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Shelton, IV et al.

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(54) **SURGICAL STAPLING INSTRUMENT HAVING FORCE CONTROLLED SPACING END EFFECTOR**

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(73) Assignee: **Ehthicon Endo-Surgery, Inc.**, Cincinnati, OH (US)

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(51) **Int. Cl.**
A61B 17/072 (2006.01)

(52) **U.S. Cl.** **227/180.1**; 227/19; 227/178.1; 227/181.1

(58) **Field of Classification Search** 227/178.1, 227/19, 175.1; 606/8, 153, 144; 411/21, 411/24

See application file for complete search history.

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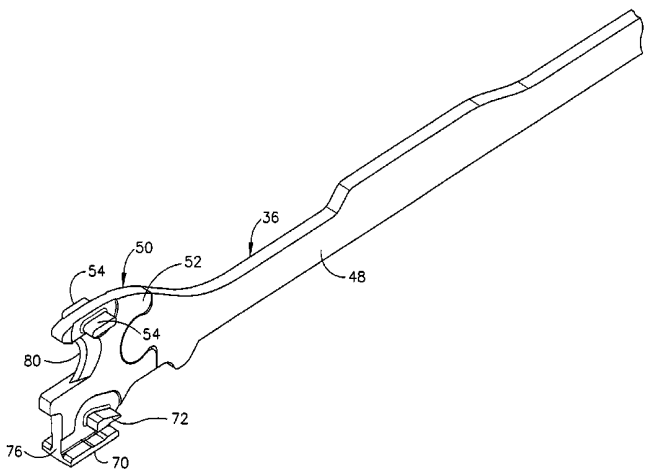
Primary Examiner—Brian D. Nash
(74) *Attorney, Agent, or Firm*—Frost Brown Todd LLC

(57) **ABSTRACT**

A surgical instrument for being endoscopically or laparoscopically inserted into a surgical site for simultaneous stapling and severing of tissue includes force adjusted spacing between an upper jaw (anvil) and a lower jaw (staple cartridge engaged to an elongate staple channel) so that the height of staple formation corresponds to the thickness of the tissue, yet does not exceed the height range that may be accommodated by the length of the staples. In particular, resilient structures are formed into an E-beam firing bar that includes a cutting surface (knife) that severs tissue between a top pin that engages the anvil and a middle pin and lower foot that engage the lower jaw. The resilience responds to the force exerted by clamped tissue to vary the spacing.

17 Claims, 8 Drawing Sheets



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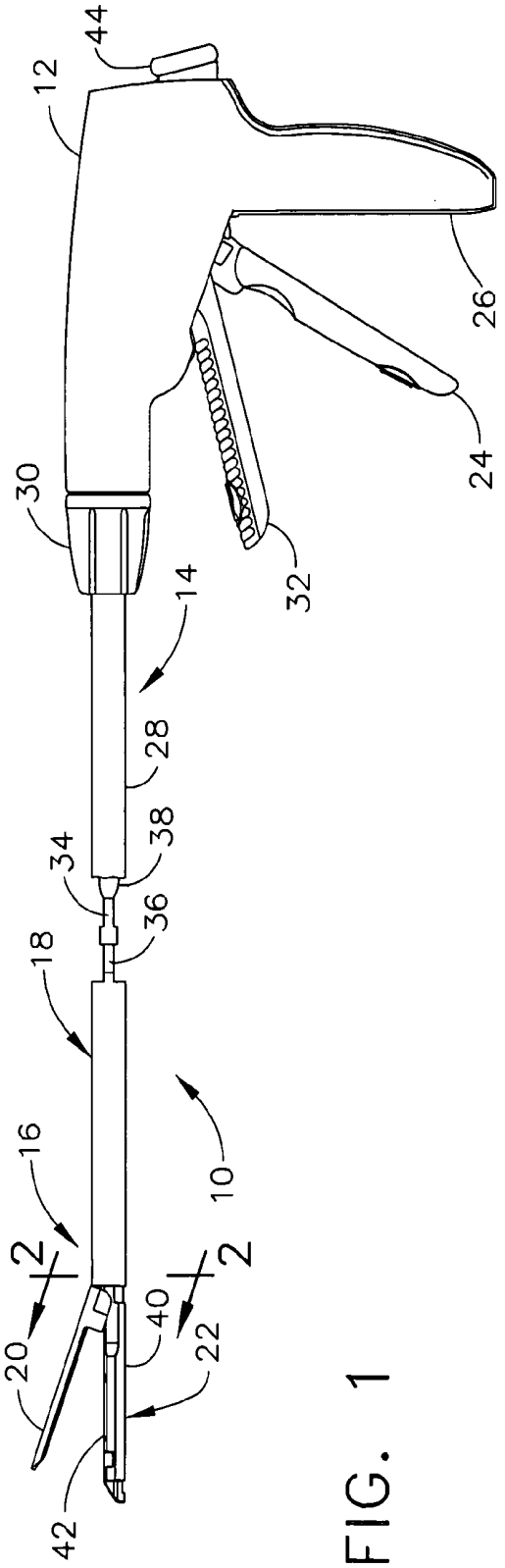
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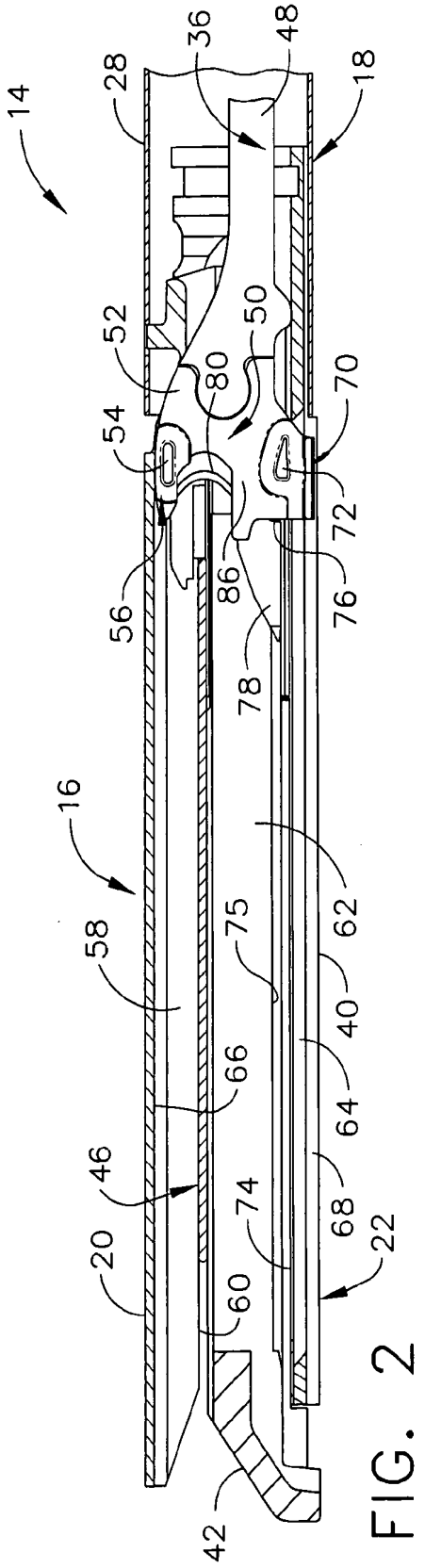
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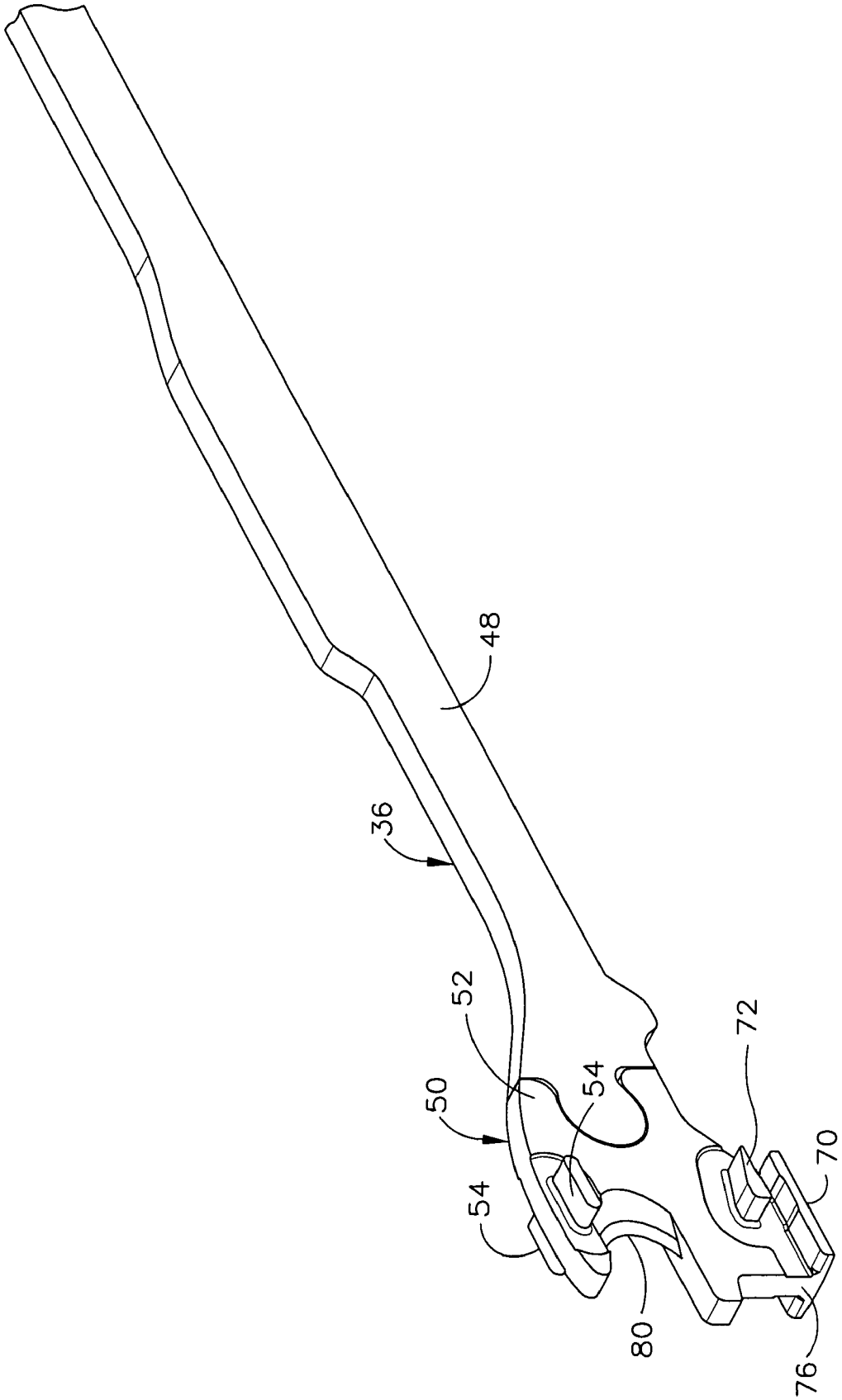

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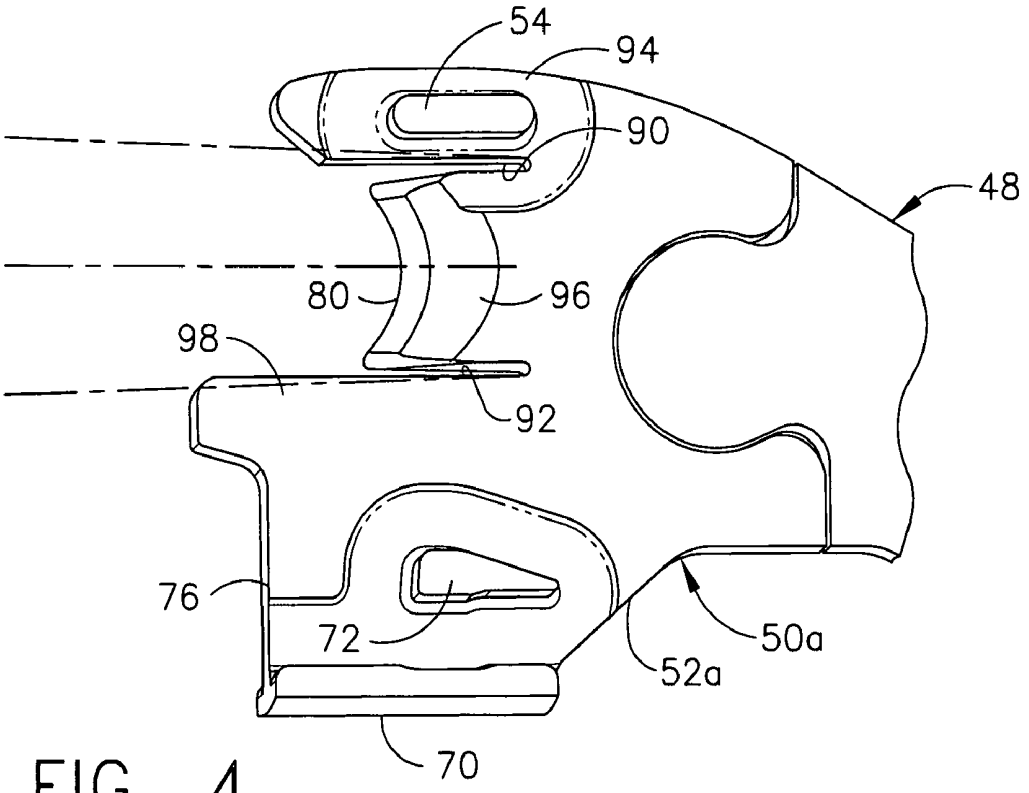
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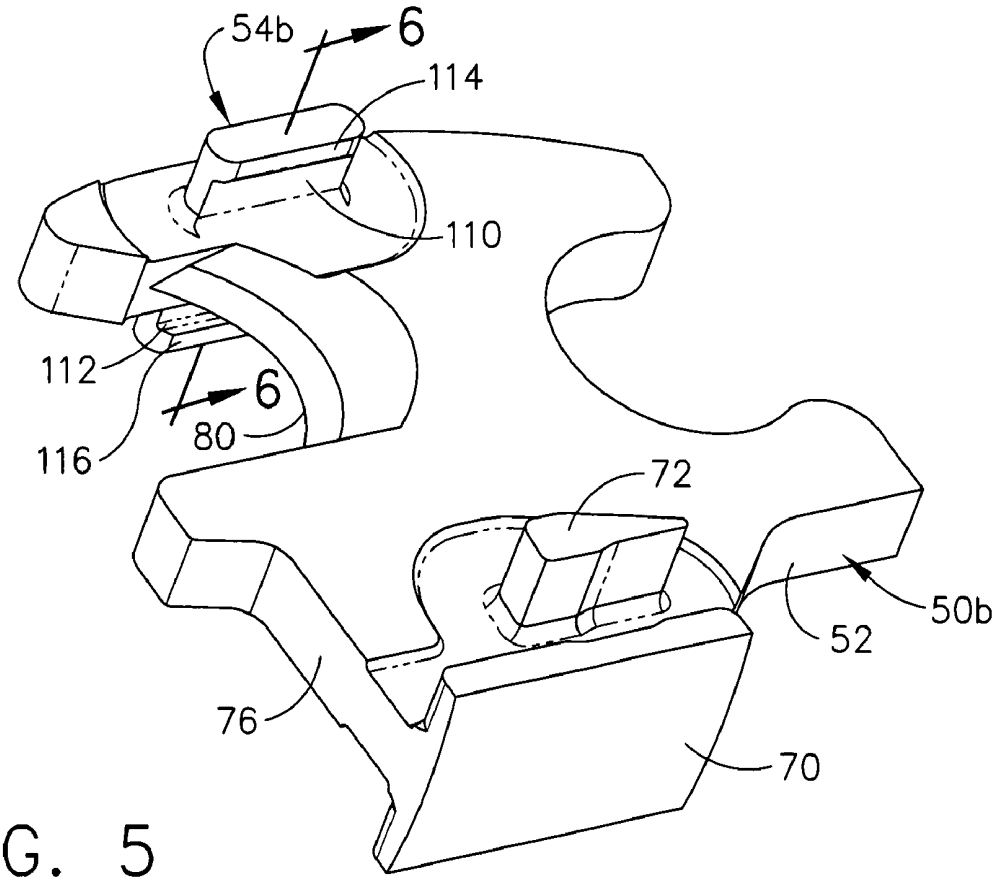
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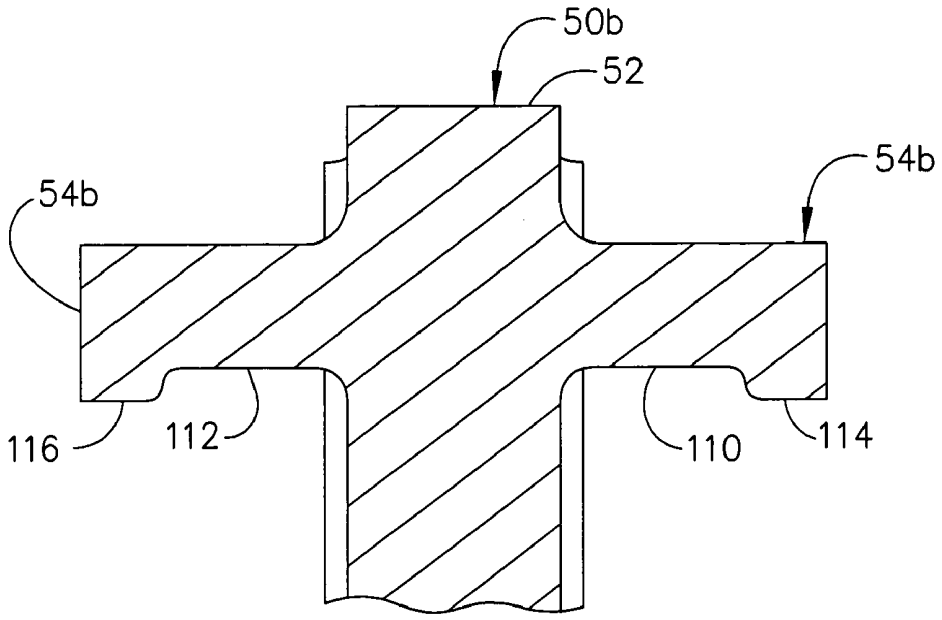

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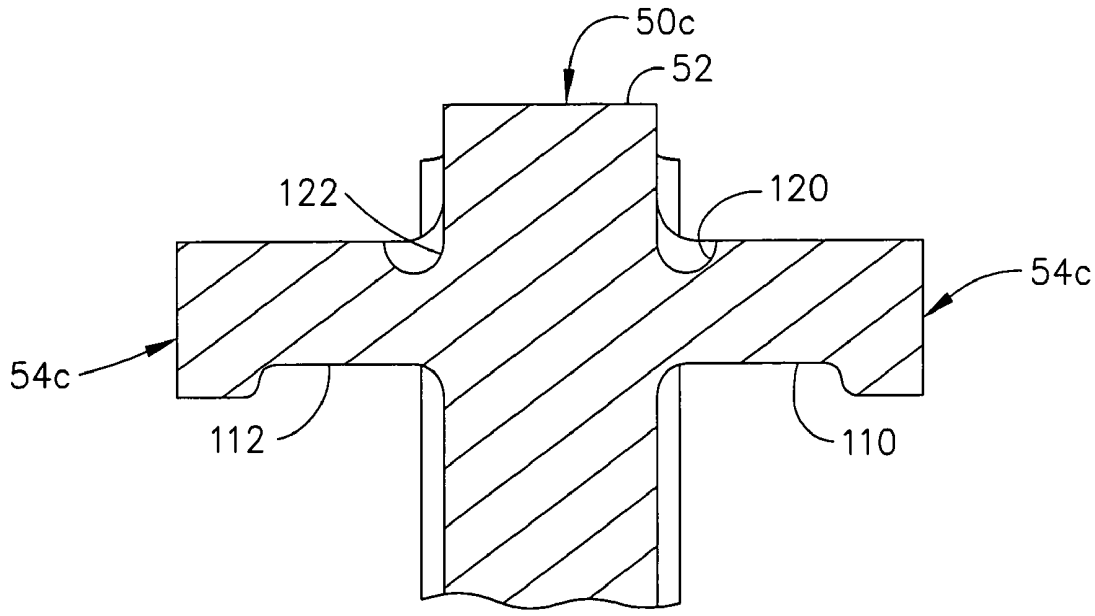

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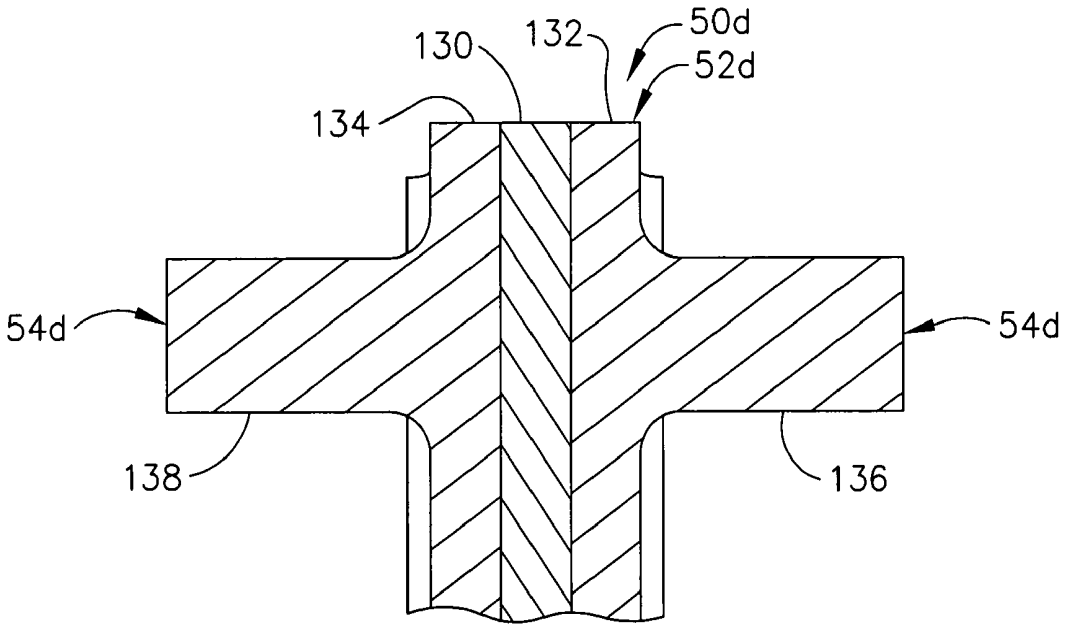


FIG. 8

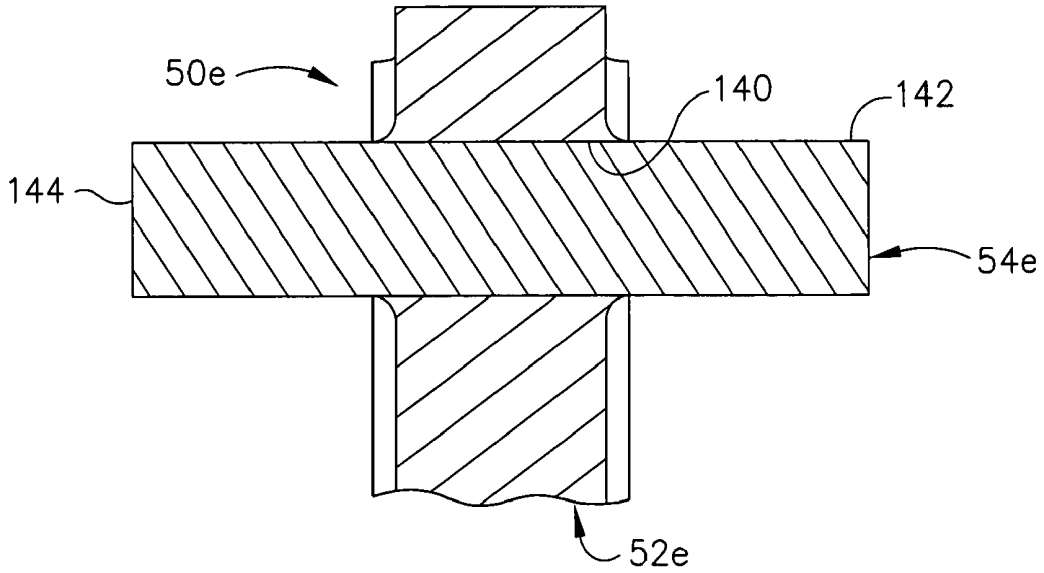
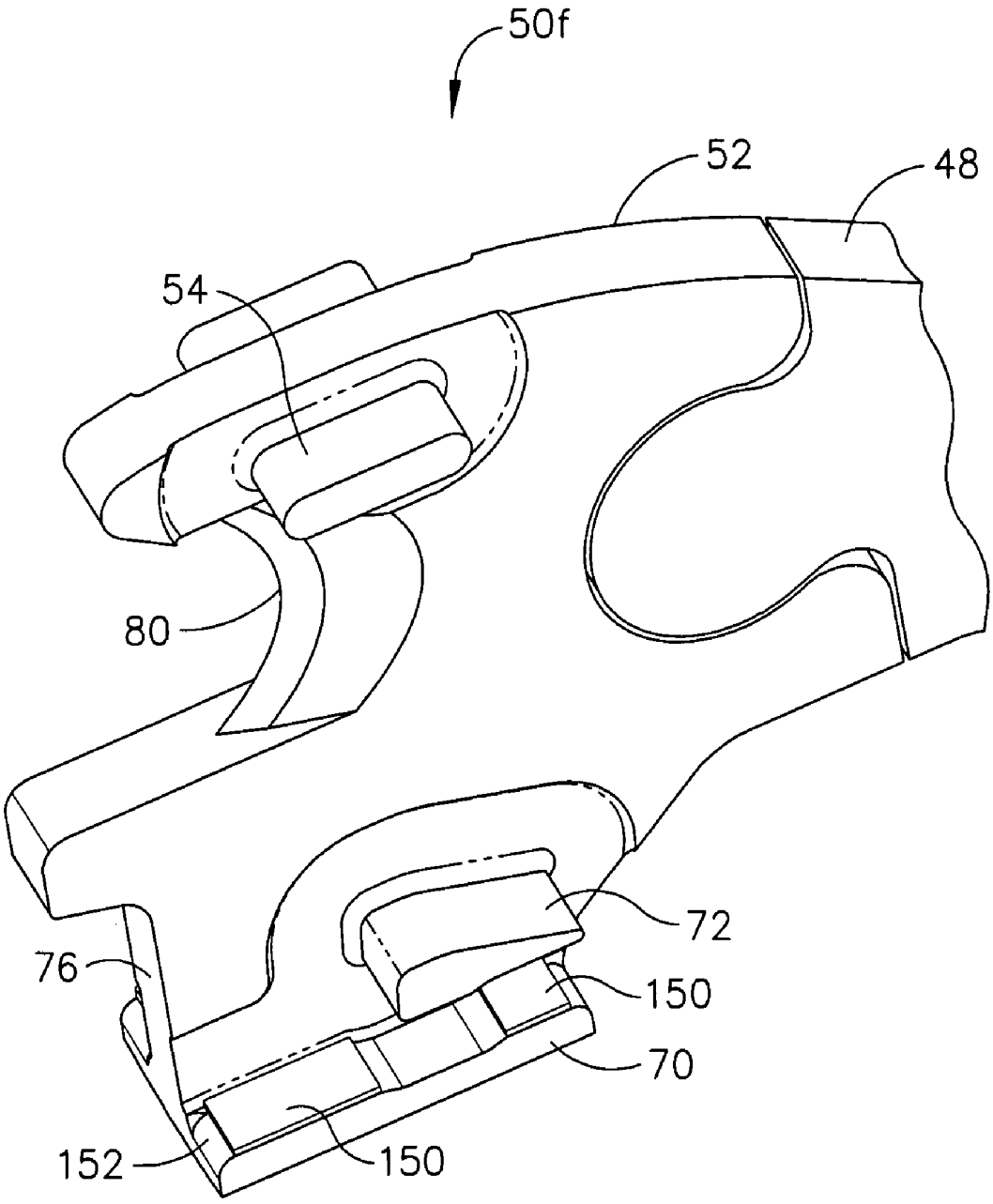


FIG. 9



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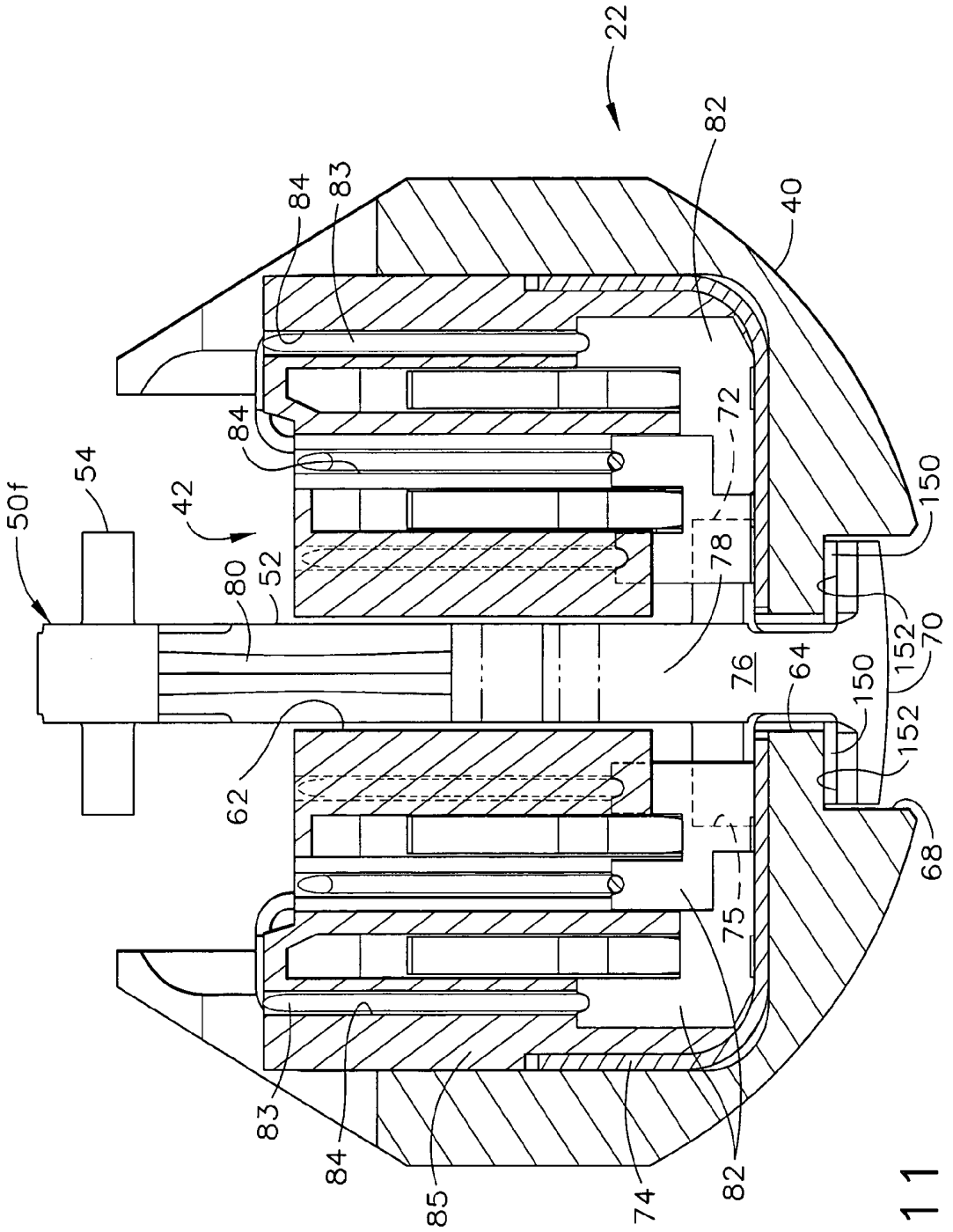
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FIG. 11

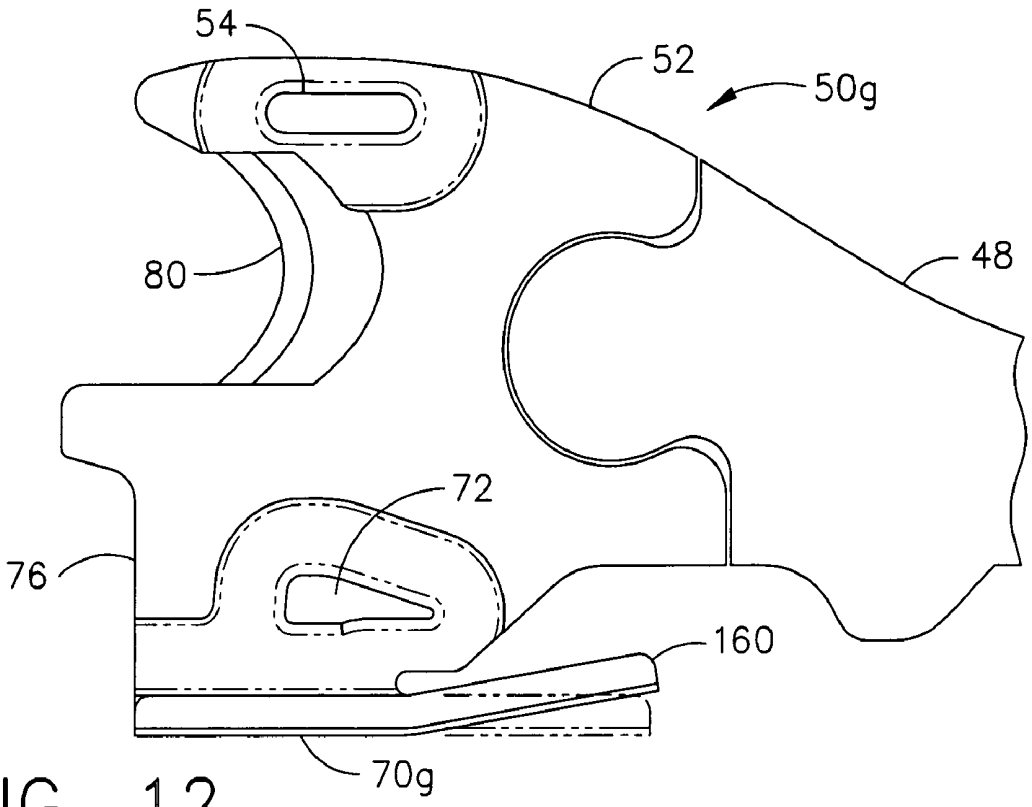

FIG. 12

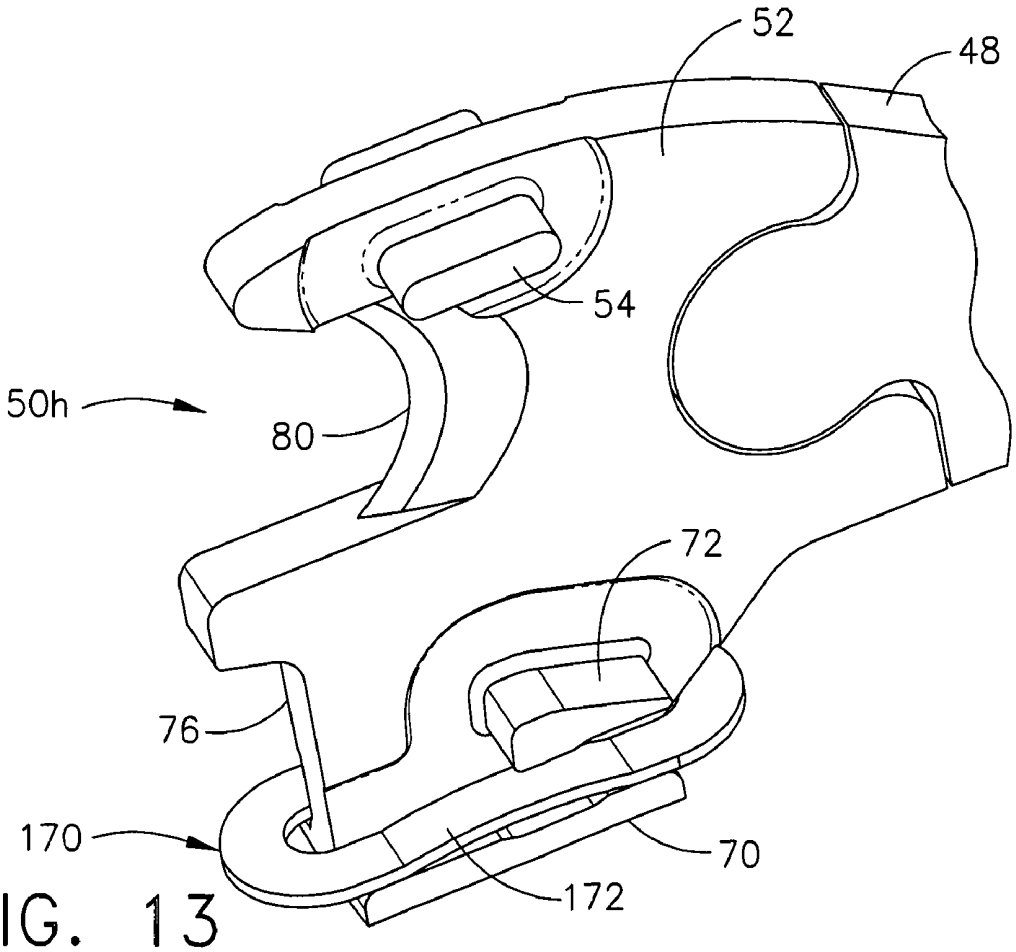

FIG. 13

SURGICAL STAPLING INSTRUMENT HAVING FORCE CONTROLLED SPACING END EFFECTOR

FIELD OF THE INVENTION

The present invention relates in general to surgical stapler instruments that are capable of applying lines of staples to tissue while cutting the tissue between those staple lines and, more particularly, to improvements relating to stapler instruments and improvements in processes for forming various components of such stapler instruments including adding bolstering material to the severed and stapled tissue.

BACKGROUND OF THE INVENTION

Endoscopic and laparoscopic surgical instruments are often preferred over traditional open surgical devices since a smaller incision tends to reduce the post-operative recovery time and complications. The use of laparoscopic and endoscopic surgical procedures has been relatively popular and has provided additional incentive to develop the procedures further. In laparoscopic procedures, surgery is performed in the interior of the abdomen through a small incision. Similarly, in endoscopic procedures, surgery is performed in any hollow viscus of the body through narrow endoscopic tubes inserted through small entrance wounds in the skin.

Laparoscopic and endoscopic procedures generally require that the surgical region be insufflated. Accordingly, any instrumentation inserted into the body must be sealed to ensure that gases do not enter or exit the body through the incision. Moreover, laparoscopic and endoscopic procedures often require the surgeon to act on organs, tissues and/or vessels far removed from the incision. Thus, instruments used in such procedures are typically long and narrow while being functionally controllable from a proximal end of the instrument.

Significant development has gone into a range of endoscopic surgical instruments that are suitable for precise placement of a distal end effector at a desired surgical site through a cannula of a trocar. These distal end effectors engage the tissue in a number of ways to achieve a diagnostic or therapeutic effect (e.g., endocutter, grasper, cutter, staplers, clip applier, access device, drug/gene therapy delivery device, and energy device using ultrasound, RF, laser, etc.).

Known surgical staplers include an end effector that simultaneously makes a longitudinal incision in tissue and applies lines of staples on opposing sides of the incision. The end effector includes a pair of cooperating jaw members that, if the instrument is intended for endoscopic or laparoscopic applications, are capable of passing through a cannula passageway. One of the jaw members receives a staple cartridge having at least two laterally spaced rows of staples. The other jaw member defines an anvil having staple-forming pockets aligned with the rows of staples in the cartridge. The instrument includes a plurality of reciprocating wedges which, when driven distally, pass through openings in the staple cartridge and engage drivers supporting the staples to effect the firing of the staples toward the anvil.

Recently, an improved "E-beam" firing bar was described for a surgical stapling and severing instrument that advantageously included a top pin that slides within an internal slot formed in the upper jaw (anvil) and has a middle pin and bottom foot that slides on opposite sides of a lower jaw of an end effector, or more particularly a staple applying assembly. Distal to the middle pin, a contacting surface actuates a staple cartridge held within an elongate staple channel that forms the lower jaw. Between the contacting surface and the top pin, a cutting surface, or knife, severs tissue clamped between the anvil and the staple cartridge of the lower jaw. Since both jaws are thus engaged by the E-beam, the E-beam maintains a desired spacing between the jaws to ensure proper staple formation. Thus, if a lesser amount of tissue is clamped, the E-beam holds up the anvil to ensure sufficient spacing for the staples to properly form against an undersurface of the anvil. In addition, if a greater amount of tissue is clamped, the E-beam draws down the anvil to ensure that the spacing does not exceed the length of the staple such that ends of each staple are not sufficiently bent to achieve a desired degree of retention. Such an E-beam firing bar is described in U.S. patent application Ser. No. 10/443,617, entitled "Surgical Stapling Instrument Incorporating an E-Beam Firing Mechanism", filed on May 20, 2003, the disclosure of which is hereby incorporated by reference in its entirety.

While an E-beam firing bar has many advantages for a surgical stapling and severing instrument, often it is desirable to sever and staple tissue of various thicknesses. A thin layer of tissue may result in staples that only form loosely, perhaps requiring the need for bolstering material. A thick layer of tissue may result in formed staples that exert a strong compressive force on the captured tissue, perhaps resulting in necrosis, bleeding or poor staple formation/retention. Rather than limiting the range of tissue thicknesses that are appropriate for a given surgical stapling and severing instrument, it would be desirable to accommodate a wider range of tissue thickness with the same surgical stapling and severing instrument.

Consequently, a significant need exists for an improved surgical stapling and severing instrument that incorporates a staple applying assembly (end effector) that adjusts to the amount of tissue that is clamped.

BRIEF SUMMARY OF THE INVENTION

The invention overcomes the above-noted and other deficiencies of the prior art by providing a surgical instrument that incorporates a firing bar that translates through a staple applying assembly having a lower jaw and a pivotally attached upper jaw, engaging each to assist in maintaining the desired spacing between inner surfaces that compress tissue in between. Advantageously, the distance between the two jaws is allowed to flex apart slightly to allow for a larger thickness of compressed tissue, yet the firing bar prevents excessive flexure that would exceed the limits on the device to form staples through the compressed tissue. Thereby, enhanced clinical flexibility is achieved with the same surgical instrument being suitable for a larger range of surgical procedures or to accommodate variations in the patient population.

In one aspect of the invention, a surgical instrument has a lower jaw that includes an elongate staple channel having a longitudinal channel slot formed therein that receives a staple cartridge. Staples in the staple cartridge have a staple length sized for forming a closed staple between a range of tissue thicknesses. A firing bar has a vertical portion passing through a longitudinal anvil slot in an anvil pivotally attached to the elongate staple channel and passes through the longitudinal channel slot formed in the elongate staple channel. An upper lateral surface extending from the vertical portion exerts an inward compressive force on the anvil during firing translation and a lower lateral surface extending from the vertical portion exerts an inward compressive force on the elongate staple channel during firing translation. The firing bar advantageously accommodates the range of effective

staple formation by including a resilient portion that varies in height between a staple forming undersurface of an anvil and an upper surface of the staple cartridge.

In another aspect of the invention, a surgical instrument has an anvil that is pivotally coupled to the elongate staple channel and includes an anvil channel that is internally formed. In particular, a vertical slot inwardly opens along a longitudinal axis of the anvil and has left and right rectangular prism-shaped recesses communicating with, bisected by, and transverse to the vertical slot, wherein said left and right rectangular prism-shaped recesses extend substantially along the longitudinal length of the vertical slot. A firing device that includes a distally presented cutting edge for severing tissue is longitudinally received between the elongate staple channel and the vertical slot of the anvil channel of the anvil. An upper member of the firing device has left and right lateral upper pins sized to slidingly engage upper and lower inner surfaces of the left and right rectangular-shaped recesses of the anvil channel. A lower member of the firing device engages the channel slot in the elongate staple cartridge. A middle member of the firing device actuates the staple cartridge by distally translating a wedge member of the staple cartridge. The firing device positively engages both the elongate staple channel and the anvil during longitudinal firing travel to provide spacing in between for staple formation. Engagement of the firing device during firing maintains vertical spacing between the elongate staple channel and the anvil resisting both pinching due to an inadequate clamped tissue and partial opening due to an excessive amount of clamped tissue. This affirmative spacing is advantageously varied within an effective range of the staple length of the staple cartridge by incorporating a resilient portion in the firing device to allow some flexure to accommodate an increased compression load due to a thicker layer of clamped tissue.

In yet another aspect of the invention, the surgical instrument advantageously operates through an elongate shaft with a closed end effector of upper and lower jaws suitably sized for insertion through a cannula of a trocar to an insufflated body cavity or body lumen.

These and other objects and advantages of the present invention shall be made apparent from the accompanying drawings and the description thereof.

BRIEF DESCRIPTION OF THE FIGURES

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention, and, together with the general description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the present invention.

FIG. **1** is a left side view in elevation of a surgical stapling and severing instrument with an open end effector (staple applying assembly) with a shaft partially cut away to expose a firing member of a proximal firing rod and distal firing bar guided by a frame ground and encompassed by a closure sleeve.

FIG. **2** is a left side view of a closed end effector (staple applying assembly) with a retracted force adjusted height firing bar consistent with the present invention of the surgical stapling and severing instrument of FIG. **1** taken in longitudinal vertical cross section along lines **2**—**2**.

FIG. **3** is a left isometric view of the force adjusted (compliant) height firing bar of FIG. **2**.

FIG. **4** is a left side view of a distal portion ("E-beam") of a first version of the force adjusted height firing bar of FIG. **2** having horizontal slits formed respectively between the top pin and cutting surface and between the middle pin and the cutting surface to enhance vertical flexure.

FIG. **5** is a lower left isometric view of a distal portion ("E-beam") of a second version of the force adjusted firing bar of FIG. **2** having a relieved lower area of an upper pin to enhance vertical flexure.

FIG. **6** is a front view in elevation of an upper portion of the E-beam of FIG. **5** taken in vertical and transverse cross section through the upper pin along lines **6**—**6**.

FIG. **7** is a front view of an upper portion of a third version of the E-beam of FIG. **5** taken in vertical and transverse cross section along lines **6**—**6** but further including relieved upper root attachments of the top pin for enhanced vertical flexure.

FIG. **8** is a front view of an upper portion of a fourth version of the E-beam of FIG. **5** taken in vertical and transverse cross section along lines **6**—**6** but including a resilient inner vertical laminate layer instead of a relieved undersurface of the top pin for enhanced vertical flexure.

FIG. **9** is a front view of an upper portion of a fifth version of the E-beam of FIG. **5** taken in vertical and transverse cross section along lines **6**—**6** but including an upper pin formed of a resilient material instead of a relieved undersurface of the upper pin for enhanced vertical flexure.

FIG. **10** is an upper left isometric view of a distal portion ("E-beam") of a sixth version of the force adjusted firing bar of FIG. **2** having resilient material upon a bottom foot to enhance vertical flexure.

FIG. **11** is a front view in elevation taken in vertical and transverse cross section through the padded lower foot of the end effector (staple applying assembly) of the surgical stapling and severing instrument of FIG. **1**.

FIG. **12** is a left view in elevation of a distal portion ("E-beam") of a seventh version of the force adjusted firing bar of FIG. **2** having a proximally and upwardly extended spring arm attached to a lower foot to enhance vertical flexure.

FIG. **13** is a left top isometric view of a distal portion ("E-beam") of an eighth version of the force adjusted firing bar of FIG. **2** having a spring washer encompassing a lower foot to enhance vertical flexure.

DETAILED DESCRIPTION OF THE INVENTION

Turning to the Drawings, wherein like numerals denote like components throughout the several views, in FIG. **1**, a surgical stapling and severing instrument **10** includes a handle portion **12** that is manipulated to position an implement portion **14** including a fastening end effector, depicted as a staple applying assembly **16**, distally attached to an elongate shaft **18**. The implement portion **14** is sized for insertion through a cannula of a trocar (not shown) for an endoscopic or laparoscopic surgical procedure with an upper jaw (anvil) **20** and a lower jaw **22** of the staple applying assembly **16** closed by depression of a closure trigger **24** toward a pistol grip **26** of the handle portion **12**, which advances an outer closure sleeve **28** of the elongate shaft **18** to pivot shut the anvil **20**.

Once inserted into an insufflated body cavity or lumen, the surgeon may rotate the implement portion **14** about its longitudinal axis by twisting a shaft rotation knob **30** that engages across a distal end of the handle **12** and a proximal end of the elongate shaft **18**. Thus positioned, the closure trigger **24** may be released, opening the anvil **20** so that tissue may be grasped and positioned. Once satisfied with the tissue held in the staple applying assembly **16**, the surgeon depresses the closure trigger **24** until locked against the pistol grip **26**, clamping tissue inside of the staple applying assembly **16**.

Then a firing trigger **32** is depressed, drawn toward the closure trigger **24** and pistol grip **26**, thereby distally advancing a firing member, depicted as including a proximal firing rod **34** attached to a distal firing bar **36**, that is supported within a frame ground **38** that connects the handle portion **12** to the staple applying assembly **16**. The firing bar **36** engages an elongate staple channel **40** and actuates a staple cartridge **42** contained therein, both forming the lower jaw **22**. The firing bar **36** also engages the closed anvil **20**. After releasing the firing trigger **32** to retract the firing bar **36**, depression of a closure release button **44** unclamps the closure trigger **24** so that the closure sleeve **28** may be retracted to pivot and open the anvil **20** to release the severed and stapled tissue from the staple applying assembly **16**.

In FIG. **2**, the staple applying assembly **16** is closed upon compressed tissue **46**. In FIGS. **2–3**, the firing bar **36** has a proximal portion **48** that is attached to a distal E-beam **50** that translates within the staple applying assembly **16**. As depicted with the firing bar **36** retracted, a vertical portion **52** of the E-beam **50** resides essentially aft of the staple cartridge **42**, as after a new staple cartridge **42** has been inserted into the elongate staple channel **40**. An upper pin **54** that extends laterally from an upper portion of the vertical portion **52** of the E-beam **50** initially resides within an anvil pocket **56** recessed near a proximal pivoting end of the anvil **20**. As the E-beam **50** is distally advanced during firing, the vertical portion **52** passes through a narrow longitudinal anvil slot **58** (FIGS. **1**, **11**) formed in an undersurface **60** of the anvil **20**, a proximally open vertical slot **62** formed in the staple cartridge **42** and an underlying longitudinal channel slot **64** formed in the elongate staple channel **40**.

In FIGS. **2**, **11**, the narrow longitudinal anvil slot **58** (FIG. **2**) communicates upwardly to a laterally widened longitudinal anvil channel **66** sized to slidingly receive the upper pin **54**. The longitudinal channel slot **64** communicates downwardly to a laterally widened longitudinal channel track **68** that receives a lower foot **70**, which is sized to slide therein and is attached at a bottom of the vertical portion **52** of the E-beam **50**. A laterally widened middle pin **72** extending from the vertical portion **52** of the E-beam **50** is positioned to slide along a top surface of a bottom tray **74** of the staple cartridge **42**, which in turn rests upon the elongate staple channel **40**. A longitudinal firing recess **75** formed in the staple cartridge **42** above the bottom tray **74** is sized to allow the middle pin **72** to translate through the staple cartridge **42**.

A distal driving surface **76** of the vertical portion **52** of the E-beam **50** is positioned to translate through the proximally open vertical slot **62** of the staple cartridge **42** and distally drive a wedge sled **78** proximally positioned in the staple cartridge **42**. The vertical portion **52** of the E-beam **50** includes a cutting surface **80** along a distal edge above the distal driving surface **76** and below the upper pin **54** that severs the clamped tissue **46** simultaneously with this stapling.

With particular reference to FIG. **11**, it should be appreciated that the wedge sled **78** drives upwardly staple drivers **82** that in turn drive upwardly staples **83** out of staple apertures **84** formed in a staple body **85** of the staple cartridge **42** to form against the undersurface **60** of the anvil **20** (FIG. **2**).

In FIGS. **2**, **11**, advantageously, the illustrative spacing, denoted by arrow **86** (FIG. **2**), between the upper pin **54** is compliantly biased toward a compressed state wherein 0.015 inches of compressed tissue **46** is contained in the staple applying assembly **16**. However, a larger amount of compressed tissue **46** up to about 0.025 inches is allowed by an inherent flexure of the E-beam **50**. Excessive flexure, of perhaps up to 0.030 inches, is avoided should the length of staples be insufficient to form with the additional height. It should be appreciated that these dimensions are illustrative for a staple height of 0.036 inches. The same would be true for each category of staple, however.

In FIG. **4**. a first version of a compliant E-beam **50***a* includes top and bottom horizontal slits **90**, **92** from a distal edge of the vertical portion **52***a*, perhaps formed by electro drilling machine (EDM). The vertical portion **52***a* thus contains a vertically compliant top distally projecting arm **94** containing the upper pin **54**, a knife flange **96** containing the cutting surface **80**, and a lower vertical portion **98** containing the distal driving surface **76**, middle pin **72** and lower foot **70**. The horizontal slits **90**, **92** allow a compliant vertical spacing by allowing the top distally arm **94** to pivot upwardly to adjust to increased force from compressed tissue **46** (not shown).

In FIGS. **5–6**, a second version of a compliant E-beam **50***b* includes left and right lower relieved areas **110**, **112** formed into an upper pin **54***b* to each side of the vertical portion **52**, leaving left and right lower bearing points **114**, **116** respectively. The outboard position of the bearing points **114**, **116** provides a long moment arm to exert the force to flex. It should be appreciated given the benefit of the present disclosure that the dimensions of the relieved areas **110**, **112** and the choice of materials for the compliant E-beam **50***b* may be selected for a desired degree of flexure, given the staple size and other considerations.

In FIG. **7**, a third version of a compliant E-beam **50***c* is as described above in FIGS. **5–6** with further flexure provided by left and right upper narrow relieved areas **120**, **122** formed into opposite top root surfaces of an upper pin **54***c* proximate to the vertical portion **52**.

In FIG. **8**, a fourth version of a compliant E-beam **50***d* is as described for FIGS. **2–3** with an added feature of a composite/laminate vertical portion **52***d* that includes a central resilient vertical layer **130** sandwiched between left and right vertical layers **132**, **134** that support respectively left and right portions **136**, **138** of an upper pin **54***d*. As the left and right portions **136**, **138** are flexed either up or down, the resulting bowing of the left and right vertical layers **132**, **134** are accommodated by a corresponding compression or expansion of the central resilient vertical layer **130**.

In FIG. **9**, a fifth version of a compliant E-beam **50***e* is as described for FIGS. **2–3** with an added feature of a discrete upper pin **54***e* formed of a more flexible material that is inserted through a horizontal aperture **140** through a vertical portion **52***e*. Thus, left and right outer ends **142**, **144** of the discrete upper pin **54***e* flex in accordance with loading forces.

Alternatively or in addition to incorporating flexure into an upper pin **54**, in FIGS. **10–11**, a sixth version of a compliant E-beam **50***f* as described for FIGS. **2–3** further includes resilient pads **150** that are attached to upper surfaces **152** of the bottom foot **70**. The resilient pads **150** adjust the spacing of the upper pin **54** in accordance to the compression force experienced at the bottom foot **70**.

In FIG. **12**, a seventh version of a compliant E-beam **50***g* is as described above for FIGS. **2–3** with the added feature of a bottom foot (shoe) **70***g* having an upwardly aft extended spring finger **160** that resiliently urges the E-beam **50***g* downwardly to adjust vertical spacing in accordance with loading force.

In FIG. **13**, an eighth version of a compliant E-beam **50***h* is as described above in FIGS. **2–3** with the added feature of an oval spring washer **170** resting upon the bottom foot **70** encircling the vertical portion **52** and having an upwardly bowed central portion **172** that resiliently urges the E-beam **50***h* downwardly to adjust vertical spacing in accordance with loading force.

While the present invention has been illustrated by description of several embodiments and while the illustrative embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications may readily appear to those skilled in the art.

For example, while a manually operated surgical stapling and severing instrument **10** is depicted for clarity, it should be appreciated that robotically manipulated and/or controlled fastening devices may incorporate a force controlled firing bar.

For another example, a compliant E-beam consistent with aspects of the present invention may include engagement to an anvil similar to the engagement in the illustrative versions of two structures that slide against opposite sides of the elongate staple channel. Similarly, a compliant E-beam may engage a lower jaw by having a laterally widened portion that slides internally within a channel formed in a lower jaw structure.

As yet an additional example, in the illustrative version, the staple cartridge **42** is replaceable so that the other portions of the staple applying assembly **16** may be reused. It should be appreciated given the benefit of the present disclosure that applications consistent with the present invention may include a larger disposable portion, such as a distal portion of an elongate shaft and the upper and lower jaws with a staple cartridge permanently engaged as part of the lower jaw.

As yet another example, the illustrative E-beam advantageously affirmatively spaces the upper and lower jaws from each other. Thus, the E-beam has inwardly engaging surfaces that pull the jaws together during firing in instances where a larger amount of compressed tissue tends to spread the jaws. Thereby the E-beam prevents malformation of staples due to exceeding their effective length. In addition, the E-beam has outwardly engaging surfaces that push the jaws apart during firing in stances where a small amount of tissue or other structure attributes of the instrument tend to pinch the jaws together that may result in staple malformation. Either or both functions may be enhanced by applications consistent with aspects of the invention wherein inherent flexure in the E-beam adjusts to force to allow a degree of closing of the jaws or of opening of the jaws.

What is claimed is:

1. A surgical instrument, comprising:

a handle portion operable to produce a firing motion;

an implement portion responsive to the firing motions from the handle portion, the implement portion comprising:

an elongate staple channel coupled to the handle portion and including a channel slot,

a staple cartridge having an upper surface and received in the elongate staple channel and containing a plurality of staples each having a staple length sized for forming a closed staple between a first height and a second height,

a wedge member movably positioned in the implement portion to drive the plurality of staples of the staple cartridge;

an anvil pivotally coupled to the elongate staple channel and including an anvil channel comprising a vertical slot inwardly open along a longitudinal axis of the anvil and comprising left and right rectangular prism-shaped recesses communicating with, bisected by, and transverse to the vertical slot, wherein said left and right rectangular prism-shaped recesses extend substantially along the longitudinal length of the vertical slot;

a firing device including a distally presented cutting edge longitudinally received between the elongate staple channel and the vertical slot of the anvil channel of the anvil, an upper member comprised of left and right lateral upper pins sized to slidingly engage upper and lower inner surfaces of the left and right rectangular-shaped recesses of the anvil channel, a lower member engaging the channel slot, and a middle member operable to actuate the staple cartridge by distally translating the wedge member through the staple cartridge, the firing device positively engaging both the elongate staple channel and the anvil during longitudinal firing travel to provide spacing therebetween for staple formation, and wherein engagement of the firing device during firing maintains vertical spacing between the elongate staple channel and the anvil resisting both pinching due to an inadequate clamped tissue and partial opening due to an excessive amount of clamped tissue; and

a resilient portion of the firing device allowing a height between the staple forming undersurface of the anvil and the upper surface of the staple cartridge to vary between the first and second heights of the closed staples in relation to the clamped tissue thickness.

2. The surgical instrument of claim **1**, wherein the anvil forms an inwardly biased relation to the elongate staple channel configured to assist the firing device in affirmatively spacing between the anvil and elongate staple channel during actuation of the staple cartridge.

3. The surgical instrument of claim **2**, further comprising a closure member operatively configured to longitudinally transfer the closure motion to the implement portion to inwardly bias distal ends of the anvil and the elongate staple channel to assist the firing device in affirmatively spacing the anvil and elongate staple channel during actuation of the staple cartridge.

4. The surgical instrument of claim **1**, wherein the staple cartridge is a selected type of a plurality of staple cartridge types, each staple cartridge type characterized by a thickness selected for a desired spacing between the anvil and elongate staple channel and characterized by staples having a length suitable for the desired spacing.

5. The surgical instrument of claim **4**, wherein the wedge member comprises a wedge sled having a plurality of connected camming wedges each having a preselected height configured for the selected type of staple cartridge, the middle member of the firing device oriented to abut each of the plurality of staple cartridge types.

6. A surgical instrument comprising:

a handle portion operable to produce a firing motion and a closing motion; and

an implement portion responsive to the firing motions from the handle portion and diametrically dimensioned for endo-surgical use, the implement portion comprising:

a shaft coupled to the handle portion operable to separately transfer the firing motion and the closing motion,

an elongate staple channel coupled to the shaft and including a channel slot and operatively configured to receive a staple cartridge having an upper surface,

an anvil pivotally coupled to the elongate staple channel, responsive to the closing motion from the shaft, and including an anvil channel, and

a firing device including a distally presented cutting edge longitudinally received between the elongate staple channel and the anvil, the firing device configured to affirmatively space the anvil from the elongate

staple channel during longitudinal travel between the anvil and elongate staple channel,

a resilient portion of the firing device allowing a height between a staple forming undersurface of the anvil and the upper surface of the staple cartridge to vary between the first and second heights in relation to the clamped tissue thickness,

wherein the firing device is configured to affirmatively space the anvil from the elongate staple channel during longitudinal travel between the anvil and elongate staple channel by including an upper member having an upper surface and a lower surface that longitudinally slidingly engage the anvil.

7. The surgical instrument of claim **6**, wherein the anvil includes a longitudinal slot having an upper surface and a lower surface that slidingly abut respectively the lower surface and upper surface of the upper member of the firing device.

8. The surgical instrument of claim **7**, wherein the longitudinal slot comprises an internal longitudinal channel communicating with a narrowed vertical slot, and wherein the firing device translates in the narrowed vertical slot and includes an upper member having the upper and lower surfaces that reside within the internal longitudinal channel for affirmatively spacing the anvil from the elongate staple channel.

9. The surgical instrument of claim **6**, wherein the firing device is configured to affirmatively space the anvil from the elongate staple channel during longitudinal travel between the anvil and elongate staple channel by including a lower portion having an upper surface and a lower surface that slidingly engage the elongate staple channel.

10. The surgical instrument of claim **9** wherein the lower portion of the firing device comprises a lower pin having the upper surface abutting the elongate staple channel and comprises a middle pin having the lower surface opposingly abutting the elongate staple channel.

11. The surgical instrument of claim **10**, wherein the firing device further comprises an upper member having an upper surface and a lower surface that longitudinally slidingly engage the anvil.

12. The surgical instrument of claim **11**, wherein the anvil includes an internal longitudinal slot having a narrowed vertical slot, and wherein the firing device translates in the narrowed vertical slot and includes an upper member having upper and lower surfaces that reside within the internal longitudinal slot for affirmatively spacing the anvil from the elongate staple channel.

13. The surgical instrument of claim **6**, further comprising a staple cartridge engaged by the elongate staple channel and including a proximally opened slot for receiving the cutting edge of the firing device, the staple cartridge including a plurality of staples cammed upwardly by the distal longitudinal movement of the firing mechanism.

14. The surgical instrument of claim **13**, wherein the staple cartridge further includes a plurality of drivers supporting the plurality of staples and a wedge sled responsive to the distal longitudinal movement of the firing mechanism to cam upwardly the drivers and thus form the plurality of staples against the anvil.

15. The surgical instrument of claim **13**, wherein the anvil forms an inwardly biased relation to the elongate staple channel configured to assist the firing device in affirmatively spacing between the anvil and elongate staple channel during actuation of the staple cartridge.

16. The surgical instrument of claim **13**, wherein the staple cartridge is a selected type of a plurality of staple cartridge types, each staple cartridge type characterized by a thickness selected for a desired spacing between the anvil and elongate staple channel and characterized by staples having a length suitable for the desired spacing.

17. The surgical instrument of claim **16**, wherein the wedge sled comprises a plurality of connected camming wedges each having a preselected height configured for the selected type of staple cartridge, the middle member of the firing device oriented to abut each of the plurality of staple cartridge types.

* * * * *

专利名称(译)	具有受力控制的间隔末端执行器的外科缝合器械		
公开(公告)号	US7407078	公开(公告)日	2008-08-05
申请号	US11/231456	申请日	2005-09-21
[标]申请(专利权)人(译)	伊西康内外科公司		
申请(专利权)人(译)	爱惜康内镜手术，INC.		
当前申请(专利权)人(译)	EHTHICON ENDO-外科INC.		
[标]发明人	SHELTON IV FREDERICK E MORGAN JEROME R		
发明人	SHELTON, IV, FREDERICK E. MORGAN, JEROME R.		
IPC分类号	A61B17/072		
CPC分类号	A61B17/07207 A61B19/30 A61B2017/320052 A61B2017/07278 A61B2017/07285 A61B2017/0725 A61B90/03		
审查员(译)	NASH，BRIAN D.		
其他公开文献	US20070075114A1		
外部链接	Espacenet USPTO		

摘要(译)

用于内窥镜或腹腔镜插入手术部位以同时缝合和切断组织的手术器械包括上颌（砧）和下颌（钉仓接合到细长钉通道）之间的力调节间隔，使得高度为钉的形成对应于组织的厚度，但是不超过钉的长度可以适应的高度范围。特别地，弹性结构形成为电子束击发杆，其包括切割表面（刀），该切割表面在与砧座接合的顶销和与下颚接合的中间销和下脚之间切断组织。弹性响应于被夹紧的组织施加的力以改变间距。