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(54) **SYSTEM FOR ACTUATING A LAPAROSCOPIC SURGICAL INSTRUMENT**

SYSTEM ZUR BETÄTIGUNG EINES LAPAROSKOPIE-INSTRUMENTS

SYSTEME D'ACTIONNEMENT D'UN INSTRUMENT CHIRURGICAL LAPAROSCOPIQUE

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention generally relates to laparoscopic surgical instruments and, in particular, to a system and method for actuating the tips of a laparoscopic surgical instrument.

Description of Prior Art

[0002] Laparoscopic surgical instruments or devices that use actuating blades or tips are typically activated by some mechanical means. In most cases, the surgical instruments or devices use an actuation rod to translate motion from a handle at one end to a tip at the opposite end of the device. Common to most laparoscopic scissors and graspers is an actuation rod that includes a pin that works in conjunction with a slot in the tips. Moving the actuation rod cams the pin in the slot which opens and closes the tips.

[0003] The blades or tips typically have slots proximal to the pivot and because of this configuration, the back end of the blades or tips need to be quite large. When used on a grasper and the tips are in their open position, the back end of the tips extend out beyond the outside diameter of the grasper shaft and look like "wings." This may be a problem for the user and, in particular, the patient as they can catch or interfere on tissue or other devices during use.

[0004] When used on scissors, these wings will most likely be covered up with a plastic shrink tubing to insulate all the metal components during electro-surgical cautery. However, when the blades or tips are open, the wings can stretch and deform the shrink tubing. This can be problematic in that when the scissors is withdrawn from the trocar, the deformed tubing may not relax and it may catch on the end of the cannula, thereby pulling the trocar out of the patient. Accordingly, there is a need in the art for an improved system and method for actuating the blades or tips of laparoscopic instruments so as to minimize the adverse wing effect.

[0005] In DE 20001492 U1, which discloses a surgical instrument according to the preamble of claim 1, there is disclosed a pin and slot design where the driving slots are moved from the blades or tips to the actuation rod in one aspect of the invention. As a result, the back end of each blade or tip can be dramatically reduced in area so that during full deflection, very little or no part of the blade or tip extends beyond the outside diameter of the outer tube or shaft. This ensures that nothing catches on the blades or tips during grasper use and the shrink tubing found on the scissors would not be deformed. This can be done because the area for the slots is not needed.

SUMMARY OF THE INVENTION

[0006] According to the present invention there is provided a surgical instrument, comprising: an elongate tube extending along an axis including an actuation rod coaxially slidable within the elongate tube; a first tip including a first pin formed on a proximal end surface of the first tip; and a second tip including a second pin formed on a proximal end surface of the second tip, the second tip pivotally connected to the first tip at a common pivot pin operably connected to the elongate tube to open and close the tips in response to movement of the actuation rod, the actuation rod having a slot to accept the pins of the first and second tips, the slot having camming surfaces for the pins to slide within the slot, and the proximal ends of the tips extend minimally outside the diameter of the elongate tube during actuation of the tips, characterized in that the slot has a depth ('A' to 'B') that varies along the length of the slot to provide different tension along the tip.

[0007] With this aspect, the actuation rod has a slot to accept the pins of the first and second tips, the slot has camming surfaces for the pins to slide within the slot, and the proximal ends of the tips extend minimally outside the diameter of the elongate tube during actuation of the tips. Preferably, the proximal ends of the tips do not extend outside the diameter of the elongate tube during actuation of the tips. The actuation rod can be formed by machining, stamping, overmolding, casting, or metal injection molding. The pins can be formed on the proximal end surfaces of the tips by press fitting, threading, welding or bonding. The actuation rod can be a tongue actuation rod or a fork actuation rod. With the fork actuation rod, the rod can include a slot on each side of the rod, which may be curved and transverse to one another. The tongue actuation rod can also include two curved and transverse slots on opposing sides of the tongue. It is appreciated that the slots can be open-ended or closed-ended. As stated above, the slots have a depth that varies along the length of the slot. The different depth of the slot provides different tension along the tip. In another aspect, the tongue actuation rod includes means for ratcheting the tips into a desired position; the ratcheting means may include a series of detents.

[0008] These and other features and advantages of the invention will become more apparent with a discussion of the embodiments in reference to the associated drawings.

DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 illustrates a perspective view of a laparoscopic view of a surgical instrument of the prior art;
FIG. 2 illustrates a side cutaway view of a tool mechanism of the surgical instrument of FIG. 1 in the open position;

FIG. 3 is an exploded perspective view of FIG. 2;
FIGS. 4(a) - 4(c) illustrate a perspective view of a laparoscopic surgical instrument of the invention, a perspective view of a blade or tip of the tool mechanism of the invention, and a side view of FIG. 4(a), respectively;
FIG. 5 illustrates a perspective view of an assembled surgical instrument of the invention having mobile tips and an actuation rod;
FIGS. 6(a) and 6(b) illustrate a fork actuation rod and a tongue actuation rod of the invention, respectively;
FIGS. 7(a) and 7(b) illustrate a perspective view and a side view of the fork actuation rod having slots on both sides of the fork end;
FIGS. 7(c) and 7(d) illustrate a perspective view and a side view of an actuation rod having a slot with an open end;
FIGS. 7(e) and 7(f) illustrate a perspective view and a side view of an actuation rod having a curved slot;
FIG. 8(a) illustrates a side view of an actuation rod having an angled slot ' in accordance with the invention;
FIG. 8(b) is a cross-section along the line A-A of FIG. 8A and shows the slot having a variable depth along its length;
FIG. 8(c) illustrates a slot in an actuation rod having a detent or elevation shift to temporarily lock or ratchet the tips into a desired position; and
FIG. 8(d) illustrates a slot in an actuation rod having a locking mechanism.

DESCRIPTION OF THE INVENTION

[0010] Referring to FIG. 1, there is shown a perspective view of a laparoscopic surgical instrument 100 of the prior art as shown in U.S. Patent No. 5,626,609. The surgical instrument 100 typically comprises a handle assembly 10 having a fixed handle 12 and a pivoting handle 14. Extending from the handle assembly 10 is a shaft assembly 20 comprising an outer tube 22 and an inner actuation rod 24. The actuation rod 24 slides in the outer tube 20 in a coaxial relationship. The outer tube 22 may be secured to the fixed handle 12, while the actuation rod 24 may be secured to the pivoting handle 14. Attached at a distal end of the shaft assembly 20 is a tool mechanism 30, which comprises of a lower jaw 32 and an upper jaw 34. The tool mechanism 30 is connected to the shaft assembly 20 at pivot point 36 through linkage mechanism 40. During use, as the actuation rod 24 slides within the outer tube 22, the linkage mechanism 40 is actuated to pivot jaws 32 and 34 about pivot point 36 to open and close the jaws.

[0011] Referring to FIGS. 2 and 3, there is shown a tool mechanism 30a of the prior art which includes, for example, a first scissor blade 32a and a second scissor blade 34a. In this embodiment, a housing member 50 is attached to the outer tube 22, and the tool mechanism 30a is attached to the housing member 50. As the handles move, the actuation rod 24 slides through the outer tube 22 towards the tool mechanism 30a. As illustrated in FIG. 2, scissor blades 32a, 34a are provided with cam slots 38 and 39, respectively, which slots accept a bearing post 60 which is attached to inner rod 24. As the rod 24 moves, the bearing post 60 slides within cam slots 38, 39 to pivot blades 32a, 34a about pivot pin 36a to open and close the blades. A drawback of this tool mechanism 30a is when the blades 32a, 34a are open, the tail end of the blades pass through slot 70 in housing member 50 to allow the blades to open. That is, the tail end of the blades 32a, 34a extend out beyond the outside diameter of the surgical instrument and look like "wings." This may be a problem for the user as they can catch or interfere on tissue or other devices during use. Moreover, when the blades 32a, 34a are open, the wings can stretch and deform the plastic shrink tubing that is used to insulate the shaft assembly 20. For example, this can be problematic in that when the instrument is withdrawn from a trocar after a procedure, the deformed tubing may not relax and it may catch on the end of the cannula, thereby pulling the trocar out of the patient.

[0012] Referring to FIGS. 4(a) - 4(c), there is shown a surgical instrument 200 in accordance with a first aspect of the invention having a tool mechanism 210 including a first blade or tip 212 and a second blade or tip 214, each of which has a pin 218 and 216, respectively, formed at the proximal end. The pins 218, 216 are fixed, typically by welding, to blades or tips 212, 214 and extend outwardly of the surface of the back end of the blades or tips 212, 214. The blades or tips 212, 214 are overlapped in a scissors configuration and are held in a pivotal relationship with an outer tube by a common pin 220. A feature of the invention is it includes the tool mechanism 210 that interacts with a slotted actuation rod 224 as further explained below. It is appreciated that because the blades or tips 212, 214 include pins 218, 216, rather than slots, much area is not needed on the back ends. This is beneficial because the "wingspan" of the blades or tips 212, 214 when opened is minimized if not eliminated. In addition, the overall strength of the blades or tips 212, 214 and the rod 224 is maximized because both the rod and the blades are integral or are single piece components.

[0013] The fork actuation rod 224 can be formed in a number of different ways. For example, the desired features can be machined from a solid rod or tube of a desired diameter. In another aspect, a strip of metal can be stamped with the desired slots at the end, then the tube can be rolled into a particular diameter where the slotted end can form a "fork". In yet another aspect, the fork features at the end of the actuation rod can be overmolded onto a shaft to provide a cost effective component.

[0014] As to the tongue actuation rod, it can be formed in a similar way to the fork actuation rod. More specifically, machining the detail in the tip is an option as is overmolding the detail. The end of the actuation rod can also be formed as a separate part, i.e., molded, machined, cast, MIM, etc., with the feature detail in it and

then attached to a standard length shaft by means of a thread, snap, adhesive, welding process or some other attachment method.

[0015] Referring to FIG. 5, there is shown a perspective view of the tool mechanism 210 of FIG. 4 being connected to the actuation rod 224. It is appreciated that there are numerous methods of manufacturing the blades or tips 212, 214. For example, the blades or tips 212, 214 can be formed from conventional stamping and then heat treated. In another example, the blades or tips 212, 214 can be formed from a blank of pre-hardened material and then EDM cut, waterjet cut, laser cut or even machined to obtain the final shape. It should be noted that pins 218, 216 in the back ends of the blades or tips 212, 214 can be formed directly onto the blades or pins themselves, or they can be added after the pins have been manufactured.

[0016] The pins 218, 216 can be locked in any one or a combination of the following ways: press-fitted, swaged, threaded and/or welded. To manufacture the pin as part of the blades or tips 212, 214, a multitude of processes can be used. A sheet of material can be machined to include a pivot hole as well as the pin. The sheet can then be heat treated and sent to a form grinder, which can grind one profile of the blade or tip. The ground plate can then be sent to be EDM cut and the second profile can be cut out. This type of process can yield numbers components, with the drive pin integrally located, with relatively low cost.

[0017] There are also additional processes that can yield the entire part from a minimum number of operations. These can include but are not limited to metal injection molding (MIM), casting, and powder metallurgy (PM). The final blade can also then be sent to be sharpened or other post processing.

[0018] The following is a discussion of the pin and slot design of the invention, where there are a number of advantages which can be realized. For example,

(1) The back end of each blade or tip is reduced in area so that during full deflection, very little or no part of the blade or tip extends beyond the outside diameter of the outer tube or shaft. This ensures that nothing catches on the blades or tips during grasper use and the shrink tubing found on scissors would not be deformed. This can be done because the area for the slots is not needed;

(2) The usable area for the drive slots on the blade or tip of the actuation rod is maximized to the overall diameter of the outer tube or shaft which provides additional leverage to the blades or tips; and

(3) The depth of the channels on the actuation rod is varied such that increased tension can be placed on the blades during actuation.

[0019] Moreover, by moving the slot from the blades or tips to the actuation rod, the "wingspan" of the blades can be reduced or eliminated because the back end does not need to endcase the slot, but rather a small pin which minimizes the chance of catching on tissue, other instruments or suture.

[0020] Referring to FIGS. 6(a) and 6(b), there are shown the end of the actuation rod which can be a fork design 224a or a tongue design 224b. With the fork design 224a, a through slot 226 can be formed on each side of the rod 224a. The back end of the blades or tips can be inserted into the rod where the pin of the first blade or tip can be locked into the first slot and the pin of the second blade or tip can be locked into the opposing second slot. The blades or tips can be fixed by a common pivot point on the outer tube or shaft. When the actuation rod is move in one direction, the blades or tips will cam via the pins and the slots 226. The pin that locks each blade or tip into the shaft can be integral to the blades or tips or they can be separate components. Similarly to the fork design 224a, the tongue design 224b can include a slot 226 on each side of the tongue as further discussed below.

[0021] Referring to FIGS. 7(a) and 7(b), there are shown a perspective view and a side view of the actuation rod 224 incorporating slots 226 on both sides of the tongue end, respectively. As explained above, the blades or tips can have pins on the back end that nest in the slots of the rod. The rod may be pushed forward or pulled backwards to cam the blades or tips, which are pivoted by a common pivot point that is attached to the outer tube or shaft. In some cases, it is beneficial to have different slot designs to actuate the tips to different openings, at different speeds, for different length tips and for varying force. Referring to FIGS. 7(c) and 7(d), the slots 226 can include an open or closed end slot (or combination of both) as desired. FIGS. 7(e) and 7(f) illustrate an actuation rod having a curved slot in accordance with another aspect of the invention. It is appreciated that as the jaw providing the blades or tips of the invention articulates a pivot point, the distance between the pin and slot and the hinge vary depending on the actuation rod position. Accordingly, the curved slot of the invention can be used to compensate for this phenomenon and provide for a more linear relation between the actuation rod and the jaw motion. For example, the slot can be shaped to provide for more control as the blades or tips are nearing the closed position, and greater acceleration as the blades or tips are near the opened position. With this aspect, the instrument can be tuned to provide the desired instrument control and user feedback.

[0022] As illustrated in FIGS. 8(a) and 8(b), a slot 226b for the tongue is formed such that it has an angle to it. In other words, the depth of the slot 226b at one end ('B') 227 is deeper or shallower than at the other end ('A') 228. This is beneficial because as the actuation rod 224 is pulled, and the blades or tips close, the pins camming in the slots can be forced apart by the angle at the bottom surface of the slots. This spreads the back end of the blades or tips which in turn push the front of the blades or tips together putting more tension along the cutting

surface.

[0023] In the embodiment illustrated in FIG. 8(c), there is shown a slot 226c having a detent or elevation shift 229 to temporarily "lock" or "ratchet" the blade or tip into a desired position without affecting the linear motion of the jaws relative to the handle actuation. FIG. 8(d) illustrates that a slot 226d can also be formed with different cross sections, e.g., slot 226d having a locking mechanism with a dovetail profile 230. With this embodiment, the mating pin on the blades or tips can match the slot to "lock" it in.

Claims

1. A surgical scissor instrument (200), comprising:

   an elongate tube extending along an axis including an actuation rod (224) coaxially slidable within the elongate tube;
   a first blade tip (212) including a first pin formed on a proximal end surface of the first blade tip; and
   a second blade tip (214) including a second pin (216) formed on a proximal end surface of the second blade tip, the second blade tip pivotally connected to the first blade tip at a common pivot pin (220) operably connected to the elongate tube to open and close the blade tips in response to movement of the actuation rod (224),
   the actuation rod having slots (226) to accept the pins of the first and second blade tips, the slots having camming surfaces for the pins to slide within the slots, and the proximal ends of the blade tips extend minimally outside the diameter of the elongate tube during actuation of the blade tips,

   characterized in that the slots (226) have a depth ('A' to 'B') that varies along the length of the slots to provide different tension along the blade tips, such that the distal ends of the first and second blade tips are pushed together putting tension along the cutting surfaces.

2. The surgical scissor instrument of claim 1, wherein the actuation rod (224) is formed by machining, stamping, overmolding, casting, or metal injection molding.

3. The surgical scissor instrument of claim 1, wherein the actuation rod (224) is a tongue actuation rod or a fork actuation rod.

4. The surgical scissor instrument of claim 3, wherein the tongue actuation rod includes two transverse slots on opposing sides of the tongue.

5. The surgical scissor instrument of claim 4, wherein at least one of the slots is an open-end slot or a closed end slot.

6. The surgical scissor instrument of claim 1, wherein the pins are formed on the proximal end surfaces of the tips by press fitting, threading, welding or bonding.

Patentansprüche

1. Chirurgisches Schereninstrument (200), umfassend:

   Ein sich verlängerndes Rohr, das sich entlang einer Achse erstreckt und das eine Betätigungsstange (224) einschließt, die innerhalb des sich verlängernden Rohrs koaxial verschiebbar ist;
   eine erste Blattspitze (212), die einen ersten Stift einschließt, der auf einer Oberfläche des proximalen Endes der ersten Blattspitze gebildet ist; und
   eine zweite Blattspitze (214), die einen zweiten Stift (216) einschließt, der auf einer Oberfläche des proximalen Endes der zweiten Blattspitze gebildet ist, wobei die zweite Blattspitze drehbar mit der ersten Blattspitze an einem gemeinsamen Drehzapfen (220) funktionsfähig mit dem sich verlängernden Rohr verbunden ist, um die Blattspitzen als Reaktion auf Bewegung der Betätigungsstange (224) zu öffnen und zu schließen,
   wobei die Betätigungsstange Schlitze (226) zum Aufnehmen der Stifte der ersten und zweiten Blattspitzen aufweist, wobei die Schlitze Kurvenoberflächen aufweisen, in denen sich die Stifte innerhalb der Schlitze verschieben können und wobei sich die proximalen Enden der Blattspitzen minimal außerhalb des Durchmessers des sich verlängernden Rohrs, während der Betätigung der Blattspitzen, erstrecken,

   dadurch gekennzeichnet, dass die Schlitze (226) eine Tiefe ('A' to 'B') aufweisen, die sich entlang der Länge der Schlitze verändert, um verschiedene Spannung entlang der Blattspitzen so bereitzustellen, dass die distalen Enden der ersten und zweiten Blattspitzen zusammengeschoben werden und Spannung entlang der Schneidflächen aufbringen.

2. Chirurgisches Schereninstrument nach Anspruch 1, wobei die Betätigungsstange (224) durch spanende Bearbeitung, Formstanzen, Umspritzen, Gießen oder Metallspritzgießen geformt ist.

3. Chirurgisches Schereninstrument nach Anspruch 1, wobei die Betätigungsstange (224) einen Zungen-

betätigungsstange oder eine Gabelbetätigungsstange ist.

4. Chirurgisches Schereninstrument nach Anspruch 3, wobei die Zungenbetätigungsstange zwei Querschlitze auf entgegengesetzten Seiten der Zunge einschließt.

5. Chirurgisches Schereninstrument nach Anspruch 4, wobei wenigstens einer der Schlitze ein Schlitz mit offenem Ende oder ein Schlitz mit geschlossenem Ende ist.

6. Chirurgisches Schereninstrument nach Anspruch 1, wobei die Stifte auf den Oberflächen des proximalen Endes der Blattspitzen durch Presspassung, Gewindeschneiden, Schweißen oder Kleben gebildet sind.

Revendications

1. Un instrument chirurgical de type ciseaux (200) comprenant :

un tube allongé s'étendant le long d'un axe comprenant une tige d'actionnement (224) coulissable coaxialement à l'intérieur du tube allongé;
une première pointe de lame (212) comprenant une première broche formée sur la surface d'extrémité proximale de la première pointe de lame; et
une deuxième pointe de lame (214) comprenant une deuxième broche (216) formée sur la surface d'extrémité proximale de la deuxième pointe de lame, cette dernière étant rotativement connectée à la première pointe de lame au niveau d'un tourillon commun (220) opérativement connecté au tube allongé pour ouvrir et fermer les pointes de lames en réponse au mouvement de la tige d'actionnement (224),
la tige d'actionnement présentant des fentes (226) pour accepter les broches des première et deuxième pointes de lames, les fentes ayant des surfaces à effet de came pour que les broches puissent coulisser à l'intérieur des fentes, et les extrémités proximales des pointes de lames s'étendant minimalement à l'extérieur du diamètre du tube allongé durant l'actionnement des pointes de lames,

caractérisé en ce que les fentes (226) ont une profondeur ("A" à "B") qui varie le long de la longueur des fentes pour procurer une tension différente le long des pointes de lames, de sorte que les extrémités distales des première et deuxième pointes de lames soient poussées ensemble pour appliquer une tension le long des surfaces de coupe.

2. Instrument chirurgical de type ciseaux de la revendication 1, la tige d'actionnement (224) étant formée par usinage, matriçage, surmoulage, coulage ou moulage par injection de métal.

3. Instrument chirurgical de type ciseaux de la revendication 1, la tige d'actionnement (224) étant une tige d'actionnement de lame ou une tige d'actionnement de fourchette.

4. Instrument chirurgical de type ciseaux de la revendication 3, la tige d'actionnement de lame comprenant deux fentes transversales sur les côtés opposés de la lame.

5. Instrument chirurgical de type ciseaux de la revendication 4, au moins l'une des fentes étant une fente à extrémité ouverte ou une fente à extrémité fermée.

6. Instrument chirurgical de type ciseaux de la revendication 1, les broches étant formées sur les surfaces d'extrémité proximales des pointes par emmanchement à la presse, filetage, soudage ou collage.

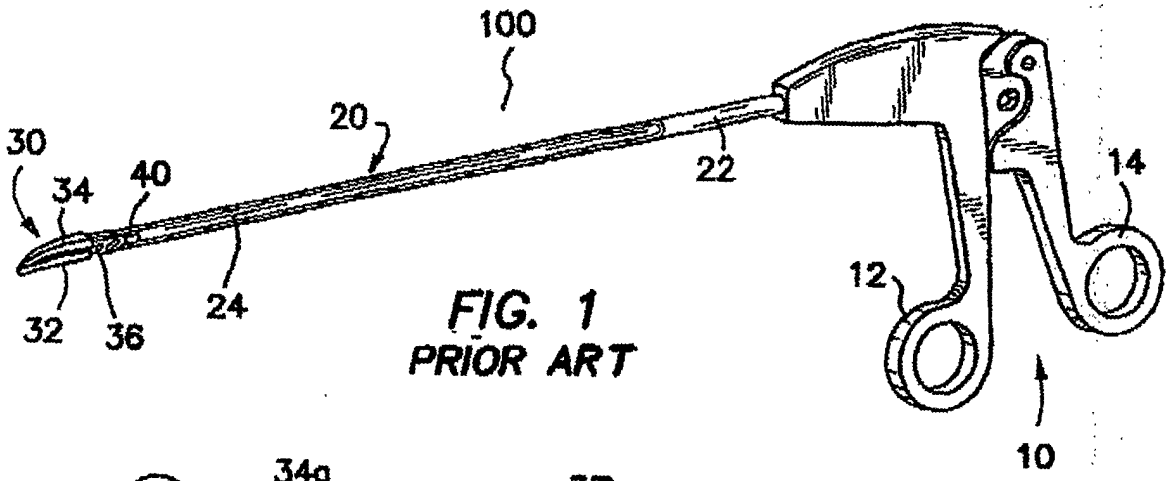


FIG. 1
PRIOR ART

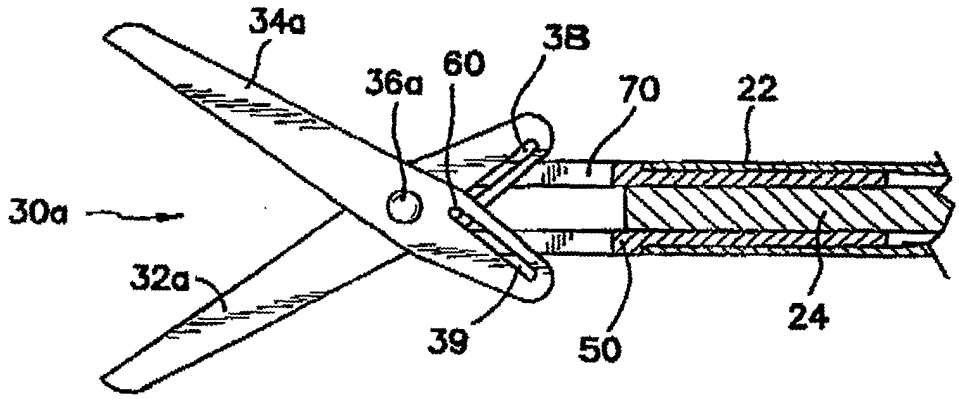


FIG. 2
PRIOR ART

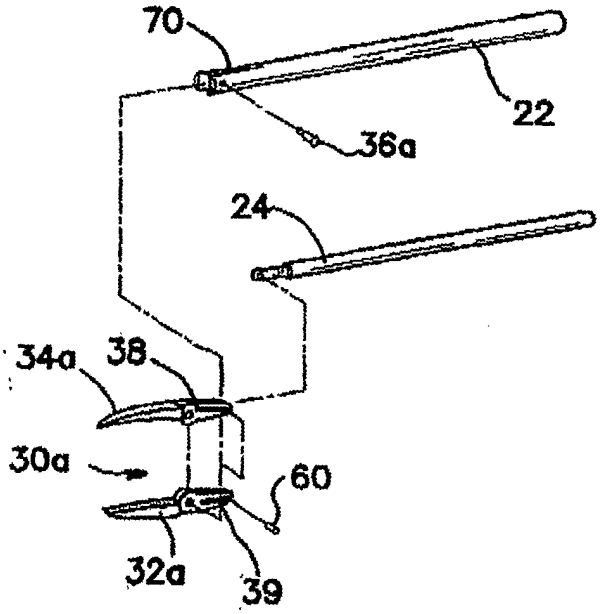


FIG. 3
PRIOR ART

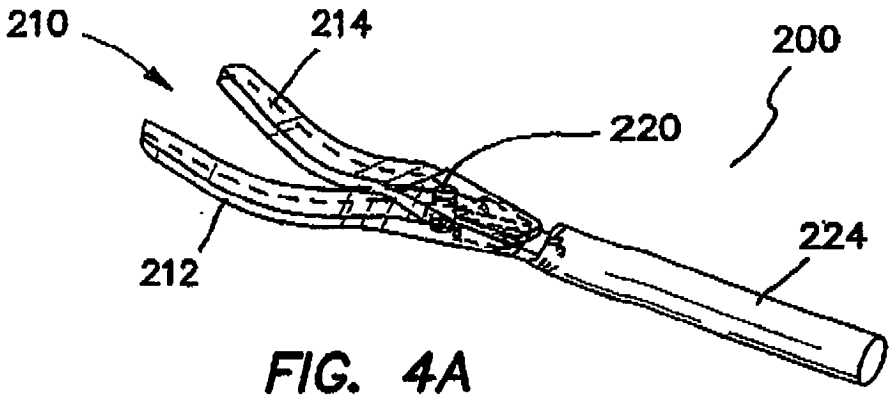


FIG. 4A

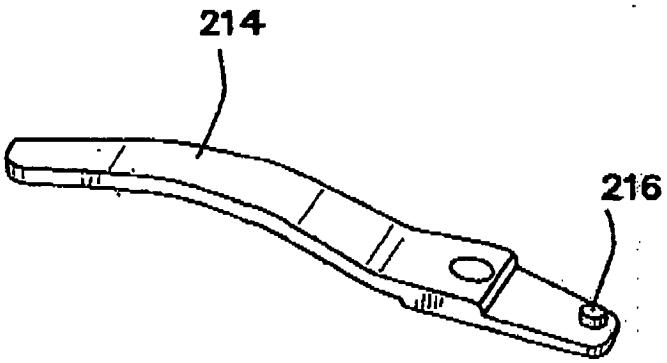


FIG. 4B

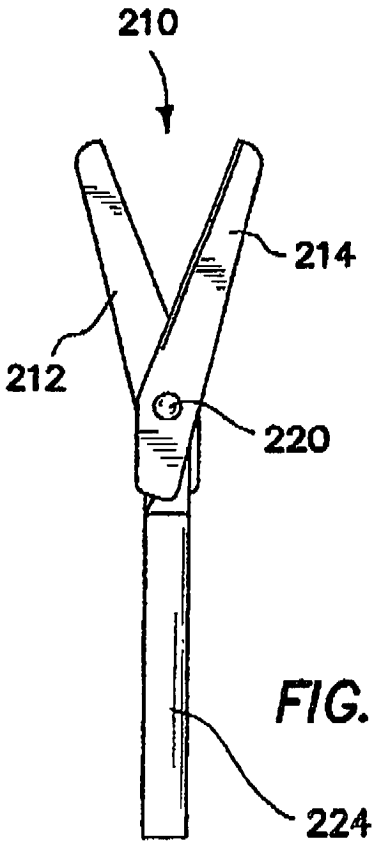


FIG. 4C

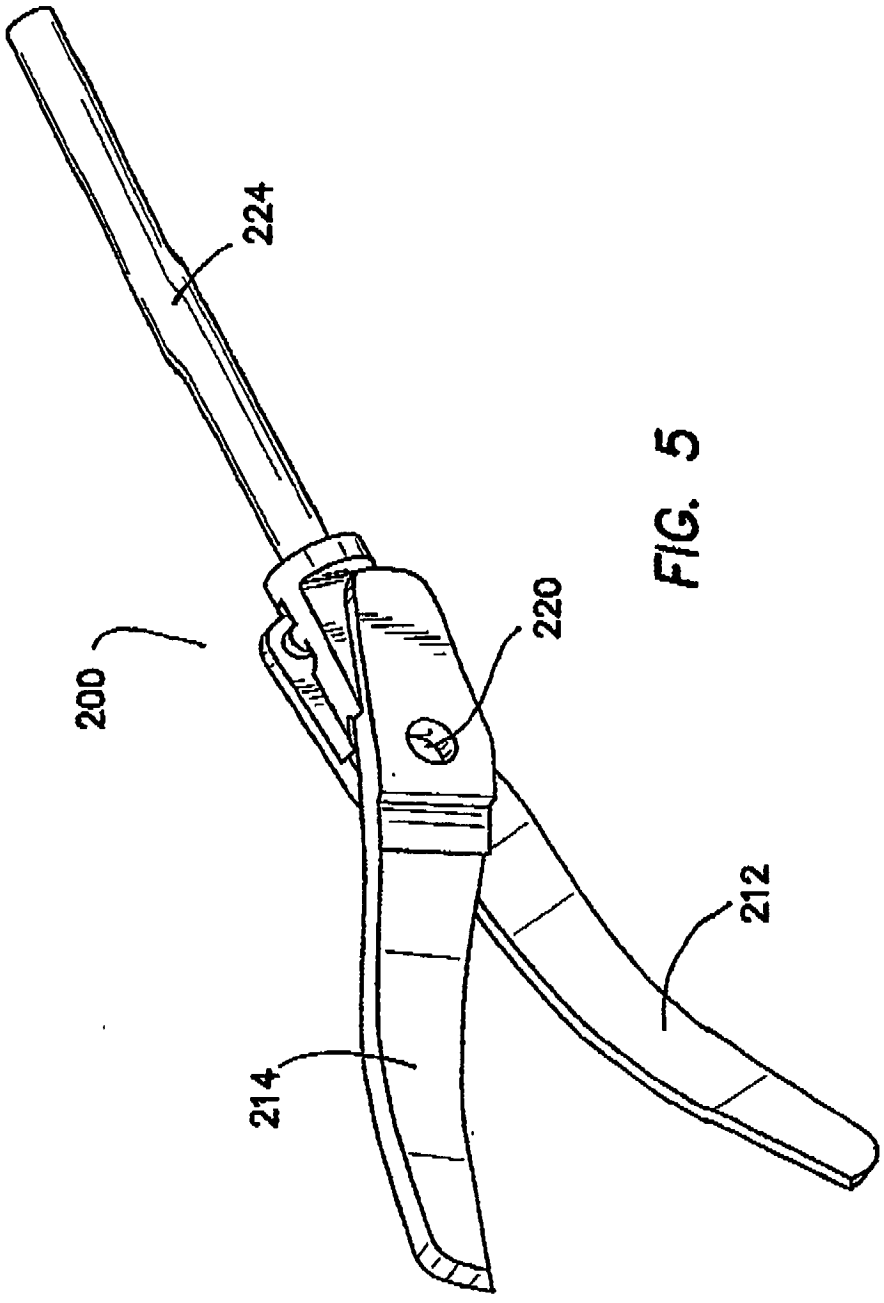


FIG. 5

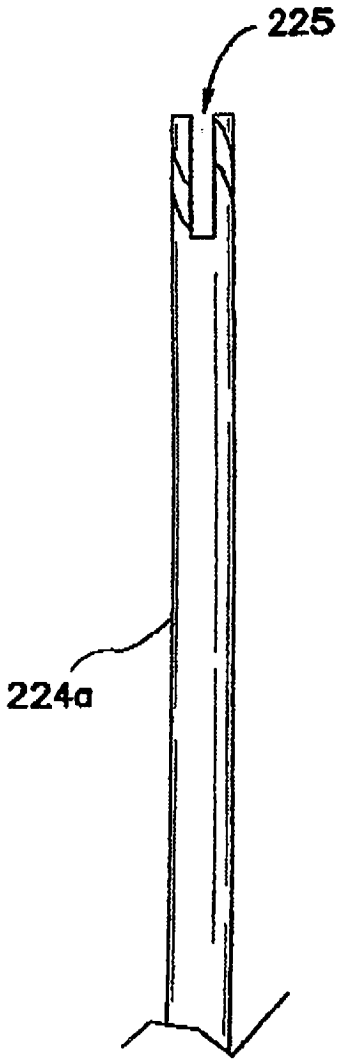


FIG. 6A

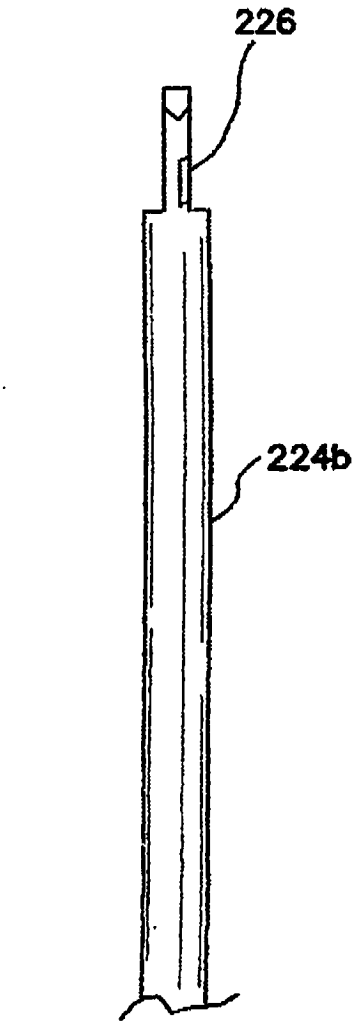


FIG. 6B

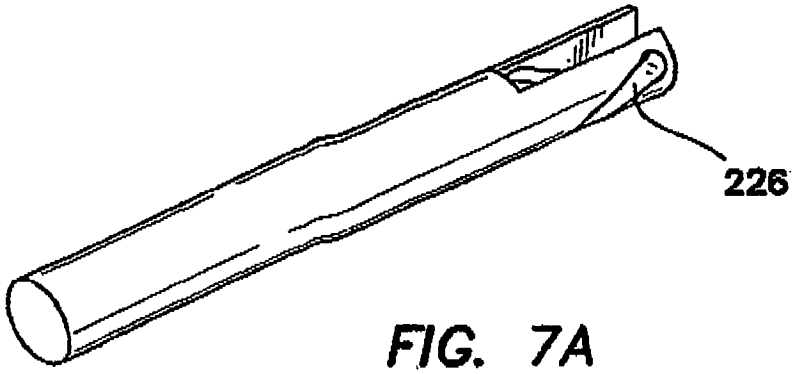


FIG. 7A

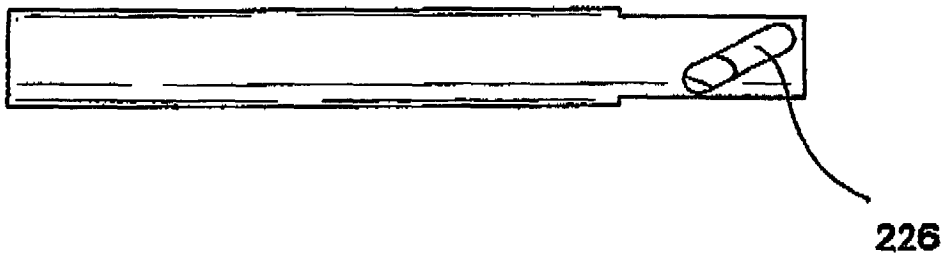
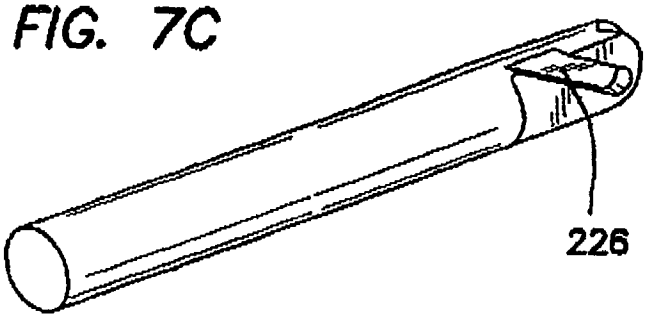


FIG. 7B

FIG. 7C



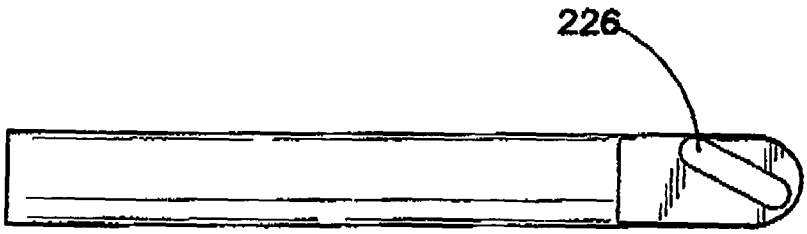
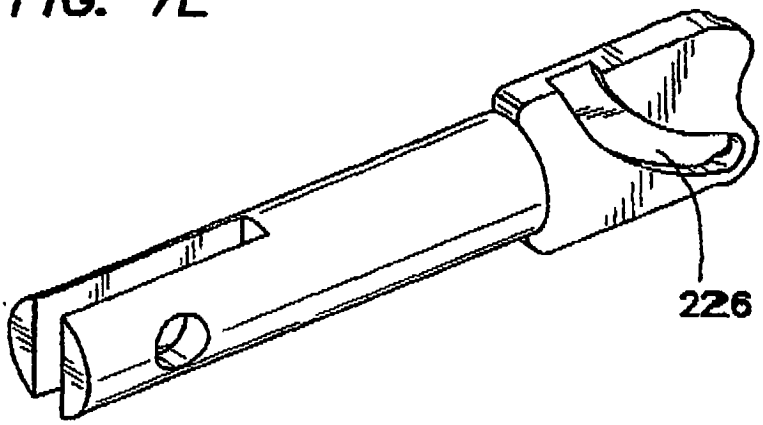


FIG. 7D

FIG. 7E



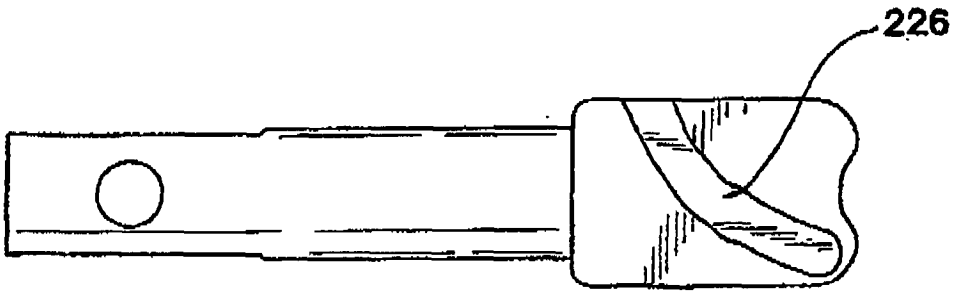
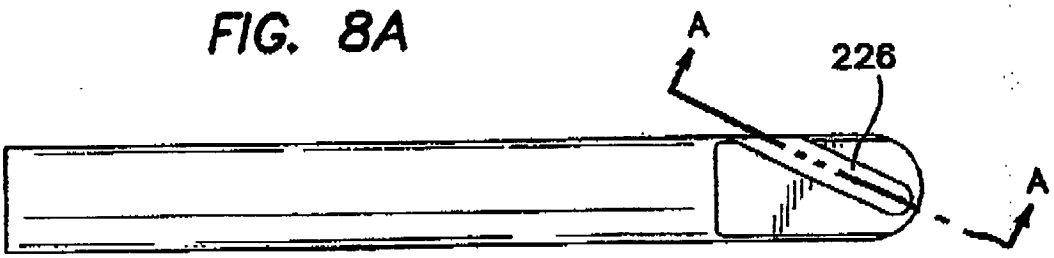


FIG. 7F

FIG. 8A



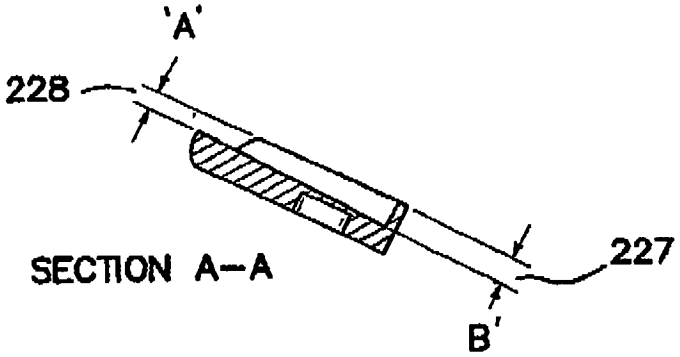


FIG. 8B

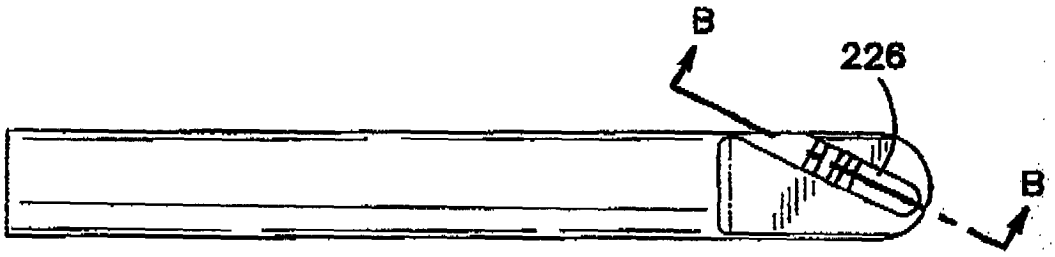
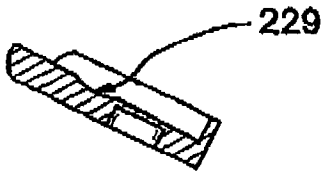


FIG. 8C



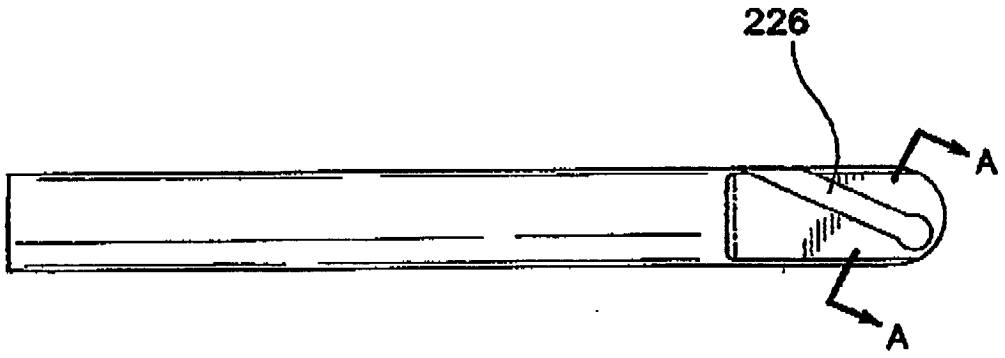
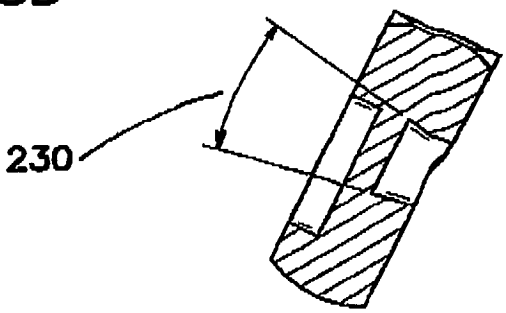


FIG. 8D



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- US 5626609 A **[0010]**

专利名称(译)	用于致动腹腔镜手术器械的系统		
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当前申请(专利权)人(译)	应用医疗资源CORPORATION		
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摘要(译)

本发明涉及一种销和槽设计，其中在本发明的一个方面中，驱动槽从尖端移动到致动杆。结果，每个叶片或尖端的后端的面积可以显着减小，使得在完全偏转期间，叶片或尖端的很少或没有部分延伸超过轴的外径。这确保了在抓紧器使用期间刀片或尖端上没有任何物体卡住，并且剪刀上的收缩管不会变形。这可以完成，因为不需要插槽的区域。此外，刀片或致动杆尖端上的驱动槽的可用区域最大化为外管或轴的总直径，这为刀片或尖端提供了额外的杠杆作用。另外，每个槽的深度可以变化，使得在致动期间增加张力可以在整个切割过程中放在刀片或尖端上。更具体地，本发明的手术器械包括沿轴线延伸的细长管，所述轴包括在细长管内可同轴滑动的致动杆，第一尖端包括形成在第一尖端的近端表面上的第一销，第二尖端包括形成在第二尖端的近端表面上的第二销，第二尖端在公共枢轴销处可枢转地连接到第一尖端，该公共枢轴销可操作地连接到细长管以响应于致动杆的运动而打开和关闭尖端。致动杆具有用于接纳第一和第二尖端的销的槽，该槽具有凸轮表面，用于销在槽内滑动，并且尖端的近端在致动期间最小地延伸到细长管的直径之外。提示。