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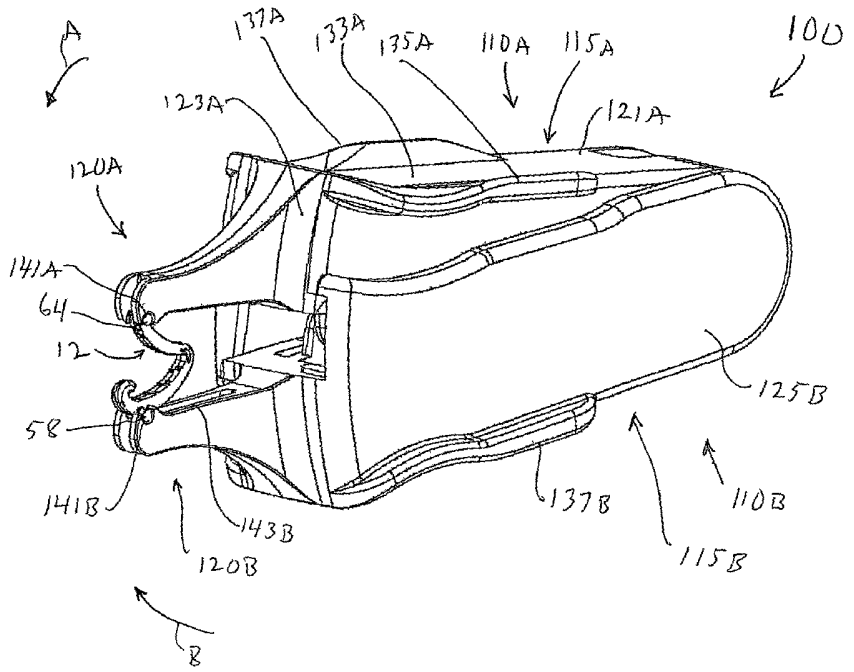
(54) Title: FINGERTIP-ACTUATED SURGICAL CLIP APPLIER AND RELATED METHODS



(57) Abstract: A fingertip-actuated surgical clip applier comprises a first body (137a) and a second body (137b) substantially structurally identical to the first body. The first body comprises a main section (115a) and a first jaw (141a) extending in a distal direction from the main section. The main section comprises a hinge zone (129a).

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Description

FINGERTIP-ACTUATED SURGICAL CLIP APPLIER AND RELATED METHODS

Technical Field

The present invention generally relates to surgical clip applying instruments and their use in manipulating clips in surgical procedures such as vessel ligation. More particularly, the present invention relates to a fingertip-actuated clip applier capable of compressing asymmetric clips by using a pair of fingertips such as the tips of the index finger and thumb.

Background Art

Many surgical procedures require vessels or other tissues of the human body to be ligated during the surgical process. For example, many surgical procedures require cutting blood vessels (e.g., veins or arteries), and these blood vessels may require ligation to reduce bleeding. In some instances, a surgeon may wish to ligate the vessel temporarily to reduce blood flow to the surgical site during the surgical procedure. In other instances a surgeon may wish to permanently ligate a vessel. Ligation of vessels or other tissues can be performed by closing the vessel with a ligating clip, or by suturing the vessel with surgical thread. The use of surgical thread for ligation requires complex manipulations of the needle and suture material to form the knots required to secure the vessel. Such complex manipulations are time-consuming and difficult to perform, particularly in endoscopic surgical procedures that afford limited space and visibility. By contrast, ligating clips are relatively easy and quick to apply. Accordingly, the use of ligating clips in both endoscopic and open surgical procedures has grown dramatically.

Various types of hemostatic and aneurysm clips are used in surgery for ligating blood vessels or other tissues to stop the flow of blood. Such clips have also been used for interrupting or occluding ducts and vessels in particular surgeries such as sterilization procedures. Typically, a clip is applied to the vessel or other tissue by using a dedicated mechanical instrument commonly referred to as a surgical clip applier, ligating clip applier, or hemostatic clip applier. A clip applier designed for use with asymmetric plastic

clips in an open (i.e., non-endoscopic) surgical procedure is disclosed in U.S. Patent No. 5,100,416 to Oh et al., assigned to the assignee of the present invention. The clip applier is used to position the clip over the desired vessel and its jaws are actuated, typically using an actuating mechanism disposed in the handle of the device, to close the clip about the vessel. The clip is typically left in place after application to the tissue until hemostasis or occlusion occurs. At some point thereafter, the clip is removed by using a separate instrument dedicated for that purpose, i.e., a clip removal instrument. A clip remover designed for use with asymmetric plastic clips in open surgery is disclosed in U.S. Patent No. 6,391,035 to Appleby et al., assigned to the assignee of the present invention.

Ligating clips can be classified according to their geometric configuration (e.g., symmetric clips or asymmetric clips), and according to the material from which they are manufactured (e.g., metal clips or polymeric clips). Symmetric clips are generally "U" or "V" shaped and thus are substantially symmetrical about a central, longitudinal axis extending between the legs of the clip. Symmetric clips are usually constructed from metals such as stainless steel, titanium, tantalum, or alloys thereof. By means of a dedicated clip applier, the metal clip is permanently deformed over the vessel. An example of one such clip is disclosed in U.S. Patent No. 5,509,920 to Phillips et al. An example of a metallic clip applier is disclosed in U.S. Patent No. 3,326,216 to Wood, in which a forceps-type applier having conformal jaws is used to grip and maintain alignment of the clip during deformation. Such appliers may additionally dispense a plurality of clips for sequential application, as disclosed in U.S. Patent No. 4,509,518 to McGarry et al.

With the advent of high technology diagnostic techniques using computer tomography (CATSCAN) and magnetic resonance imaging (MRI), metallic clips have been found to interfere with the imaging techniques. To overcome such interference limitations, biocompatible polymers have been increasingly used for surgical clips. Unlike metallic clips, which are usually symmetric, polymeric clips are usually asymmetric in design and hence lack an

axis of symmetry. Inasmuch as the plastic clip cannot be permanently deformed for secure closure around a vessel or other tissue, latching mechanisms have been incorporated into the clip design to establish closure conditions and to secure against re-opening of the vessel. For example, polymeric clips are disclosed in U.S. Patent Nos. 4,834,096 to Oh et al. and 5,062,846 to Oh et al., both of which are assigned to the assignee of the present invention. These plastic clips generally comprise a pair of curved legs joined at their proximal ends with an integral hinge or heel. The distal ends of the curved legs include interlocking latching members. The distal end of one leg terminates in a lip or hook structure into which the distal end of the other leg securely fits to lock the clip in place. The distal ends of the clips taught by Oh et al. also include lateral bosses that are engaged by the jaws of the clip applier.

A clip applier specifically designed for asymmetric plastic clips, such as the aforementioned U.S. Patent No. 5,100,416 to Oh et al., is used to close the clip around the tissue to be ligated, and to latch or lock the clip in the closed condition. In operation, the jaws of this clip applier are actuated into compressing contact with the legs of the clip. This causes the legs to pivot inwardly about the hinge, thereby deflecting the hook of the one leg to allow reception therein of the distal end of the other leg.

In addition to compatibility with sophisticated diagnostic techniques, asymmetric clips have other advantages over symmetric clips. For example, because asymmetric clips are formed from polymeric materials, the mouths of asymmetric clips can be opened wider than the mouths of symmetric clips. This allows a surgeon to position the clip about the desired vessel with greater accuracy. In addition, a clip of the type described in U.S. Patent Nos. 4,834,096 and 5,062,846 can be repositioned before locking the clip on the vessel or before removing the clip from the vessel, in a process referred to as "approximating" the clip.

As indicated above, U.S. Patent No. 5,100,416 to Oh et al. discloses a clip applier designed for use with asymmetric plastic clips in an open (i.e., non-

endoscopic) surgical procedure. Other types of clip appliers have been developed for applying metallic clips. Clip appliers can also be classified according to whether they are designed for either open or endoscopic surgical procedures. Clip appliers designed for use with metallic clips in open surgery are disclosed in U.S. Patent Nos. 3,270,745 to Wood; 3,326,216 to Wood; 3,439,522 to Wood; 3,439,523 to Wood; 4,146,130 to Samuels et al.; 4,646,740 to Peters et al. (assigned to the assignee of the present invention); 4,509,518 to McGarry et al.; 5,047,038 to Peters et al. (assigned to the assignee of the present invention); and 5,104,395 to Thornton et al. (assigned to the assignee of the present invention). Clip appliers designed for use with metallic clips in endoscopic surgery are disclosed in U.S. Patent Nos. 5,403,327 to Thornton et al.; 5,112,343 to Thornton; 5,527,320 to Carruthers et al.; and 5,634,930 to Thornton et al., all of which are assigned to the assignee of the present invention.

As a general matter, endoscopic, and other minimally invasive surgical techniques enable surgeons to perform complex procedures through relatively small entry points, or surgical ports, in the body. Endoscopic surgery involves the use of an endoscope, which is an instrument permitting the visual inspection and magnification of a body cavity. The endoscope is inserted into a body cavity through a cannula extending through a hole or port in the soft tissue protecting the body cavity. The port is typically made with a trocar, which includes a cutting instrument slidably and removably disposed within a trocar cannula. After forming the port, the cutting instrument can be withdrawn from the trocar cannula. A surgeon can then perform diagnostic and/or therapeutic procedures at the surgical site with the aid of specialized medical instruments adapted to fit through the trocar cannula and additional trocar cannulas providing openings into the desired body cavity. Minimally invasive surgical techniques are often desirable due to reduced trauma to the patient, reduced likelihood of infection at the surgical site, and lower overall medical costs.

Laparoscopic techniques are another type of minimally invasive procedure. The term "laparoscopic" refers to surgical procedures performed on

the interior of the abdomen. One common laparoscopic procedure is hand-assisted laparoscopic surgery or HALS. In a typical HALS procedure, the surgeon uses a scalpel to make an abdominal incision. This incision is large enough to allow sufficient access of the surgeon's hand and forearm to the desired operative area in the abdomen. An inflatable device that includes two resilient rings attached to a translucent, polymeric cuff or sleeve is then inserted through the incision. The device is manipulated so as to form a port circumscribed by the incision, with one of the rings contacting the outer surface of the abdominal wall and the other ring contacting the inner surface of the abdominal wall. The surgeon then inserts one hand and forearm through the incisional area shaped by the port and into the peritoneal cavity of the abdomen, with the translucent sleeve surrounding the hand and forearm. The surgeon then uses his other hand to operate a manual inflation pump that is fluidly connecting to the sleeve through surgical-grade tubing. The device is consequently inflated so as to effect a seal between the surgeon's inserted forearm and the abdominal incision. The abdomen is then insufflated with a gas while the surgeon's hand remains in the peritoneal cavity, allowing the surgeon to move this hand around while using his other hand to manipulate one or more endoscopic devices, such as a clip applier, through a separately located trocar cannula.

Clip appliers can be further classified according to whether they are manual or automatic. The term "automatic" denotes the kind of clip appliers that retain a plurality of hemostatic clips adjacent to the jaws of a clip applier in a way such that a new clip is automatically fed to the jaws after the previous clip has been crimped or latched into place. Automatic clip appliers are disclosed in the aforementioned U.S. Patent Nos. 4,509,518; 4,646,740; 5,047,038; 5,104,395; 5,112,343; 5,403,327; 5,527,320; and 5,634,930.

By contrast, the term "manual" denotes the kind of clip appliers that receive one clip at a time between the jaws, and which have to be reloaded manually after the previous clip has been crimped or latched. These manual instruments usually have a forceps-type design. The reloading operation is

generally accomplished by inserting the jaws of the applier into a clip holder or cartridge and engaging or grasping a clip contained therein. Many types of clip cartridges currently available contain a plurality of longitudinally-spaced clip-retaining chambers. A single clip is retained in each chamber by a variety of means, and is removed from its chamber by a forceps-type clip applier that is inserted into the selected clip chamber and secured to the clip sufficiently to overcome whatever clip retention means is utilized, thereby enabling the clip to be removed from the clip chamber. Manual clip appliers are disclosed in the aforementioned U.S. Patent Nos. 3,270,745; 3,326,216; 3,439,522; 3,439,523; 4,146,130; and 5,100,416.

Conventional clip appliers of all types discussed above include a pair of jaws, and a handle or grip assembly designed for manipulation by the hand and fingers of the user to actuate the jaws. In addition, an elongate (e.g., 11 inches) intermediate section separates the jaws and the handle assembly. This intermediate section is usually a shaft section in the case of automatic and/or endoscopic clip appliers, or a pair of pivoting arms in the case of most manual clip appliers. In the case of a shaft section, some type of linkage is provided in the shaft section and/or the handles through which the force imparted by the surgeon's hand to move the handles (e.g., squeezing) is transferred into pivoting of the jaws and thus compression of the clip.

It is thus evident that for conventionally designed clip appliers, the surgeon's hand is remotely located with respect to the jaws and the clip loaded into the jaws, due to the intervening shaft assembly. Moreover, the shaft assembly or pair of forceps-style arms are designed to provide mechanical assistance and leverage when using the handles to actuate the jaws. While such conventional features in most cases serve the intended purposes of the clip applier well, it is acknowledged that the degree of "feel" of the clip in the jaws afforded to the surgeon is not optimal. It is further acknowledged that the lengthy configuration of conventional clip appliers is not always needed, especially in HALS procedures and non-endoscopic procedures where large-area access is already provided to the surgical site. In addition, the mechanical

assistance provided by the conventional configuration is not always needed. This is especially true with respect to polymeric clips, which do not require much force to compress in comparison to metallic clips.

Therefore, many types of surgical procedures could be facilitated by providing a clip applier having a much smaller configuration than has heretofore been available. Applicant has discovered an improved fingertip clip applier that meets the long-felt need for such a device.

Disclosure of the Invention

In general terms, the present invention provides a clip applying instrument that is advantageously employed to manipulate surgical clips such as ligating clips, and especially polymeric, latchable clips of asymmetric design such as those described herein by way of example. The present invention takes into account the fact that polymeric clips require much less force to be deflected, compressed or otherwise manipulated during the course of a surgical procedure as compared with metallic clips. Accordingly, for many surgical procedures, the mechanical assistance and leverage provided by previously available clip appliers of conventional forceps-type or shaft/linkage design, which have large-dimensioned features such as shafts or arms and/or force-transmitting/multiplying components, is not needed. The low forces required to latch a polymeric clip enable the clip applier of the present invention to have a significantly smaller size in comparison to conventional clip appliers, and enable the clip applier to be actuated sufficiently by forces imparted by the fingertips of the surgeon or user. Thus, the clip applier of the present invention has a relatively simple structure. The clip applier generally comprises a pair of opposing jaws for handling a surgical clip, and a pair of opposing areas that are contacted by opposing fingertips of the user such as the tips of the index finger and the thumb. Once a clip has been loaded into the jaws, the jaws can be compressed by squeezing the fingertips together by application of low forces imparted by the user.

During operation of the clip applier of the present invention, the fingertips of the user are very close to the jaws of the clip applier and thus close to the

clip being manipulated. This configuration provides the user with a high level of tactile feedback or "feel", and consequently improved control over the clip and the procedure being performed. The design of the clip applier of the present invention and its small size not only afford the user precise control over placement of the clip, but also allows greater maneuverability of the clip within or at the surgical site. The compact size also allows the clip applier to be employed at surgical sites where conventional larger clip appliers cannot fit.

In addition to the miniature size of the clip applier of the present invention, the clip applier was designed so as to be assembled from two identical or substantially identical body pieces or halves. That is, a first body piece is manufactured, a similar or identical second body piece is manufactured, and the two body pieces are then assembled by snapping them together to form the clip applier of the present invention. As will become evident from the detailed description below, these two body pieces contain all the features necessary for the successful operation of the clip applier. Preferably, the cost of the clip applier is minimized and its manufacturing simplified further by constructing the body pieces from an appropriate polymeric material. The low cost of the resulting clip applier justifies its use as a single-use instrument that can be disposed of after one surgical procedure if desired, thereby eliminating the requirement for post-procedure sterilization of the clip applying instrument.

According to one embodiment of the present invention, a fingertip-actuated surgical clip applier comprises a first body and a second body substantially structurally identical to the first body. The first body comprises a main section and a first jaw extending in a distal direction from the main section. The main section comprises a hinge region and a first longitudinal wall extending between the first jaw and the hinge region. The first longitudinal wall comprises a first outside surface adapted for contacting a first fingertip. The second body comprises a second jaw and a second longitudinal wall. The second longitudinal wall comprises a second outside surface adapted for contacting a second fingertip. The second body is inverted in relation to the

first body and is pivotably connected to the hinge region. The first and second jaws are pivotable toward each other to a closed position and away from each other to an open position.

Preferably, each body of the clip applier has a unitary, polymeric construction.

Preferably, the clip applier, when at the closed position, has a gap defined between the first and second jaws to prevent the first and second jaws from contacting each other.

Preferably, the first and second outside surfaces of the clip applier comprises contoured areas for contact with the first and second fingertips, respectively.

According to another embodiment of the present invention, the first body comprises a first boss and a first aperture, and the second body comprises a second boss and a second aperture. The first boss is pivotably disposed within the second aperture, and the second boss is pivotably disposed within the first aperture. A first rib extends from the first body toward the second body, and a second rib extends from the second body toward the first body. At both the open and closed positions of the clip applier, the first rib is adjacent to the second body to retain the first boss in the second aperture, and the second rib is adjacent to the first body to retain the second boss in the first aperture.

According to yet another embodiment of the present invention, the first body comprises a first spring element contacting the second body, and the second body comprises a second spring element contacting the first body. The first and second spring elements bias the first and second jaws toward the open position.

According to still another embodiment of the present invention, the first body comprises a first rib extending toward the second body and the second body comprises a second rib extending toward the first body. The first rib is adjacent to the second rib at the open and closed positions of the clip applier to maintain alignment of the first jaw with the second jaw.

According to a further embodiment of the present invention, the first body comprises a first stop surface spaced from the first longitudinal wall, and the second body comprises a second stop surface spaced from the second longitudinal wall. At the closed position of the clip applier, the first and second stop surfaces abut each other to prevent further pivoting of the first and second jaws toward each other. Preferably, the abutment of the first and second stop surfaces maintains a gap between the first and second jaws to prevent the first and second jaws from contacting each other.

According to a yet further embodiment of the present invention, the first body comprises a first shoulder and a first protrusion transversely spaced from the first shoulder. The second body comprises a second shoulder and a second protrusion transversely spaced from the second shoulder at the open position of the clip applier. The first shoulder abuts against the second protrusion and the second shoulder abuts against the first protrusion to prevent further pivoting of the first and second jaws away from each other. Moreover, the first body can comprise a first recess defined between the first longitudinal wall and the first shoulder, and the second body can comprise a second recess defined between the second longitudinal wall and the second shoulder. During the pivoting of the first and second jaws between the open and closed positions, the first protrusion slides along the second recess and the second protrusion slides along the first recess.

According to an additional embodiment of the present invention, a fingertip-actuated surgical clip applier comprises a first body and a second body. The first body comprises a main section and a first jaw extending in a distal direction from the main section. The main section comprises a hinge region and a first longitudinal wall extending between the first jaw and the hinge region. The first longitudinal wall comprises a first outside surface adapted for contacting a first fingertip and an opposing first inside surface. The second body comprises a second main section and a second jaw extending in the distal direction from the second main section in opposing relation to the first jaw. The second main section comprises a second hinge region and a second

longitudinal wall extending between the second jaw and the second hinge region. The second longitudinal wall comprises a second outside surface adapted for contacting a second fingertip, and a second inside surface generally facing the first inside surface. The second hinge region is pivotably connected to the first hinge region. The first and second jaws are pivotable toward each other to a closed position and away from each other to an open position.

According to another aspect of this embodiment, the main section comprises first and second lateral walls extending from the first longitudinal wall and transversely spaced from each other. The second main section comprises third and fourth lateral walls extending from the second longitudinal wall and transversely spaced from each other. The first lateral wall comprises a first boss, the second lateral wall comprises a first aperture, the third lateral wall comprises a second boss, and the fourth lateral wall comprises a second aperture. The first boss is pivotably disposed within the second aperture and the second boss is pivotably disposed within the first aperture.

According to yet another aspect of this embodiment, a first rib extends from the first inside surface of the first longitudinal wall, and a second rib extends from the second inside surface of the second longitudinal wall. The fourth lateral wall is interposed between the first rib and the first lateral wall to retain the first boss of the first lateral wall in the second aperture of the fourth lateral wall. The second lateral wall is interposed between the second rib and the third lateral wall to retain the second boss of the third lateral wall in the first aperture of the second lateral wall.

According to yet another aspect of this embodiment, the second lateral wall comprises a first spring element contacting the second inside surface of the second longitudinal wall. The fourth lateral wall comprises a second spring element contacting the first inside surface of the first longitudinal wall. The first and second spring elements bias the first and second jaws toward the open position of the clip applier.

According to still another aspect of this embodiment, at both the open and closed positions of the clip applier, the first lateral wall is adjacent to the fourth lateral wall and the second lateral wall is adjacent to the third lateral wall. This configuration maintains alignment of the first jaw with the second jaw.

The present invention also provides a method for manipulating a surgical clip comprising the following steps. A fingertip-actuated clip applier is provided that comprises a first body and a second body. The first body comprises a main section and a first jaw extending in a distal direction from the main section. The main section comprises a hinge region and a first longitudinal wall extending between the first jaw and the hinge region. The second body comprises a second jaw and a second longitudinal wall. The second body is inverted in relation to the first body, and is pivotably connected to the hinge region. The first and second jaws are pivotable toward each other to a closed position and away from each other to an open position. The clip is loaded into engagement with the first and second jaws. The clip applier is grasped by contacting the first longitudinal wall with a first fingertip and the second longitudinal wall with a second fingertip such that the first and second fingertips generally oppose each other. The first and second fingertips are moved toward each other to cause the first and second jaws to pivot from the open position toward the closed position, thereby compressing the clip. In one aspect of this method, the first and second fingertips are moved toward each other against first and second biasing forces. The first biasing force is created by a first spring element of the first body that contacts the second body. The second biasing force is created by a second spring element of the second body that contacts the first body. The method also encompasses permitting the first and second fingertips to move away from each other to cause the first and second jaws to pivot toward the open position under the influence of the first and second biasing forces.

The present invention further provides a method for fabricating a fingertip-actuated surgical clip applier according to the following steps. A first polymeric workpiece is provided. A first body is formed from the workpiece.

The first body comprises a main section and first jaw extending in a distal direction from the main section. The main section comprises a hinge region and a longitudinal wall extending between the first jaw and the hinge region. A second polymeric workpiece is provided. A second body is formed from the second workpiece. The second body is substantially structurally identical to the first body and comprises a second jaw. The second body is inverted in relation to the first body. The second body is connected to the first body such that the first and second jaws are disposed in opposing relation, and are pivotable toward each other to a closed position and away from each other to an open position.

According to another aspect of this method, a first boss is formed on the first body and a first aperture is formed in the first body. A second boss is formed on the second body and a second aperture is formed in the second body. The first and second bodies are connected together by inserting the first boss into the second aperture and the second boss into the first aperture.

It is therefore an object of the present invention to provide a surgical clip applying instrument capable of being actuated by the fingertips of the user.

It is another object of the present invention to provide a fingertip-actuated clip applying instrument adapted for manipulating surgical clips of the polymeric, asymmetric design.

It is yet another object of the present invention to provide a surgical clip applying instrument having a simpler construction and design than has been heretofore available.

It is still another object of the present invention to provide a surgical clip applying instrument that can be assembled by snapping together two identical or substantially identical body pieces.

It is an additional object of the present invention to provide a surgical clip applying instrument that is much smaller in size as compared to instruments heretofore available, so as to enable access to surgical sites not heretofore possible and to facilitate and improve access to other kinds of surgical sites.

It is a further object of the present invention to provide a surgical clip applying instrument that affords the user enhanced control over manipulation of a surgical clip and improved tactile feedback as the clip is being manipulated and/or latched.

Some of the objects of the invention having been stated hereinabove, and which are addressed in whole or in part by the present invention, other objects will become evident as the description proceeds when taken in connection with the accompanying drawings as best described hereinbelow.

Brief Description of the Drawings

Figure 1A is a side elevation view of one example of an asymmetric surgical clip suitable for use in conjunction with the clip applier of the present invention;

Figure 1B is a front elevation view of the surgical clip illustrated in Figure 1A directed into the open side of the clip;

Figure 2 is a perspective view of a clip applier of the present invention shown in an open position with a surgical clip loaded in its jaws;

Figure 3 is a perspective view showing the two unassembled structural halves of the clip applier illustrated in Figure 2;

Figure 4 is a side elevation view of one of the clip applier halves;

Figure 5 is a bottom plan view of the clip applier half of Figure 4, showing inside features thereof;

Figure 6 is a top plan view of the clip applier half showing outside features thereof;

Figure 7A is a front elevation view of the clip applier in its open position;

Figure 7B is a front elevation view of the clip applier in its closed position;

Figure 8 is a rear elevation of the clip applier; and

Figure 9 is a side elevation view of the clip applier in its closed position.

Detailed Description of the Invention

The clip applier of the present invention as described in detail below is particularly designed for use in manipulating a polymeric, asymmetric clip that

is movable into a closed, latched state when clamped onto tissue. An example of this type of clip, generally designated **12**, is illustrated in Figures 1A and 1B. Clip **12** preferably comprises a one-piece integral polymeric body formed from a suitable strong, biocompatible engineering plastic such as the type commonly used for surgical implants. Examples include polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polyoxymethylene, or other thermoplastic materials having similar properties that can be injection-molded, extruded or otherwise processed into like articles.

The body of clip **12** comprises a first or outer leg, generally designated **22**, and a second or inner leg, generally designated **24**. First and second legs **22** and **24** are joined at their proximal ends by an integral hinge or heel section, generally designated **26**. First and second legs **22** and **24** have complementary arcuate profiles. Thus, first leg **22** has a concave inner surface **28** and a convex outer surface **30**, and second leg **24** has a convex inner surface **32** and a concave outer surface **34**. Convex inner surface **32** of second leg **24** and concave inner surface **28** of first leg **22** have substantially matching radii of curvature. Hinge section **26** has a continuous concave inner surface **36** and a continuous convex outer surface **38**. Concave inner surface **36** of hinge section **26** joins concave inner surface **28** of first leg **22** and convex inner surface **32** of second leg **24**. Convex outer surface **38** of hinge section **26** joins convex outer surface **30** of first leg **22** and concave outer surface **34** of second leg **24**. First leg **22** transitions to a curved, C-shaped hook section **40** at its distal end. Second leg **24** transitions to a pointed tip section **42** at its distal end. Hook section **40** is distally reversely curved inwardly, and has a transverse beveled surface **44**. Beveled surface **44** and concave inner surface **28** define a latching recess **46**, which is adapted for conformally engaging tip section **42** in the course of compressing clip **12** into a latched or locked position around a vessel or other tissue.

As best shown in Figure 1B, which is an elevation view directed into the open concave side of clip **12**, clip **12** comprises parallel, opposed side surfaces **52** and **54**. Typically, the body of clip **12** has a constant thickness between

side surfaces **52** and **54**. Adjacent to the distal end of the first leg **22** and immediately inwardly of hook section **40**, a pair of cylindrical bosses **56** and **58** are formed coaxially on the opposed lateral surfaces of first leg **22**. In the illustrated example of clip **12**, a bridge section **66** couples bosses **56** and **58** together. As evident in Figure 1A, bosses **56** and **58** project outwardly beyond convex outer surface **30** of first leg **22**. Referring back to Figure 1B, at the distal end of inner leg **24**, another pair of cylindrical bosses **62** and **64** are formed coaxially on the opposed lateral surfaces of inner leg **24** at tip section **42**. As evident in Figure 1A, bosses **62** and **64** of second leg **24** extend longitudinally forwardly beyond tip section **42**. Also in the illustrated example of clip **12**, hook section **40** of first leg **22** terminates at a sharp tip **68**, the distal end of second leg **24** includes a pair of sharp tissue-penetrating teeth **72** and **74**, and both first and second legs **22** and **24** have a plurality of protrusions or teeth **76** extending from their respective inner surfaces **28** and **32**. These latter features are designed to engage the tissue of the vessel being clamped and assist in preventing the vessel from sliding laterally or longitudinally during or following clip closure. It will be noted, however, that other clips equally suitable for use in conjunction with the invention do not contain such features.

In the practice of ligating a vessel as understood by persons skilled in the art, clip **12** is designed to be compressed into a latched or locked position around the vessel through the use of an appropriate clip applicator instrument, such as the known type described in the aforementioned U.S. Patent No. 5,100,416, or the novel fingertip-actuated clip applying instrument described and claimed herein. The clip applicator instrument engages bosses **56, 58, 62** and **64** of clip **12** and pivots bosses **56, 58, 62** and **64** inwardly about hinge section **26**. This causes first and second legs **22** and **24** to close around the vessel, with convex inner surface **32** of second leg **24** and complementary concave inner surface **28** of first leg **22** contacting the outer wall of the vessel. Tip section **42** of second leg **24** then begins to contact hook section **40**. Further pivotal movement by the applicator instrument **100** longitudinally elongates first leg **22** and deflects hook section **40**, allowing tip section **42** to

align with latching recess **46**. Upon release of the applicator instrument **100**, tip section **42** snaps into and is conformably seated in latching recess **46**, at which point clip **12** is in its latched condition. In the latched condition, tip section **42** is engaged between concave inner surface **28** and beveled surface **44**, thereby securely clamping a designated vessel or other tissue between concave inner surface **28** and convex inner surface **32**.

Clips similar to clip **12** are described in detail in commonly assigned U.S. Patent No. 4,834,096 to Oh et al. and 5,062,846 to Oh et al., the disclosures of which are incorporated herein in their entireties. In addition, a particularly suitable clip is the HEM-O-LOK® clip commercially available from the assignee of the present invention. These clips are currently available in sizes designated "M", "ML", and "L". The clip applier of the invention described hereinbelow can be dimensioned to specifically handle any sizes of HEM-O-LOK® clips commercially available.

Referring now to Figures 2 and 3, a fingertip-actuated clip applier, according to the present invention, generally designated **100**, is illustrated in assembled and unassembled configurations, respectively, in accordance with an exemplary, preferred embodiment of the present invention. In the preferred embodiment, as particularly shown in Figure 3, clip applier **100** generally comprises two identical structural halves: a first clip applier body generally designated **110A**, and a second clip applier body generally designated **110B**. Preferably, first and second bodies **110A** and **110B** each are constructed as unitary components from a suitable biocompatible material such as a molded plastic, e.g., nylon, polycarbonate, ABS (acrylonitrile butadiene styrene) or any of these materials that have been reinforced with glass or carbon fibers. The various features of clip applier **100** described below are formed from the unitary structures of first and second bodies **110A** and **110B**. In one example, first and second bodies **110A** and **110B** are each 2 inches in length from their respective proximal ends to their distal jaw-containing ends. By comparison, the overall length of a conventional clip applier typically ranges from about 8 – 11 inches.

Referring to Figure 3, first body **110A** comprises a first main section, generally designated **115A**, and a first jaw, generally designated **120A**. First main section **115A** comprises a first longitudinal wall **121A**, a first distal end wall **123A** from which first jaw **120A** extends outwardly in the distal direction, a first boss-side lateral wall **125A**, and a first aperture-side lateral wall **127A**. First distal end wall **123A**, first boss-side lateral wall **125A**, and first aperture-side lateral wall **127A** extend from first longitudinal wall **121A**, thereby cooperatively defining a partially enclosed chamber associated with first main section **115A**. A first pivot boss **129A** extends transversely into the chamber of first body **110A** from an inside surface of first boss-side lateral wall **125A**. A first aperture **131A** is formed in first aperture-side lateral wall **127A** and is disposed generally across the chamber from first pivot boss **129A**.

As indicated above, second body **110B** is preferably structurally identical to first body **110A**, and thus likewise comprises a second main section generally designated **115B**, and a second jaw generally designated **120B**. Second main section **115B** comprises a second longitudinal wall **121B** (see Figure 8), a second distal end wall **123B** from which second jaw **120B** extends outwardly in the distal direction, a second boss-side lateral wall **125B**, and a second aperture-side lateral wall **127B** (see Figure 8). Second distal end wall **123B**, second boss-side lateral wall **125B**, and second aperture-side lateral wall **127B** extend from second longitudinal wall **121B**, thereby cooperatively defining a partially enclosed chamber associated with second main section **115B**. A second pivot boss **129B** extends transversely into the chamber of second body **110B** from an inside surface of second boss-side lateral wall **125B**. A second aperture **131B** is formed in second aperture-side lateral wall **127B** and is disposed generally across the chamber from second pivot boss **129B**.

Clip applier **100** is assembled by inverting second body **110B** with respect to first body **110A** as shown in Figure 3, and securing first and second bodies **110A** and **110B** together at their respective rear or proximal ends. As

shown in the rear view of Figure 8, this is accomplished by inserting first pivot boss **129A** into second aperture **131B** and second pivot boss **129B** into first aperture **131A**. When first and second bodies **110A** and **110B** are assembled together in this manner, first and second jaws **120A** and **120B** oppose each other as shown in Figure 2. The connection made between first and second bodies **110A** and **110B** at their proximal ends enables first and second bodies **110A** and **110B** to pivot with respect to each other. As a result, first and second jaws **120A** and **120B** are likewise pivotable with respect to each other, and thus are movable toward and away from each other between open and closed positions, respectively, as indicated by arrows **A** and **B** in Figure 2. As also shown in Figure 2, this movement enables the user of clip applier **100** to manipulate a tissue-ligating clip, such as clip **12** described in detail above and illustrated in Figures 1A and 1B, in the course of an appropriate surgical procedure.

It will be noted that conventional clip appliers contain some form of a handle or grip assembly remotely disposed from their jaws through a distance (e.g., eleven inches) dictated by an elongate shaft section (or a pair of scissors-like arms) interposed between the jaws and the handles. By contrast, clip applier **100** of the present invention is designed to be manipulated by an opposing pair of fingertips (e.g., the tips of the thumb and index finger) of the user. In this manner, the user can actuate first and second jaws **120A** and **120B** to compress clip **12** into its latched state by squeezing clip applier **100** between the user's fingertips. This fingertip-actuated manipulation of clip **12** is facilitated by providing first and second longitudinal walls **121A** and **121B** of first and second bodies **110A** and **110B** with respective first and second fingertip areas **133A** and **133B**, as shown in Figures 2, 3, 6 and 8. First and second fingertip areas **133A** and **133B** (Figure 8) are contoured to respectively include opposing winged sections **135A/137A** and **135B/137B** (Figure 8) on both sides of the longitudinal axis of clip applier **100**. As used herein, the term "contoured" is broadly taken to mean non-planar. In addition, as best shown in Figure 6 (specifically illustrating first body **110A** but analogous to second body

110B), first and second fingertip areas **133A** and **133B** are preferably wider than the remaining portions of first and second longitudinal walls **121A** and **121B**. In one example, first and second fingertip areas **133A** and **133B**, including winged sections **135A**, **137A**, **135B** and **137B**, are each 9/16 inch in width. These features improve contact between clip applier **100** and the fingertips of the user, as well as control over clip applier **100** by the user and, consequently, control over manipulation of clip **12**.

In Figure 2, clip **12** is securely loaded into first and second jaws **120A** and **120B**. For this purpose, as best shown in Figure 3, first jaw **120A** has a pair of first jaw recesses **141A** at its distal end and second jaw **120B** has a pair of second jaw recesses **141B** at its distal end. First jaw recesses **141A** securely engage a pair of bosses **56/58** or **62/64** of clip **12** and second jaw recesses **141B** securely engage the opposite pair of bosses **62/64** or **56/58**. It will be noted that in the perspective view of Figure 2, only bosses **58** and **64** of clip **12** are shown. First jaw **120A** also includes a first open jaw channel **143A** (see Figure 5) and second jaw **120B** includes a second open jaw channel **143B** (see Figures 2 and 3). First and second jaw channels **143A** and **143B** accommodate legs **22** and **24** of clip **12** (see Figure 1A) to enhance control over clip **12** and securement of clip **12** in first and second jaws **120A** and **120B**.

Additional features of clip applier **100** will now be described with reference primarily to Figures 3 – 8. It will be understood that while the features illustrated in Figures 4 – 6 are described only in relation to first body **110A** of clip applier **100**, Figures 4 – 6 are equally representative of second body **110B**. That is, second body **110B** is identical or substantially identical to first body **110A** and hence includes a corresponding set of the same features as first body **110A**.

Referring now to Figure 4, first body **110A** comprises a first spring element **145A** extending at an angle from the proximal region of first aperture-side lateral wall **127A** toward the distal end of first body **110A**. First spring element **145A** terminates at a first arcuate contact region **147A**. As shown in

Figure 3, second body **110B** comprises a similar second spring element **145B** with a second arcuate contact region **147B**. The dimensions of first and second spring elements **145A** and **145B** and the material selected for first and second bodies **110A** and **110B** are sufficient to render first and second spring elements **145A** and **145B** resilient and deflectable, and hence capable of storing spring energy. In the assembled, operational form of clip applier **100**, first arcuate contact region **147A** of first spring element **145A** bears against an inside surface (not shown) of second longitudinal wall **121B** (see Figures 2 and 3) of second body **110B**, and second spring element **145B** bears against an inside surface **149** (see Figure 5) of first longitudinal wall **121A** of first body **110A**. By this configuration, first and second spring elements **145A** and **145B** bias clip applier **100** toward its open position when the fingertips of the user are not imparting sufficient force to first and second fingertip areas **133A** and **133B** of first and second longitudinal walls **121A** and **121B**.

Referring now to Figures 3 and 5, first body **110A** further comprises a first distal rib **153A** and a first proximal rib **155A** disposed in its chamber, both of which depend from inside surface **149** (Figure 5) of first longitudinal wall **121A**. Second body **110B** also comprises a second distal rib **153B** and a second proximal rib **155B** disposed in its chamber, which depend from the inside surface (not shown) of second longitudinal wall **121B**. As shown in the front view of clip applier **100** in Figure 7A and the rear view in Figure 8, first distal rib **153A** and first proximal rib **155B** are offset from each other relative to the central vertical axis of clip applier **100**, and second distal rib **153B** and second proximal rib **155B** are likewise offset from each other in relation to the same reference axis. In the assembled form of clip applier **100** shown in Figure 7A, first and second distal ribs **153A** and **153B** are disposed adjacent to each other. A juxtaposition is thus created between first and second distal ribs **153A** and **153B**, as well as between first boss-side lateral wall **125A** and second aperture-side lateral wall **127B**, and between second boss-side lateral wall **125B** and first aperture-side lateral wall **127A**. These juxtapositions restrict

lateral movement of first and second bodies **110A** and **110B** with respect to each other, and thus assist in maintaining proper alignment of first and second jaws **120A** and **120B** with respect to each other.

As shown in Figure 8, first proximal rib **155A** is disposed adjacent to second aperture-side lateral wall **127B** and second proximal rib **155B** is disposed adjacent to first aperture-side lateral wall **127A**. These juxtapositions also restrict lateral movement of first and second bodies **110A** and **110B** with respect to each other. Moreover, the location of first proximal rib **155A** within the interior of clip applier **100** assists in maintaining second aperture-side lateral wall **127B** in close proximity to first boss-side lateral wall **125A**, and thus assists in retaining first pivot boss **129A** in second aperture **131B**. Likewise, the location of second proximal rib **155B** within the interior of clip applier **100** assists in maintaining first aperture-side lateral wall **127A** in close proximity to second boss-side lateral wall **125B**, and thus assists in retaining second pivot boss **129B** in first aperture **131A**.

Referring now to the front elevation views of Figures 7A and 7B, clip applier **100** is movable between an extreme open position (Figure 7A) and an extreme closed position (Figure 7B). Both first and second bodies **110A** and **110B** of clip applier **100** include an identical set of features that cooperatively define the extreme open position of clip applier **100**, and thus limit the degree to which first and second jaws **120A** and **120B** can open. First body **110A** includes a first recess or track **161A** formed in the edge of first boss-side lateral wall **125A**. First track **161A** extends from first distal end wall **123A** and terminates at a first open-position stop surface **163A**. A first stop element **165A** protrudes transversely outwardly from first aperture-side lateral wall **127A**. Analogously, second body **110B** includes a second recess or track **161B** formed in the edge of second boss-side lateral wall **125B**. Second track **161B** extends upwardly from second distal end wall **123B** and terminates at a second open-position stop surface **163B**. A second stop element **165B** protrudes transversely outwardly from second aperture-side lateral wall **127B**.

It is evident from Figures 7A and 7B that, as first and second jaws **120A** and **120B** pivot away from each other under the influence of first and second spring elements **145A** and **145B** (see Figure 3), first stop element **165A** travels along the length of second track **161B** and second stop element **165B** travels along the length of first track **161A**. As shown in Figure 7A, first stop element **165A** eventually abuts against second open position stop surface **163B** and second stop element **165B** eventually abuts against first open position stop surface **163A**. Further opening movement of first and second jaws **120A** and **120B** is prevented. These features enable enhanced control over clip **12** by the user by ensuring that clip **12** remains properly aligned and loaded in first and second jaws **120A** and **120B**, with bosses **56**, **58**, **62** and **64** of clip **12** (see Figures 1A – 2) secured in first and second jaw recesses **141A** and **141B** and first and second legs **22** and **24** of clip **12** retained in first and second jaw channels **143A** and **143B**.

First and second bodies **110A** and **110B** of clip applier **100** also include first and second opposing closed-position stop surfaces **167A** and **167B** that cooperatively define the extreme closed position of clip applier **100**, and thus limit the degree to which first and second jaws **120A** and **120B** can close. Preferably, first closed-position stop surface **167A** is the edge of first distal end wall **123A** opposite first longitudinal wall **121A**, and second closed-position stop surface **167B** is the edge of second distal end wall **123B** opposite second longitudinal wall **121B**. For clarity, a gap is illustrated in Figure 7B between first and second closed-position stop surfaces **167A** and **167B**. It will be evident from Figure 7B, however, that the abutment of first and second closed-position stop surfaces **167A** and **167B** against each other upon actuation of clip applier **100** maintains a small gap between first and second jaws **120A** and **120B**. The gap between first and second jaws **120A** and **120B** is best shown in Figure 9. This feature lowers the risk of pinching or damaging tissue at a surgical site during use of clip applier **100**.

In accordance with the invention, clip applier **100** can be used to manipulate clip **12** in much the same manner as conventional clip appliers. Clip **12** is first loaded into first and second jaws **120A** and **120B** of clip applier **100**, such as by the known method of inserting clip applier **100** into a clip cartridge, a desired surgical site is accessed by a known procedure, and clip applier **100** is actuated by the surgeon to apply clip **12** to a target vessel or other tissue. An example of a typical application of clip **12** to a vessel is given hereinabove. As noted above, however, only the fingertips of the surgeon are needed to handle and actuate clip applier **100**. The design of clip applier **100** enables to surgeon to easily maneuver clip applier **100** around the surgical site, and make quick decisions and adjustments regarding where to actually apply **12** to completion. The invention is not limited to the types of surgical procedures in which clip applier **100** can be implemented. Any open surgery requiring the use of surgical clips is contemplated. In addition, clip applier **100** could be employed with the HALS procedure discussed hereinabove. It is contemplated that clip applier **100** could be inserted through the port created by the above-described inflatable device to access the abdominal cavity, thereby eliminating the need for an endoscopic clip applier. In addition to general ligating procedures and HALS procedures, other examples of surgical procedures for which clip applier **100** can be employed include vasectomies, lymph node dissections, and tubal ligations.

It will be understood that various details of the invention may be changed without departing from the scope of the invention. Furthermore, the foregoing description is for the purpose of illustration only, and not for the purpose of limitation—the invention being defined by the claims.

CLAIMS

What is claimed is:

1. A fingertip-actuated surgical clip applier comprising:

(a) a first body comprising a main section and a first jaw extending in a distal direction from the main section, the main section comprising a hinge region and a first longitudinal wall extending between the first jaw and the hinge region, the first longitudinal wall comprising a first outside surface adapted for contacting a first fingertip; and

(b) a second body substantially structurally identical to the first body and comprising a second jaw and a second longitudinal wall, the second longitudinal wall comprising a second outside surface adapted for contacting a second fingertip, the second body inverted in relation to the first body and pivotably connected to the hinge region, wherein the first and second jaws are pivotable toward each other to a closed position and away from each other to an open position.

2. The clip applier according to claim 1 wherein the first and second bodies each have a unitary, polymeric construction.

3. The clip applier according to claim 1 wherein, at the closed position, a gap is defined between the first and second jaws to prevent the first and second jaws from contacting each other.

4. The clip applier according to claim 1 wherein the first and second outside surfaces comprise contoured areas.

5. The clip applier according to claim 1 wherein the first body comprises a first boss and a first aperture, the second body comprises a second boss and a second aperture, the first boss is pivotably disposed within the second aperture, and the second boss is pivotably disposed within the first aperture.

6. The clip applier according to claim 5 comprising a first rib extending from the first body toward the second body and a second rib extending from

the second body toward the first body wherein, at both the open and closed positions, the first rib is adjacent to the second body to retain the first boss in the second aperture, and the second rib is adjacent to the first body to retain the second boss in the first aperture.

7. The clip applier according to claim 1 wherein the first body comprises a first spring element contacting the second body, the second body comprises a second spring element contacting the first body, and the first and second spring elements bias the first and second jaws toward the open position.

8. The clip applier according to claim 1 wherein the first body comprises a first rib extending toward the second body, the second body comprises a second rib extending toward the first body, and the first rib is adjacent to the second rib at the open and closed positions to maintain alignment of the first jaw with the second jaw.

9. The clip applier according to claim 1 wherein the first body comprises a first stop surface spaced from the first longitudinal wall, the second body comprises a second stop surface spaced from the second longitudinal wall and, at the closed position, the first and second stop surfaces abut each other to prevent further pivoting of the first and second jaws toward each other.

10. The clip applier according to claim 9 wherein the abutment of the first and second stop surfaces maintains a gap between the first and second jaws to prevent the first and second jaws from contacting each other.

11. The clip applier according to claim 1 wherein the first body comprises a first shoulder and a first protrusion transversely spaced from the first shoulder, the second body comprises a second shoulder and a second protrusion transversely spaced from the second shoulder and, at the open position, the first shoulder abuts against the second protrusion and the second shoulder abuts against the first protrusion to prevent further pivoting of the first and second jaws away from each other.

12. The clip applier according to claim 11 wherein the first body comprises a first recess defined between the first longitudinal wall and the first shoulder, the second body comprises a second recess defined between the second longitudinal wall and the second shoulder and, during pivoting of the first and second jaws between the open and closed positions, the first protrusion slides along the second recess and the second protrusion slides along the first recess.

13. A fingertip-actuated surgical clip applier comprising:

(a) a first body comprising a first main section and a first jaw extending in a distal direction from the first main section, the first main section comprising a first hinge region and a first longitudinal wall extending between the first jaw and the first hinge region, the first longitudinal wall comprising a first outside surface adapted for contacting a first fingertip and an opposing first inside surface; and

(b) a second body comprising a second main section and a second jaw extending in the distal direction from the second main section in opposing relation to the first jaw, the second main section comprising a second hinge region and a second longitudinal wall extending between the second jaw and the second hinge region, the second longitudinal wall comprising a second outside surface adapted for contacting a second fingertip and a second inside surface generally facing the first inside surface, wherein the second hinge region is pivotably connected to the first hinge region, and the first and second jaws are pivotable toward each other to a closed position and away from each other to an open position.

14. The clip applier according to claim 13 wherein the first main section comprises first and second lateral walls extending from the first longitudinal wall and transversely spaced from each other, and the second main section comprises third and fourth lateral walls extending

from the second longitudinal wall and transversely spaced from each other.

15. The clip applier according to claim 14 wherein the first lateral wall comprises a first boss, the second lateral wall comprises a first aperture, the third lateral wall comprises a second boss, and the fourth lateral wall comprises a second aperture, wherein the first boss is pivotably disposed within the second aperture and the second boss is pivotably disposed within the first aperture.

16. The clip applier according to claim 15 comprising a first rib extending from the first inside surface of the first longitudinal wall and a second rib extending from the second inside surface of the second longitudinal wall, wherein the fourth lateral wall is interposed between the first rib and the first lateral wall to retain the first boss of the first lateral wall in the second aperture of the fourth lateral wall, and the second lateral wall is interposed between the second rib and the third lateral wall to retain the second boss of the third lateral wall in the first aperture of the second lateral wall.

17. The clip applier according to claim 14 wherein the second lateral wall comprises a first spring element contacting the second inside surface of the second longitudinal wall, the fourth lateral wall comprises a second spring element contacting the first inside surface of the first longitudinal wall, and the first and second spring elements bias the first and second jaws toward the open position.

18. The clip applier according to claim 14 wherein, at both the open and closed positions, the first lateral wall is adjacent to the fourth lateral wall and the second lateral wall is adjacent to the third lateral wall to maintain alignment of the first jaw with the second jaw.

19. The clip applier according to claim 18 wherein the first body comprises a first rib extending from the first inside surface of the first longitudinal wall, the second body comprises a second rib extending from the second inside surface of the second longitudinal wall, and the first rib is

adjacent to the second rib at the open and closed positions to maintain alignment of the first jaw with the second jaw.

20. The clip applier according to claim 13 wherein the first body comprises a first boss and a first aperture, the second body comprises a second boss and a second aperture, the first boss is pivotably disposed within the second aperture, and the second boss is pivotably disposed within the first aperture.

21. The clip applier according to claim 20 comprising a first rib extending from the first inside surface of the first longitudinal wall and a second rib extending from the second inside surface of the second longitudinal wall wherein, at both the open and closed positions, the first rib is adjacent to the second body to retain the first boss in the second aperture, and the second rib is adjacent to the first body to retain the second boss in the first aperture.

22. The clip applier according to claim 13 wherein the first body comprises a first spring element contacting the second inside surface of the second longitudinal wall, the second body comprises a second spring element contacting the first inside surface of the first longitudinal wall, and the first and second spring elements bias the first and second jaws toward the open position.

23. The clip applier according to claim 13 wherein the first body comprises a first rib extending from the first inside surface of the first longitudinal wall, the second body comprises a second rib extending from the second inside surface of the second longitudinal wall, and the first rib is adjacent to the second rib at the open and closed positions to maintain alignment of the first jaw with the second jaw.

24. The clip applier according to claim 13 wherein the first body comprises a first stop surface spaced from the first longitudinal wall, the second body comprises a second stop surface spaced from the second longitudinal wall and, at the closed position, the first and second stop surfaces abut

each other to prevent further pivoting of the first and second jaws toward each other.

25. The clip applier according to claim 24 wherein the abutment of the first and second stop surfaces maintains a gap between the first and second jaws to prevent the first and second jaws from contacting each other.

26. The clip applier according to claim 24 wherein the first body comprises a first shoulder and a first protrusion transversely spaced from the first shoulder, the second body comprises a second shoulder and a second protrusion transversely spaced from the second shoulder and, at the open position, the first shoulder abuts against the second protrusion and the second shoulder abuts against the first protrusion to prevent further pivoting of the first and second jaws away from each other.

27. The clip applier according to claim 13 wherein the first body comprises a first shoulder and a first protrusion transversely spaced from the first shoulder, the second body comprises a second shoulder and a second protrusion transversely spaced from the second shoulder and, at the open position, the first shoulder abuts against the second protrusion and the second shoulder abuts against the first protrusion to prevent further pivoting of the first and second jaws away from each other.

28. The clip applier according to claim 27 wherein the first body comprises a first recess defined between the first longitudinal wall and the first shoulder, the second body comprises a second recess defined between the second longitudinal wall and the second shoulder and, during pivoting of the first and second jaw between the open and closed positions, the first protrusion slides along the second recess and the second protrusion slides along the first recess.

29. A method for manipulating a surgical clip comprising the steps of:

(a) providing a fingertip-actuated clip applier comprising:

(i) a first body comprising a main section and a first jaw extending in a distal direction from the main section, the main section comprising a hinge region and a first

longitudinal wall extending between the first jaw and the hinge region; and

(ii) a second body comprising a second jaw and a second longitudinal wall, the second body inverted in relation to the first body and pivotably connected to the hinge region, wherein the first and second jaws are pivotable toward each other to a closed position and away from each other to an open position;

(b) loading the clip into engagement with the first and second jaws;

(c) grasping the clip applier by contacting the first longitudinal wall with a first fingertip and the second longitudinal wall with a second fingertip, whereby the first and second fingertips generally oppose each other; and

(d) moving the first and second fingertips toward each other to cause the first and second jaws to pivot from the open position toward the closed position, whereby the clip becomes compressed.

30. The method according to claim 29 wherein the first and second fingertips are moved toward each other against first and second biasing forces, the first biasing force created by a first spring element of the first body contacting the second body, and the second biasing force created by a second spring element of the second body contacting the first body.

31. The method according to claim 30 comprising the step of permitting the first and second fingertips to move away from each other to cause the first and second jaws to pivot toward the open position under the influence of the first and second biasing forces.

32. A method for fabricating a fingertip-actuated surgical clip applier, comprising the steps of:

(a) providing a first polymeric workpiece;

(b) forming from the first workpiece a first body comprising a main section and a first jaw extending in a distal direction from the main section, wherein the main section comprises a hinge region

and a longitudinal wall extending between the first jaw and the hinge region;

(c) providing a second polymeric workpiece;

(d) forming from the second workpiece a second body, wherein the second body is substantially structurally identical to the first body and comprises a second jaw;

(e) inverting the second body in relation to the first body;

(f) connecting the second body to the first body whereby the first and second jaws are disposed in opposing relation and are pivotable toward each other to a closed position and away from each other to an open position.

33. The method according to claim 31 comprising the steps of forming a first boss on the first body and a first aperture in the first body, and forming a second boss on the second body and a second aperture in the second body, wherein the step of connecting the second body to the first body comprises inserting the first boss into the second aperture and inserting the second boss into the first aperture.

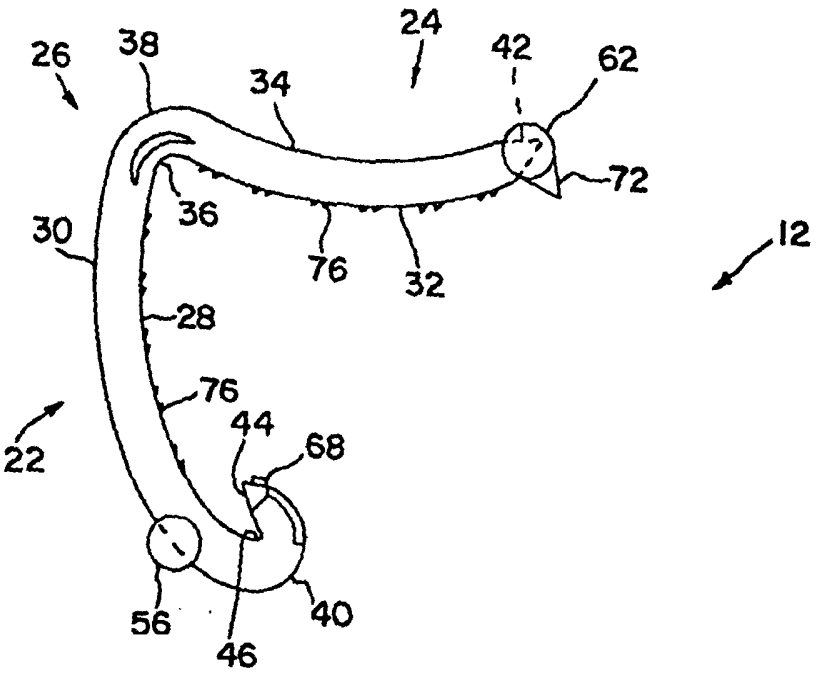


FIG. IA
PRIOR ART

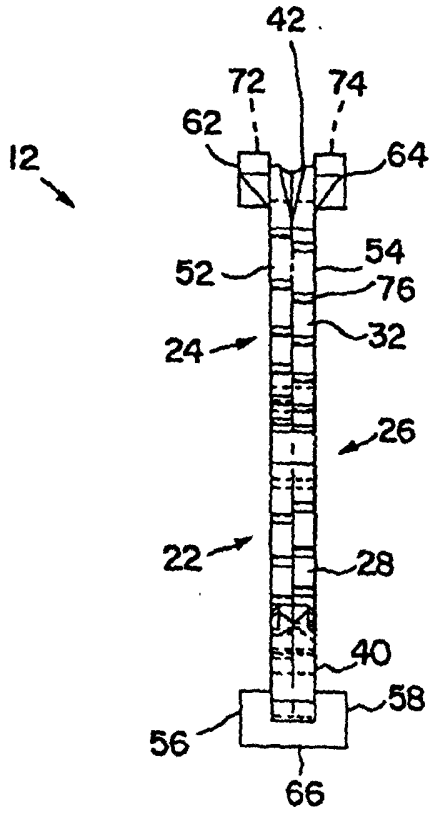
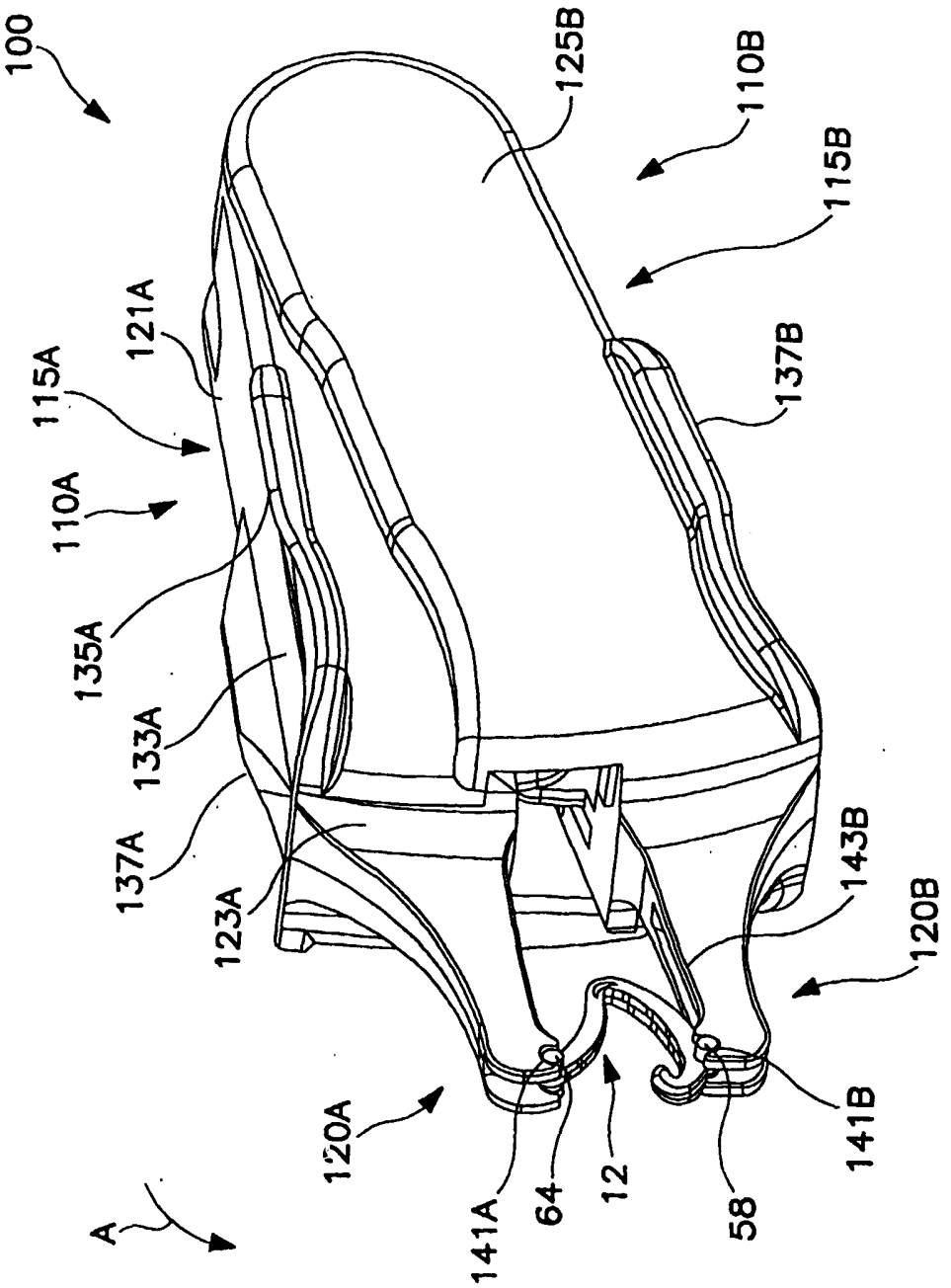


FIG. IB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B
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A
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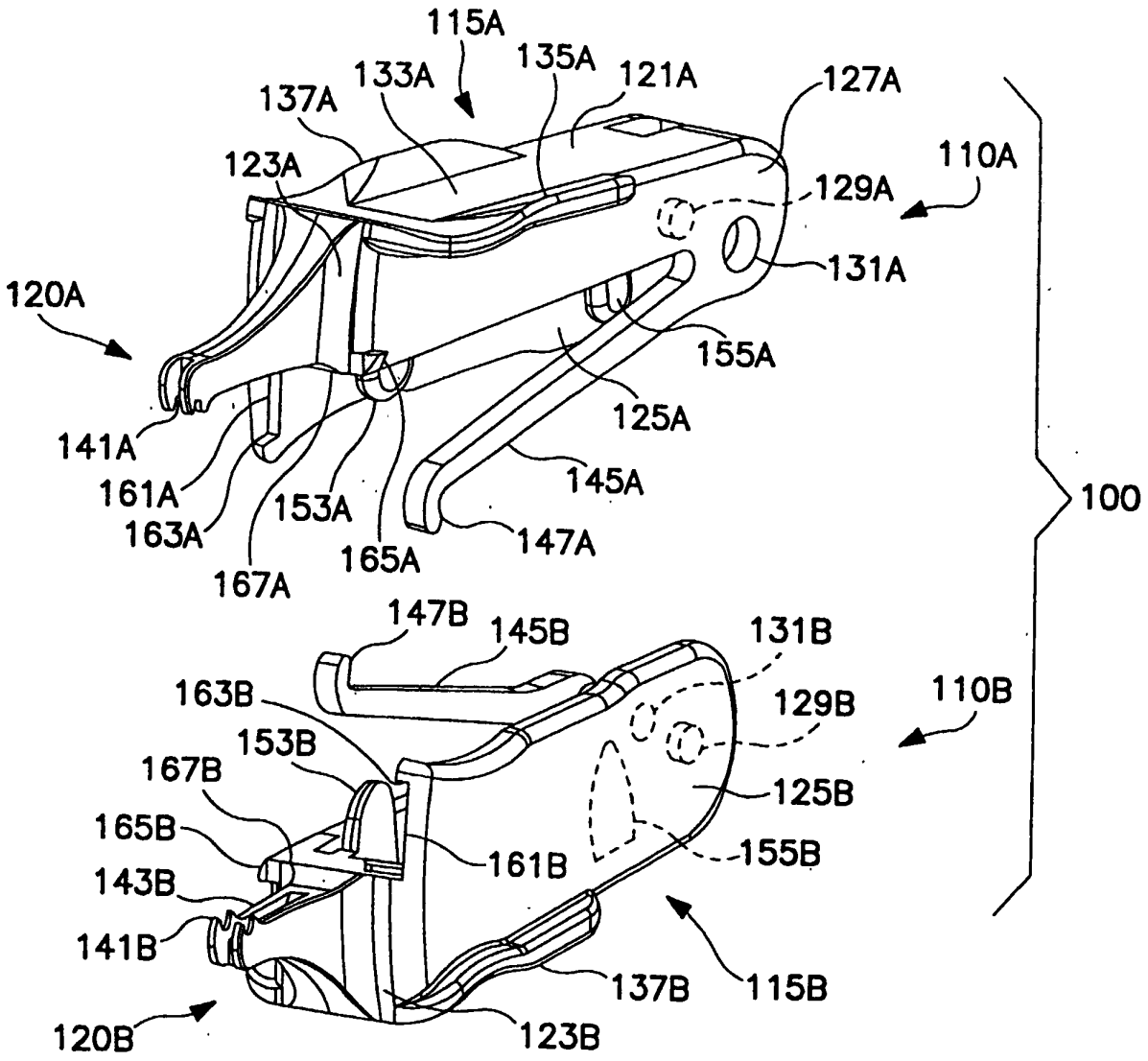
12
58
141B

FIG. 2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163A
147A
165A
167A
100
147B
145B
131B
163B
129B
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123B

FIG. 3

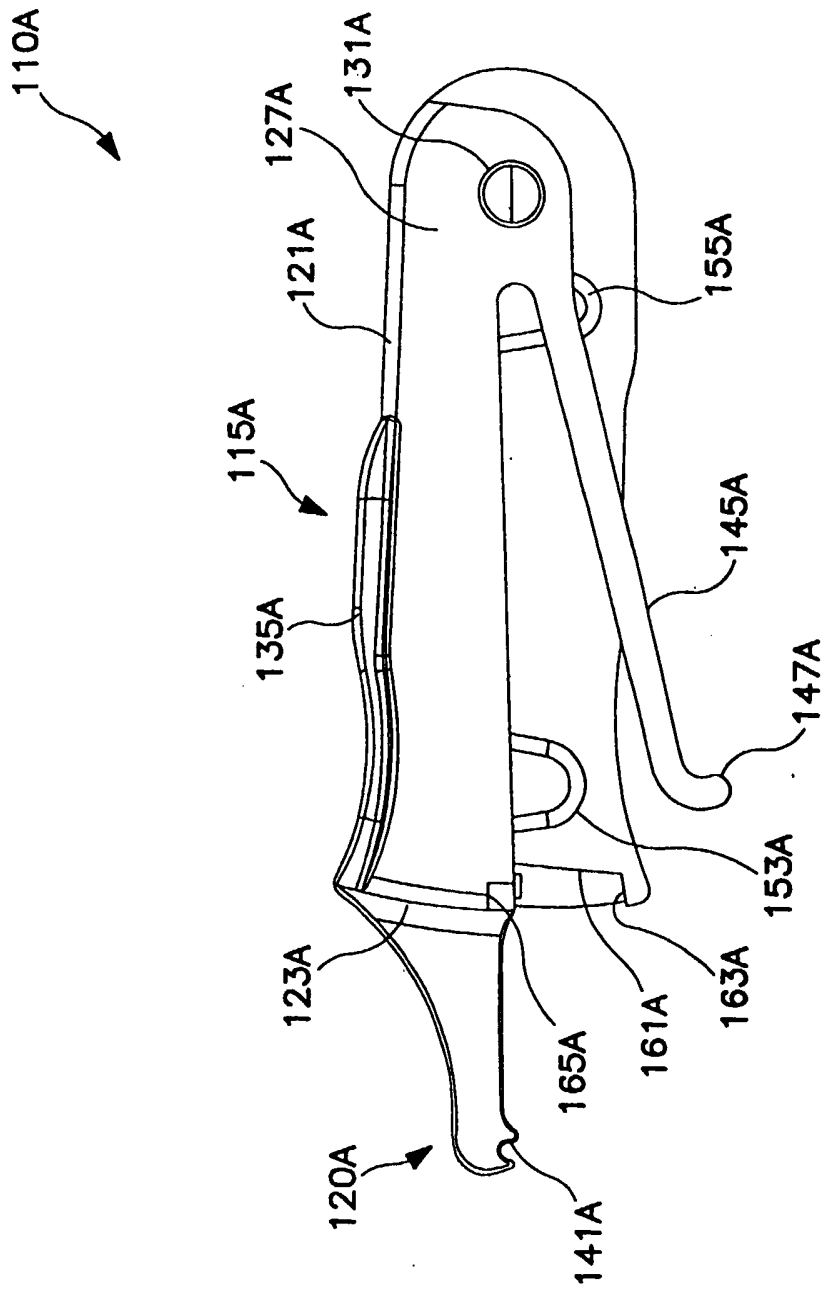
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FIG. 4

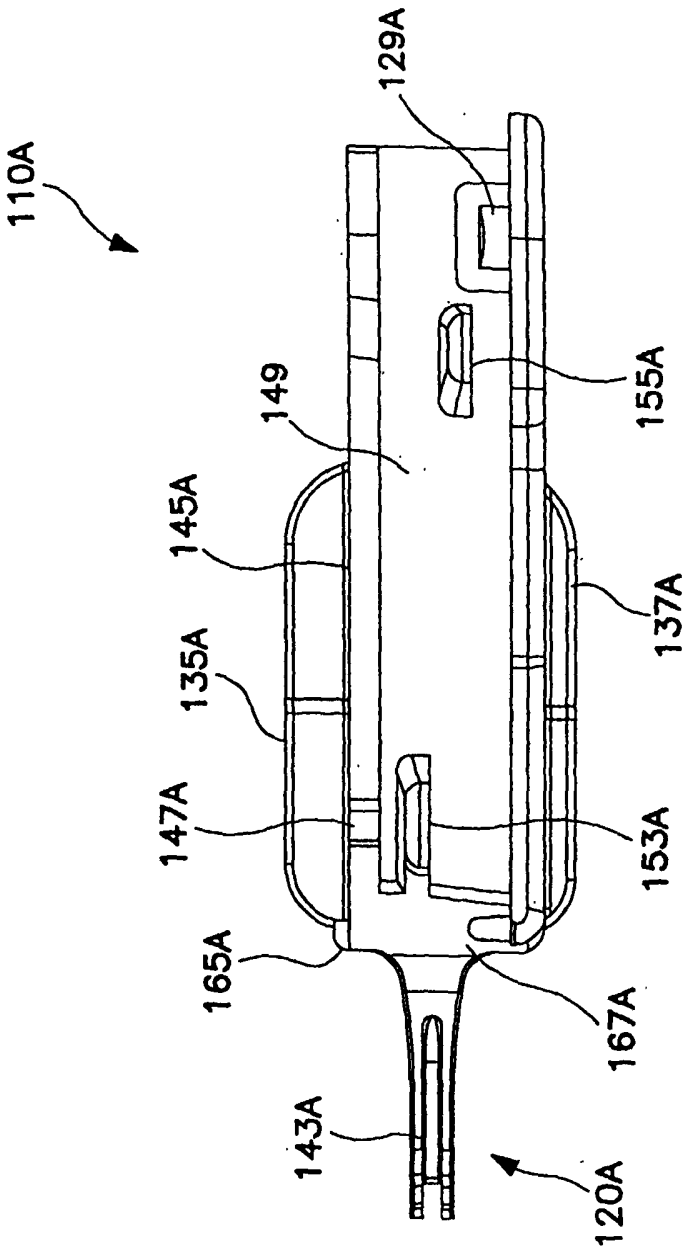
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FIG. 5

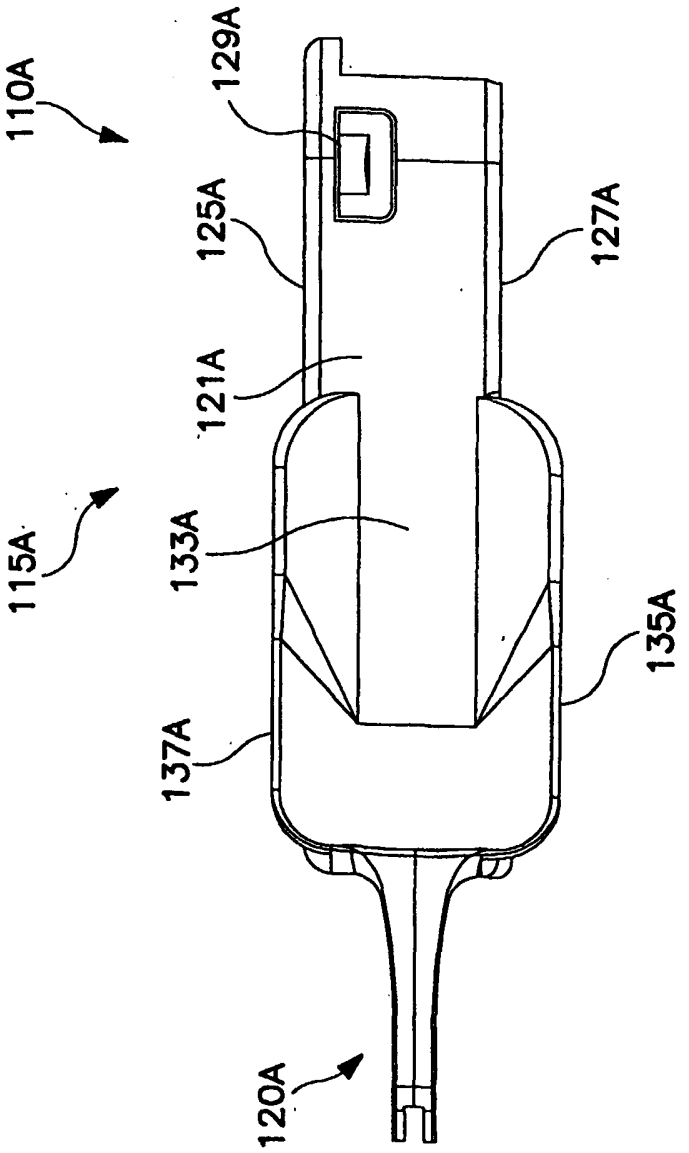
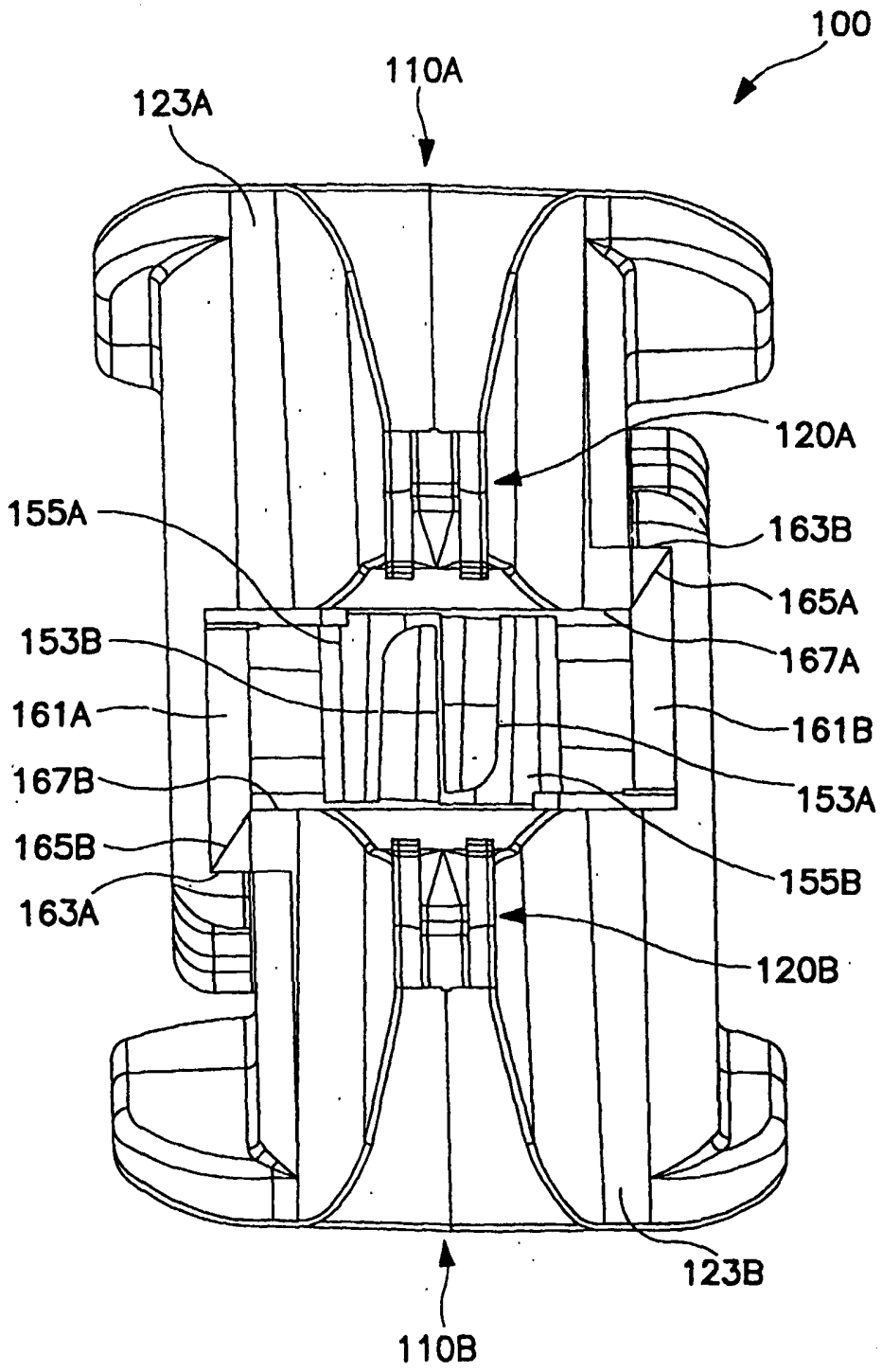


FIG. 6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123B
110B

FIG. 7A

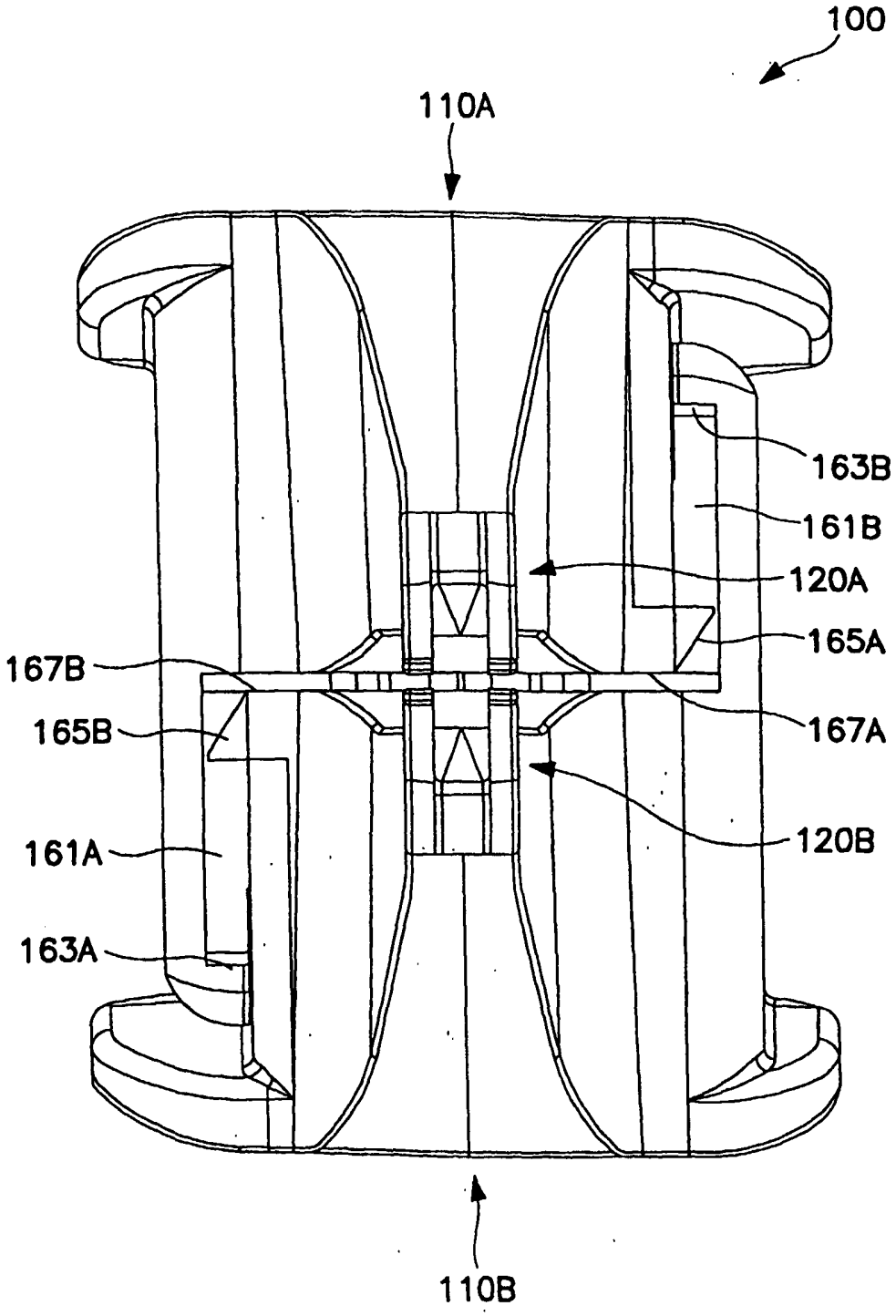
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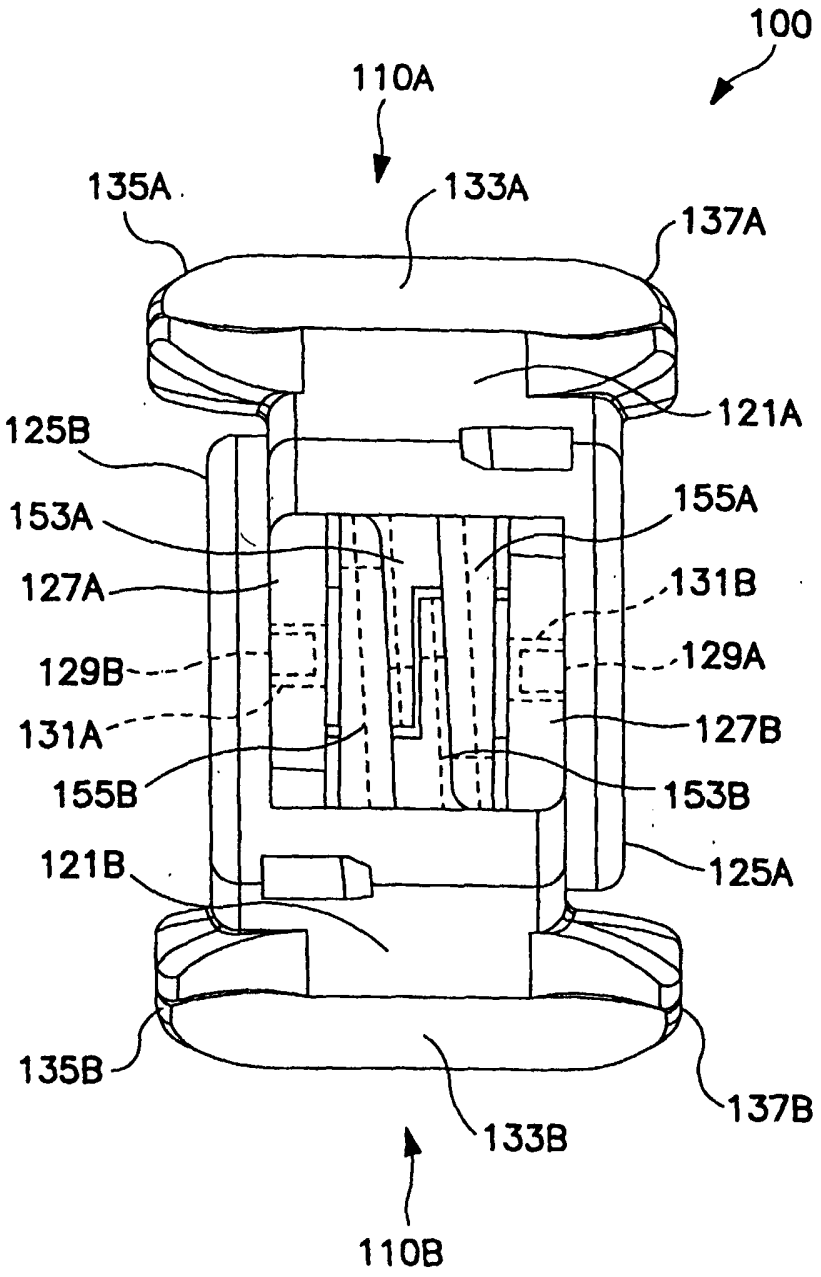
FIG. 7B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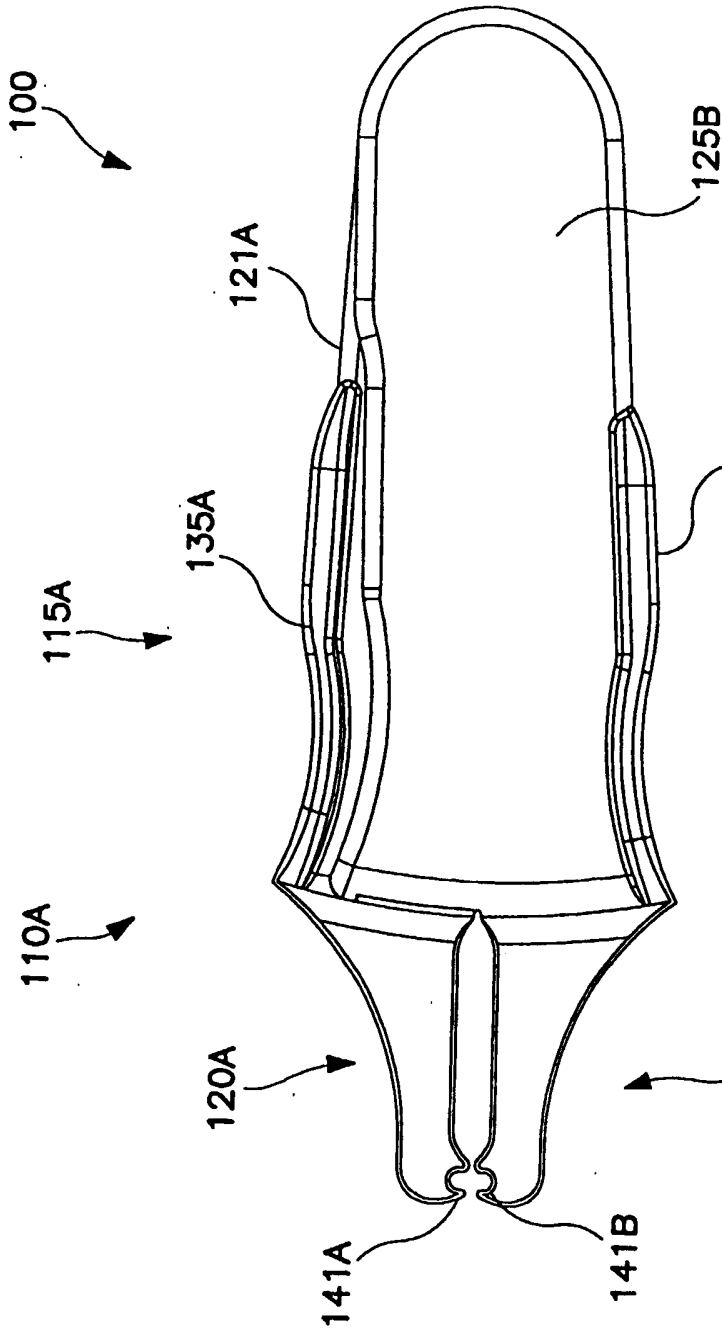
135B
137B
133B
110B

FIG. 8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141B

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/20029

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61B 17/10

US CL : 606/142

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. :

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 5,951,574 A (STEFANCHIK et al.) 14 September 1999 (14.06.1999), see col. 2 lines 34-60.	1, 2, 4, 5, 7, 9, 11, 12, 13, 14, 15, 17, 18, 19, 20, 2, 23, 24, 26, 27, 29, 30, 31, 32
X	US 5,868,761 A (NICHOLAS et al.) 09 February 1999 (09.02.1999), see col. 3, lines 5-40.	1, 2, 4, 5, 7, 9, 11, 12, 13, 14, 15, 17, 18, 19, 20, 2, 23, 24, 26, 27, 29, 30, 31, 32
X	US 5,833,698 A (HINCHLIFFE et al.) 10 November 1998 (10.11.1998), see col. 5, 10-35.	1, 2, 4, 5, 7, 9, 11, 12, 13, 14, 15, 17, 18, 19, 20, 2, 23, 24, 26, 27, 29, 30, 31, 32

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"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

"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

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Date of the actual completion of the international search

27 August 2003 (27.08.2003)

Date of mailing of the international search report

29 OCT 2003

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