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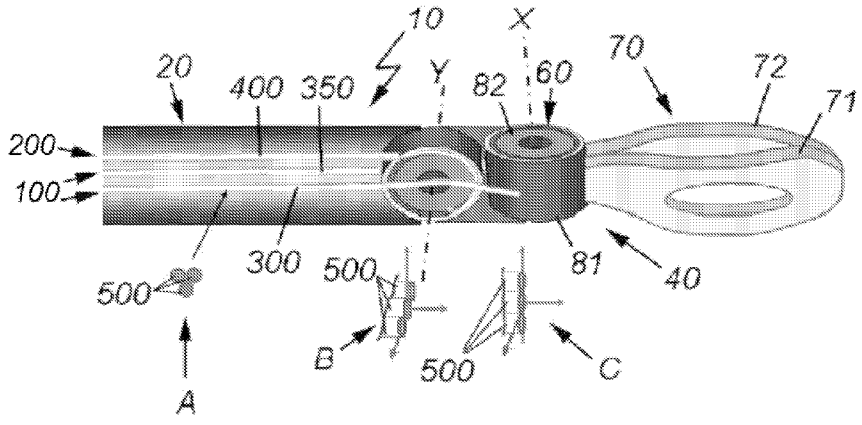
(54) **Title**: MINIMALLY INVASIVE LAPAROSCOPIC SURGICAL PLIERS

FIG. 4



(57) **Abstract**: They comprise jaw means (70) mounted on a rotating body (60), first and second means (100, 200) for transmitting movement of jaw means (70) and the rotating body (60), respectively, comprising respectively at least one tendon (300, 350, 400) consisting of several cables (500) arranged so that the cross-section of at least one tendon (300, 350) associated with the first means (100) for transmitting movement has a variable geometry (A, B, C) therealong formed by a first arrangement (A) in which cables (500) are arranged, in cross-section, with their longitudinal axes in a radial distribution (A), a second arrangement (B) in which said axes are arranged in a first orientation, and a third arrangement (C) in which said axes are arranged in a second orientation, perpendicular to the first orientation.

MINIMALLY INVASIVE LAPAROSCOPIC SURGICAL PLIERS

Field of the Invention

The present invention finds application in the field of robotic surgery and specifically refers to pliers suitable for minimally invasive robotic laparoscopic surgery.

The pliers of the present invention comprise a kinematic arrangement provided with jaw means that can be opened and closed which are mounted on a rotating body. The pliers of the invention further include first means for transmitting movement of the jaw means and second means for transmitting movement of the rotating body.

Background of the Invention

Current robotic laparoscopic surgical techniques allow high precision operations to be carried out, providing significant advantages especially in certain complex surgeries, including those in which there is great difficulty in accessing a surgical site. The present invention is particularly applicable in such type of robotic laparoscopic surgery that is a minimally invasive technique as it is performed through small incisions in the patient. This technique is widely currently employed, such that in many cases it is used as an alternative to conventional laparoscopic surgery.

In this type of robotic surgery, robotic arm devices are employed actuating pliers capable of holding certain tools and instruments. In addition to the surgical precision achieved by the use of computing associated with these operations, direct contact of the surgeon on the patient can be reduced by such mechanisms, with consequent reduction of infections. Through a small incision, cameras and/or pliers are introduced into the patient to perform various operations with minimal trauma and negligible postoperative pain sequel.

The term pliers as used herein according to the intended use for the object of this invention should be understood as a tool designed to be coupled to a robotic arm end. This robotic arm is usually operated remotely by a surgeon

skilled in robotic laparoscopic operations and it is designed to grip and even to hold over any useful tool, body or device.

Many types of laparoscopic pliers exist based on their movement and geometry, which aspects depend to a great extent on the type of operation to which the pliers are ultimately intended. In a laparoscopic surgical operation several pliers are typically used, which usually have a configuration such that its distal end is provided with jaws having different configurations as mentioned above, for example, with or without teeth, having a straight or curved shape, etc.

One example of laparoscopic pliers used in robotic laparoscopic surgery is described in US patent US6969385. This document shows pliers used in a robotic device consisting of jaws fitted on a rotating body. The jaws comprise fingers that can be rotated to each other. The transmission of rotational movement of the fingers of the jaws is carried out through cables wound around grooved pulleys. The pulleys are mounted in correspondence with the axes of rotation of the fingers and the shaft of said rotating body that is attached to the robotic arm end, respectively.

A further example of transmission of movement of the pliers is by means of gears. In US2009192521 a surgical instrument is described consisting of pliers including a fixed finger and a movable finger. The moving finger of the pliers is driven through a gear train mechanism.

The use of cables and pulleys or gears in pliers as those described in this document is necessary for transmitting movement from driving means to pliers themselves for positioning them and for moving the jaws. This results in a pliers mechanism that is considerably complex. This mechanical complication is of great importance in the case in which the movement transmission cables have to pass through an articulated body, which usually occurs in the above described pliers. The fact that the transmission cables have to pass through an articulated body requires the provision of additional pulleys for being able to perform such transmission of movement from driving means to jaws.

The invention provides laparoscopic surgical pliers having a configuration that allows movement to be transmitted through a kinematic assembly comprising

various rotating members, from driving means to rotating members. This kinematic assembly of the pliers comprises members allowing the pliers to be positioned and members allowing jaw means of pliers to be moved. As it will be seen hereinafter, with the laparoscopic surgical pliers of the invention this object can be achieved with a simple, compact and reliable configuration, resulting in additional advantages, as it will be seen in the following.

Description of the Invention

The present invention provides pliers suitable for being used in a robotic arm. More specifically, the invention relates to pliers intended to be used to carry out minimally invasive laparoscopic surgical operations, driven by robotic arms.

According to the invention, pliers for use in robotic laparoscopic surgical operations are provided including a main body having a proximal end and a distal end. The proximal end of the body is adapted to receive a universal joint capable to perform two passive rotations. At the distal end of the main body a kinematic assembly is coupled formed by a rotating body that is rotatably mounted on that end and being provided with jaw means. This rotating body is capable of performing several active rotations.

The jaw means of the pliers of the invention comprise at least two moving parts or fingers that can be rotatably driven independently. The movement of the fingers of the pliers is performed by first movement transmission means. For its part, the rotary movement of the rotating body is carried out through second movement transmission means. Said first and second transmission means are driven by driving means comprising, for example, electric motors. The combination of the driving means and the first and second transmission means allows the pliers to be suitably positioned and allows the jaw means to be opened and closed, moving the fingers towards and away to each other.

According to the invention, both the first and second movement transmission means comprise tendons extending inside the main body therealong, between the proximal end and the distal end. In use, said tendons can be moved lengthways along said main body.

More specifically, the pliers comprise at least one tendon associated with the first movement transmission means and one tendon associated with the second movement transmission means. The first movement transmission means may comprise one or two tendons depending on the embodiment of the pliers, either for controlling one or more fingers of the pliers, depending on the application to which the pliers are intended.

Each of said tendons is formed of several steel cables, preferably three, which are arranged packed inside a sheath that encloses them therein. The cables forming each tendon have preferably a circular cross-section to obtain the greater stiffness as possible, and thus avoid buckling when under compression. With this section, friction of tendon with the sheath thereof is also reduced.

The packaging of several cables to form each tendon for transmitting the movement of the pliers provides the necessary stiffness both for being able to work to compression and to traction, allowing efficient power transmission as if it were a rod transmission.

The cross-sectional geometry of each tendon is defined by the arrangement of the cables forming the tendon. According to the invention, the arrangement of cables is such that the tendon, in the vicinity of the distal end of the main body, has a cross-section with variable geometry along its length. This is met at least for tendons associated with the first movement transmission means. Therefore, the variation in the cross-sectional geometry of the tendon allows a very efficient operation of the jaw means.

With the configuration described according to the invention, the pliers can be rotated about a first axis and the rotating body can be rotated about a second axis. The first axis and the second axis may be disposed substantially orthogonal to each other.

In one embodiment of the pliers of the invention, it is preferred that the variation of the cross-sectional geometry of each tendon is as follows. As stated above, the tendons extend lengthways through the interior of the main body, defining a first cross-sectional geometry arrangement of the tendons in which the respective cables are arranged, in cross-section, with their

longitudinal axes in a radial distribution. Then the cross-sectional geometry of the tendons is changed into a second arrangement in which the respective cables are arranged, in cross-section, with their longitudinal axes in a distribution in a first orientation. Finally, the cross-sectional geometry of the tendons is changed into a third arrangement, in which the respective cables are arranged, in cross-section, with their longitudinal axes in a second orientation, different from said first orientation.

In other words, in the first arrangement of the cross-sectional geometry of the tendons, the cables of each tendon in most of the length of the main body are arranged radially, so that the cross-section of the tendon is substantially circular in shape. In other words, if it is a tendon formed of three cables, for example, as noted above, the cables would be arranged, in such a case, with their respective longitudinal axes in a substantially triangular arrangement, in cross section. In one portion corresponding to the vicinity of the distal end of the main body, the cross-section of the same tendon is changed into said second arrangement in which its cables are arranged with their respective longitudinal axes aligned transversely in a first orientation, for example horizontally aligned. The necessary flexibility to overcome the flexion of the joint in the direction parallel to its axis of rotation is therefore obtained. Finally, the cross-section of the tendon is changed into this third arrangement in which the cables are arranged with their respective longitudinal axes transversely aligned in a second orientation, forming an angle to said first orientation, for example 90°, i.e., vertically aligned. In this way the necessary flexibility to overcome the flexion of the joint in the direction perpendicular to the above is therefore obtained.

The first and second movement transmission means comprising said tendons further include rotating drums for tangential winding of tendons. These drums allow, in said distal end of the assembly, the longitudinal movement from the tendons to be converted into a rotational movement in two directions, i.e., both to traction and to compression, to rotatably drive the rotating body of the pliers and their jaw means. Said drums have a grooved periphery suitable for winding of the tendons. The rotating body of the pliers is formed by two of said drums, which are arranged overlapped. Each of said two drums for winding of the rotating body is integral with each jaw finger, respectively.

The change in the cross-section configuration of tendons (at least that of those associated with the first transmission means), as it moves along its length toward the distal end of the main body, allows an effective winding and twisting of the tendon in respective drums in both directions of travel.

In order to cause the cross-sectional geometry of each tendon to be changed, as indicated, at different planes in the vicinity of the distal end of the main body, several tendon changing orientation modules are provided. Each changing orientation module includes a block fixed to the interior of the elongated body within which elongated channels are formed that are shaped to guide the cables of each tendon in one rotation (e.g. at 90°).

Two changing orientation modules are used for each tendon, which makes it possible the above mentioned two changes in the tendon cross-sectional shape (from circular to straight in a first orientation, and from straight in said first orientation to straight in a second, different orientation). Each changing orientation module may have a first dimension (width or height) corresponding, for example, to a diameter of a cable used and a second dimension (width or height) corresponding, for example, to three of said diameters. Between two changing orientation modules in the same tendon length, the cables thereof are housed inside a flat sheath suitable to maintain the configuration thereof.

For the transmission of movement through the displacement of the tendons along the elongated body driving means are used, as stated above, such as electric motors. In one embodiment of the invention, other means may be adapted to rotatably drive internally threaded tubes which are mounted axially retained within the main body. Inside such internally threaded tubes a corresponding externally threaded tube is received that is fixed to the outer sheath within which tendon cables are disposed. The externally threaded tube can be rotated to said internally threaded tube (retained axially within the main body) so that the rotation thereof through the driving means results in a longitudinal movement of the outer threaded tube and consequently, a longitudinal movement of the tendon of the first transmission means (to drive the fingers from the pliers jaw means) or the second transmission means (for rotatably driving the moving body for positioning the jaw means).

With the pliers as described according to the invention an assembly having a great mechanical simplification over the pliers which for the same purpose have been used so far, with consequent cost savings. With the variable geometry cross-section configuration of the tendons of the driving means of the pliers for each change of orientation of said section it is possible, according to the invention, to dispense with the use of idler pulleys or gears for transverse rotation of parts where the tendons run. The configuration of the invention further allows a very robust assembly to be obtained with a large durability of the cables as well as the drums around which they are to be rolled up.

Other objects, advantages and features of the minimally invasive laparoscopic surgical pliers of this invention will become apparent from the description of a preferred embodiment of the invention. This description is given only by way of an example and it is shown in the accompanying drawings.

Brief Description of Drawings

In said drawings,

Figure 1 is a perspective part view of the main body of the minimally invasive laparoscopic surgical pliers of the present invention;

Figure 2 is a perspective view of one embodiment of one module for changing the orientation in the tendon of pliers;

Figure 3 is a perspective part view of the minimally invasive laparoscopic surgical pliers of the present invention, with jaw means and rotating body mounted at the distal end in the main body of the assembly;

Figure 4 is a perspective part view of the pliers of the present invention in which the configuration of the tendons and the change of orientation thereof are diagrammatically shown.

Detailed description of a preferred embodiment

In the Figures 1-4 enclosed herein a preferred embodiment of minimally

invasive laparoscopic surgical pliers in robotic arms is shown. Pliers have been indicated in the figures as a whole by reference numeral 10.

Pliers 10 include, in the exemplary embodiment shown, an elongated shaped main body 20 having a proximal end 30 (left-hand side in the figures) and a distal end 40 (right-hand side in the figures). The main body 20 of the pliers 10 with its proximal end 30 is partly shown in the Figure 1 of the drawings. The distal end 40 of the main body 20 is shown in the Figure 3 and 4 of the drawings.

As shown in Figure 1, the proximal end 30 of the body 20 of the pliers 10 can be attached to a robotic arm 50 through a universal joint 55. For the sake of clarity, the universal joint 55 is shown in said figure 1 separated from the main body 20. The universal joint 55 allows the assembly to perform two passive rotations GP1, GP2, as shown in Figure 1 by respective arrows. At the distal end 40 of the body 20 a kinematic assembly is coupled comprising a body 60 pivotally mounted on the distal end 40. The rotating body 60 is provided with jaw means (jaws 70), which will be described in greater detail hereinafter.

The jaws 70 of the embodiment illustrated by way of an example in Figures 3 and 4 include two scoop-shaped fingers 71, 72. In the embodiment of Figure 3, the fingers 71, 72 of the jaws 70 have a flat, rough inner surface. In the embodiment of Figure 4, the fingers 71, 72 of the jaws 70 have a curved, smooth inner surface. It will be understood, however, that fingers 71, 72 of pliers 70 may have any other configuration as well as an inner surface having different surface finishes as required.

The fingers 71, 72 of the jaws 70 may be rotatably driven in a coordinated and independent way according to active rotating movements GA2, GA3 shown in Figure 3, about a first axis X, for moving towards and/or away to each other. This allows the pliers 10 to grip and even to hold over any useful tool, body or device (not shown).

The kinematic assembly of the pliers 10 can also be rotated around the longitudinal axis Z of the main body 20 according to the passive angular movement GA4 depicted in Figure 1. This passive rotation GA4 is performed at an angle greater than 360º and allows positioning of the working plane of

the pliers 10.

Each finger 71, 72 of the jaws 70 is integral with a winding drum 81, 82 respectively, which will be described in detail further on.

At the proximal end 30 of main body 20 driving means M are provided for controlled driving of jaws 70 and its orientation in the space. The driving means M will be described in greater detail further below.

In collaboration with the driving means M, first movement transmission means 100 are provided for causing the fingers 71, 72 of the jaws 70 to be rotated towards and away from each other, as depicted in Figure 3 by GA2 and GA3 for each finger 71, 72, respectively. Second movement transmission means 200 are also provided for causing the rotating body 60 to be rotated according to GA1 around a second axis Y, as shown in figure 3, for positioning the pliers 10 sideways in the space when used in a laparoscopic intervention. In one embodiment it is preferred the first axis X and the second axis Y form an angle of 90º to each other.

The first transmission means 100 include tendons 300, 350, and the second transmission means comprise one tendon 400, respectively. Tendon 350 is arranged symmetrically with respect to tendon 300 and it is therefore hidden in Figure 3 of the drawings (shown in dashed lines). It is clear that in other embodiments of the invention, the pliers 70 could comprise a single mobile finger, the other one being fixed, so that the first transmission means 100 would include, in this case, a single tendon (300 or 350).

Tendons 300, 350, 400 all extend along the main body 20, from proximal end 30 to distal end 40, as it can be seen in Figures 3 and 4 of the drawings. Tendons 300, 350, 400 are adapted to be moved lengthways within the main body 20 therealong to drive the pliers 10, as will be described in detail below.

In the embodiment shown by way of example, tendons 300, 350, 400 of transmission means 100, 200 are each formed by three steel cables 500 having a circular cross-section arranged packaged within a sheath that encloses them (not shown) providing the necessary rigidity for working* both to traction and to compression.

Several arrangements of the cables 500 in one tendon 300, 350, 400 are shown in figures 2 and 4. Figure 4 shows the various arrangements A, B, C of the cross-sectional geometries taken on by at least tendons 300, 350 associated with the first transmission means 100. This variation in the cross-sectional geometry of tendons 300, 350 is defined by the arrangement or orientation of cables 500 forming each tendon. In the embodiment shown, the arrangement of cables 500 in tendons 300, 350 is such that, near the distal end 40 of the main body 20, tendons have their cross-sectional geometry changed as they advance lengthways towards the distal end 40 of main body 20 of the pliers 10. This variation in the cross-sectional geometry of tendon 300, 350 allows the rotational movement GA2, GA3 of the fingers 71, 72 of the jaws 70 around axis X in both directions and allows tendons 300, 350 associated with the first transmission means 100 to be passed through the joint of the rotating body 60, as it will be described below.

The variation in the cross-sectional geometry of each tendon 300, 400 will be described below with reference to Figure 4 of the drawings. The cross-sectional geometry of each tendon 300, 350 is changed twice on its path, so there is a first cross-sectional geometry arrangement A of tendon 300, 350, a second cross-sectional geometry arrangement B of tendon 300, 350, and a third cross-sectional geometry arrangement C of tendon 300, 350. Arrangements A, B and C are schematically shown in figure 4.

According to Figure 4, in most of the length of the main body 20 tendons 300, 350 run with their respective cables 500 arranged radially from the proximal end 30 to the distal end 40. This radial arrangement of the cables 500 is achieved by a substantially triangular arrangement thereof, as seen in cross-section, defining a substantially circular shape for the first cross-sectional geometry arrangement A of tendon 300, 350. Near the distal end 40 of the main body 20, the cross-sectional geometry of the same tendon 300, 350 is changed from a first arrangement of cables 500 (radially) with their longitudinal axes triangularly distributed into a second arrangement B with their longitudinal axes aligned in a first orientation, horizontally aligned, as seen in cross-section such as shown in Figure 4. Finally, the cross-sectional geometry of tendon 300, 350 is changed again from this second arrangement B of the cables 500 (in the first orientation, with their longitudinal axes aligned

horizontally) into an arrangement in which said longitudinal axes are aligned in a second orientation, thus defining a third arrangement C of the cross-sectional geometry of tendon 300, 350, as shown in Figure 4. For the disclosed embodiment, the first orientation in the second arrangement B of the cross-section of tendon 300, 350 forms an angle of substantially 90º to the second orientation of the third arrangement C of the cross-section of the tendon 300, 350. Therefore, the third arrangement C of the cross-section of tendon 300, 350 corresponds to one in which its cables 500 are arranged vertically aligned, as seen in cross-section, as shown seen in figure 4.

The cross-section of tendons 300, 350 of pliers 10 provides the rigidity needed for working to traction and to compression, and at the same time it allows tendons to be wound around each drum 81, 82, 83 accordingly. The change in orientation of at least tendons 300, 350 in the first transmission means 100 (not needed for tendon 400 associated with the second transmission means 200 in the embodiment shown) further allows the passage of the tendons 300, through joint 350 associated with axis Y, to be adapted, i.e., that allowing rotation of the body 60 according to rotation GA1.

As mentioned above, the first and second movement transmission means 100, 200 formed by the respective tendons 300, 350, 400 further include rotating drums 81, 82, 83 around which the above mentioned corresponding tendons 300, 350, 400 are wound. In particular, drums 81, 82 are arranged coaxially one above the other forming the rotating body 60 of the pliers 10 and they are adapted to be rotatably driven independently by actuation of the first transmission means 100, that is by tendon 300, and tendon 350 (symmetric thereto, not visible) respectively. Tendon 300, which extends along the interior of the main body 20, surrounds the periphery of drum 81, while tendon 350, which extends along the interior of the main body 20, surrounds the periphery of drum 82. Finally, tendon 400, which also extends along the interior of the main body 20, surrounds the periphery of drum 83. Displacement of tendons 300, 350 associated with the first transmission means 100 causes respective independent rotation of respective drums 81, 82 of the rotating body 60 of pliers 10, causing the fingers 71, 27 of the jaws 70 to be rotated independently around axis X according to the respective active rotating movements GA2, GA3 depicted in Figure 3, rotating around axis X towards or away from each other, as desired, to grip, hold over, etc. instruments, organs, etc.

Displacement of tendon 400 associated with the second transmission means 200 causes rotation of the drum 83 making the rotating body 60 of the pliers 10 to be rotated around axis Y according to active movement GA1 shown in Figure 3, for proper positioning of pliers 10 in the space.

For a proper rotating movement of drums 81, 82, 83, they are provided with a grooved periphery (not shown) suitable for winding of the respective tendons 300, 350, 400. Each winding drum 81, 82 defining the rotating body 60 is integral with each respective finger 71, 72 of the jaws 70.

In the embodiment of the minimally invasive laparoscopic surgical pliers 10 that is described herein according to the figures, a module 600 for changing orientation of tendons 300, 350 is further provided. One example of one of these changing orientation modules 600 is shown in figure 2. In said figure 2 a module 600 for changing orientation of tendons 300, 350 is shown designed for causing a change in the cross-sectional geometry arrangement A, B, C of each tendon 300, 350 in said first transmission means 100 at different planes in the vicinity of the distal end 40 of the main body 20 of pliers 10. The changing orientation module 600 includes an integrated block fixed inside the main body 20. Inside the changing orientation module 600 an elongated inner channel 650 is provided shaped to guide the cables 500 of each tendon 300, 350 and to force them to be rotated about 90º as they are passed through the interior of the channel 650.

For each tendon 300, 350 of the first transmission means 100 two changing orientation modules 600 are provided. Modules 600 associated with said first movement transmission means 100, i.e., those causing the change in orientation of tendons 300 and 350 when moving lengthways around the main body 20, are arranged one just at the distal end 40 of the main body 20 and the other one in the vicinity of each of the respective drums 81, 82 of the rotating body 60.

The configuration described for changing orientation modules 600 allows two changes in the cross-sectional arrangement of the tendons, from circular A to straight horizontal B, and from straight horizontal B finally to straight vertical C, as diagrammatically shown in Figure 4 and such as described above.

The inner channel 650 of each changing orientation module 600 may have a first dimension d corresponding to the diameter of cable used (typically 0.3 mm) and a second dimension D corresponding to three of said diameters (0.9 mm). It will be understood that said dimensions d, D in a particular orientation may correspond to width and height of said channel 650 in the example shown, although the geometry of the module 600 can be defined by other dimensions.

Between two changing orientation modules 600 in the same tendon 300, 350, cables 500 are housed inside a flat sheath suitable to maintain their configuration in that path between two modules 600.

Turning now to Figure 1 of the drawings, means M for displaceably driving the tendons 300, 350, 400 are described below in greater detail.

In the embodiment illustrated by way of an example, driving means M comprise several electric motors 700 adapted for rotatably driving outer tubes 800. These outer tubes 800 are provided with an inner thread and they are axially retained in the proximal end 30, inside the main body 20, as shown in Figure 1. Inside the outer tubes 800 corresponding inner tubes are threadably received having an outer thread 850, attached to the exterior of respective tendons 300, 350, 400. The inner tubes 850 can be rotated relative to the respective outer tubes 800 which, as noted above, are axially retained within the main body 20. Thus, rotation of each outer tube 800 through the corresponding motor 700 results in longitudinal movement of the inner tube 850 and, consequently, in a corresponding longitudinal movement of the tendon 300, 350 of the first transmission means 100 for actuating the fingers 71, 72 of the jaws 70 of the pliers 10 around axis X (independent movements GA2, GA3), and/or of the second transmission means 200, for rotatably driving the movable body 60 for positioning the jaws 70 around the axis Y (movement GA1).

While the present invention has been described in the specification and illustrated in the accompanying drawings with reference to a preferred embodiment thereof, the minimally invasive laparoscopic surgical pliers of the invention are susceptible to various changes without departing from the scope of protection defined in the appended claims.

Claims

1 - Minimally invasive laparoscopic surgical pliers (10) comprising jaw means (70) mounted on a rotating body (60), first means (100) for transmitting movement of the jaw means (70) and second means (200) for transmitting movement of the rotating body (60), characterized in that said first and second transmission means (100, 200) respectively comprise at least one tendon (300, 350, 400) each formed by several cables (500) that are arranged such that the cross-section of at least one tendon (300, 350) associated with the first means (100) for transmitting movement has a variable geometry (A, B, C) along its path through the interior of a main body (20).

2 - Pliers (10) as claimed in claim 1, wherein the cross-sectional geometry of each tendon (300, 350) has a first arrangement (A) in which the respective cables (500) are arranged, in cross-section, with their longitudinal axes in a radial arrangement (A), a second arrangement (B) in which the respective cables (500) of each tendon (300, 350) are arranged, in cross-section, with their longitudinal axes in a distribution in a first orientation, and a third arrangement (C) in which the respective cables (500) of each tendon (300, 350) are arranged, in cross section, with their longitudinal axes in a second orientation, different from the first orientation.

3 - Pliers (10) as claimed in claim 2, wherein said first and second orientations, of the second and third arrangements (B, C), respectively, form an angle of substantially 90° to each other.

4 - Pliers (10) as claimed in any of the preceding claims, wherein at least one of said tendons (300, 350, 450) is formed by at least three cables (500).

5 - Pliers (10) as claimed in any of the preceding claims, wherein the jaw means (70) are adapted to be rotated about a first axis (X).

6 - Pliers (10) as claimed in any of the preceding claims, wherein said rotating body (60) can be rotated about a second axis (Y).

7 - Pliers (10) as claimed in any of the claims 5 and 6, wherein said first axis (X) and said second axis (Y) form an angle of substantially 90° to each other.

8 - Pliers (10) as claimed in any of the preceding claims, wherein said rotating body (60) includes rotating drums (81, 82) that are respectively associated with said jaw means (70).

9 - Pliers (10) as claimed in any claim 8, wherein said rotating drums (81, 82) are adapted to be operated independently each by a respective tendon (300, 350) of said first transmission means (100).

10 - Pliers (10) as claimed any of the preceding claims, wherein they comprise modules (600) for changing orientation of the cables (500) forming each tendon (300, 350), each module (600) being formed by a block within which an elongated channel (605) is formed shaped to guide said cables (500) of the corresponding tendon causing a rotation on its orientation.

FIG. 1

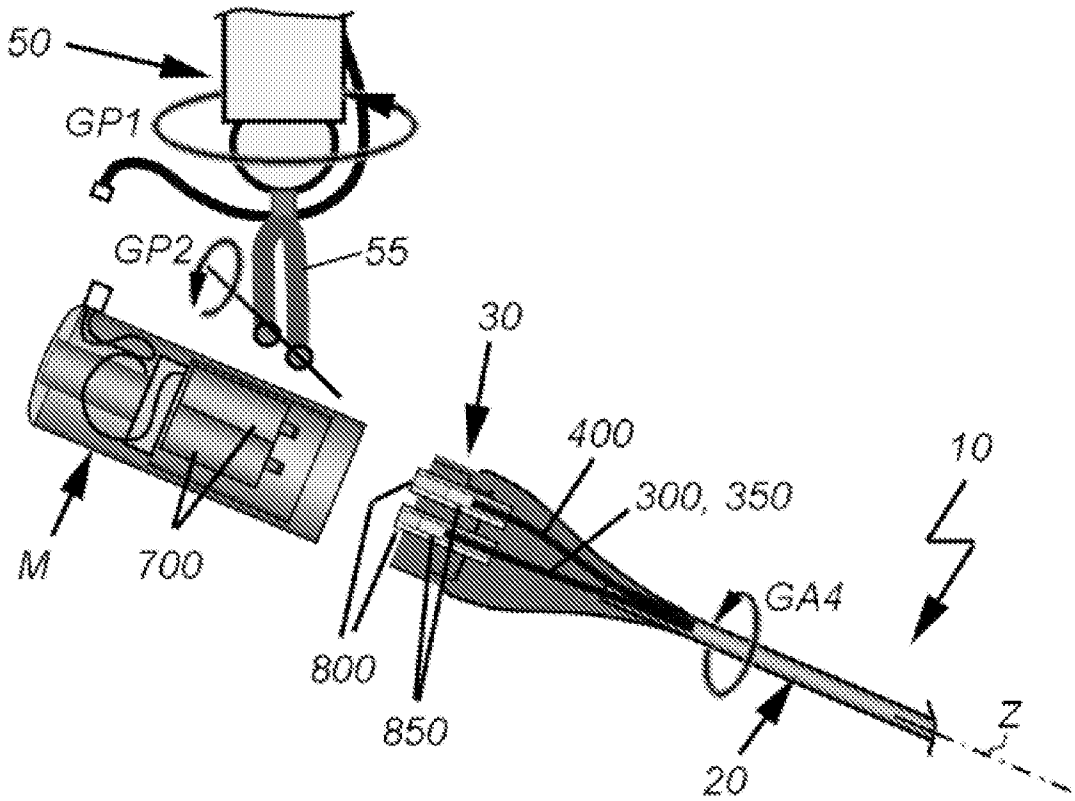

50
GP1
GP2
55
30
400
300, 350
10
M
700
GA4
800
850
20
Z

FIG. 2

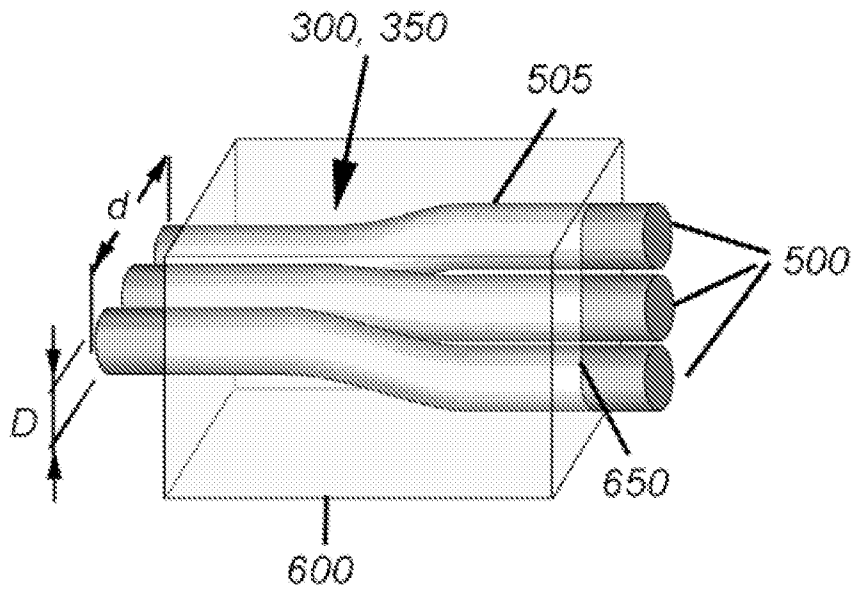

300, 350
505
d
500
D
650
600

FIG. 3

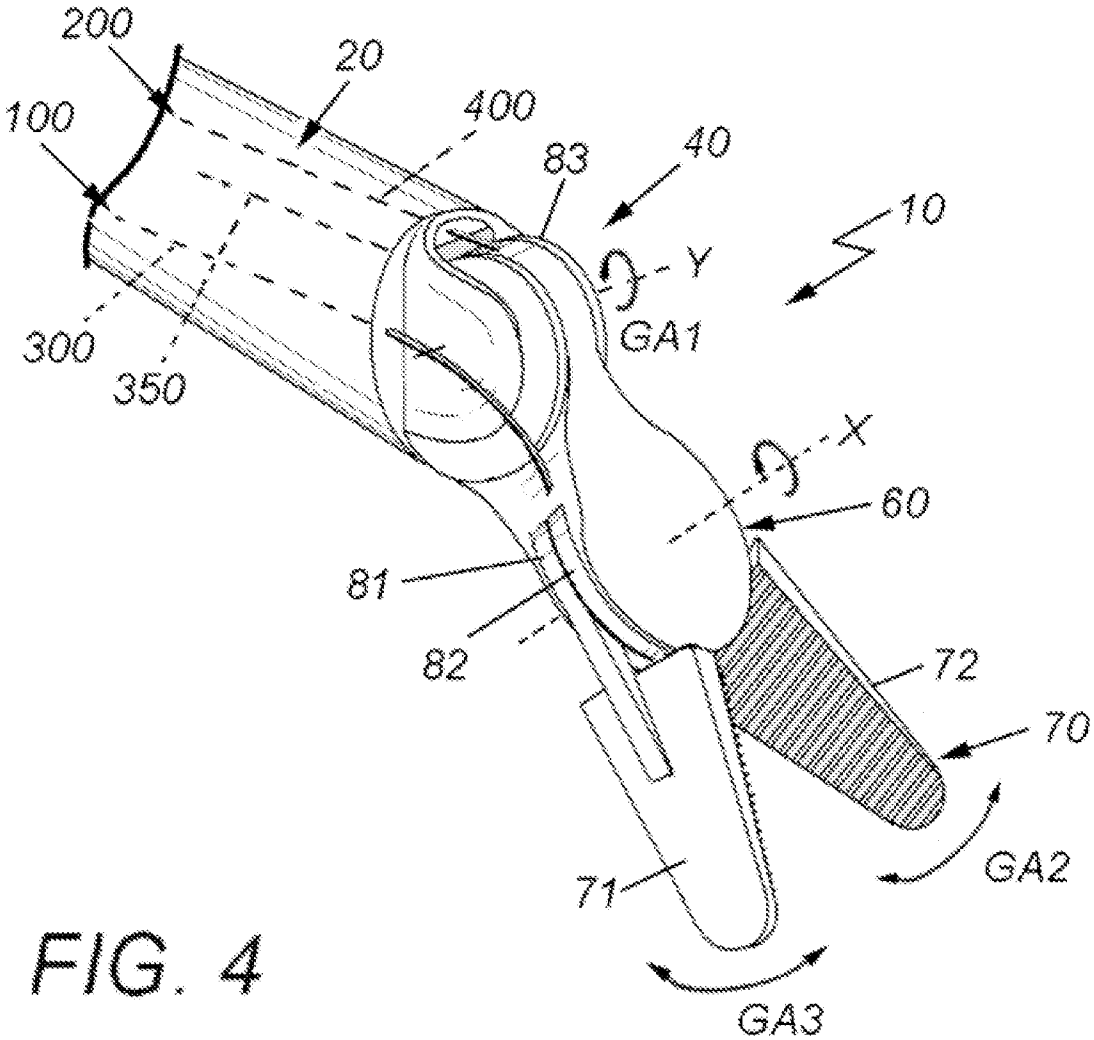
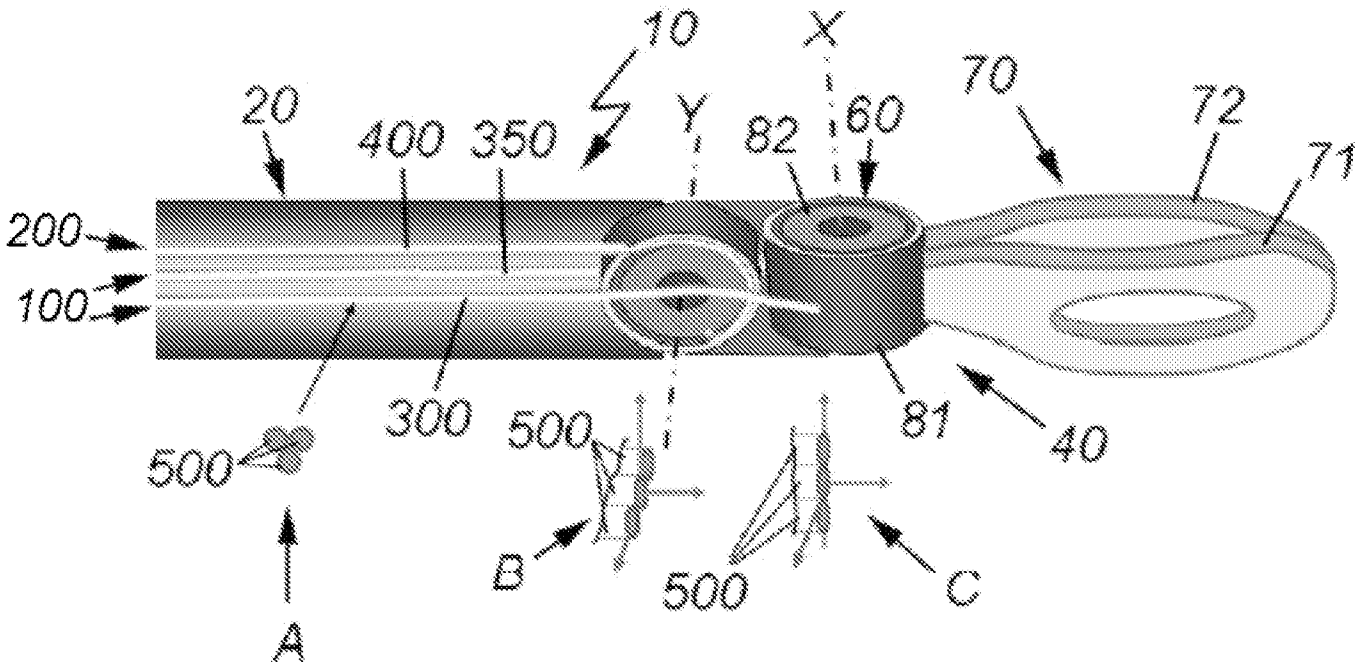

200
20
100
400
83
40
10
Y
GA1
300
350
X
60
81
82
72
70
71
GA2
GA3

FIG. 4


10
X
20
400
350
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82
60
70
72
71
200
100
500
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500
81
40
B
500
C
A

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/066111

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B19/00
ADD. A61B17/29

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/054726 A1 (SAKAGUCHI AKIRA [JP] ET AL) 26 February 2009 (2009-02-26) paragraphs [0002], [0043], [0044], [0046], [0052], [0005], [0060] - [0062], [0066]; figures 1,3,4,5,6,7,8,9	1,5-10
A	US 6 969 385 B2 (MOREYRA MANUEL RICARDO [US]) 29 November 2005 (2005-11-29) cited in the application the whole document	1
A	US 2009/062602 A1 (ROSENBERG CRAIG R [US] ET AL) 5 March 2009 (2009-03-05) paragraphs [0010], [0068], [0118], [0119]; figure 1	1

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 January 2011	08/02/2011

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/066111

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No
PCT/EP2010/066111

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