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(54) **STAPLE FOR USE IN SURGICAL PROCEDURES**

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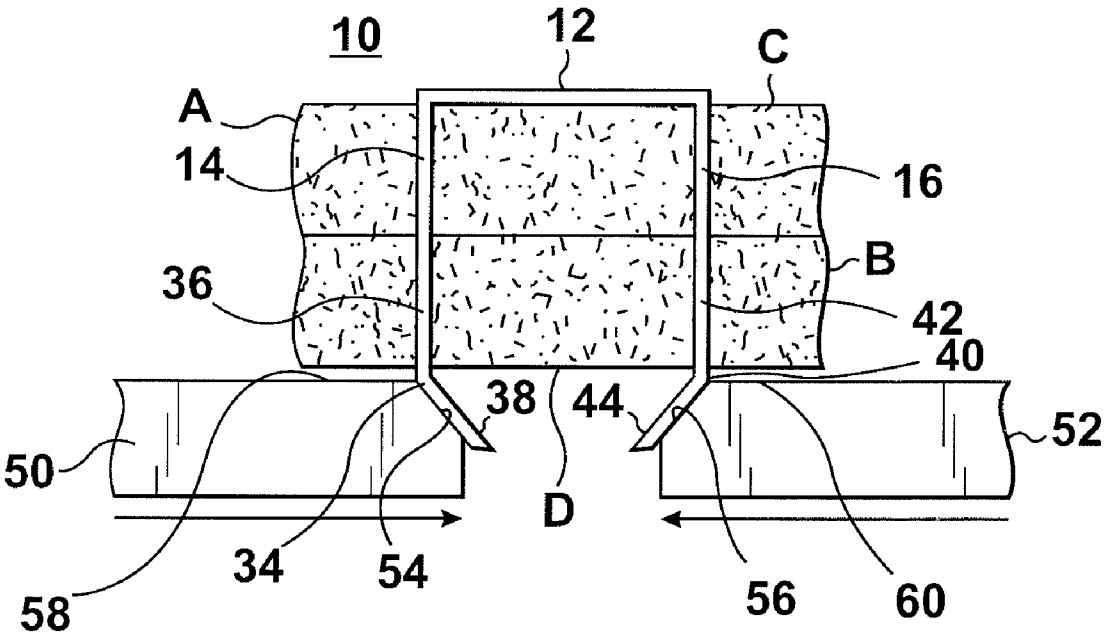
(52) **U.S. Cl.** **606/219**

(57) **ABSTRACT**

A staple having a backspan and a first and second leg extending distally from the backspan. Each of the first and second legs includes a bend zone dividing each leg into a traversing leg portion and a linear clenching leg portion. When formed through tissue, each of the clenching leg portions of the first and second legs are formed substantially parallel to the backspan. A staple assembly is also provided including a substantially box staple having a backspan and a first and a second leg extending distally from the backspan. The staple assembly includes a staple plate positionable over the first and second legs.



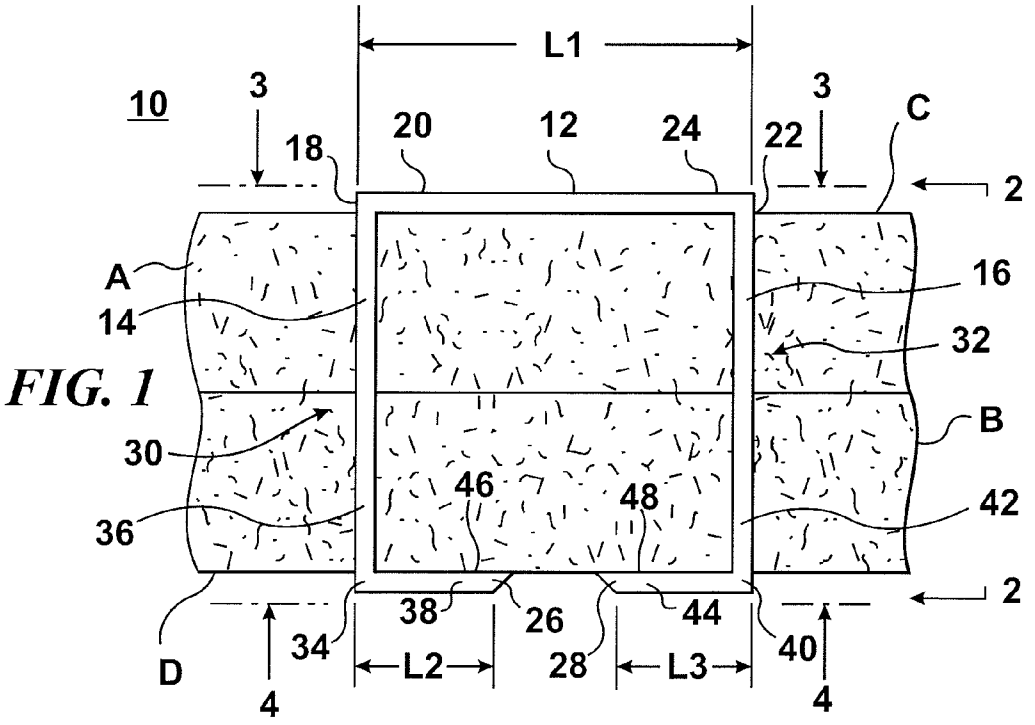


FIG. 1

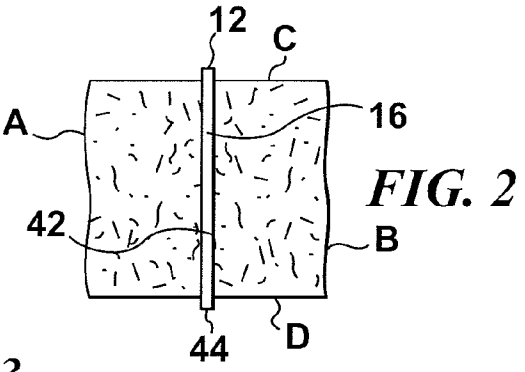


FIG. 2

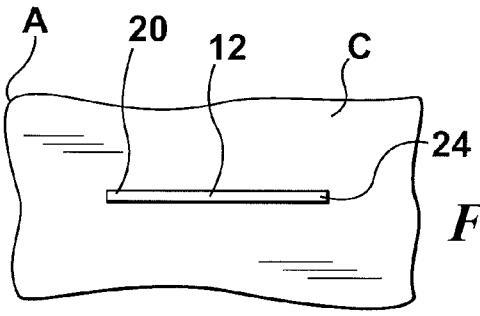


FIG. 3

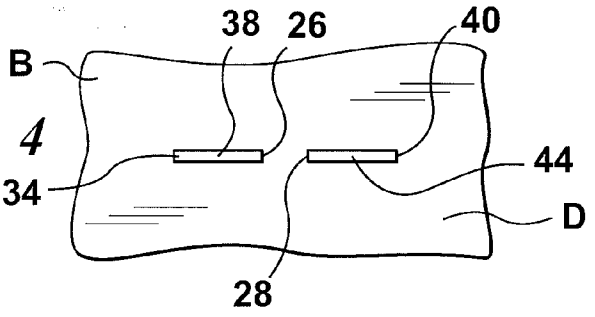


FIG. 4

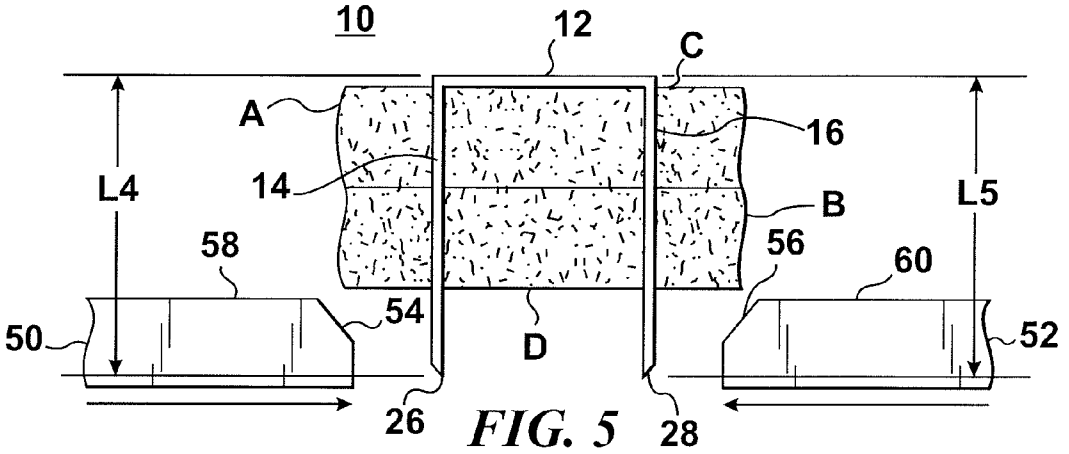


FIG. 5

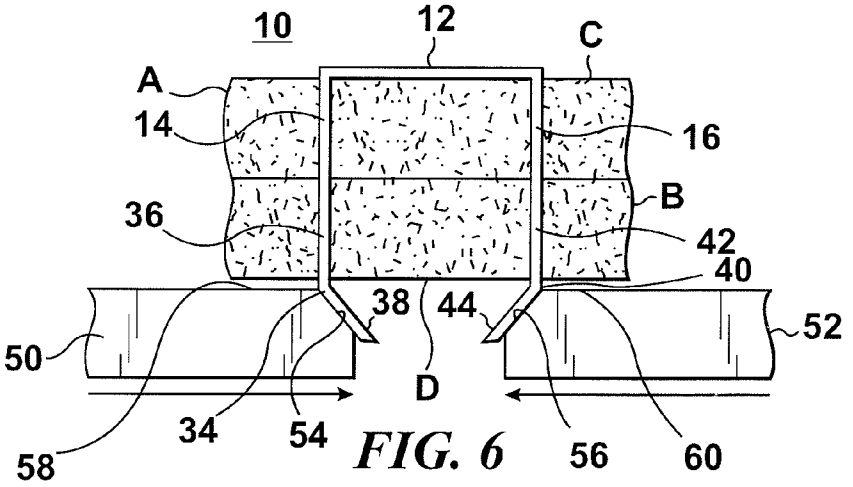


FIG. 6

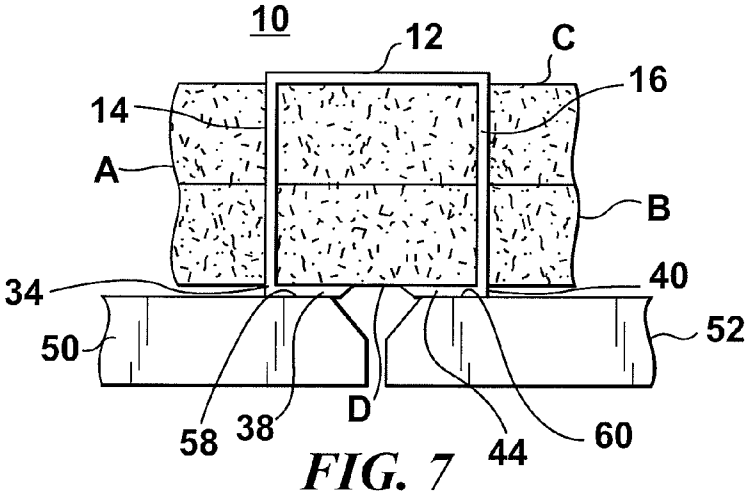


FIG. 7

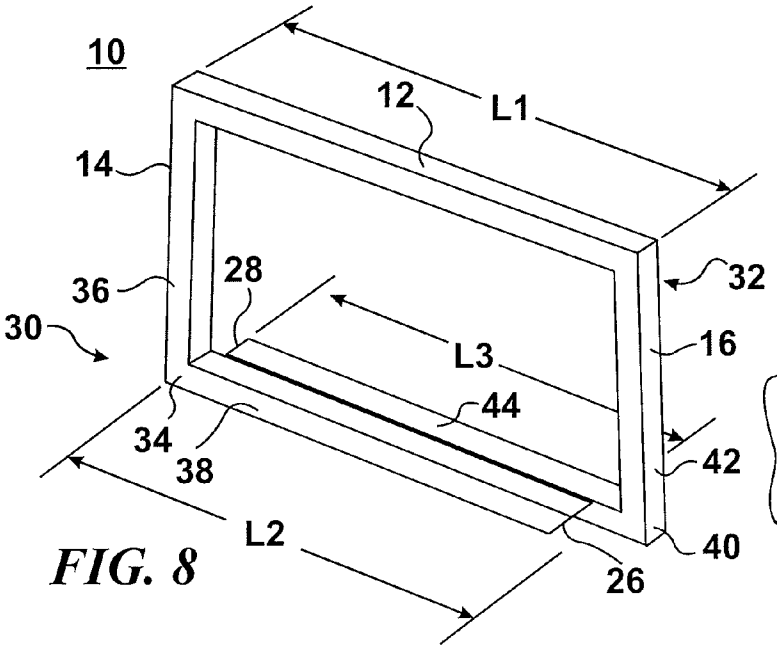


FIG. 8

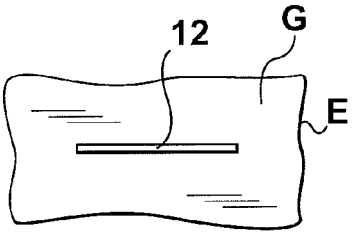


FIG. 10

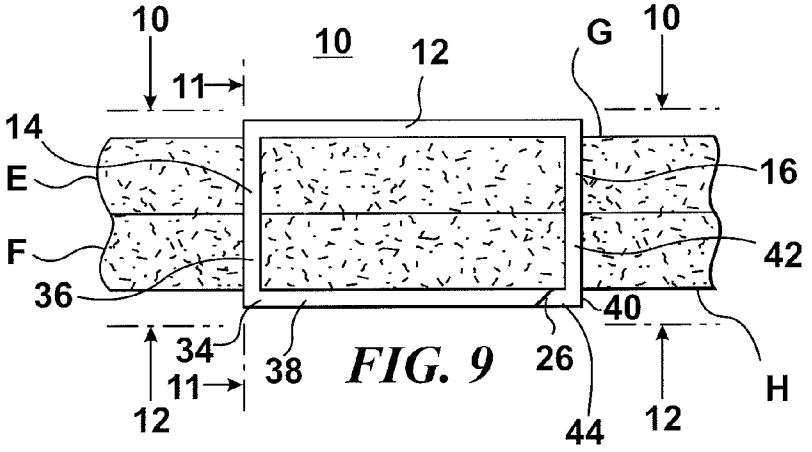


FIG. 9

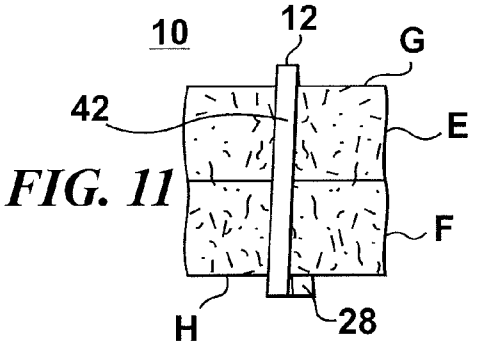


FIG. 11

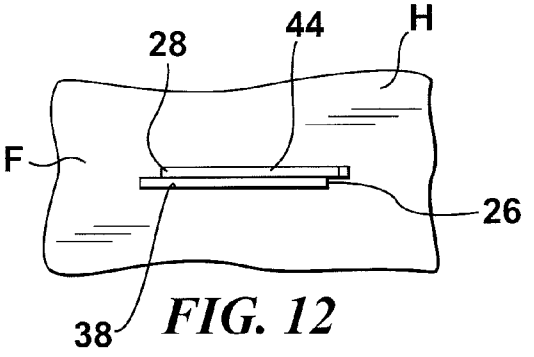
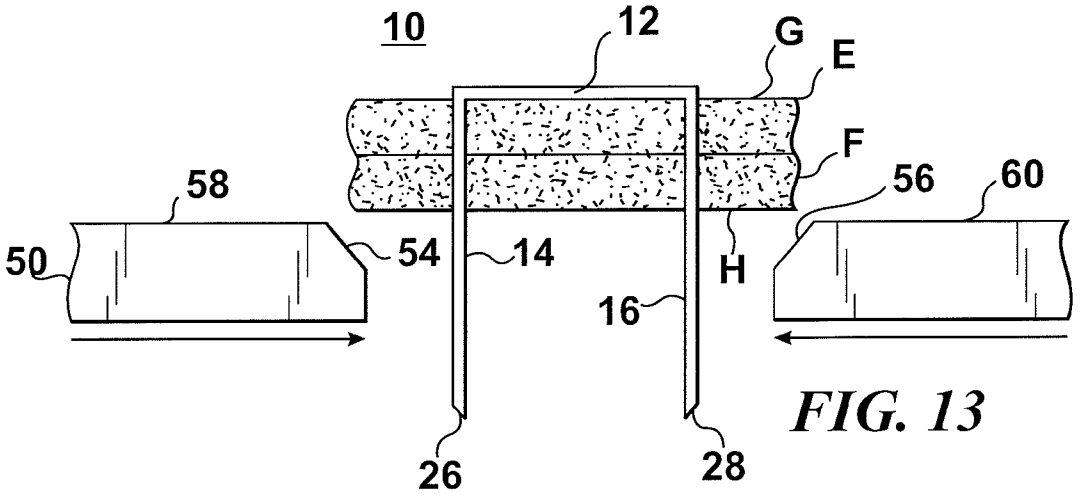


FIG. 12



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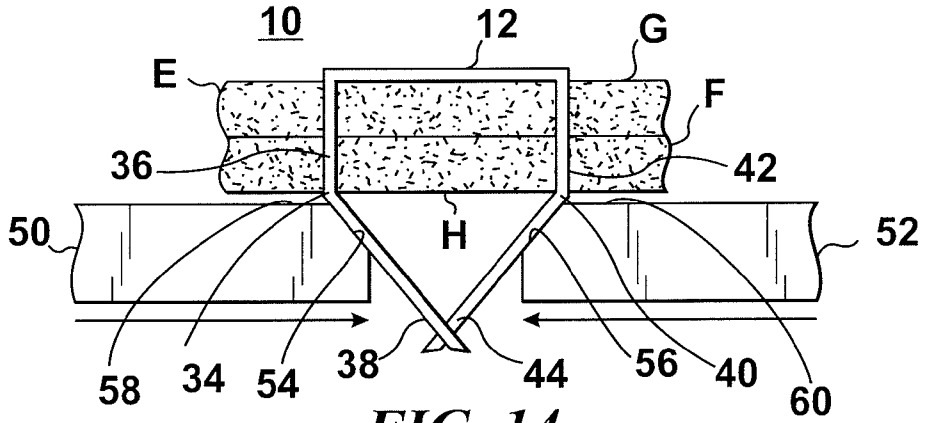


FIG. 14

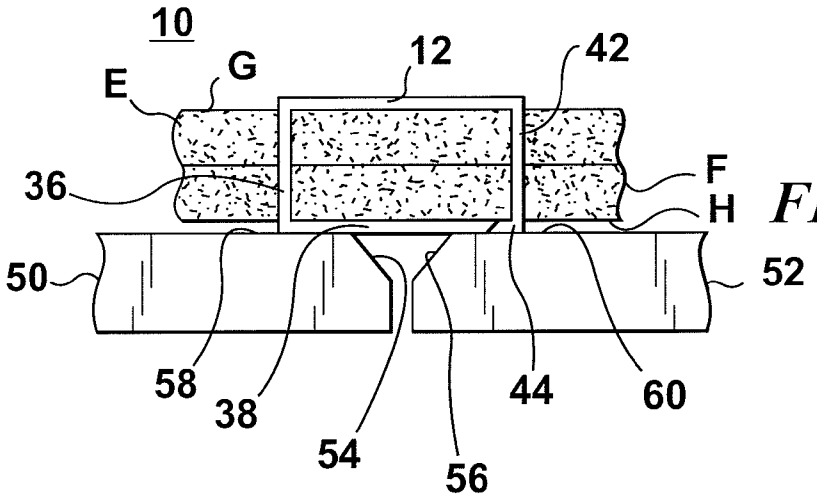


FIG. 15

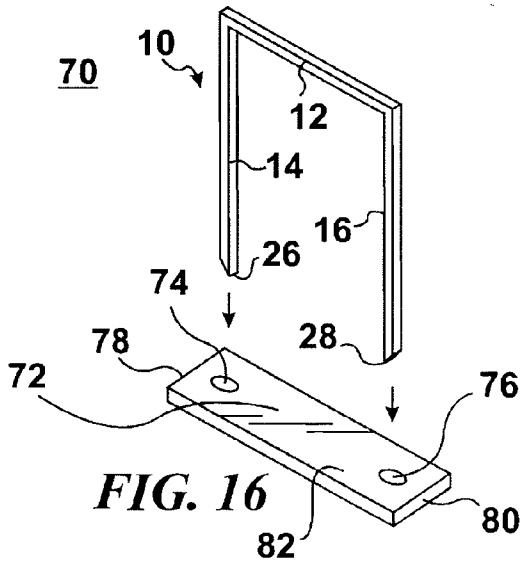


FIG. 16

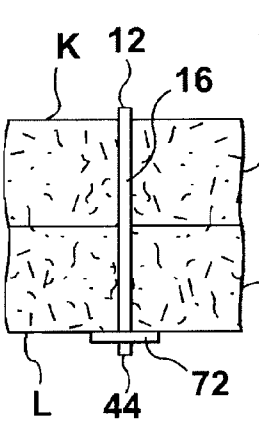


FIG. 18

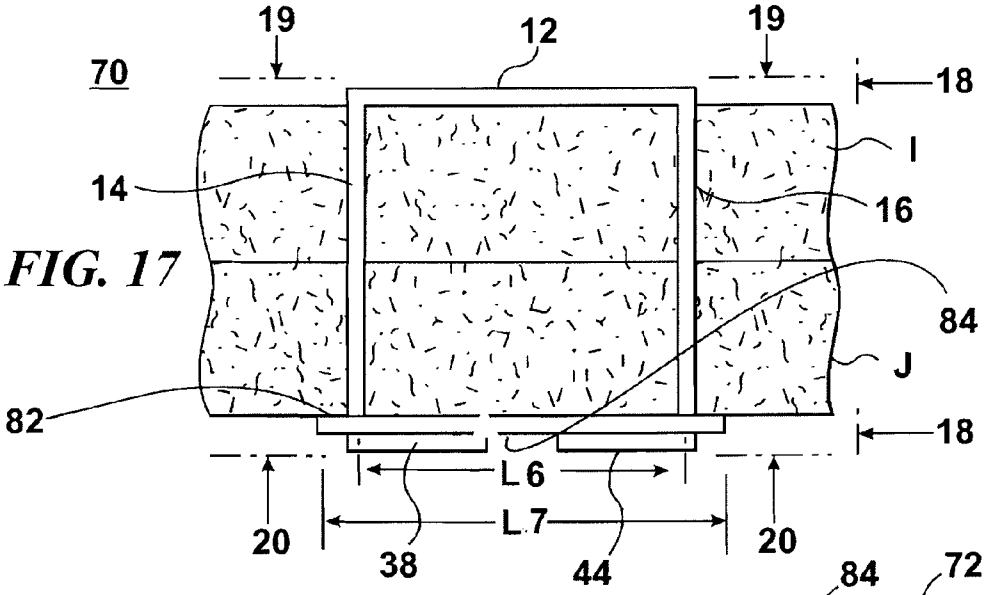


FIG. 17

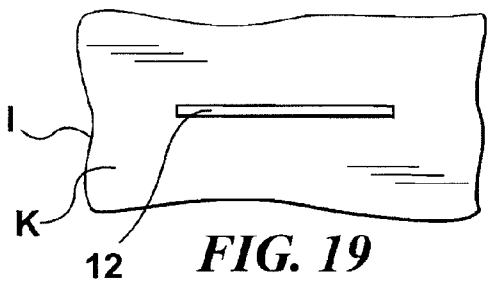


FIG. 19

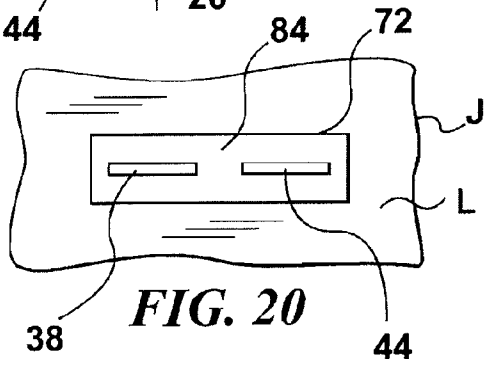
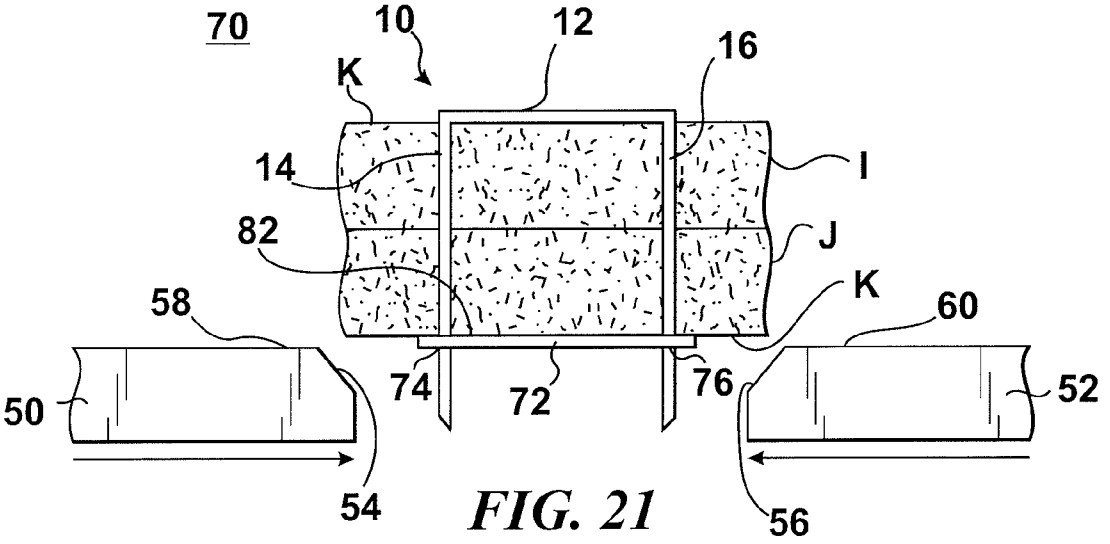


FIG. 20



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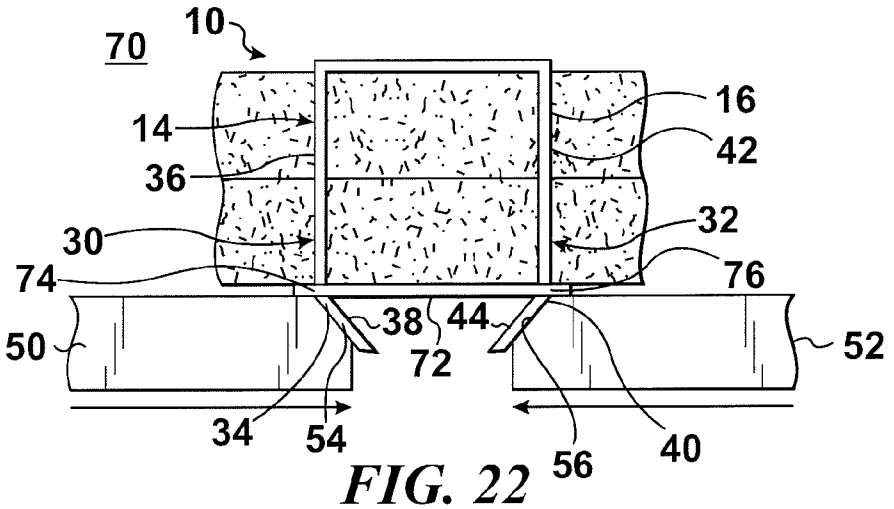
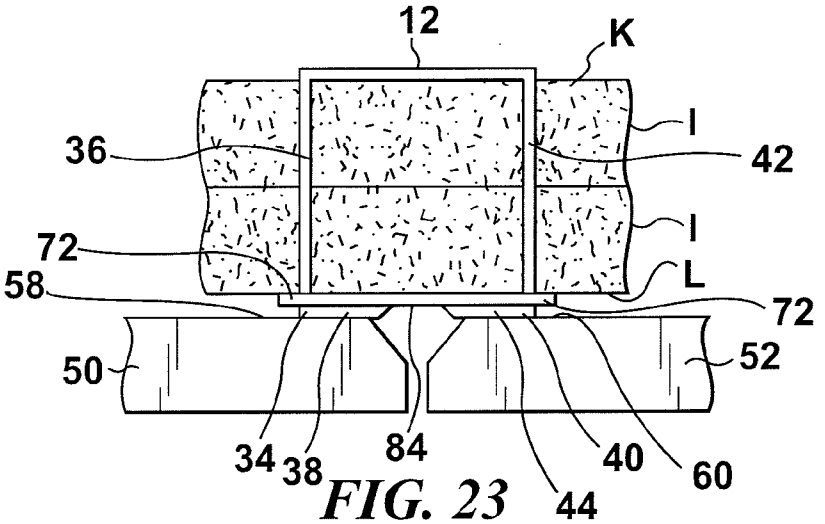


FIG. 22



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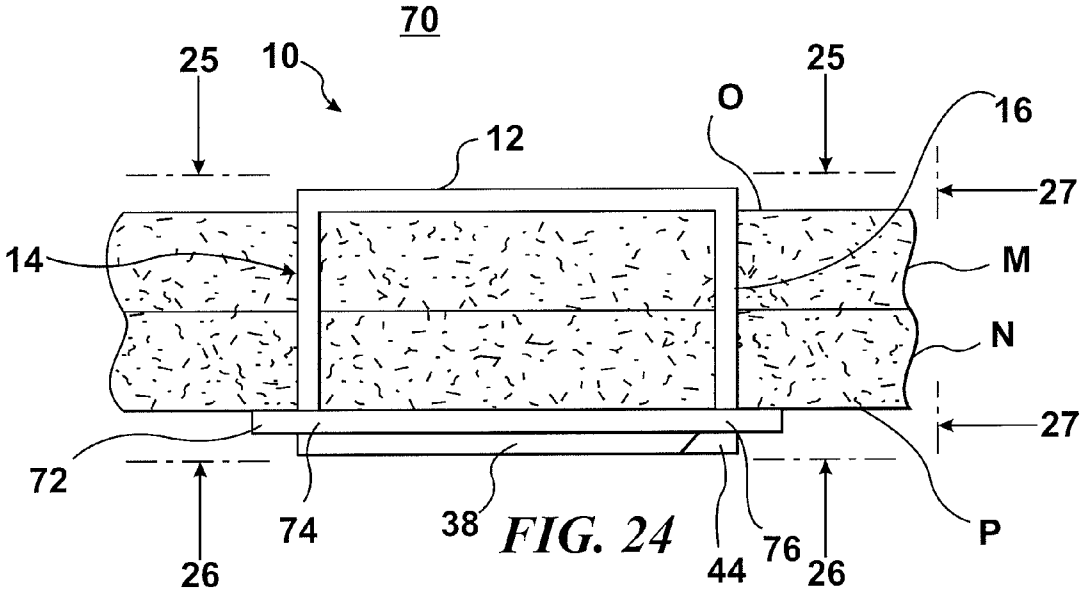

FIG. 24

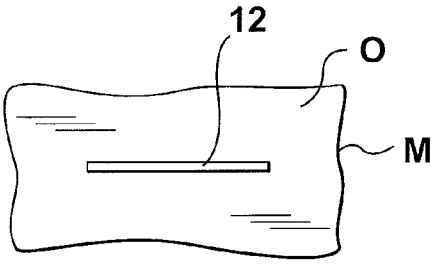

FIG. 25

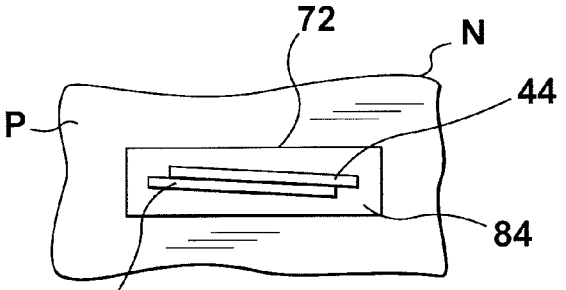

FIG. 26

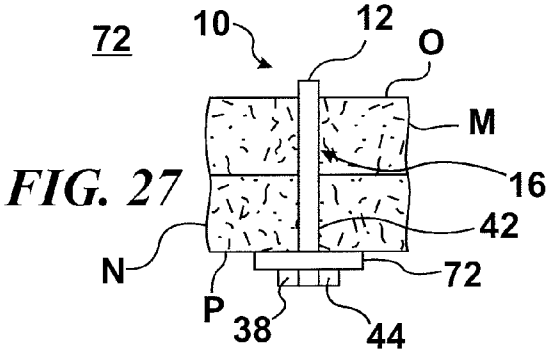

FIG. 27

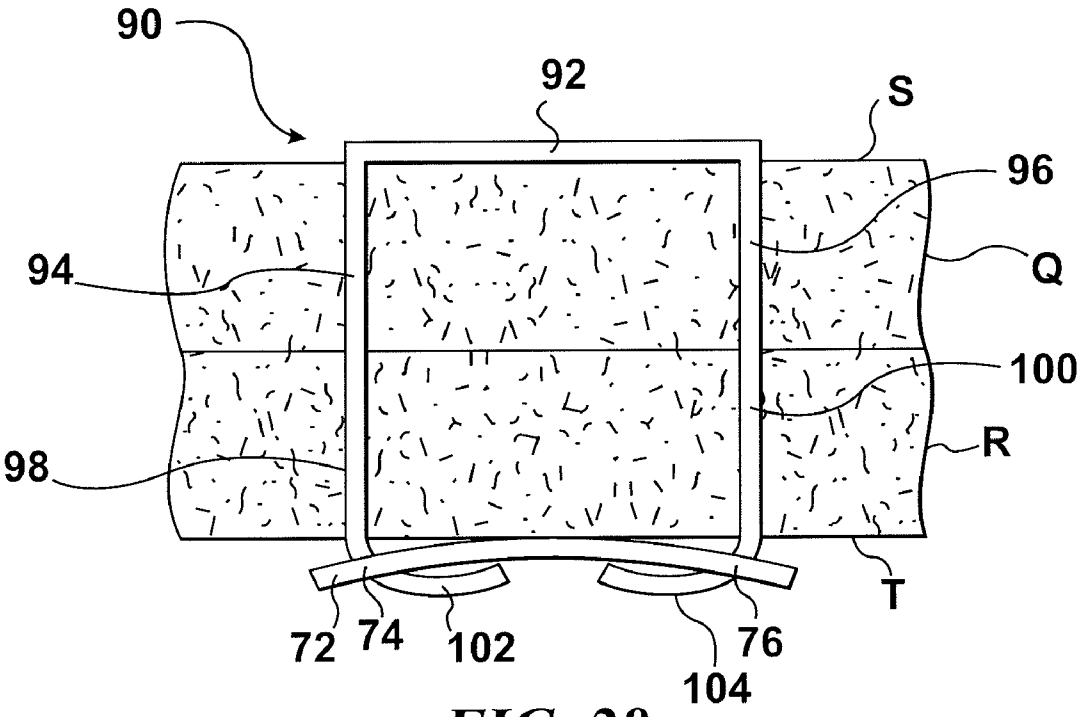
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FIG. 28

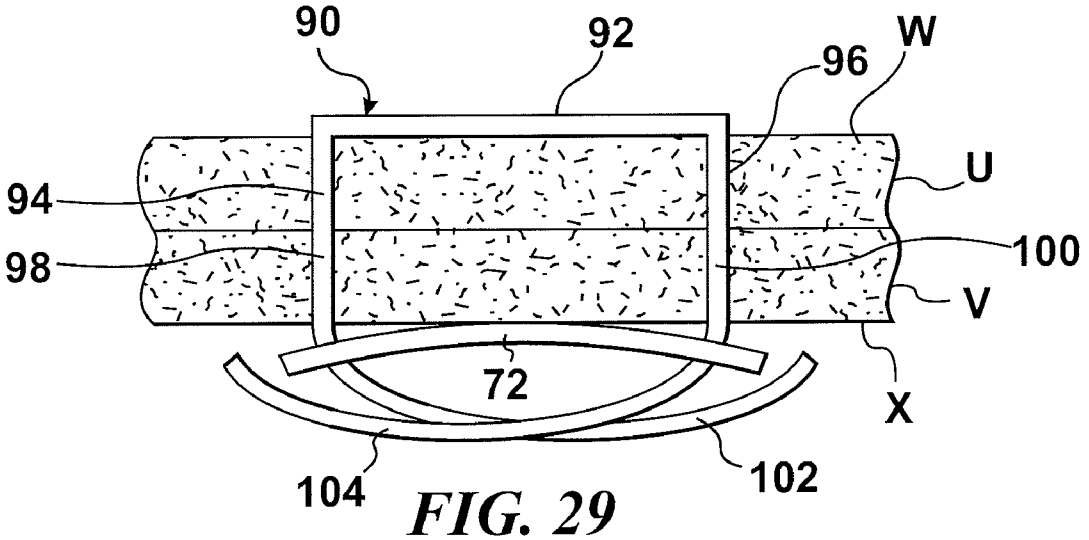
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FIG. 29

STAPLE FOR USE IN SURGICAL PROCEDURES

[0001] This application claims priority to provisional application No. 61/082,852, file Jul. 23, 2008, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] 1. Technical Field

[0003] The present disclosure relates to a surgical staple for use in surgical procedures. More particularly, the present disclosure relates to a surgical staple and a staple assembly configured to accommodate various thicknesses of tissue by assuming a substantially box-shaped configuration upon formation through tissue. The present disclosure also relates to a method of stapling tissues of various thicknesses with a single, uniform size staple.

[0004] 2. Background of Related Art

[0005] During various surgical procedures it is often necessary to secure one or more tissue sections together or to secure auxiliary structures such as, for example, mesh, buttress material, etc. to tissue. This is typically accomplished by driving a conventional staple, having a backspan and a pair of legs extending from the backspan, through the tissue and/or through the auxiliary structure. Once the conventional staple has been driven through the tissue, the ends of the legs are engaged with an anvil of the type typically having a pair of arcuate anvil pockets. This engagement causes the ends of the legs to be bent or recurved back towards the tissue to secure the tissue sections together and/or to secure the auxiliary material to the tissue. These bent or recurved portions of the staple legs are the tissue clenching portions of the legs.

[0006] When attempting to secure relatively thick sections of tissue together or auxiliary material to a relatively thick tissue section, the sizing of the conventional staple is selected to ensure sufficient leg lengths to traverse the tissue. Insufficient leg lengths will result in incomplete stapling of the tissue.

[0007] Further, when attempting to secure relatively thin sections of tissue together, or auxiliary material to the relatively thin tissue section, the sizing of the conventional staple is selected to ensure that there is not an excess of leg length. Excess leg length may result in the clenching portions of the legs projecting substantially away from the tissue as well as causing the ends of the leg to recurve back into and penetrate the tissue.

[0008] Therefore, it would be desirable to provide a staple having a leg length sufficient for various tissue thicknesses expected to be encountered.

SUMMARY

[0009] There is disclosed a staple substantially box-shaped and including a backspan and a first leg extending from the backspan. The first leg is divided into a first traversing leg portion and a first substantially linear clenching leg portion by a first bend. A second leg extends from the backspan and is divided into a second traversing leg portion and a second substantially linear clenching leg portion by a second bend. At least one of the first and second substantially linear clenching leg portions is oriented substantially parallel to the backspan. In one embodiment, both the first and second substantially linear clenching leg portions are oriented substantially parallel to the backspan.

[0010] Preferably, at least one of the first and second traversing leg portions is oriented substantially perpendicular to the backspan. In one embodiment, both the first and second traversing leg portions are oriented substantially perpendicular to the backspan.

[0011] In one embodiment, a combined length of the first and second clenching leg portions is less than an overall length of the backspan. In an alternative embodiment, the combined length of the first and second clenching leg portions is equal to an overall length of the backspan. In another alternative embodiment, the combined length of the first and second clenching leg portions is greater than an overall length of the backspan.

[0012] There is also disclosed a staple assembly for use in tissue which generally includes a substantially box-shaped staple having a backspan and first and second legs extending from the backspan. The first leg is divided into a first traversing leg portion and a first substantially linear clenching leg portion by a first bend. The second leg is also divided into a second traversing leg portion and a second substantially linear clenching leg portion by a second bend. A staple plate is positioned on the first and second legs between the backspan and the first and second linear clenching leg portions. At least one of the first and second substantially linear clenching leg portions is oriented substantially parallel to the staple plate.

[0013] The staple plate preferably has first and second holes to receive the first and second traversing leg portions, respectively. In a preferred embodiment, an overall length of the staple plate is greater than an overall length of the backspan and the distance between the first and second holes is substantially equal to the overall length of the backspan.

[0014] There is also disclosed a method of forming a substantially box-shaped staple through tissue including the step of providing a substantially box-shaped staple having a backspan, a first leg extending from the backspan and including a first bend zone located between the backspan and a first end of the first leg, and a second leg extending from the backspan and including a second bend zone located between the backspan and a second end of the second leg. The first and second ends of the first and second legs are driven through a tissue section. The first leg is impacted in the first bend zone with a first angled portion of a first anvil to form a first bend within the first bend zone to form a first traversing leg portion and a first substantially linear clenching leg portion.

[0015] The method may further include the step of impacting the first clenching leg portion with a first finishing surface of the first anvil to orient the first clenching leg portion substantially parallel to the backspan.

[0016] The method may further include the step of impacting the second leg in the second bend zone with a second angled portion of a second anvil to form a second bend within the second bend zone and dividing the second bend zone into a second traversing leg portion and a second substantially linear clenching leg portion.

[0017] The second clenching leg portion may be impacted with a second finishing surface of the second anvil to orient the second clenching leg portion substantially parallel to the backspan.

[0018] In one embodiment of the disclosed method, the first and second ends are driven through tissue such that the backspan engages an upper surface of the tissue.

[0019] In one embodiment of the disclosed method, a staple plate is positioned over the first and second legs and engages an underside of the tissue prior to the step of impacting the first leg in the first bend zone.

DESCRIPTION OF THE DRAWINGS

[0020] Embodiments of the presently disclosed staple and staple assembly are disclosed herein with reference to the drawings, wherein:

[0021] FIG. **1** is a side view, partially shown in section, of one embodiment of a disclosed substantially box staple formed through a pair of tissue sections;

[0022] FIG. **2** is an end view taken along line **2-2** of FIG. **1**;

[0023] FIG. **3** is a top view taken along line **3-3** of FIG. **1**;

[0024] FIG. **4** is a bottom view taken along line **4-4** of FIG. **1**;

[0025] FIG. **5** is a side view, partially shown in section, of the staple of FIG. **1**, inserted through the pair of relatively thick tissue sections, immediately prior to formation;

[0026] FIG. **6** is a side view similar to FIG. **5** during formation of the staple through the pair of relatively thick tissue sections;

[0027] FIG. **7** is a side view similar to FIG. **6** after formation of the staple through the pair of relatively thick tissue sections;

[0028] FIG. **8** is perspective view of the fully formed substantially box staple (when formed in relatively thin tissue sections);

[0029] FIG. **9** is a side view, partially shown in section, of the staple of FIG. **8** formed through a pair of relatively thin tissue sections;

[0030] FIG. **10** is a top view taken along line **10-10** of FIG. **9**;

[0031] FIG. **11** is an end view taken along line **11-11** of FIG. **9**;

[0032] FIG. **12** is a bottom view taken along line **12-12** of FIG. **9**;

[0033] FIG. **13** is a side view, partially shown in section, of the staple immediately prior to formation through the pair of relatively thin tissue sections;

[0034] FIG. **14** is a side view similar to FIG. **13** during formation of the staple through the pair of relatively thin tissue sections;

[0035] FIG. **15** is similar to FIG. **14** after formation of the staple through the pair of relatively thin tissue sections;

[0036] FIG. **16** is a perspective view of a staple assembly including a substantially box staple and a staple plate;

[0037] FIG. **17** is a side view, partially shown in section, of the staple assembly formed through a pair of relatively thick tissue sections;

[0038] FIG. **18** is an end view taken along line **18-18** of FIG. **17**;

[0039] FIG. **19** is a top view taken along line **19-19** of FIG. **17**;

[0040] FIG. **20** is a bottom view taken along line **20-20** of FIG. **17**;

[0041] FIG. **21** is a side view, partially shown in section, of the staple assembly of FIG. **16** immediately prior to formation through the pair of relatively thick tissue sections;

[0042] FIG. **22** is a side view, similar to FIG. **21**, during formation of the staple assembly through the pair of relatively thick tissue sections;

[0043] FIG. **23** is a side view, similar to FIG. **22**, after formation of the staple assembly through the pair of relatively thick tissue sections;

[0044] FIG. **24** is side view, partially shown in section, of the staple assembly formed through a pair of relatively thin tissue sections;

[0045] FIG. **25** is a top view taken along line **25-25** of FIG. **24**;

[0046] FIG. **26** is a bottom view taken along line **26-26** of FIG. **24**;

[0047] FIG. **27** is an end view taken along line **27-27** of FIG. **24**;

[0048] FIG. **28** is a side view, partially shown in section, of an alternate embodiment of a staple assembly including a staple and an arcuate staple plate shown formed through a pair of relatively thick tissue sections; and

[0049] FIG. **29** is a side view, partially shown in section, of the staple assembly of FIG. **28** formed through a pair of relatively thin tissue sections.

DETAILED DESCRIPTION OF EMBODIMENTS

[0050] Embodiments of the presently disclosed staple and staple assembly will now be described in detail with reference to the drawings wherein like numerals designate identical or corresponding elements in each of the several views. As is common in the art, the term 'proximal" refers to that part or component closer to the user or operator, i.e. surgeon or physician, while the term "distal" refers to that part or component further away from the user.

[0051] Referring to FIG. **1-4**, and initially to FIG. **1**, there is disclosed an embodiment of a universal staple **10** for use in various thickness of tissues. Staple **10** is substantially box-shaped and has the further advantage of providing uniform pressure against the underside of the tissues stapled as described in more detail hereinbelow. Substantially box-shaped staple **10** generally includes a backspan **12** and first and second legs **14** and **16**, respectively, extending from backspan **12**. Specifically, a first end **18** of first leg **14** extends downwardly (as viewed in FIG. **1**) from a first end **20** of backspan **12** and a second end **22** of second leg **16** extends downwardly from a second end **24** of backspan **12**. First leg **14** terminates in a tissue penetrating tip **26** and second leg **16** terminates in a tissue penetrating tip **28**. The legs **14** and **16** are shown extending substantially perpendicular to the backspan, although it is also contemplated that the legs **14**, **16** can extend from other angles.

[0052] Substantially box staple **10** is preferably formed from a length of material having a generally rectangular cross-section, although other cross sections are also contemplated. Staple **10** can be formed from any number of biocompatible materials such as, for example, stainless steel, titanium, various malleable plastic materials, various bio-absorbable materials etc. When formed from metallic materials such as stainless steel or titanium, staple **10** can be formed by drawing and cutting a length of metallic wire, stamping box staple **10** from a sheet of metallic material, etc. When staple **10** is formed from a plastic or bio-absorbable material, staple **10** can be formed by injection molding, carving staple **10** from a block of plastic material, etc.

[0053] As noted above, staple **10** is designed for use in tissues of various thicknesses, such as, for example, relatively thick tissues A and B. In order to accommodate the various thickness tissues without excessive or insufficient compression of tissues A and B, first leg **14** has a first bend zone **30**

which extends substantially between first end **18** and tissue penetrating tip **26** of first leg **14**. Depending upon the thickness of the tissues encountered, first leg **14** can be bent at any location within bend zone **30** to accommodate those tissues. This is facilitated by the use of a pair of anvils as described in more detail herein below. Second leg **16** also includes a second bend zone **32** which extends substantially between second end **22** and tissue penetrating tip **28** of second leg **16** and can be bent at any location within bend zone **32**.

[0054] When staple **10** is fully formed through relatively thick tissues A and B, backspan **12** provides uniform compression on an upper surface C of relatively thick tissue section A (FIGS. **1** and **3**). First leg **14** is formed with a first bend **34** in first transition zone **30** such that first leg **14** is divided into a first, substantially linear traversing leg portion **36** extending through relatively thick tissues A and B (FIG. **1**) and a first substantially linear clenching leg portion **38** lying substantially flush with an underside D of relatively thick tissue section B (FIGS. **1** and **4**). It should be noted that first bend **34** formed between first traversing leg portion **36** and first clenching leg portion **38** is preferably a substantially sharp or abrupt 90° bend in contrast to the relatively gradually curving bends typically associated with prior art staples. Likewise, second leg **16** is formed with a second bend **40** in second bend zone **32** which divides second leg **16** into a second substantially linear traversing leg portion **42** extending through relatively thick tissue sections A and B (FIGS. **1** and **2**) and a second substantially linear clenching leg portion **44** lying substantially flush with underside D of relatively thick tissue section B. (FIGS. **1** and **4**). Second bend **40** also preferably forms a relatively sharp or abrupt 90° transition between second traversing leg portion **42** and second clenching like portion **44**. By maintaining first and second clenching leg portions **38** and **44** in a relatively linear or straight configuration against underside D of relatively thick tissue section B, first clenching leg portion **38** and second clenching leg portion **44** maintain a uniform compression against underside D without the associated pinching or tip penetration of underside D.

[0055] As best shown in FIG. **1**, when staple **10** is formed through relatively thick tissue sections A and B, the length L**1** of backspan **12** is preferably greater than or equal to the combined lengths L**2** and L**3** of first and second linear clenching leg portions **38** and **44**, respectively.

[0056] Referring now to FIGS. **5-7**, and initially with respect to FIG. **5**, the use and formation of staple **10** with relatively thick tissue sections A and B will now be described. Initially, the dimensions of staple **10** are preferably chosen such that legs **14** and **16** have overall lengths L**4** and L**5** which are substantially greater than the anticipated combined thicknesses of any tissues to be encountered. Furthermore, each of the overall lengths L**4** and L**5** of first and second legs **14** and **16**, respectively, is preferably greater than half the overall length L**1** of backspan **12**. This ensures sufficient leg length to traverse and secure both relatively thick and thin tissue sections. Staple **10** is initially driven through relatively thick tissue sections A and B by engaging backspan **12** with a staple driver (not shown) thereby driving first and second tissue penetrating tips **26** and **28**, respectively, through tissue sections A and B.

[0057] Referring to FIG. **6**, thereafter, a pair of anvils, such as, for example, first and second driven anvils **50** and **52**, are driven laterally against first and second staple legs **14** and **16** to form staple **10** through relatively thick tissue sections A and B. First and second driven anvils **50** and **52** generally include respective first and second angled surfaces **54** and **56** and respective first and second finishing surfaces **58** and **60**. First and second angled surfaces **54** and **56** are provided to initially impact or impinge against first and second legs **14** and **16** within the respective first and second bend zones **30** and **32** to initially create first and second bends **34** and **40**. This divides first bend zone **30** of first leg **14** into first traversing leg portion **36** and first linear clenching leg portion **38**. Similarly, this divides second bend zone **32** into second traversing leg portion **42** and second linear clenching leg portion **44**.

[0058] Referring to FIG. **7**, as first and second anvils **50** and **52** are driven to the final position, first and second linear clenching leg portions **38** and **44** are engaged by relatively linear finishing surfaces **58** and **60** of driven anvils **50** and **52**, respectively, such that first and second linear clenching leg portions **38** and **44** are brought substantially flush into engagement with underside D of relatively thick tissue section B. As noted hereinabove, when substantially box staple **10** is used in relatively thin tissue sections, the combined lengths L**2** and L**3** of first and second clenching leg portions **38** and **44**, respectively, are substantially less than or equal to the overall length L**1** of backspan **12**.

[0059] Referring now to FIGS. **8-12**, and initially with regard to FIG. **8**, substantially box staple **10** is illustrated in the configuration it assumes when used through a pair of relatively thin tissue sections. Specifically, when staple **10** is formed through relatively thin tissue sections, each of the lengths L**2** and L**3** of respective first and second linear clenching leg portions **38** and **44** are almost equal to or greater than the overall length L**1** of backspan **12**.

[0060] As shown in FIG. **9**, first and second traversing leg portions **36** and **42** pass through thin tissue sections E and F. First and second linear clenching leg portions **38** and **44** preferably lie substantially parallel to and substantially flush with tissue section F. As best shown in FIG. **10**, backspan **12** engages an upper surface G of tissue section E while first and second linear clenching leg portions **38** and **44** engage an underside surface H of tissue G.

[0061] As best shown in FIGS. **8**, **11** and **12**, the excess lengths of first and second clenching leg portions **38** and **44** are accommodated by allowing them to lie in substantially parallel relation (side by side) to each other against underside F of tissue H. Thus, staple **10** functions as a universal staple suitable for use with both thick and thin tissue sections without risk of penetrating the tissue sections with first and second tissue penetrating tips **26** and **28** of respective first and second legs **14** and **16**.

[0062] Referring now to FIGS. **13-15**, in order to form staple **10** through pair of relatively thin tissue sections E and F, staple **10** is initially driven through tissue sections E and F. Thereafter, driven anvils **50** and **52** impact staple legs **14** and **16** to initially begin to bend staple legs **14** and **16**. As shown in FIG. **14**, angled faces **54** and **56** of driven staples **50** and **52** initially form bends **34** and **40** to create respective first and second traversing leg portions **36** and **42** and first and second linear clenching leg portions **38** and **44**. Thereafter, with reference to FIG. **15**, finishing surfaces **58** and **60** of driven anvils **50** and **52** engage first and second linear clenching leg portions **38** and **44** to form first and second linear clenching leg portions **38** and **44** against underside H of tissue F and, substantially parallel to backspan **12**. Thus, staple **10** is particularly suited for use with relatively thin tissue sections such

that first and second linear clenching leg portions **38** and **44** lie substantially flush against the tissue to be stapled.

[0063] Referring now to FIGS. **16-20**, and initially with regard to FIG. **16** there is disclosed an alternate embodiment having a staple assembly **70** including a substantially box-shaped staple **10** and a pledget or staple plate **72**. Staple plate **72** increases the surface area engaging a tissue being stapled as well as protecting the tissue from engagement with staple legs **14** and **16** upon crimping of staple **10** about tissue. Staple **10** is as described herein above including backspan **12** and legs **14** and **16** extending from backspan **12**.

[0064] Staple plate **72** is substantially rectangular as shown (although other shapes are also contemplated) having first and second holes **74** and **76** adjacent first and second ends **78** and **80**, respectively. First and second holes **74** and **76** are configured and dimensioned to receive first and second legs **14** and **16** of staple **10** therethrough. Staple plate **72** has an overall length L**7** which is preferably greater than the length L**1** of backspan **12** (FIG. **1**). Additionally, the spacing or length L**6** between holes **74** and **76** is preferably substantially identical to the length L**1** of backspan **12** as the legs **14** and **16** are preferably substantially perpendicular thereto. Other lengths are also contemplated.

[0065] As best shown in FIGS. **17** and **18**, staple assembly **70** is provided to secure a pair of tissue sections, such as, for example, tissue sections I and J. Backspan **12** engages an upper surface K of tissue section I (FIG. **19**) while an upper surface **82** of staple plate **72** engages a lower surface L of tissue section J (FIG. **20**).

[0066] Referring to FIG. **20**, as noted above, staple plate **72** protects tissue section J from engagement with first and second clenching leg portions **38** and **44** of first and second legs **14** and **16**, respectively. Specifically, upon formation of staple **10** through tissue sections I and J, staple plate **72** is interposed between tissue section J and first and second clenching leg portions **38** and **44**.

[0067] Referring to FIGS. **21-23**, the use of staple assembly **70** to secure a pair of relatively thick tissue sections I and J together will now be described. With reference to FIG. **21**, initially, staple **10** is driven by a staple driver (not shown) toward tissue sections I and J such that first and second legs **14** and **16** penetrate tissue sections I and J until backspan **12** engages upper surface K of tissue section I. Staple plate **72** is positioned against undersurface K of tissue section J and legs **14** and **16** are extended through holes **74** and **76** of staple plate **72**. This brings upper surface **82** of staple plate **72** into engagement with undersurface K of tissue section J.

[0068] With reference to FIGS. **21** and **22**, thereafter, first and second driven anvils **50** and **52** are moved inwardly toward first and second legs **14** and **16**. Upon engagement of first and second angled surfaces **54** and **56** with first and second legs **14** and **16**, first and second legs **14** and **16** are initially bent within respective bend zones **30** and **32** to form first and second bends **34** and **40** within first and second legs **14** and **16**. As noted here in above, first bend **34** divides first leg **14** into first traversing leg portion **36** and first linear clenching leg portion **38** while second bend **40** divides second leg **16** into second traversing leg portion **42** and second linear clenching leg portion **44**. Notably, the extension of first and second legs **14** and **16** through first and second holes **74** and **76** in staple plate **72** facilitate forming bends **74** and **76** at substantially right angles relative to first and second traversing leg portions **36** and **38** of first and second legs **14** and **16**, respectively.

[0069] Finally, with reference to FIG. **23**, engagement of first and second finishing surfaces **58** and **60** of the first and second driven anvils **50** and **52** with first and second linear clenching leg portions **38** and **44** serve to secure first and second linear clenching leg portions **38** and **44** against underside **84** of staple plate **72** thereby securing staple plate **84** against underside L of tissue section J.

[0070] Referring now to FIGS. **24-27**, the use of staple assembly **70** to secure a pair of relatively thin tissue sections, such as, for example, tissue sections M and N will now be described. The method disclosed herein with respect to relatively thin tissue sections M and N is substantially identical to the method disclosed herein above with respect to relatively thick tissue sections I and J. Initially, with reference to FIG. **24**, staple **10** is driven by a staple driver (not shown) such that first and second legs **14** and **16** are driven through tissue sections M and N until backspan **12** engages an upper surface O of tissue section M (FIG. **25**). Further movement of the staple driver drives first and second legs **14** and **16** through holes **74** and **76** of staple plate **72**. Thereafter, first and second driven anvils **50** and **52** (FIGS. **21-23**) are moved toward each other as described above to form first and second linear clenching leg portions **38** and **44** against underside **84** of staple plate **72** (FIG. **26**).

[0071] As best shown in FIGS. **26** and **27**, similar to that disclosed hereinabove with respect to staple **10** in FIGS. **11** and **12**, first and second linear clenching leg portions **38** and **44** are in a side-by-side and overlapping relation with respect to each other due to the excess lengths of legs **14** and **16** when used through relatively thin tissue sections M and N. In this manner, the provision of substantially box staple **10** having first and second legs **14** and **16** with overall lengths almost equal to or greater then at least the overall length of backspan **12** allows staple **10** to function as a universal staple suitable for use with various thicknesses of tissue. As noted hereinabove, the provision of staple plate **72** provides additional surface bearing area against the tissue section while facilitating forming an abrupt 90° bend within first and second legs **14** and **16**.

[0072] Referring now to FIGS. **28** and **29**, while staple plate **72** has been disclosed for use with staple **10**, staple plate **72** may be formed of a material which allows staple plate **72** to be used with a staple **90** similar to staple **10** in situations wherein staple **90** is formed with conventional anvils. As used herein, the term "conventional anvils" refers to those anvils having arcuate anvil pockets resulting in arcuate rather than linear clenching leg portions in the formed staple.

[0073] For example, with reference to FIG. **28**, staple **90** includes a backspan **92** having first and second legs **94** and **96** extending from backspan **92**. In use, staple **90** is driven through relatively thick tissue sections Q and R resulting in first and second traversing leg portions **98** and **100** extending through tissue sections Q and R while backspan **92** engages an upper surface S of tissue section Q. First and second legs **94** and **96** are extended through holes **74** and **76** in staple plate **72** and are clenched against staple plate **72** by arcuate anvil pockets formed in an anvil associated with a conventional stapler (not shown).

[0074] Similarly, with reference to FIG. **29**, when used in conjunction with relatively thin tissue sections U and V, backspan **92** engages an upper surface W of tissue section U while traversing leg portions **98** and **100** extend through tissue sections U and V. Staple plate **72** bears against an undersurface X of tissue section V. First and second clenching leg

portions **102** and **104** of first and second legs **94** and **96** are formed into a roughly arcuate overlapping relation due to the excess length of legs **94** and **96**.

[0075] As shown in FIGS. **28** and **29**, staple plate **104** is preferably curved, thereby an arcuate top surface of the plate abuts the bottom surface of the tissue section R or V.

[0076] It will be understood that various modifications may be made to the embodiments disclosed herein. For example, the legs of the disclosed substantially box staple may be heat treated at specific points to facilitate the formation of the abrupt 90° bend between the traversing portion of the leg and the linear clenching portion of the leg. Further, alternative embodiments of anvils may be provided to form the substantially right angle within their respective legs. Additionally, the disclosed staple may be formed from a shape memory alloy such that the substantially right angle between the traversing leg portion and the substantially linear clenching leg portion is formed at a predetermined location along the length of the leg. Also curved or planar plates can be used with the embodiments of the staple disclosed herein. Therefore, the above description should not be construed as limiting, but merely as exemplifications of particular embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.

1. A substantially box-shaped staple for use in tissue comprising:
- a backspan;
- a first leg extending from the backspan, the first leg being divided into a first traversing leg portion and a first substantially linear clenching leg portion by a first bend; and
- a second leg extending from the backspan, the second leg being divided into a second traversing leg portion and a second substantially linear clenching leg portion by a second bend, wherein at least one of the first and second substantially linear clenching leg portions is oriented substantially parallel to the backspan.

2. The staple as recited in claim **1**, wherein both the first and second linear clenching leg portions are oriented substantially parallel to the backspan.

3. The staple as recited in claim **1**, wherein at least one of the first and second traversing leg portions is oriented substantially perpendicular to the backspan.

4. The staple as recited in claim **3**, wherein both the first and second traversing leg portions are oriented substantially perpendicular to the backspan.

5. The staple as recited in claim **1**, wherein a combined length of the first and second clenching leg portions is less than an overall length of the backspan.

6. The staple as recited in claim **1**, wherein a combined length of the first and second clenching leg portions is equal to an overall length of the backspan.

7. The staple as recited in claim **1**, wherein a combined length of the first and second clenching leg portions is greater than an overall length of the backspan.

8. A substantially box-shaped staple assembly for use in tissue comprising:
- a backspan;
- a first leg extending from the backspan, the first leg being divided into a first traversing leg portion and a first substantially linear clenching leg portion by a first bend;
- a second leg extending from the backspan, the second leg being divided into a second traversing leg portion and a second substantially linear clenching leg portion by a second bend; and
- a staple plate positioned on the first and second legs between the backspan and the first and second clenching leg portions, wherein at least one of the first and second substantially linear clenching leg portions is oriented substantially parallel to the staple plate.

9. The staple assembly as recited in claim **8**, wherein the staple plate has first and second holes to receive the first and second traversing leg portions respectively.

10. The staple assembly as recited in claim **8**, wherein an overall length of the staple plate is greater than an overall length of the backspan.

11. The staple assembly as recited in claim **9**, wherein the distance between the first and second holes is substantially equal to an overall length of the backspan.

12. The method as recited in claim **9**, wherein the staple plate has an arcuate top surface.

13. A method of forming a substantially box-shaped staple through tissue comprising:
- providing a substantially box-shaped staple having a backspan, a first leg extending from the backspan and including a first bend zone located between the backspan and a first end of the first leg, and a second leg extending from the backspan and including a second bend zone located between the backspan and a second end of the second leg;
- driving the first and second ends of the first and second legs through a tissue section; and
- impacting the first leg in the first bend zone with a first angled portion of a first anvil to form a first bend within the first bend zone to form a first traversing leg portion and a-first substantially linear clenching leg portion.

14. The method as recited in claim **13**, further comprising the step of impacting the first substantially linear clenching leg portion with a first finishing surface of the first anvil to orient the first substantially linear clenching leg portion substantially parallel to the backspan.

15. The method as recited in claim **14**, further comprising the step of impacting the second leg in the second bend zone with a second angled portion of a second anvil to form a second bend within the second bend zone to form a second traversing leg portion and a second substantially linear clenching leg portion.

16. The method as recited in claim **15**, further comprising the step of impacting the second linear clenching leg portion with a second finishing surface of the second anvil to orient the second substantially linear clenching leg portion substantially parallel to the backspan.

17. The method as recited in claim **13**, wherein the first and second ends are driven through tissue such that the backspan engages an upper surface of the tissue.

18. The method as recited in claim **14**, further comprising the step of positioning a staple plate over the first and second legs and into engagement with an underside of the tissue prior to the step of impacting the first leg in the first bend zone.

19. The method as recited in claim **18**, wherein the first substantially linear clenching leg portion is oriented substantially parallel to the staple plate.

20. The method as recited in claim **18**, wherein the staple plate has an arcuate surface.

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