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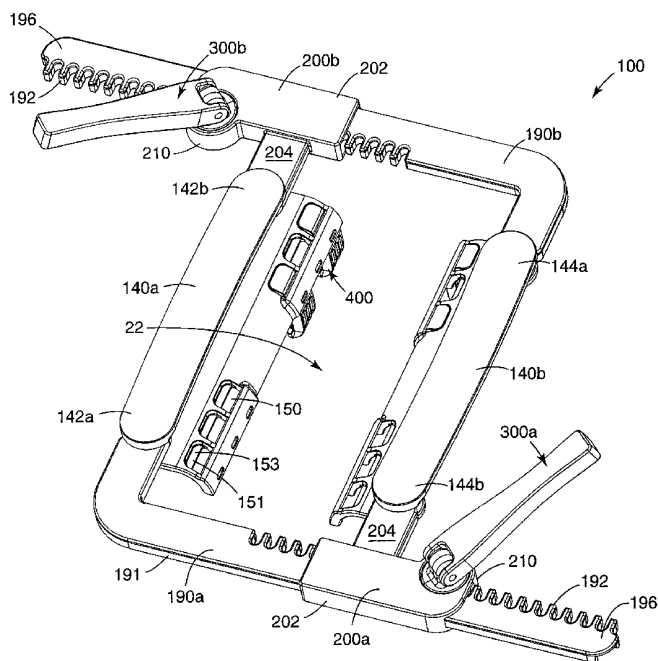
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(54) Title: SURGICAL ACCESS DEVICE



(57) Abstract: A surgical access device (100) utilizing two side members (140a, 140b) carrying repositionable tissue engaging flanges (400) and two lateral members (190a, 190b) that are pivotably hinged to the side members by a bayonet hinge mechanism that allows variable amounts of retraction at either end of the retractor.



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

SURGICAL ACCESS DEVICE

FIELD OF THE INVENTION

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The present invention provides an improved surgical access device of the type used to gain access to an internal cavity of a patient's body.

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BACKGROUND OF THE INVENTION

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Surgeons frequently need to gain access to patients' body cavities to perform various procedures. One way to gain access to such a cavity is to perform invasive surgery where the cavity is opened fairly widely from the exterior to allow the surgeon ready access to the interior of the cavity. For example, in most traditional heart surgery, the patient's sternum is split and the overlying tissue is cut back to allow the surgeon to place both hands in the chest cavity. Such procedures traditionally employ a retractor to maintain the incision in an open configuration during surgery.

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A wide variety of surgical retractors are known in the art. Most surgical retractors are intended to allow a surgeon to forcibly urge tissue out of the way to enable unfettered access to the underlying anatomical structures. For example, United States Patent No. 4,765,311 issued to Kulik et al. (the teachings of which are hereby incorporated by reference), shows a "wound retractor" that comprises a split tube. Each of the two tube halves are carried on holders which can be moved apart from one another to retract the tissue and provide access to the abdominal cavity. United States Patent No. 1,157,202 issued to Bates, teaches a retractor which is used to retract the sides of an incision in the abdominal wall. The retractor includes four separate retractile elements which are arranged about an oval frame. The tissue can be pulled apart to expand the size of the opening of the incision by pulling the retractile elements away from one another.

United States Patent No. 5,125,396 issued to Ray (the teachings of which are incorporated herein by reference), suggests a surgical retractor which comprises two separate arcuate blades. A separate ring carries each of these arcuate blades. By turning

these two rings with respect to one another, one can move the blades with respect to one another to open a generally cylindrical passageway through the patient's tissue.

When opening up the chest cavity for performing coronary bypass surgery,
5 following the typical incision through the sternum, it is desirable to retract the layers of tissue to the minimum degree possible. Minimal retraction causes less trauma to other areas of the patient's body, resulting in less pain and faster overall healing time. Coronary bypass surgery typically involves the coronary arteries on the caudal side of the heart (*i.e.*, the apical side of the heart). Because coronary bypass surgery usually does not
10 require access to the cranial parts of the chest cavity, a lesser amount of retraction is ideally required toward the cranial regions of the chest cavity than is required toward the caudal regions of the chest cavity. Other procedures, such as open heart valve replacement or repair, require a greater amount of retraction across the entire chest cavity, to expose both the cranial and caudal regions of the heart.

15 When performing surgical procedures in the thoracic cavity, access is gained by making an incision between the ribs. This area is referred to as the intercostal space. The ribs are attached posteriorly to the spine and anteriorly to the sternum. This creates a bowing of the rib and non-uniformity of the distance of the intercostal space. A
20 procedure in which a section of a lung, or the entire lung is removed may require non-parallel retraction of the ribs to address the bowing of the ribs and variance of the intercostal space. Ideally, this retraction is minimized to lessen trauma, specifically the breakage or removal of ribs. Non-parallel retraction is presently only performed by the use of two surgical retractor devices placed at opposite ends of the intercostal incision and
25 opened independently of each other.

Thus, what is needed is a single surgical retractor allowing for non-parallel retraction when required, and parallel retraction in other instances.

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SUMMARY OF THE INVENTION

The Present Invention contemplates both a surgical access device and a method of gaining surgical access to a body cavity. In accordance with one embodiment of the

invention, a surgical device for accessing a body cavity comprises first and second longitudinally opposed side members, each of the side members having first and second ends. A first lateral member adjustably connects the first end of the first side member to the second end of the second side member, with at least one of the side member ends
5 being moveable along a length of the first lateral member, thereby permitting adjustment of the lateral distance between the first end of the first side member and second end of the second side member. Likewise, a second lateral member adjustably connects the second end of the first side member to the first end of the second side member, with at least one of the side member ends being moveable along a length of the second lateral member,
10 thereby permitting adjustment of the lateral distance between the second end of the first side member and first end of the second side member. At least one transversely extending repositionable flange is releasably attached to each side member.

In another embodiment, the Present Invention also comprises the first and second
15 side members being pivotably articulated to the first and second lateral members by a bayonet hinge mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

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Fig. 1 shows a perspective view of an embodiment of the invention in parallel retracting configuration.

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Fig. 2 shows a perspective view of the first side member shown in Figs. 1 and 19.

Fig. 3 shows a perspective view of the second side member shown in Figs. 1 and 19.

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Fig. 4 shows a plan view of the lower surface of the lower plate of the first side member.

Fig. 5 shows a plan view of the lower surface of the lower plate of the second side member.

Fig. 6 shows a plan view of the upper surface of the first lateral member shown in Figs. 1 and 19.

Fig. 7 shows a plan view of the upper surface of the second lateral member shown in Figs. 1 and 19.

Fig. 8 shows a plan view of the lower surface of the first lateral member.

Fig. 9 shows a plan view of the lower surface of the second lateral member.

Fig. 10 shows a perspective view from the lower surface of the first carriage.

Fig. 11 shows a perspective view from the lower surface of the second carriage.

Fig. 12 shows an end view of the first carriage.

Fig. 13 shows an end view of the second carriage.

Fig. 14 shows a disassembled perspective view of the mating gear assembly.

Fig. 15 shows an assembled perspective view of the first mating gear assembly.

Fig. 16 shows an assembled perspective view of the second mating gear assembly.

Fig. 17 shows a perspective view of a tissue engaging flange.

Fig. 18 shows a side view of a tissue engaging flange.

Fig. 19 shows a perspective view of the assembled surgical access device configured for non-parallel retraction.

DETAILED DESCRIPTION OF THE INVENTION
INCLUDING A BEST MODE

Definitions

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“Bayonet Hinge” as used herein, unless otherwise defined, refers to the pivoting articulation between a side member and a carriage and the pivoting articulation between a side member and a lateral member. The carriage has an essentially perpendicular extension terminating in a hook. The hook defines a slot extending into the body of the extension, the slot terminating at a concavity facing toward the opening of the slot. A peg extends perpendicularly away from the hook a distance less than the width of the hook. The hook of the carriage is designed to articulate with and form a hinge capable of pivoting against a side member. Both end portions of each side member comprise a cylindrical post extending between upper and lower plates. A beam perpendicularly disposed between the plates forms an “I” configuration if viewed from an end perspective separates upper and lower plates. The length of the beam is less than the length of the upper and lower beams, to allow for the post to extend between the plates. The upper plate is solid and raised proximally (*i.e.*, extends away from the patient’s body) when the surgical access device is in use by the physician. The lower plate is parallel and distal to the upper plate and has an arcuate channel extending partially around the lower plate. To complete articulating the channel with the side member requires first placing the hook around the post, with the carriage and side member disposed in parallel planes to each other. The raised peg on the perpendicular extension of the carriage is aligned with and fits into the arcuate channel and guides the carriage in a pivoting motion with respect to the side member, while maintaining the carriage and side member in a parallel planar disposition to each other. The lateral members utilize a similar configuration as the carriage to articulate with the side member. The lateral member is essentially a bar having a first leg with an extended length and a second leg of shorter length attached to one end of the first leg at approximately a right angle. The second leg is configured in a similar manner to the perpendicular extension of the carriage (*i.e.*, the hook and peg arrangement is designed to articulate with the post and arcuate channel of the side member to provide a pivoting arrangement).

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“Caudal” as used herein, unless otherwise defined, refers to the inferior or lower part of the human body (*i.e.*, toward the feet).

5 “Cranial” as used herein, unless otherwise defined, refers to the superior or upper part of the human body (*i.e.*, toward the head).

“Lower” as used herein, unless otherwise defined, refers to the direction toward the interior of the patient’s body.

10 “Inside” as used herein, unless otherwise defined, refers to the space defined by the articulated and assembled surgical access device and bounded by the first side member, second side member, first carriage, second carriage, first lateral member and second lateral member.

15 “Kit” as used herein, unless otherwise defined, refers to a set of elements in unassembled form, which when assembled forms a surgical access device.

“Upper” as used herein, unless otherwise defined, refers to the direction away from the interior of the patient’s body.

20 “Outside” as used herein, unless otherwise defined, refers to the space outside the area created by the articulated and assembled surgical access device and bounded by the first side member, second side member, first carriage, second carriage, first lateral member and second lateral member.

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Nomenclature

22	Access Port
100	Surgical Access Device
138a	Inside Edge of First Side Member
138b	Inside Edge of Second Side Member
140a	First Side Member
140b	Second Side Member

	142a	First End of First Side Member
	142b	Second End of First Side Member
	144a	First End of Second Side Member
	144b	Second End of Second Side Member
5	150	Aperture
	151	Shelf
	152	Upper Plate
	153	Upper Surface of Shelf
	154	Upper Surface of Upper Plate
10	156	Lower Surface of Upper Plate
	158	First Post
	160	Lower Plate
	162	Upper Surface of Lower Plate
	164	Lower Surface of Lower Plate
15	168	Second Post
	172	First Arcuate Channel
	174	Second Arcuate Channel
	186	Upper Surface of Lateral Member
	188	Lower Surface of Lateral Member
20	190a	First Lateral Member
	190b	Second Lateral Member
	191	Width of Lateral Member
	192	Teeth on Lateral Member
	196	Free End of Lateral Member
25	200a	First Carriage
	200b	Second Carriage
	202	Body of Carriage
	204	Extension
	206	Channel
30	208	Projection
	210	Bearing
	212	Terminal End of Carriage Extension
	214	Hook on Carriage
	216	Top Side of Carriage

	217	Closed End of Slot
	218	Bottom Side of Carriage
	220	Upper Surface of Carriage
	222	Lower Surface of Carriage
5	224	Slot (Carriage)
	226	Peg (Carriage)
	250	First leg of Lateral Member
	252	Second Leg of Lateral Member
	254	Terminal End of First Leg
10	256	Terminal End of Second Leg
	270	Hook (Lateral Member)
	272	Slot (Lateral Member)
	273	Closed End of Slot
	274	Peg (Lateral Member)
15	276	Trough
	300a	First Mating Gear Assembly
	300b	Second Mating Gear Assembly
	302	Mating Gear
	304	Upper Disc
20	306	Lower Disc
	308	Gear Teeth
	310	Raised Portion of Mating Gear
	312	Aperture in Raised Portion
	314	Gear Handle
25	315	Free End of Gear Handle
	316	Projections On Gear Handle
	317	Attached End of Gear Handle
	318	Apertures in Gear Handle Projections
	320	Pin
30	400	Flange
	402	Upper End of Flange
	403	Offset Portion of Flange
	404	Lower End of Flange
	405	Portion Extending in Retraction Direction

- 406 Length of Flange
- 408 Width of Flange
- 410 Leading Edge of Flange

5 *Construction*

Figures 1 and 19 illustrate an embodiment of the present invention. The assembled surgical access device **100** defines an access port **22** which extends therethrough. This access port **22** can take any desired shape or dimension to achieve a particular clinical objective. For example, the access port **22** can be circular, elliptical, rectangular, or deltoid. In Figure 1, the access port **22** is shown as being rectangular, while in Figure 19, the access port **22** is shown as being deltoid. The dimensions of the access port **22** vary significantly depending on the body cavity being accessed and the reason for such access. If the surgeon is attempting to gain access to a patient's thoracic cavity through an incision through the intercostal space, typical dimensions of the access port **22** for an adult patient will be on the order of 2.5 inches (about 6.3 cm) long by 1.5 inches wide. If the surgeon is attempting to perform a sternotomy, typical dimensions of the access port **22** for an adult patient will be on the order of 6 inches long by 1.5 to 6 inches wide (to provide an asymmetric incision). The dimensions would decrease proportionately for a child.

As shown in Fig. 1, one embodiment of the Present Invention comprises first **140a** and second **140b** longitudinally extending opposed side members, each having a first end **142a**, **144a** and a second end **142b**, **144b**. The first end **142a** of the first side member **140a** is pivotably attached to the first lateral member **190a** by means more fully discussed below. The first lateral member **190a** extends through the first carriage **200a** in a slidable manner more fully discussed below. An extension **204** extends perpendicularly from the first carriage **200a** and is pivotably attached to the second end **144b** of the second side member **140b**. In a similar manner the first end **144a** of the second side member **140b** is pivotably attached to the second lateral member **190b** by means more fully discussed below. The second lateral member **190b** extends through the second carriage **200b** in a slidable manner more fully discussed below. An extension **204** extends perpendicularly from the second carriage **200b** and is pivotably attached to the second end **142b** of the first side member **140a**. Viewed from any side of itself, the assembled Present Invention

presents mirror images of itself. The mirror image nature of the Present Invention is further reflected in that similar parts are identical and therefore completely interchangeable. For example, the first **140a** and second **140b** side members are identical as are first **190a** and second **190b** lateral members. Finally, the first **200a** and second **200b** carriages are also identical with each other and interchangeable as are first **300a** and second **300b** mating gear assemblies. The feature of identical similar parts adds to the simplicity of the design by eliminating any ambiguity following sterilization when reassembling the surgical access device **100** prior to use.

As shown in Figs. 2 and 3, the first **140a** and second **140b** side members, which are identical in all respects and completely interchangeable with each other, comprise an upper plate **152** having a length, a width, a first end **142a**, **144a**, a second end **142b**, **144b** an upper surface **154** and a lower surface **156**. A lower plate **160** is attached to the upper plate **152** in a generally parallel planar manner. The lower plate **160** has an upper surface **162** and a lower surface **164**. A first post **158** extends in a generally perpendicular manner between the upper surface **162** of the lower plate **160** and the lower surface **156** of the upper plate **152** proximate the first end **142a**, **144a** of the first and second side member **140a**, **140b**. In a similar manner a second post **168** extends in a generally perpendicular manner between the upper surface **162** of the lower plate **160** and the lower surface **156** of the upper plate **152** proximate the second end **142b**, **144b** of the first **140a** and second **140b** side members. A first arcuate channel **172** and a second arcuate channel **174** extend into the lower plate **160** from the upper surface **162**. In a preferred embodiment, the first **172** and second **174** arcuate channels extend completely through the lower plate **160** for simplicity of manufacture and more importantly, improved sterilizability. In an alternate embodiment, however, the first **172** and second **174** arcuate channels could also comprise a groove extending into but not through the lower plate **160** from the upper **162** or lower **164** surface as design contingencies dictate. As best shown in Fig. 4, the first arcuate channel **172** is concentric with the first post **158** and begins at the first end **142a**, **144a** of the first **140a** and second **140b** side members and arcs toward the inside edge **138a**, **138b** of the first **140a** and second **140b** side members. In a similar manner (as best shown in Fig. 5), the second arcuate channel **174** is concentric with the second post **168** and begins at the second end **142b**, **144b** of the first **140a** and second **140b** side member and arcs toward the inside edge **138a**, **138b** of the first **140a** and second **140b** side member. In one embodiment, a plurality of longitudinally arranged

apertures **150** designed to hold and secure one or more tissue engaging flanges **400** during use of the surgical access device **100** are defined proximate the inside edge **138a**, **138b** of the first **140a** and second **140b** side member. Each aperture **150** defines an associated shelf **151** that is attached to the lower plate **160** and terminates toward the first **138a** or
5 second **138b** inside edge of the first **140a** or second **140b** side member, respectively.

The upper plate **152** defines a substantially consistent thickness along its length. This permits the surgeon to attach a plurality of surgical accessories (not shown) to the surgical access device **100** during surgery. This greatly increases the efficiency of the
10 surgical team during an operation by permitting the surgical accessories (not shown) to be fixed in place during the operation, thus freeing up space and allowing fewer personnel in the immediate operating area. Such devices (not shown) include suction/irrigation probes (suckers), beating heart stabilizers, malleable instrument arms, diaphragm retractors, valve instrument retractors (primarily for mitral valve), cautery pencil holders,
15 illumination probes and sternal approximators. Suture pads (not shown) can also be attached to the upper plate **152**. The suture pads give the physician the ability to suture to the tissue and then suture or re-suture anywhere along the length of the suture pad to achieve the appropriate retraction. By being able to have sutures attached at any location along the length of the first **140a** and second **140b** side members, the suture pads
20 essentially provide an infinite number of connection locations, enabling a physician to reorient the sutured tissue by moving the suture to a different location on the pad to alter the direction the suture is pulling. In use, the physician will pass the suture through the patient's tissue and through one of the suture pads or may tie a knot at each end to hold the suture in place, as is conventional.

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As shown in Figs. 6 and 7, the first **190a** and second **190b** lateral members comprise a first leg **250** and a second leg **252**, and have an upper surface **186** and a lower surface **188** and a width **191**. First lateral member **190a** and second lateral member **190b** are identical in all respects and are thus completely interchangeable. First leg **250** has a
30 longitudinal dimension and a terminal end **254**. Second leg **252** has a longitudinal dimension and a terminal end **256**. In one embodiment, first leg **250** defines a greater longitudinal dimension than does second leg **252**. It is possible, however, that uses for the surgical access device **100** may exist wherein the second leg **252** would need to be longer than the first leg **250**. Accordingly, it is not critical that first **190a** and second

190b lateral members have a first leg **250** longer than the second leg **252**. Thus, combinations of various lengths of the first leg **250** and second leg **252** are contemplated and within the scope of the invention. Veterinary applications on large animals such as horses and cattle require lateral members having greater dimensions than would a human application. Likewise, pediatric applications in human beings would require smaller sized lateral members than would adults. In a preferred embodiment, the first **250** and second **252** legs are fixedly attached to each other at an approximate angle of ninety degrees. Other angles, however, would also work and are contemplated by and within the scope of the Present Invention. A plurality of regularly spaced teeth **192** are disposed along the length of the first leg **250**. The teeth **192** are sized to mate with first **300a** and second **300b** mating gear assemblies as shown in Figs. 15 and 16. A hook **270** is disposed proximate the terminal end **254** of the second leg **252**. The hook **270** defines a slot **272** that in a preferred embodiment extends toward, is substantially parallel with the first leg **250** and terminates at a closed end **273** facing away from the terminal end **254** of the first leg **250**. As best shown in Figs. 8 and 9, peg **274** extends perpendicularly from the lower surface **188** of the first **190a** and second **190b** lateral members. The peg **274** extends from the lower surface **188** of the first **190a** or second **190b** lateral member so as to be received by the first arcuate channel **172** in an essentially parallel-planar relationship with the first end **142a**, **144a** of the first side member **140a** or second side member **140b**. The tolerance between the first **190a** or second **190b** lateral member and first **140a** or second **140b** side member, guided in an arcing motion by the peg **274** extending into the first arcuate channel **172** results in a pivotable hinge between the first **190a** or second **190b** lateral member and the first end **142a**, **144a** of the first **140a** or second **140b** side member. As best shown in Figs. 8 and 9, an off-center trough **276** is defined on the lower surface **188** of the first **190a** and second **190b** lateral members and runs parallel with the longitudinal dimension of the first **190a** and second **190b** lateral member.

As best shown in Figs. 10 and 11, first **200a** and second **200b** carriages are identical in all aspects and therefore completely interchangeable with each other. First **200a** and second **200b** carriages comprise a body **202** having a top side **216**, a bottom side **218**, an upper surface **220** and a lower surface **222**. A channel **206** extends through the body **202** and is configured and arranged to slidably accept the first leg **250** of the first **190a** or second **190b** lateral member. A bearing **210** is defined by the body **202** and is configured and arranged to receive a first **300a** or second **300b** mating gear assembly as

will be discussed in greater detail below. An off-center projection **208** runs the length of and is in parallel alignment with the channel **206**. An extension **204** extends from the top side **216** of the body **202** in a perpendicular manner and has a terminal end **212**. A hook **214** is defined at the terminal end **212** of the extension **204**. A slot **224** runs substantially
5 parallel with the top side **216** of the body **202** and terminates at a closed end **217** facing the bearing **210**. A peg **226** proximate the closed end **217** of the slot **224** extends perpendicularly toward the lower surface **222** of the carriage **200a**, **200b**. The particular configuration and arrangement of the extension **204**, slot **224** and peg **226** enable the carriage **200a**, **200b** to be removably and pivotably hinged to the second post **168**
10 proximate the second end **142b**, of the first side member **140a**, or to the second post **168** proximate the second end **144b** of the second side member **140b** in only one way. Put another way, it is impossible to attach the first **200a** or second **200b** carriage to the second end **142b**, **144b** of the first **140a** or second **140b** side member in any way other than a pivotable parallel planar way. When the first **200a** or second **200b** carriage is
15 attached to the second end **142b**, **144b** of the first **140a** or second **140b** side member, the channel **206** is positioned to slidably receive the first leg **250** of the first **190a** or second **190b** lateral member due to the off-center alignment of the trough **276** and projection **208**. This allows the slot **272** of the first **190a** or second **190b** lateral member to attach to the first end **142a**, **144a** of the first **140a** or second **140b** side member with the first leg
20 **250** extending toward the opposing side member **140a** or **140b**. Finally, in a preferred embodiment, the length of the extension **204** is similar to the length of the second leg **252** of the first **190a** and second **190b** lateral members. Similarity of length of the second leg **252** ensures the ability of the assembled surgical access device **100** to be able to perform parallel retraction, if desired. It is contemplated by and therefore within the scope of the
25 invention to have the length of the extension **204** of the first carriage **200a** be different than the length of the extension **204** of the second carriage **200b**. It is also contemplated by and therefore within the scope of the invention to have different lengths for each of the extensions **204** of the first **200a** and second **200b** carriages and each of the second legs **252** of the first **190a** and second **190b** lateral members.

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Fig. 14 shows the disassembled first **300a** and second **300b** mating gear assemblies. The first **300a** and second **300b** mating gear assemblies comprise a mating gear **302** defining an upper disc **304** and a lower disc **306**. Two gear teeth **308** sized and spaced to mate with the teeth **192** on the first **190a** and second **190b** lateral members are

disposed between and separate the upper disc **304** and lower disc **306**. The distance defined by the length of the gear teeth **308** is of a length slightly greater than the width **191** of the first **190a** and second **190b** lateral members. A raised portion **310** extends from the upper disc **304** and defines an aperture **312** therethrough. The outer diameter of the upper disc **304** and lower disc **306** is slightly smaller than the inner diameter of the bearing **210** defined by the body **202** of the first **200a** or second **200b** carriage. A gear handle **314** defines a free end **315** and an attached end **317**. A pair of centered projections **316** extend longitudinally from the attached end **317** and define apertures **318**.

Figs. 15 and 16 show the assembled first **300a** and second **300b** mating gear assemblies. The first **300a** and second **300b** mating gear assemblies are identical in all aspects and therefore completely interchangeable with each other. The gear handle **314** is pivotably attached to the raised portion **310** of the mating gear **302** by means of a pin **320** extending through the gear handle projection **316** apertures **318** and through the raised portion aperture **312**. The rack and pinion system defined by the first **190a** and second **190b** lateral members, and first **300a** and second **300b** mating gear assemblies provides a mechanism for increasing the mechanical advantage of a force applied to the first **200a** and second **200b** carriage to move it along the first **190a** or second **190b** lateral members. Turning of the gear handle **314** will move the carriage **200a**, **200b** laterally along the lateral member **190a**, **190b**, with the gear ratio of the mating gear **302** and teeth **192** determining the mechanical advantage. The two cylindrical gear teeth **308** provide a locking mechanism wherein in the position of the first **200a** or second **200b** carriage can be locked in a desired position on the first **190a** or second **190b** lateral member. The **200a** or second **200b** carriage is locked into position when the gear teeth **308** are aligned with the teeth **192** of the first **190a** or second **190b** lateral member with the gear handle **314** at an angle so as to extend parallel with the first **190a** or second **190b** lateral member. Put another way, this geometry results in a locked position every 180 degrees, or a linear movement of the pitch of the gear (in this embodiment 0.26" along the travel of the teeth **192** of the first **190a** or second **190b** lateral member.

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As explained in greater detail below, the assembled surgical access device **100** is configured and arranged to receive and hold a plurality of tissue engaging flanges **400**. As best shown in Figs. 17 and 18, the flange **400** comprises an upper end **402**, a lower end **404**, a length **406** and a width **408**. In one embodiment, the distal end **404** defines a

portion **405** extending in the direction of retraction. In a further embodiment, the upper end **402** defines an offset portion **403** that extends in the direction of retraction. The offset portion **403** is sized so as to be received within an aperture **150**. When the flange **400** is inserted into the aperture **150**, the offset portion **403** will rest against the upper surface **153** of the shelf **151**. This ensures that during retraction the flange **400** will lever against the upper surface **153** of the shelf **151**, enabling the leading edge **410** of the flange **400** to firmly exert force against the retracted tissue without becoming dislodged. Finally, it is contemplated by and within the scope of the invention that the length **406** of the flanges **400** can be varied to accommodate the needs of a particular surgeon or surgical procedure. While in one embodiment the flanges **400** are releasably attached to the side members **140a**, **140b** by the alignment of the offset portion **403** and the shelf **151**, other methods (not shown) for attachment are also contemplated by and therefore within the scope of the invention. For example, a stainless steel flange (not shown) could also be used that would be repositionably fastenable to several positions along the inside edge **138a**, **138b** of the first **140a** and second **140b** side members using a fastener mechanism, such as a screw (not shown). An additional mechanism comprises a clamping mechanism (not shown).

Materials

First **140a** and second **140b** side members, first **190a** and second **190b** lateral members, first **200a** and second **200b** carriages, and first **300a** and second **300b** mating gear assemblies are preferably constructed from 17-4 PH metal injection molded stainless steel. 17-4 stainless steel is preferred due to its resistance to corrosion, surface hardness (wear resistance), and strength. In an alternate embodiment, first **140a** and second **140b** side members, first **190a** and second **190b** lateral members, first **200a** and second **200b** carriages, and first **300a** and second **300b** mating gear assemblies could also be machined from stainless steel. Stainless steel offers the advantages of relatively low cost, great strength, biocompatibility and endurance. In a further embodiment, the first **140a** and second **140b** side members, first **190a** and second **190b** lateral members, first **200a** and second **200b** carriages, and first **300a** and second **300b** mating gear assemblies could also be made of various plastics such as polycarbonate and ABS provided the first **190a** and second **190b** lateral members are reinforced with stainless steel to resist bending.

The flanges **400** are preferably made from injection molded polycarbonate plastic with a barium sulfate load for radiopacity. Radiopacity is a desirable characteristic in the flanges **400** in the event one remains behind in the patient following completion of surgery. Other plastic materials such as ABS with a barium sulfate load are also suitable and therefore contemplated by and within the scope of the invention. In one embodiment, the flanges are disposable and come ready to use in a sterilized package.

Assembly

As explained in detail above, the design of the Present Invention ensures that the various components can be articulated together in only one way. While the following description of the assembly process discusses the process in terms such as “first side member **140a** being attached to first lateral member **190a**”, etc. it should be remembered that in all cases regarding the intended articulation of the various components of the invention, where first and second parts are specified, the first and second parts are identical to and interchangeable with each other. Assembly of the components as described below need not take place in any particular order, thus the order to be described should be regarded as exemplary and not limiting the scope of the invention.

The first lateral member **190a** and first side member **140a** are placed in similar planar positions. The slot **272** of the first lateral member **190a** is aligned so as to engage the first post **158** proximate the first end **142a** of the first side member **140a**. The first lateral member **190a** is slid toward the first post **158** until the closed end of the slot **273** contacts the first post **158**. The peg **274** of the first lateral member **190a** is simultaneously slid into the first arcuate channel **172**. The first lateral member **190a** can now be pivoted toward the inside edge **138a** of the first side member **140a** so that the first leg **250** of the first lateral member **190a** extends away from the inside edge **138a** of the first side member **140a**. The first carriage **200a** is fitted with the first mating gear assembly **300a** and aligned with the upper surface **220** facing the assembler so that the slot **224** faces away from the first lateral member **190a**. The channel **206** is aligned with the free end **196** of the first lateral member **190a** and the first mating gear assembly **300a** rotated until the gear teeth **308** mesh with the teeth **192** on the first lateral member **190a**. The first mating gear assembly **300a** is continued to be rotated until the first carriage **200a** rests at a position on the first leg **250** of the first lateral member **190a** where at least

the free end **196** of the first leg **250** extends from the first carriage **200a**. Next, the second post **168** at the second end **144b** of the second side member **140b** is aligned with the slot **224** of the first carriage **200a**, simultaneously aligning the peg **226** of the first carriage **200a** with the second arcuate channel **174** of the second side member **140b**. The second side member **140b** is slid toward the second post **168** until the closed end of the slot **217** contacts the second post **168**. The second side member **140b** is now pivoted toward the inside edge **138a** of the first side member **140a**. Following this step, the second lateral member **190b** is aligned with the first post **158** proximate the first end **144a** of the second side member **140b**. Next, the second lateral member **190b** is slid toward the first post **158** of the second side member **140b** until the closed end **273** contacts the first post **158**, while simultaneously aligning the peg **274** of the second lateral member **190b** with the second arcuate channel **174** of the second side member **140b**. At this point, the second lateral member **190b** is pivoted toward the inside edge **138b** of the second side member **140b** until it is substantially perpendicular to the second side member **140b**. The second carriage **200b** is aligned with the second end **142b** of the first side member **140a** so that the second post **168** at the second end **142b** of the first side member **140a** is aligned with the slot **224** of the second carriage **200b**, simultaneously aligning the peg **226** of the second carriage **200b** with the second arcuate channel **174** of the first side member **140a**. The second carriage **200b** is fitted with the second mating gear assembly **300a** and aligned with the upper surface **220** facing the assembler so that the slot **224** faces toward the second lateral member **190b**. The channel **206** is aligned with the free end **196** of the second lateral member **190b** and the second mating gear assembly **300b** rotated until the gear teeth **308** mesh with the teeth **192** on the second lateral member **190b**. The second mating gear assembly **300b** is continued to be rotated until the second carriage **200b** rests at a position on the first leg **250** of the second lateral member **190b** where at least the free end **196** of the first leg **250** extends from the second carriage **200b**. At least one flange **400** is attached to each of the first side member **140a** and second side member **140b**. In a preferred embodiment, the placement of the flanges **400** is symmetrical (*i.e.*, equal numbers of flanges **400** are placed at the mirror image aperture **150** on the opposite side member **140a** or **140b**). This completes assembly of the surgical access device **100**.

Use

For purposes of illustration, the following discussion is based on retraction as would be used in performing open-chest heart surgery.

5

Following preoperative procedures, an incision is made into the patient. Several layers of tissue will normally need to be incised to gain access to the anatomical site where the operation is to occur. When all tissue layers are incised, the sterilized, assembled surgical access device **100** is carefully inserted into the incision. It is
10 important that the length **406** of the flange **400** is sufficiently long that the lower end **404** of the flange **400** extends into the body at a point deeper than the tissue to be retracted. To minimize trauma to the patient, the first **300a** and second **300b** mating gear assemblies are rotated by the surgeon or technician causing retraction only to the minimum extent required.

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As shown Fig. 19, the illustrated design permits the first end **142a** of the side member **140a** to be moved away from or toward the second end **144b** of the second side member **140b** along the first lateral member **190a** without requiring any movement of the second end **142b** of the first side member **140a** toward the first end **144a** of the second
20 side member **140b**. Alternatively, the second end **142b** of the first side member **140a** can be moved with respect to the first end **144a** of the second side member **140b** along the second lateral member **190b** without requiring any movement of the previously discussed half of the surgical access device **100**.

25

For example, the surgical access device **100** may be initially deployed with both carriages **200a**, **200b** locked as described above against movement with respect to the associated lateral member **190a**, **190b** and with the side members **140a**, **140b** positioned immediately adjacent another in a parallel manner. The gear handle **314** of the first carriage **200a** can be lifted upwardly from the locked position and rotated to move the
30 first carriage **200a** with respect to the first lateral member **190a**. The first end **142a** of the first side member **140a** will pivot with respect to the second leg **252** of the first lateral member **190a** about the first post **158** of the first side member **140a**. The second end **144b** of the second side member **140b** will pivot with respect to the terminal end **212** of the carriage extension **204** about the second post **168** of the second side member **140b**.

Once the carriage **200a** has been moved the desired distance toward the free end **196** of the first lateral member **190a**, the gear handle **314** may be pushed downwardly toward the substantially parallel planar position to lock the carriage **200a** in place on the first lateral member **190a**. Due to the mirror image nature of the invention, the procedure described
5 above works equally well when applied to the other side of the surgical access device **100** (*i.e.*, second end **142b** of first side member **140a** toward first end **144a** of second side member **140b**). Differential retraction at each end of the surgical access device **100** is thus possible, resulting in a wide variety of retraction possibilities. Following completion of the surgical procedure, the gear handles **314** are unlocked, and the surgical access
10 device **100** re-retracted to the insertion configuration, and removed from the patient.

What is claimed is:

1. A surgical device for accessing a body cavity, comprising:
 - (a) first and second longitudinally extending opposed side members, each of
5 the side members having a first end and a second end;
 - (b) a first lateral member adjustably connecting the first end of the first side
member to the second end of the second side member, at least one of the
side member ends being moveable along a length of the first lateral
member, thereby permitting adjustment of the lateral distance between the
10 first end of the first side member and second end of the second side
member;
 - (c) a second lateral member adjustably connecting the second end of the first
side member to the first end of the second side member, at least one of the
side member ends being moveable along a length of the second lateral
15 member, thereby permitting adjustment of the lateral distance between the
second end of the first side member and first end of the second side
member; and
 - (d) at least one transversely extending repositionable flange releasably
attached to each side member.
20
2. The surgical access device of claim 1 wherein the first and second side members
are pivotably articulated to the first and second lateral members by a bayonet
hinge mechanism.
- 25 3. The surgical access device of claim 2 wherein pivotable articulation between the
first and second side members and the first and second lateral members occurs in
substantially a single plane.
4. The surgical access device of claim 1 wherein a first carriage attaches the first
30 lateral member to the second end of the second side member and a second carriage
attaches the second lateral member to the second end of the first side member.

5. A surgical device for accessing a body cavity, comprising:
- (a) first and second opposed side members, each of the side members having a first end and a second end;
 - (b) a first lateral member adjustably connecting the first end of the first side member to the second end of the second side member, at least one of the side member ends being moveable along a length of the first lateral member, thereby permitting adjustment of the space between the first end of the first side member and the second end of the second side member;
 - (c) a second lateral member adjustably connecting the second end of the first side member to the first end of the second side member, at least one of the side member ends being moveable along a length of the second lateral member, thereby permitting adjustment of the space between the second end of the first side member and the first end of the second side member; and
 - (d) wherein the first and second side members are pivotably attached to the first and second lateral members by a bayonet hinge mechanism.
6. The surgical access device of claim 5 wherein pivotable articulation between the first and second side members and first and second lateral members occurs in substantially a single plane.
7. The surgical access device of claim 5 further including at least one transversely extending repositionable flange releasably attached to each side member.
8. The surgical access device of claim 5 wherein a first carriage attaches the first lateral member to the second end of the second side member and a second carriage attaches the second lateral member to the second end of the first side member.
9. The surgical device of claim 2 or 5 wherein the bayonet hinge mechanisms permit operable attachment of each end of the side members to only one end of the lateral members.

10. A surgical device for accessing a body cavity, comprising:
- (a) first and second opposed mirror image side members, each side member having a first end, a second end, an inside edge and an outside edge, comprising;
- 5 (i) an upper plate having a length, a width, a first end, a second end, and upper and lower surfaces,
- (ii) a lower plate having a length, a width, an inner edge, an outer edge, an upper surface, a lower surface, the lower plate a plurality of apertures disposed along the length of the lower plate proximate the inner edge adapted to releasably receive and hold tissue engaging flanges,
- 10 (iii) a first post attaching the lower surface of the upper plate and the upper surface of the lower plate in spaced relationship proximate the first ends of the upper and lower plates,
- 15 (iv) a second post attaching the lower surface of the upper plate and the upper surface of the lower plate in spaced relationship proximate the second ends of the upper and lower plates,
- (v) a first arcuate channel in each side member, concentric with the first post, portside to a point greater than a quarter turn around the post; and
- 20 (vi) a second arcuate channel in each side member, concentric with the second post, portside to a point greater than a quarter turn around the post;
- (b) a first lateral member adjustably connecting the first end of the first side member to the second end of the second side member, at least one of the ends being moveable along a length of the first lateral member, thereby permitting adjustment of the space between the first end of the first side member and the second end of the second side member, the first lateral member comprising;
- 25 (i) a bar having a first leg with a length and a terminal end and a second leg with a length having a terminal end, the first and second legs being disposed to each other at an angle,
- (ii) a plurality of regularly spaced gear teeth disposed along the length of the first leg,
- 30

- 5
- (iii) an off-center linear trough or projection disposed on an upper or lower surface of the first leg extending along at least a portion of the length of the first leg,
- (iv) a hook defining a slot disposed proximate the terminal end of the second leg, and
- (v) a peg protruding from an upper or lower surface of the second leg proximate the slot;
- 10
- (c) a second lateral member adjustably connecting the second end of the first side member to the first end of the second side member, at least one of the ends being moveable along a length of the first lateral member, thereby permitting adjustment of the space between the second end of the first side member and the first end of the second side member, the second lateral member comprising;
- 15
- (i) a bar having a first leg with a length and a terminal end and a second leg with a length having a terminal end, the first and second legs being disposed to each other at an angle,
- (ii) a plurality of regularly spaced gear teeth disposed along the length of the first leg,
- 20
- (iii) an off-center linear trough or projection disposed on an upper or lower surface of the first leg extending along at least a portion of the length of the first leg,
- (iv) a hook defining a slot disposed proximate the terminal end of the second leg, and
- 25
- (v) a peg protruding from an upper or lower surface of the second leg proximate the slot;
- (d) a first carriage, comprising;
- 30
- (i) a carriage body having a length, a channel extending through the length of the body, configured and arranged to accept the first leg of the first lateral member therethrough, and a bearing with an off-center trough or projection within the channel mated to the trough or projection of the first leg of the first lateral member, whereby only a single spatial orientation of the first lateral member relative to the first carriage allows passage of the first leg of the first lateral member through the channel in the first carriage, and

- (ii) a perpendicular extension terminating in a hook, defining a slot disposed proximate a terminal end of the extension;
 - (e) a second carriage, comprising;
 - (i) a carriage body having a length, a channel extending through the length of the body, configured and arranged to accept the first leg of the second lateral member therethrough, and a bearing with an off-center trough or projection within the channel mated to the trough or projection of the first leg of the second lateral member, whereby only a single spatial orientation of the second lateral member relative to the second carriage allows passage of the first leg of the second lateral member through the channel in the second carriage, and
 - (ii) a perpendicular extension terminating in a hook, defining a slot disposed proximate a terminal end of the extension;
 - (f) a first mating gear disposed in the bearing in the first carriage for mating with the teeth disposed on the first leg of the first lateral member whereby the lateral position of the first lateral member with regard to the side member can be varied when the gear is rotated; and
 - (g) a second mating gear disposed in the bearing of the second carriage for mating with the teeth disposed on the first leg of the second lateral member whereby the lateral position of the second lateral member with regard to the side member can be varied when the gear is rotated.
- 11. The surgical access device of claim 10 wherein the lower plate of the first and second members further comprises a plurality of apertures, the apertures defining recessed portions extending from the lower plate so as to provide a shelf extending in the inside direction, coplanar and continuous with the lower surface of the lower plate and terminating so as to provide an opening through the lower plate.
- 12. The surgical access device of claim 10 wherein the tissue engaging flange comprises an extended finger defining proximal and distal ends, a longitudinal dimension, a thickness and a width, the distal end having portions angled toward the outside edge, the proximal end defining a portion angled to the outside edge of

the lower plate when inserted in the lower plate and having a lesser thickness and a narrower width than the width of the aperture so as to be insertable through the selected aperture from the outer surface of the lower plate, wherein upon insertion the proximal end rests against the shelf such that when retraction force is applied to the inserted flange, the flange is firmly secured to the side member by being levered against the shelf.

13. A kit assemblable to form a surgical access device for accessing a body cavity, comprising:

- (a) a first longitudinally extending side member having a first end and a second end;
- (b) a second longitudinally extending side member having a first end and a second end;
- (c) a first lateral member;
- (d) a second lateral member;
- (e) at least one transversely extending repositionable flange releasably attachable to each side member;
- (f) wherein the first lateral member is configured and adapted to pivotably attach to the first end of the first side member and the second end of the second side member, with at least one of the first end or the second end being movable along a length of the first lateral member, thereby permitting adjustment of the lateral distance between the first end of the first side member and the second end of the second side member; and
- (g) wherein the second lateral member is configured and adapted to pivotably attach to the second end of the first side member and the first end of the second side member, with at least one of the first end or the second end being movable along a length of the second lateral member, thereby permitting adjustment of the lateral distance between the second end of the first side member and the first end of second side member.

14. The kit of claim 13 wherein the first and second side members can be pivotably articulated to the first and second lateral members by a bayonet hinge mechanism when assembled.

15. The kit of claim 14 wherein pivotable articulation between the first and second side members and the first and second lateral members can occur in substantially a single plane when assembled.
- 5 16. The kit of claim 13 wherein a first carriage can attach the first lateral member to the second end of the second side member and a second carriage can attach the second lateral member to the second end of the first side member.
- 10 17. A kit assemblable to form a surgical access device for accessing a body cavity, comprising:
- (a) a first side member having a first end and a second end;
 - (b) a second side member having a first end and a second end;
 - (c) a first lateral member;
 - (d) a second lateral member;
 - 15 (e) at least one transversely extending repositionable flange releasably attachable to each side member;
 - (f) wherein the first lateral member is configured and adapted when assembled to pivotably attach to the first end of the first side member and the second end of the second side member, with at least one of the first end or the second end being movable along a length of the first lateral member, thereby permitting adjustment of the lateral distance between the first end of the first side member and the second end of the second side member;
 - 20 (f) wherein the second lateral member is configured and adapted when assembled to pivotably attach to the second end of the first side member and the first end of the second side member, with at least one of the first end or the second end being movable along a length of the second lateral member, thereby permitting adjustment of the lateral distance between the second end of the first side member and the first end of second side member; and
 - 25 (g) wherein the first and second side members are pivotably attachable to the first and second lateral members by a bayonet hinge mechanism when assembled.
 - 30

18. The kit of claim 17 wherein pivotable articulation between the first and second side members and the first and second lateral members can occur in substantially a single plane when assembled.
- 5 19. The kit of claim 17 wherein a first carriage can attach the first lateral member to the second end of the second side member and a second carriage can attach the second lateral member to the second end of the first side member when assembled.

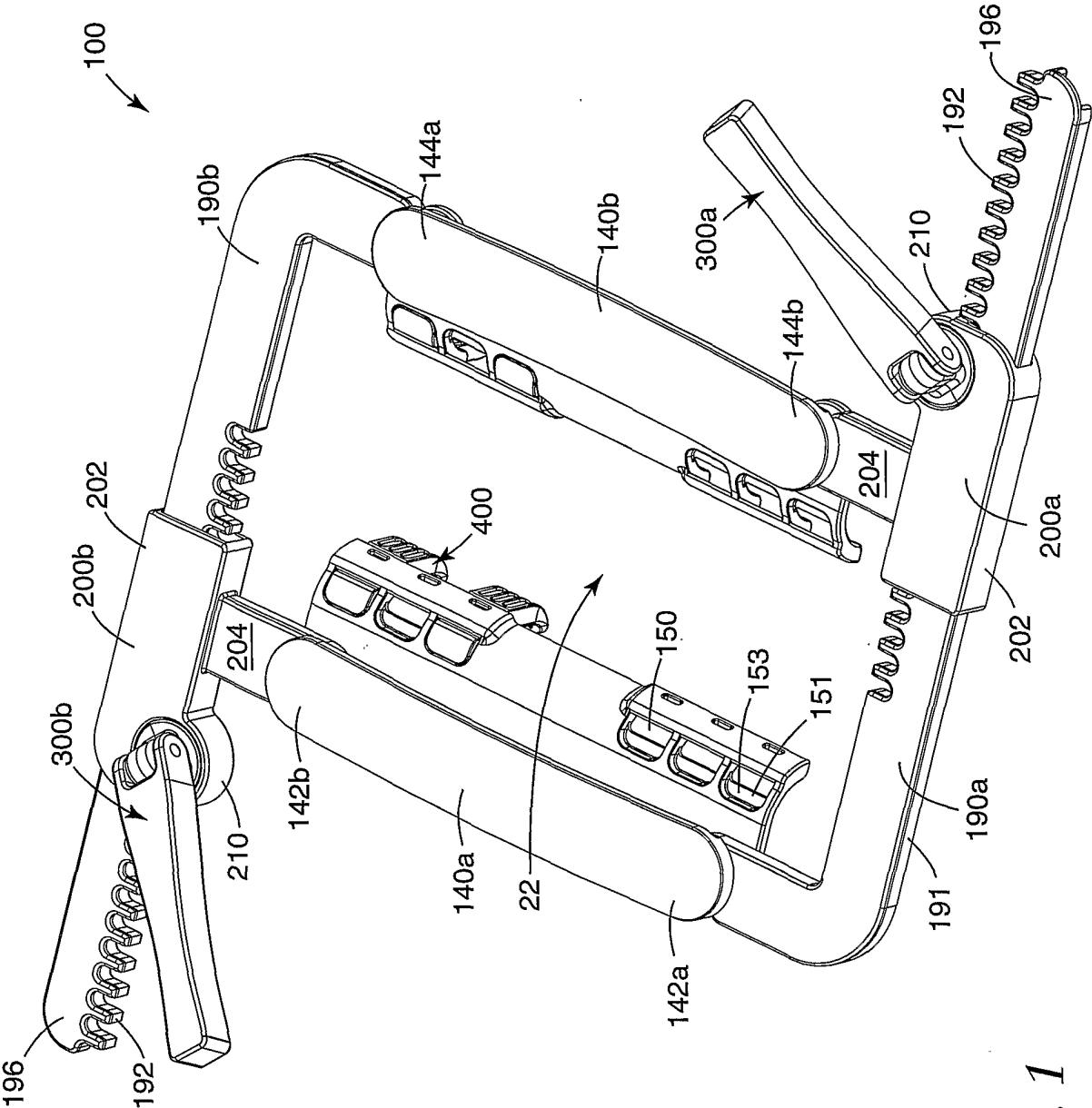


Fig. 1

Fig. 2

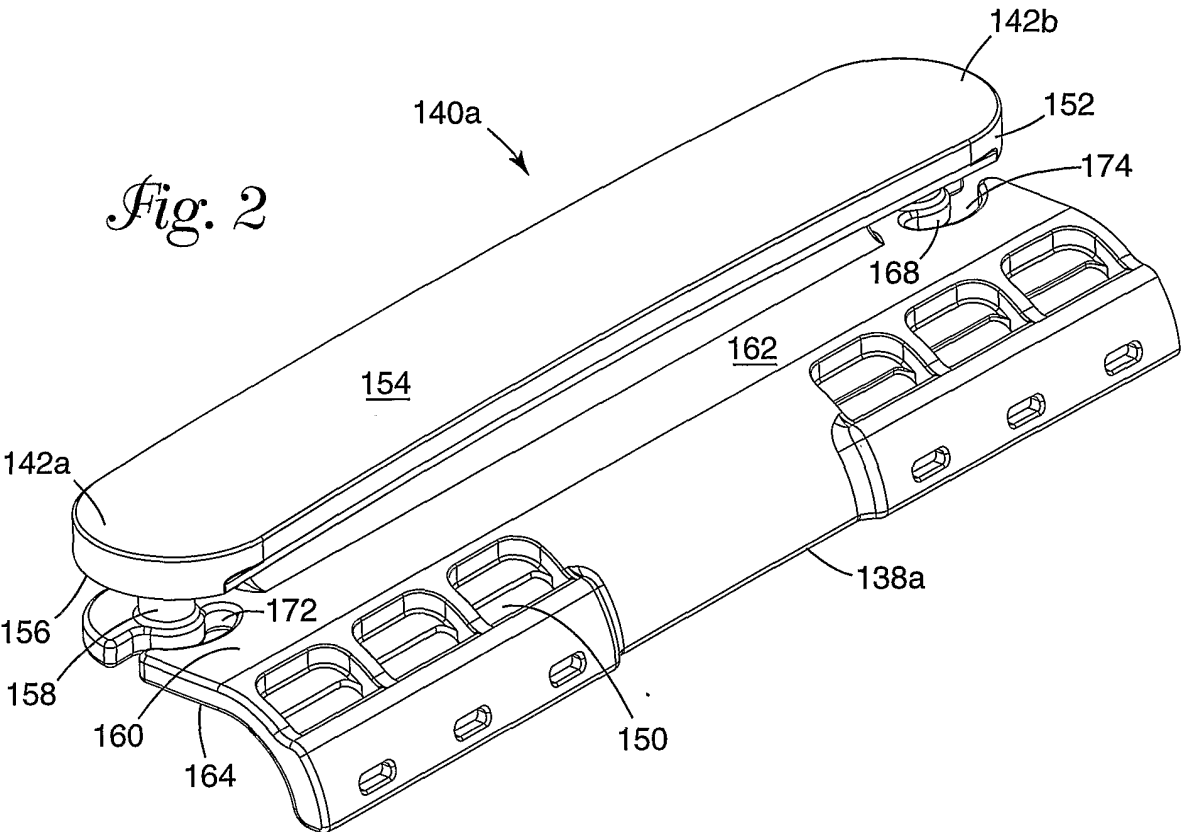
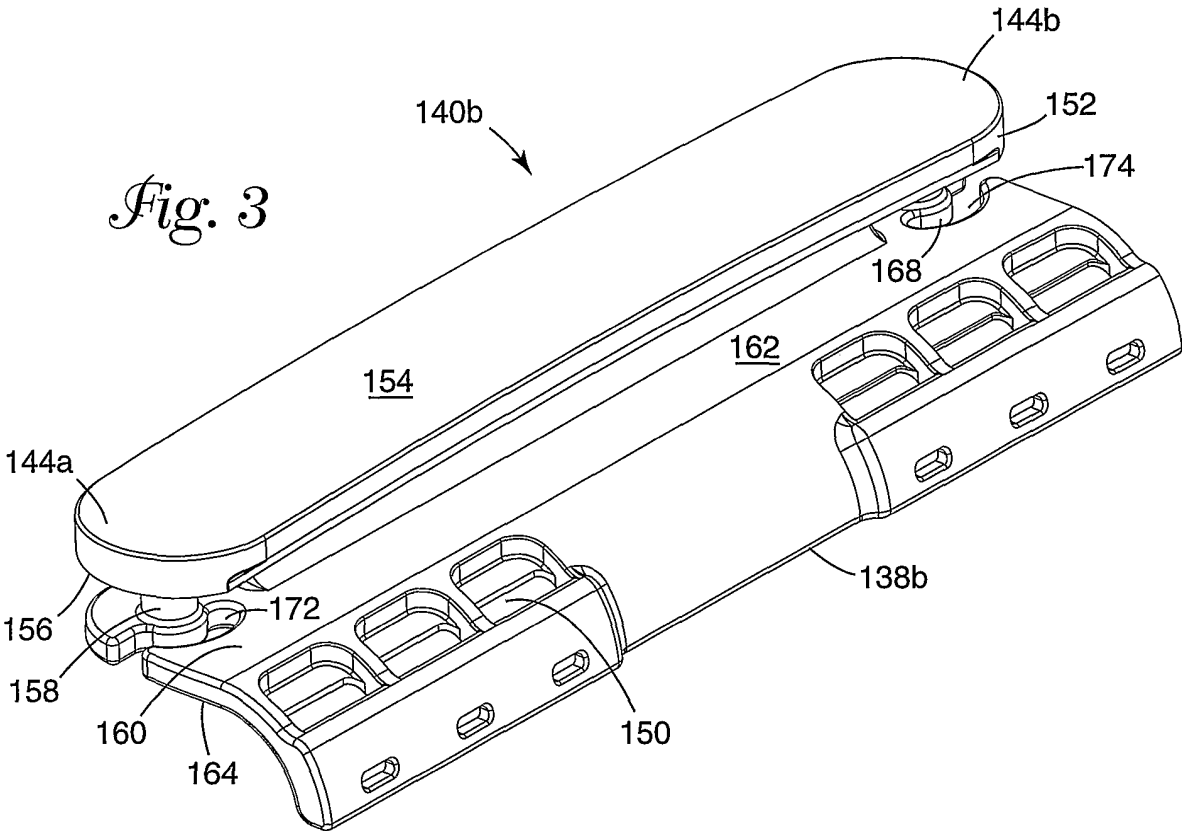


Fig. 3



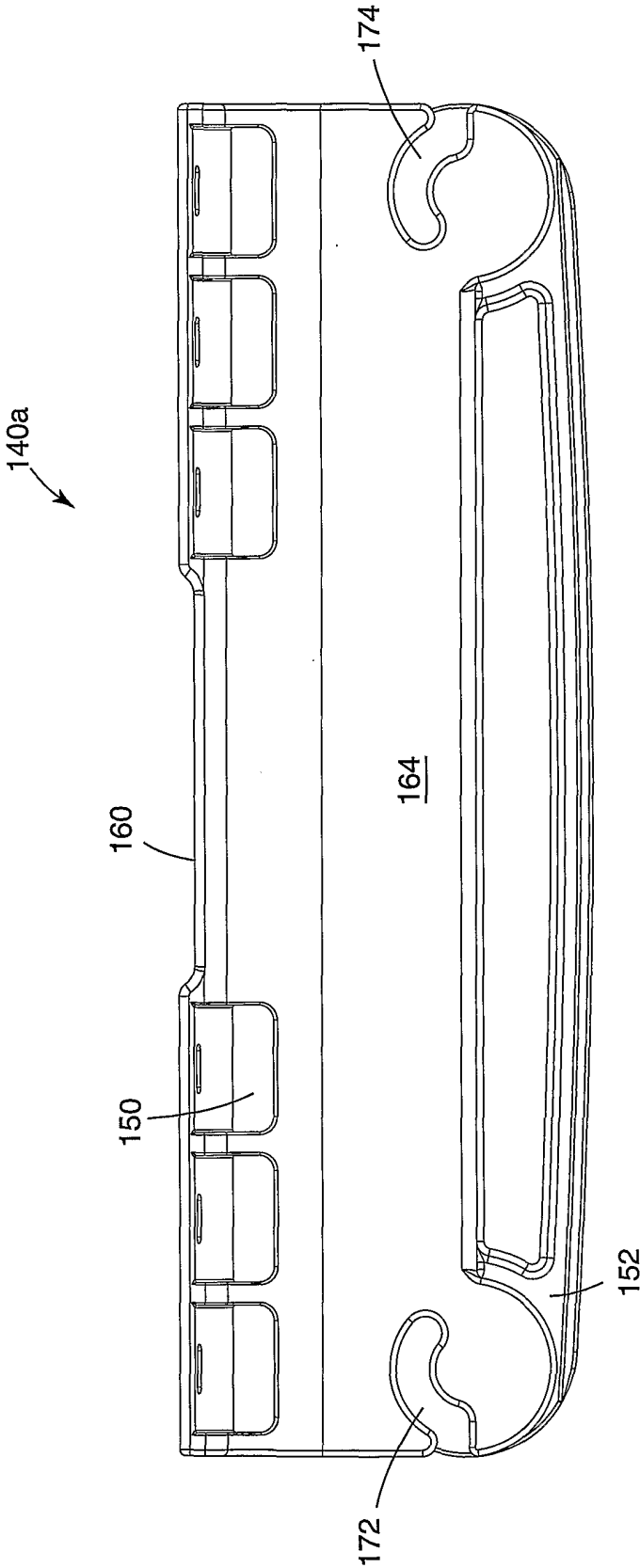


Fig. 4

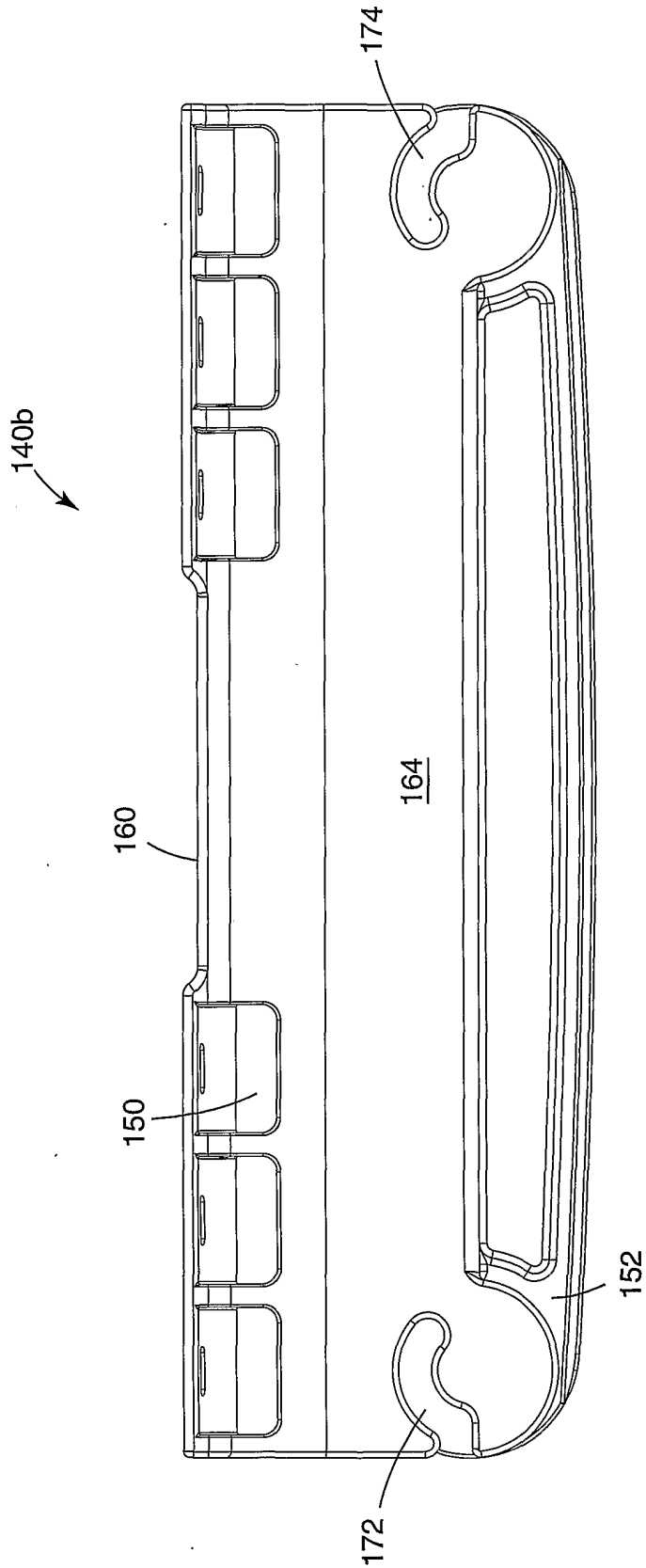
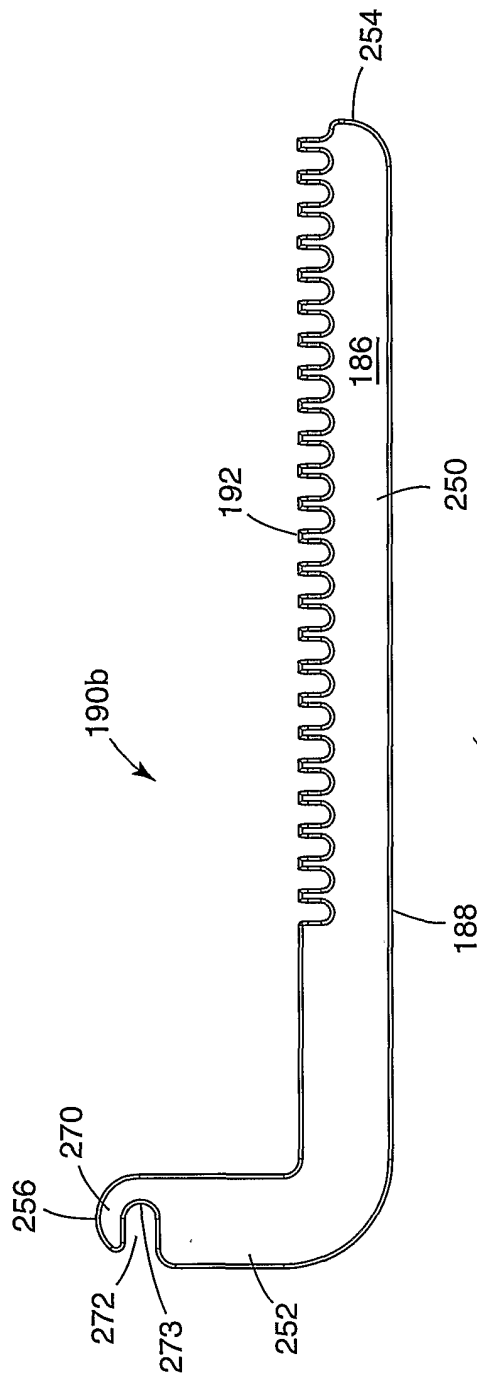
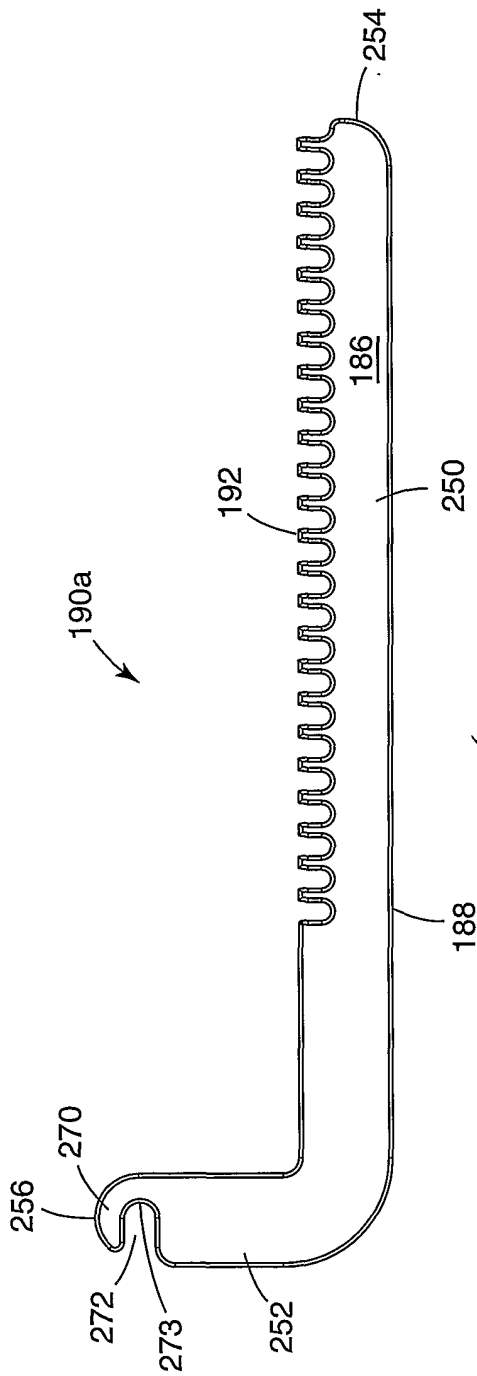
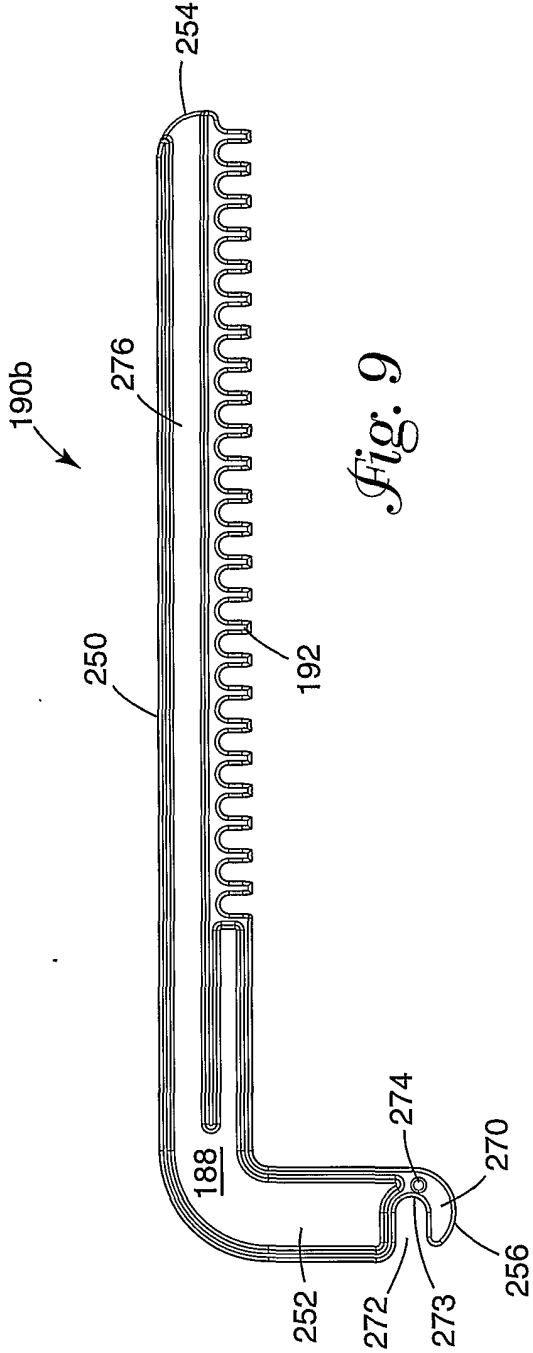
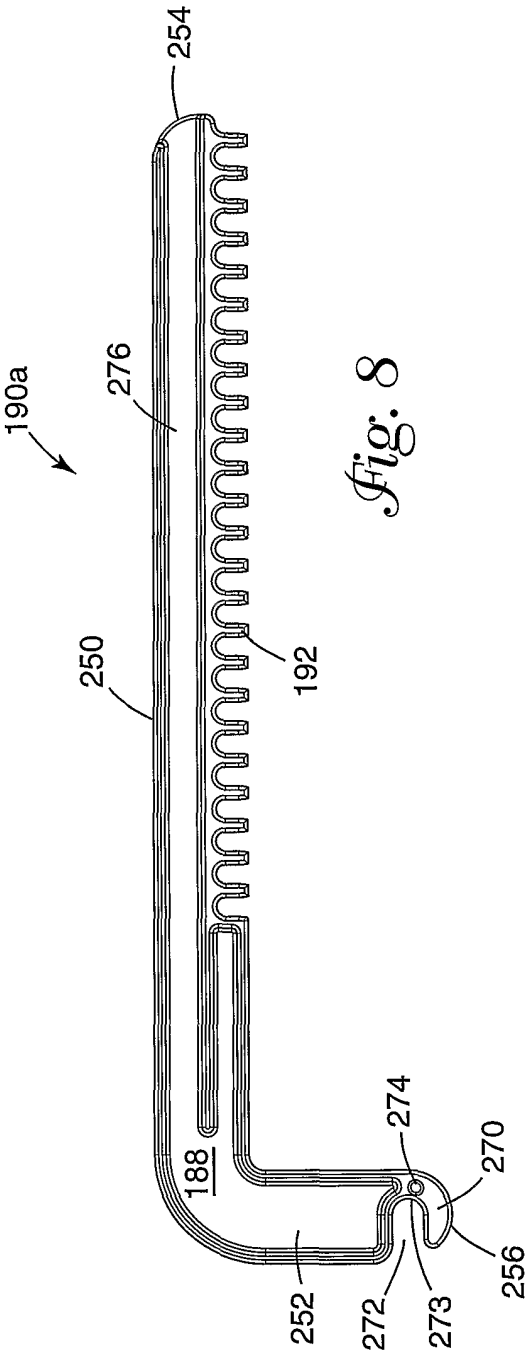
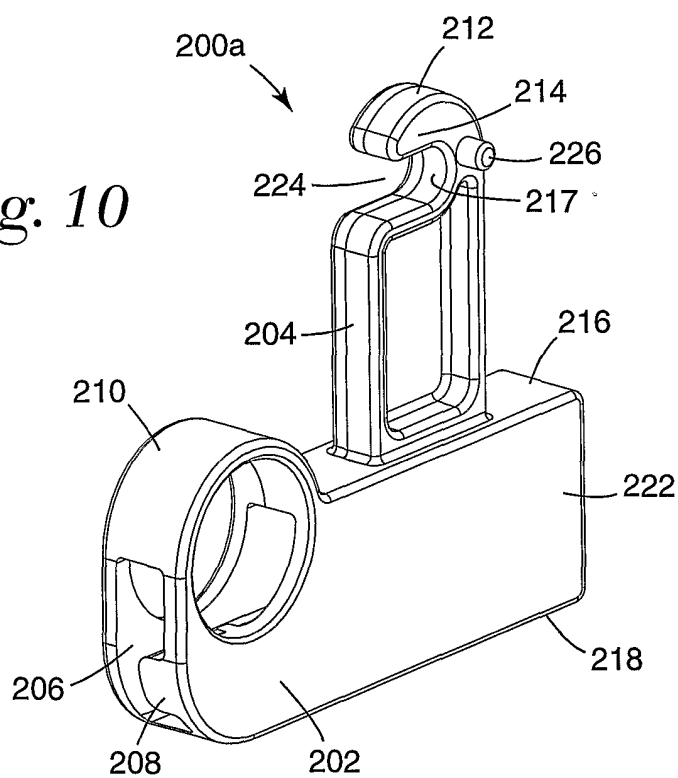
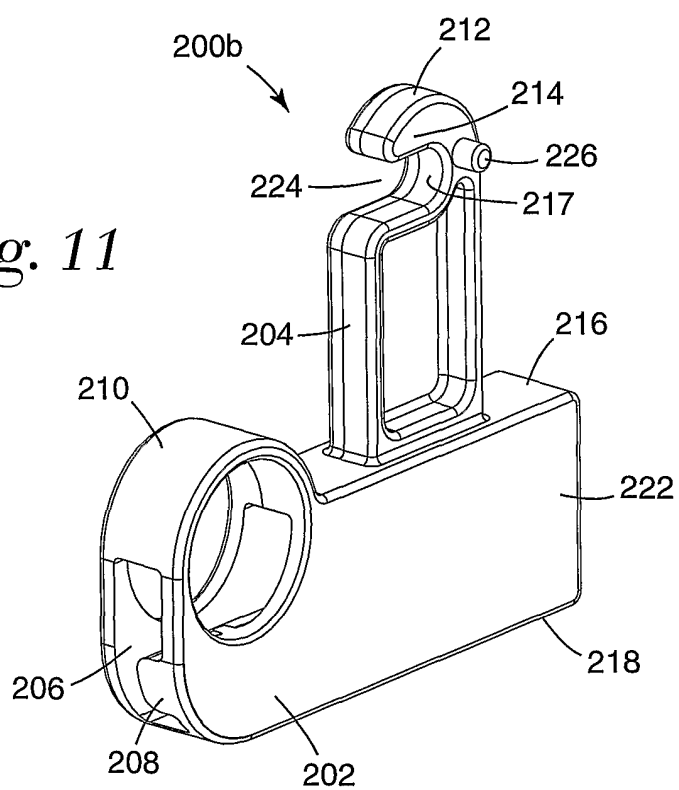


Fig. 5





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Fig. 10*Fig. 11*

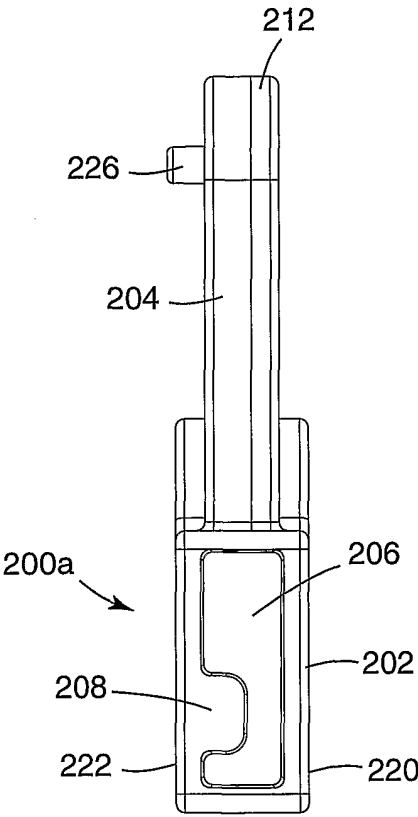


Fig. 12

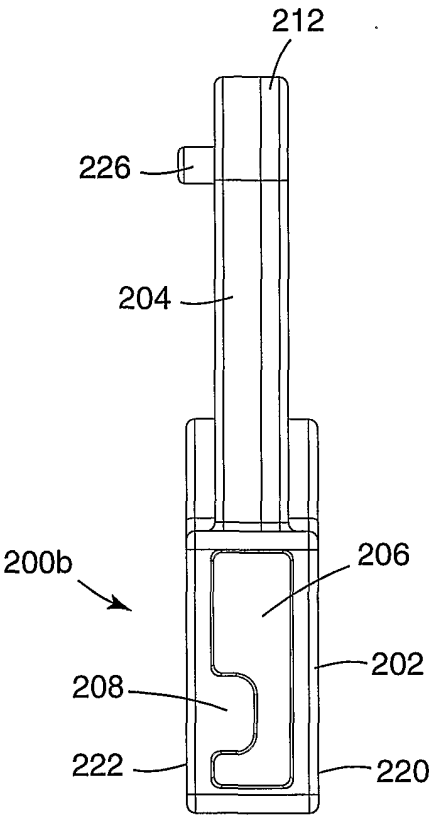


Fig. 13

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Fig. 14

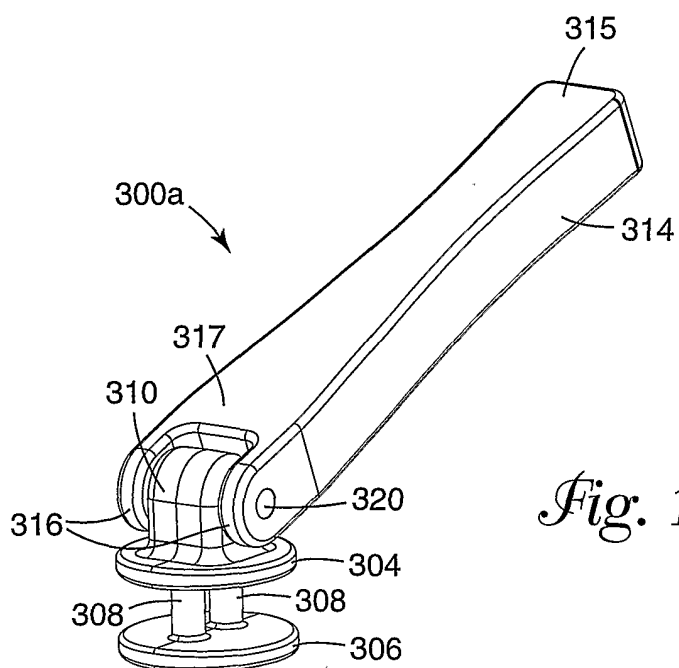
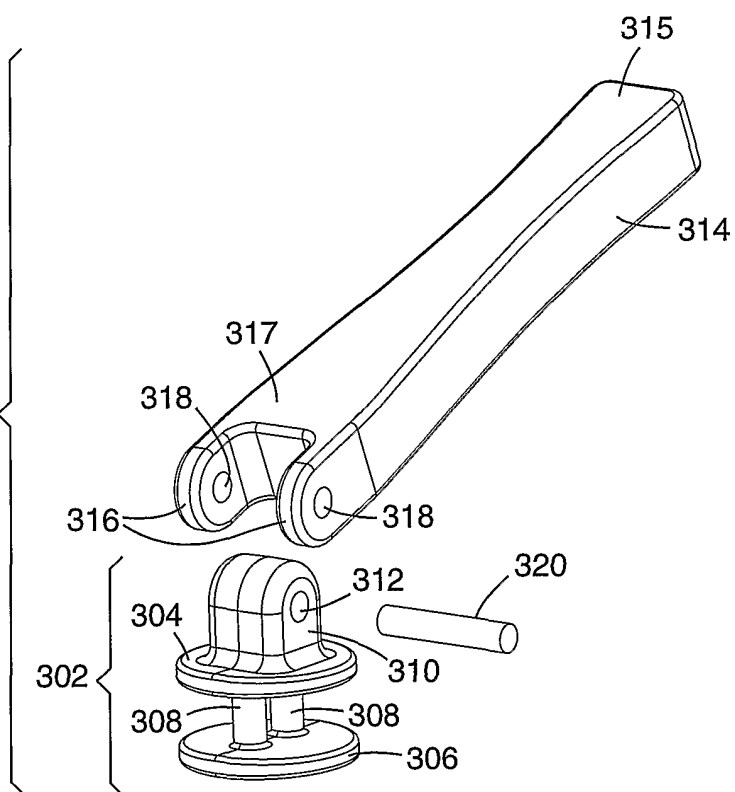
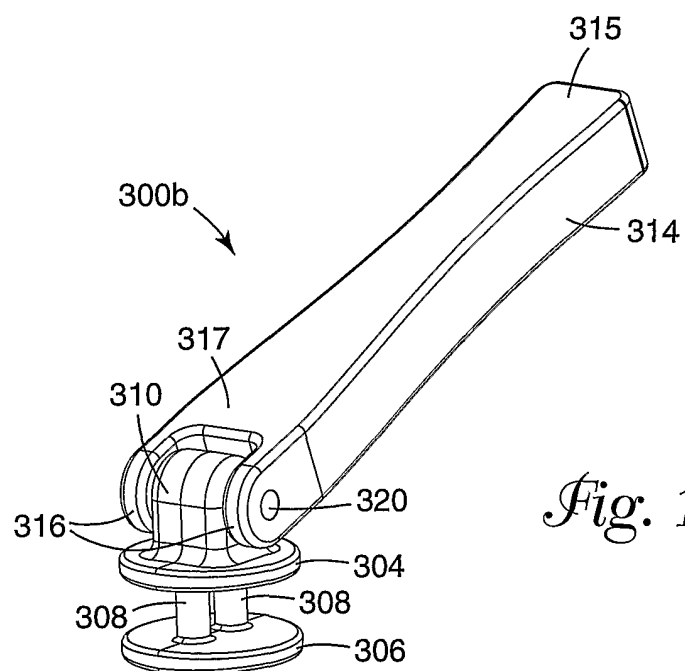
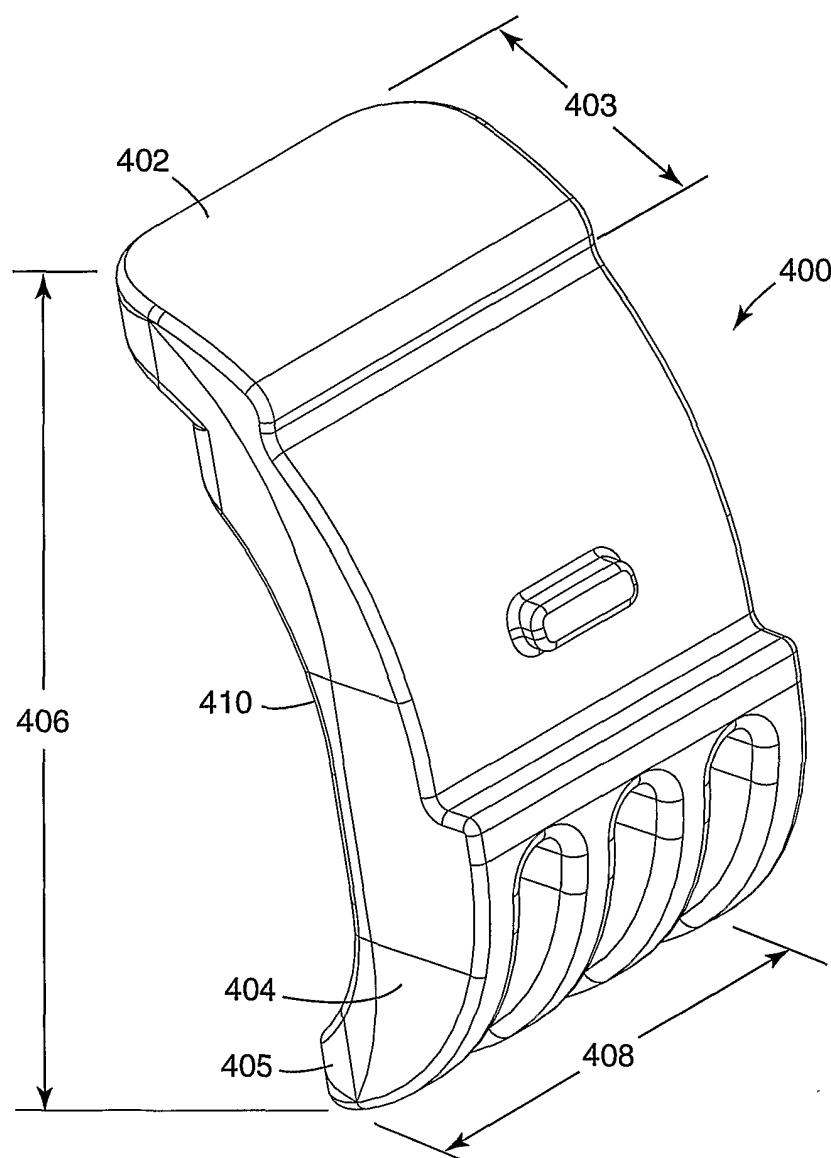


Fig. 15



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*Fig. 17*

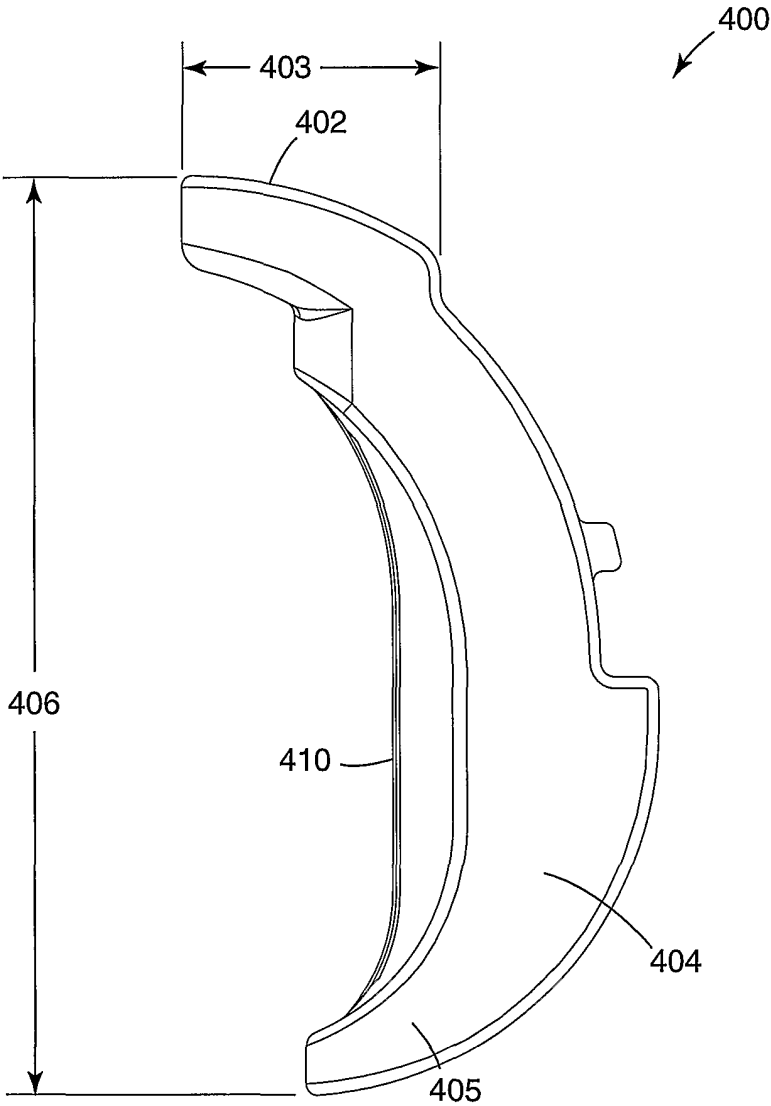


Fig. 18

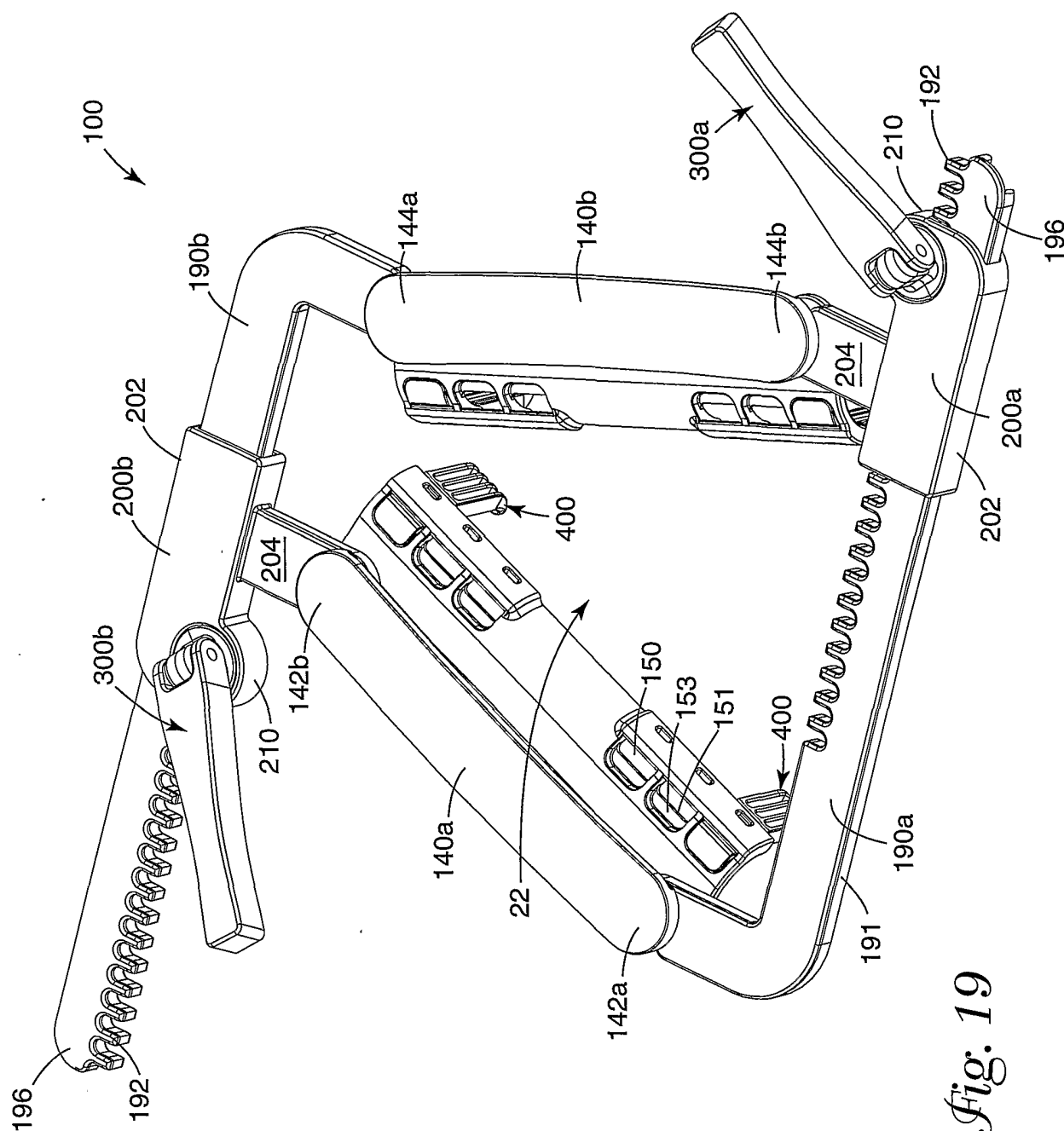


Fig. 19

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/10898

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61B 1/32

US CL : 600/233

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)

U.S. : 600/227, 231-233

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 1,707,689 A (SLOAN) 02 April 1929, entire document.	1-9, 13-19
X	US 3,038,468 A (RAEUCHLE) 12 June 1962, entire document.	1-9, 13-19
X	US 1,963,173 A (MORIN) 19 June 1934, entire document.	1, 4



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:		"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

05 SEPTEMBER 2000

Date of mailing of the international search report

03 OCT 2000

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