US009668736B2

(12) **United States Patent**
Holsten et al.

(10) **Patent No.: US 9,668,736 B2**
(45) **Date of Patent: *Jun. 6, 2017**

(54) **SURGICAL STAPLING INSTRUMENTS INCLUDING A CARTRIDGE HAVING MULTIPLE STAPLES SIZES**

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(73) Assignee: **Covidien LP**, Mansfield, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/232,009**

(22) Filed: **Aug. 9, 2016**

(65) **Prior Publication Data**

US 2016/0345975 A1 Dec. 1, 2016

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(Continued)

(51) **Int. Cl.**
A61B 17/068 (2006.01)
A61B 17/072 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC .. ***A61B 17/07207*** (2013.01); ***A61B 17/00491*** (2013.01); ***A61B 17/068*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC . A61B 17/068; A61B 17/0686; A61B 17/072; A61B 17/07207; A61B 17/115;
(Continued)

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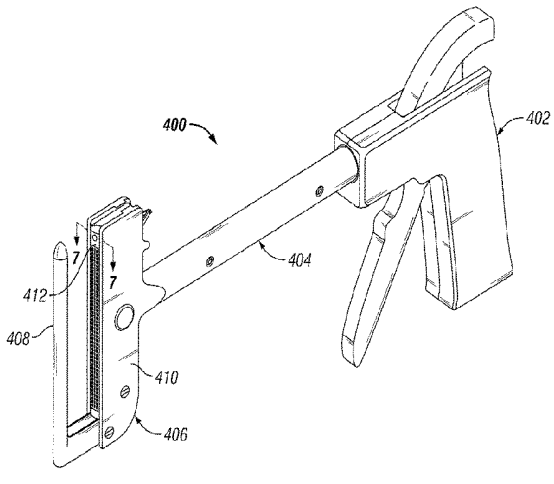
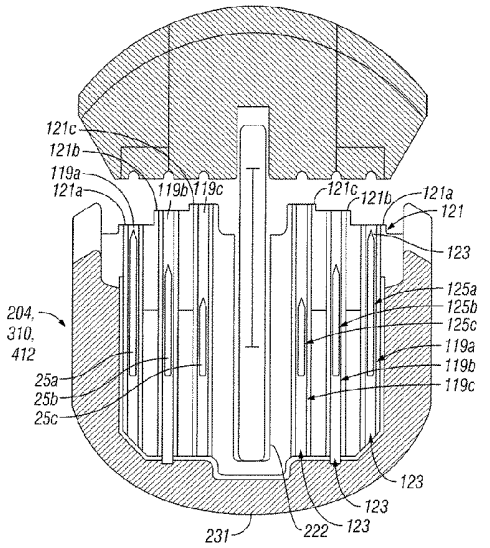
Primary Examiner — Scott A. Smith

(57) **ABSTRACT**

A surgical stapling apparatus includes a staple cartridge and an anvil member. The staple cartridge includes a plurality of surgical fasteners disposed in rows of retention slots. The staple cartridge may have an annular or linear configuration of retention slots. The tissue contacting surface of the staple cartridge may be tapered or stepped. The anvil member has a tissue contacting surface that includes a number of pockets arranged for substantially aligning with the retention slots. In addition, the tissue contacting surface of the anvil member may complement the tissue contacting surface of the staple cartridge.

16 Claims, 35 Drawing Sheets





Related U.S. Application Data

No. 14/824,712, filed on Aug. 12, 2015, now Pat. No. 9,192,387, which is a continuation of application No. 14/491,328, filed on Sep. 19, 2014, now Pat. No. 9,370,365, which is a continuation of application No. 14/249,820, filed on Apr. 10, 2014, now Pat. No. 8,925,786, which is a continuation of application No. 14/071,783, filed on Nov. 5, 2013, now Pat. No. 8,840,004, which is a continuation of application No. 13/419,586, filed on Mar. 14, 2012, now Pat. No. 8,579,178, which is a continuation of application No. 13/286,544, filed on Nov. 1, 2011, now Pat. No. 8,157,152, which is a continuation of application No. 12/916,926, filed on Nov. 1, 2010, now Pat. No. 8,070,035, which is a continuation of application No. 12/556,760, filed on Sep. 10, 2009, now Pat. No. 7,837,081, which is a division of application No. 12/178,739, filed on Jul. 24, 2008, now Pat. No. 7,588,174, which is a division of application No. 11/974,637, filed on Oct. 15, 2007, now Pat. No. 7,455,676, which is a continuation of application No. 11/592,566, filed on Nov. 3, 2006, now Pat. No. 7,398,908, which is a continuation-in-part of application No. 11/436,222, filed on May 18, 2006, now Pat. No. 7,401,721, which is a continuation-in-part of application No. 11/204,060, filed on Aug. 15, 2005, now Pat. No. 7,407,075.

(51) **Int. Cl.**

A61B 17/10	(2006.01)
A61B 17/00	(2006.01)
A61B 17/11	(2006.01)
A61B 17/115	(2006.01)
A61B 17/3205	(2006.01)
A61B 17/32	(2006.01)

(52) **U.S. Cl.**

CPC ***A61B 17/072*** (2013.01); ***A61B 17/105*** (2013.01); ***A61B 17/11*** (2013.01); ***A61B 17/115*** (2013.01); ***A61B 17/1114*** (2013.01); ***A61B 17/1155*** (2013.01); ***A61B 17/32*** (2013.01); *A61B 17/32053* (2013.01); *A61B 2017/07214* (2013.01); *A61B 2017/07235* (2013.01); *A61B 2017/07242* (2013.01); *A61B 2017/07257* (2013.01); *A61B 2017/07271* (2013.01); *A61B 2017/07278* (2013.01); *A61B 2017/320052* (2013.01)

(58) **Field of Classification Search**

CPC A61B 17/1155; A61B 17/07292; A61B 2017/07214

USPC .. 227/19, 175.1, 175.2, 176.1, 178.1, 180.1; 606/139, 153, 219

See application file for complete search history.

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Chinese Invalidation Decision dated May 3, 2016, issued in Chinese Application No. 200610138870 (2016042700003390).

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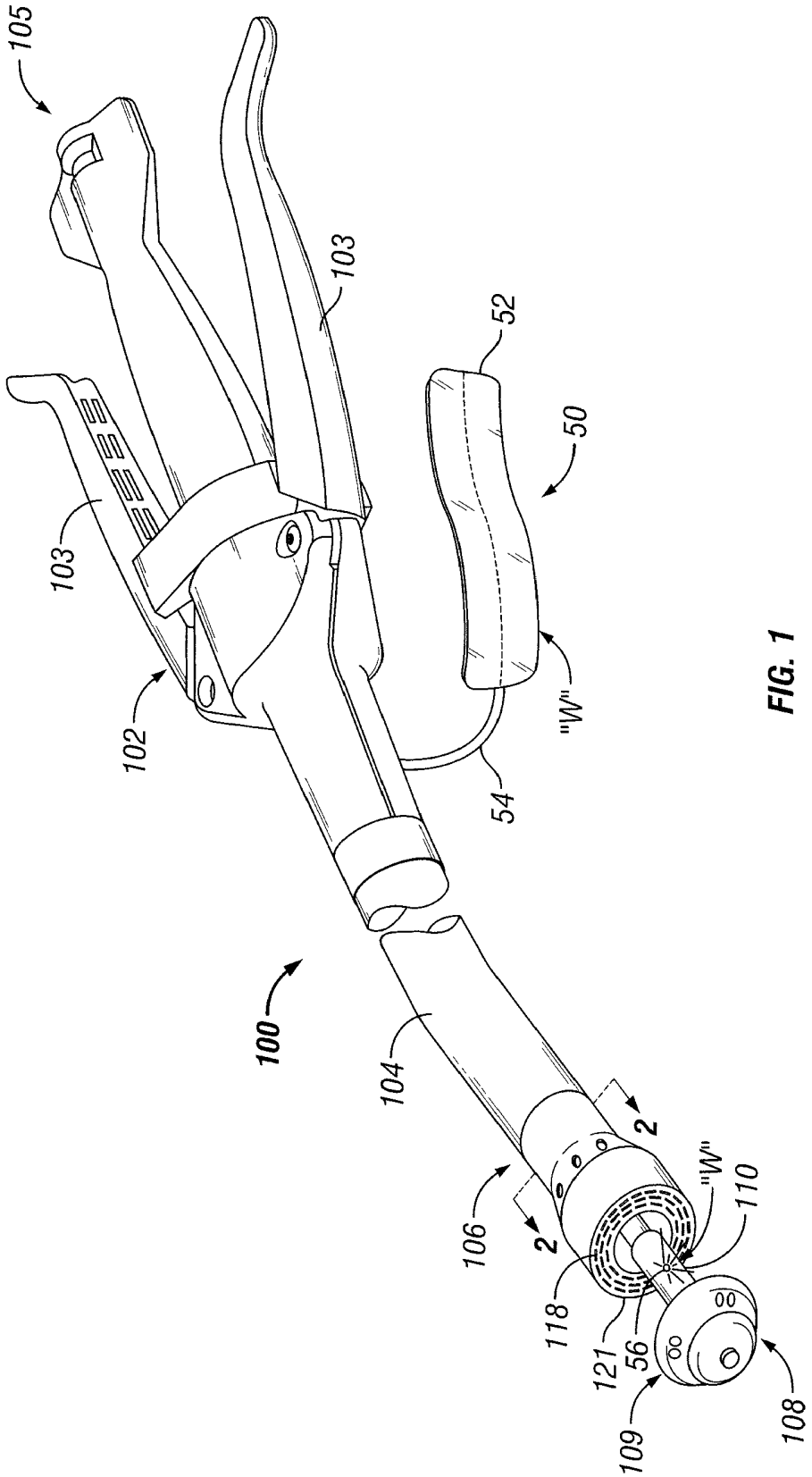

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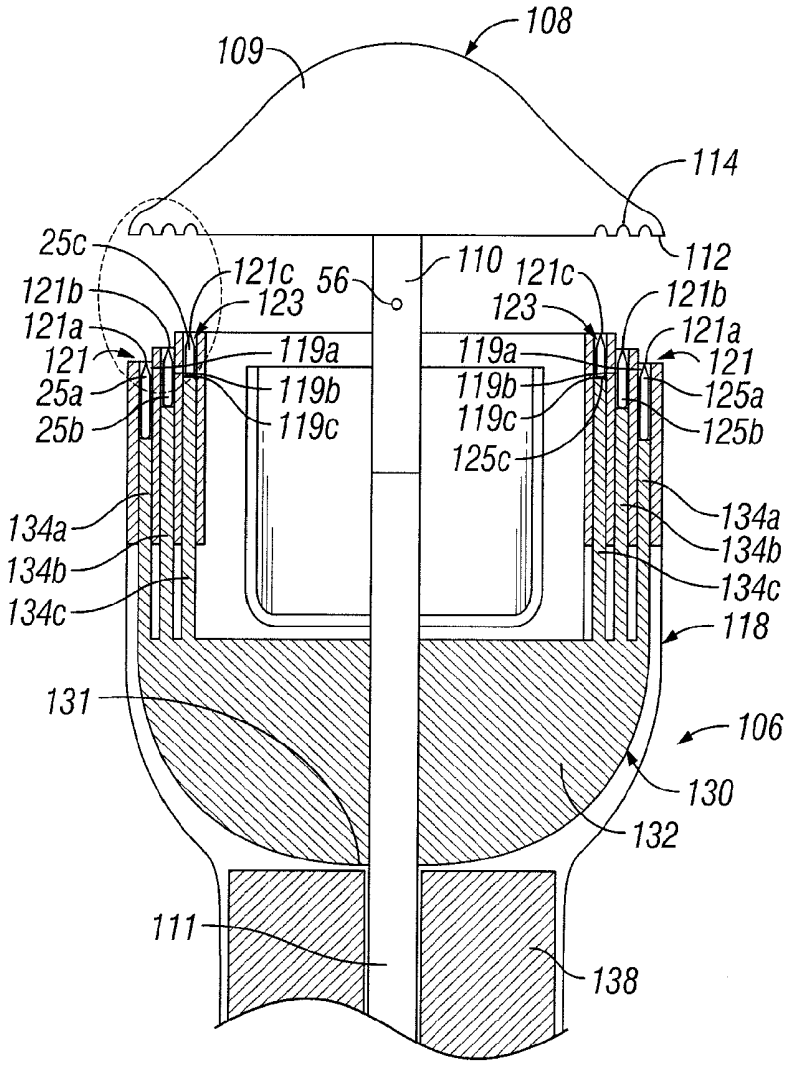
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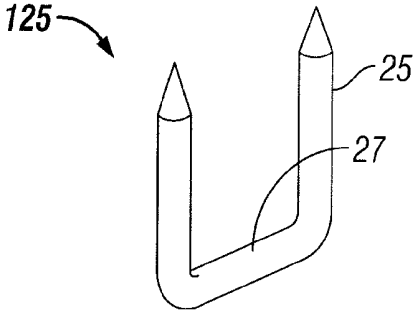
FIG. 2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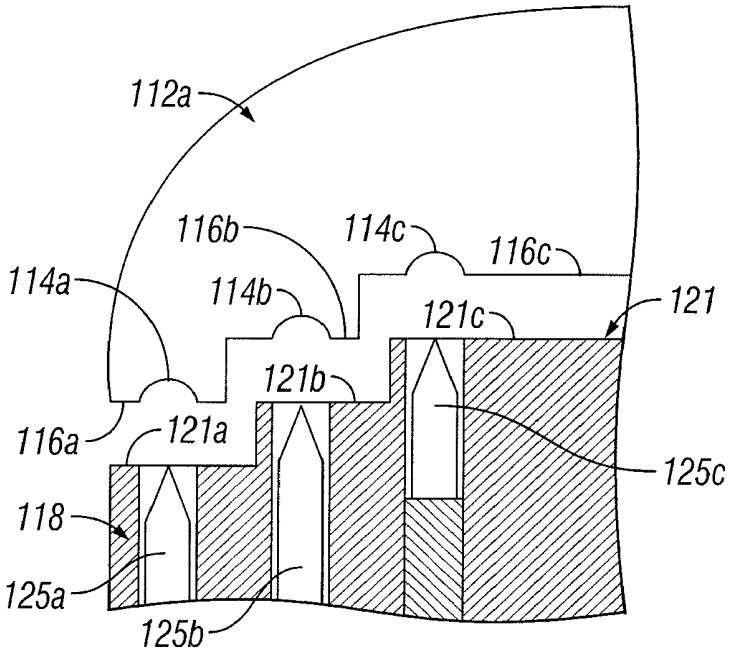
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FIG. 3A

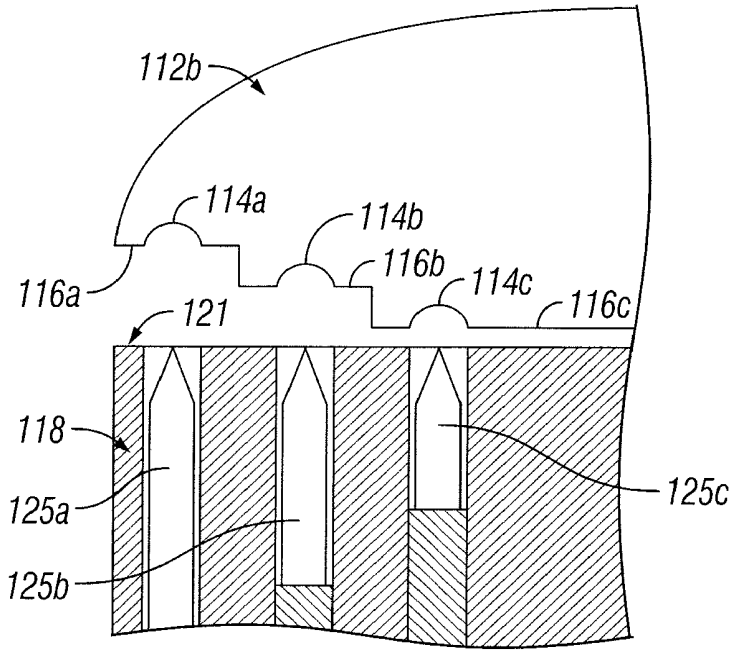
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FIG. 3B

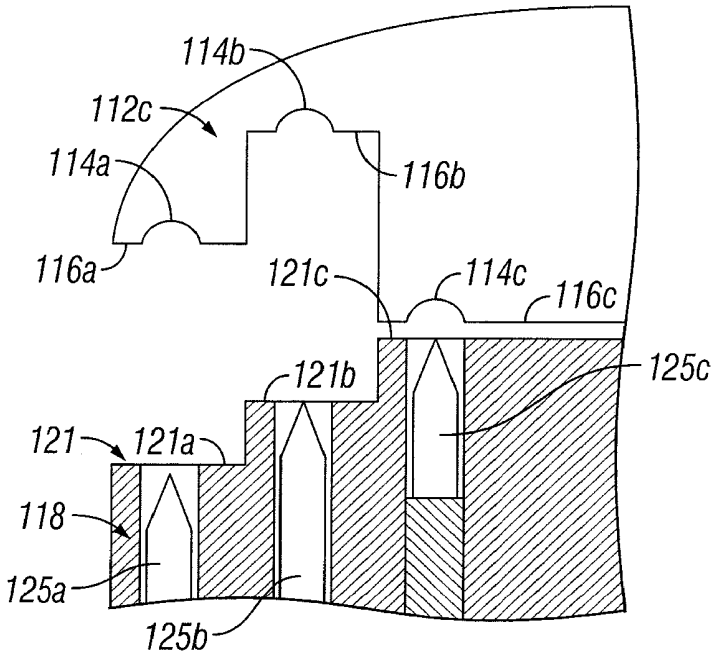
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FIG. 3C

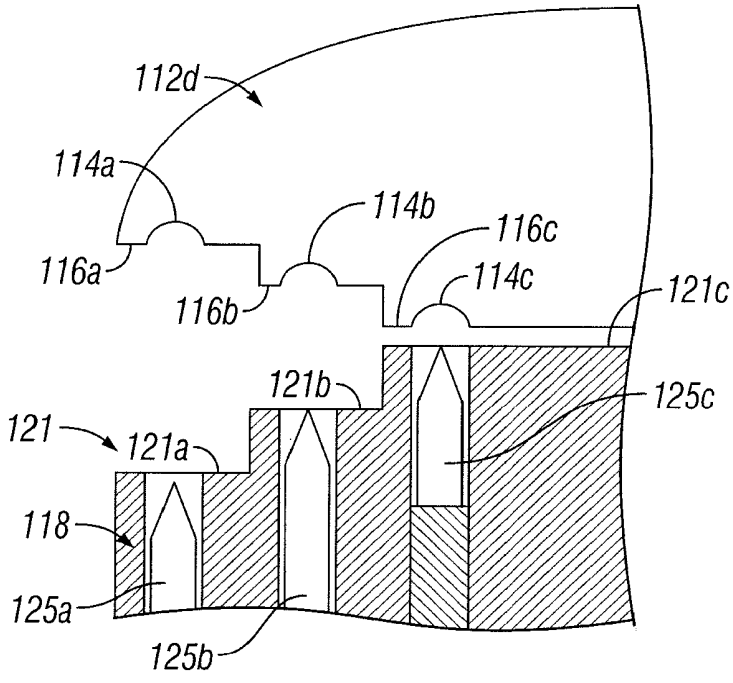
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FIG. 3D

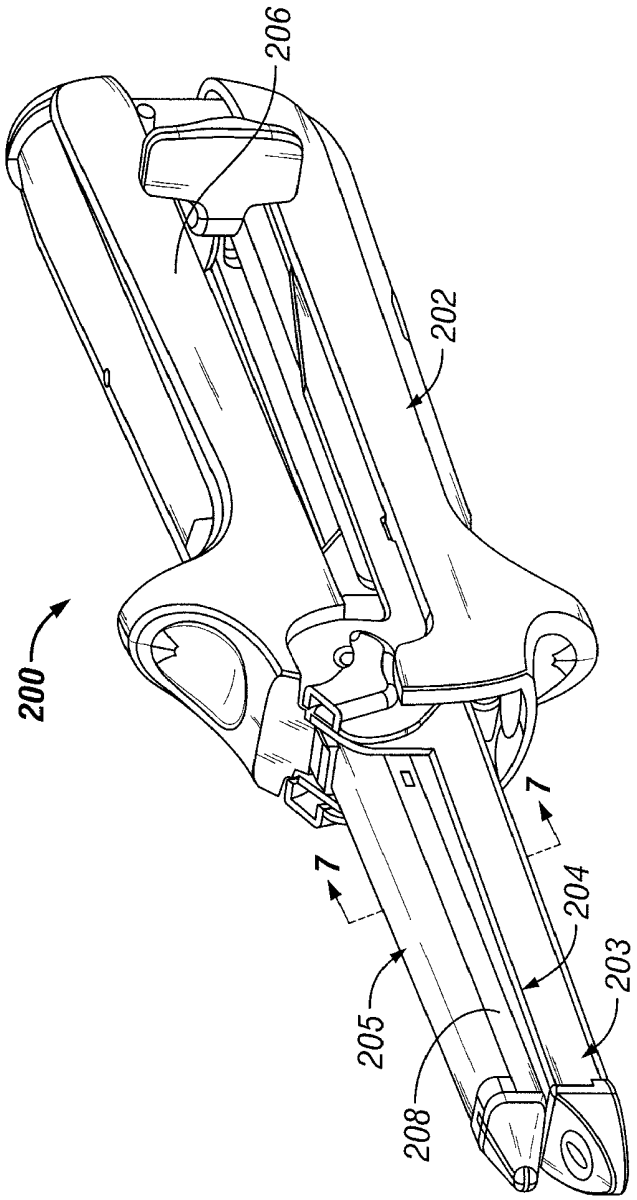


FIG. 4

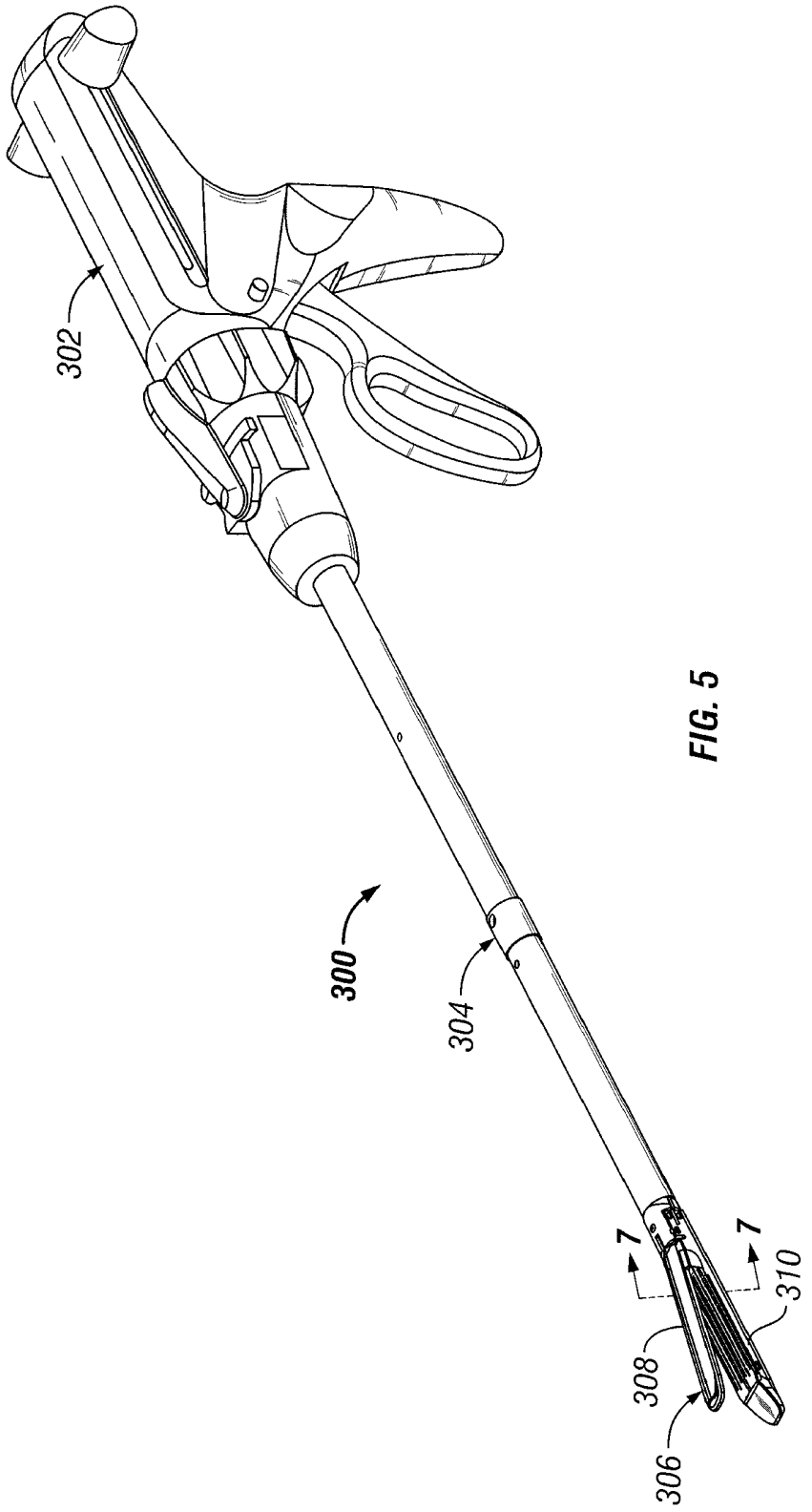
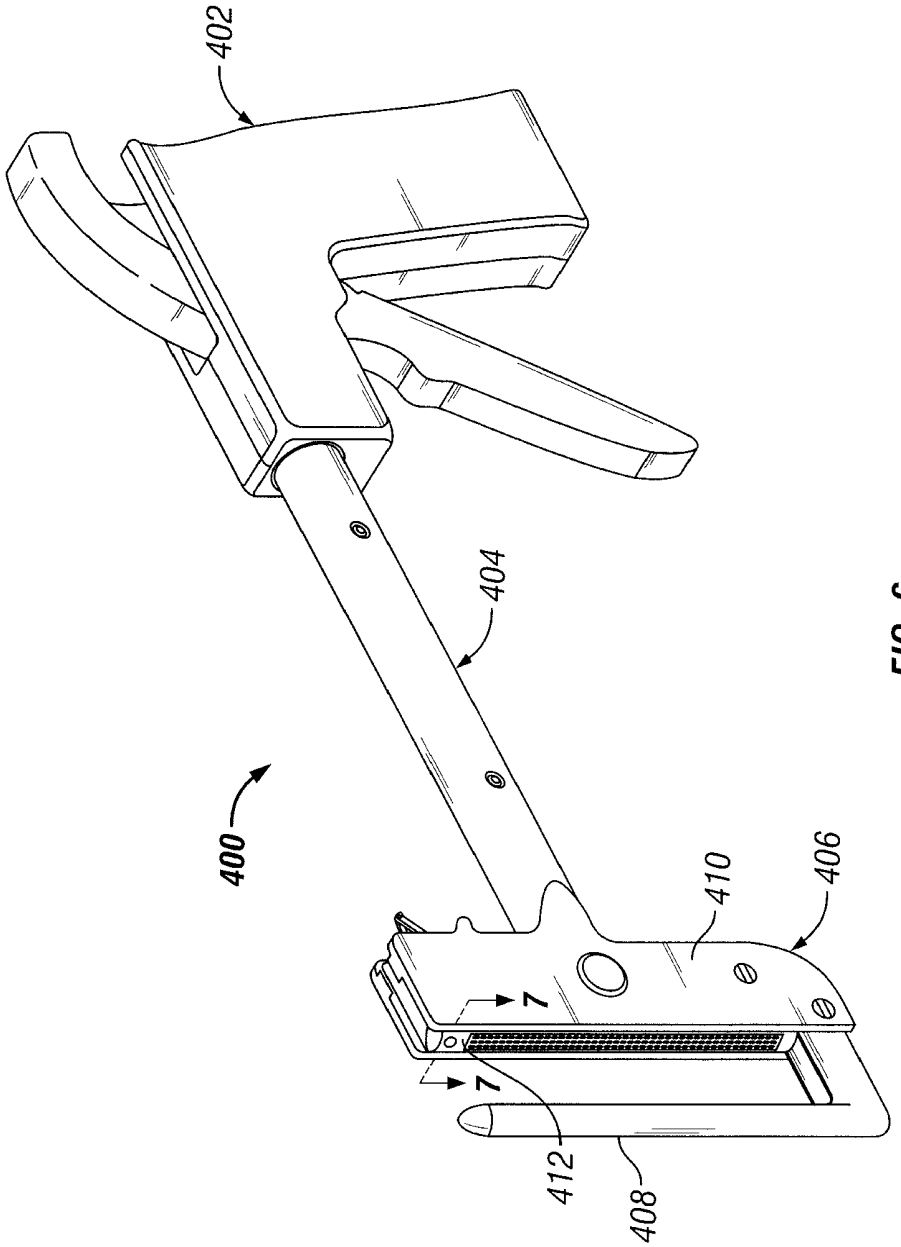


FIG. 5



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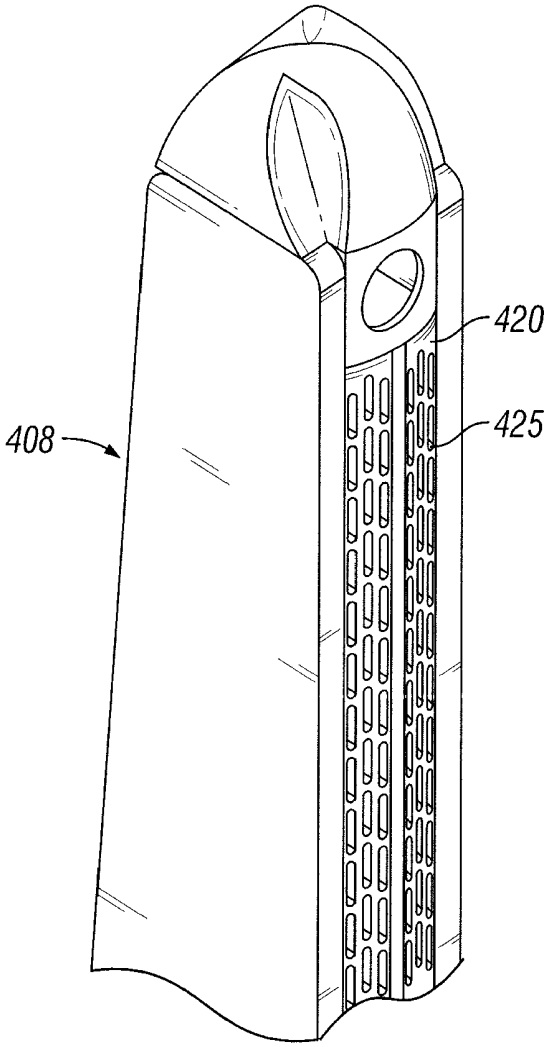
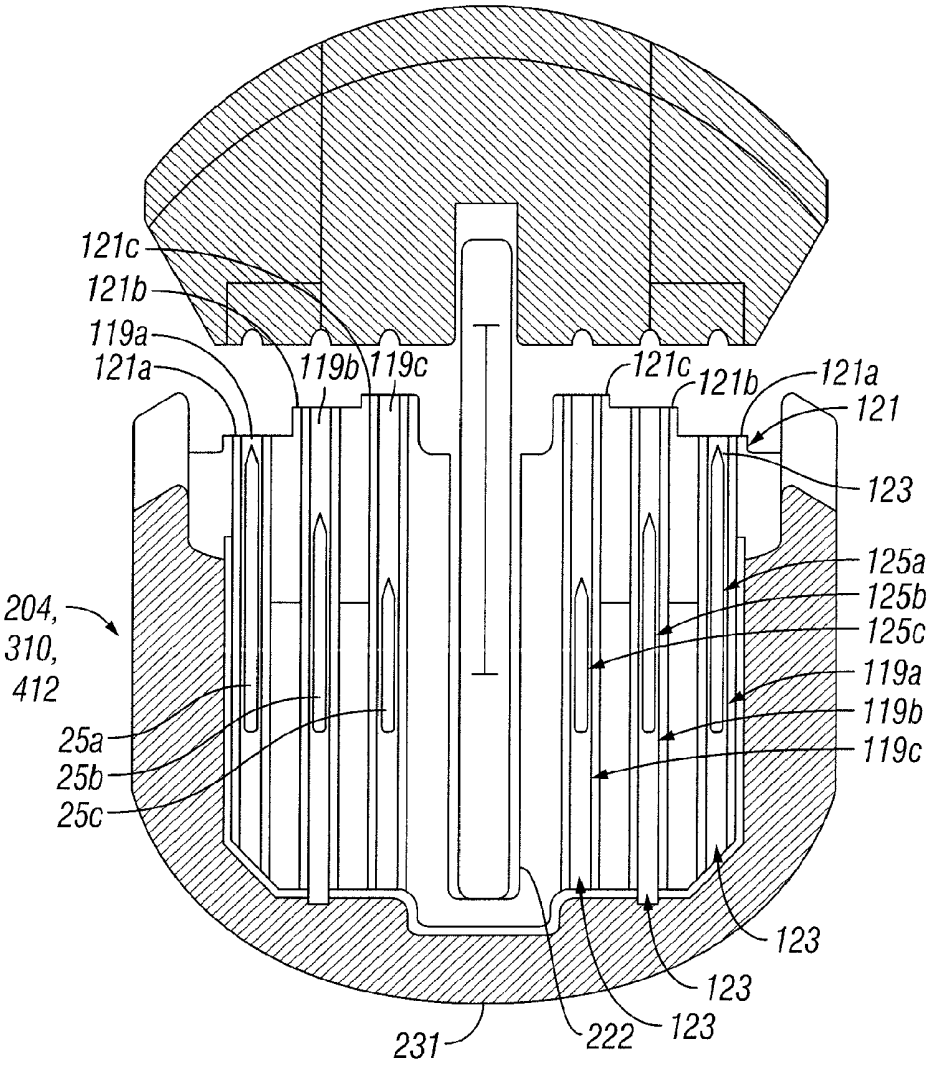


FIG. 6A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25c
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222
231

FIG. 7

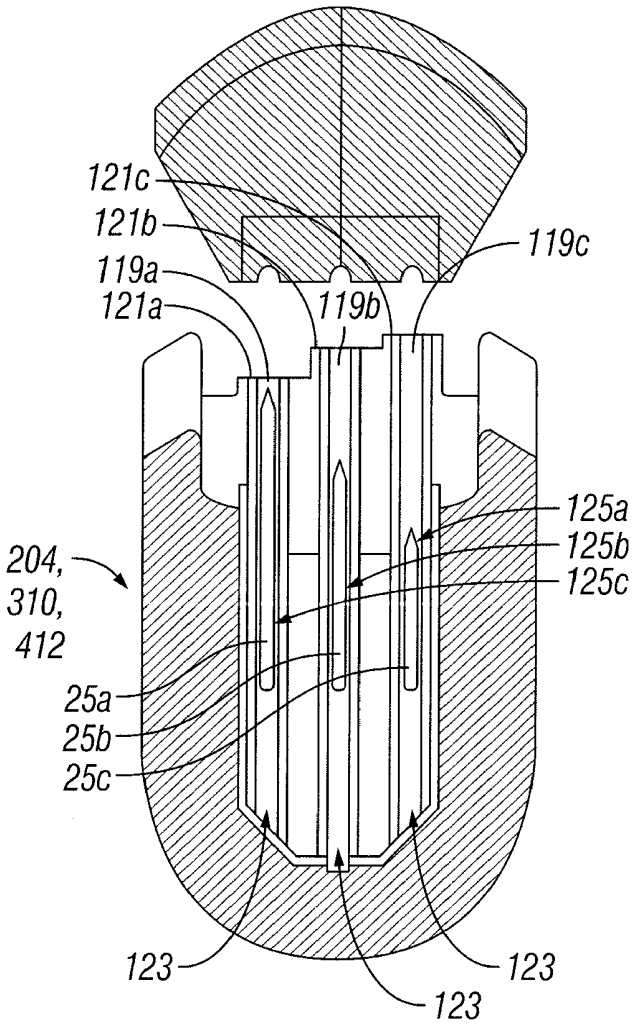
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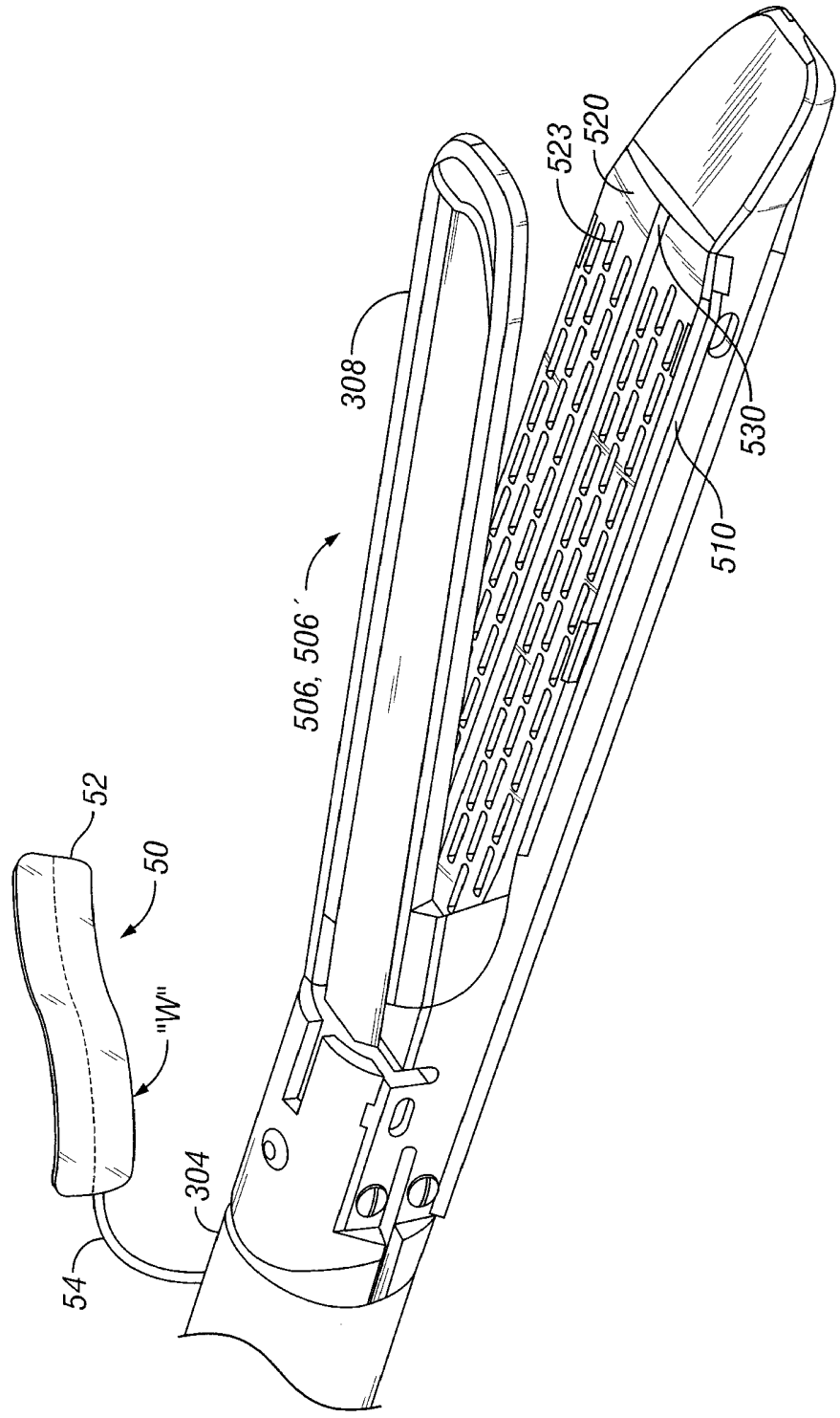
FIG. 7A



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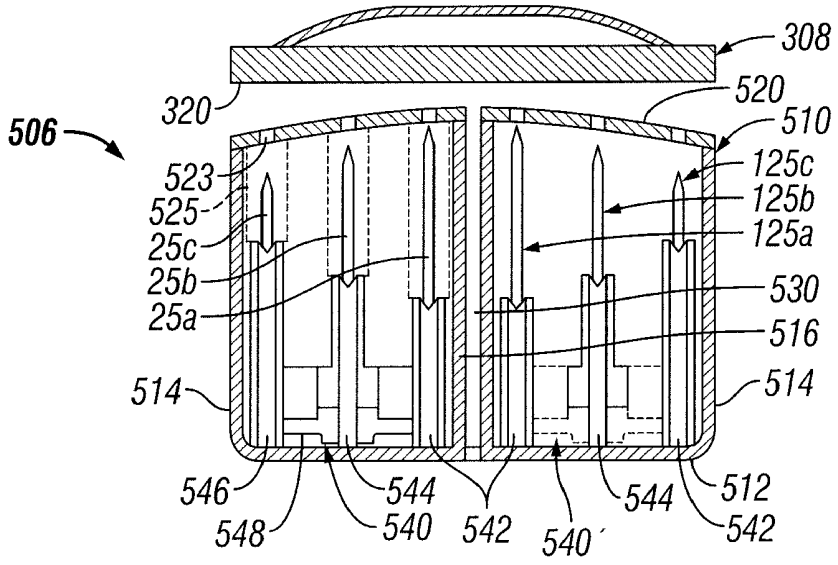
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542
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544
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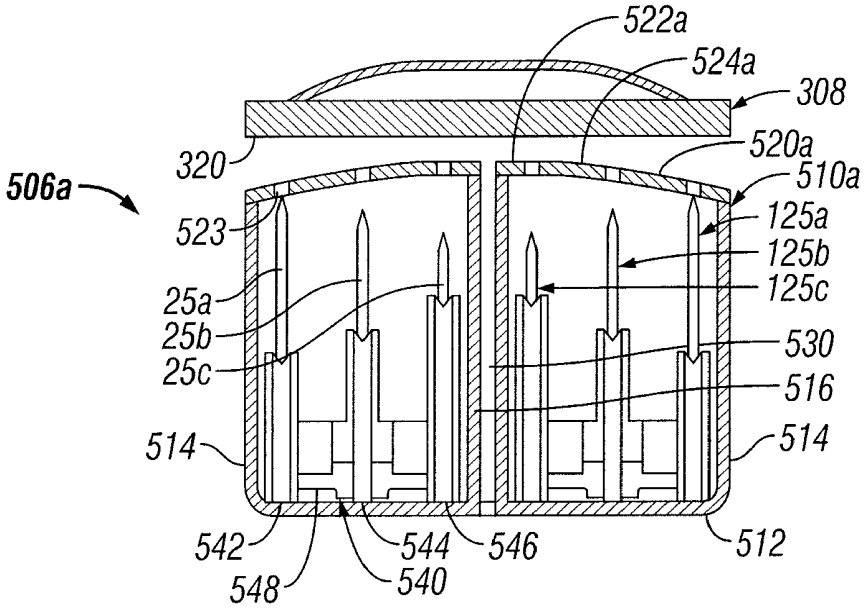
542

FIG. 9A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546
512

FIG. 9B

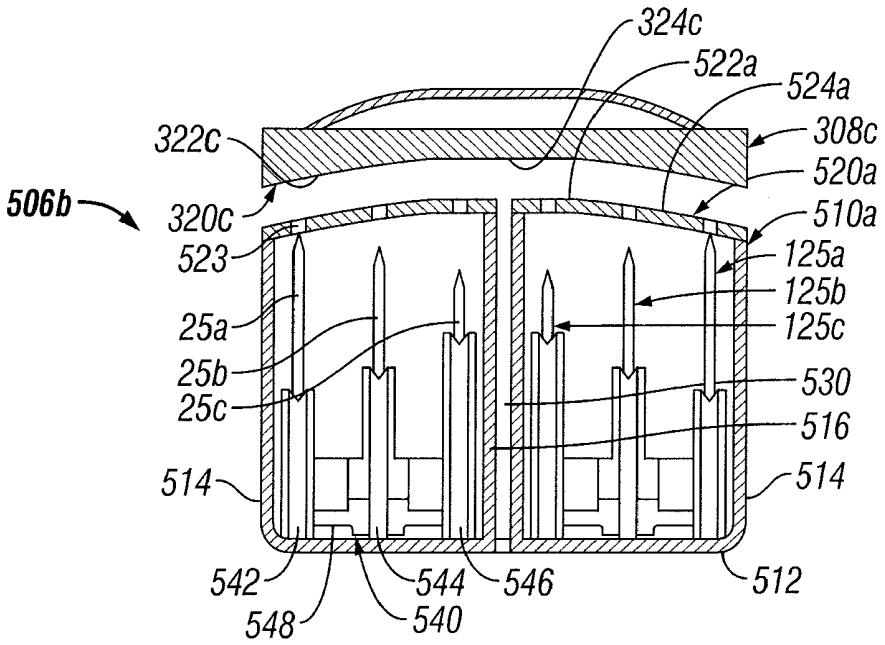
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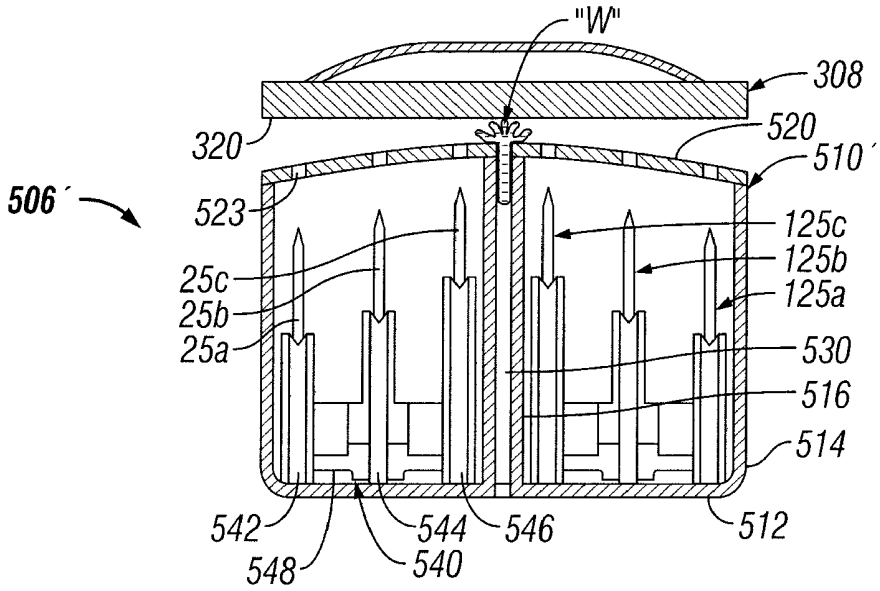
FIG. 9C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540

FIG. 10

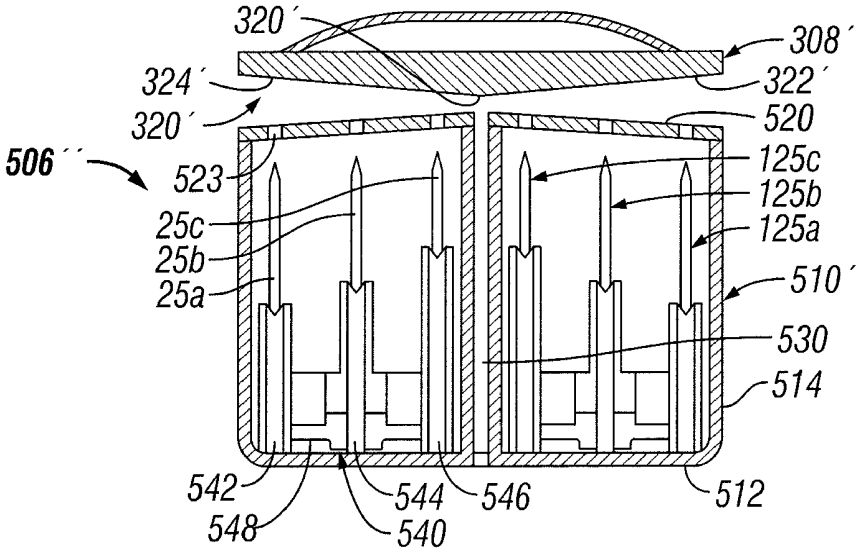
320´
308´
324´
322´
320´
520
506´´
523
125c
125b
125a
25c
25b
25a
510´
530
514
542
544
546
512
548
540

FIG. 11

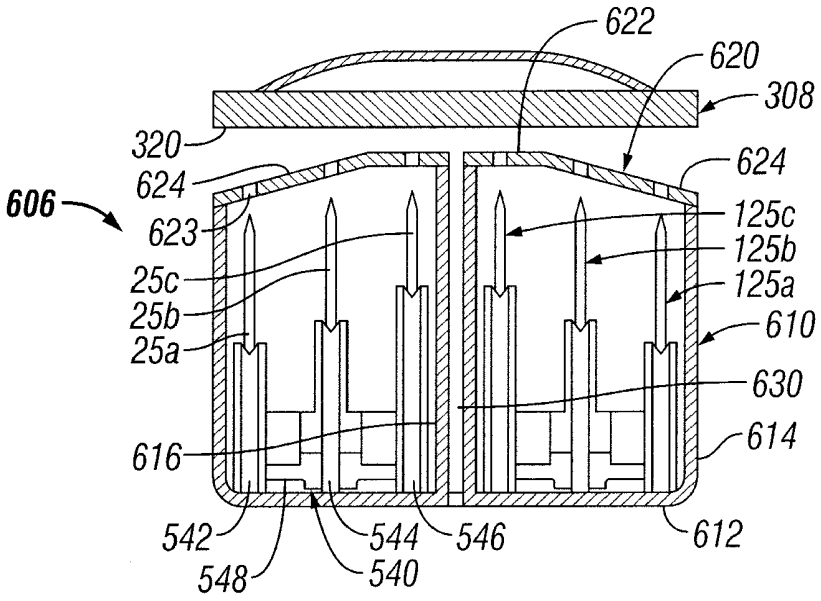
622
620
308
320
624
624
606
623
125c
125b
125a
25c
25b
25a
610
630
616
614
542
544
546
612
548
540

FIG. 12

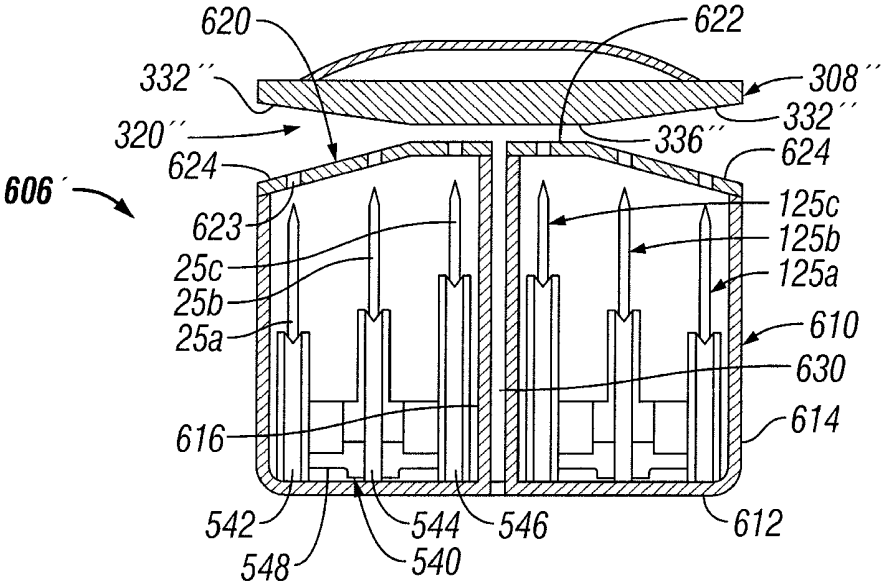
620
622
332''
308''
320''
332''
336''
624
624
606'
623
125c
125b
125a
25c
25b
25a
610
630
614
616
542
544
546
612
548
540

FIG. 13

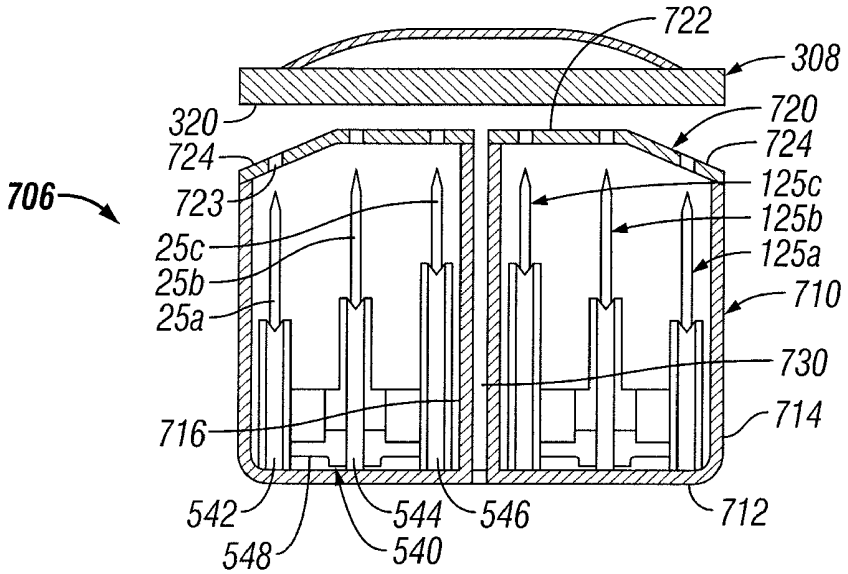
722
308
320
720
724
724
706
723
125c
125b
125a
25c
25b
25a
710
730
714
716
542
544
546
712
548
540

FIG. 14

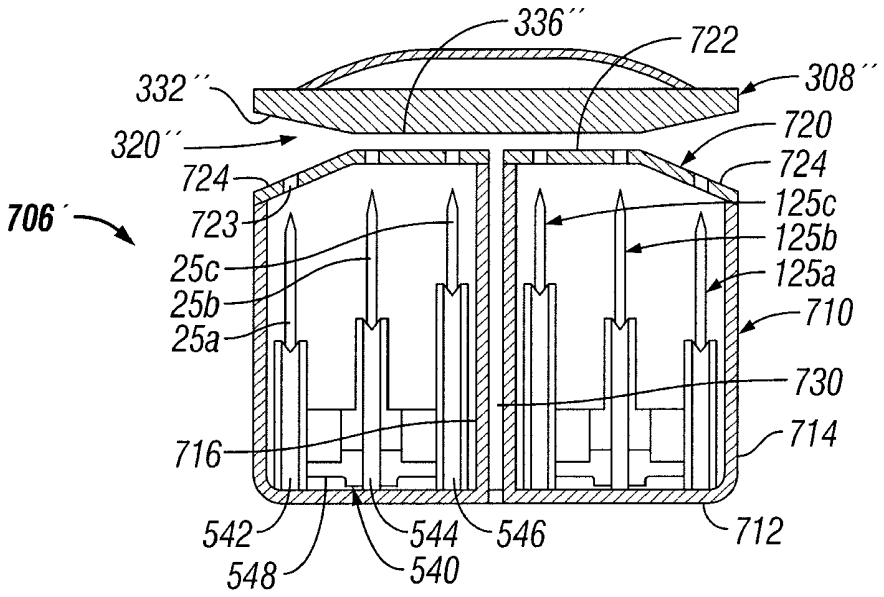
336''
722
308''
332''
320''
720
724
724
706'
723
125c
125b
25c
125a
25b
710
25a
730
716
714
542
544
546
712
548
540

FIG. 15

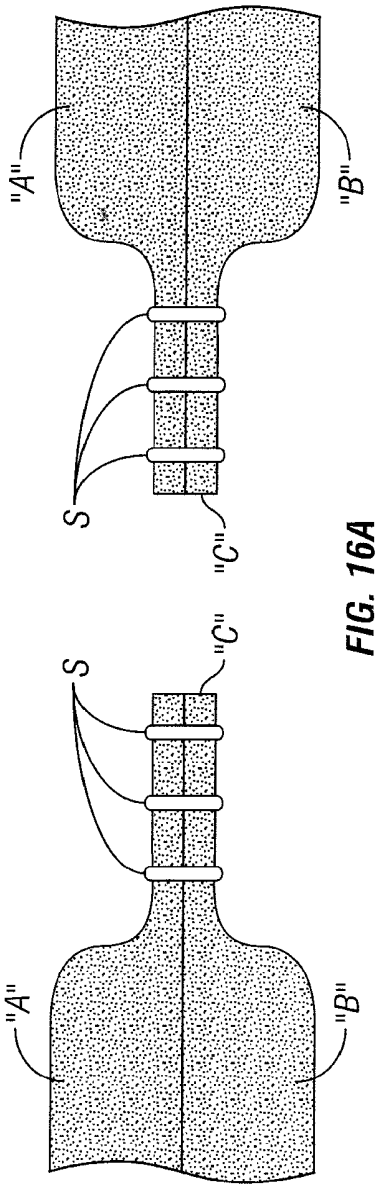

FIG. 16A
(Prior Art)

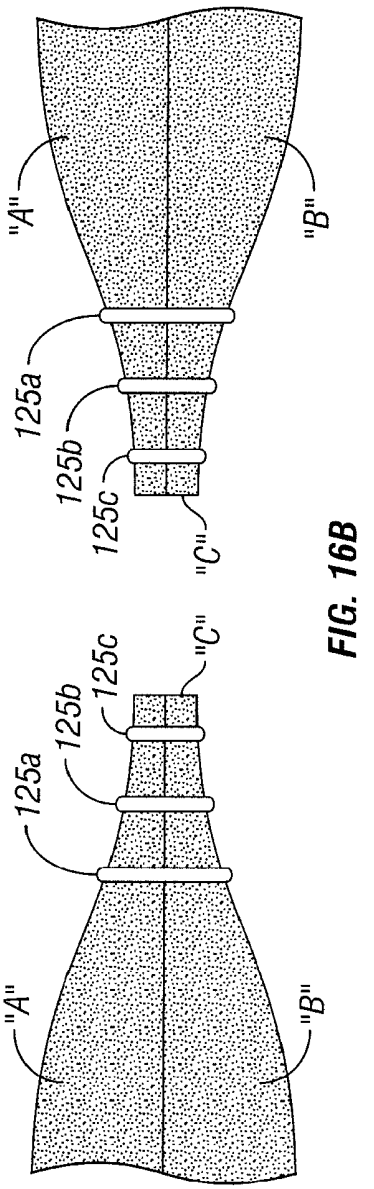

FIG. 16B

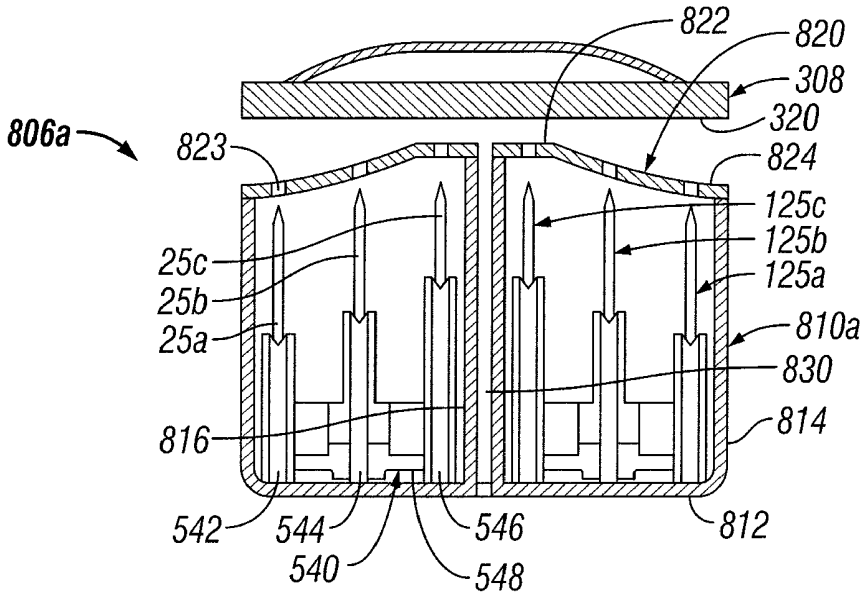

FIG. 17A

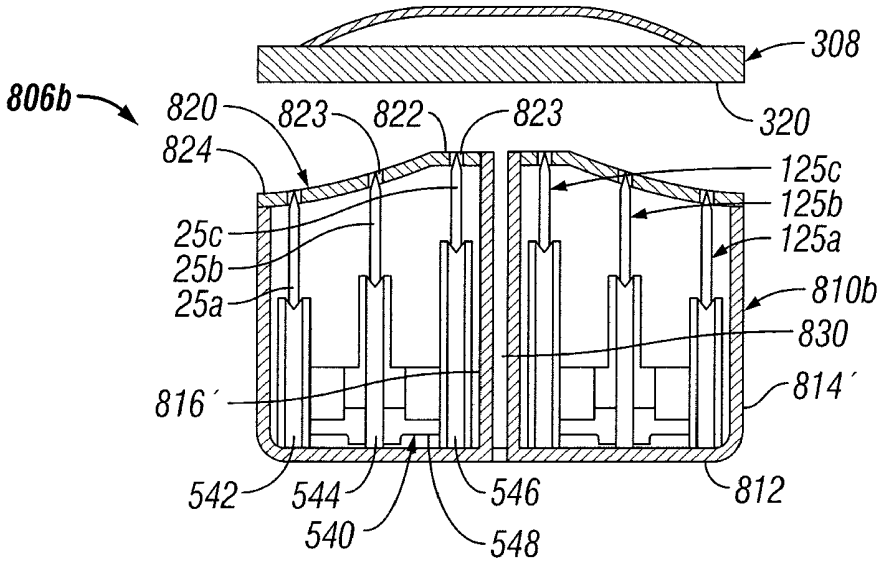

FIG. 17B

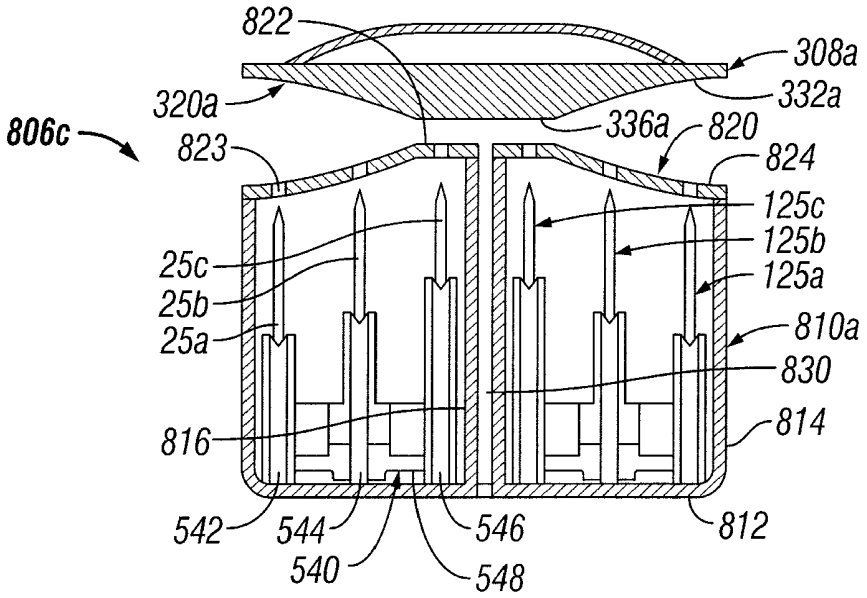

FIG. 17C

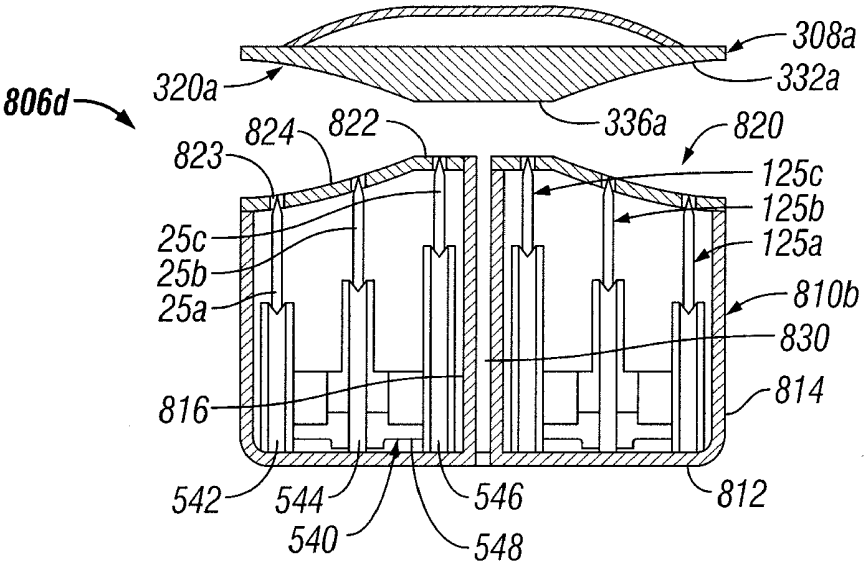

FIG. 17D

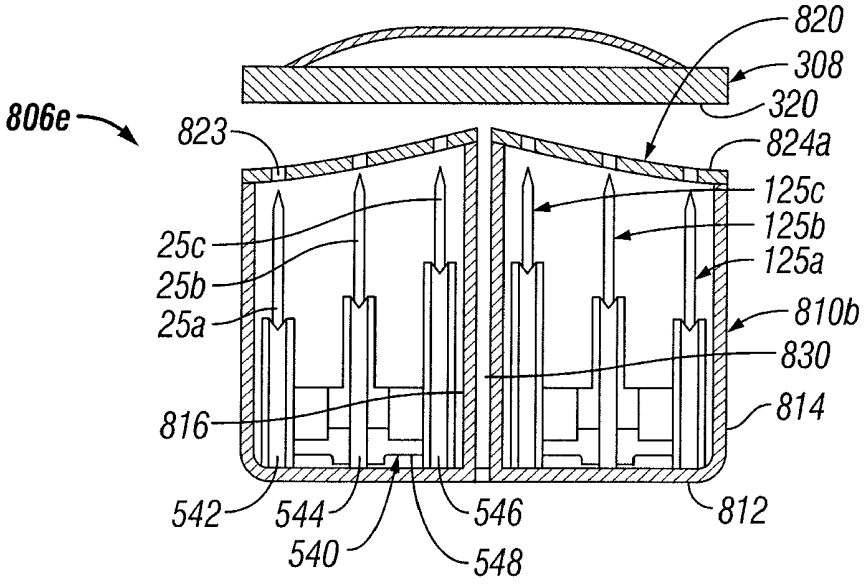

FIG. 17E

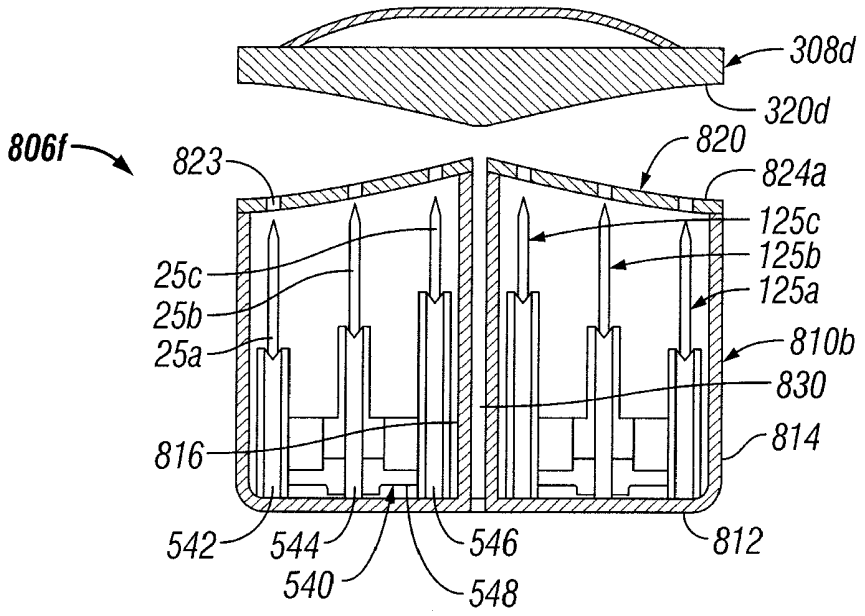

FIG. 17F

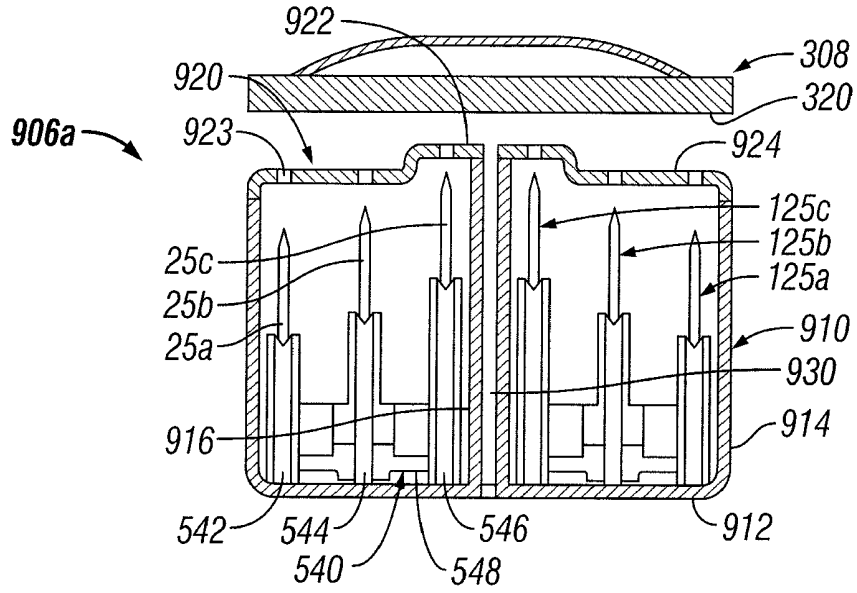

FIG. 18A

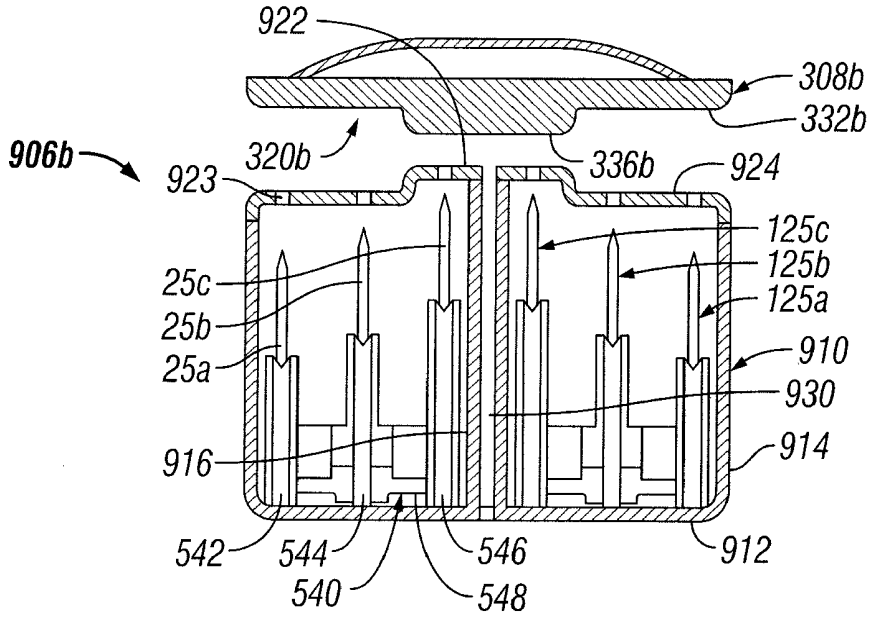

FIG. 18B

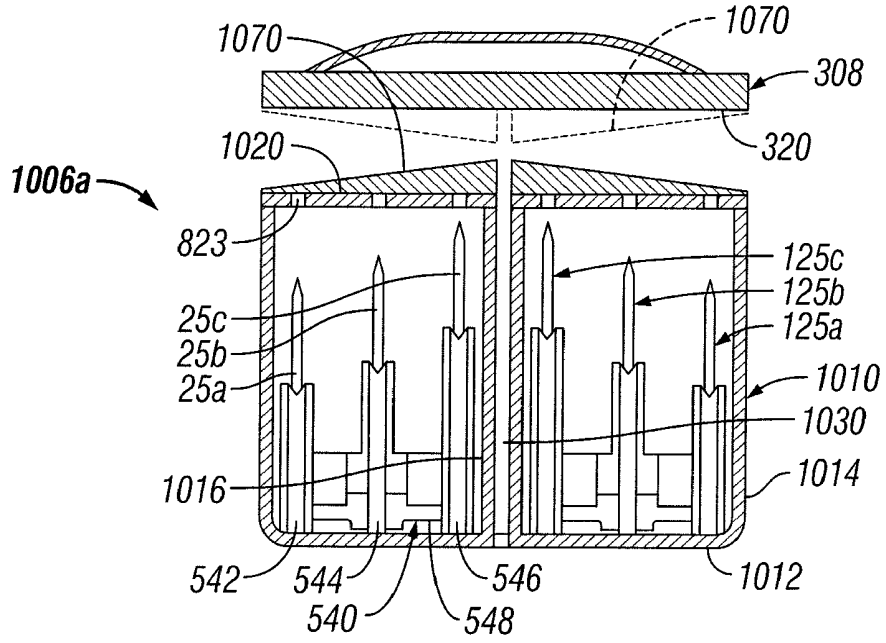

FIG. 19A

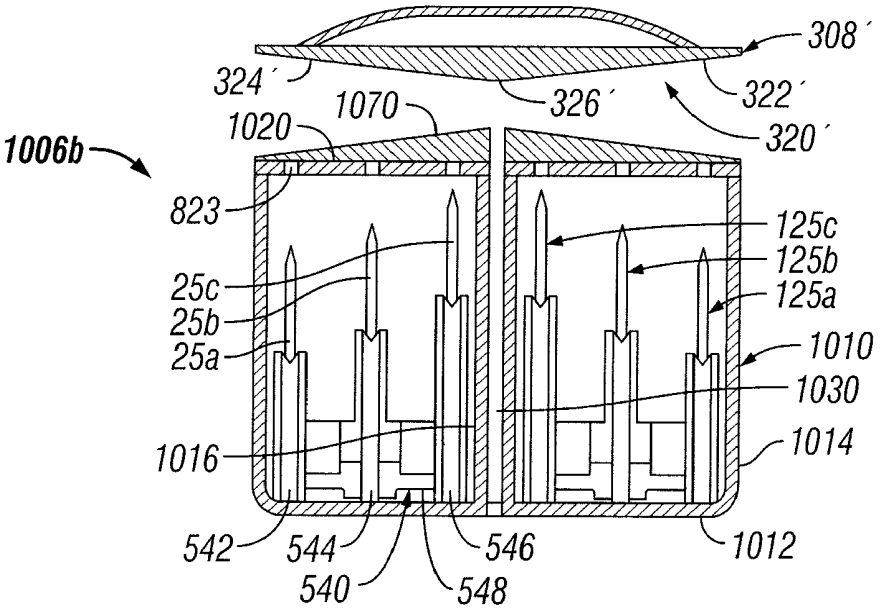

FIG. 19B

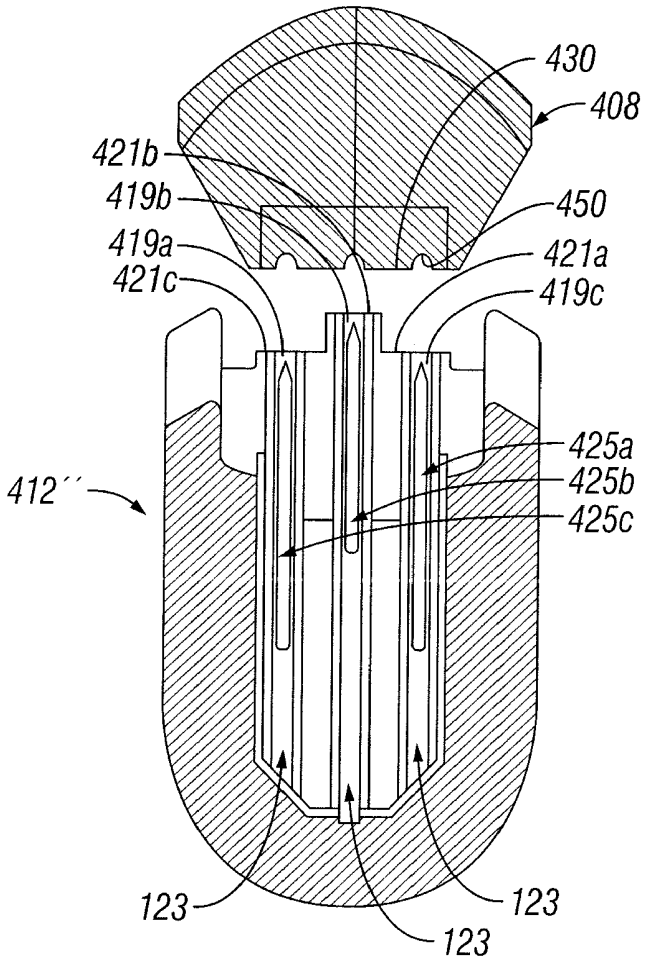
430
408
421b
419b
450
419a
421a
421c
419c
425a
412''
425b
425c
123
123
123

FIG. 20A

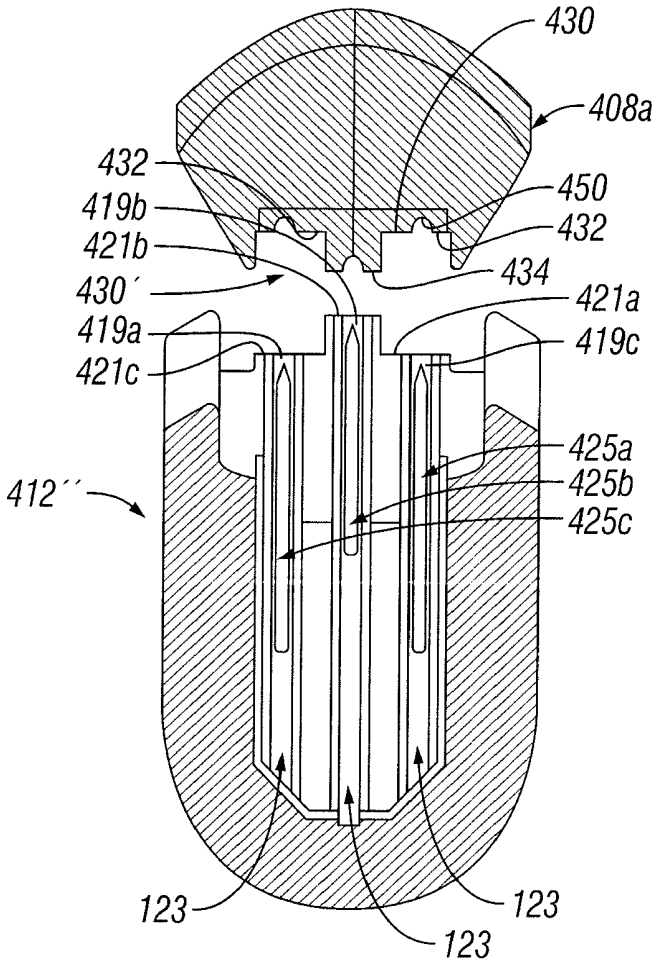
430
408a
432
419b
421b
430´
419a
421c
450
432
434
421a
419c
425a
425b
425c
412´´
123
123
123

FIG. 20B

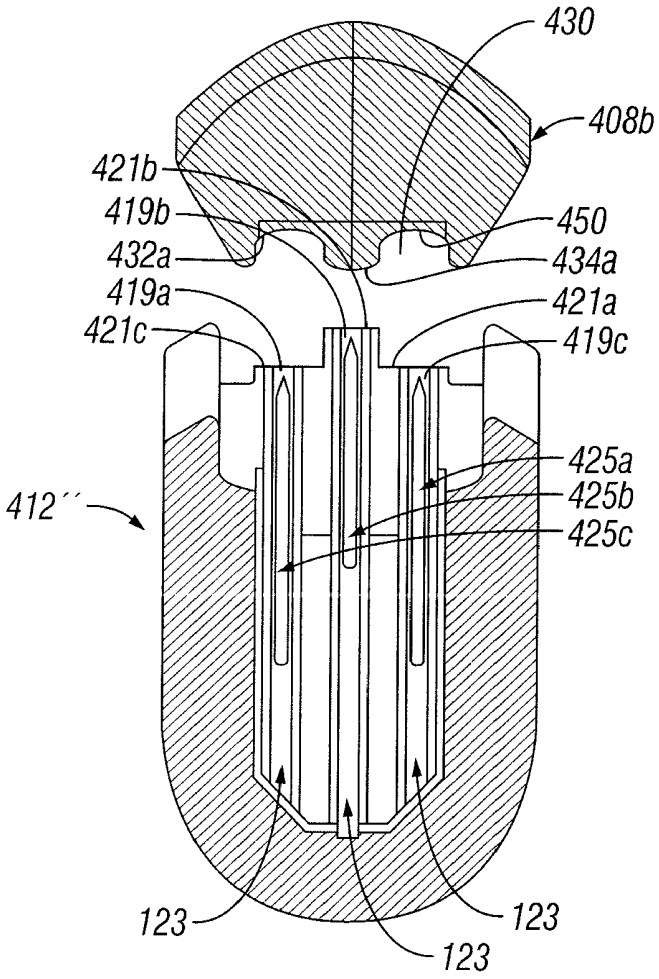
430
408b
421b
419b
450
432a
434a
419a
421a
421c
419c
425a
425b
425c
412''
123
123
123

FIG. 20C

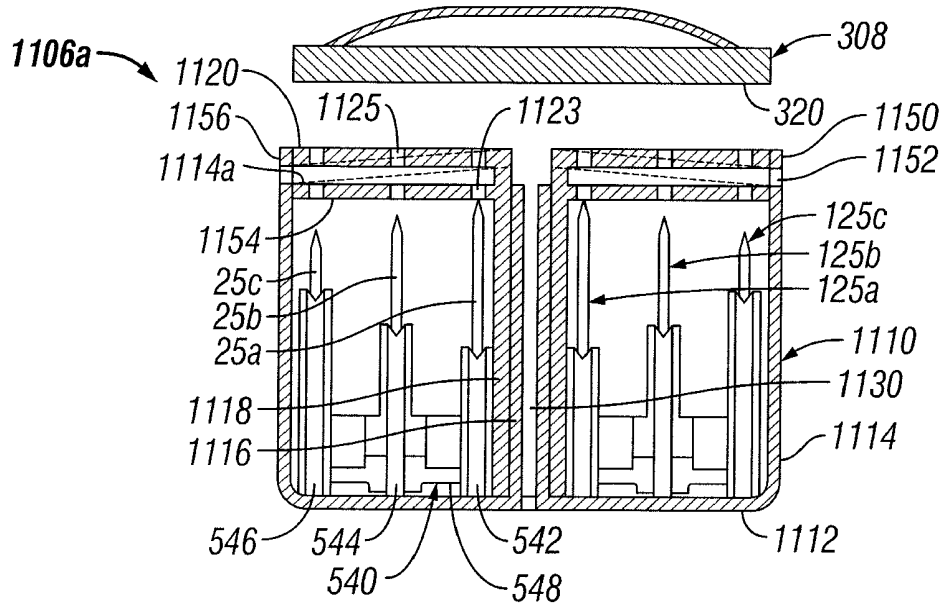

FIG. 21A

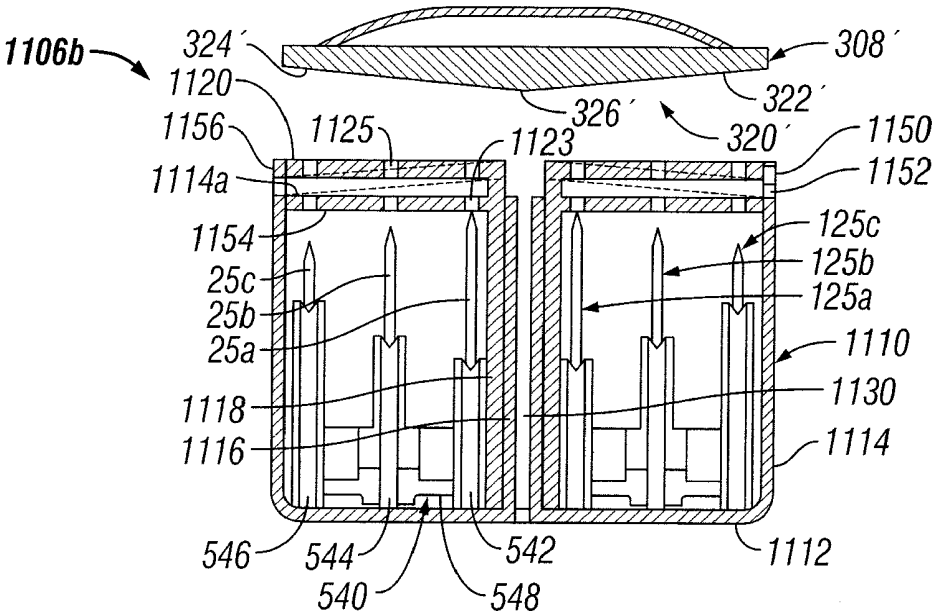

FIG. 21B

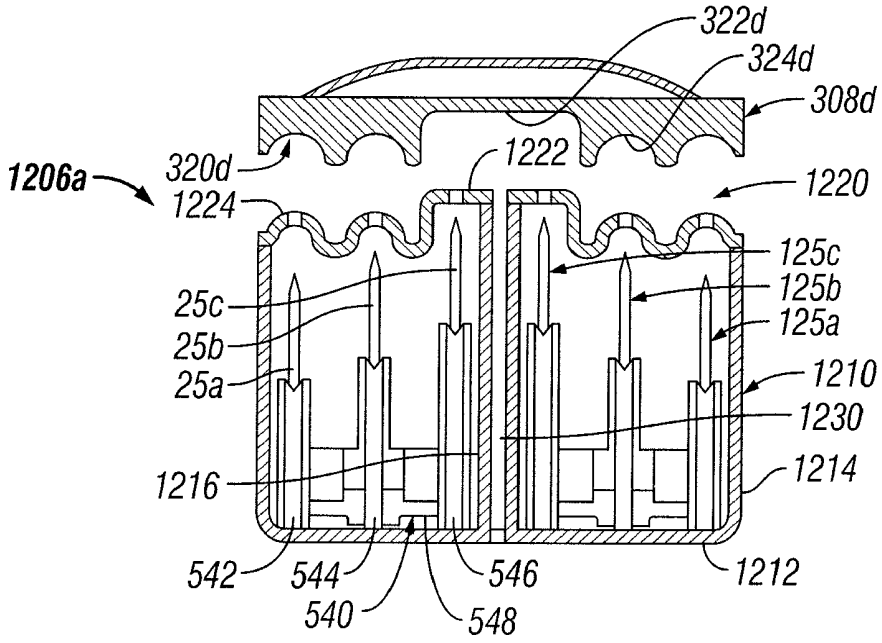

FIG. 22A

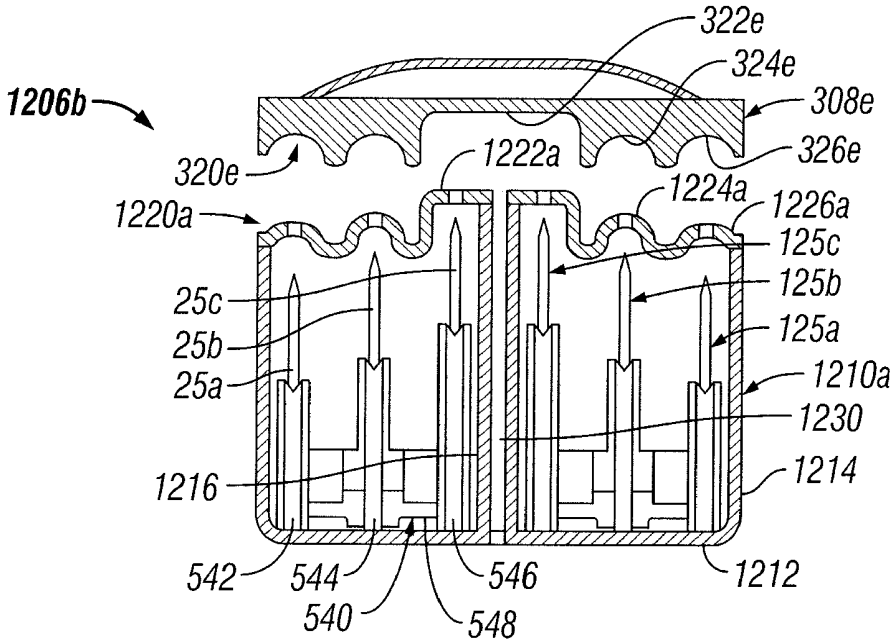

FIG. 22B

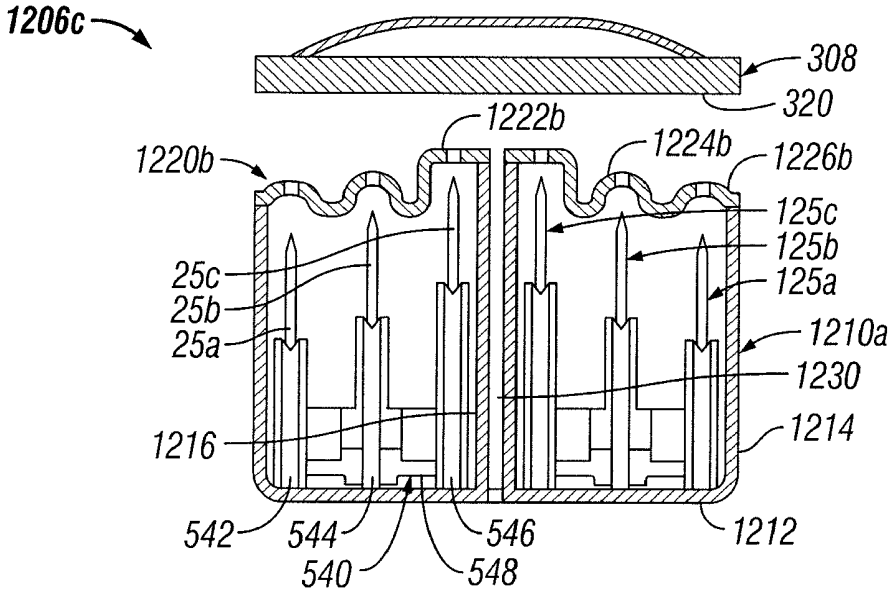
1206c
308
320
1222b
1224b
1226b
1220b
125c
125b
125a
25c
25b
25a
1210a
1230
1214
1216
542
544
546
1212
540
548

FIG. 22C

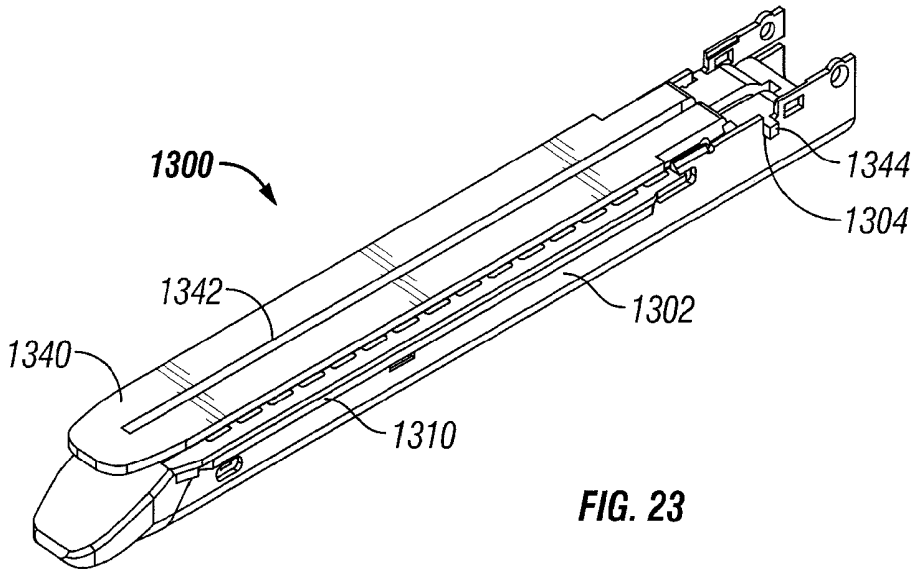
1300
1344
1304
1342
1302
1340
1310

FIG. 23

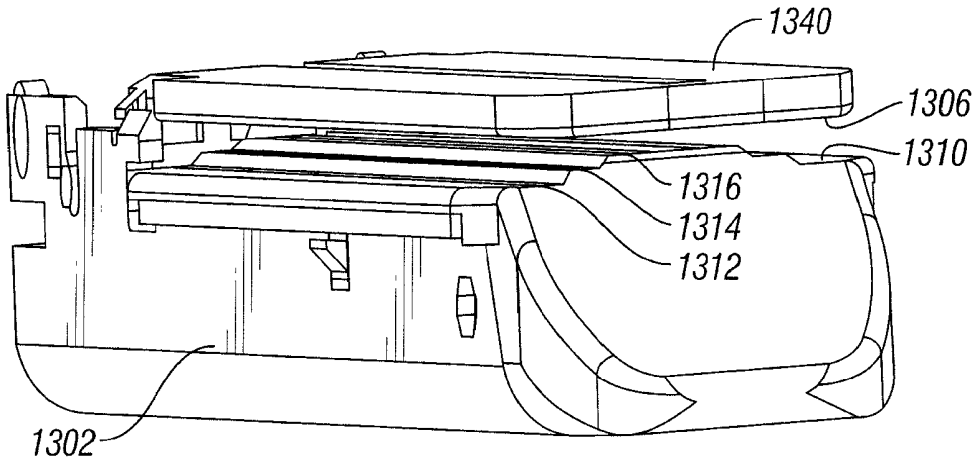
1340
1306
1310
1316
1314
1312
1302

FIG. 24

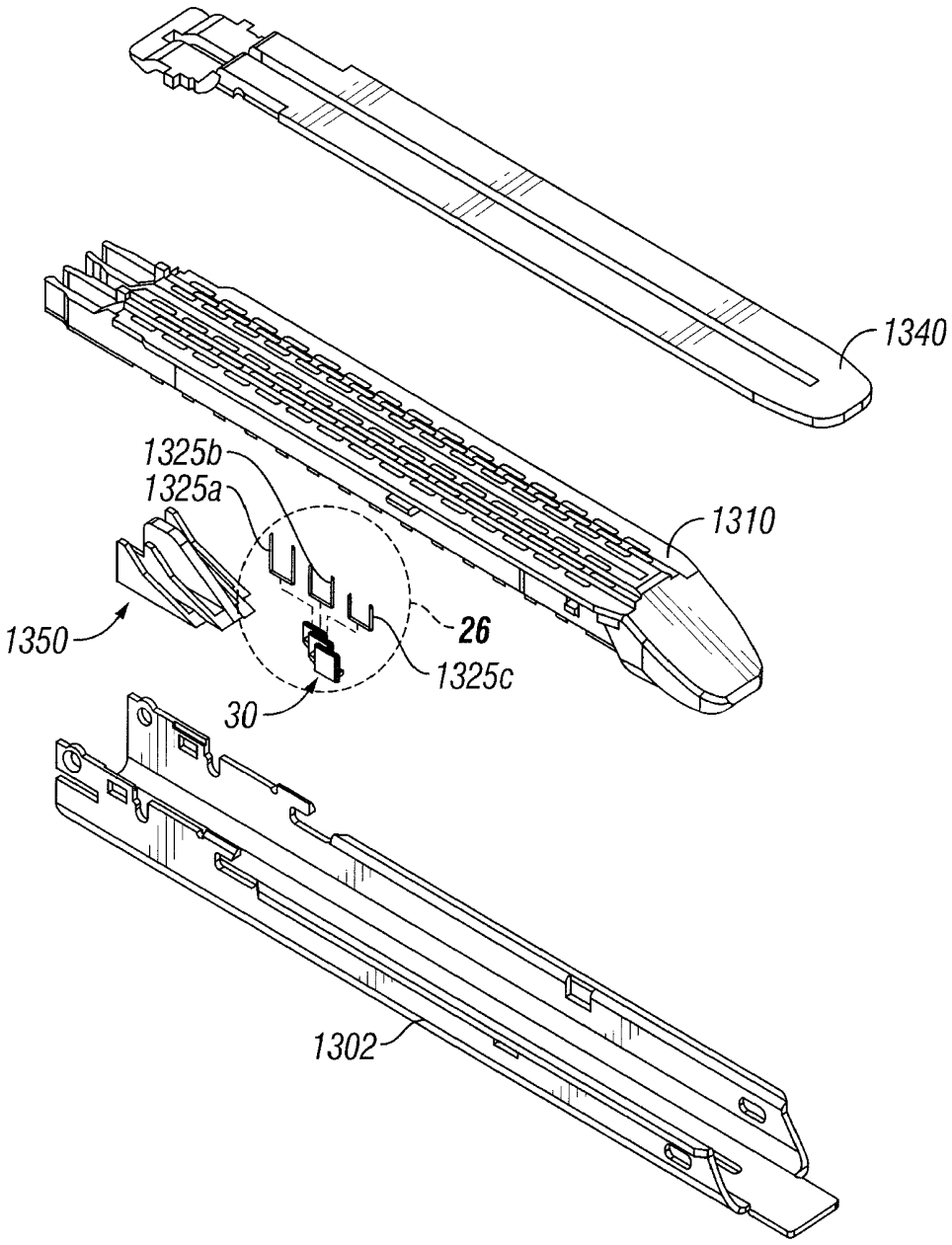

FIG. 25

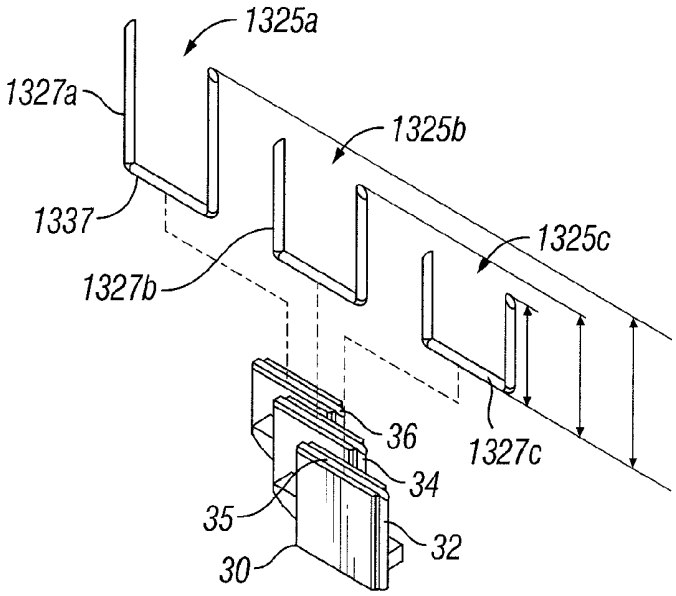
1325a
1327a
1325b
1337
1325c
1327b
36
1327c
34
35
32
30

FIG. 26

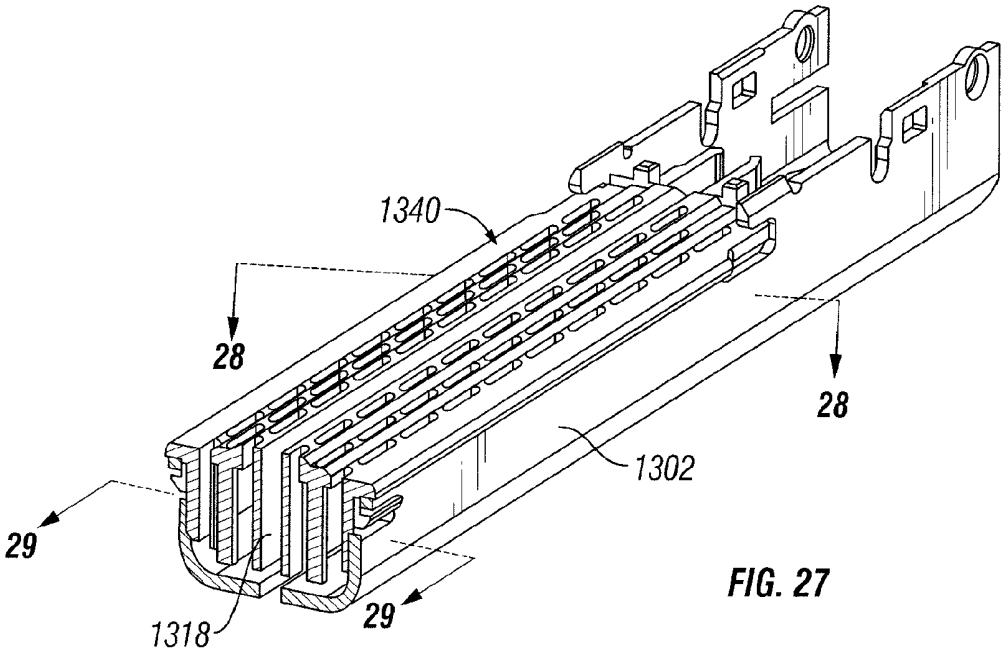
1340
28
28
1302
29
29
1318

FIG. 27

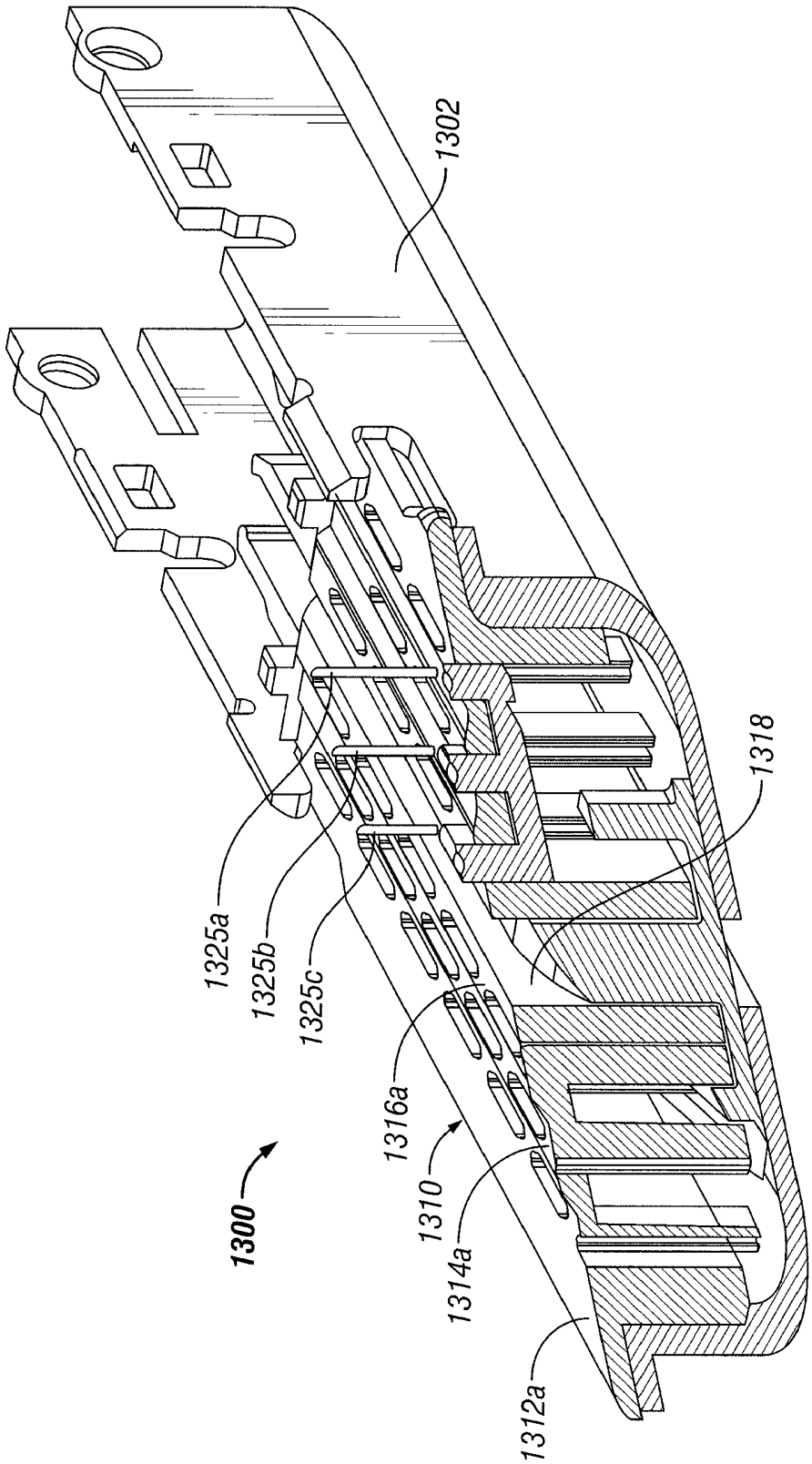

FIG. 28

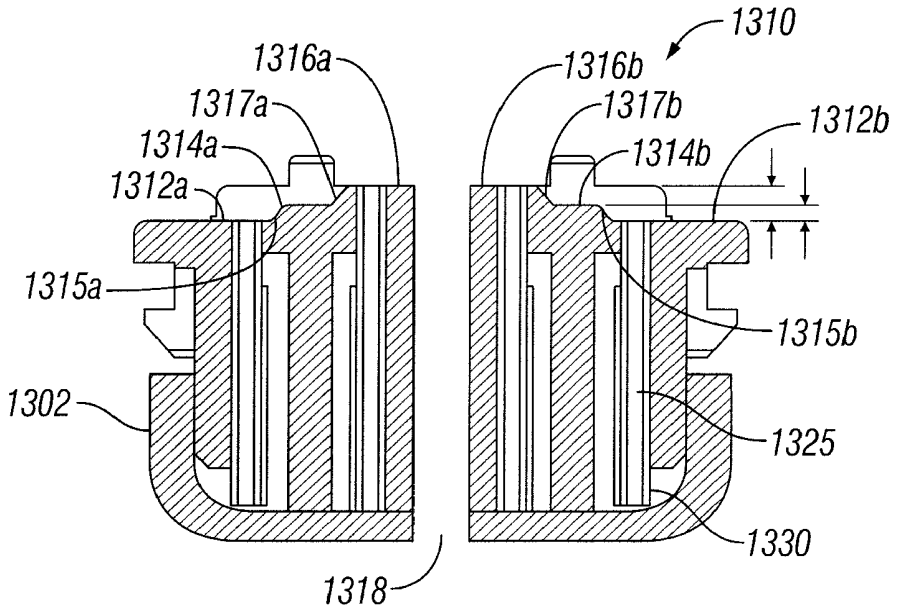
1310
1316a
1316b
1317a
1317b
1314a
1314b
1312a
1312b
1315a
1315b
1302
1325
1330
1318

FIG. 29

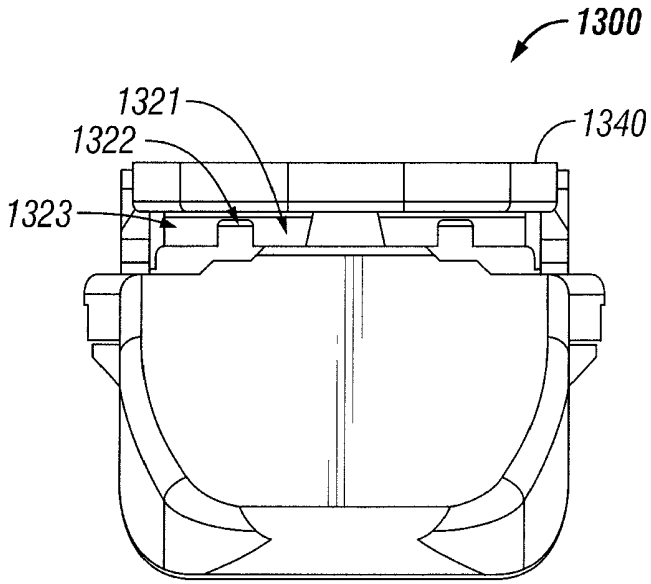
1300
1321
1322
1340
1323

FIG. 30

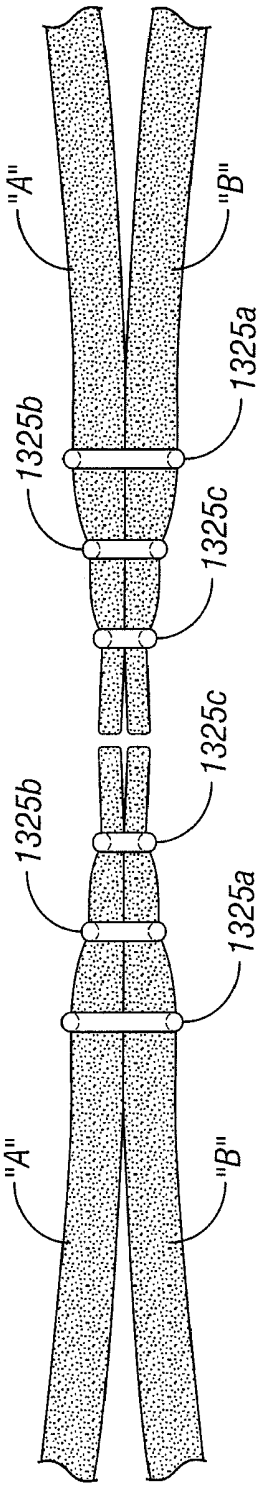

FIG. 31

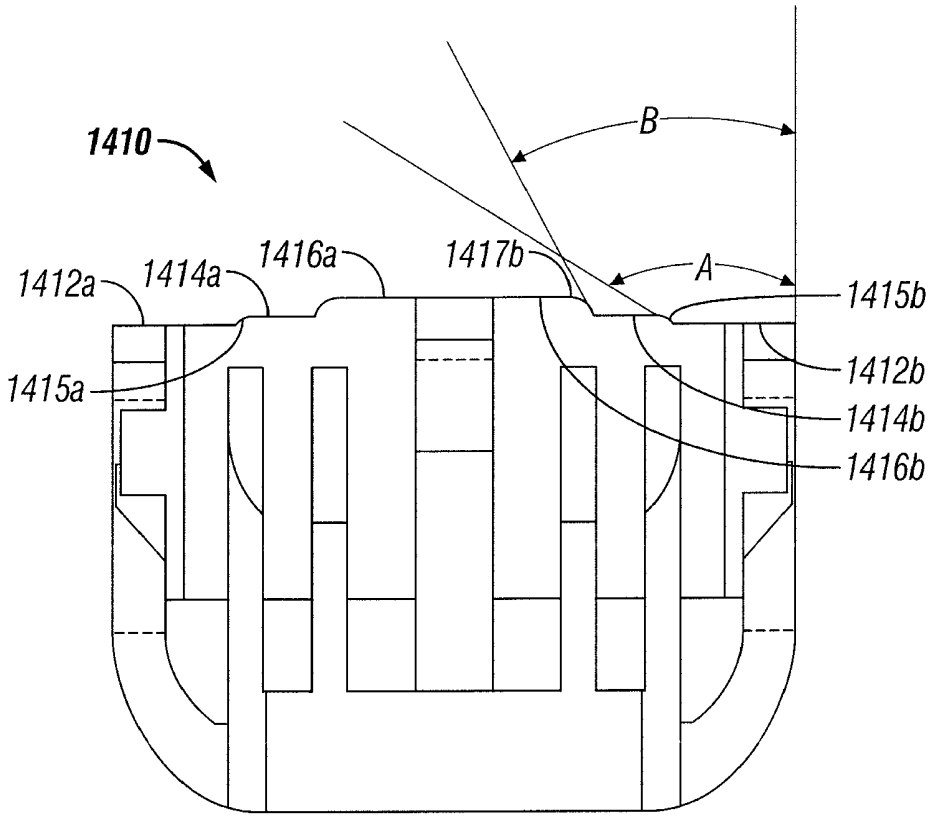
1410
B
A
1412a
1414a
1416a
1417b
1415b
1412b
1414b
1416b
1415a

FIG. 32

SURGICAL STAPLING INSTRUMENTS INCLUDING A CARTRIDGE HAVING MULTIPLE STAPLES SIZES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 15/160,318, filed May 20, 2016, which is a continuation of U.S. patent application Ser. No. 14/824,712, filed Aug. 12, 2015, now U.S. Pat. No. 9,192,387, which is a continuation of U.S. patent application Ser. No. 14/491,328, filed Sep. 19, 2014, now U.S. Pat. No. 9,370,365, which is a continuation of U.S. patent application Ser. No. 14/249,820, filed Apr. 10, 2014, now U.S. Pat. No. 8,925,786, which is a continuation of U.S. patent application Ser. No. 14/071,783, filed Nov. 5, 2013, now U.S. Pat. No. 8,840,004, which is a continuation of U.S. patent application Ser. No. 13/419,586, filed Mar. 14, 2012, now U.S. Pat. No. 8,579,178, which is a continuation of U.S. patent application Ser. No. 13/286,544, filed Nov. 1, 2011, now U.S. Pat. No. 8,157,152, which is a continuation of U.S. patent application Ser. No. 12/916,926, filed Nov. 1, 2010, now U.S. Pat. No. 8,070,035, which is a continuation of U.S. patent application Ser. No. 12/556,760, filed Sep. 10, 2009, now U.S. Pat. No. 7,837,081, which is a divisional of U.S. patent application Ser. No. 12/178,739, filed Jul. 24, 2008, now U.S. Pat. No. 7,588,174, which is a divisional of U.S. patent application Ser. No. 11/974,637, filed Oct. 15, 2007, now U.S. Pat. No. 7,455,676, which is a continuation of U.S. patent application Ser. No. 11/592,566, filed on Nov. 3, 2006, now U.S. Pat. No. 7,398,908, which is a continuation-in-part of U.S. patent application Ser. No. 11/436,222, filed on May 18, 2006, now U.S. Pat. No. 7,401,721, which is a continuation-in-part of U.S. patent application Ser. No. 11/204,060, filed on Aug. 15, 2005, now U.S. Pat. No. 7,407,075, the entire contents of each of which are hereby incorporated by reference herein.

BACKGROUND

1. Technical Field

The present disclosure relates to surgical stapling instruments and, more particularly, to surgical stapling instruments including a cartridge having multiple staple sizes.

2. Background of Related Art

There are several known types of surgical stapling instruments specifically adapted for use in various procedures such as end-to-end anastomosis, gastrointestinal anastomosis, endoscopic gastrointestinal anastomosis, and transverse anastomosis. Examples of stapling instruments for these various procedures can be found in U.S. Pat. Nos. 5,915,616; 6,202,914; 5,865,361; and 5,964,394.

Each surgical stapling instrument includes an anvil which is approximated relative to a staple cartridge. The staple cartridge typically has one or more laterally spaced rows of staples which, depending on the particular stapling instrument, may be arranged in a linear or non-linear configuration. The anvil includes staple forming depressions which are aligned with and/or in registration with the staple slots of the staples in the cartridge. In use, each of the surgical stapling instruments involves the gripping of tissue to be fastened, the ejecting of individual staples, the forcing of staples through the gripped tissue and the closing and/or forming of the staples against the staple forming depressions of the anvil.

A common issue in transecting tissue and/or in anastomosis procedures, employing any one of the surgical stapling instruments disclosed above, is the balance between anastomotic strength and the degree of hemostasis achievable. It is known to include different size staples in a surgical stapling apparatus having a constant gap (i.e. a uniform distance) between an anvil and a staple cartridge.

SUMMARY

The present disclosure is directed towards surgical stapling instruments configured to effectuate an improved balance between the anastomotic strength and the degree of hemostasis at the tissue interface. In particular, embodiments of the present disclosure include surgical fasteners of different sizes. Further still, the distance between an anvil member and a staple cartridge (i.e. the gap) varies from a centerline of the staple cartridge to an outer edge of the staple cartridge. Preferably, the gap is greater at the outer edge of the cartridge in comparison to the gap at the centerline. This can be achieved by either varying the contour (i.e. profile) of the staple cartridge and/or the anvil member. Combining the different sizes of surgical fasteners with the varying gap between the anvil member and the staple cartridge improves the anastomotic strength and the degree of hemostasis at the tissue interface.

According to one aspect of the disclosure, the surgical stapling instrument includes a first structure defining having an anvil member operatively associated therewith, and a second structure defining a staple cartridge operatively associated therewith. The staple cartridge has a tissue contacting surface with a stepped cross-sectional profile. The tissue contacting surface of the staple cartridge also includes a plurality of retention slots formed therein for retaining a surgical fastener. During operation of the surgical stapling instrument, the anvil member and the staple cartridge can be approximated relative to one another.

The stepped tissue contact surface of the staple cartridge defines a plurality of tissue contacting surfaces each having a different height. In one embodiment, the stepped tissue contacting surface of the cartridge includes an inner tissue contacting surface having a height, an intermediate tissue contacting surface having a height less than the height of the inner tissue contacting surface, and an outer tissue contacting surface having a height less than the height of the intermediate tissue contacting surface.

The inner, intermediate, and outer tissue contacting surfaces each include at least one row of retention slots formed therein. A plurality of surgical fasteners is disposed, one each, in each retention slot. Each surgical fastener includes a backspan and a pair of descending legs.

The surgical fasteners retained in the retention slots formed in the inner tissue contacting surface have a first leg length, the surgical fasteners retained in the retention slots formed in the intermediate tissue contacting surface have a second leg length, and the surgical fasteners retained in the retention slots formed in the outer tissue contacting surface have a third leg length. In one embodiment, the surgical fasteners retained in the retention slots formed in the inner tissue contacting surface have a leg length of about 2.3 mm, while the surgical fasteners retained in the retention slots formed in the intermediate tissue contacting surface have a leg length of about 3.5 mm, and the surgical fasteners retained in the retention slots formed in the outer tissue contacting surface have a leg length of about 4.1 mm.

It is envisioned that the surgical stapling instrument can be a circular-type surgical stapling instrument wherein the

anvil member and the staple cartridge can be annular. In one embodiment, the plurality of tissue contacting surfaces decreases in height in a radially outward direction. Accordingly, the inner tissue contacting surface is closest to the center and the outer tissue contacting surface is furthest from the center of the annular staple cartridge. Moreover, surgical fasteners having relatively short leg lengths are retained in the retention slots closest to the center of the annular staple cartridge while surgical fasteners having relatively longer leg lengths are retained in the retention slots furthest from the center of the annular staple cartridge.

It is further envisioned that the surgical stapling instrument can be a linear-type surgical stapling instrument wherein the anvil member and the staple cartridge are linear. In these instruments, the staple cartridge and/or the anvil member may define a knife cut line. Accordingly, the plurality of tissue contacting surfaces decreases in height in a direction orthogonally outward from the knife cut line. In particular, the inner tissue contacting surface is closest to the knife cut line while the outer tissue contacting surface is furthest from the knife cut line. In addition, surgical fasteners having relatively short leg lengths are retained in the retention slots closest to the knife cut line while surgical fasteners having relatively longer leg lengths are retained in the retention slots furthest from the knife cut line.

It is envisioned that the anvil member can have a tissue contacting surface with a stepped cross-sectional profile including a plurality of tissue contacting surfaces, wherein each tissue contacting surface has a different height. In addition, each one of the plurality of tissue contacting surfaces can include at least one annular and/or linear row of surgical fastener forming depressions formed therein.

In one embodiment, the anvil member can have a tissue contacting surface which is shaped (i.e. stepped) to complement the stepped tissue contacting surface of the staple cartridge. In another embodiment, the anvil member can have a tissue contacting surface which is stepped while the tissue contacting surface of the staple cartridge is substantially planar. In yet another embodiment, the anvil member can have a tissue contacting surface which is shaped to substantially complement the stepped tissue contacting surface of the staple cartridge (i.e. the depths of the tissue contacting surfaces of the stepped anvil member are not equal to the heights of the individual tissue contacting surfaces of the tissue contacting surface of the staple cartridge). In still another embodiment, the anvil member can have a tissue contacting surface which is stepped to mirror the tissue contacting surface of the staple cartridge (i.e. the depths of individual tissue contacting surfaces of the tissue contacting surface of the anvil member are substantially equal to the depths of the individual tissue contacting surfaces of the staple cartridge).

In other embodiments of the present disclosure, a surgical stapling instrument includes an operative tool disposed at one end thereof. The operative tool includes an anvil member and a staple cartridge. The staple cartridge may be included in a disposable surgical stapling apparatus or in a reusable surgical stapling apparatus. Further still, a replaceable loading unit may be located in either the disposable or the reusable surgical stapling apparatus. In one embodiment, the replaceable loading unit includes a staple cartridge, while an alternate embodiment of the replaceable loading unit includes a staple cartridge and an anvil member. In particular, the staple cartridge includes a plurality of surgical fasteners disposed in rows of retention slots. The surgical fasteners may have different leg lengths wherein a plurality of surgical fasteners having substantially the same leg length is disposed in a row. A number of fastener ejection members are disposed in the staple cartridge wherein each fastener ejection member includes a plurality of staple pushers for ejecting the surgical fasteners in cooperation with an actuation mechanism. The staple pushers of the fastener ejection member each have a shape that generally corresponds to the shape of the staple pockets of the anvil member and the retention slots of the staple cartridge.

The staple cartridge may include an angled tissue contacting surface that peaks at a centerline of the staple cartridge and tapers towards outer walls of the staple cartridge. Alternatively, the tissue contacting surface of the staple cartridge may have a surface that is parallel with the bottom surface of the staple cartridge or parallel to a plane defined by the backspans of surgical fasteners disposed in a selected row. The parallel surface of the tissue contacting surface has a width dimension that is sufficient to accommodate at least one row of surgical fasteners. The staple cartridge may include a knife channel.

In cooperation with the presently disclosed staple cartridge, the anvil member may include a planar tissue contacting surface that is substantially parallel to the bottom surface of the staple cartridge or parallel to a plane defined by the backspans of surgical fasteners disposed in a selected row. In the alternative, the tissue contacting surface of the anvil member may be angled in an opposed manner to the angle of the tissue contacting surface of the staple cartridge. Further still, the tissue contacting surface of the anvil member may have a planar surface that is substantially parallel to the bottom surface of the staple cartridge or parallel to a plane defined by the backspans of surgical fasteners disposed in a selected row and tapered surfaces that define angles opposite to the angles defined by the tissue contacting surface of the staple cartridge. The parallel surfaces of the anvil member have a width dimension that corresponds to a width dimension of the parallel surface of the staple cartridge.

It is further contemplated that one embodiment of the surgical stapling apparatus includes structures for supplemental sealing of the fastened layers of tissue. In one embodiment, the surgical stapling apparatus includes a wound closure assembly having a reservoir and a supply line. The reservoir is adapted for storing a quantity of a wound closure material and is fluidly coupled to the staple cartridge via the supply line for delivering amounts of the wound closure material to the plurality of retention slots.

In yet another embodiment of the presently disclosed surgical stapling apparatus, the staple cartridge may include a planar surface proximate a centerline of the staple cartridge and an arcuate surface adjacent to the planar surface. The arcuate surface extends outwards from the centerline and downwards towards the base of the staple cartridge defining a concave configuration with respect to the base of the staple cartridge. Each of the surfaces includes at least one row of retention slots and defines a tissue contacting surface. In addition, this embodiment of the staple cartridge includes a plurality fastener ejection members and a plurality of surgical fasteners. Tips of the unfired surgical fasteners may be positioned beneath the arcuate and planar surfaces or may extend into the retention slots wherein the tips are substantially flush with the tissue contacting surface. This embodiment of the staple cartridge may be combined with an anvil member having a planar tissue contacting surface that cooperates with the tissue contacting surface of the staple cartridge to position layers of tissue therebetween and form completed surgical fasteners. Alternatively, an anvil member may have a planar surface corresponding in width

to the planar surface of the staple cartridge and curvate surfaces that have the same curvature as the arcuate surfaces of the staple cartridge in an opposed direction. The staple cartridge may include a knife channel that is located along the centerline of the staple cartridge.

In a further embodiment of the presently disclosed surgical stapling apparatus, the staple cartridge may include first and second planar surfaces, wherein each planar surface includes at least one row of retention slots. The first and second planar surfaces are substantially parallel with a bottom surface of the staple cartridge and with each other, but are vertically spaced apart such that there are not coplanar with each other. As in the previous embodiments, the staple cartridge includes a plurality of fastener ejection members and a plurality of surgical fasteners. A first gap is defined between a planar tissue contacting surface of an anvil member and the first planar surface of the staple cartridge and a second gap is defined between the planar tissue contacting surface of the anvil member and the second planar surface. The staple cartridge may include a knife channel that is located along the centerline of the staple cartridge. Alternatively, an anvil member having a complementary surface configuration may be used in combination with the staple cartridge, wherein the spacing between the second planar surface of the staple cartridge and a corresponding surface of the anvil member defines a gap that is greater than the second gap.

In a further embodiment of the presently disclosed surgical stapling apparatus, a staple cartridge is provided having a plurality of fastener ejection members and a plurality of surgical fasteners. The staple cartridge includes a planar surface opposed to a bottom surface. A filler layer is positioned atop the planar surface. The filler layer may be formed from a buttress material. The filler layer is generally triangular in shape and extends downwards and outwards from a centerline of the staple cartridge such that its maximum height is proximate to the centerline. An anvil member having a planar surface may be used in cooperation with the staple cartridge for forming completed surgical fasteners. Alternatively, an anvil member having a tapered (i.e. angled) surface that complements the filler layer may be used. The staple cartridge may include a knife channel.

An alternate embodiment of the presently disclosed surgical stapling apparatus includes a staple cartridge and an anvil member. The staple cartridge includes a plurality of surgical fasteners and a plurality of fastener ejection members. A top plate extends between inner and outer walls of the staple cartridge and is a planar structure that is substantially parallel to a bottom surface of the staple cartridge. A vertical member abuts the inner wall. Vertically spaced from the top plate is a cross member that is flexibly attached to the vertical member. A top surface of the cross member defines a tissue contacting surface in opposition to a tissue contacting surface of the anvil member. During approximation and/or formation of surgical fasteners, the cross member flexes such that the gap between the tissue contacting surfaces is at a minimum near the centerline of the staple cartridge and a maximum near the outer wall of the staple cartridge. The staple cartridge may include a knife channel. Alternatively, the anvil member may include tapered surfaces that define the tissue contacting surface, wherein the tapered surfaces extend outwards and upwards from the centerline of the staple cartridge such that the anvil member has its maximum thickness near the centerline and its minimum thickness near outer edges of the anvil member.

In an additional embodiment of the presently disclosed surgical stapling apparatus, a substantially planar anvil member and a stepped staple cartridge are disclosed. In this embodiment, the staple cartridge includes a plurality of stepped surfaces each of which is substantially a planar structure. Each stepped surface of the staple cartridge is configured for contacting tissue and includes a plurality of retention slots. Each retention slot is adapted for receiving a surgical fastener therein. Similar to the previously disclosed embodiments, the surgical fasteners in one surface may have a leg length that is different from the leg length of the surgical fasteners in an adjacent surface. The tissue contacting (i.e. stepped surfaces) surfaces may be arranged in two linear rows that are separated by a knife channel. The tissue contacting surfaces in each row are parallel to one another, but are not coplanar with each other thereby defining the stepped arrangement of the tissue contacting surfaces. The transition from one tissue contacting surface to the adjacent tissue contacting surface is an angled wall surface.

All of the presently disclosed embodiments of the surgical stapling instrument provide a variable pressure gradient (i.e. load profile) to the layers of tissue that are joined together with the surgical fasteners. Therefore, the layers of tissue that are proximate to the center of the surgical stapling instrument (i.e. center of the staple cartridge) are subjected to higher compressive forces (i.e. loads), thereby forming thinner layers of tissue as compared to layers of tissue that are further away from the center of the surgical stapling instrument. Since the layers of tissue nearest the center of the surgical stapling instrument can be compressed more, a smaller sized surgical staple or fastener can be used to mechanically suture (i.e. fasten) the transected layers of tissue. Further still, providing a gradual compression gradient to the layers of tissue to be joined, may result in a higher degree of hemostasis. Due to the contoured shape of the staple cartridge, the layers of tissue can be compressed more at the center of the surgical stapling instrument, because tissue can translate (i.e. move) from a region of relatively high pressure (i.e. at the center) to a region of relatively low pressure (i.e. at the edges) as the anvil member is moved relative to the staple cartridge, thereby defining the pressure gradient.

In a further aspect of the present disclosure, a staple cartridge for a surgical stapling apparatus comprises a first tissue contacting surface and a second tissue contacting surface. The first tissue contacting surface and the second tissue contacting surface are not co-planar. A third surface generally extends between the first tissue contacting surface and the second tissue contacting surface and an angle is defined between the third surface and at least one of the first or second tissue contacting surfaces. A plurality of first retention slots are defined in the first tissue contacting surface and a plurality of second retention slots are defined in the second tissue contacting surface. Each retention slot is configured for housing a staple therein.

The cartridge may have staples having a first leg length in the first retention slots and staples having a second leg length in the second retention slots, wherein the second leg length is different from the first leg length. The cartridge may be releasably attached to a body of the surgical apparatus, or may be part of a detachable disposable loading unit.

A knife channel desirably extends longitudinally along the cartridge. The first tissue contacting surface is desirably adjacent the knife channel. In certain preferred embodiments, the staples with the first leg length, which have leg lengths smaller than the staples with the second leg length, are disposed adjacent the knife channel.

The first tissue contacting surface may be substantially parallel to the second tissue contacting surface.

In a further aspect of the present disclosure, a surgical stapling apparatus comprises a handle portion, a body portion extending distally from the handle portion and defining a longitudinal axis, and a tool assembly at a distal end of the body portion. The tool assembly includes a cartridge having a first tissue contacting surface and a second tissue contacting surface. The first tissue contacting surface and the second tissue contacting surface are not co-planar. A third surface generally extends between the first tissue contacting surface and the second tissue contacting surface. An angle is defined between the third surface and at least one of the first or second tissue contacting surfaces. A plurality of first retention slots are defined in the first tissue contacting surface and a plurality of second retention slots are defined in the second tissue contacting surface. Each retention slot is configured for housing a staple therein. The tool assembly of the surgical stapling apparatus desirably includes an anvil member having a surface for contacting tissue and a number of staple forming depressions defined in the surface of the anvil member. The surface of the anvil member is disposed in opposition to the first tissue contacting surface and the second tissue contacting surface. The surface of the anvil member and the first tissue contacting surface define a first gap and the surface of the anvil member and the second tissue contacting surface define a second gap. The first gap has a different dimension from the second gap. In certain preferred embodiments, the first gap is less than the second gap. The staples with the smaller length are desirably disposed adjacent a centerline of the staple cartridge.

In another aspect of the present disclosure, a staple cartridge for a surgical stapling apparatus comprises a first tissue contacting surface and a second tissue contacting surface. The first tissue contacting surface and the second tissue contacting surface are not co-planar. A third surface generally extends between the first tissue contacting surface and the second tissue contacting surface. The third surface is a non-planar surface. A plurality of first retention slots are defined in the first tissue contacting surface and a plurality of second retention slots are defined in the second tissue contacting surface. Each retention slot is configured for housing a staple therein.

The cartridge may have staples having a first leg length in the first retention slots and staples having a second leg length in the second retention slots, wherein the second leg length is different from the first leg length. The cartridge may be releasably attached to a body of the surgical apparatus, or may be part of a detachable disposable loading unit.

A knife channel desirably extends longitudinally along the cartridge. The first tissue contacting surface is desirably adjacent the knife channel. In certain preferred embodiments, the staples with the first leg length, which have leg lengths smaller than the staples with the second leg length, are disposed adjacent the knife channel.

The first tissue contacting surface may be substantially parallel to the second tissue contacting surface.

The presently disclosed surgical stapling instruments, together with attendant advantages, will be more clearly illustrated below by the description of the drawings and the detailed description of the embodiments.

Other objects and features of the present disclosure will become apparent from consideration of the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the presently disclosed surgical stapling apparatus are described herein with reference to the accompanying drawings, wherein:

FIG. **1** is a perspective view of a surgical stapling instrument constructed in accordance with the present disclosure;

FIG. **2** is a schematic cross-sectional side elevational view of the distal end portion of the surgical stapling instrument of FIG. **1**, as taken through **2-2** of FIG. **1**;

FIG. **2**A is a perspective view of a surgical fastener in accordance with an embodiment of the present disclosure;

FIG. **3**A is an enlarged schematic representation of the indicated area of FIG. **2**, illustrating tissue contacting surfaces in accordance with an alternate embodiment of the present disclosure;

FIG. **3**B is an enlarged schematic representation of the indicated area of FIG. **2**, illustrating tissue contacting surfaces in accordance with another embodiment of the present disclosure;

FIG. **3**C is an enlarged schematic representation of the indicated area of FIG. **2**, illustrating tissue contacting surfaces in accordance with still another embodiment of the present disclosure;

FIG. **3**D is an enlarged schematic representation of the indicated area of FIG. **2**, illustrating tissue contacting surfaces in accordance with a further embodiment of the present disclosure;

FIG. **4** is a perspective view of an alternative surgical stapling instrument constructed in accordance with the present disclosure;

FIG. **5** is a perspective view of yet another surgical stapling instrument constructed in accordance with the present disclosure;

FIG. **6** is a perspective view of still another surgical stapling instrument constructed in accordance with the present disclosure;

FIG. **6**A is a perspective view of a portion of an anvil member of FIG. **6**;

FIG. **7** is a schematic cross-sectional side elevational view of the distal end portion of the surgical stapling instruments of FIGS. **4-6**, as taken through **7-7** of each of FIGS. **4-6**;

FIG. **7**A is a schematic cross-sectional side elevational view of an alternate embodiment of the distal portion of the surgical stapling instrument of FIG. **6**

FIG. **8** is a perspective view of a staple cartridge according to another embodiment of the present disclosure;

FIG. **9**A is a cross-sectional end view of the staple cartridge of FIG. **8** showing a first arrangement of surgical fasteners;

FIG. **9**B is a cross-sectional end view of the staple cartridge of FIG. **8** showing a second arrangement of surgical fasteners;

FIG. **9**C is an alternate embodiment of the staple cartridge of FIG. **8** showing a second arrangement of surgical fasteners and an alternate embodiment of an anvil member;

FIG. **10** is an alternate embodiment of the staple cartridge of FIG. **9**A illustrating a second embodiment of the surgical fasteners;

FIG. **11** is an alternate embodiment of an anvil member and the staple cartridge of FIG. **10**;

FIG. **12** is a further embodiment of the staple cartridge of FIG. **8**;

FIG. **13** is another embodiment of the anvil member and the staple cartridge of FIG. **12**;

FIG. **14** is another embodiment of the staple cartridge and anvil member of FIG. **8**;

FIG. **15** is alternate embodiment of an anvil member with the staple cartridge of FIG. **14**;

FIG. **16**A is a cross-sectional side elevation view of a tissue interface following the firing of a conventional surgical stapling instrument;

FIG. **16**B is a cross-sectional side elevational view of the resulting tissue interface following the firing of surgical stapling instrument of FIGS. **7** and **10-15**;

FIG. **17**A is a cross-sectional end view of another embodiment of the staple cartridge of FIG. **8** showing a first arrangement of surgical fasteners;

FIG. **17**B is an alternate embodiment of the staple cartridge of FIG. **17**A showing a second arrangement of surgical fasteners;

FIG. **17**C is an alternate embodiment of an anvil member and the staple cartridge of FIG. **17**A;

FIG. **17**D is an alternate embodiment of an anvil member and the staple cartridge of FIG. **17**B;

FIG. **17**E is a further embodiment of the staple cartridge of FIG. **17**A;

FIG. **17**F is an alternate embodiment of an anvil member and the staple cartridge of FIG. **17**E;

FIG. **18**A is a cross-sectional end view of a further embodiment of the staple cartridge of FIG. **8**;

FIG. **18**B is an alternate embodiment of an anvil member and the staple cartridge of FIG. **18**A;

FIG. **19**A is a cross-sectional end view of a further embodiment of the staple cartridge of FIG. **8** illustrating a shaped support member disposed on a tissue contacting surface of the staple cartridge and a shaped support member, in phantom, disposed on a tissue contacting surface of the anvil member;

FIG. **19**B is an alternate embodiment of an anvil member and the staple cartridge of FIG. **19**A;

FIG. **20**A is a cross-sectional end view of another embodiment of the staple cartridge of FIG. **7**A;

FIG. **20**B is a cross-sectional end view of an alternate embodiment of an anvil member and the staple cartridge of FIG. **20**A;

FIG. **20**C is a further embodiment of an anvil member and the staple cartridge of FIG. **20**B;

FIG. **21**A is a cross-sectional end view of another embodiment of the staple cartridge of FIG. **8**;

FIG. **21**B is another embodiment of an anvil member and the staple cartridge of FIG. **21**B;

FIG. **22**A is a cross-sectional end view of a further embodiment of the staple cartridge of FIG. **8** and a further embodiment of an anvil member;

FIG. **22**B is an alternate embodiment of the staple cartridge and the anvil member of FIG. **22**A;

FIG. **22**C is a further embodiment of an anvil member with the staple cartridge of FIG. **22**B;

FIG. **23** is a perspective view of another embodiment of the presently disclosed operative tool illustrating a staple cartridge and an anvil member in an approximated position;

FIG. **24** is an enlarged perspective view of the operative tool of FIG. **23** illustrating the relationship between tissue contacting surfaces of the staple cartridge;

FIG. **25** is an exploded view of the operative tool showing a number of staples, a staple pusher, and a sled;

FIG. **26** is an enlarged perspective view of the section of detail in FIG. **25** illustrating the leg lengths of the staples;

FIG. **27** is a perspective cross-sectional view of the operative tool of FIG. **23** with the anvil member removed;

FIG. **28** is a cross-sectional view of the cartridge of FIG. **27** including staples having different leg lengths taken along section line **28-28**;

FIG. **29** is a front cross-sectional view of the cartridge of FIG. **27** taken along section line **29-29**;

FIG. **30** is a front elevational view of the operative tool of FIG. **27**;

FIG. **31** is a cross-sectional side elevational view of a tissue interface following the firing of operative tool shown in FIGS. **23-30**; and

FIG. **32** is front cross-sectional view of an alternate embodiment of the cartridge shown in FIG. **29**.

DETAILED DESCRIPTION OF EMBODIMENTS

Embodiments of the presently disclosed surgical stapling instruments will now be described in detail with reference to the drawing figures wherein like reference numerals identify similar or identical elements. In the drawings and in the description which follows, the term "proximal", as is traditional, will refer to the end of the surgical stapling instrument which is closest to the operator while the term "distal" will refer to the end of the device which is furthest from the operator.

The present disclosure relates to a staple cartridge and an anvil member for use in a disposable or re-usable surgical stapling apparatus. The presently disclosed staple cartridge and anvil member, as will be discussed in detail hereinbelow, may be used with any of the surgical stapling apparatus shown in FIG. **1**, **4**, **5**, or **6**. In addition, a replaceable loading unit may be located in either the disposable or the reusable surgical stapling apparatus. In one embodiment, the replaceable loading unit includes a staple cartridge, including any of the staple cartridges disclosed herein. Alternatively, the replaceable loading unit includes the staple cartridge and an anvil member, including any of the anvil members disclosed herein. In combination with the disposable or the reusable surgical stapling apparatus, the replaceable loading unit provides improved flexibility of the respective surgical stapling apparatus in that the respective surgical stapling apparatus is readily adaptable for different stapling procedures. In each of the embodiments that are hereinafter disclosed, staples or surgical fasteners disposed in the staple cartridge are arranged such that tips of the surgical fasteners may be substantially flush with a tissue contacting surface of the staple cartridge. Alternately, the tips of the surgical fasteners may be located above or below the tissue contacting surface.

Referring now in detail to FIGS. **1-2**, in which like reference numerals identify similar or identical elements, a surgical stapling instrument, in accordance with a first embodiment of the disclosure, is generally designated as **100**.

As seen in FIG. **1**, surgical stapling instrument **100** includes a handle assembly **102** having at least one pivotable actuating handle member **103**, and further includes advancing means **105**. Extending from handle assembly **102**, there is provided a tubular body portion **104** which may be constructed so as to have a curved shape along its length. Tubular body portion **104** terminates in a fastener ejection assembly **106** having a circular staple cartridge **118** including a tissue contacting surface **121** disposed at a distal end thereof. An anvil shaft **110** operatively couples an anvil assembly **108** to handle assembly **102**. Anvil assembly **108** is repositionable from a location where it is in close cooperative alignment with staple cartridge **118** to a location where it is spaced apart from staple cartridge **118**. Anvil assembly **108** includes an anvil head **109**. Further still, surgical stapling instrument **100** may include a wound closure assembly **50**. Wound closure assembly **50** includes at least one storage device or reservoir **52** and at least one supply line **54**. Supply line **54** fluidly couples reservoir **52** to anvil shaft **110**, wherein anvil shaft includes at least one opening **56** for dispensing wound closure material "W". By

providing wound closure material "W" in combination with surgical fasteners, the bond formed between the layers of tissue has improved strength.

As seen in FIG. **2**, tissue contacting surface **121** is stepped including an outer tissue contacting surface **121***a*, an intermediate tissue contacting surface **121***b*, and an inner tissue contacting surface **121***c*. Each tissue contacting surface **121***a*-**121***c* has a different height from one another as measured from a point **131** on a bottom surface of a staple pusher or fastener ejection member **130**. Point **131** is proximal to a shaft **111** in a region where the bottom surface of fastener ejection member **130** is substantially planar. Specifically, tissue contacting surfaces **121***a*-**121***c* are planar structures that are substantially parallel to one another, but are not co-planar (i.e. stepped) with one another. In addition, each tissue contacting surface **121***a-c* defines a planar axis that extends through the respective tissue contacting surface **121***a-c*. A first wall surface interconnects tissue contacting surfaces **121***a* and **121***b*, while a second wall surface interconnects tissue contacting surfaces **121***b* and **121***c*. The first and second wall surfaces are planar structures wherein each wall surface defines a planar axis. In one embodiment, the planar axes of the wall surfaces are orthogonal to the planar axes of tissue contacting surfaces **121***a-c*.

Inner tissue contacting surface **121***c* has the greatest height, outer tissue contacting surface **121***a* has the least height, and intermediate tissue contacting surface **121***b* has a height between the heights of outer and inner tissue contacting surfaces **121***a*, **121***c*. While tissue contacting surfaces **121***a*-**121***c* are shown as increasing in height from outer tissue contacting surface **121***a* to inner tissue contacting surface **121***c* (i.e. radially inward), it is within the scope of the present disclosure that the heights of each tissue contacting surface can vary depending on the particular surgical procedure. For example, tissue contacting surfaces **121***a*-**121***c* can increase in height in a radially outward direction, the intermediate tissue contacting surface **121***b* can be the highest or the lowest tissue contacting surface, or at least two of tissue contacting surfaces **121***a*-**121***c* can have the same height.

In one embodiment, each tissue contacting surface **121***a*-**121***c* includes a respective annular row **119***a*-**119***c* of retention slots **123** formed therein. Each retention slot **123** of annular rows **119***a*-**119***c* is configured and dimensioned to retain a staple or surgical fastener **125** therein. As shown in FIG. **2**A, each surgical fastener **125** includes a backspan **27** and a pair of depending legs **25**. Each leg **25** forms a right angle in relation to backspan **27**. In one embodiment, each annular row **119***a*-**119***c* of slots **123** includes a respective surgical fastener **125***a*-**125***c* having its own characteristic features.

As seen in FIG. **2**, legs **25***a* of surgical fasteners **125***a* have a first leg length, legs **25***b* of surgical fasteners **125***b* have a second leg length, and legs **25***c* of surgical fasteners **125***c* have a third leg length. In particular, surgical fasteners **125***a*-**125***c* increase in height in a radially outward direction. In one embodiment, legs **25***c* of surgical fasteners **125***c* have a leg length of about 2.3 mm, legs **25***b* of surgical fasteners **125***b* have a leg length of about 3.5 mm, and legs **25***a* of surgical fasteners **125***a* have a leg length of about 4.1 mm. As such, inner tissue contacting surface **121***c* has the greatest height and retains surgical fasteners **125***c* having the shortest leg lengths, and outer tissue contacting surface **121***a* has the least height and retains surgical fasteners **125***a* having the longest leg lengths. Having tissue contacting surface **121** step progressively downward at intermediate tissue contacting surface **121***b* and then again at outer tissue contacting surface **121***a* results in the formation of surgical fasteners **125***b* and **125***c*, respectively. It is envisioned and within the scope of the present disclosure that any number of arrangements are possible.

While a single annular row **119***a*-**119***c* of retention slots **123** is shown for each tissue contacting surface **121***a*-**121***c*, it is envisioned and within the scope of the present disclosure that each tissue contacting surface **121***a*-**121***c* can include multiple annular rows of retention slots.

As seen in FIG. **2**, a fastener ejection assembly **106** of surgical stapling instrument **100** includes fastener ejection member **130** disposed within staple cartridge **118**. Fastener ejection member **130** includes a proximal portion **132** having a generally frusto-conical shape and a distal portion defining concentric rings of peripherally spaced staple pushers **134***a-c*, each one of which is received within a respective staple retention slot **123** and is cooperative with its respective surgical fastener **125***a-c* disposed in annular rows **119***a-c*. In one embodiment, it is envisioned that proximal portion **132** of fastener ejection member **130** is configured and dimensioned to be contacted by a distal end of a driver tube **138**. Hence, upon advancing fastener ejection member **130** by advancing driver tube **138**, staple pushers **134***a-c* will pass further into retention slots **123** thereby pushing surgical fasteners **125** contained therein axially outward.

In an alternate embodiment, staple pushers **134***a-c* of fastener ejection member **130** have different heights for cooperating with different sized surgical fasteners. In particular, staple pushers **134***a-c* are sized such that when surgical fasteners **125***a-c* are disposed in their respective annular rows **119***a-c*, tips of surgical fasteners **125***a-c* are located substantially in the same plane despite the difference in leg lengths between each row of surgical fasteners.

Surgical stapling instrument **100** (FIG. **1**) includes circular anvil assembly **108** having anvil head **109** and anvil shaft **110** extending from a proximal end thereof and adapted to engage shaft **111** extending distally from staple cartridge **118**. Anvil head **109** includes an annular anvil member **112** disposed at a proximal end thereof, wherein anvil member **112** includes at least one, row of fastener forming depressions **114** formed circumferentially thereabout. In one embodiment, surgical stapling instrument **100** includes three laterally spaced rows of fastener forming depressions **114** formed circumferentially thereabout. Each fastener forming depression **114** is in registration with a corresponding retention slot **123**.

While anvil member **112** is shown in FIG. **2** as having a substantially planar tissue contacting surface, it is envisioned and within the scope of the present disclosure for surgical stapling instrument **100** to have a number of alternate configurations. For example, as seen in FIG. **3**A, anvil member **112***a* can have a tissue contacting surface, including surfaces **116***a*-**116***c*, which is shaped (i.e. stepped) to complement stepped tissue contacting surface **121** of staple cartridge **118** or, as seen in FIG. **3**B, anvil member **112***b* can have a tissue contacting surface, including surfaces **116***a-c*, which is stepped while tissue contacting surface **121** of staple cartridge **118** is substantially planar. In addition, for example, as seen in FIG. **3**C, anvil member **112***c* can have one row of staple pockets **114***b* that extends a greater distance than staple pockets **114***a* or **114***c* into anvil member **112***c* for accommodating surgical fasteners having a longer leg length or, as seen in FIG. **3**D, anvil member **112***d* can have a tissue contacting surface, including surfaces **116***a-c*, which is stepped to mirror tissue contacting surface **121** of staple cartridge **118** (i.e. the depths of individual tissue contacting surfaces of the tissue contacting surface of anvil

member **112***d* are substantially equal to the depths of the individual tissue contacting surfaces **121***a*-**121***c* of staple cartridge **118**).

The sizes of surgical fasteners **125***a*-**125***c* are selected and intended for use in gastric firings typically required in bariatric procedures. However, it is envisioned and within the scope of the present disclosure that the sizes of surgical fasteners **125***a*-**125***c* selected can be chosen for performance in different types of tissue, such as, for example, the colon, bowels, lungs, the bronchus, pulmonary vessels, the liver, and the like.

In operation, surgical stapling instrument **100** is positioned within a tubular organ in the body of the patient and the ends of the organ to be joined are positioned in a gap between staple cartridge **118** and anvil assembly **108**. As is conventional, the ends of the organ may be secured around anvil shaft **110** by a purse string suture prior to approximation of anvil assembly **108** to staple cartridge **118**. Surgical stapling instrument **100** is then approximated and fired. An example of a surgical stapling apparatus and methods for its use are disclosed in U.S. Pat. No. 5,915,616, currently assigned to Tyco Healthcare Group LP, the entire contents of which is incorporated herein by reference.

Turning now to FIGS. **4** and **7**, a surgical stapling instrument, of the gastrointestinal anastomosis type for performing surgical anastomotic stapling, in accordance with another embodiment of the disclosure, is generally designated as **200**. Surgical stapling instrument **200** includes a first handle **202** having a jaw **203** defining a staple cartridge receiving section extending from a distal end thereof, a staple cartridge **204** receivable in jaw **203**, a second handle **206** having a jaw **205** defining an anvil member receiving section extending from a distal end thereof, and an anvil member **208** operatively associated with jaw **205**. First and second handles **202**, **206** are configured such that staple cartridge **204** is substantially aligned with anvil member **208**.

As seen in FIG. **7**, staple cartridge **204** includes a stepped tissue contacting surface **121** including an outer tissue contacting surface **121***a*, an intermediate tissue contacting surface **121***b*, and an inner tissue contacting surface **121***c*, each of which has a different height from one another as measured from a point **231** that is located on a bottom surface of staple cartridge **204**, wherein point **231** exists along a centerline of staple cartridge **204**. Tissue contacting surfaces **121***a*-**121***c* are planar structures that are substantially parallel to one another, but are not co-planar with one another. For example, tissue contacting surfaces **121***a*-**121***c*, as shown in FIG. **7**, can decrease in height in a direction orthogonally outward from knife track **222**. In embodiments that do not include knife track **222**, tissue contacting surfaces **121***a-c* decrease in height in a direction orthogonally outward from a centerline of staple cartridge **204**.

Each tissue contacting surface **121***a*-**121***c* includes a respective linear row **119***a*-**119***c* of retention slots **123** formed therein. Each retention slot **123** of linear rows **119***a*-**119***c* is configured and dimensioned to retain a surgical fastener **125** therein. Each linear row **119***a*-**119***c* of slots **123** includes a respective surgical fastener **125***a*-**125***c* having its own characteristic features.

As seen in FIG. **7**, legs **25***a* of surgical fasteners **125***a* have a first leg length of about 4.1 mm, legs **25***b* of surgical fasteners **125***b* have a second leg length of about 3.5 mm, and legs **25***c* of surgical fasteners **125***c* have a third leg length of about 2.3 mm. In particular, surgical fasteners **125***a*-**125***c* increase in height in an orthogonally outward direction relative towards optional knife track **222**. Knife track **222** is disposed along a centerline of staple cartridge **204**, **310**, or **412** and is adapted for slidably receiving an optional knife (not shown). Having tissue contacting surface **121** step progressively downward at intermediate tissue contacting surface **121***b* and then again at outer tissue contacting surface **121***a* results in the formation of surgical fasteners **125***b* and **125***c*, respectively. It is envisioned and within the scope of the present disclosure that any number of arrangements are possible.

In operation, surgical stapling instrument **200** is fired similarly to and in accordance with other known surgical stapling instruments. An example of a surgical stapling apparatus and methods for its use are is disclosed in U.S. Pat. No. 6,202,914, currently assigned to Tyco Healthcare Group LP, the entire contents of which is incorporated herein by reference.

Referring additionally to FIG. **16**B, following the firing of surgical stapling instrument **200**, the resulting tissue interface is seen in cross-section. Accordingly, some or all of surgical fasteners **125***a*-**125***c* serve to hold tissues "A" and "B" to one another while surgical fasteners **125***c* also provide the hemostasis.

While surgical stapling instrument **200** is a linear-type surgical stapler, it is envisioned and within the scope of the present disclosure, that surgical stapling instrument **200** can include a tissue contacting surface having a cross-sectional profile for at least one of the anvil member and the staple cartridge which is substantially similar to the tissue contacting surfaces of the anvil member and the staple cartridge of surgical stapling instrument **100**, as shown in FIGS. **3**A-**3**D.

Turning now to FIGS. **5** and **7**, a surgical stapling instrument, of the laparoscopic type for performing surgical anastomotic stapling, in accordance with another embodiment of the disclosure, is generally designated as **300**. Surgical stapling instrument **300** includes a handle **302**, an operative tool **306**, and an elongated shaft **304** for interconnecting operative tool **306** to handle **302**. In general, operative tool **306** is designed to clamp over and then to staple and divide tissue held therein. Accordingly, as seen in FIG. **5**, operative tool **306** is a pair of opposed jaws including an anvil member **308** and a staple cartridge **310** pivotally coupled to one another.

Staple cartridge **310** of surgical stapling instrument **300** includes a stepped tissue contacting surface **121** similar to tissue contacting surface **121** of staple cartridge **204** of surgical stapling instrument **200**. Accordingly, reference is made to FIG. **7** and the above detailed discussion of tissue contacting surface **121** of staple cartridge **204** for an illustration and a discussion of tissue contacting surface **121** of staple cartridge **310** of surgical stapling instrument **300**.

In operation, surgical stapling instrument **300** is fired similarly to and in accordance with other known surgical stapling instruments. For a detailed discussion of the approximation and firing of surgical stapling instrument **300**, reference is made to commonly assigned U.S. Pat. No. 5,865,361, currently assigned to Tyco Healthcare Group LP, the entire contents of which is incorporated herein by reference.

Following the firing of surgical stapling instrument **300** the resulting tissue interface, as seen in cross-section, is substantially similar to the resulting tissue interface, as seen in cross-section, following the firing of surgical stapling instruments **100** and **200**. Accordingly, as seen in FIG. **16**B, some or all of surgical fasteners **125***a*-**125***c* serve to hold tissues "A" and "B" to one another while surgical fasteners **125***c* also provide the hemostasis.

While surgical stapling instrument **300** is a linear-type surgical stapler as compared to surgical stapling instrument **100**, it is envisioned and within the scope of the present disclosure, that surgical stapling instrument **300** can include a tissue contacting surface having a cross-sectional profile for at least one of the anvil and the staple cartridge which is substantially similar to the tissue contacting surfaces of the anvil and the staple cartridge of surgical stapling instrument **100**, as shown in FIGS. **3**A-**3**D.

Turning now to FIGS. **6**, **6**A, **7**, and **7**A, a surgical stapling instrument, of the transverse anastomosis type for performing surgical anastomotic stapling, in accordance with yet another embodiment of the disclosure, is generally designated as **400**. Surgical stapling instrument **400** includes a handle **402**, a barrel **404** extending from handle **402**, and an arm **406** extending from the distal end of barrel **404**. Surgical stapling instrument **400** further includes an anvil member **408** orthogonally affixed to a distal end of arm **406** and a staple cartridge receiver **410** operatively coupled to the distal end of barrel **404** for holding a disposable staple cartridge **412** thereon. Anvil member **408** is illustrated in further detail in FIG. **6**A and includes a tissue contacting surface **420** wherein tissue contacting surface **420** has a plurality of pockets **425** that substantially align with retention slots **123** (FIG. **7**). Cooperative alignment between pockets **425** and retention slots **123** form completed surgical fasteners **125** upon actuation of the actuation mechanism in surgical stapling instrument **400**.

Staple cartridge **412** of surgical stapling instrument **400** includes a stepped tissue contacting surface **121** similar to tissue contacting surface **121** of staple cartridge **204** of surgical stapling instrument **200**. Accordingly, reference is made to FIG. **7** and the above detailed discussion of tissue contacting surface **121** of staple cartridge **204** for an illustration and a discussion of tissue contacting surface **121** of staple cartridge **412** of surgical stapling instrument **400**. Further still, staple cartridge **412** may include knife track **222** for slidably receiving a knife (not shown) therein.

In a further embodiment of the present disclosure, staple cartridge **412'** is illustrated in FIG. **7**A and discussed in detail hereinafter. Staple cartridge **412'** is similar to staple cartridge **412**, but only includes three rows **119***a-c* of retention slots **123** disposed between outer walls of staple cartridge **412'**. As in the previously discussed embodiment, each row **119***a-c* includes a plurality of surgical fasteners wherein surgical fasteners in row **119***a* have a different leg length from surgical fasteners disposed in row **119***b*, while surgical fasteners disposed in row **119***c* have a leg length that is different from at least one of rows **119***a* or **119***b*. This embodiment of the staple cartridge does not include a knife track. The arrangement and interrelationship of tissue contacting surfaces **121***a-c* is similar to that previously disclosed with reference to FIG. **7**.

In operation, surgical stapling instrument **400** is fired similarly to and in accordance with other known surgical stapling instruments. For a detailed discussion of the approximation and firing of surgical stapling instrument **400**, reference is made to commonly assigned U.S. Pat. No. 5,964,394, currently assigned to Tyco Healthcare Group LP, the entire contents of which is incorporated herein by reference.

Following the firing of surgical stapling instrument **400** the resulting tissue interface, as seen in cross-section, is substantially similar to the resulting tissue interface, as seen in cross-section, following the firing of surgical stapling instruments **100-300**. Accordingly, as seen in FIG. **16**B, some or all of surgical fasteners **125***a*-**125***c* serve to hold tissues "A" and "B" to one another while surgical fasteners **125***c* also provide the hemostasis.

While surgical stapling instrument **400** is a linear-type surgical stapler as compared to surgical stapling instrument **100**, it is envisioned and within the scope of the present disclosure, that surgical stapling instrument **400** can include a tissue contacting surface having a cross-sectional profile for at least one of the anvil and the staple cartridge which is substantially similar to the tissue contacting surfaces of the anvil and the staple cartridge of surgical stapling instrument **100**, as shown in FIGS. **3**A-**3**D.

While each of the surgical stapling instruments described above and shown herein are configured and adapted to fire surgical fasteners **125**, it is envisioned and within the scope of the present disclosure, that tissue contacting surfaces of surgical instruments used in connection with applying two-part fasteners can also have stepped configurations as shown and described herein. A typical two-part surgical fastener applying instrument is shown and described in commonly assigned U.S. Pat. No. 5,573,169, currently assigned to Tyco Healthcare Group LP, the entire contents of which is incorporated herein by reference.

In one further embodiment of the present disclosure, as illustrated in FIGS. **8-10**, surgical stapling apparatus **300** includes an operative tool **506** disposed at one end of elongated shaft **304**. Operative tool **506** includes anvil member **308** and a staple cartridge **510**. Staple cartridge **510** may be included in a disposable surgical stapling apparatus or in a reusable surgical stapling apparatus. In particular, staple cartridge **510** includes a tissue contacting surface **520** having a plurality of retention slots **523** disposed therein and arranged in rows that are substantially aligned with a longitudinal axis of staple cartridge **510**. As seen in FIG. **8**, each row of retention slots **523** is longitudinally offset from an adjacent row of retention slots. In particular, an optional knife channel **530** is disposed along the longitudinal axis of staple cartridge **510** that is adapted for slidably receiving a knife (not shown).

Referring now to FIG. **9**A, operative tool **506** is shown in cross-section and illustrates the several components included in staple cartridge **510**. Anvil member **308** includes a substantially planar tissue contacting surface **320** that is substantially parallel to a bottom surface **512** or parallel to a plane defined by the backspans of surgical fasteners **125***a*, **125***b*, or **125***c*. Staple cartridge **510** includes outer walls **514** having a first height and inner walls **516** having a second height wherein the second height is greater than the first height. Tissue contacting surface **520** is attached to inner walls **516** and to outer walls **514** and defines an angle with respect to a plane that is orthogonal to inner walls **516**. Tissue contacting surface **520** defines a generally curved path between outer walls **514** (i.e. generally convex or elliptical as viewed in cross-section). Additionally, a plurality of surgical fasteners **125***a-c* are disposed in staple cartridge **510** wherein each row of retention pockets **523** includes a number of substantially identical surgical fasteners (i.e. **125***a*, **125***b*, or **125***c*). Similar to previous embodiments, legs **25***a-c* of surgical fasteners **125***a-c* have different lengths. In this embodiment, surgical fasteners **25***a* have a leg length of about 3.8 mm, surgical fasteners **25***b* have a leg length of about 3.5 mm, and surgical fasteners **25***c* have a leg length of about 2.5 mm.

As seen in FIG. **9**A, surgical fasteners **125***a-c* are disposed in staple cartridge **510** such that surgical fasteners **125***c* are proximate to outer walls **514**, surgical fasteners **125***a* are disposed proximate to inner walls **516**, and surgical fasteners **125***b* are disposed therebetween. In cooperation with the

surgical fasteners of varying height, staple cartridge **510** includes fastener ejection members **540** that include staple pushers **542**, **544**, and **546** of differing heights. Staple pusher **542** has the greatest height dimension, staple pusher **546** has the least height dimension, and staple pusher **544** has a height dimension therebetween. In this embodiment, surgical fasteners **125***a-c* are arranged to cooperate with staple pushers **546**, **544**, and **542** respectively. Fastener ejection member **540** is adapted for substantially vertical movement when it cooperatively engages with an actuation mechanism (not shown). An example of a suitable actuation mechanism is disclosed in U.S. Pat. No. 5,865,361 as discussed with reference to previously disclosed surgical stapling instrument **300**.

As illustrated in FIG. **9**A, fastener ejection member **540** includes staple pushers **542**, **544**, and **546** that are connected to each other by a connecting member **548**, such that all of the pusher plates translate substantially simultaneously through staple cartridge **510**. In an alternate embodiment, fastener ejection member **540'** includes pusher plates **542**, **544**, and **546** that are individually set within staple cartridge **510**. In this embodiment, each row of staple pushers is individually actuatable and independent of the other rows of staple pushers. Either embodiment of the fastener ejection member **540**, **540'** may be used in any of the disclosed staple cartridges. Fastener ejection member **540'** is illustrated in FIG. **9**A and, for the sake of clarity, will not be illustrated in other embodiments of the disclosed surgical stapling apparatus.

In addition, staple cartridge **510** may include a plurality of staple guides or channels **525**, shown in phantom, that extend from an inside surface of tissue contacting surface **520** towards fastener ejection member **540** or **540'**. In particular, staple channels **525** extend towards staple pushers **542**, **544**, and **546**, and may also vary in height according to their placement within staple cartridge **510**. Each staple channel **525** is substantially equal in width to a width of its corresponding staple pusher **542**, **544**, or **546**. Staple channels **525**, in cooperation with retention slots **523** form staple pockets and improve the stability of surgical fasteners **125***a-c*, thereby minimizing lateral or rotational movement of surgical fasteners **125***a-c* and consequently improving the formation of completed fasteners. Further still, staple channels **525** typically have a shape that corresponds to the shape of staple pushers **542**, **544**, and **546**. For the sake of clarity, staple channels **525** are only illustrated in FIG. **9**A, although staple channels **525** may be included in any of the disclosed embodiments of the staple cartridge.

Alternate embodiments of operative tool **506** are illustrated in FIGS. **9**B and **9**C. These alternate embodiments are identified as operative tool **506***a* and **506***b* respectively. Referring initially to FIG. **9**B, operative tool **506***a* includes substantially the same or similar components discussed hereinabove for operative tool **506** with the differences discussed hereinbelow. In contrast to operative tool **506** (FIG. **9**A), surgical fasteners **125***a-c* of operative tool **506***a* are arranged in staple cartridge **510***a* such that surgical fasteners **125***a* are proximate to outer walls **514**, surgical fasteners **125***c* are proximate to inner walls **516**, and surgical fasteners **125***b* are disposed therebetween. In addition, operative tool **506***a* includes tissue contacting surface **520***a* that includes first and second surfaces **522***a* and **524***a*. Each of first and second surfaces **522***a*, **524***a* has a width dimension sufficient to include at least one row of surgical fasteners. First surface **522***a* is substantially parallel to bottom surface **512**, while second surface **524***a* defines a substantially uniform angle. In particular, second surface **524***a* extends outwards and downwards from an outer edge of first surface **522***a* and defines the substantially uniform angle with respect to bottom surface **512**.

Turning now to FIG. **9**C, operative tool **506***b* includes staple cartridge **510***a* that was discussed in reference to FIG. **9**B and anvil member **308***c*. Anvil member **308***c* includes tissue contacting surface **320***c*. In particular, tissue contacting surface **320***c* includes surfaces **322***c* and **324***c*. Surface **324***c* is substantially parallel to bottom surface **512** has a width dimension that is substantially equal to the width dimensions of the first surfaces **522***a* and knife channel **530**, while each surface **322***c* substantial complements corresponding second surface **524***a*. This arrangement between the surfaces of anvil member **308***c* and tissue contacting surface **520***a* maintains a substantially uniform gap between the surfaces from the centerline of operative tool **506***b* to its outer walls **514**.

Alternatively, as shown in FIG. **10**, surgical fasteners **125***a-c* are disposed in staple cartridge **510'** such that surgical fasteners **125***a* are proximate to outer walls **514**, surgical fasteners **125***c* are disposed proximate to inner walls **516**, and surgical fasteners **125***b* are disposed therebetween. Contrary to the previous embodiment, surgical fasteners **125***a-c* are arranged to cooperate with staple pushers **542**, **544**, and **546** respectively. After a number of layers of body tissue are positioned between tissue contacting surfaces **320** and **520**, the actuation mechanism is actuated for sequentially ejecting surgical fasteners **125***a-c* through retention slots **523** whereby interaction between surgical fasteners **125***a-c* and anvil member **308** forms completed surgical fasteners for joining the layers of body tissue.

When tissue contacting surface **320** of anvil member **308** is repositioned proximate to tissue contacting surface **520** of staple cartridge **510'**, the amount of pressure applied to the layers of tissue disposed therebetween varies along a plane that is transverse to the longitudinal axis of staple cartridge **510'**. Since the distance between tissue contacting surfaces **320** and **520** is at a minimum in the region nearest inner walls **516** (i.e. the centerline of staple cartridge **510'**), a maximum pressure is applied to the layers of tissue disposed in this region. Conversely, the distance between tissue contacting surfaces **320** and **520** is at a maximum in the region near outer walls **514**, a minimum pressure is applied to the layers disposed in this region. In addition, the proximal relationship between anvil member **308** and staple cartridge **510'** defines a plurality of gaps therebetween. A first gap is defined between tissue contacting surfaces **320** and **520** (i.e. along the centerline of staple cartridge **510'**), while a second gap is defined between tissue contacting surfaces **320** and **520** along outer walls **514**. As seen in FIG. **10**, the first gap is not equal to the second gap. Further still, a number of other gaps may be defined between tissue contacting surfaces **320** and **520** at other points of reference existing between the centerline and outer walls **514** in staple cartridge **510'**. Since tissue contacting surface **520** slopes toward outer walls **514** to define a substantially uniform angle, the pressure applied to the layers of tissue disposed between tissue contacting surfaces **320** and **520** uniformly decreases from inner wall **516** to outer wall **514**.

By angling tissue contacting surface **520** downwards from the centerline of staple cartridge **510'**, reduced compressive forces are applied to the layers of tissue disposed between tissue contacting surfaces **320** and **520** thereby minimizing trauma to the layers of tissue disposed therebetween. Therefore, layers of tissue disposed between tissue contacting surfaces **320** and **520** will have a minimum thickness nearest knife channel **530** (i.e. nearest the centerline of staple

cartridge **510'**) and a maximum thickness nearest outer walls **514**. In addition, anvil member **308** and staple cartridge **510'** are dimensioned and arranged such that compressive forces applied to the layers of tissue are minimal thereby further reducing trauma to the layers of tissue. This configuration defines a gap between tissue contacting surfaces **320** and **520** that is a maximum along knife channel **530** (i.e. the centerline of staple cartridge **510** or **510'**) and a minimum along outer walls of staple cartridge **510** (FIG. **9**A) or **510'** (FIG. **10**).

Further still, this configuration is applicable to similar staple cartridges and anvil members as will be discussed in detail hereinafter with respect to FIGS. **11-15**. When anvil member **308'** is repositioned into proximity with staple cartridge **510'** (i.e. in a pre-fire position) to retain layers of body tissue therebetween, the layers of tissue are compressed. The maximum compression occurs along the centerline (i.e. first or minimum gap) and urges fluid stored in the layers of tissue towards the outer edges of the tissue (i.e. away from the centerline of staple cartridge **510'**). By reducing the amount of fluid retained in the layers of tissue proximal to the centerline, the overall thickness of the tissue layers decreases. The decrease in overall tissue thickness is such that a staple having a shorter leg length (i.e. surgical fastener **125***c*) is capable of fastening both layers of tissue while minimizing trauma to the fastened layers of tissue. The gap increases towards the outer walls of staple cartridge **510'** (i.e. the amount of compression decreases) and surgical fasteners having a longer leg length (i.e. surgical fasteners **125***a* and **125***b*) are capable of fastening both layers of tissue.

Leg lengths of surgical fasteners **125***c*, **125***b*, and **125***a* increase in a direction moving from inner walls **516** towards outer walls **514**. By providing surgical fasteners having increasing leg lengths along a plane that is orthogonal to inner walls **516**, the completed (i.e. formed) surgical fasteners join increasing thicknesses of tissue without unduly traumatizing the joined layers of tissue.

In a further embodiment, as illustrated in FIG. **11**, operative tool **506"** includes staple cartridge **510'** and anvil member **308'**. Staple cartridge **510'** was previously discussed in detail hereinabove with reference to FIG. **10**. Tissue contacting surface **520** may define a more uniform angle (FIG. **11**) than in the embodiments of FIGS. **9**A and **10** wherein the angle or pitch of tissue contacting surface is substantially constant between inner walls **516** and outer walls **514**. Anvil member **308'** includes tissue contacting surface **320'** having tapered surfaces **322'** and **324'**. Surfaces **322'** and **324'** are connected to outer walls of anvil member **308'** while extending inwards (i.e. towards the centerline of staple cartridge **510'**) and downwards (i.e. towards tissue contacting surface **520**) thereby defining an angle. It is envisioned that the angle defined by tapered surfaces **322'** and **324'** will be substantially similar to the angle defined by tissue contacting surface **520**, but in an opposed direction forming a generally V-shaped configuration. Thus, compressive forces applied to the layers of tissue will be further reduced thereby further reducing the trauma to layers of tissue disposed between tissue contacting surfaces **520** and **320'**. As in the embodiment of FIG. **10**, the maximum pressure applied to the layers of tissue will exist in the region near knife channel **530** while pressures applied to the layers of tissue will decrease uniformly towards outer walls **514**. Formation and location of surgical fasteners **125***a-c* is substantially similar to that of the embodiment of FIG. **10** along with the attendant advantages.

Referring now to FIG. **12**, a further embodiment of the present disclosure is shown as part of operative tool **606**. Operative tool **606** includes a staple cartridge **610** and anvil member **308**. In this embodiment, tissue contacting surface **620** includes surfaces **622** and **624**. Surface **622** is bisected along its longitudinal axis by knife channel **630** and substantially parallel to a bottom surface **612** or parallel to a plane defined by the backspans of surgical fasteners **125***a*, **125***b*, or **125***c*. In addition, surface **622** has a width dimension sufficient to accommodate at least one row of retention slots **623** on each side of knife channel **630**. Surface **624** connects outer edges of surface **622** to outer walls **614** defining an angle on either side of knife channel **630** with respect to a plane that is substantially orthogonal to inner walls **616** (i.e. substantially parallel to surface **622**) and has a width dimension sufficient to accommodate at least one row of retention slots on each side of knife channel **630**. Staple cartridge **610** includes a plurality of surgical fasteners **125***a-c* and fastener ejection members **540** that were previously discussed in detail with respect to FIGS. **9**A and **10**. In particular, staple cartridge **610** includes the arrangement of surgical fasteners **125***a-c* and fastener ejection members **540** as described with respect to staple cartridge **510'** (FIGS. **10** and **11**).

Similar to operative tool **506**, tissue contacting surface **320** is repositioned proximate to tissue contacting surface **620** of staple cartridge **610**. In this arrangement, the amount of pressure applied to the layers of tissue disposed therebetween varies along a plane that is transverse to the longitudinal axis of staple cartridge **610**. Specifically, the distance between tissue contacting surface **320** and surface **622** is a minimum, a maximum pressure is applied to the layers of tissue disposed in this region. Conversely, the distance between tissue contacting surface **320** and surfaces **624** is at a maximum in the region near outer walls **614**, a minimum pressure is applied to the layers disposed in this region. Since surface **624** slopes toward outer walls **614** to define a substantially uniform angle, the pressure applied to the layers of tissue disposed between tissue contacting surface **320** and surfaces **624** uniformly decreases from an outer edge of surface **622** towards outer wall **614**.

By angling surface **624** downwards from the edge of surface **622**, reduced compressive forces are applied to the layers of tissue disposed between tissue contacting surface **320** and surfaces **624** thereby minimizing trauma to the layers of tissue disposed therebetween. Layers of tissue disposed between tissue contacting surfaces **320** and **620** will have a minimum thickness nearest knife channel **630** and a maximum thickness nearest outer walls **614**. In addition, anvil member **308** and staple cartridge **610** are dimensioned and arranged such that compressive forces applied to the layers of tissue are minimal thereby further reducing trauma to the layers of tissue.

Leg lengths of surgical fasteners **125***c*, **125***b*, and **125***a* increase in a direction moving from inner walls **616** towards outer walls **614**. By providing surgical fasteners having increasing leg lengths along a plane that is orthogonal to inner walls **616**, the completed (i.e. formed) surgical fasteners join increasing thicknesses of tissue without unduly traumatizing the joined layers of tissue.

In a further embodiment, operative tool **606'** is illustrated in FIG. **13**. Operative tool **606'** includes staple cartridge **610**, that was described in detail hereinabove with respect to FIG. **12**, and anvil member **308"**. Anvil member **308"** includes a tissue contacting surface **320"** formed from surfaces **332"** and **336"**. Surface **336"** is substantially parallel to surface **622** and has a width dimension that is substantially similar

to the width dimension of surface **622**. Surfaces **332"** are tapered and connected to outer walls of anvil member **308"** and extend inwards (i.e. towards the centerline of staple cartridge **610**) and downwards (i.e. towards tissue contacting surface **620**) thereby defining an angle. It is envisioned that the angle defined by tapered surfaces **332"** will be substantially similar to the angle defined by surfaces **624**, but in an opposed direction. Thus, compressive forces applied to the layers of tissue will be further reduced thereby further reducing the trauma to layers of tissue disposed between surfaces **624** and **332"**. As in the embodiment of FIG. **10**, the maximum pressure applied to the layers of tissue will exist in the region along surface **622** while pressures applied to the layers of tissue will decrease uniformly along surfaces **624** towards outer walls **614**. Formation and location of surgical fasteners **125***a-c* is substantially similar to that of the embodiment of FIG. **12** along with the attendant advantages.

In yet another embodiment, operative tool **706** is illustrated in FIG. **14**. Staple cartridge **710** is similar to staple cartridge **610**. The differences between staple cartridges **610** and **710** will be discussed hereinafter. As in staple cartridge **610** (FIG. **12**), staple cartridge **710** includes tissue contacting surface **720** formed from surfaces **722** and **724**. Surface **722** differs from surface **622** in that it has a width dimension sufficient to accommodate at least two rows of surgical fasteners. As in staple cartridge **610**, surfaces **724** are attached to outer edges of surface **722** and outer walls **714** to define angles. The interaction between staple cartridge **710** and anvil member **308** for capturing tissue and forming surgical fasteners is substantially similar to the interaction between staple cartridge **610** and anvil member **308** and, for the sake of brevity, will not be repeated herein.

In FIG. **15**, an alternate embodiment of operative tool **706'** is illustrated. Operative tool **706'** includes staple cartridge **710**, as discussed in detail hereinabove, and anvil member **308"**. Anvil member **308"** includes a tissue contacting surface **320"** formed from surfaces **332"** and **336"**. Surface **336"** is substantially parallel to surface **722** and has a width dimension that is substantially similar to a width dimension of surface **722**. Surfaces **332"** are tapered and connected to outer walls of anvil member **308"** and extend inwards (i.e. towards centerline of staple cartridge **710**) and downwards (i.e. towards tissue contacting surface **720**) thereby defining an angle. It is envisioned that the angle defined by tapered surfaces **332"** will be substantially similar to the angle defined by surfaces **724**, but in an opposed direction. Thus, compressive forces applied to the layers of tissue will be further reduced, thereby further reducing the trauma to the layers of tissue disposed between surfaces **724** and **332"**. As in the embodiment of FIG. **14**, the maximum pressure applied to the layers of tissue will exist in the region along surface **722** while pressures applied to the layers of tissue will decrease uniformly along surfaces **724** towards outer walls **714**. Formation and location of surgical fasteners **125***a-c* is substantially similar to that of the embodiment of FIG. **14** along with the attendant advantages.

Turning now to FIG. **16**B, a cross-section of the resulting tissue interface, following the firing of staple cartridge **510'**, is shown. As seen in FIG. **16**B, the tissue interface has a substantially tapered profile. In particular, some or all of surgical fasteners **125***a*-**125***c* serve to hold tissues "A" and "B" to one another while surgical fasteners **125***c* also provide the hemostasis. This resulting cross-section is also applicable to the firing of staple cartridges **610** and **710**. When staple cartridge **510** is fired, some or all of surgical fasteners **125***a*-**5***c* serve to hold tissues "A" and "B" to one another while surgical fasteners **125***a* also provide the hemostasis. When layers of tissue "A" and "B" are fastened using a conventional surgical stapling device and conventional staples "S", there exists a sharp transition from the un-fastened layers of tissue to the fastened layers of tissue that is illustrated in FIG. **16**A. This may result in a greater load being placed on the layers of tissue and may produce an undesirable effect on the layers of tissue. In comparison, as shown in FIG. **16**B, the tissue interface has a gradual transition from the un-fastened layers of tissue to the fastened layers of tissue and also within the fastened layers of tissue. This arrangement provides gradual tissue loading or compression due to the varying sizes of the formed surgical fasteners **125***a-c*, thereby minimizing tissue trauma while maintaining a relatively high degree of hemostasis and anastomotic strength.

In a further embodiment of the present disclosure, as shown in FIGS. **8** and **10**, operative tool **506'** includes a wound closure assembly **50**. Wound closure assembly **50** includes at least one storage device or reservoir **52** and at least one supply line **54**. Supply line **54** fluidly couples reservoir **52** to staple cartridge **510'** for delivering an amount of a wound closure material "W". In particular, supply line **54** delivers wound closure material "W" into knife channel **530** such that when surgical fasteners **125***a-c* are formed, wound closure material "W" migrates along the layers of tissue adjacent to tissue contacting surface **520** (i.e. the target site). By providing wound closure material "W" in combination with surgical fasteners **125***a-c*, the bond formed between the layers of tissue has improved strength.

Compression of reservoir **52** causes wound closure material "W" contained therein to be urged through supply line **54** and dispensed via knife channel **530**. Preferably, wound closure material "W" is dispensed during the staple firing procedure so that wound closure material "W" is dispensed along the length of the staple line and/or a knife cut line. Although wound closure assembly is discussed and illustrated with respect to FIG. **10**, it is contemplated that wound closure assembly **50** is adaptable for use with other disclosed embodiments of staple cartridge **510'** (i.e. **510**, **610**, or **710**). It is further contemplated that an additional reservoir may be included for wound closure materials formed by combining two substances or that reservoir **52** may include a plurality of internal chambers (shown in phantom) for storing quantities of substances to be combined to form wound closure material "W".

It is envisioned that wound closure material "W" can include one or a combination of adhesives, hemostats, sealants. Surgical biocompatible wound closure materials which can be employed in or applied the surgical instruments, especially surgical staplers, include adhesives whose function is to attach or hold organs, tissues or structures, sealants to prevent fluid leakage, and hemostats to halt or prevent bleeding. Examples of adhesives which can be employed include protein derived, aldehyde-based adhesive materials, for example, the commercially available albumin/glutaraldehyde materials sold under the trade designation BIOGLUE™ by Cryolife, Inc., and cyanoacrylate-based materials sold under the trade designations INDERMIL™ and DERMA BOND™ by Tyco Healthcare Group, LP and Ethicon Endosurgery, Inc., respectively. Examples of sealants, which can be employed, include fibrin sealants and collagen-based and synthetic polymer-based tissue sealants. Examples of commercially available sealants are synthetic polyethylene glycol-based, hydrogel materials sold under the trade designation COSEAL™ by Cohesion Technologies and Baxter International, Inc. Examples of hemostat mate-

rials, which can be employed, include fibrin-based, collagen-based, oxidized regenerated cellulose-based and gelatin-based topical hemostats. Examples of commercially available hemostat materials are fibrinogen-thrombin combination materials under sold the trade designations COSTASIS™ by Tyco Healthcare Group, LP, and TISSEEL™ sold by Baxter International, Inc. Hemostats herein include astringents, e.g., aluminum sulfate, and coagulants.

It is to be understood that the dispensing of wound closure material "W" can be as a fluid spray of any suitable volume, including a mist, applied temporarily, continuously, or continually. Particulate material, e.g. a fine powder is contemplated to be a fluid within the scope of this disclosure.

It is provided that a number of different wound closure materials "W" can be dispensed by wound closure assembly **50** or a combination of the number of different wound closure materials "W". The wound closure material dispensed by wound closure assembly **50** can, for example, be an astringent, such as a sulfate of aluminum, which causes small blood vessels to close and helps the blood to coagulate. It is provided that wound closure material "W" can be an astringent provided in the material commercially available under the trade designation NO NIX® Styptic Pencils from Requa, Inc.

Referring now to FIGS. **17**A-F, further embodiments of the presently disclosed operative tool are illustrated. As shown in FIG. **17**A, operative tool **806***a* includes anvil member **308** and staple cartridge **810***a*. Anvil member **308** was previously described hereinabove with reference to FIG. **9**A and, for the sake of brevity, will not be discussed again. In addition, staple cartridge **810***a* is similar to staple cartridge **710** (FIG. **14**) with the differences being discussed in detail hereinbelow. Similar to staple cartridge **710**, staple cartridge **810***a* includes a tissue contacting surface **820**, outer and inner walls **814**, **816**, a knife channel **830**, and a bottom surface **812**. Located within staple cartridge **810***a* is a plurality of surgical fasteners **125***a*, **125***b*, and **125***c* that were previously discussed with respect to staple cartridge **710**. In addition, staple cartridge **810***a* includes a plurality of fastener ejection members **540** that were previously described with respect to FIG. **9**.

In this embodiment, surfaces **822** and **824** define tissue contacting surface **820**. As with previous embodiments of the presently disclosed staple cartridge, tissue contacting surface **820** includes a plurality of retention slots **823**. Surface **822** is a planar surface that is substantially parallel to bottom surface **812**, while surface **824** is a generally arcuate surface. Each surface **822**, **824** includes at least one row of retention slots **823**. Additionally, inner wall **816** has a first height and outer wall **814** has a second height, wherein the first height is greater than the second height. One edge of surface **824** is attached to outer wall **814** while the opposing edge is attached to an edge of surface **822**, thereby defining a generally concave surface with respect to surface **822**.

Similar to previous embodiments of the presently disclosed operative tool, tissue contacting surface **320** of anvil member **308** is repositioned proximate to tissue contacting surface **820** of staple cartridge **810***a*. In this arrangement, the amount of pressure applied to the layers of tissue disposed therebetween varies along a plane that is transverse to the longitudinal axis of staple cartridge **810***a*. Specifically, the distance between tissue contacting surface **320** and surface **822** is a minimum, such that a maximum pressure is applied to the layers of tissue disposed in this region. Conversely, the distance between tissue contacting surface **320** and surfaces **824** is at a maximum in the region near outer walls **814**, such that a minimum pressure is applied to the layers disposed in this region. Since surface **824** curves downward as it approaches outer walls **814**, the pressure applied to the layers of tissue disposed between tissue contacting surface **320** and surfaces **824** decreases from an outer edge of surface **822** towards outer wall **814**. The amount of pressure decrease is a function of curvature of surface **824**.

By curving surface **824** downwards from the edge of surface **822**, reduced compressive forces are applied to the layers of tissue disposed between tissue contacting surface **320** and surfaces **824** thereby minimizing trauma to the layers of tissue disposed therebetween. Layers of tissue disposed between tissue contacting surfaces **320** and **820** will have a minimum thickness nearest knife channel **830** and a maximum thickness nearest outer walls **814**. In addition, anvil member **308** and staple cartridge **810***a* are dimensioned and arranged such that compressive forces applied to the layers of tissue are minimal thereby further reducing trauma to the layers of tissue.

Leg lengths of surgical fasteners **125***c*, **125***b*, and **125***a* increase in a direction moving from inner walls **816** towards outer walls **814**. By providing surgical fasteners having increasing leg lengths along a plane that is orthogonal to inner walls **816**, the completed (i.e. formed) surgical fasteners join increasing thicknesses of tissue without unduly traumatizing the joined layers of tissue. A more detailed description of surgical fasteners **125***a-c* and fastener ejection members **540** is discussed hereinabove with reference to FIG. **9**.

In the embodiment illustrated in FIG. **17**B, operative tool **806***b* includes staple cartridge **810***b* that is substantially similar to staple cartridge **810***a* with the differences between them being discussed below. In staple cartridge **810***b*, outer walls **814'** and inner walls **816'** have a lower height than outer walls **814** and inner walls **816** of staple cartridge **810***a*. In this configuration, tissue contacting surface **820** is closer to bottom surface **812** such that tips of surgical fasteners **125***a*, **125***b*, and **125***c* extend into retention slots **823** and are substantially flush with tissue contacting surface **820**.

Referring now to FIGS. **17**C and **17**D, operative tools **806***c* and **806***d* are illustrated. Operative tools **806***c* and **806***d* include staple cartridges **810***a* and **810***b* (as discussed hereinabove) respectively. In these embodiments, anvil member **308***a* replaces anvil member **308**. In this embodiment, anvil member **308***a* includes a tissue contacting surface **320***a* formed from surfaces **332***a* and **336***a*. Surface **336***a* is substantially parallel to surface **822** and has a width dimension that is substantially similar to the width dimension of surface **822**. Surfaces **332***a* are generally arcuate such that a thickness of anvil member **308***a* is at a minimum in the region near its outer edge and a maximum along surface **336***a*. It is envisioned that the curve defined by surfaces **332***a* will be substantially similar to the curve defined by surfaces **824**, but in an opposed direction (i.e. defining a convex relationship with respect to surface **822**). Thus, compressive forces applied to the layers of tissue will be further reduced, thereby further reducing trauma to the layers of tissue positioned between surfaces **824** and **332***a*.

As in the embodiment of FIGS. **17**A and **17**B, the maximum pressure applied to the layers of tissue will exist in the region along surface **822** while pressures applied to the layers of tissue will decrease along surfaces **824** towards outer walls **814**, **814'**. The decrease in pressure along the gradient defined by surfaces **824** and **332***a* is proportional to the curvature of each surface. Formation and location of

surgical fasteners **125***a-c* is substantially similar to that of the embodiment of FIGS. **17**A and **17**B along with the attendant advantages.

In a further embodiment, operative tool **906** is illustrated in FIG. **18**A. Operative tool **906** includes anvil member **308** and staple cartridge **910**. Staple cartridge **910** is substantially similar to staple cartridge **810** wherein the same or similar components are renumbered accordingly and the differences discussed in detail hereinafter. Tissue contacting surface **920** includes surfaces **922** and **924** wherein each surface includes a plurality of retention slots **923**. Similar to the embodiment shown in FIGS. **17**A-D, surface **922** is a generally planar surface that is substantially parallel to a bottom surface **912** and defines a right angle at its junction with inner wall **916**. Surface **924** is also a generally planar surface that substantially parallel with bottom surface **912** and surface **922**, wherein surfaces **922** and **924** are vertically spaced apart such that they are not coplanar with one another. Additionally, inner wall **916** has a first height and outer wall **914** has a second height, wherein the first height is greater than the second height.

As in the previous embodiments of the presently disclosed operative tool, tissue contacting surface **320** of anvil member **308** is repositioned proximate to tissue contacting surface **920** of staple cartridge **910**. In this arrangement, the amount of pressure applied to the layers of tissue disposed therebetween varies along a plane that is transverse to the longitudinal axis of staple cartridge **910**. Specifically, the distance between tissue contacting surface **320** and surface **922** is a minimum, such that a maximum pressure is applied to the layers of tissue disposed in this region. Conversely, the distance between tissue contacting surface **320** and surfaces **824** is at a maximum, such that a minimum pressure is applied to the layers disposed in this region. Since surface **924** is generally planar, the pressure applied to the layers of tissue disposed between tissue contacting surface **320** and surfaces **924** is substantially uniform and less than the pressure applied to the layers of tissue positioned between tissue contacting surface **320** and surface **922**.

Leg lengths of surgical fasteners **125***c*, **125***b*, and **125***a* increase in a direction moving from inner walls **916** towards outer walls **914**. By providing surgical fasteners having increasing leg lengths along a plane that is orthogonal to inner walls **916**, the completed (i.e. formed) surgical fasteners join increasing thicknesses of tissue without unduly traumatizing the joined layers of tissue. A more detailed description of surgical fasteners **125***a-c* and fastener ejection members **540** is discussed hereinabove with reference to FIG. **9**.

Referring now to FIG. **17**E, a further embodiment of operative tool **806** is illustrated and referenced as operative tool **806***e*. Operative tool **806***e* includes substantially the same or similar components as operative tool **806***a* (FIG. **17**A) with the differences being discussed hereinafter. In particular, operative tool **806***e* includes anvil member **308** and staple cartridge **810***b*. Staple cartridge differs from staple cartridge **810***a* in that tissue contacting surface **824***a* is an arcuate structure extending from the centerline to outer walls **514** of staple cartridge **810***b*. The arrangement between tissue contacting surface **824***a* and tissue contacting surface **320** provides the same advantages and benefits as does the arrangements provided in the embodiments illustrated in FIGS. **17**A-D.

Alternatively, staple cartridge **810***b* may be used with anvil member **308***d* to form operative tool **806***f* that is illustrated in FIG. **17**F. Anvil member **308***d* includes tissue contacting surface **320***d* that is substantially complementary to tissue contacting surface **824***a*. In this configuration, a substantially uniform gap is maintained between the surfaces from the centerline of operative tool **806***f* to its outer walls **814**.

A further embodiment of the presently disclosed operative tool is illustrated in FIG. **18**B wherein anvil member **308** is replaced by anvil member **308***b*. Operative tool **906***a* includes staple cartridge **910** and anvil member **308***b*. In particular, anvil member **308***b* includes a tissue contacting surface **320***b* that is defined by surfaces **332***b* and **336***b*. Similar to the embodiment shown in FIG. **17**D, tissue contacting surface **320***b* of anvil member **308***b* is complementary to tissue contacting surface **920** of staple cartridge **910** such that a greater gap is defined between surfaces **924** and **332***b* than between surfaces **924** and tissue contacting surface **320** (FIG. **18**A). In this configuration, a reduced amount of pressure is applied to the layers of tissue captured therebetween.

Referring now to FIGS. **19**A and **19**B, operative tools **1006***a* and **1006***b* are illustrated. Operative tool **1006***a* includes anvil member **308** and a staple cartridge **1010**. Staple cartridge **1010** is substantially similar to staple cartridge **510** wherein the same or similar components are renumbered accordingly and the differences discussed in detail hereinafter. Surface **1020** is substantially planar and substantially parallel to bottom surface **1012**. In this embodiment, a filler layer **1070** is positioned on surface **1020**. Filler layer **1070** is formed from a material that has sufficient resiliency to support layers of tissue while permitting surgical fasteners **125***a-c* to pass through during the formation of completed surgical fasteners. Filler layer **1070** may be a buttress material that is an organic or synthetic tissue used to reinforce tissue at a staple line. An example of a suitable material includes SEAMGUARD® from W.L. Gore & Associates, Inc.

Filler layer **1070** is a generally triangular structure that tapers from a maximum height near knife channel **1030** towards a minimum height near outer walls **1014**. Thus, the gap defined between tissue contacting surface **320** and filler layer **1070** is at a minimum near knife channel **1030** and at a maximum near outer walls **1014**. As such, the amount of pressure applied to layers of tissue captured between tissue contacting surface **320** and filler layer **1070** is at a minimum near knife channel **1030** and at a maximum near outer walls **1014**, thereby providing the attendant advantages as in previous embodiments with respect to forming the surgical fasteners and minimizing trauma to the layers of tissue. In addition, filler layer **1070** may be formed from a resilient or semi-resilient material, thereby further minimizing trauma to the layers of tissue that are captured between tissue contacting surface **320** and surface **1020**.

Alternatively, a second filler layer **1070**, shown in phantom, may be positioned on tissue contacting surface **320**. Staple cartridge **1010** may include filler layer **1070** disposed on tissue contacting surface **1020**, on tissue contacting surface **320**, or on both tissue contacting surfaces **320**, **1020** according to the surgical procedure to be performed.

In FIG. **19**B, operative tool **1006***b* includes previously described staple cartridge **1010** in cooperation with anvil member **308'**. Anvil member **308'** includes tissue contacting surface **320'** having tapered surfaces **322'** and **324'**. Surfaces **322'** and **324'** are connected to outer walls of anvil member **308'** while extending inwards (i.e. towards the centerline of staple cartridge **1010**) and downwards (i.e. towards tissue contacting surface **1020**) thereby defining an angle. It is envisioned that the angle defined by tapered surfaces **322'** and **324'** will be substantially similar to the angle defined by

filler layer **1070**, but in an opposed direction forming a generally V-shaped configuration. Thus, compressive forces applied to the layers of tissue will be further reduced thereby further reducing the trauma to layers of tissue disposed between tissue contacting surface **320'** and filler layer **1070**. The maximum pressure applied to the layers of tissue will exist in the region near knife channel **1030** while pressures applied to the layers of tissue will decrease uniformly towards outer walls **1014**. Formation and location of surgical fasteners **125***a-c* is substantially similar to that of the embodiment of FIG. **19**A along with the attendant advantages.

Turning now to FIG. **20**A, an alternate embodiment of staple cartridge **412'** (FIG. **7**A) is illustrated and described hereinafter. Staple cartridge **412"** is similar to staple cartridge **412'** wherein the same or similar components are renumbered accordingly and the differences discussed in detail hereinafter. Staple cartridge **412"** includes a plurality of tissue contacting surfaces **421***a-c*, wherein each tissue contacting surface is a generally planar structure. Of the three surfaces, tissue contacting surface **421***b* has the greatest height and is vertically spaced apart from tissue contacting surfaces **421***a* and **421***c*. Tissue contacting surfaces **421***a-c* are substantially parallel with one another, wherein tissue contacting surface **421***b* does not lie in the same plane as either of tissue contacting surfaces **421***a* or **421***c*.

Anvil member **408** includes pockets **450** and tissue contacting surface **430**. Pockets **450** substantially align with retention slots **123** for forming completed surgical fasteners. In this configuration, a minimum gap is defined between tissue contacting surface **430** and tissue contacting surface **421***b* while a maximum gap is defined between tissue contacting surface **430** and tissue contacting surfaces **421***a* and **421***c*. Surgical fasteners **425***a-c* are associated with tissue contacting surfaces **421***a-c* respectively. Surgical fasteners **425***a-c* are substantially similar to surgical fasteners **125***a-c* and the differences between them are discussed in detail hereinafter. In one embodiment, surgical fasteners **425***a* and **425***c* are substantially identical and have a greater leg length than surgical fastener **425***b*. By providing this arrangement of tissue contacting surfaces and surgical fasteners, reduced compressive forces are applied to the layers of tissue disposed between tissue contacting surface **430** and tissue contacting surfaces **421***a*, **421***c* as was discussed previously with respect to other embodiments of the presently disclosed staple cartridge.

In the alternative, staple cartridge **412"** may be used in cooperation with anvil member **408***a* as illustrated in FIG. **20**B. Anvil member **408***a* includes pockets **450** and tissue contacting surface **430'**. Further still, tissue contacting surface **430'** includes surfaces **432** and **434**. Each of surfaces **432**, **434** are generally planar surfaces that are substantially parallel to tissue contacting surfaces **421***a-c* of staple cartridge **412"**. Surfaces **432** are vertically spaced apart from surface **434** such that the gap defined between surface **434** and tissue contacting surface **421***b* is a minimum while the gap defined between surfaces **432** and tissue contacting surfaces **421***a*, **421***c* is a maximum. Thus, reduced compressive forces are applied to the layers of tissue disposed between tissue contacting surfaces **421***a*, **421***c* and surfaces **432** of anvil member **408***a*.

Alternatively, staple cartridge **412"** may be used in cooperation with anvil member **408***b* as illustrated in FIG. **20**C. Anvil member **408***b* includes surfaces **432***a* and **434***a*. In contrast to surfaces **432** and **434** of anvil member **408***a* (FIG. **20**B), surfaces **432***a* and **434***a* are generally arcuate. In this configuration, any potential trauma to tissue positioned between anvil member **408***b* and staple cartridge **412"** is reduced while maintaining the advantages and benefits of an increased gap between tissue contacting surfaces of anvil member **408***b* and staple cartridge **412"**.

A further embodiment of the presently disclosed operative tool is illustrated in FIG. **21**A and generally designated as **1106**. Operative tool **1106** includes staple cartridge **1110** and anvil member **308**. Anvil member **308** was previously described in detail with reference to FIG. **9**. Staple cartridge **1110** includes the same or substantially similar components to staple cartridge **510** (FIG. **9**), wherein the same or similar components are renumbered accordingly and the differences discussed in detail hereinafter.

In particular, staple cartridge **1110** includes surgical fasteners **125***a-c* and corresponding pushers **1140**. In addition, staple cartridge **1110** includes outer walls **1114**, inner walls **1116**, and vertical members **1118**. Inner walls **1116** may be spaced apart for defining a knife channel **1130** therebetween. In addition, vertical members **1118** are generally planar structures that abut inner walls **1116** and generally have a height at least equal to that of inner walls **1116**. A top plate **1154** is a generally planar structure that connects inner wall **1116** and outer wall **1114**. In one embodiment, top plate **1154** is substantially parallel to bottom surface **1112**. In addition, top plate **1154** includes a plurality of retention slots **1123**. Vertically spaced above top plate **1154** is cross member **1150**.

Cross member **1150** includes a plurality of openings **1125** that are aligned with retention slots **1123** of top plate **1154**. In addition, cross member **1150** defines a tissue contacting surface **1120** that is substantially parallel to bottom surface **1112** in a first position. Specifically, an inner edge of cross member **1150** is flexibly attached to an edge of vertical member **1118** while an outer edge **1156** is spaced apart from a top edge **1114***a* of outer wall **1114** defining a gap **1152** therebetween. Cross member **1150** has sufficient rigidity such that when layers of tissue are positioned between tissue contacting surfaces **320** and **1120**, cross member **1150** maintains its substantially parallel relationship to bottom surface **1112**. Gap **1152** may include an elastomeric compression member that controls the amount of deflection by tissue contacting surface **1120**.

As anvil member **308** and staple cartridge **1110** are brought into a closer cooperative arrangement (i.e. during approximation and/or formation of the surgical fasteners), compressive forces generated by the relative movement between anvil member **308** and staple cartridge **1110** urge outer edge **1156** towards top edge **1114***a*, thereby reducing gap **1152**. In addition, cross member **1154** (shown in phantom) flexes towards bottom wall **1112**, thereby providing an increased distance between tissue contacting surfaces **320** and **1120** at outer wall **1114** while maintaining a fixed (i.e. unflexed) distance between tissue contacting surfaces **320** and **1120** at vertical member **1118**. As cross member **1154** flexes, the distance between tissue contacting surfaces **320** and **1120** increases along an axis that is transverse to a longitudinal axis of staple cartridge **1110**. The distance between tissue contacting surfaces **320** and **1120** at any selected position along the transverse axis is related to the amount of flexion provided by cross member **1154**. Cross member **1150** is positionable throughout a plurality of positions including at least a first position that is substantially parallel to bottom surface **1112** and a second position wherein outer edge **1156** is in contact with top edge **1114***a*.

When tissue contacting surface **320** of anvil member **308** is repositioned proximate to tissue contacting surface **1120** of staple cartridge **1110**, the amount of pressure applied to

the layers of tissue disposed therebetween varies along a plane that is transverse to the longitudinal axis of staple cartridge **1110**. Since tissue contacting surface **1120** slopes toward outer walls **1114**, the pressure applied to the layers of tissue disposed between tissue contacting surfaces **320** and **1120** decreases from inner wall **1116** to outer wall **1114**. Further still, when cross member **1150** flexes towards top plate **1154**, it defines a curvate surface similar to tissue contacting surface **520** (FIG. **9**). Openings **1125** have a greater width dimension such that when cross member **1150** is urged towards top plate **1154**, the alignment of openings **1125** and retention slots **1123** is such that an unobstructed path is defined for surgical fasteners **125***a-c*, thereby allowing surgical fasteners **125***a-c* to engage layers of tissue and contact anvil member **308**.

By flexing tissue contacting surface **1120** downwards from the centerline of staple cartridge **1110**, reduced compressive forces are applied to the layers of tissue disposed between tissue contacting surfaces **320** and **1120** thereby minimizing trauma to the layers of tissue disposed therebetween. Therefore, layers of tissue disposed between tissue contacting surfaces **320** and **1120** will have a minimum thickness nearest knife channel **1130** (i.e. nearest the centerline of staple cartridge **1110**) and gradually increasing to a maximum thickness nearest outer walls **1114**.

Leg lengths of surgical fasteners **125***c*, **125***b*, and **125***a* increase in a direction moving from inner walls **1116** towards outer walls **1114**. By providing surgical fasteners having increasing leg lengths along a plane that is orthogonal to inner walls **1116**, the completed (i.e. formed) surgical fasteners join increasing thicknesses of tissue without unduly traumatizing the joined layers of tissue.

Referring now to FIG. **21**B, an alternate embodiment of the presently disclosed operative tool is illustrated and referenced as **1106***a*. Operative tool **1106***a* includes staple cartridge **1110**, as discussed above, in cooperation with anvil member **308'** that was discussed in detail with reference to FIG. **11**. Anvil member **308'** includes tissue contacting surface **320'** having tapered surfaces **322'** and **324'**. It is envisioned that the angle defined by tapered surfaces **322'** and **324'** will be substantially similar to the angle defined by tissue contacting surface **1120**, but in an opposed direction forming a generally V-shaped configuration. Thus, compressive forces applied to the layers of tissue will be further reduced thereby further reducing the trauma to layers of tissue disposed between tissue contacting surfaces **1120** and **320'**. As in the previous embodiments, the maximum pressure applied to the layers of tissue will exist in the region near knife channel **1130** while pressures applied to the layers of tissue will decrease uniformly towards outer walls **1114**. Formation and location of surgical fasteners **125***a-c* is substantially similar to that of the embodiment of FIG. **21**A along with the attendant advantages.

Further embodiments are illustrated in FIGS. **22**A-C and discussed hereinbelow. Referring initially to FIG. **22**A, operative tool **1206***a* is illustrated and includes anvil member **308***d* and staple cartridge **1210**. In particular, staple cartridge **1210** includes surgical fasteners **125***a-c* and fastener ejection members **540** that were previously discussed in detail with respect to FIG. **9**A. Similar to previous embodiments, staple cartridge **1210** includes a bottom surface **1212**, outer walls **1214**, inner walls **1216**, and a knife channel **1230**. In addition, staple cartridge **1210** includes a tissue contacting surface **1220** formed from surfaces **1222** and **1224**. Each of surfaces **1222** and **1224** has a width dimension that is sufficient to accommodate at least one row of surgical fasteners. As shown in FIG. **22**A, surface **1222** is substantially parallel to bottom surface **1212**, while surface **1224** is a generally arcuate structure. Further still, the topmost portions of surfaces **1224** have substantially the same height dimension as measured from bottom surface **1212**. A complementary anvil member **308***d* is provided in operative tool **1206***a* wherein anvil member **308***d* includes a substantially planar surface **322***d* that corresponds to surfaces **1222** and knife channel **1230**. Additionally, anvil member **308***d* includes surfaces **324***d* that are generally arcuate so as to correspond to surfaces **1224** of staple cartridge **1210**. By providing this arrangement between staple cartridge **1210** and anvil member **308***d*, a substantially uniform tissue gap is defined between the surfaces of anvil member **308***d* and staple cartridge **1210**.

Alternatively, operative tool **1206***b*, as shown in FIG. **22**B, includes anvil member **308***e* in cooperation with staple cartridge **1210***a*. Staple cartridge **1210***a* is substantially similar to staple cartridge **1210** (FIG. **22**A) with the differences therebetween discussed below. Most notably, tissue contacting surface **1220***a* includes surfaces **1222***a*, **1224***a*, and **1226***a*. Surfaces **1222***a* and **1224***a* are substantially similar to surfaces **1222** and **1224** of FIG. **22**A, while surface **1226** is a generally arcuate structure having a lower height dimension that surface **1224** (i.e. with respect to bottom surface **1212**). Thus, surfaces **1222**, **1224**, and **1226** "step down" from the centerline towards outer walls **1214** of staple cartridge **1210***a*. Anvil member **308***e* has a tissue contacting surface **320***e* that substantially complements tissue contacting surface **1220***a*. As such, tissue contacting surface **320***e* includes a substantially planar surface **322***e* that corresponds to surfaces **1222***a* and knife channel **1230**. Additionally, anvil member **308***d* includes surfaces **324***e* and **326***e* that are generally arcuate so as to correspond to surfaces **1224***a* and **1226***a* of staple cartridge **1210***a*. By providing this arrangement between staple cartridge **1210***a* and anvil member **308***e*, a substantially uniform tissue gap is defined between the surfaces of anvil member **308***e* and staple cartridge **1210***a*.

Alternatively, staple cartridge **1210***a* may be used in cooperation with anvil member **308** as shown in FIG. **22**C. In this configuration, the gap defined between tissue contacting surfaces **320** and **1220***b* increases from a first gap at knife channel **1230** to a second gap at outer walls **1214**, wherein the second gap is greater than the first gap.

In a further embodiment of the present disclosure, an operative tool assembly is illustrated in FIGS. **23-30** and generally referenced as **1300**. As in the previously disclosed embodiments, operative tool assembly **1300** includes a staple cartridge **1310** and an anvil member **1340**. Tool assembly **1300** includes a body **1302** for receiving staple cartridge **1310**.

Anvil member **1340** optionally includes a slot **1342** in tissue contacting surface **1306**. Tissue contacting surface **1306** includes staple forming depressions. A pair of tabs **1344** is located in a proximal portion of anvil member **1340** and cooperates with recesses **1304** of body **1302**. As such, anvil member **1340** is pivotably coupled to body **1302** and is repositionable between an open position and an approximate position. In the open position, anvil member **1340** is spaced apart from staple cartridge **1310** and allows tissue to be positioned therebetween. In the approximated position, anvil member **1340** cooperates with staple cartridge **1310** and captures tissue therebetween. Slot **1342** is configured for allowing the passage of a knife blade (not shown) as the knife blade passes longitudinally through anvil member **1340** and staple cartridge **1310**. In certain embodiments, the knife blade is carried on, or integrally formed with, a drive

beam (not shown) that is advanced distally through anvil member **1340** and staple cartridge **1310** for approximating anvil cartridge **1340** and staple cartridge **1310** with respect to one another, and to deploy staples from staple cartridge **1310** against anvil member **1340**. Operative tool assembly **1300** may be arranged as described in U.S. Pat. No. 5,865,361, the disclosure of which is hereby incorporated by reference herein in its entirety. In other embodiments, anvil member **1340** and staple cartridge **1310** are approximated with respect to one another by the advancement distally of a clamp tube, such as disclosed in U.S. Pat. No. 5,318,221, the disclosure of which is hereby incorporated by reference herein in its entirety.

Staple cartridge **1310** includes a plurality of tissue contacting surfaces. In one embodiment, staple cartridge **1310** includes tissue contacting surfaces **1312**, **1314**, and **1316**. Tissue contacting surfaces **1312**, **1314**, and **1316** are substantially planar surfaces that are substantially parallel to the other tissue contacting surfaces, but are spaced apart (i.e. the tissue contacting surfaces are in a stepped configuration) as seen in FIGS. **24** and **29**. Referring also to FIG. **29**, a wall surface **1315** extends between tissue contacting surfaces **1312** and **1314**, while a wall surface **1317** extends between tissue contacting surfaces **1314** and **1316**. Wall surfaces **1315**, **1317** are generally planar surfaces that define an angle with respect to an adjacent tissue contacting surface. As illustrated in FIG. **29**, wall surfaces **1315**, **1317** are arranged such that each of the wall surfaces is in an angular relationship with the adjacent tissue contacting surfaces **1312**, **1314**, and **1316**. The angle defined between the wall surface and the adjacent tissue contacting surface may be in a range of angles that is greater than 0° to about 90°.

Providing tissue contacting surfaces **1312**, **1314**, and **1316** in a stepped configuration (FIG. **29**), improves the anastomotic strength and the degree of hemostasis obtained at the cut line when layers of body tissue are clamped between anvil member **1340** and staple cartridge **1310**. In particular, this arrangement provides gradual tissue loading or compression due to the varying gap defined between tissue contacting surface **1306** of anvil member **1340** and tissue contacting surfaces **1312**, **1314**, **1316** of staple cartridge **1310** when they are in the approximated position, thereby minimizing tissue trauma while maintaining a relatively high degree of hemostasis and anastomotic strength. Notably, when anvil member **1340** and staple cartridge **1310** are in the approximated position, first, second, and third tissue gaps are defined between tissue contacting surfaces **1312**, **1314**, **1316** and a tissue contacting surface **1306** of anvil member **1340**. As such, the first tissue gap **1321** is the smallest, while the third tissue gap **1323** is the greatest with the second tissue gap **1322** in-between the first and third tissue gaps. It is envisioned that the tissue contacting surface **1306** of anvil member **1340** includes a plurality of depressions for forming completed surgical fasteners.

Staple cartridge **1310** includes a plurality of surgical fasteners disposed in retention slots **1330** that are open at tissue contacting surfaces **1312**, **1314**, **1316**. Referring now to FIGS. **25** and **26**, the arrangement of the surgical fasteners is illustrated. Staple cartridge **1310** includes surgical fasteners or staples **1325***a*, **1325***b*, and **1325***c*. Staples **1325***a*, **1325***b*, and **1325***c* are substantially similar to staples **25***a*, **25***b*, and **25***c* that were previously discussed. Staples **1325***a*, **1325***b*, and **1325***c* each include a backspan **1337**. Briefly, legs **1327***a* of surgical fasteners **1325***a* have a first leg length, legs **1327***b* of surgical fasteners **1325***b* have a second leg length, and legs **1327***c* of surgical fasteners **1325***c* have a third leg length. In one embodiment, legs **1327***c* of surgical fasteners **1325***c* have a leg length of about 3.0 mm, legs **1327***b* of surgical fasteners **1325***b* have a leg length of about 3.5 mm, and legs **1327***a* of surgical fasteners **1325***a* have a leg length of about 4.0 mm. It is contemplated that other embodiments of the present disclosure include legs **1327***c* in a range of about 2.0 mm to about 4.0 mm, legs **1327***b* in a range of about 2.5 mm to about 4.5 mm, and legs **1327***a* in a range of about 3.0 mm to about 5.0 mm. In certain preferred embodiments, surgical fasteners **1325***a* have the longest leg length, surgical fasteners **1325***c* have the shortest leg length, and surgical fasteners **1325***b* have a leg length therebetween. It is contemplated that the staples in the staple cartridge **1310** can range from about 2.0 mm to about 5.0 mm. Surgical fasteners **1325***a* are arranged in a longitudinally extending row located in tissue contacting surface **1312**; surgical fasteners **1325***b* are arranged in a longitudinally extending row located in tissue contacting surface **1314**; and surgical fasteners **1325***c* are arranged in a longitudinally extending row located in tissue contacting surface **1316**. In this arrangement, layers of body tissue that are fastened using staple cartridge **1310** have improved hemostasis and anastomotic strength. It is envisioned and within the scope of the present disclosure that any number of arrangements are possible.

Surgical fasteners **1325***a-c* cooperate with staple pusher **30** (FIG. **26**) and sled **1350** (FIG. **25**) such that the longitudinal translation of sled **1350** by a drive beam through staple cartridge **1310** urges pushers **30** in a vertical direction to eject surgical fasteners **1325***a-c*. As shown in FIG. **26**, staple pusher **30** includes pusher plates **32**, **34**, and **36**, each of which has a different vertical dimension. Pusher plate **32** has the greatest vertical dimension and cooperates with surgical fastener **1325***c*, while pusher plate **36** has the smallest vertical dimension and cooperates with surgical fastener **1325***a*. Pusher plate **34** has a vertical dimension greater than pusher plate **36**, but less than pusher plate **32** and cooperates with surgical fastener **1325***b*. By providing surgical fasteners **1325***a-c* and pusher plates **30** with complementary heights, tips of surgical fasteners **1325***a-c* are substantially flush with their respective tissue contacting surfaces prior to ejecting surgical fasteners **1325***a-c* from their respective retention slots. It is also envisioned that other arrangements of pusher plates and surgical fasteners may be used. For example, the pusher plates may have heights that are selected to define a gap with the tissue contacting surface **1306** for forming a staple having a leg length of a particular size.

As illustrated in FIG. **25**, staple cartridge **1310** fits into cartridge body **1302**. In one embodiment, staple cartridge **1310** is replaceable. After the user has fired the staples in staple cartridge **1310**, the user removes staple cartridge **1310** from cartridge body **1302** and installs a new staple cartridge **1310** having a full complement of staples. In an alternate embodiment, staple cartridge **1310** is fixedly attached to cartridge body **1302**. In such an embodiment, operative tool assembly **1300** including anvil member **1340**, body **1302**, and staple cartridge **1310** may constitute a replaceable loading unit so that upon the installation of a new loading unit, a new knife blade is also provided. Staple cartridge **1310** may also include a knife channel **1318** to allow passage of a knife blade and drive beam.

In a certain embodiments, the staples are arranged in the staple cartridge **1310** so that staples **1325***a* are disposed in retention slots **1330** (FIG. **29**) that extend in a linear row, along tissue contacting surface **1312**. Staples **1325***b* are disposed in retention slots **1330** that extend in a linear row, along tissue contacting surface **1314**. Staples **1325***a* have leg

lengths that are longer than the leg lengths of staples **1325***b* and are disposed further away from the knife channel **1318**, as compared to staples **1325***b*. In the embodiment shown in FIGS. **23-31**, the staple cartridge **1310** further has staples **1325***c*, which have leg lengths that are shorter than the leg lengths of staples **1325***a* and **1325***b*, and are disposed adjacent the knife channel **1318**. As shown in FIG. **31**, when the staples are deployed and formed in tissue, the smaller staples **1325***c* are disposed adjacent the cut line in the tissue, with the intermediate-sized staples **1325***b* being adjacent to staples **1325***c* and outwardly from staples **1325***c* with respect to the cut line. Staples **1325***a*, which are the largest staples, are disposed outwardly of the staples **1325***b* and **1325***c*. This arrangement provides improved hemostasis in the tissue.

In a surgical stapling instrument such as surgical stapling instrument **300** (FIG. **5**) or surgical stapling instrument **200** (FIG. **4**), two linear rows of each size staple are provided, on opposite sides of the knife channel **1318**. As seen in FIG. **29**, the staple cartridge **1310** has outer tissue contacting surfaces **1312***a* and **1312***b*. Retention slots **1330** housing staples **1325***a* are defined in the outer tissue contacting surfaces **1312***a* and **1312***b*. Retention slots **1330** housing staples **1325***b* are defined in the intermediate tissue contacting surfaces **1314***a* and **1314***b*. Retention slots **1330** housing staples **1325***c* are defined in the inner tissue contacting surfaces **1316***a* and **1316***b*. Wall surface **1315***a* provides a sloping surface extending generally from the tissue contacting surfaces **1312***a* to tissue contacting surface **1314***a*. A wall surface **1315***b* is arranged similarly on the opposite side of the knife channel **1318**, as shown in FIG. **29**. Wall surface **1317***a* extends generally between tissue contacting surfaces **1314***a* and **1316***a* and a similar wall surface **1317***b* is provided on the opposite side of the knife channel **1318**. The sloping wall surfaces **1315***a*, **1315***b*, **1317***a* and **1317***b* provide a gradually varying compressive force on the tissue when the surgical stapling instrument is used. When tissue is clamped between anvil member **1340** and staple cartridge **1310**, fluid within the tissue flows generally outwardly and the sloping wall surfaces facilitate this process.

In tool assemblies according to the present disclosure, staples having different leg lengths may be arranged so that the staples with the larger leg lengths are arranged adjacent the knife channel. In addition, the staple cartridge may have a single planar tissue contacting surface and the anvil member may be provided with more than one tissue contacting surface so as to define more than one gap with respect to the tissue contacting surface of the staple cartridge. One or both of the staple cartridge and anvil member may have stepped surfaces, angled or sloped surfaces, or curved surfaces that are selected to correspond to staples having predetermined leg lengths. In certain embodiments, more than one tissue contacting surface is provided, on the staple cartridge, the anvil member, or both, with sloped surfaces extending therebetween. In certain embodiments, the staple pushers have heights corresponding to the different staple sizes.

Referring additionally to FIG. **31**, following the firing of surgical stapling instrument **1300**, the resulting tissue interface is seen in cross-section. Accordingly, some or all of surgical fasteners **1325***a*-**1325***c* serve to hold tissues "A" and "B" to one another while the surgical fasteners also provide the hemostasis.

All of the presently disclosed embodiments of the surgical stapling instrument provide a variable pressure gradient (i.e. load profile) to the layers of tissue that are joined together with the surgical fasteners. Therefore, the layers of tissue that are proximate to the center of the surgical stapling instrument (i.e. center of the staple cartridge) are subjected to higher compressive forces (i.e. loads), thereby forming thinner layers of tissue as compared to layers of tissue that are further away from the center of the surgical stapling instrument. Since the layers of tissue nearest the center of the surgical stapling instrument can be compressed more, a smaller sized surgical staple or fastener can be used to mechanically suture (i.e. fasten) the transected layers of tissue. Further still, providing a gradual compression gradient to the layers of tissue to be joined (see FIG. **16**B), may result in a higher degree of hemostasis. Due to the contoured shape of the staple cartridge, the layers of tissue can be compressed more at the center of the surgical stapling instrument, because the layers of tissue can translate (i.e. move) from a region of relatively high pressure (i.e. at the center) to a region of relatively low pressure (i.e. at the edges) as the anvil member is moved relative to the staple cartridge, thereby defining the pressure gradient.

In a further embodiment, the staple cartridge **1410** is as shown above in FIGS. **23-31**, except that the wall surfaces **1417***a* and **1417***b* are convex, non-planar surfaces. (See FIG. **32**). It is contemplated that any of the wall surfaces **1415***a*, **1417***a*, **1415***b* and **1417***b* are non-planar and may be concave or convex. The tissue contacting surfaces **1412***a*, **1414***a*, **1416***a*, **1412***a*, **1414***a*, and/or **1416***a* may also be planar or non-planar.

FIG. **32** also shows an angle A between wall surface **1315***b* and a reference line, which is shown as a vertical line, as well as an angle B between wall surface **1317***b* and the reference line. Angle A is desirably greater than angle B. In one preferred embodiment, angle A is about 63 degrees and angle B is about 42 degrees.

In addition, while each of the surgical stapling instruments described above and shown herein include tissue contacting surfaces having a stepped profile, it is envisioned that any of the surgical stapling instruments disclosed herein can have tissue contacting surfaces having any one of a number of profiles including and not limited to angles, conical, tapered, arcuate and the like, as disclosed in commonly assigned U.S. patent application Ser. No. 10/411,686, filed on May 11, 2003, entitled "Surgical Stapling Apparatus Including an Anvil and Cartridge Each Having Cooperating Mating Surfaces," currently assigned to Tyco Healthcare Group LP, the entire contents of which is incorporated herein by reference.

It will be understood that various modifications may be made to the embodiments of the presently disclosed surgical stapling instruments. Therefore, the above description should not be construed as limiting, but merely as exemplifications of embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the present disclosure.

What is claimed is:

1. A surgical stapling instrument, comprising:

an anvil member including a tissue contacting surface;

a staple cartridge having a surface defining first retention slots and second retention slots, a first plurality of staples having a first leg length being disposed in the first retention slots, and a second plurality of staples having a second leg length being disposed in the second retention slots, wherein the second leg length is different from the first leg length, the surface of the staple cartridge including a first tissue contacting surface and a second tissue contacting surface, wherein the first tissue contacting surface and the second tissue contacting surface define different gaps with the tissue contacting surface of the anvil member; and

a first filler layer positioned on the surface of the staple cartridge.

2. The surgical stapling instrument of claim **1**, wherein the first filler layer is formed from a resilient material.

3. The surgical stapling instrument of claim **2**, further comprising a second filler layer positioned on the tissue contacting surface of the anvil member.

4. The surgical stapling instrument of claim **3**, wherein the first filler layer positioned on the surface of the staple cartridge and the second filler layer are formed from a resilient material.

5. The surgical stapling instrument of claim **1**, wherein the staple cartridge is receivable in a staple cartridge receiving section of the surgical stapling instrument.

6. The surgical stapling instrument of claim **1**, wherein the staple cartridge has staple pushers that have differing heights.

7. The surgical stapling instrument of claim **6**, wherein the first and second pluralities of staples are arranged to cooperate with the staple pushers.

8. The surgical stapling instrument of claim **1**, wherein the first tissue contacting surface defines a greater gap with the tissue contacting surface of the anvil member and the second tissue contacting surface defines a lesser gap with the tissue contacting surface of the anvil member.

9. The surgical stapling instrument of claim **8**, wherein the second tissue contacting surface is adjacent a knife channel of the staple cartridge.

10. The surgical stapling instrument of claim **9**, wherein the second leg length is smaller than the first leg length, and the second plurality of staples having the second leg length are arranged in a row adjacent the knife channel.

11. The surgical stapling instrument of claim **10**, wherein the surgical stapling instrument is of the laparoscopic type.

12. The surgical stapling instrument of claim **1**, wherein the surgical stapling instrument is of the transverse anastomosis type.

13. The surgical stapling instrument of claim **10**, wherein the surgical stapling instrument is of the transverse anastomosis type.

14. The surgical stapling instrument of claim **1**, wherein the surgical stapling instrument is of the laparoscopic type.

15. The surgical stapling instrument of claim **14**, wherein the surgical stapling instrument has an elongated shaft.

16. The surgical stapling instrument of claim **12**, wherein the anvil member of the surgical stapling instrument is orthogonally affixed.

* * * * *

专利名称(译)	外科缝合器械包括具有多个钉尺寸的钉仓		
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[标]申请(专利权)人(译)	柯惠有限合伙公司		
申请(专利权)人(译)	COVIDIEN LP		
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优先权	14/824712 2015-11-24 US 14/491328 2016-06-21 US 14/249820 2015-01-06 US 14/071783 2014-09-23 US 13/419586 2013-11-12 US 13/286544 2012-04-17 US 12/916926 2011-12-06 US 12/556760 2010-11-23 US 12/178739 2009-09-15 US 11/974637 2008-11-25 US 11/592566 2008-07-15 US 11/436222 2008-07-22 US 11/204060 2008-08-05 US		
其他公开文献	US20160345975A1		
外部链接	Espacenet USPTO		

摘要(译)

外科缝合器械包括钉仓和砧构件。钉仓包括设置在多排保持槽中的多个外科紧固件。钉仓可具有环形或线性构造的保持槽。钉仓的组织接触表面可以是锥形的或阶梯状的。砧座构件具有组织接触表面，该组织接触表面包括多个口袋，这些口袋布置成与保持槽基

本对齐。另外，砧座构件的组织接触表面可以与钉仓的组织接触表面互补。