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(54) **Title**: RECIPROCATING SAW BLADE CARTRIDGE THAT INCLUDES A STATIC BAR TO WHICH A RECIPROCATING RACK IS ATTACHED

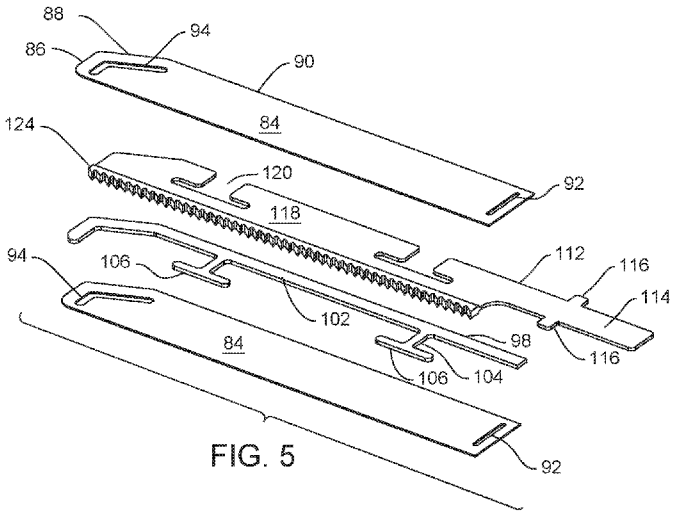

FIG. 5

(57) **Abstract**: A surgical blade cartridge (80) that includes a blade bar (82) in which a rack (112) is moveably mounted. Teeth (126) extend outwardly from the portion of the rack disposed outside of the bar. The blade bar and rack are formed with a complementary static member (106) and a slot (120) such that the static member seats in the slot so as to retain the rack in the bar and allow the rack to move reciprocate linearly

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RECIPROCATING SAW BLADE CARTRIDGE THAT INCLUDES A STATIC BAR TO WHICH A RECIPROCATING RACK IS ATTACHED

Field Of The Invention

[0001] This application is generally related to a reciprocating saw blade. More particularly, this application is directed a reciprocating saw blade cartridge that is releasably mounted to the saw with which the cartridge is used. The cartridge includes a static bar to which a reciprocating rack is attached.

Background Of The Invention

[0002] In a surgical procedure, it is sometimes necessary to use a saw to remove tissue, including bone and cartilage. Often a powered saw is used to perform this procedure. Attached to the saw is a saw blade. A drive assembly internal to the saw oscillates the blade in a back and forth motion. Some blades move back and forth along their longitudinal axes. This type of blade is known as a reciprocating saw blade. This type of blade is provided with teeth that extend outwardly from a side edge of the blade body. Many reciprocating saw blades are designed to remove hard tissue, bone.

[0003] Reciprocating saw blades generally work well for the purposes for which they are designed. These saw blades are able to cut the bones to which they are applied.

[0004] However, there are times when use of a reciprocating saw blade results in undesirable side effects. One such side effect is due to the fact that, when a reciprocating saw blade is positioned to cut some types of tissue, the body of the blade presses against soft tissue that is not targeted for removal. This can occur when a reciprocating saw blade is used in oral surgery to remove a

portion of the jaw. The body of a reciprocating saw blade may also press tissue when the blade is used in small bone orthopedic surgery, surgery of the hand or foot and ankle.

[0005] A problem can arise in these types of surgical procedure because a reciprocating saw blade can move back and forth at a rate of between 10,000 and 15,000 cycles per minute. This rapid movement of the blade can foster appreciable friction-induced heating of the soft tissue against which the blade body is pressed. The heating of this tissue can sometimes damage the tissue. If the damages tissue is part of the nerve system, a muscle or a ligament, the effects of the damage can especially undesirable.

[0006] Also, there are procedures in which, owing to how the reciprocating saw blade is positioned in the tissue, it is extremely difficult, if not impossible, for the surgeon to see the end section of the blade. For example in a rhinoplasty procedure a reciprocating saw blade is used to remove a portion of the nose bone. In this type of procedure, to avoid the ready appearance of a scar, the blade is typically inserted into the nose through the flap of the skin between the nostrils. In some hip replacement procedures a reciprocating saw blade may likewise be positioned so it can be difficult to see the free end of the blade. Again, it should be understood that a reciprocating blade moves back and forth. In procedures in which the distal section of the blade is hidden from view, there is a possibility that this section of the blade repeatedly presses against tissue that is not targeted for removal. This back and forth movement of the tissue can stress the tissue to the point at which it tears or is otherwise damaged

[0007] In some procedures, to ensure a planar cut, it is a common practice to insert the reciprocating saw blade in a device known as a resection guide. This guide is sometimes

referred to as a guide block or a cutting jig. The resection guide has a slot in which the blade is inserted. The device is held static relative to the tissue to be cut. Since the device is held static, the blade is blocked from movement out of the plane of the slot. By so restricting the movement of the blade, the surface of the bone left after the cut is formed s planar in shape. This facilitates the proper seating of an implant, which typically has its own planar surface, against the bone. When a reciprocating saw blade moves back and forth in the resection guide, the body of the blade invariably rubs against the inner surfaces of the guide that define the cut. This metal-against-metal rubbing results in the rubbing away of the material forming the resection guide. One adverse effect of this wear is that at least some of the fine dust of metal generated by this wear invariably lands on the exposed internal tissue of the patient. This means that after the cut is formed and the resection guide is removed, care must be taken to clean the tissue to remove these debris so as to prevent them causing harm to the patient. A second adverse effect of this wear is that, over time, the wear can appreciable widen the slot or slots formed in the resection guide. If these slots become too wide relative to the blade, the resection guide may no longer function as a useful guide for ensuring that the cut formed by the reciprocating blade has the desired shape.

[0008] US Pat. Pub. US 2006/0009796 A1/PCT Pub. WO 2006/017066 A2, the contents of which are incorporated herein by reference, discloses a type of a saw blade known as a sagittal saw blade. A sagittal saw blade has teeth that pivot back and forth around an axis that extends through the plane of the blade. One of the sagittal saw blades disclosed in this publication has a blade head that extends laterally outwardly from the side of a static blade

bar. The blade head pivots around an axis that extends through the opposed major surfaces of the blade bar. This blade head, when pivoted, cuts the tissue against which the teeth are pressed. However, the length of the cut formed by this blade is relatively short, typically less than one-third length of the cut that would be performed by a compatibly sized conventional reciprocating saw blade. It therefore can take an appreciably longer time to make a cut with this cartridge than it would in order to make the same length cut using a conventional reciprocating saw blade

[0009] A species of the reciprocating saw blade is the sternum saw. As implied by its name, the sternum saw blade is used to cut the sternum. Typically, it is necessary, to cut, separate, the sternum so the surgeon can gain access to the tissue and organs below the sternum. These organs include the heart and lungs. When cutting the sternum it is naturally desirable to avoid positioning the saw blade so the blade strikes, cuts, the organs and tissue immediately below the blade. To prevent this undesirable result, a sternum saw blade is mounted in a guard. A foot extends outwardly from the free end of this guard. This foot, in comparison to a narrow width blade, is relatively wide. During the process cutting the sternum, the surgeon holds the saw so the foot of the sternum guard presses against the undersurface of the sternum. The foot functions as a stop that ensures that, as the blade is advanced along the sternum, the blade cuts completely through the sternum from the outer surface to the undersurface. Further, by ensuring that the blade is so positioned, the guard ensures that the blade does not become so positioned that, as the blade is advanced the blade cuts the organs and tissues that underlying the sternum.

[00010] Sternum guards work well for the purpose for which they are designed. A problem with some sternum guards is

that is that they are designed to be used with saws especially designed to hold these guards. This means a surgical facility in which the sternum is to be cut is required to have one or more of the special saws, called sternum saws, available. The facility may be required to have these saws available even though these saws have essentially no use outside of performing this one specific procedure.

SUMMARY OF THE INVENTION

[00011] This invention is related to a new and useful reciprocating saw blade. The reciprocating saw blade of this invention is constructed to minimize the extent to which moving components of the blade other than the teeth, press against tissue. Some versions of the saw blade of this invention are further constructed to be used as a sternum blade without requiring the use of a supplemental sternum guard.

[00012] A blade of this invention, is referred to as a cartridge. The cartridge includes an elongated bar. The bar includes features that facilitate the releasable attachment of the bar to the saw used to actuate the blade. One side of the bar is open.

[00013] The cartridge also includes a rack. The rack has a base that is moveably disposed in the bar. A portion of the rack extends to the opening in the side of the bar. The rack also includes a set of teeth. The teeth extend outwardly from the section of the bar adjacent the opening in bar. The teeth are wider in depth than the base of the rack. More particularly, have sufficient width so that when the rack is reciprocated and the teeth pressed against tissue, the teeth form a kerf of sufficient that the cartridge is able to advance through the kerf.

[00014] In most versions of the invention the rack and bar are formed with complementary features that retain the rack in the bar while allowing the rack to move linearly in the bar.

[00015] Some versions of the cartridge of this invention are formed to have a foot that protrudes outwardly from the opposed major surfaces of the bar. This foot functions in a manner similar to the foot of a sternum guard. Thus the foot functions as a stop to facilitate the proper positioning of the cartridge relative to the bone the cartridge is employed to cut.

[00016] This application is also directed to an attachment that can be used to couple the above-described blade cartridge to a conventional saw. A conventional saw is understood to be a saw that can be used to reciprocate a conventional reciprocating saw blade. The attachment of this invention includes a body. The body includes features for releasably holding the body static to the distal end of a conventional saw. Attached to the body is a coupling feature. The coupling feature is shaped to engage with a complementary coupling feature integral with the bar of the cartridge so as to releasably hold the bar static to the attachment. In some versions of the invention, the attachment coupling feature can be a member dimensioned to seat in a void formed in the bar. In other versions of the invention the coupling feature is an opening or other void in body that receives the complementary coupling feature integral with the bar.

[00017] This application is also directed to a saw specifically for use with the blade cartridge of this invention. This saw has a feature for engaging the bar of the cartridge to releasably hold the bar static to the body of the saw.

BRIEF DESCRIPTION OF THE DRAWINGS

[00018] The invention is pointed out with particularity in the claims. The above and further features and benefits of this invention are understood from the following Detailed Description taken in conjunction with the accompanying drawings in which:

[00019] Figure 1 is side view of a reciprocating saw of this invention to which a reciprocating blade cartridge of this invention is attached;

[00020] Figure 2 is a top view of how a reciprocating blade cartridge is attached to the associated saw;

[00021] Figure 3 is an exploded view of the grasping assembly that holds the reciprocating blade cartridge to the saw;

[00022] Figure 4 is a perspective view of the reciprocating blade cartridge;

[00023] Figure 5 is an exploded view of the reciprocating blade cartridge;

[00024] Figure 6 is a cross sectional view of the reciprocating blade cartridge;

[00025] Figure 7 is a side view of a second reciprocating saw of this invention and the complementary second reciprocating blade cartridge that is used with the saw;

[00026] Figure 8 is a top view of the saw and blade cartridge of Figure 7;

[00027] Figure 9 is an exploded view of the saw, front end attachment and blade cartridge of Figure 7;

[00028] Figure 10 is a cross sectional view of the blade cartridge of Figure 7 coupled to the complementary front end attachment;

[00029] Figure 11 is an exploded view of the reciprocating blade cartridge of Figure 7;

[00030] Figure 12 is a side view of a third reciprocating blade cartridge of this invention, the cartridge being coupled to a saw;

[00031] Figure 13 is an exploded view of the basic components of the saw, front end attachment and reciprocating blade cartridge of Figure 12;

[00032] Figure 14 is a cross sectional view of the blade cartridge of Figure 11 coupled to the complementary saw attachment;

[00033] Figure 15 is an exploded view of the reciprocating blade cartridge of Figure 11 and the associated front end attachment;

[00034] Figure 16 is a plan view of a third reciprocating blade cartridge of this invention; and

[00035] Figure 17 is a cross sectional view taken along line 17-17 of Figure 16 of the blade cartridge of Figure 16.

DETAILED DESCRIPTION

I. FIRST EMBODIMENT

[00036] Figure 1 illustrates a surgical reciprocating saw 30 of this invention to which a complementary reciprocating blade cartridge 80 of this invention is removably attached. The saw 30 has a pistol shaped body or housing 32. The saw housing 32 includes a grip 34. A barrel 36 is formed integrally with handgrip 34. The barrel 36 extends proximally, rearwardly, from and distally forward of the handgrip 34. (Here, "proximally" is understood to mean towards the surgeon holding the saw 30, away from the surgical site to which the blade cartridge 80 is applied. "Distally" is understood to mean away from the surgeon and towards the site to which the blade cartridge 80 is applied.) A nose 38 projects forward from the barrel 36.

[00037] Internal to the saw barrel 36 is a motor, represented by a dashed rectangle 40 and a reciprocating

shaft, represented by dashed rectangle 46. A transmission, represented by dashed rectangle 44, is located between the motor 40 and reciprocating rod. The transmission converts the rotational movement of the motor rotor into motion that reciprocates the shaft back and forth. Here "reciprocation" is understood to mean a repetitive proximal-to-distal-to-proximal motion along the longitudinal axis of the component under discussion. The distal end of the reciprocating shaft is provided with features that facilitate the removable coupling of the below discussed cartridge rack 112 to the shaft. The exact structure of these features are not part of the invention. By way of an example, sometimes the shaft is provided with openings designed to receive complementary components integral with the rack. A chuck, represented by dashed ring 47, is fitted to the distal end of the shaft. The chuck 47 holds the features integral with the rack 112 to the shaft.

[00038] In many versions of the invention, the motor internal to the saw is a DC motor. A battery (not illustrated) is attached to the base of the saw handgrip 34. A trigger 48 extends forward from the distally directed face of the handgrip 34. Internal to the handgrip is a control module represented by dashed rectangle 50. The control module is configured to control the sourcing of the current from the battery or other power supply to the motor. The control module also includes a transducer that monitors the actuation of the trigger 48. Based on the actuation of the trigger 48, the control module regulates the application of current to the motor so as to regulate the actuation of the saw 30 and by extension, the actuation of the blade cartridge 80.

[00039] Many versions of saw 30 are configured to reciprocate a conventional reciprocating saw blade (not illustrated). This is a saw blade that existed prior to

cartridge 80 of this invention. This chuck 47 is designed to hold a conventional reciprocating saw blade to reciprocating shaft 46 so the blade can be reciprocated by the shaft 46.

[00040] An attachment 52, seen best in Figures 2 and 3, is removably secured to the saw nose 38. The attachment 52 releaseably holds the below described bar 82 of the blade cartridge 80 to the saw 30. Attachment 52 includes two shells 54. Shells 54 form the body of the attachment 52. Each shell 54 includes a planner base 56 and two wings 58 that extend outwardly from opposed sides of the base 56. Each shell 54 is shaped so that as the wings 58 extends away from the shell base, the wings curve away from the base. When the saw 30 is assembled, shells 54 are placed on the opposed sides of the nose 38 so the ends of the wings 58 of each shell 54 face the ends of the wings of the other shell. Bolts 60 extends through each wing 58 to the opposed adjacent wings. Bolts 60 clamp the shells 54 together to hold the shells 54 around the opposed sides of the nose 38. Shells 54 and bolts 60 thus releasably hold the attachment 52 static to the nose 38.

[00041] A hand 64, also part of the attachment 52, extends distally forward from each shell 54. Each hand 64 includes a rectangular palm 66, one palm identified. Palms 66 are dimensioned to seat over the exposed surface of the shell 54 from which the hand 64 extends. Screws 74 hold the each palm to the associated shell 54. (Not identified are the openings in the shells 54 and hands 64 through which the screws 74 extend. A finger 68, also part of each hand 64, extends forward from each palm 66. Each finger 68 has a main section (not identified) that extends along a longitudinal axis that is parallel to the proximal-to-distal longitudinal axis through the saw barrel 36. Each finger 68 has a tip 70 that extends perpendicularly to the

longitudinal axis of the main section of the finger. A small rib 72 protrudes forward from end face of each finger tip 70. The clamping assembly 54 is arranged so that when the assembly is fitted to the saw the opposed ribs 72 face each other.

[00042] From Figures 4 and 5 it can be seen that the reciprocating blade cartridge 80 of this invention includes a static bar 82 in which a rack 112 is moveably mounted. Bar 82 includes two plates 84. The plates 84 are generally rectangular in shape. Each plate 84 is further formed so as to have between the distally directed face 86 and the top face 90 a transition face 88. In Figure 5 the edges of faces 86, 88, and 90 are identified. Each transition face 88 is tapered in that the face 88 angles both upwardly as the face extends proximally away from the associated distally directed face 86. Each plate 84 is formed with plural slots. A first slot, slot 92 is formed in the bar so as to be forward of the proximal end of the plate 84. The plates 84 are formed so that slots 92 extend along axes that are perpendicular to the proximal-to-distal longitudinal axes through the plates. Each slot 92 is dimensioned to receive a separate one of the ribs 72 integral with the saw clamping assembly 54. The second slot, slot 94, formed in each plate 84 is located immediately proximal to the distal and transition faces 88 and 90, of the plate. Each slot 94 thus has a first section that adjacent the plate distal face that is parallel to slot 92 and a section that extends diagonally away from the first section. The second section of each slot 94 extends parallel to the transition face 88 of the plate 84 in which the slot 94 is formed.

[00043] The cartridge bar 82 also includes a spacer 98 that is sandwiched between the plates 84. Spacer 98 includes an elongated beam 102. The beam 102 has three sections, individual sections not identified. A first

section of the beam extends distally from the proximal end of the plates 92 so as to be flush with the top faces 90 of the plates. A second section of the beam as it extends forward from the first section angles downwardly so as to be flush with the transition faces 88 of the plates 84. The third section of the beam extends downwardly from the second section so as to be flush with the distal faces 86 of the plates 84.

[00044] Spacer 98 also has two webs 104, one web identified. Webs 104 extend perpendicularly away from the first section of the beam 102. Webs 104 are parallel. A foot 106, one foot identified also part of spacer 98, is located at the end of each web 104. Feet 106 are parallel to the first section of the beam 102. Each foot 106 extends both proximal away from and distally away from the web 104 with which the foot is integral.

[00045] When the cartridge is assembled, spacer is welded between the plates 84. In Figure 4 the weld lines 108 formed by the penetration welding of one plate to the underlying webs 102 and feet 106 are seen.

[00046] Rack 112 includes a base 118. The base 118 is dimensioned to move in the space within the bar 82 between the plates 84 and around the web 104 and feet 106 of the spacer 98. Not identified are the top and distally directed surfaces of the rack base. Likewise not identified is the transition surface between the top and distally directed surfaces. The rack base is formed with two T shaped openings 120. Each opening 120 has a center section that is wider in width than the proximal to distal width across the webs 104. The end section of each opening 120 is longer in length than the length of the spacer feet 106. When the cartridge is assembled, each spacer web 104 and associated foot 106 seats in one of the openings 120 in the rack base 118. Owing to the dimensioning of the components

forming the cartridge it should be understood that the rack 112 is able to move longitudinally back and forth in the bar 82.

[00047] A tail 114, also part of the rack 112, extends proximally from the base 118 so as to extend out of the bar 82. The tail has features that facilitate the removable coupling of the tail to the reciprocating rod internal to the saw 30. In the described version of the invention, this means the tail is planar in shape and has a top to bottom height, less than the same dimension of the base. Further, in this version of the invention, the tail is formed so that two tabs 116 extend from the opposed top and bottom sides of the tail. Tabs 116 are diametrically opposed to each other relative to the proximal to distal longitudinal axis through the tail 114.

[00048] Rack 112 also has a head 124 that extends outwardly from the base 118. The head 124 extends outwardly from the side of the base opposite the side of the base in which openings 120 are formed. The rack 112 is formed so that when the cartridge 80 is assembled, head 124 is located outside of and immediately adjacent the bottom of the bar, the portion of the rack opposite the plate top faces 90. The head 124 is formed so as to have teeth 126. The teeth 126 extend linearly, proximally to distally, along the head. The head and, more particularly the teeth have a side-to-side width that is greater than the thickness between the opposed major faces of the base of the rack. More specifically, the teeth have a width such that the kerf cut by the teeth can accommodate cartridge bar 82. This means that the teeth have a side to side width that is at least 0.2 mm greater than the side to side thickness across bar 82.

[00049] This invention is prepared for use by coupling the cartridge 80 to the saw 30. An initial step of this process

is the coupling of the rack tail 114 to the reciprocating shaft internal to the saw 30. Tail 114 thus functions as the drive link that connects the reciprocating shaft of the saw 30 to the rest of the rack 112. The clamp assembly hands 64 are secured over the cartridge so that the ribs 72 integral with the arms seat in slots 92 formed in the cartridge bar 82. This completes the removable attachment of the cartridge 80 to the saw 30. The saw and cartridge are ready for use.

[00050] The saw 30 and cartridge 80 of this invention are used by positioning the cartridge teeth 126 adjacent the tissue, typically bone, in which the cut is to be formed. The trigger 48 is depressed. The control module, in response to the detecting that depression of the trigger 18, actuates the motor. The actuation of the motor results in the reciprocation of the reciprocating shaft internal to the saw 30. The movement of the shaft causes a like linear reciprocal movement of the rack 112. It should be appreciated that, as the rack reciprocates, feet 106 internal to the bar 82, hold the rack in the bar. The teeth 126 are pressed against the tissue to be cut. The reciprocation of the teeth when pressed against the tissue result in the teeth forming the desired cut in the tissue.

[00051] When the saw is used to cut tissue, debris formed in the cutting process enter the space between the bar plates 94. The movement of the rack forces the debris out of the bar through slots 94. This prevents the debris from clogging the inside of the bar to such an extent that the debris impede the reciprocation of the rack.

[00052] The cartridge of this invention is designed so that when actuated, the only exposed portion that moves is the rack head 124. The sides of bar 82 that are pressed against tissue do not reciprocate. Since the bar does not

reciprocate, the possibility that the tissue could be damages such motion is eliminated.

[00053] The fact that the cartridge bar 82 does not reciprocate also means that when the distal end of the cartridge 80 is pressed against tissue, this tissue is not exposed to back and forth motion as a result of the actuation of the cartridge. Since this tissue is not exposed to this motion, it is not subjected to the stress of this motion that can tear or otherwise damage the tissue.

[00054] Furthermore, when the cartridge 80 of this invention is inserted in the slot of resection guide and actuated the cartridge bar does not reciprocate. This eliminates the wear to that otherwise occurs as a result of the metal-against-metal reciprocal movement of the whole of the blade in the resection guide. The elimination of this wear results in a like elimination of the adverse effects of this wear.

[00055] A further feature of this invention is that webs 204 and feet 206 extend through the void space in the bar 82 between the opposed inner surfaces of plates 184. Webs 204 and 206 thus provide the bar with stiffness. The feet 206 are thus perform two functions, the feet retain the rack 112 in the bar 82 will also providing structural strength to the bar.

[00056] It should likewise be understood that a feature of this invention is that attachment 52 allows cartridge 80 to be used with a conventional saw 30. This means that a facility that wants to use cartridge 80 is not required to purchase a saw the only purpose of which is to be used with cartridge 80.

II. SECOND EMBODIMENT

[00057] Figures 7-9 illustrate the basic features of an alternative reciprocating saw 130 and cartridge 180 of this invention. Saw 130 has a tubular or pencil shaped body 132. A motor, represented by a dashed rectangle 134 is disposed in the body 132. A reciprocating shaft, represented by dashed rectangle 140 extends forward of the motor. A transmission, not depicted, is located between the motor 134 and reciprocating rod. The transmission converts the rotational movement of the motor rotor into motion that reciprocates the shaft back and forth. Not shown are the components that power the motor. If the motor is an electric motor, these components can include a control console or a battery that sources a drive current. If the motor is a pneumatic motor. The drive components are the source of pressurized gas and the line over which the gas is supplied to the saw 130. If the motor is a hydraulically driven motor, these components are the source of pressurized liquid and the line over which the liquid is supplied to the saw 130.

[00058] Saw 130, like saw 30 is designed to reciprocate a conventional reciprocal saw blade that preceded this invention.

[00059] A front end attachment 150 is removably attached to the distal end of the saw body 132. Front end attachment 150 has a base 152. Base 152 is the body of the attachment 150. Base 152 is dimensioned to seat over and be removably attached to the distal end of the saw body. The coupling means by which the base is removably attached to the saw body 132. One possible means is complementary threading on the saw 130 and on the attachment. An alternative coupling means is provide one of the saw 130 or the attachment 150 with a snap lock that engages the other of the attachment or the saw. Still another means of

removably holding attachment 150 static to the saw body is to provide one or more compressible members that that provide a friction hold or a snap fit of the attachment 150 to the saw 130.

[00060] Forward of the base 152, the front end attachment has a nose 154. The attachment is formed so that as the nose 154 extends distally from the base 152 the diameter of the nose decreases. The attachment 150 is generally hollow. Not identified are the proximal and distal openings into the nose 154. Attachment 150 is further formed so a slot 156 is formed in the nose. Slot 156 is elongated in shape and has a major axis that is parallel to the longitudinal axis through the attachment. The attachment is formed so that the distal end of the slot 156 is spaced proximally from the distal end of the nose 154. Forward of slot 156, the attachment is formed to have two diametrically opposed slots 158, one slot 158 identified. Slots 158 extend proximally from the distal end of the attachment nose 154. One slot 158 is aligned with slot 156.

[00061] Cartridge 180 of this version of the invention, as seen best in Figures 10 and 11 includes a static bar 182 in which a rack 212 is removably mounted. Bar 182 is formed from two plates 184. The plates 184 are generally rectangular in shape. More specifically, each plate 184 has a top face 190 the edge of one of which is identified in Figure 11. Forward of the top face each plate has a distally directed face 186 the edge of one of which is identified in Figure 11. Between the distally directed face 186 and the top face 190 there is a transition face 188, the edge of one of which is identified in Figure 11. A plate 184 is formed so that, as the transition face 186 extends proximally from the distally directed face 186 tapers upwardly to the top face 190. The plates 184 are further formed so a rib 191

protrudes upwardly from the top faces 190. Each rib 191 extends forward a short distance, less than 1 cm, from the proximal end of the plate 184 with which the rib is integral.

[00062] Each plate 184 is formed so as to have a slot 192 that is located entirely within the plate and that is located inward of the distally directed face 190 and a short distance above the bottom face 185. Each slot 192 has an elongated section that extends parallel to the distally directed face 186 and an elongated section that extend parallel to the transition face 188. Each plate 184 also has a slot 194 that extends distally forward from proximal end of the plate. The plates are formed so the distal end perimeters of slots 194 are semi-circular in shape.

[00063] A spacer 198 is disposed between the plates 184. Spacer 198 includes a beam 202 similar to the first described beam 102. Thus beam 202 has sections that are flush with the distally directed faces 186, the transition faces 188 and the top faces 190 of the plates 184. The portion of the beam 202 that extends flush with the plate top faces 190 does not extend to the proximal end of the top faces. Instead, spacer 198 is further formed to have leg 201 that extends proximally between the proximal portions of the plate top faces 190. Leg 201 while integral with beam 202 has a top to bottom height less than that of beam. The spacer 198 is formed so that leg 201 extends proximally rearward beyond the plates 184. A foot 203 projects laterally upwardly from the section of the leg 201 located proximal to the plates 184.

[00064] A single web 204 extends perpendicularly from the beam 202. A foot 206 is located at the end of web 204. Web 204 and foot 206 have the same relationship to each other and beam 202 as web 104 and feet 106 due to beam 102.

[00065] When cartridge 180 is assembled, beam 202, web 204 and foot 206 are held static between the plates 184. Leg 201 and foot 203 are able to flex up and down.

[00066] Rack 212 includes a base 218. Base 218 is analogues in shape and function to base 118 of cartridge 80. Thus base 218 has a single T-shaped opening 220 in which the cartridge web 204 and foot 206 seat. A leg 217, also part of the rack 212, extends proximally from the base 218. Leg 217 extends into the space between the slots 194 formed in the cartridge bar 182. Rack 212 is further formed to have a head 224 from which a set of linearly aligned teeth 126 extend. Head 224 extends outwardly from the section of the base 218 adjacent the bottom faces of the bar plates 184. Again it should be understood that the head 224 and teeth 126 have a thickness greater than that of the rack leg 217 and base 218 and at least as great as the side to side thickness of the cartridge bar 182. Thus, as in the other versions of this invention, the components of cartridge 180 are designed to that the kerf cut by the teeth is of sufficient width to accommodate the cartridge bar 182.

[00067] An arbor 228 extends proximally from the leg 217 of the rack 212. Arbor 228 is in the form of a solid cylindrical rod. Not identified is the slot that extends proximally from the distal end of the arbor. This slot which extends across the arbor 228, is dimensioned to receive leg 217 integral with rack 212. The arbor 228 is braised or welded over the leg 217. When cartridge 180 is assembled, the distal sections of the arbor that extend outwardly of the rack 212 seat in slots 194 formed in the blade bar. The components forming the cartridge 180 are dimensioned so that the arbor 228 can reciprocate in the bar slots 194.

[00068] The proximal end of the arbor 228 is formed with retention features. The retention features are dimensioned

to engage complementary retention features integral with the reciprocating shaft internal to the saw. These features when engaged, releasably hold the arbor 228 to the reciprocating shaft so the arbor reciprocates with the shaft. In the illustrated version of the invention these retention features are a set of notches 230 formed in the arbor.

[00069] Saw 130 and cartridge 180 of this version of the invention are readied for use by first fitting attachment 150 over the distal end of the saw body 132. Cartridge 180 is then fitted to the saw. As part of this process arbor 228 is coupled to the reciprocating shaft internal to the saw 130. The leg 201 integral with spacer 202 is inserted into the attachment 150 until the associated foot 203 snaps into slot 156 formed in the attachment. The seating of foot 203 in the attachment slot 156 releasably holds the cartridge bar 182 to attachment 150 and, by extension, the saw 130. As a result of the attachment of the cartridge 180 to the attachment, rib 191 and the portion of the spacer 202 sandwiched between the ribs seat in the slot 158 adjacent slot 156. The ends of plates 184 opposed to ribs 191 seat in the second slot.

[00070] The saw 130 with attached cartridge 180 is used in the same manner in which a conventional micro-style reciprocating saw is used. The actuation of the motor internal to the saw results in the back and forth movement of the reciprocating shaft. The reciprocation of the rod is, through the arbor 228 transferred to the rack 212 to cause the like movement of the rack. Owing to the dimensioning of the components, the seating of foot 206 in the rack opening 220 holds the rack for reciprocation in the cartridge bar 182. The movement of the teeth 126 saws the tissue against which the head 224 is applied.

[00071] During the cutting process, debris may enter the space between plates 184. The debris are discharged through slots 194

III. THIRD EMBODIMENT

[00072] Figures 12 and 13 depict a second alternative cartridge, cartridge 240 attached to the saw 130 and attachment 150. Cartridge 240, seen best in Figures 14 and 15, includes a blade bar 242. The blade bar 242 is formed from two plates 244, seen best in Figure 15. Plates 244 have a distal end that is generally in the shape of the distal end of plates 184 of cartridge 180. Plates 244 differ from plates 184 in that plates 244 have a top face 249 that extends proximally from the front face 248, initially curves upwardly and then tapers upwardly. The tapered section of top face 249 subtends a length between 30 and 70% of the overall length of the plate 244 with which the face is integral. Plates 244 include proximally located slots 245 similar in shape and function to previously described slots 194.

[00073] Windows 246 are formed in plates 244 so as to be below and parallel to the tapered sections of plate top faces 249

[00074] A spacer 250, also part of the blade bar 242, is located between the plates 244. Spacer 250 has a foot 252 and a leg 254 similar to the foot 203 and leg 201 of cartridge 180. A beam 256 extends distally from the leg 254. Beam 256 is shaped to be flush with the top faces of the plates 244 between which the beam is disposed. Thus, the proximal section of beam 256 extends along a line that is parallel to the longitudinal axis of the cartridge. A distal section 258 of the beam 256, extending distally from the proximal section, tapers downwardly. The distal end of beam 256 is formed to define a finger 260 that is angled

relative to the adjacent tapered distal section 258. Finger 260 is shaped to have an outer face, not identified, that is flush with the outer faces of the plate 244. The beam 256 is further formed to have a second finger, finger 262. Finger 262 projects proximally from the inner face of the beam section 258, the face of the beam section disposed within the plates 244. Finger 262 extends along a line that is parallel to or in registration with the longitudinal axis of the cartridge 180.

[00075] Also part of cartridge 240 is a rack 270. Rack 270 includes a base 274 dimensioned to seat in and reciprocate in the void space between the plates 244 that is proximal to spacer 250. The rack base 274 has a top edge, not identified that is tapered. The taper of the rack top edge corresponds to the taper of the beam distal section 258. Rack base 274 is formed to have an elongated slot 276. The slot 276 extends proximally from the tapered top edge of the rack base 274. The rack 270 is formed so that the slot 276 is positioned to and dimensioned to receive the finger 262 internal to the cartridge bar 242.

[00076] A head 280, also part of the rack 270, extends from the bottom of the rack base 274. Head 280 is the portion of the rack 270 that is located outwardly the bottom end of the blade bar 242. In the depicted version of the invention, a section of the head 280 is located forward of the distal end of the rack base 274. The head 280 is formed to have teeth 282. The teeth are shaped to cut the tissue against which the cartridge 230 is applied. As with the other versions of the invention, the thickness of at least the teeth is greater than the thickness across the rack base 274. More particularly, the teeth have a thickness so that the kerf cut by the teeth can accommodate the insertion of the cartridge bar into the kerf. At a minimum, the teeth 282, if not the whole of the head 280, has a thickness

at least equal to the side-to-side thickness between the outer faces of plates 244.

[00077] Cartridge 240 includes the previously described arbor. Arbor 228 is welded or otherwise secured to the proximal portion of the rack base 274.

[00078] Cartridge 240 is fitted to the saw 130 using the same technique employed to fit cartridge 180 to the saw. The seating of foot 252 in the slot 156 releasably holds the cartridge to the saw 130.

[00079] Cartridge 240 is used in the manner in which cartridge 130 is employed. The seating of finger 262 in rack slot 276 holds the rack to the bar 242. Cartridge 240 has a distal section with a relative short top to bottom height. In some versions of the invention, cartridge height, from the cutting edge of the teeth 282 to the top of the blade bar of the distalmost 1 cm portion of the cartridge is a maximum of 1.5 cm. This feature of this version of the invention facilitates the positioning of the cartridge in confined spaces such as during intra oral cutting of the mandible in orthognathic procedures or when cutting the maxilla adjacent the infraorbital nerve. Cartridge 240 of this invention is thus well suited to cut tissue in locations where it may be difficult to position a cartridge of larger bottom-to-top height.

[00080] During the cutting of tissue the debris generated by the cutting process that enter the space between the plates 240 are discharged from the bar through windows 246.

IV. ALTERNATIVE EMBODIMENTS

[00081] The above is directed to specific versions of the invention. Alternative versions of the invention may have features different from what has been described. For example, the features of the described versions of the invention may be combined as necessary.

[00082] Likewise, the structural features of the invention may be different from what has been described. Thus, there is no requirement that in all versions of the invention, the static component internal to the cartridge bar that holds the rack in the bar so the rack, while remaining in the bar, reciprocates, be an elongated foot or finger. It is within the scope of the invention that this component be a pin like structure. In these versions of the invention, this pin or set of pins may not be formed integrally with the component that functions as the spacer between the bar plates. In these versions of the invention the plural pins may seat in a single slot formed in the base of the rack. By extension, in these versions of the invention, the complementary void in the base of the rack in which this static component is disposed may not be open to the perimeter of the rack. This opening could be an elongated opening that is disposed entirely within the base of the rack.

[00083] In some versions of the invention, the component or components that hold the rack to the bar may be formed integrally with one or more of the plates that form the body of the bar. Thus, as a result of a stamping or machining process, one or more of the plates is formed with a raised member. This raised member is dimensioned to seat in the complementary elongated opening in the base of the rack. The static component may be formed by the selective molding or machining of the bar of the bar or rack with which the member is integral. It should likewise be appreciated that there is no requirement this static component have any curved surfaces. Thus this component can be rectangular or square in shape.

[00084] In versions of the invention wherein the slot that receives the static member is formed in the rack, this slot may not extend from an opening that extends inwardly from

the outer perimeter of the rack. In these versions of the invention the slot is a closed slot located completely in the rack.

[00085] Further in some versions of the invention, the complementary features of the bar and rack that hold the rack to the bar while allowing the rack to move linearly may be opposite what has been disclosed above. In these versions of the invention, one or more static members extend outwardly from one or both of the opposed sides of the base of the rack. The bar is formed with one or more elongated openings, slots, to receive the static members. Thus, when the cartridge is assembled, the rack is disposed between the plates of the bar and the static member or members integral with the rack base are disposed in the one or more slots formed in the bar. The static members and slots are formed so that the rack can move linearly in the bar. Since the static member or members are seated in the bar, the member or members hold the rack in the bar.

[00086] It should furthermore be understood that the static member, regardless of if this member is part of the bar or the rack, may be integrally formed with the component from which the member extends. Thus, in some versions of the invention, the static member may be formed punching out a section of bar or rack with which the member is integral.

[00087] In the described version of the invention, the rack base subtends a surface area that is more than 50% of the surface are of the bar in which the base is seated. There may be versions of this invention where the rack base subtends an area less than this percentage of the surface of the bar.

[00088] It may not be necessary to provide the bars of all versions of this invention with openings through which the debris generated in the cutting process can be discharged.

[00089] The features integral with the rack to releasably hold the rack to the reciprocating rod employed to reciprocate the rack may be different from what has been described. Likewise, the features integral with bar that facilitates holding the bar static to the associated attachment or saw to which the cartridge is coupled may vary from what has been described.

[00090] In one described version of the invention, the rack is formed so the teeth project distally beyond the rack base. In some versions of the invention, the rack may be formed so that head and teeth project beyond the distal proximal end of the bar.

[00091] Still another alternative cartridge 292 is now described with reference to Figures 16 and 17.
Cartridge 292 includes the previously described rack 212 and arbor 228. Rack 212 is enclosed in a blade bar 294. Blade bar 294 is formed to have two opposed plates 296.
Plates 296 are formed to have outer surfaces that, extending away from the side adjacent which the head 224 and teeth extend away from the bar, taper outwardly from the rack 212. Spacer 202 separates the plates 296 so as to define the void space internal to the bar 294 in which the base 218 of the rack 212 is seated. The blade bar 294 is further formed so at the distal end to have a head 298. Head 298 projects outwardly from the opposed outer surfaces of the plates 296. The blade bar 294 is further formed so that this head is located distal to the distalmost location along the bar 294 from which teeth 126 extend when rack 212 reciprocates back and forth. Cartridge 292 of this invention can be used to cut bone when it is desirable limit the depth to which the cartridge is inserted by pressing a stop against the underside of the bone being cut. One such procedure is a procedure in which it is desirable to cut across the sternum without cutting the tissue below the sternum. In this type

of procedure, the protruding head 298 of the cartridge bar performs the same function as the foot of a sternum guard.

[00092] A benefit of cartridge 292 of the invention, sometimes called a sternum cartridge, is that this cartridge can be fitted to a saw 30 or attachment of this invention to which a standard cartridge 80, 180 or 230 is attached. This means it is possible to use a cartridge of this invention to cut through the sternum without going to the expense of providing a saw especially designed to hold a sternum guard. The tapered surfaces of the bar 294 serve to spread the sternum after the teeth 126 form the initial cut.

[00093] Another procedure in which the above described cartridge is useful is when the cartridge is used to make a cut through the skull. In this type of procedure the stop integral with the cartridge bar is employed to ensure the cartridge is not inserted to a depth that will result in the unintended cutting of tissue below the skull.

[00094] From the above it should be understood that there is no requirement that in all versions of the invention, the bar be constructed so the opposed sides are planar and parallel.

[00095] It should be appreciated that when the bar has a tapered shape the head and teeth of the rack may not have a width thereacross equal to the maximum width of the bar. Instead, in these versions of the invention, the head and teeth are formed so that the kerf cut by the rack is at a minimum of sufficient depth to receive the adjacent section of the bar from which the rack head extends. Here the adjacent section of the bar is generally understood to be the first 3 to 10 mm portion of the bar that follows the head of the rack into the bone and, typically, no more than the first 8 mm portion of the bar that follows the head of rack into the bone. The wedge forming portion or portions of the bar that follow this bottom section are understood

to, after the bone is cut, further separate the cut sections of bone apart from each other.

[00096] It should further be understood that in alternative system of this invention, the saw may include features for both releasably holding the cartridge bar static to the body of the saw and releasably holding the rack to the reciprocating shaft. Thus the features of the attachments that hold the bar static to the attachment may simply be incorporated into the saw. This saw is of use if the facility determines it is in the interest of the facility to simply have a saw available that, without an attachment, can be used to actuate the blade cartridge 80 of this invention.

[00097] Accordingly, it is an object of the appended claims to cover all such variations and modifications that come within the true spirit and scope of this invention.

What is claimed is:

1. A blade cartridge (80, 180, 240, 292) for use with a surgical saw (30, 130), comprising:

bar (82, 182, 242, 294) formed with a feature (92, 203, 252) for removably holding the bar static to the saw (30, 130);

a rack (112, 212, 270), the rack having: a base (118, 218, 274) moveably disposed in the bar (82, 182, 242, 294); the rack having a head (124, 224, 280) that extends from the base and that is located outside a perimeter of the bar, the head having teeth (126) for cutting tissue against which the teeth are pressed, the teeth having a width such that a kerf cut by the teeth is of sufficient width to accommodate the perimeter of the bar adjacent the head; and

a drive link (114, 228) that extends from the base of the rack, the drive link being formed with features with features for releasably engaging a reciprocating drive (46, 140) integral with the saw (30, 130)

characterized in that:

one of the base (118, 218, 274) of the rack (112, 212, 270) or the bar (82, 182, 242, 294), is formed with at least one slot (120, 220, 276); and

the other of the bar (82, 182, 242, 294) or the base (118, 218, 276) of the rack (112, 212, 270) is formed with at least one static member (106, 206, 262) that extends into the at least one slot so as to retain the rack in the bar, and the at least one slot and the at least one static member are collectively shaped to allow the rack to engage in linear reciprocal movement in the bar.

2. The blade cartridge (80, 180, 240, 292) of Claim 1, wherein:

the base (118, 218, 274) of the rack (112, 212, 270), is formed with the at least one slot (120, 220, 276); and

the bar (82, 182, 242, 294) is formed with said at least one static member (106, 206, 262) that extends into the at least one slot of the rack so as to retain the rack in the bar, and the at least one slot and the at least one static member are collectively shaped to allow the rack to engage in linear reciprocal movement in the bar.

3. The blade cartridge (80, 180, 240, 292) of Claim 2, wherein the slot (120, 220, 276) in the base (118, 218, 274) of the rack (112, 212, 270) extends between opposed sides of the base.

4. The blade cartridge (80, 180, 240, 292) of any one of Claims 2 or 3, wherein:

the bar (82, 182, 242, 294) includes two plates (84, 184, 244) that are spaced apart from each other so as to form a void space and the base (118, 218, 274) of the rack (112, 212, 270) is disposed in the void space; and

said static member (106, 206, 262) of said bar extends between opposed inner surfaces of said plates (84, 184, 244).

5. The blade cartridge (80, 180, 240, 292) of any one of Claims 2 to 4, wherein the rack (112, 212, 270) is formed so that the at least one slot (120, 220, 276) formed in the rack is accessible through an opening in the outer perimeter of the rack.

6. The blade cartridge (80, 180, 240, 292) of any one of Claims 2 to 5, wherein the rack (112, 212, 270) is formed so that the at least one slot (120, 220, 276) formed in the rack is accessible through an opening in the outer perimeter of the rack.

7. The blade cartridge (80, 180, 240, 292) of any one of Claim 1 to 6, wherein the static member (106, 206, 262) of the bar or the base of said rack is an elongated member.

8. The blade cartridge (80, 180, 240, 292) of any one of Claims 1 to 7, wherein:

the bar (82, 182, 242, 294) includes two plates (84, 184, 244) and a spacer (98, 198, 250) located between said plates so as to space said plates apart from each other; and

the base (118, 218, 274) of the rack (112, 212, 270) is located between said plates.

9. The blade cartridge (80, 180, 240, 292) of Claim 8, wherein:

the base (118, 218, 274) of the rack (112, 212, 270), is formed with the at least one slot (120, 220, 276); and

said static member (106, 206, 262) (82, 182, 242, 294) extends from said spacer (98, 198, 250) so as to seat in the at least one slot.

10. The blade cartridge (80) of Claims 8 or 9, wherein the feature (92) for holding the bar to the saw is formed in at least one of the static plates.

11. The blade cartridge (180, 240, 292) of Claims 8 or 9, wherein the feature (9203, 252) for holding the bar to the saw extends from the spacer.

12. The blade cartridge (80) of any one of Claims 1 to 11, wherein one of said bar or the base of said rack is formed with plural said static members (106) that extend into the at least one slot (120) in the other of said base of said rack or said bar.

13. The blade cartridge (80) of Claim 12, wherein:

the one of said base (118) of said rack (112) or said bar formed with the at least one slot (120) is formed with plural slots; and

the one of said bar or the base of rack is configured so that the plural static members (106) are arranged so that at least two of the static members extend into separate slots.

14. The blade cartridge (80, 180, 240) of any one of Claims 1 to 14, wherein the bar (82, 182, 242) is formed so that the bar has opposed outer surfaces that are planar and parallel.

15. The blade cartridge (292) of any one of Claims 1 to 14, wherein a head (298) extends outwardly from an outer surface of the bar (294) adjacent a distal end of the bar.

16. An attachment (52, 150) for attaching the blade cartridge (80, 180, 240, 292) of any one of Claims 1 to 14 to a surgical saw (30 ,130) said attachment including:

a body (56, 150), the body having a first coupling feature (56, 58) that engage the saw (30, 130) to releasably hold said body to the saw; and

a second coupling feature (68, 156) integral with said body that engages a complementary coupling feature (68, 203) integral with the bar of the cartridge so as to releasable hold the bar to said body.

17. The attachment (150) of Claim 16, wherein said second coupling feature of said body is an opening (156) formed in the body that is dimensioned to receive the coupling feature integral with the bar of the cartridge.

18. The attachment (52) of Claim 16, wherein said second coupling feature of said body is at least one finger (68) that is dimensioned to seat in an opening in the bar of the cartridge, the opening being the coupling feature of the cartridge.

19. The attachment (52) of any one of Claims 16 to 18, wherein said first coupling feature are components (56, 58) attached to said body (56) to clamp said body to the surgical saw (30).

20. A saw (30, 130) for use with the blade cartridge (80, 180, 240, 292) of any one of Claims 1 to 14, said saw including:

a housing (32, 132);

a coupling feature (68 156) attached to the housing (32, 132) for releasably hold the blade cartridge bar (82, 182, 242, 294) to the housing

a motor (40, 134) disposed in the housing (32, 132); and

a reciprocating shaft that is connected to the motor for reciprocation by the motor (40, 134) and that includes a feature (47) for releasing holding the blade cartridge drive link to the shaft.

21. The saw of Claim 20, wherein in the motor (40) is one from the group consisting of: an electrical motor; a pneumatic motor; and a hydraulically driven motor.

22. The saw (30) of Claims 20 or 21, wherein said housing (32) is pistol shaped.

23. The saw (130) of Claims 20 or 21, wherein said housing (132) is pencil shaped.

24. The saw (130) of any one of Claims 20 to 23, wherein said coupling feature is an opening (156) that is dimensioned to receive the coupling feature integral with the bar of the cartridge.

25. The saw (52) of any one of Claims 20 to 23, wherein said coupling is at least one finger (68) that is dimensioned to seat in an opening in the bar of the cartridge, the opening being the coupling feature of the cartridge.

26. The saw (30, 130) of any one of Claims 20 to 25, wherein said coupling feature (68, 130) is part of an attachment (52, 150) that is removably attached to the saw (30, 130).

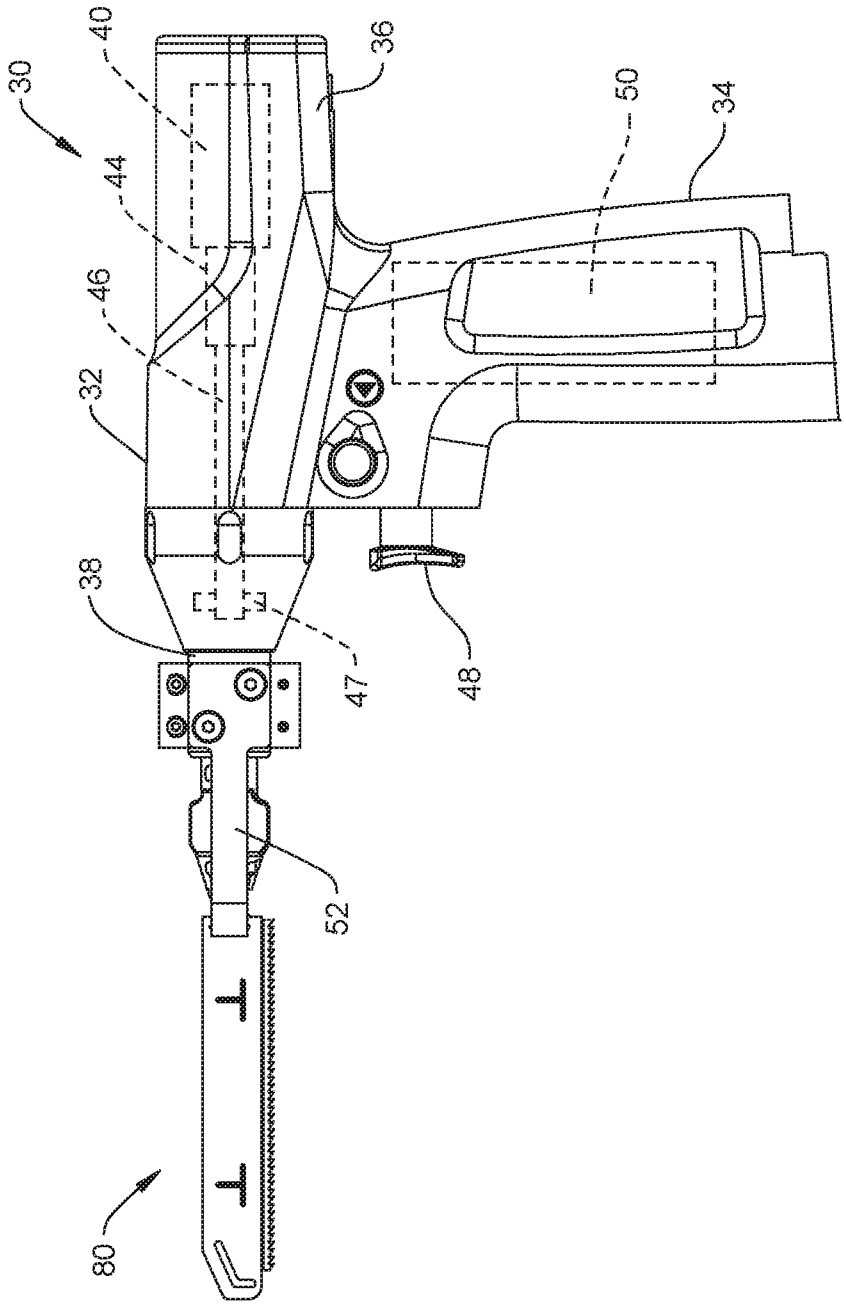


FIG. 1

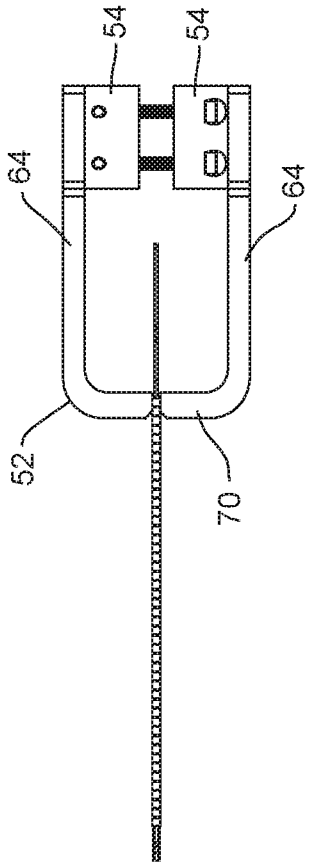


FIG. 2

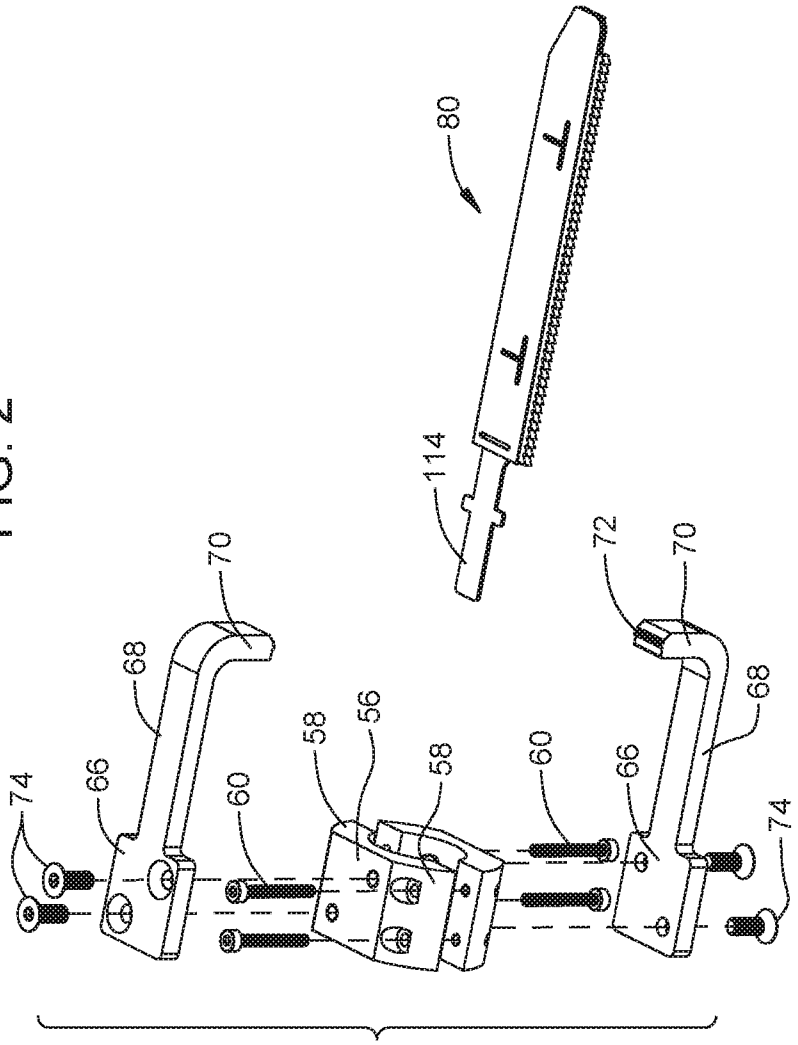
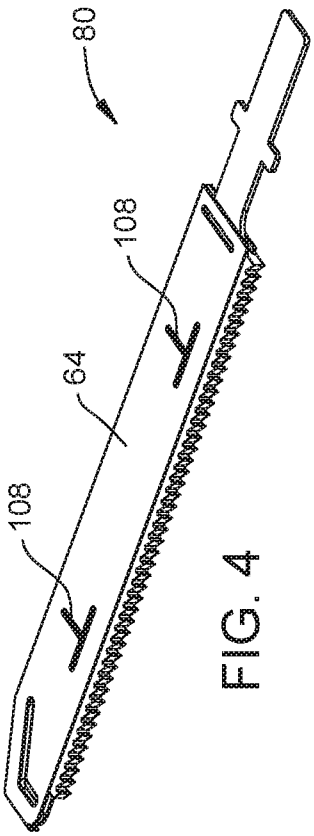


FIG. 3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108

FIG. 4

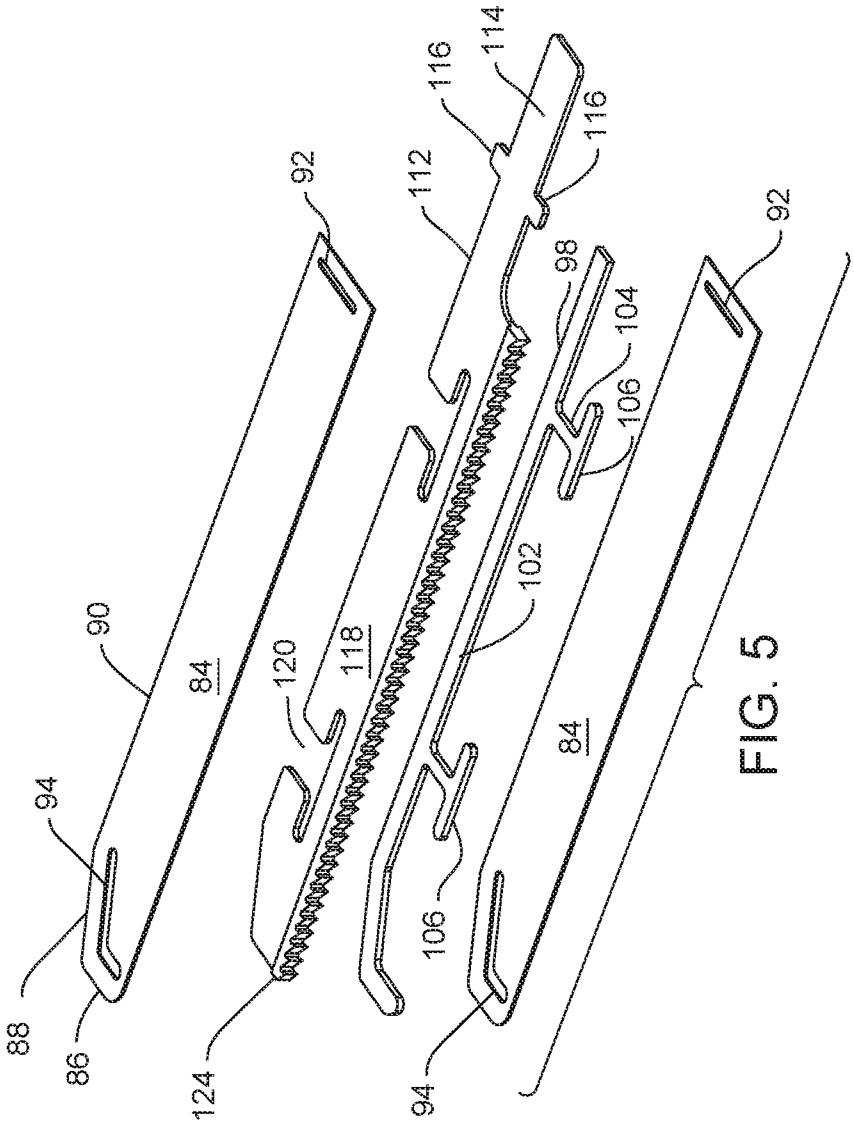
92
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FIG. 5

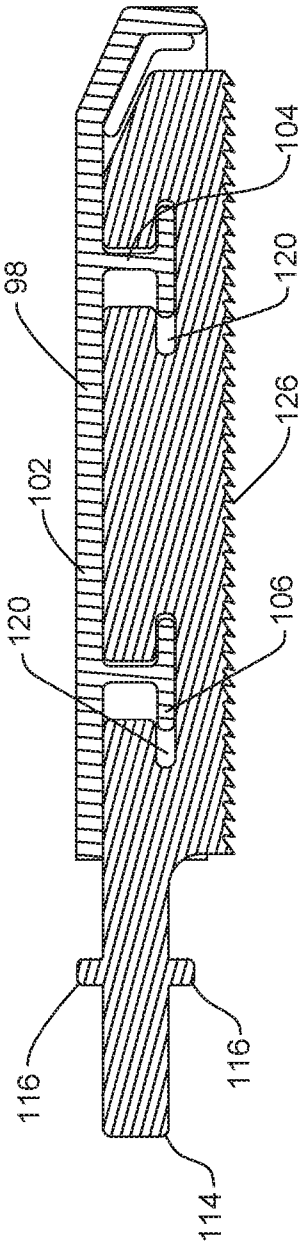

FIG. 6

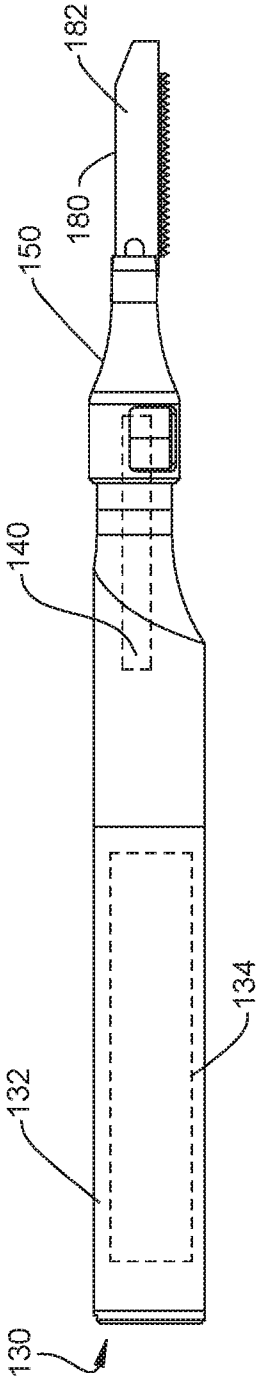

FIG. 7

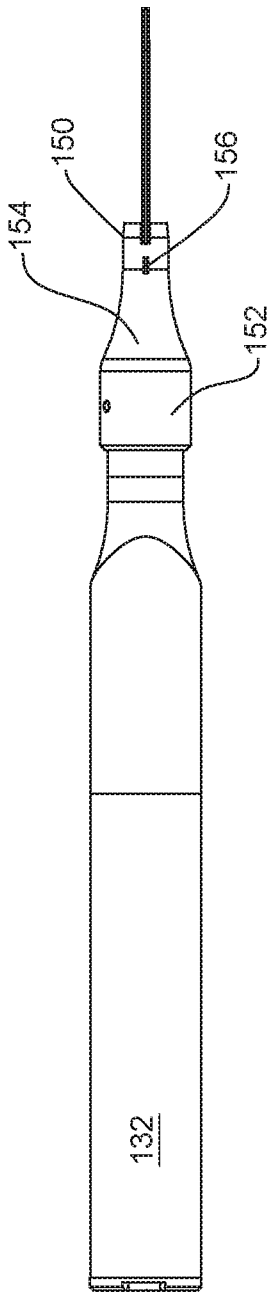

FIG. 8

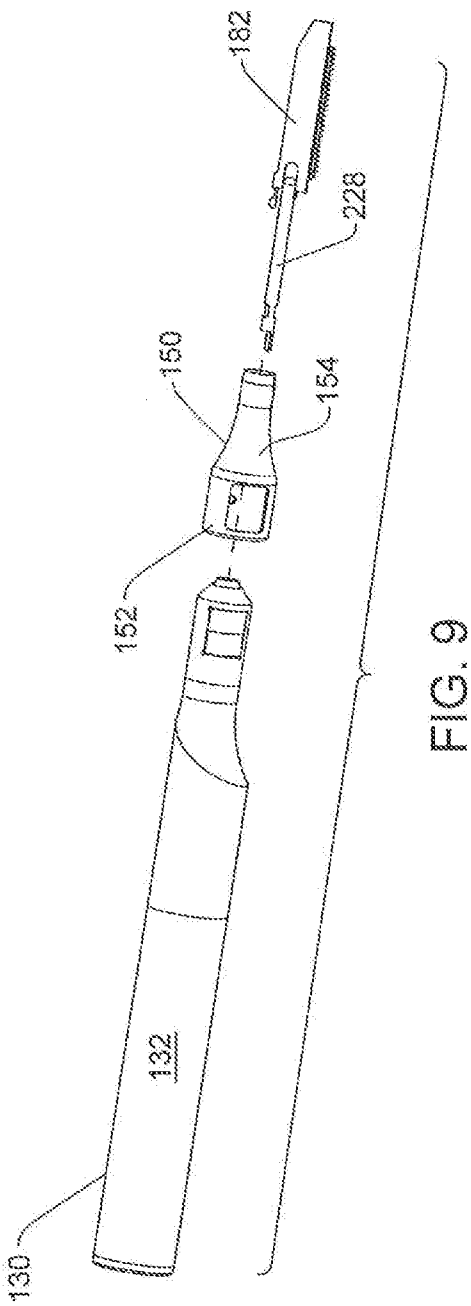

FIG. 9

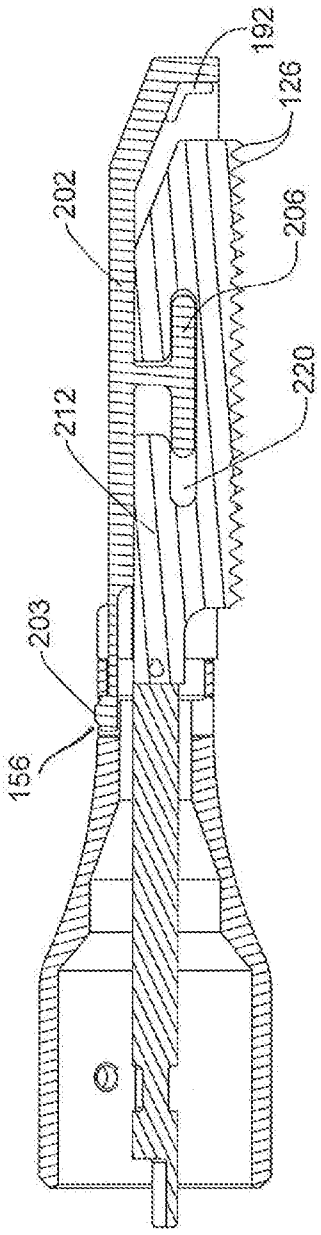

FIG. 10

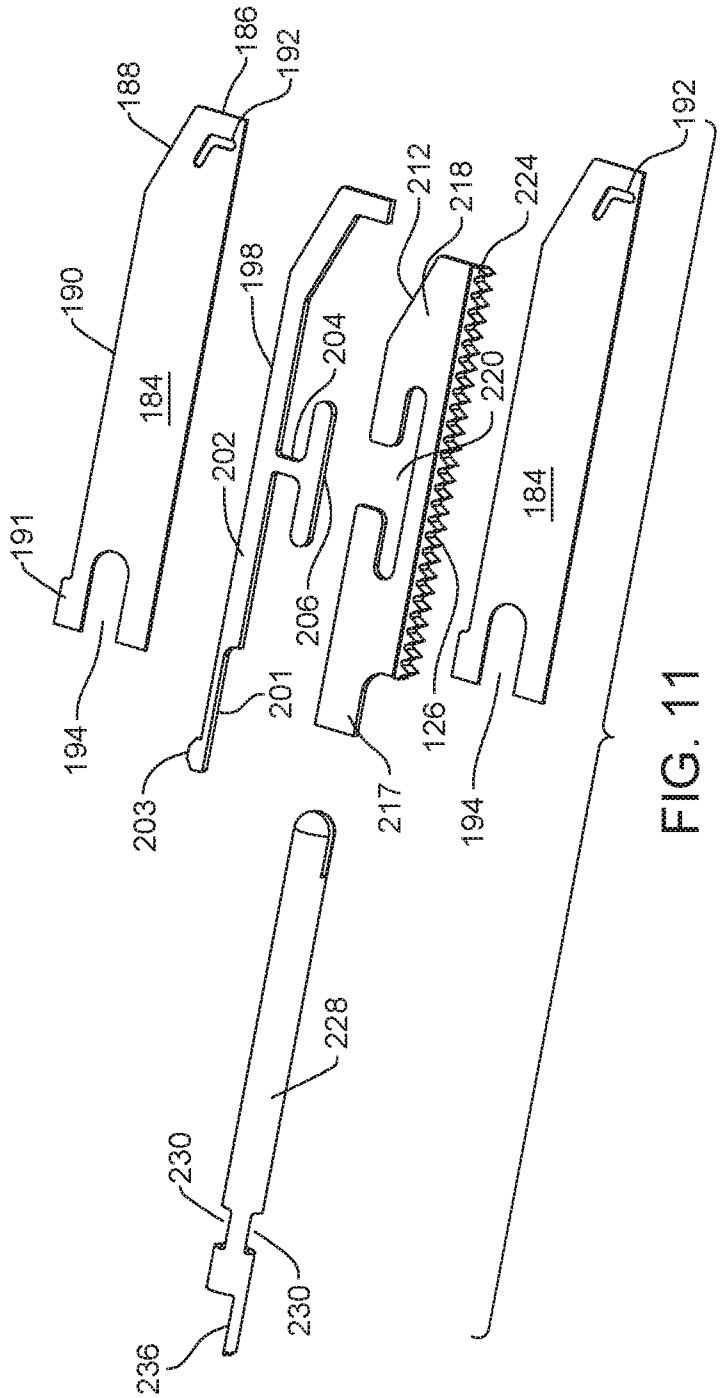
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FIG. 11

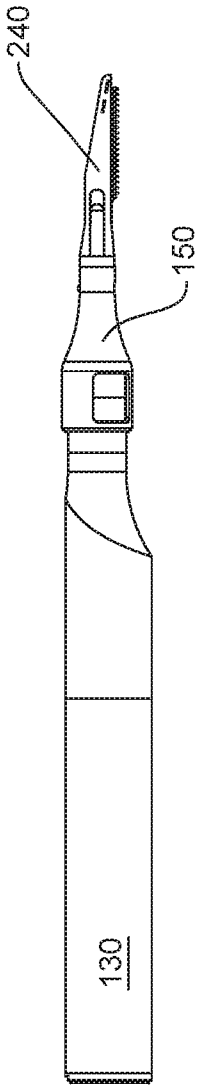


FIG. 12

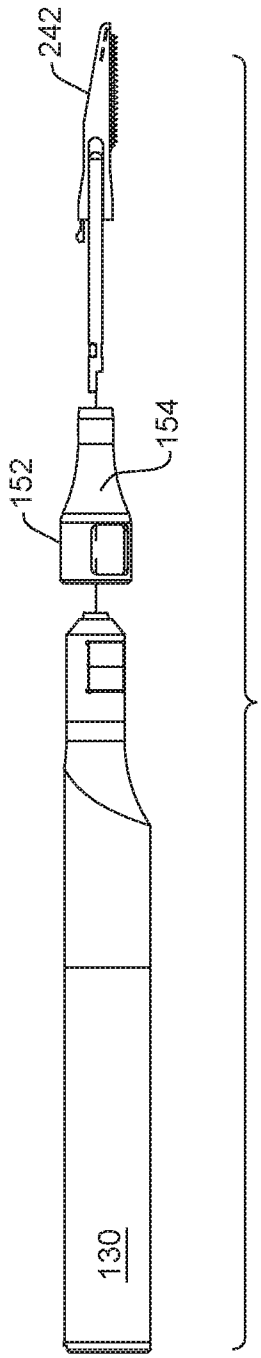


FIG. 13

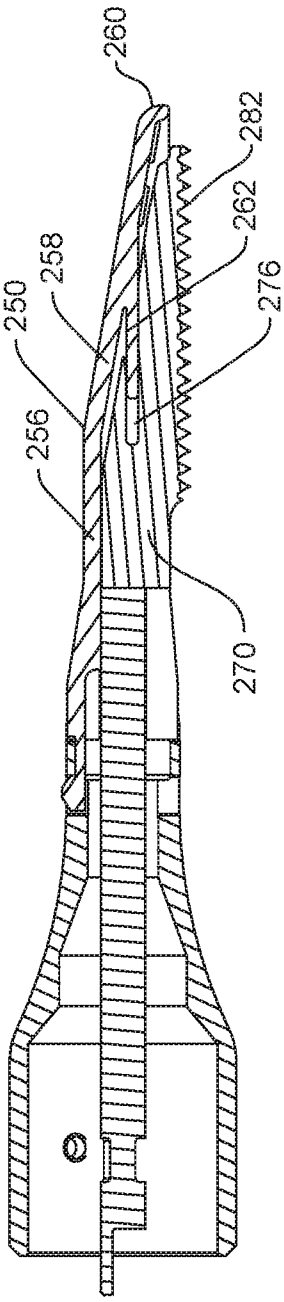
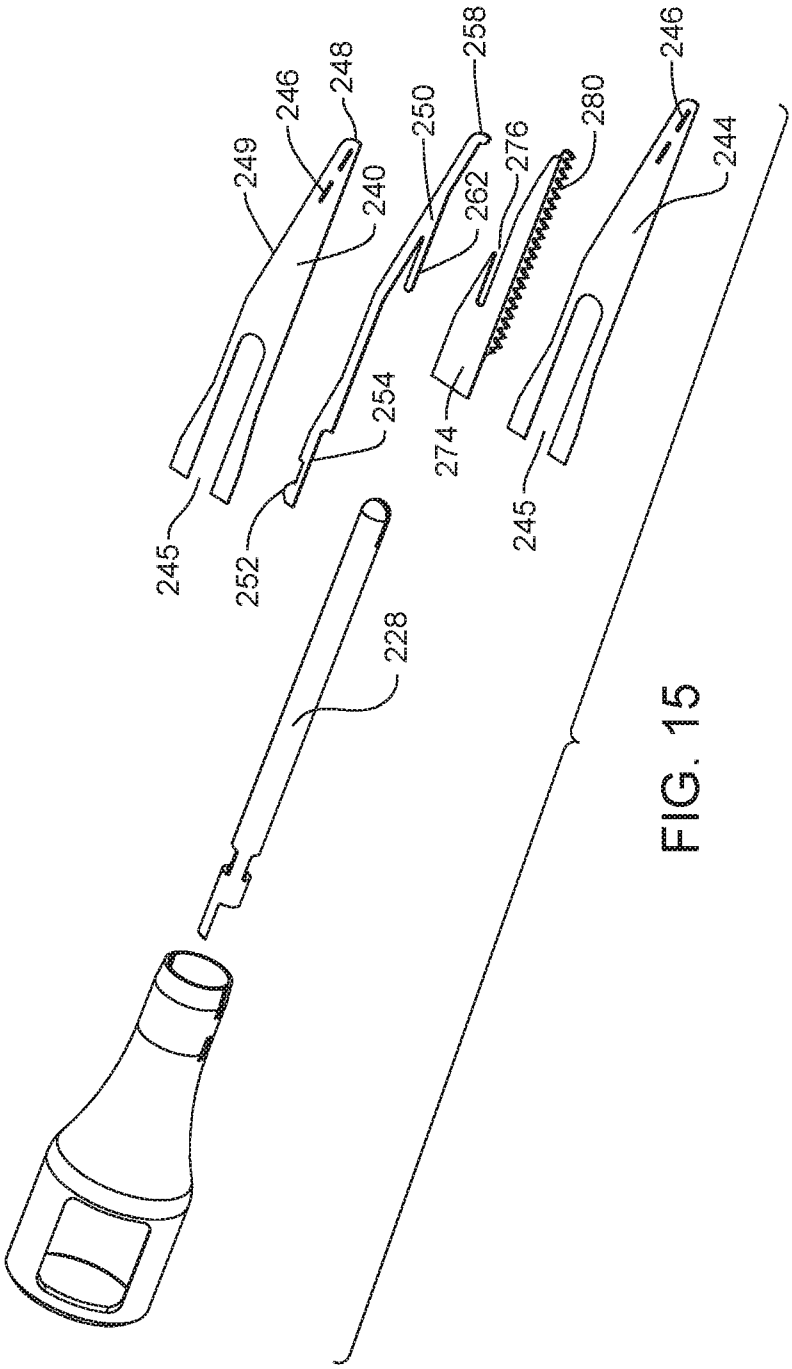


FIG. 14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244
245

FIG. 15

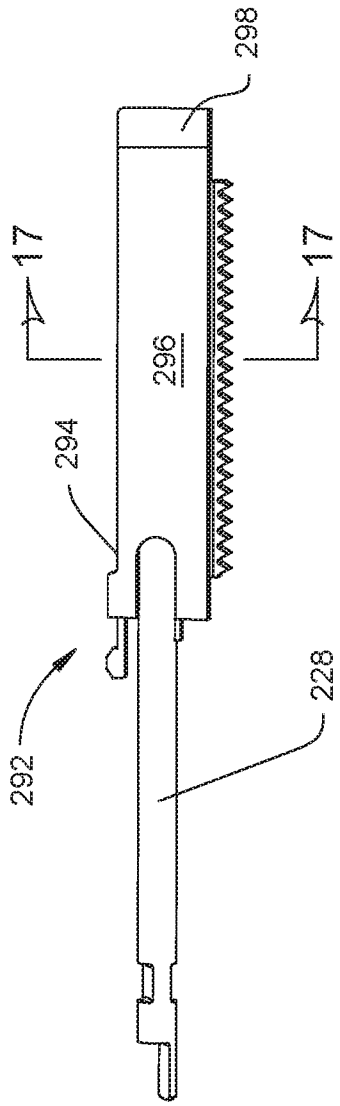

FIG. 16

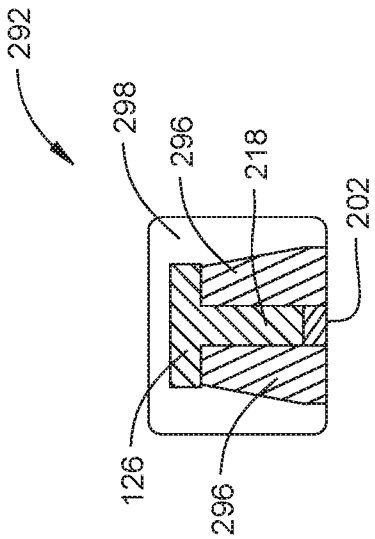

FIG. 17