has been discussed in the foregoing detailed description with reference to an exemplary fourth embodiment of the tissue transport device of the invention, the invention is not restricted to this particular embodiment which can be varied in many ways without departing from the invention. This discussed exemplary fourth embodiment shall therefore not be used to construe the appended claims strictly in accordance therewith. On the contrary the fourth embodiment is merely intended to explain the wording of the appended claims without intent to limit the claims to this exemplary embodiment. The scope of protection of the invention shall therefore be construed in accordance with the appended claims only, wherein a possible ambiguity in the wording of the claims shall be resolved using this exemplary embodiment.

As will be clear from the foregoing, other possible embodiments are not shown in the drawing of figures 1 and 2, yet such other embodiments are also feasible.

Possible other embodiments show one of more of the following features:

- that the wall sections 6 are selected from the group comprising cables, rods, tubes, glassfibres;

- that the wall sections 6 are provided with a shape selected from the group comprising round, square, rectangular, or triangular;

- that the first and second wall sections 6 have mutually different dimensions to provide that these wall sections exert mutually different frictional forces on the tissue;

-that facing the lumen 3 the first and second wall sections 6 have mutually different surface properties or claddings or structures to provide that these wall sections exert mutually different frictional forces on the tissue; and

5 -that the first and second wall sections 6 move during transportation of the tissue at mutually different speeds and/or accelerations.

CLAIMS

1. Tissue transfer device (1) comprising a tubular structure (2) with a lumen (3), wherein the lumen (3) is arranged between a proximal end (5) and a distal end (4) of the device (1), and wherein tissue is transportable between the distal end (4) and the proximal end (5), **characterized in that** the tubular structure (2) comprises longitudinally movable wall sections (6, 6', 6''), and that said wall sections (6, 6', 6'') are individually back and forth movable in the longitudinal direction of the device (1), wherein the device (1) is arranged such that during transport of tissue between the distal end (4) and the proximal end (5), first wall sections (6') assume a repetitious cycle of longitudinally moving in the direction of the proximal end (5) and back, and second wall sections (6'') assume a repetitious shifted cycle with reference to the motions of the first wall sections (6') such that while the first wall sections (6') move in the direction of the proximal end (5) and back, the second wall sections (6'') longitudinally move in the direction of the distal end (4) and forth, wherein the first wall sections (6') and the second wall sections (6'') exert in absolute terms mutually different frictional forces on the tissue.

2. Tissue transfer device according to claim 1, **characterized in that** the combination of the frictional forces exerted by the first wall sections (6') and the second wall sections (6'') are arranged to result in a net frictional force acting on the tissue pointing in an intended direction towards one of the proximal end (5) and the distal end (4).

3. Tissue transfer device according to claim 1 or 2, **characterized in that** the wall sections (6) are selected from the group comprising cables, rods, tubes, glassfibres.

4. Tissue transfer device according to any one of claims 1 - 3, **characterized in that** the wall sections (6) are provided with a shape selected from the group comprising round, square, rectangular, or triangular.

5. Tissue transfer device according to any one of claims 1 - 4, **characterized in that** the first and second wall sections (6) have mutually different dimensions to provide that these wall sections exert mutually different frictional forces

on the tissue.

6. Tissue transfer device according to any one of claims 1 - 5, **characterized in that** facing the lumen (3) the first and second wall sections (6) have mutually different surface properties or claddings or structures to provide that these wall sections exert mutually different frictional forces on the tissue.

7. Tissue transfer device according to any one of claims 1 - 6, **characterized in that** the first and second wall sections (6) move at mutually different speeds and/or accelerations.

8. Tissue transfer device according to any one of claims 1 - 7, **characterized in that** the first wall sections and the second wall sections differ in number.

9. Tissue transfer device according to claim 8, **characterized in that** a preselected first number of wall sections (6') cyclically moves in the direction of the proximal end (5) and back, and a preselected second number of wall sections (6'') longitudinally moves in the direction of the distal end (4) and forth, wherein the first number is higher than the second number in case it is desired that the tissue moves towards the proximal end and lower in case it is desired that the tissue moves towards the distal end.

10. Tissue transfer device according to claim 9, **characterized in that** when the wall sections are mutually identical the first number and the second number add up to a total of at least three longitudinally movable wall sections (6).

11. Tissue transfer device according to claim 9 or 10, **characterized in that** the first number is four and the second number is two.

12. Tissue transfer device according to any one of claims 1 - 11, **characterized in that** the tubular structure (2) comprises an outer tube (7) wherein the longitudinally movable wall sections (6) are at least in part contained.

13. Tissue transfer device according to any one of claims 1 - 12, **characterized in that** the device (1) comprises a motor drive (8) at the proximal end (5) for individually driving the longitudinally movable wall sections (6).

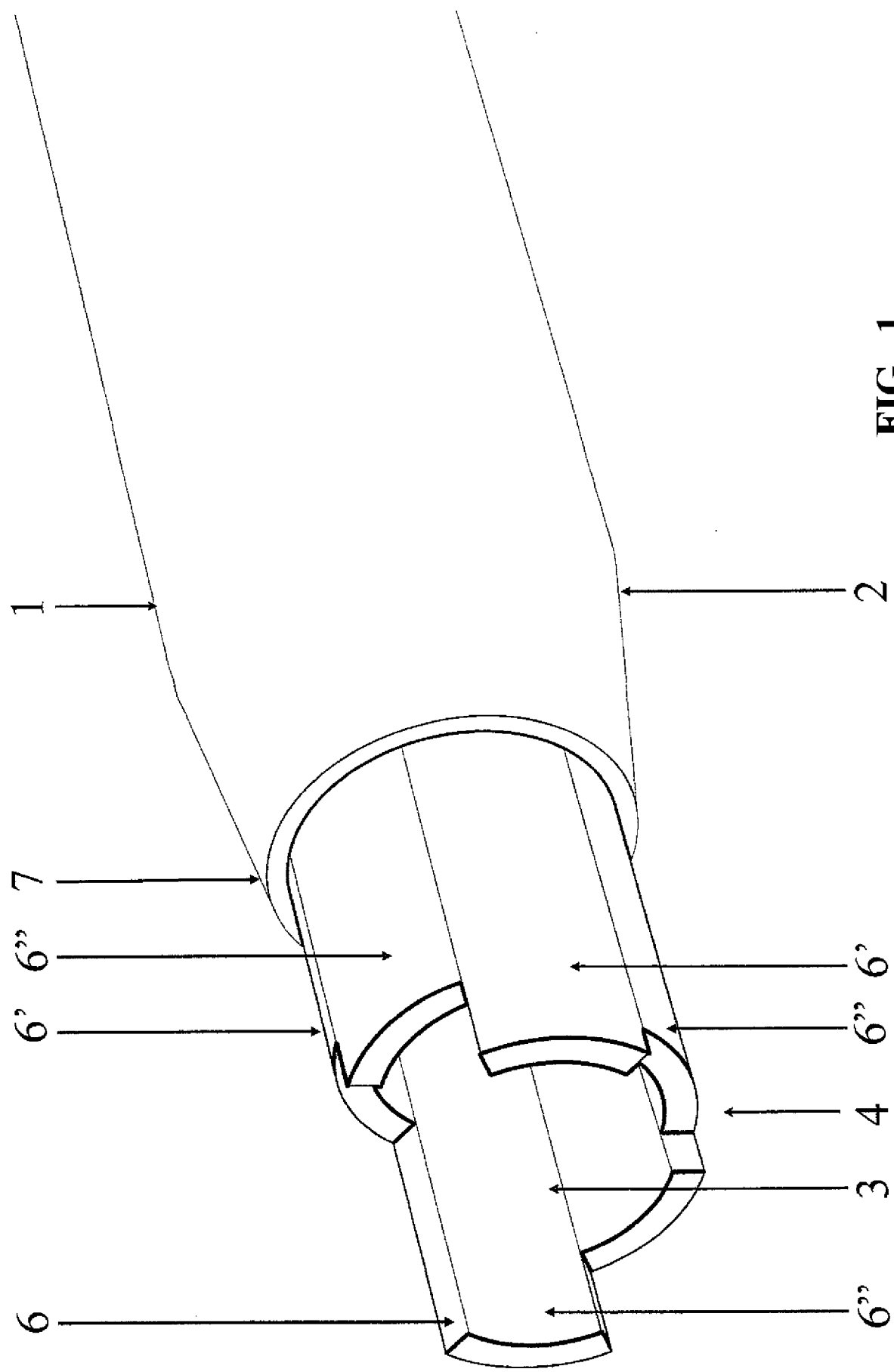


FIG. 1

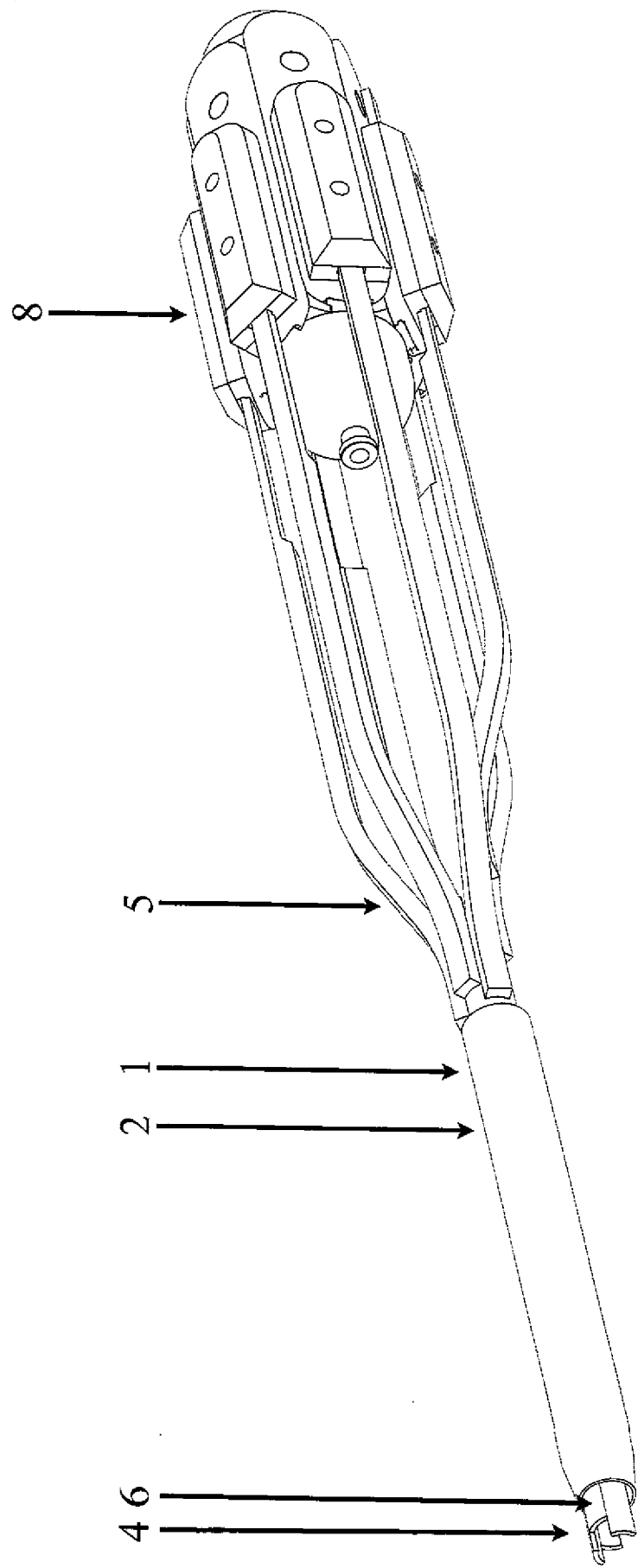


FIG. 2

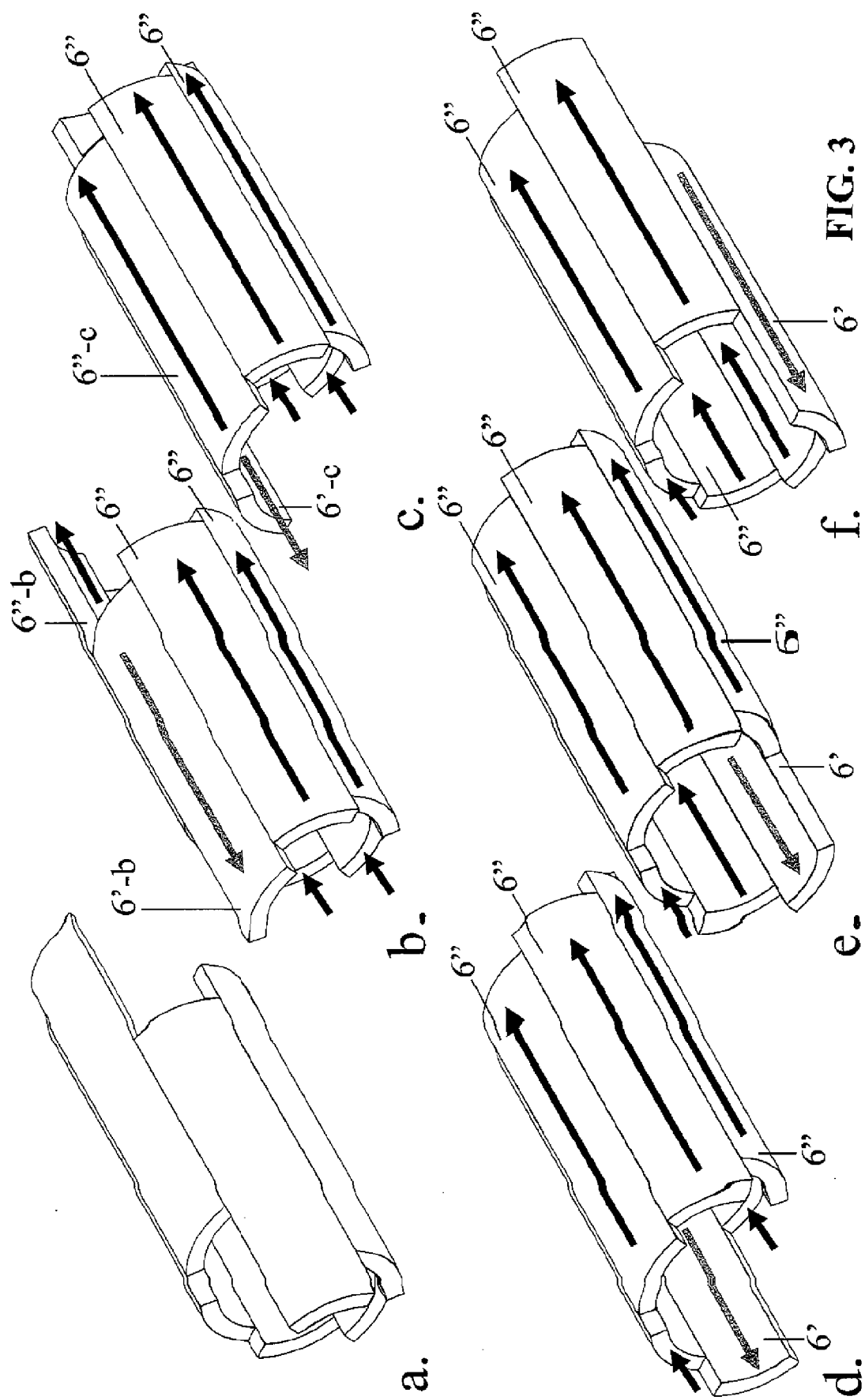


FIG. 3

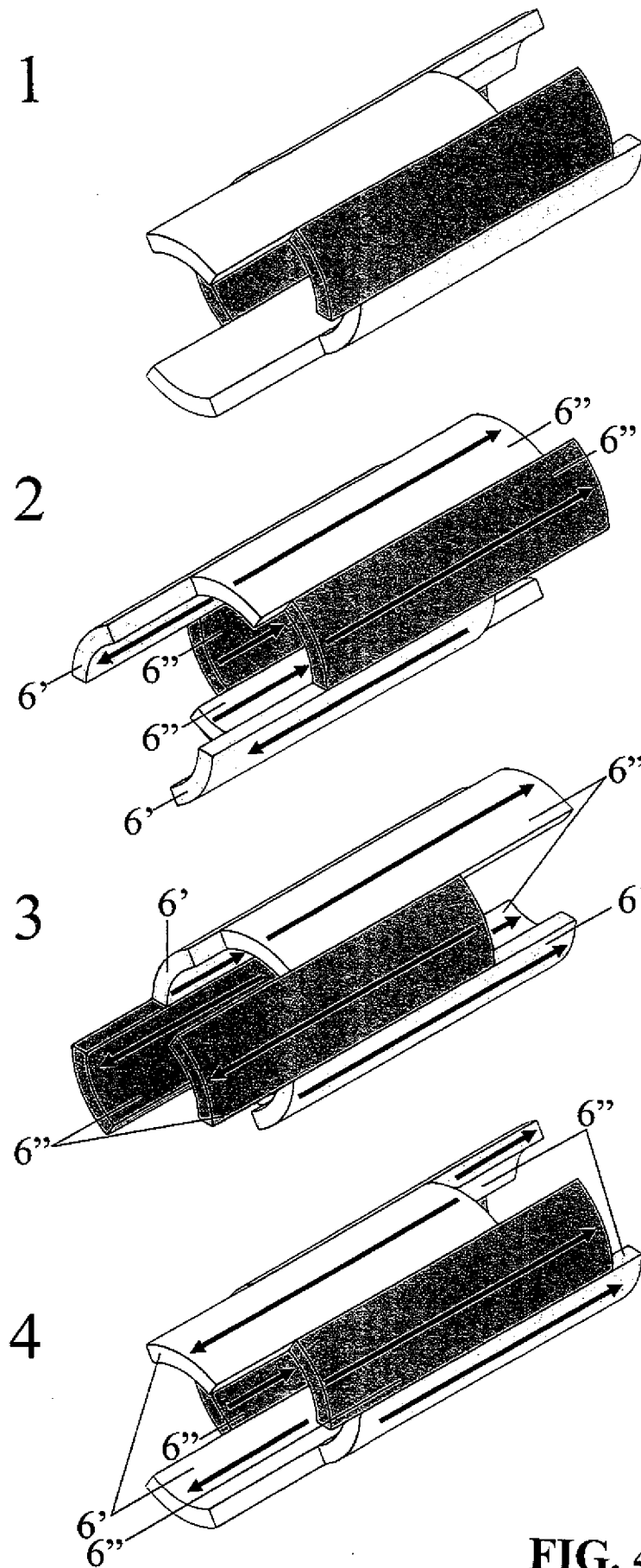


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2019/050608

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B17/34 A61B17/32
ADD. A61B17/00 A61B10/02

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)

A61B

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)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010/331883 A1 (SCHMITZ GREGORY P [US] ET AL) 30 December 2010 (2010-12-30) paragraphs [0811] - [0815]; figures 32-35 -----	1-13
A	US 2015/223787 A1 (COONAHAN TIMOTHY J [US] ET AL) 13 August 2015 (2015-08-13) paragraphs [0070] - [0071], [0073] - [0074]; figures 1A-1D, 2A-2E -----	1-13
A	US 2008/249553 A1 (GRUBER WILLIAM HARWICK [US] ET AL) 9 October 2008 (2008-10-09) paragraphs [0151], [0178]; figures 1,15(a), 15(b), 28 -----	1



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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