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(54) **PRECISION SKIVER**

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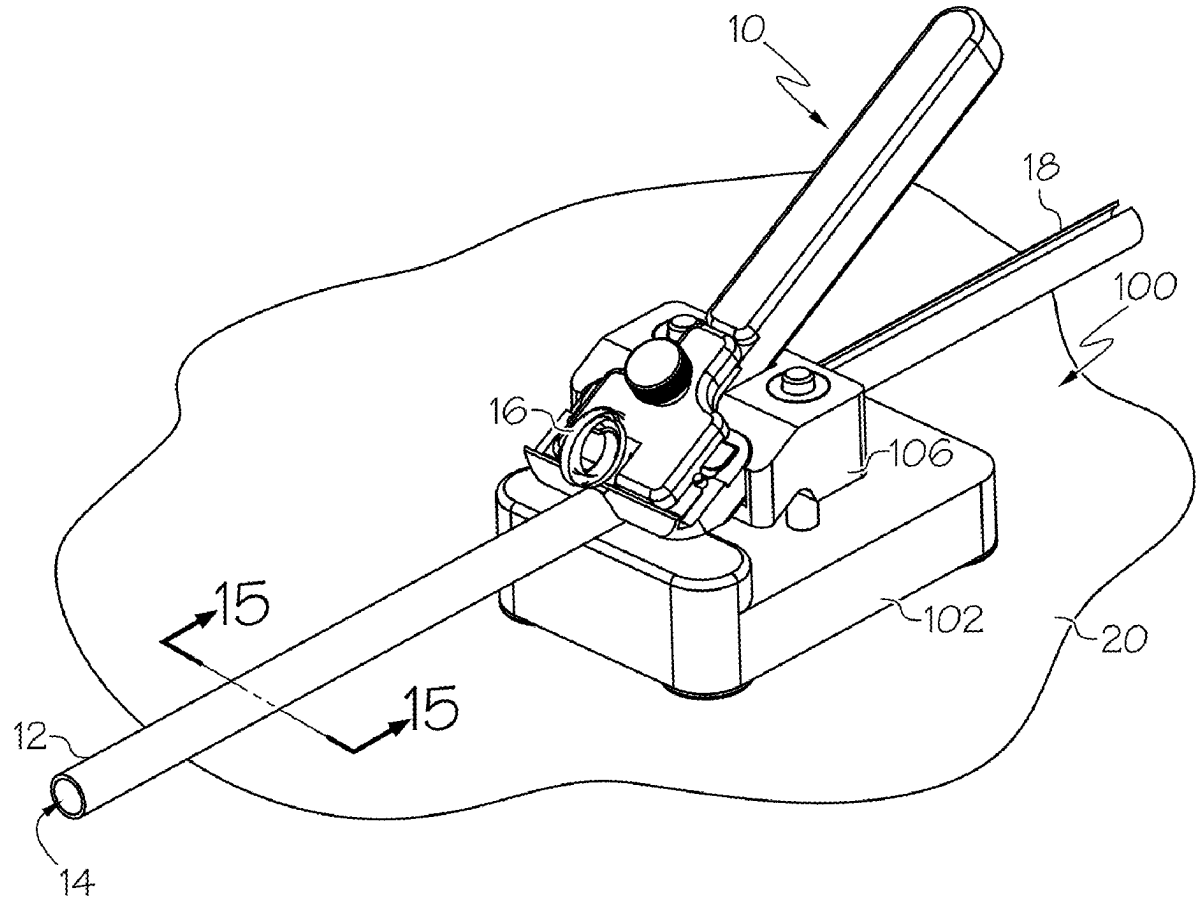
(52) **U.S. Cl.**

CPC ***B26D 3/001*** (2013.01); ***B26D 1/585*** (2013.01); *B26D 2001/004* (2013.01)

(57) **ABSTRACT**

A skiver for precise removal of outside material from an elongated device, such as a medical catheter or the like, includes a longitudinal recess in a surface and a transverse replaceable blade therein. A removable cover holds the blade in place. In some embodiments, the skiver has a handle extending from the skiver. In other embodiments, an automated mechanism is used to move the elongated device through the skiver.



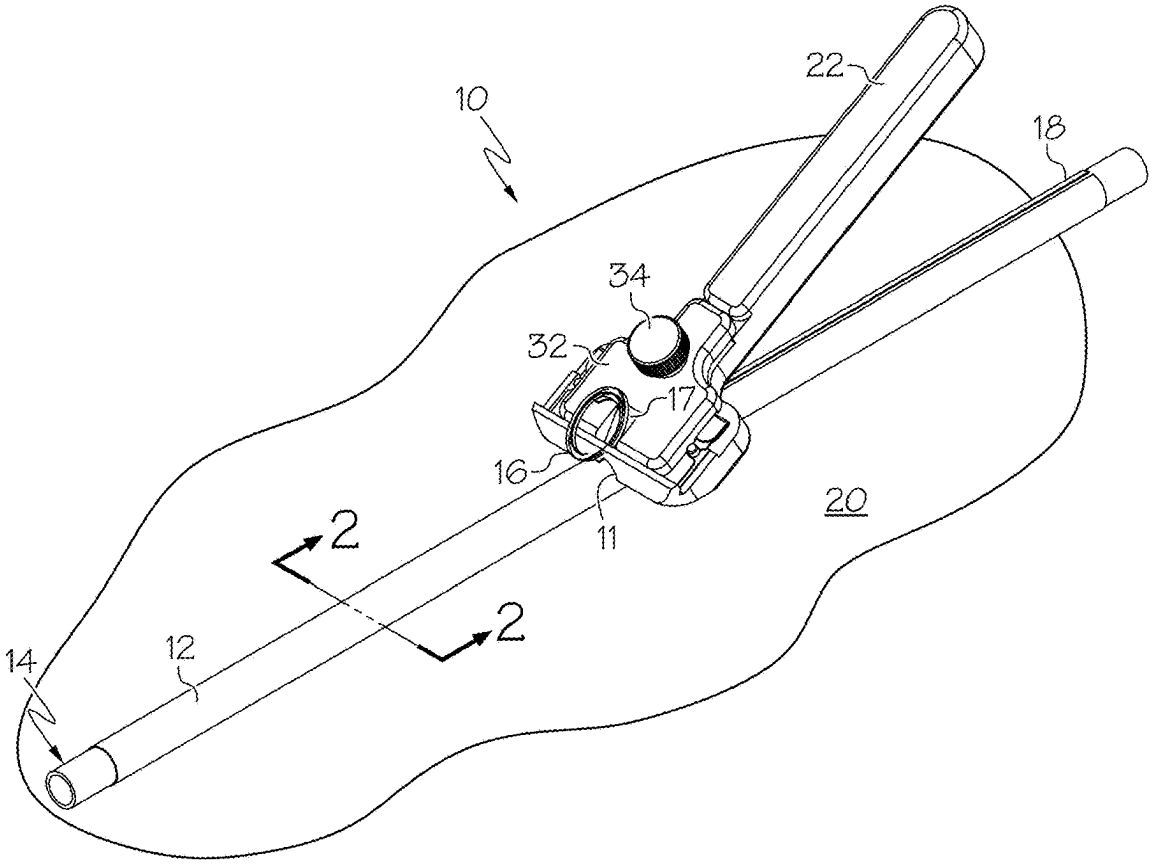

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FIG. 1

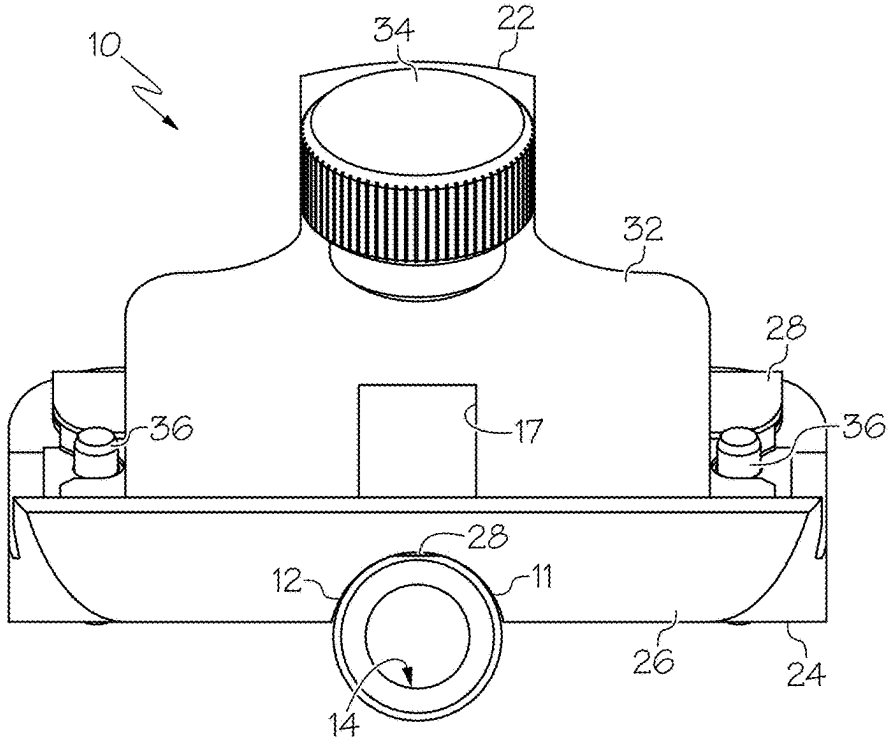
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FIG. 2

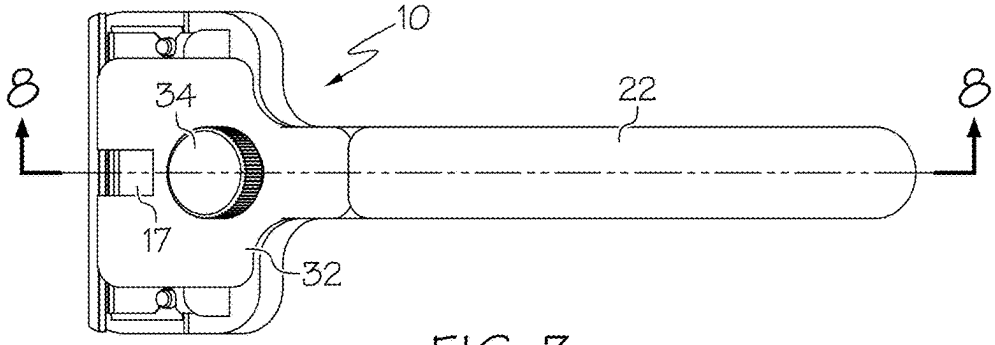


FIG. 3

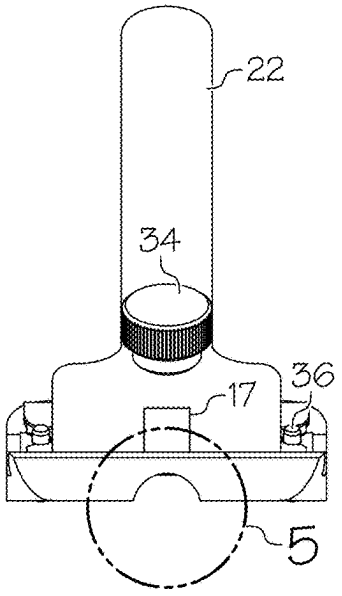


FIG. 4

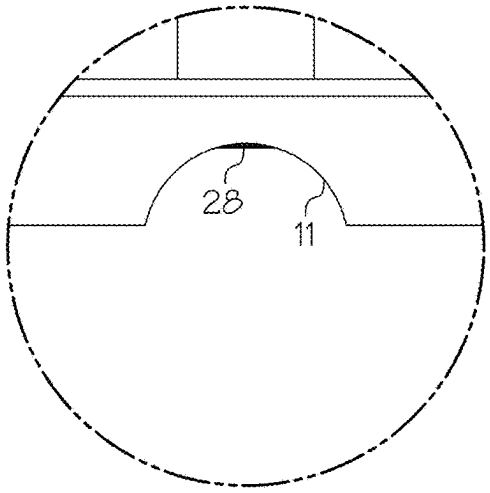


FIG. 5

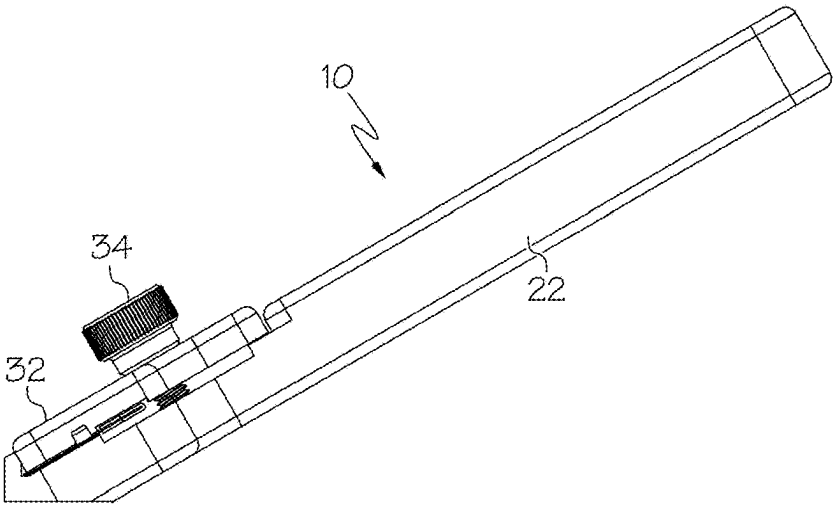
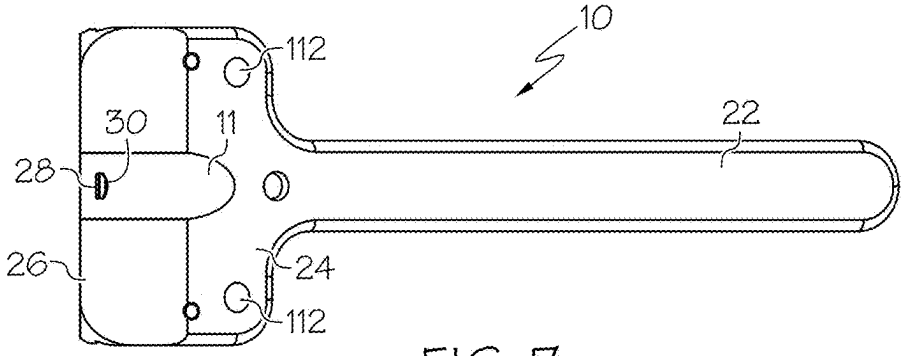


FIG. 6



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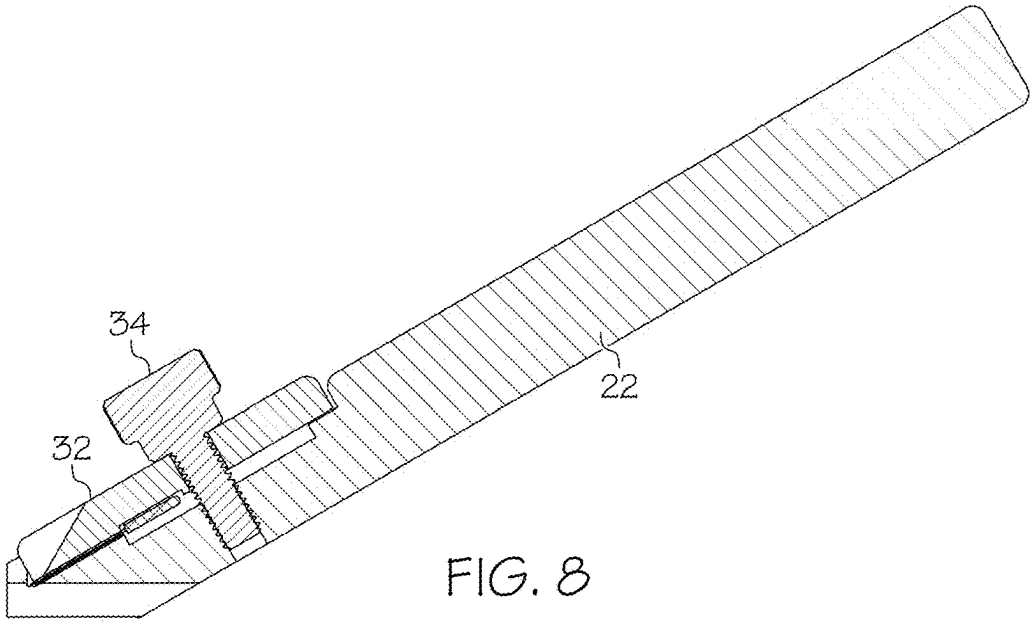

FIG. 8

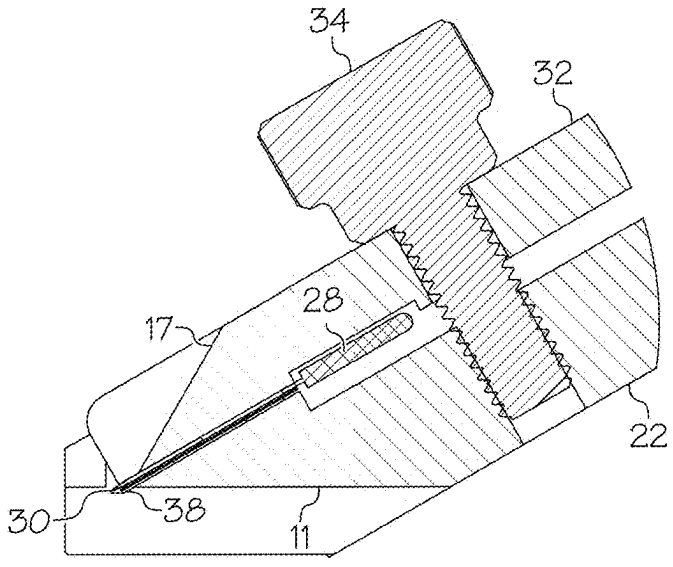

FIG. 9

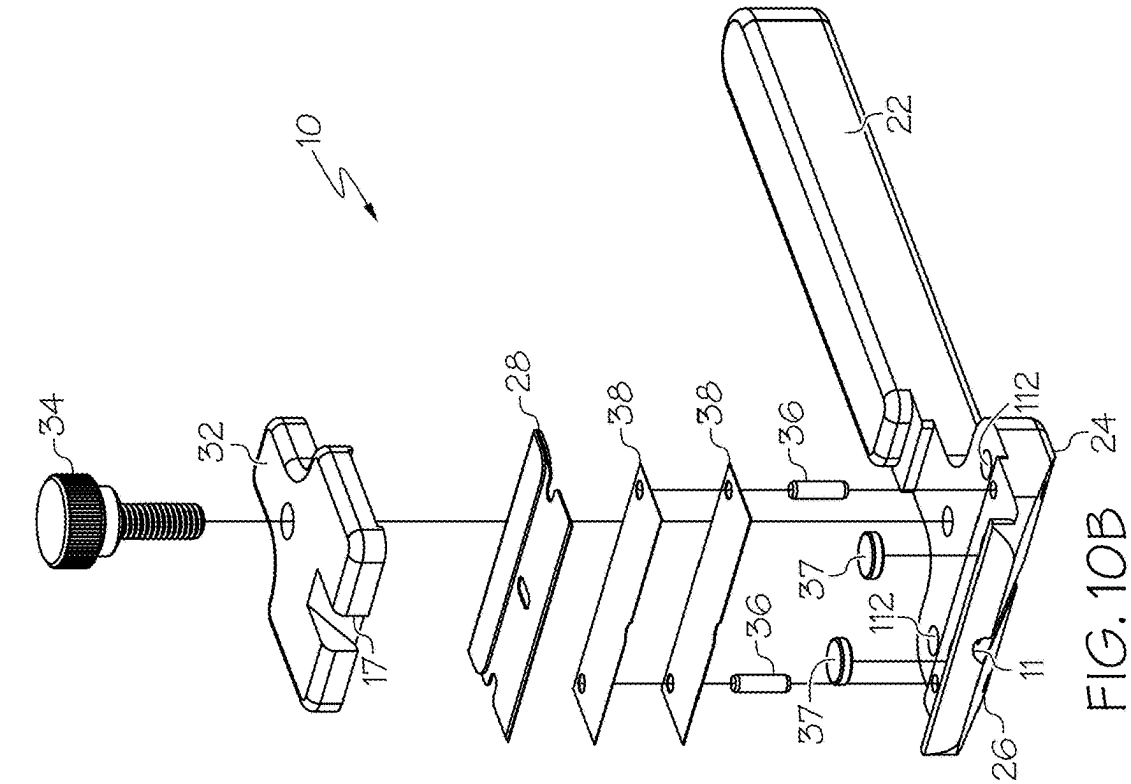

FIG. 10B

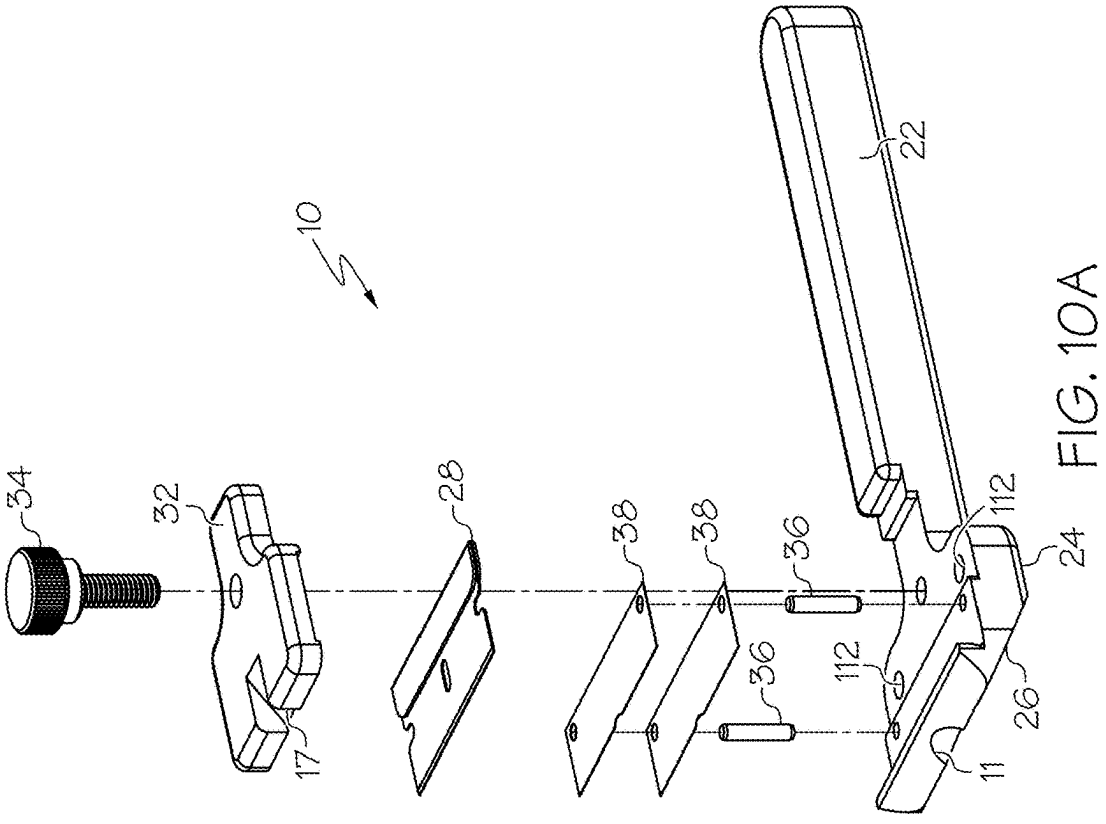

FIG. 10A

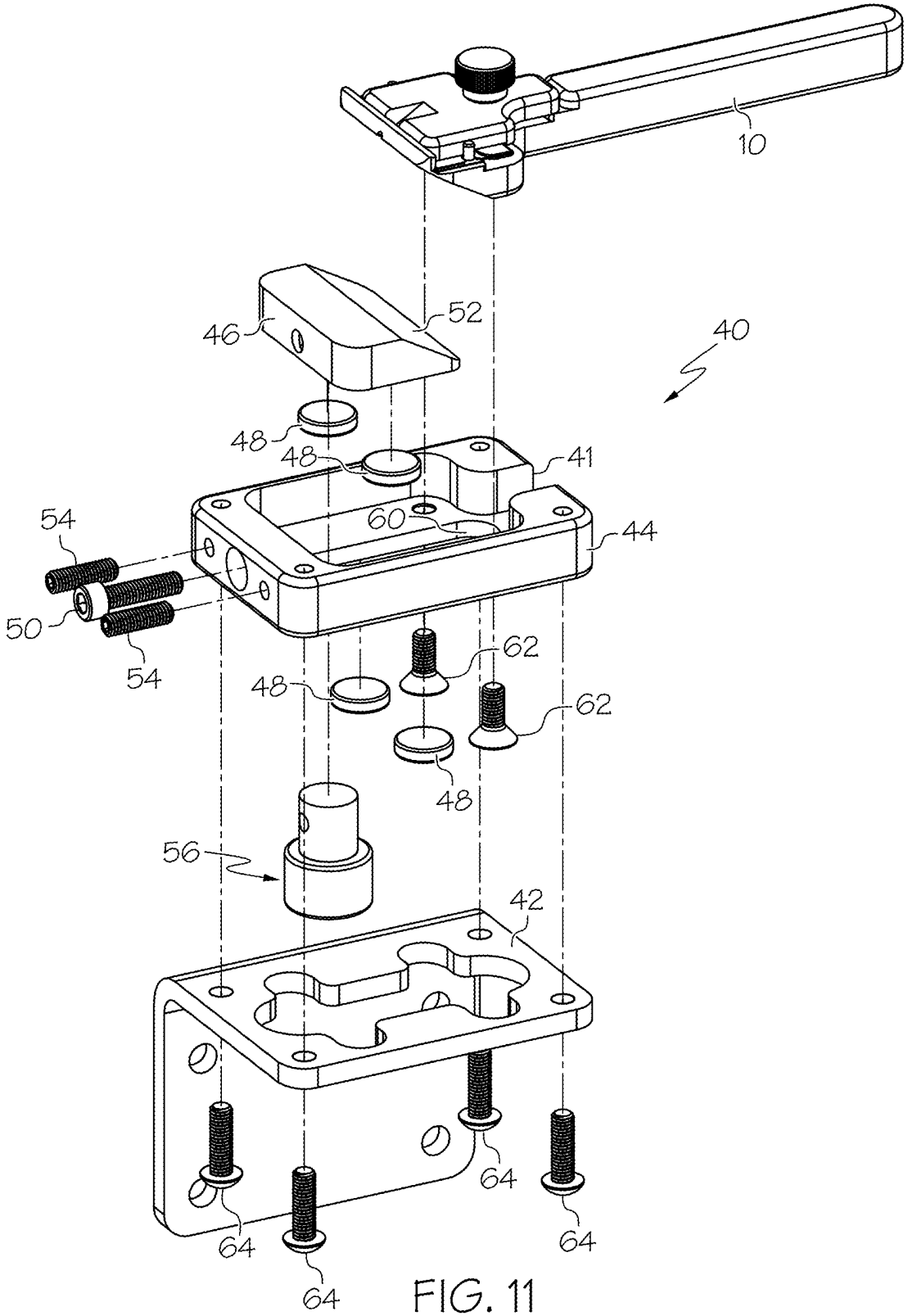

FIG. 11

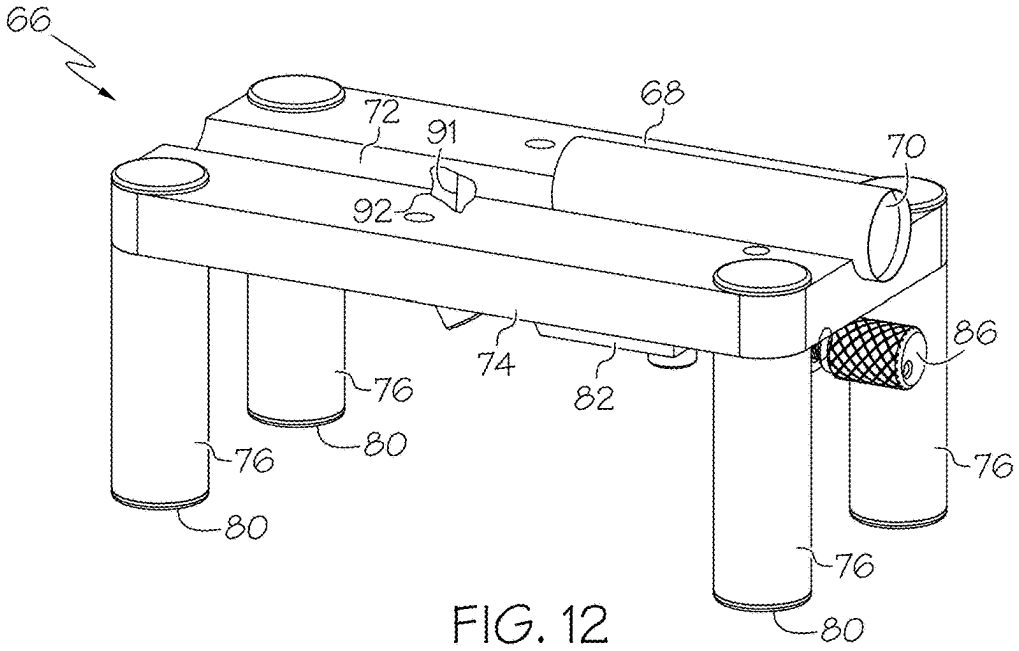
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FIG. 12

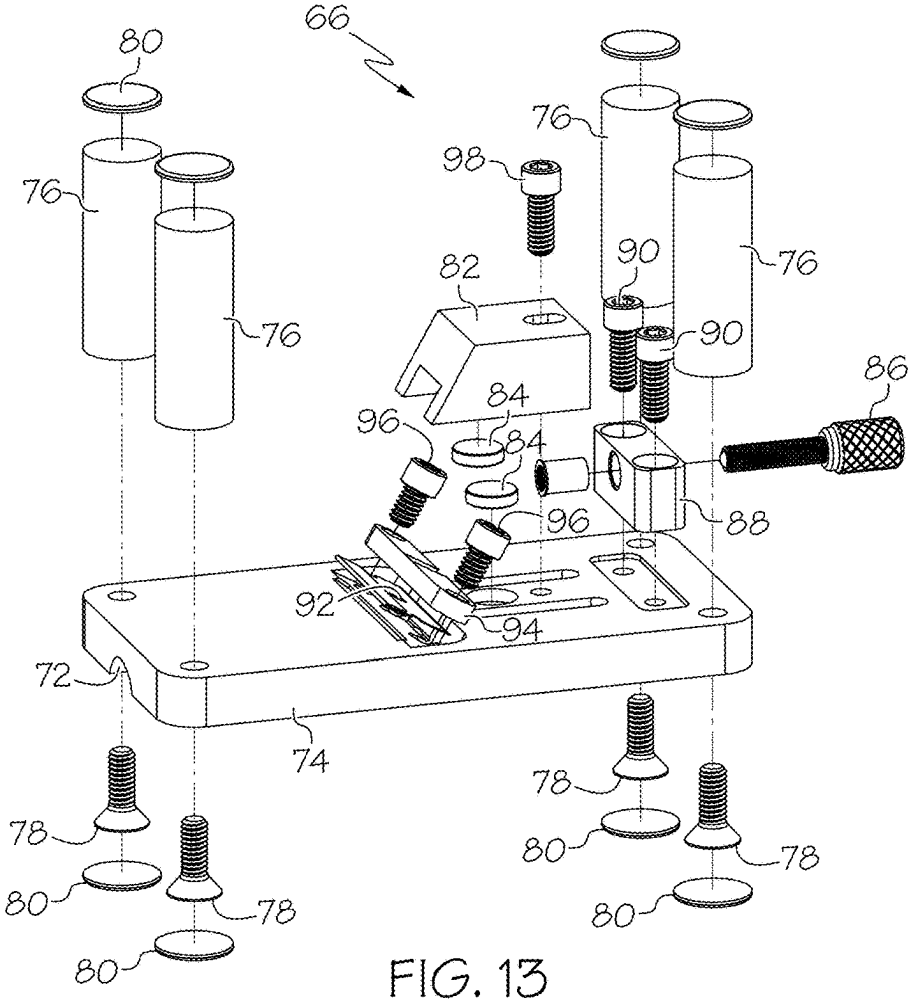
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FIG. 13

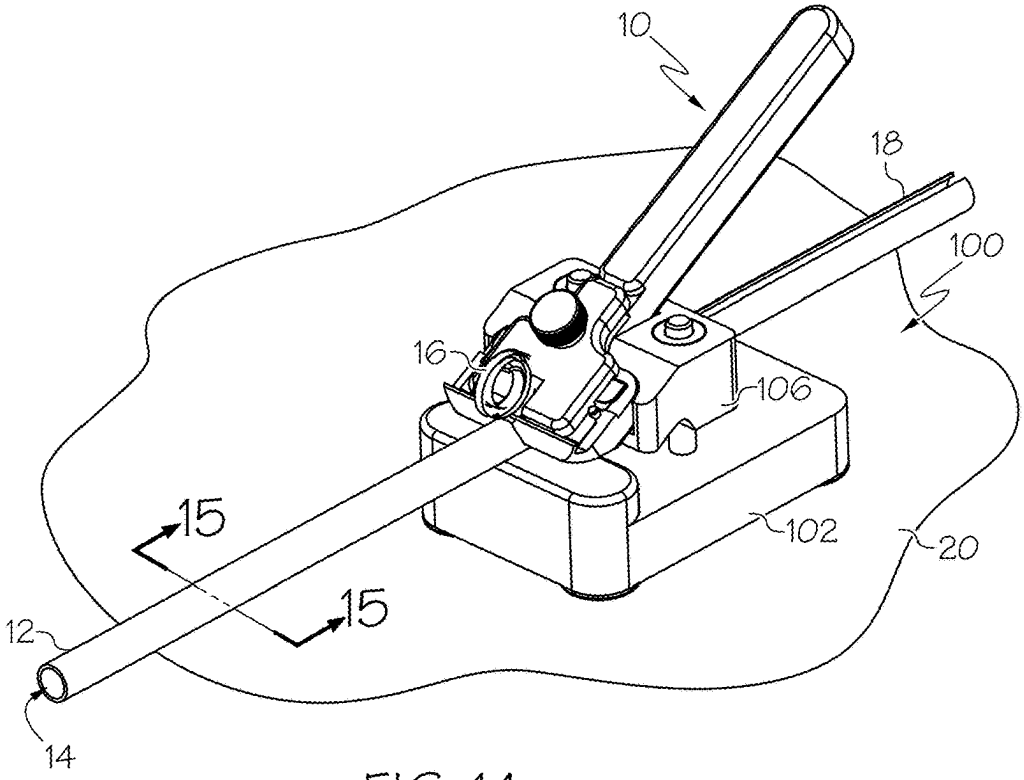
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FIG. 14

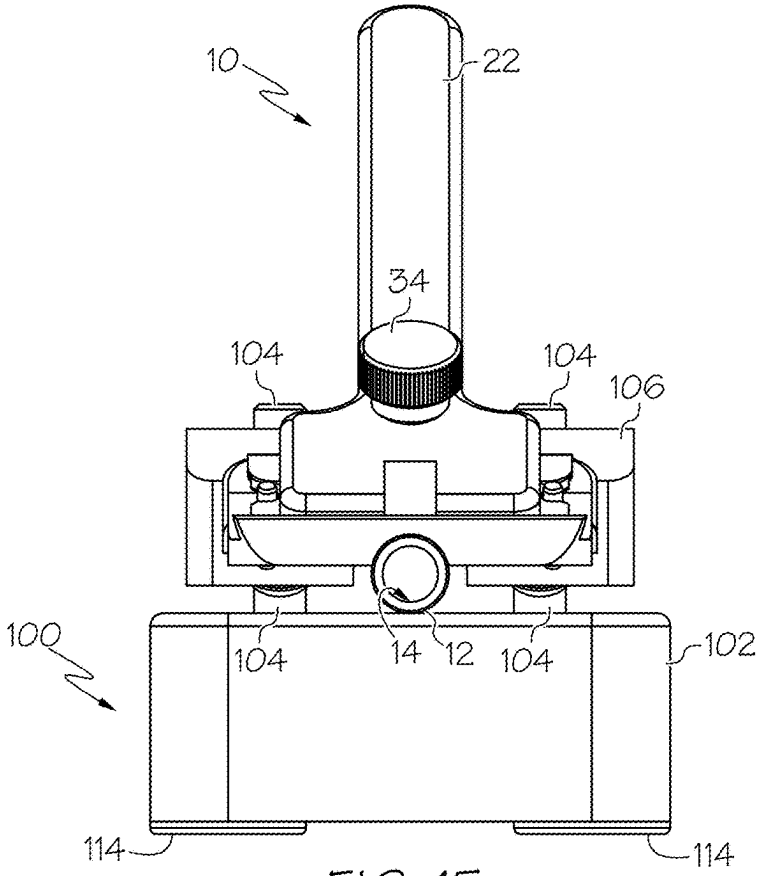
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FIG. 15

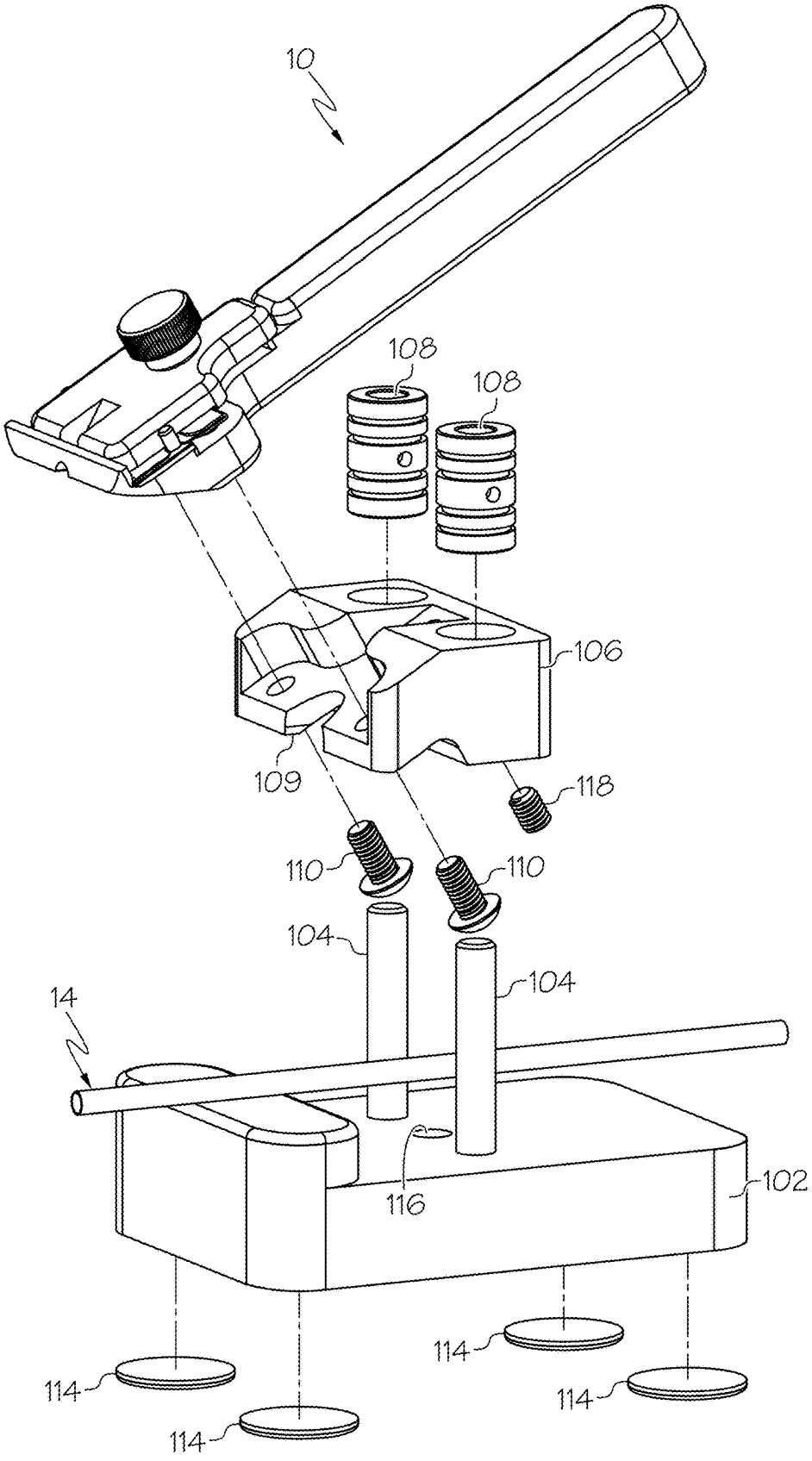
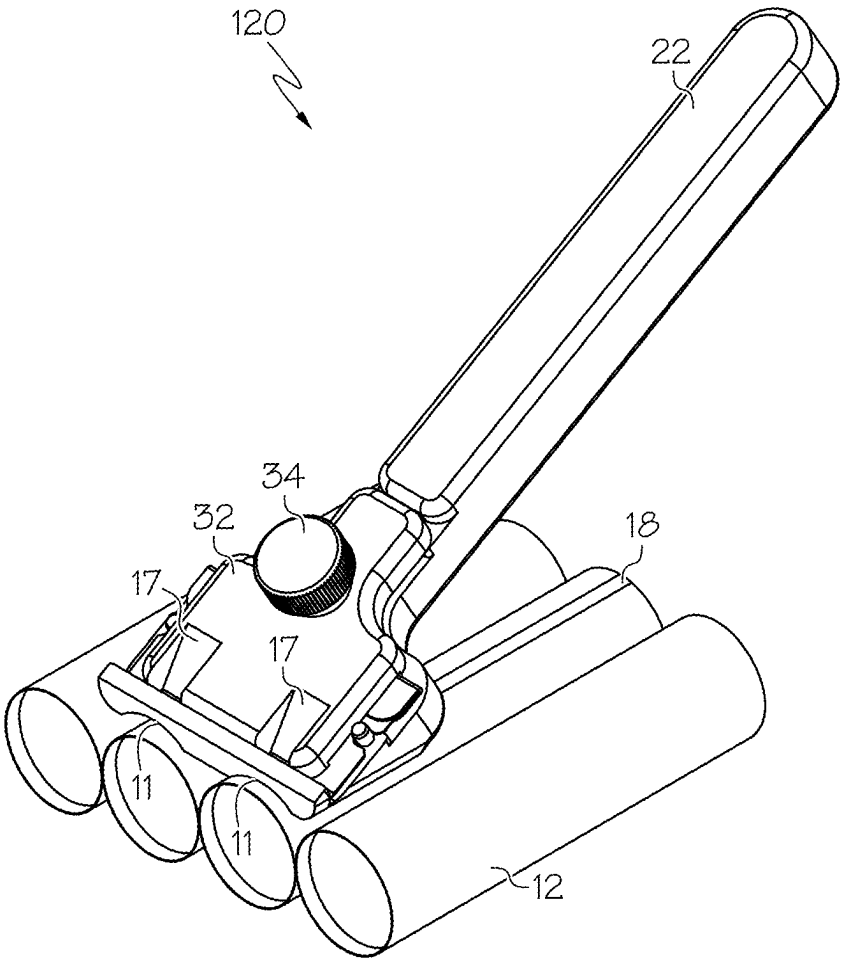


FIG. 16



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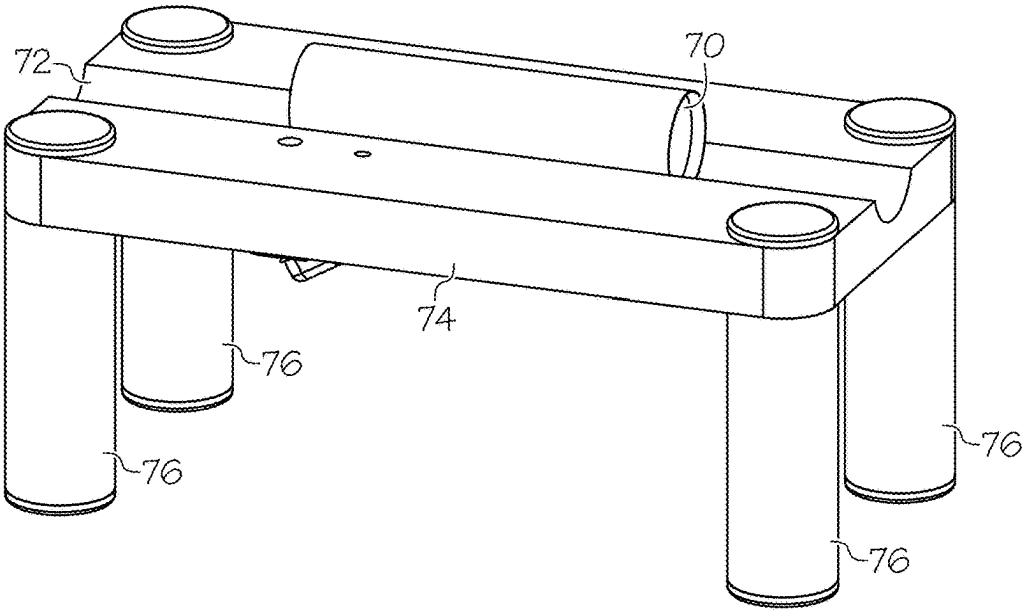

FIG. 18A

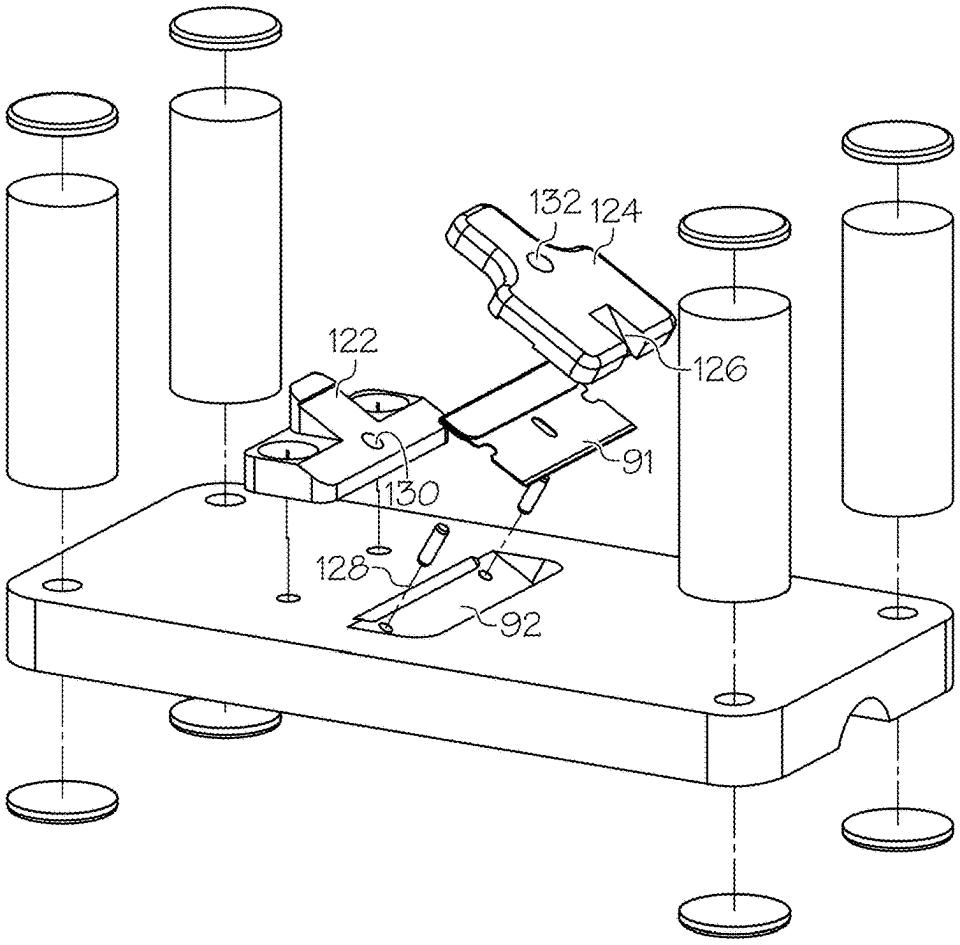

FIG. 18B

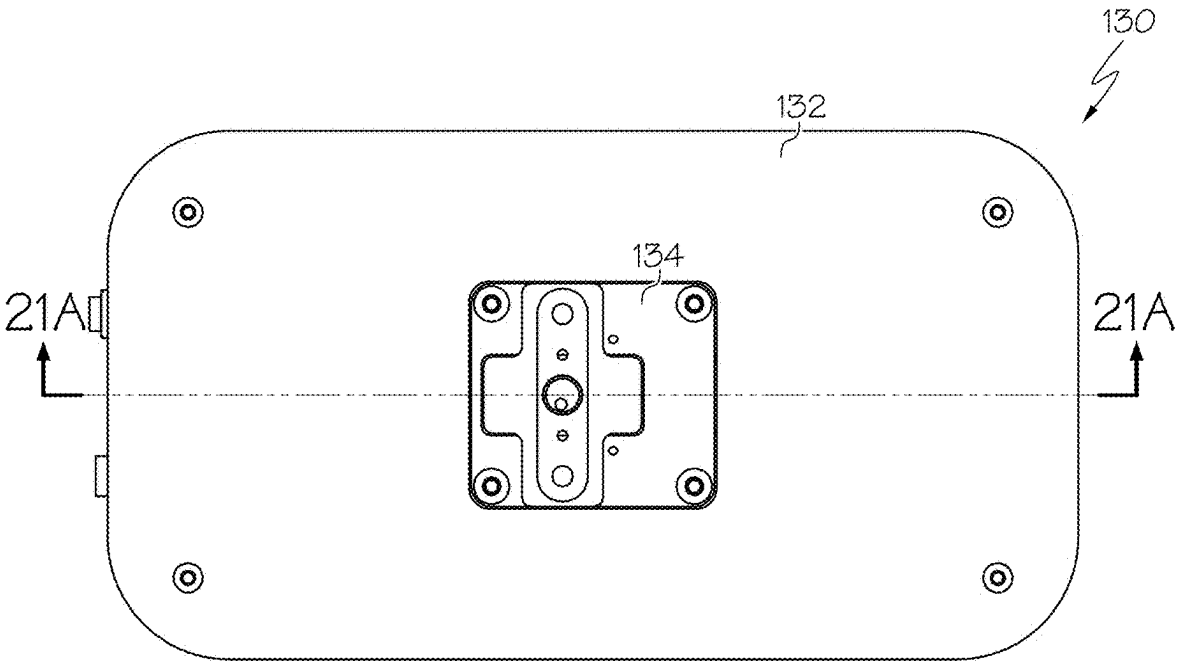

FIG. 19

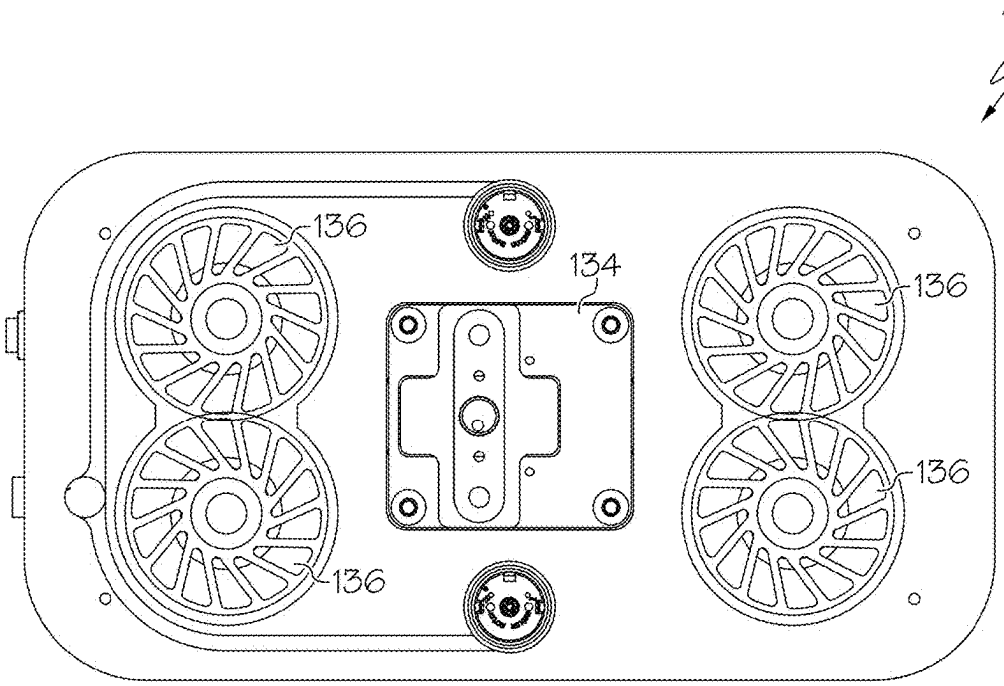

FIG. 20

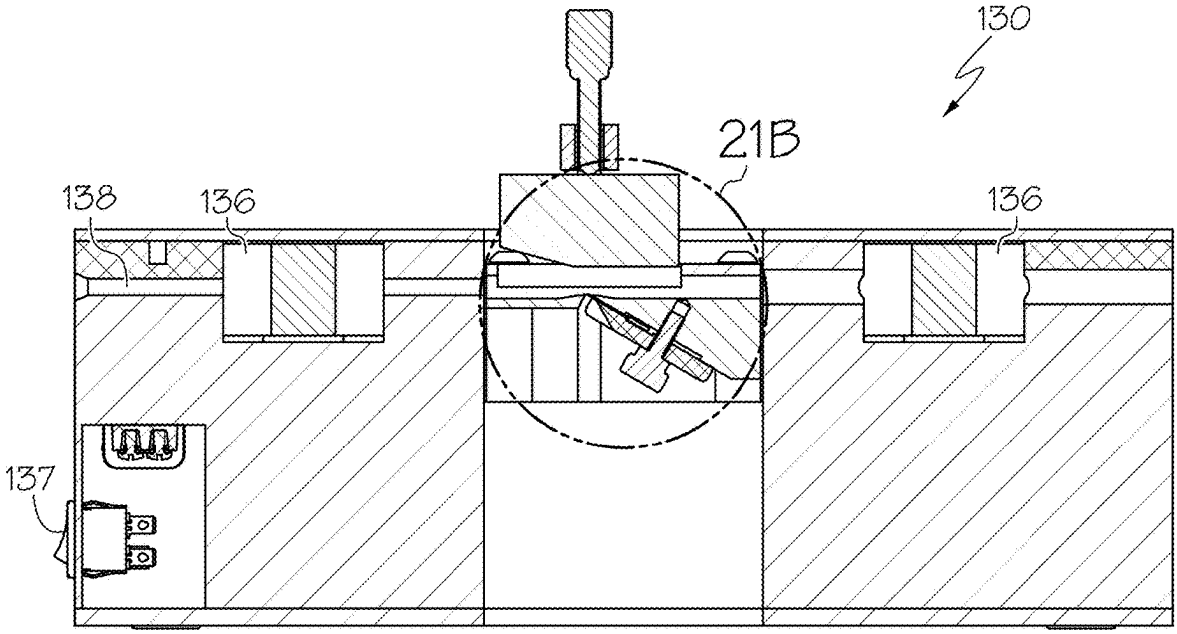

FIG. 21A

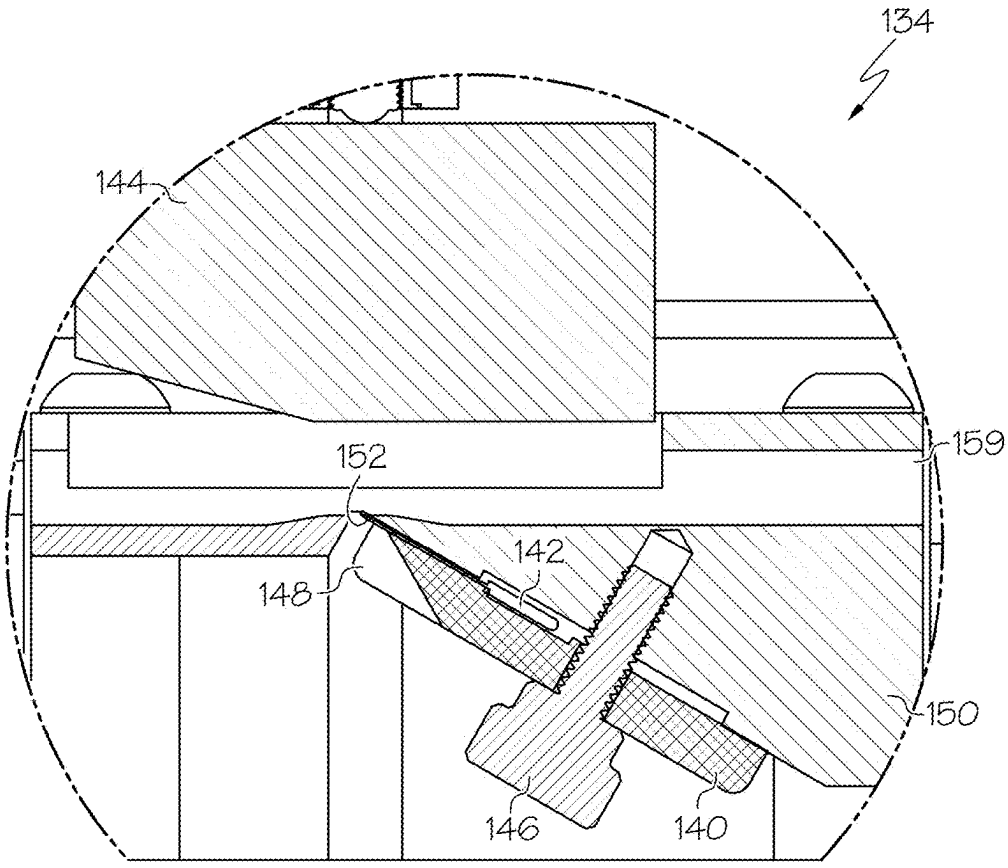

FIG. 21B

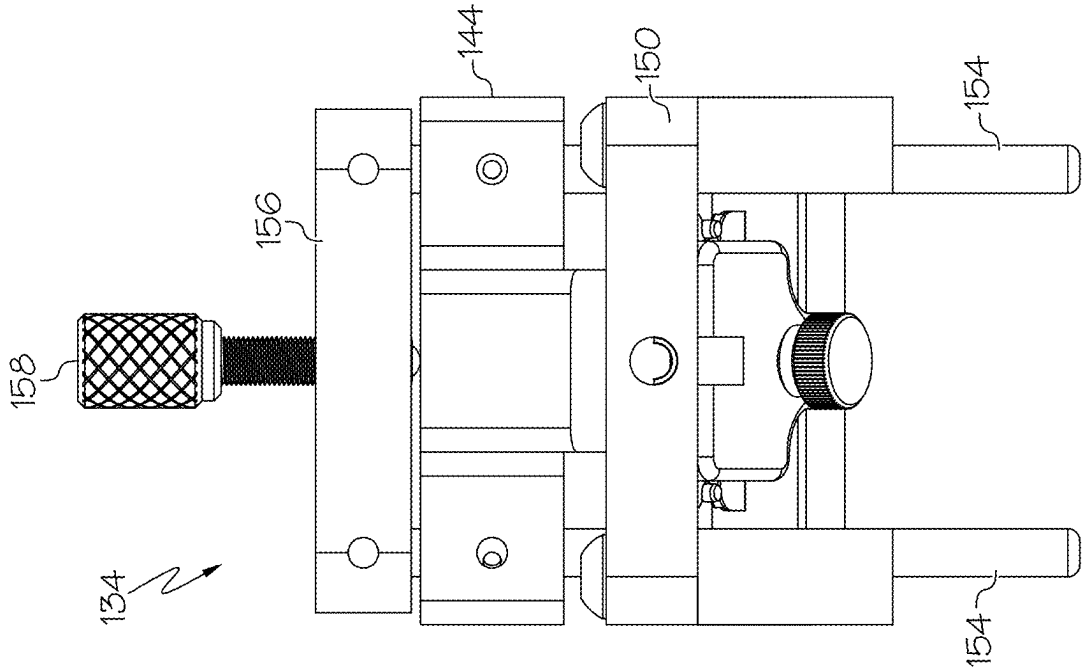

FIG. 22B

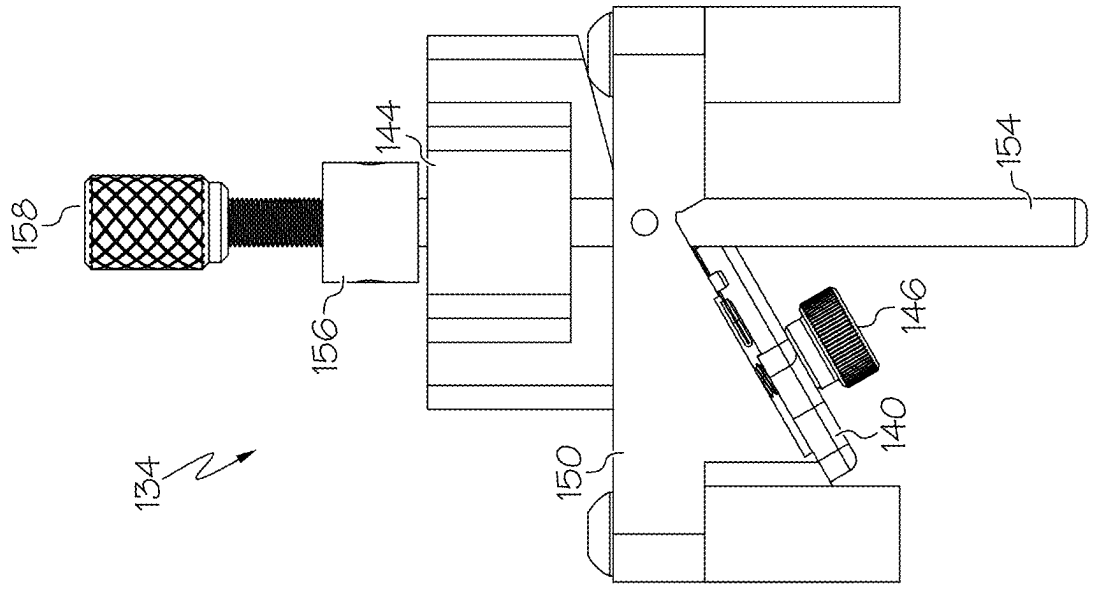

FIG. 22A

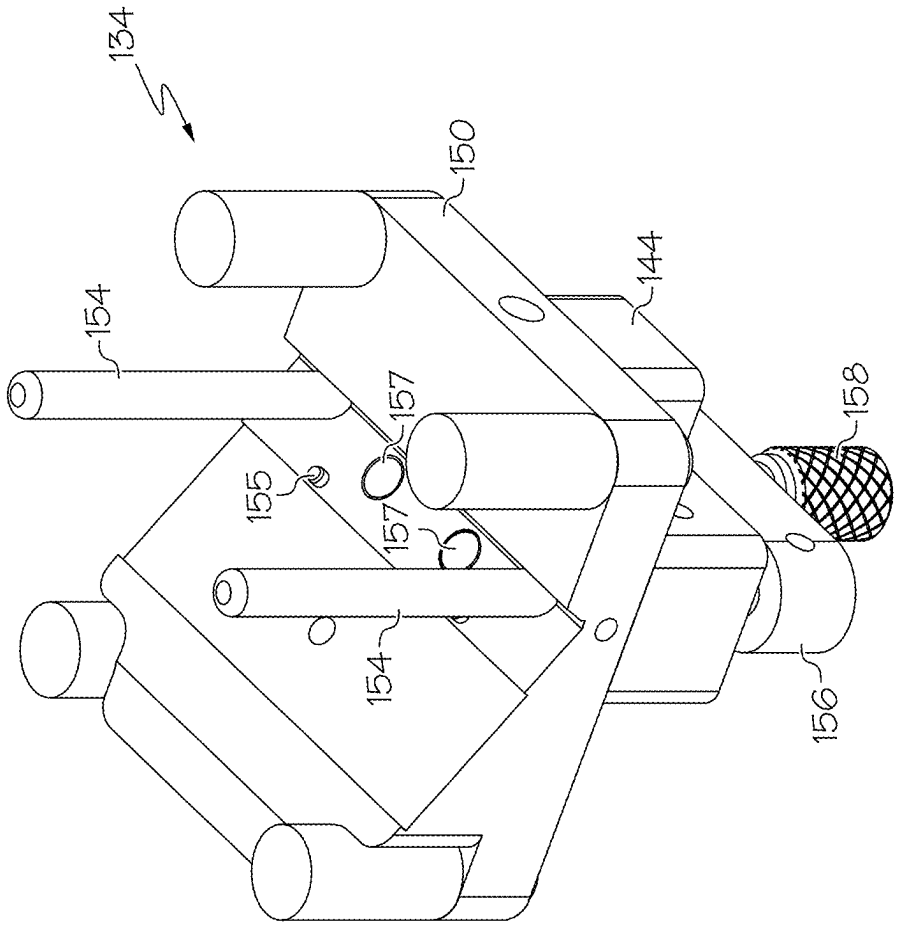

FIG. 22C

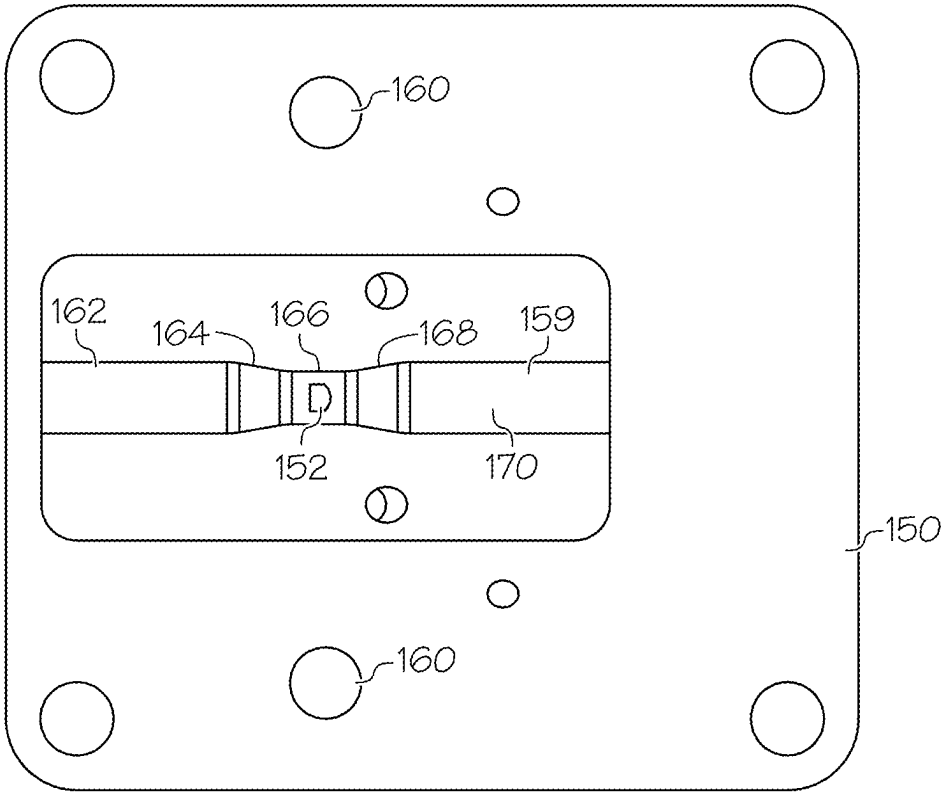

FIG. 23

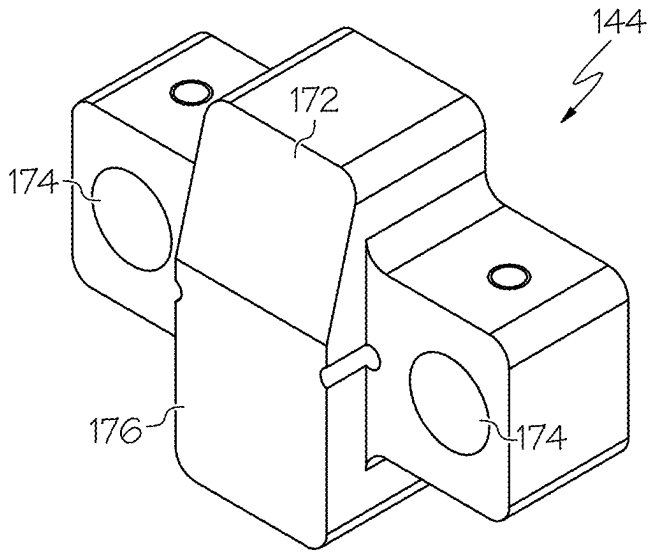

FIG. 24

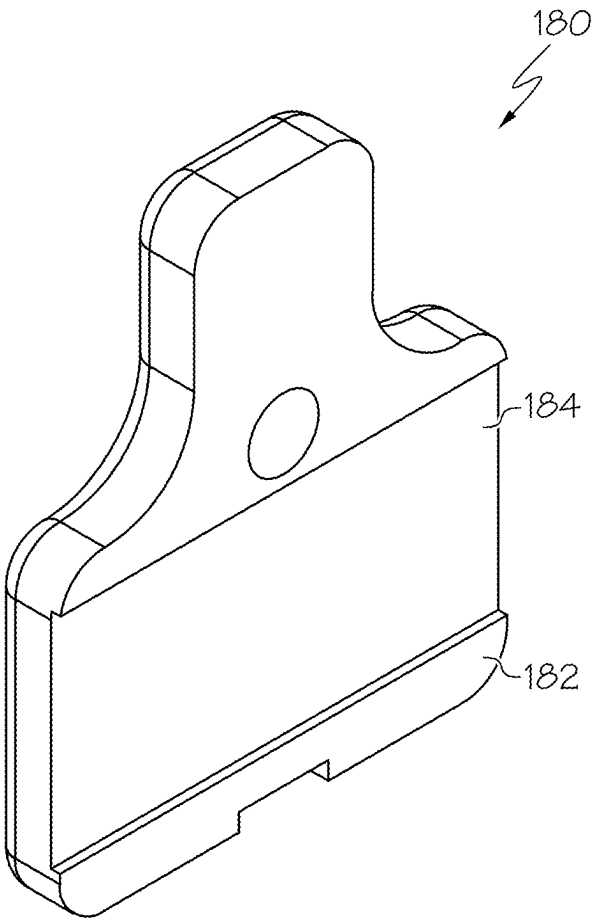

FIG. 25

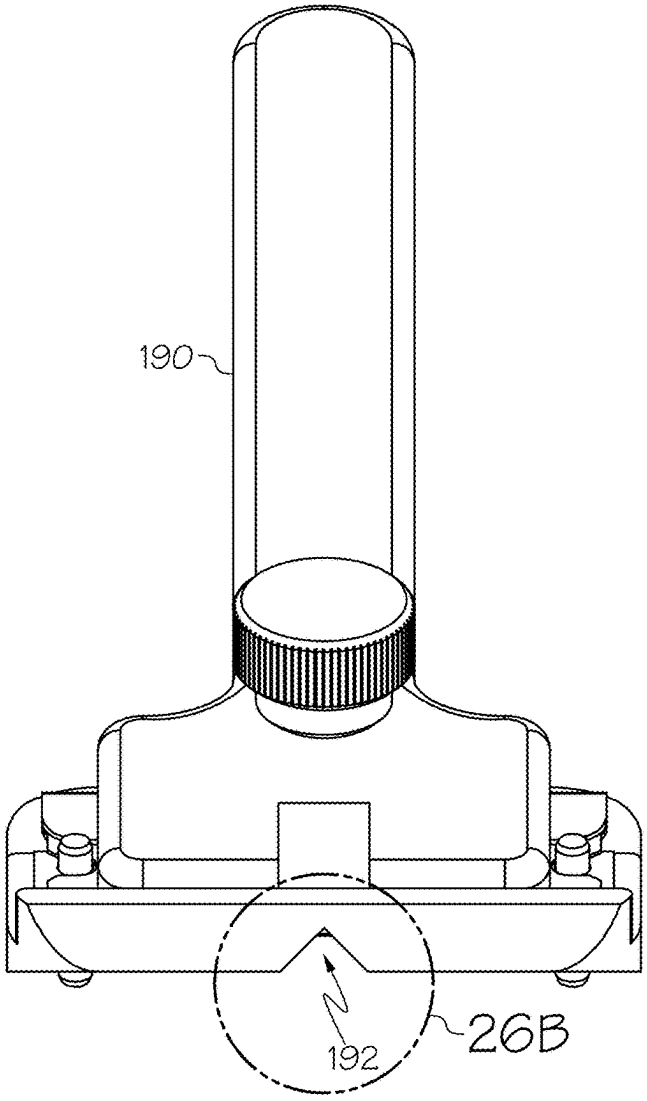

FIG. 26A

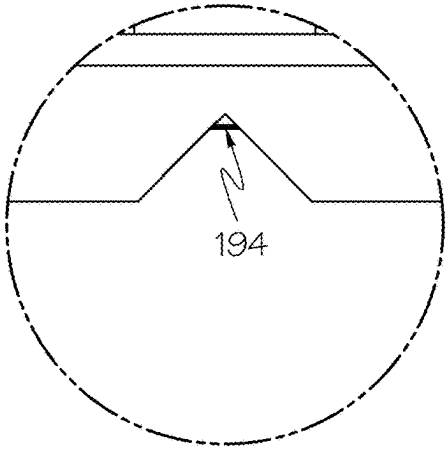

FIG. 26B

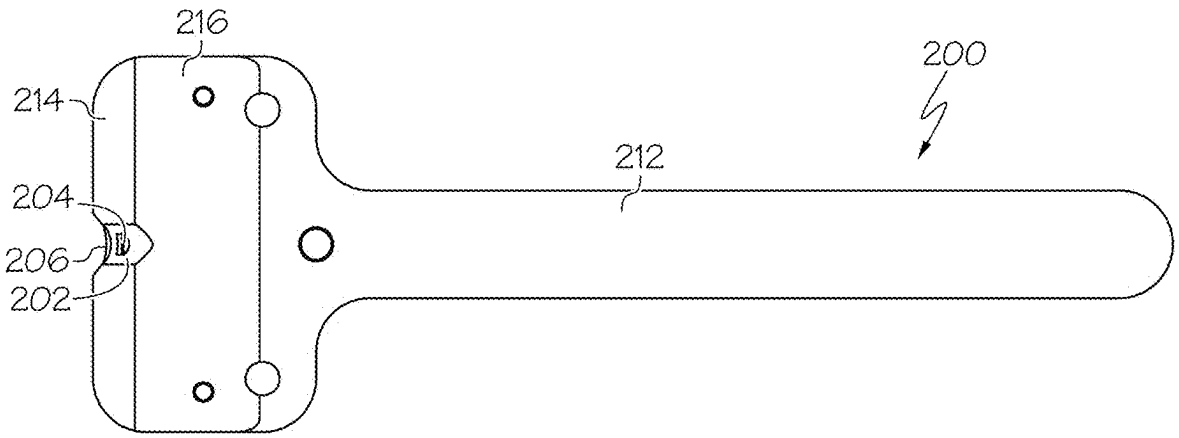

FIG. 27A

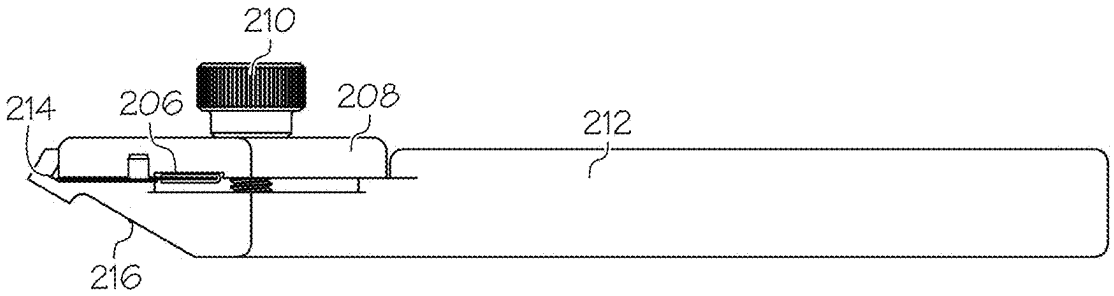

FIG. 27B

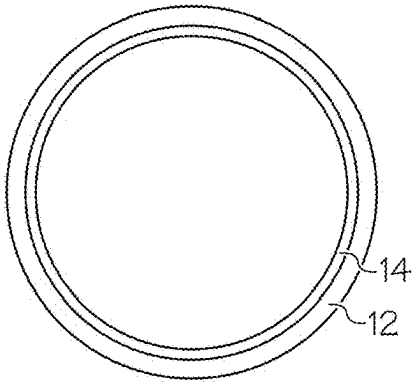

FIG. 28A

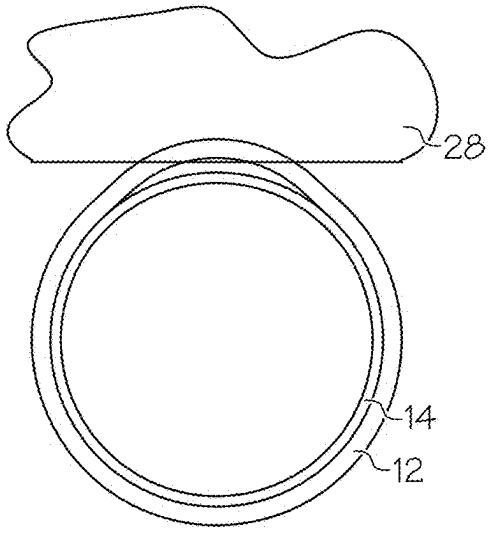

FIG. 28B

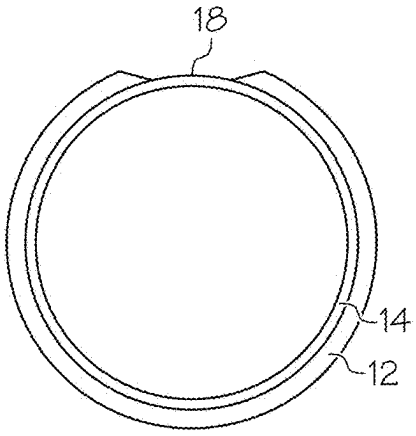

FIG. 28C

PRECISION SKIVER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. patent application Ser. No. 17/206,060, filed Mar. 18, 2021, which claims the benefit of U.S. patent application Ser. No. 16/873,334, filed Mar. 20, 2020, the entire content of each of which is hereby incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates generally to cutting tools, and more particularly to a new and unique skiver for precisely removing a thin layer of material from the outside of an elongated, tubular object such as a medical catheter.

BACKGROUND

[0003] In the manufacture of some products, such as medical catheters, for example, manufacturers may use a thin outer layer of thermoplastic heat shrink during construction of the products. In some circumstances, some catheters are formed using layers different materials, or have material changes along the length. The thin layer of thermoplastic is put on the product and heated to combine the multiple layers into one. This is called reflowing. The heat shrink pulls the product tight on a mandrel (metal or plastic rod in the center of the catheter) keeping it round. Similarly, some batteries are manufactured with such an outside layer to prevent electrical shorting before packaging. Such heat shrink is quite thin and tight on the product.

[0004] Some standard heat shrink can be removed by holding the product, making a small cut in the end of the layer to facilitate grasping the layer, then tearing the heat shrink in a spiral motion. This is nearly impossible on smaller devices, is time consuming and requires the use of an open blade. A peelable version of heat shrink has been invented to fix this problem. Peelable heat shrink requires a slit in the end of the heat shrink to create two tabs to grab on to. The tabs are then pulled perpendicular to the device to remove the heat shrink. This requires no open blades, but the peeled heat shrink can stretch up to three times longer in the perpendicular direction when compared to the starting length of the material. Removal with this method can be ergonomically undesirable as well as much more expensive than standard heat shrink.

[0005] Tools used for removing heat shrink have a sharp "tooth" or "shoe" that goes under the heat shrink. A vertical surgical blade is aligned with the sharp end pointing down the length of the catheter. The shoe or tooth is shoved between the heat shrink and the catheter dragging down the length. The shoe or tooth lifts the heat shrink and is slit by the blade. This type of skiving may leave drag marks along the length of the product and will dig into the product if not used correctly. They are made to order and are highly sensitive to the size of the machined channel matching the OD of the catheter exactly. Some skivers do not have a guard over the tooth and if one slips out of the heat shrink it can stab the operator if not careful. Thus, while various manual cutting tools for various purposes have been available heretofore, there has not been a tool that is specifically adapted for this purpose while avoiding possible injury to the user.

[0006] A need has thus arisen for a new and improved skiver for precisely and safely removing a thin layer of heat shrink or other similar material from products such as medical catheters, small batteries and the like without risking injury or damage.

SUMMARY OF THE INVENTION

[0007] The present invention comprises a new and unique skiver of improved construction which overcomes the foregoing and other difficulties associated with the prior art. In one embodiment in accordance with the invention there is provided a skiver with a body attached to the front end of a handle. A longitudinal recess is provided in the lower surface of the skiver body for guiding a catheter or the like past a transverse blade extending into the top of the recess as the skiver is advanced along the length thereof to precisely remove a thin layer of outside material such as plastic heat shrink without damaging the underlying catheter. In another embodiment of the invention the body of the skiver is attached to a table or other mounting system so that the skiver is supported either on a flat work surface or a separate mount. In another embodiment of the invention, a more automated skiver is provided. The skiver body is held in position and powered rollers advance the catheter or other object into the skiver. This embodiment is safe and efficient and protects the user from injury.

[0008] In the present invention, the precise placement of the blade as well as the angle of the blade allows the blade depth to be set to about half of the wall thickness of the material to be removed. When moving the tool along the length of the device (or moving the device along the tool), the blade will want to dig in deeper (due to angle of approach) and, in some instances, will lift (stretch) the heat shrink off of the part and cut off a strip of material allowing the remaining heat shrink to simply be pulled off the part. In contrast to prior devices which merely slice the material to be removed, the devices and methods of the present invention remove a section of the heat shrink.

[0009] In some embodiments, a skiver comprises a body having front and back ends and top and bottom surfaces. A longitudinal recess of a predetermined cross section is defined by the body. An opening in the body extends from the bottom surface to the recess. A blade is disposed in the opening. A pair of motorized rollers are arranged to move an object oriented in the longitudinal recess.

[0010] In some embodiments, a skiver comprises a body comprising a top surface, a bottom surface and a magnet. The bottom surface comprises a longitudinal recess and the top surface defines a blade recess. The magnet is adjacent to the blade recess. The body comprises an opening between the longitudinal recess and the blade recess. A blade is oriented in the blade recess. The blade comprising a cutting edge and a portion of the cutting edge is positioned in the opening. A cover is attached to the body, which comprises a lower surface. The top surface of the body and the lower surface of the cover secure the blade directly adjacent to the cutting edge.

[0011] In some embodiments, a skiver comprises a body comprising a longitudinal recess, a blade recess and an opening between the longitudinal recess and the blade recess. A blade is oriented in the blade recess. The blade comprises a cutting edge and a portion of the cutting edge is positioned in the opening. A cover is attached to the body that is arranged to secure the blade. A guide member is moveable with respect to the body. In some embodiments, a portion of the guide member extends into the longitudinal

recess. In some embodiments, the guide member is positioned across the longitudinal recess from the blade. In some embodiments, the guide member comprises a guide pin, the body comprises a cavity and a portion of the guide pin is oriented in the cavity. In some embodiments, the guide member is moveable with respect to the body along a length of the guide pin. In some embodiments, the longitudinal recess comprises a longitudinal axis and the guide member is arranged to move orthogonal to the longitudinal axis. In some embodiments, a drive system is arranged to move an object oriented in the longitudinal recess.

[0012] In some embodiments, a skiver comprises a body comprising a top surface, a bottom surface and a central axis. The bottom surface comprises a longitudinal recess. The top surface defines a blade recess. The body comprises an opening between the longitudinal recess and the blade recess. A blade is oriented in the blade recess. The blade comprises a cutting edge and a portion of the cutting edge is positioned in the opening. A cover is attached to the body that comprises a lower surface. The top surface of the body and the lower surface of the cover secure the blade directly adjacent to the cutting edge and the longitudinal recess is laterally offset from the central axis. In some embodiments, the skiver comprises a second longitudinal recess extending parallel to the first longitudinal recess. In some embodiments, the central axis is centered between the first longitudinal recess and the second longitudinal recess.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] A better understanding of the invention can be had by reference to the following Detailed Description in conjunction with the accompanying Drawing, wherein:

[0014] FIG. **1** is a perspective view of the improved skiver according to a first embodiment of the invention herein.

[0015] FIG. **2** is an enlarged cross-sectional view taken along lines **2**-**2** of FIG. **1** in the direction of the arrows.

[0016] FIG. **3** is a top view thereof.

[0017] FIG. **4** is a front view thereof.

[0018] FIG. **5** is a detail view of a portion of FIG. **4**.

[0019] FIG. **6** is a side view thereof.

[0020] FIG. **7** is a bottom view thereof.

[0021] FIG. **8** is a cross-sectional view taken along lines **8**-**8** of FIG. **3** in the direction of the arrows.

[0022] FIG. **9** is an enlarged, detail view of a portion of FIG. **8**.

[0023] FIGS. **10**A and **10**B are an exploded view of the skiver herein.

[0024] FIG. **11** is an exploded view of an optional hand-held accessory and an optional mounting bracket.

[0025] FIG. **12** is a perspective view of the improved skiver according to another embodiment of the invention herein.

[0026] FIG. **13** is an inverted, reverse exploded view of the embodiment of FIG. **12**.

[0027] FIG. **14** is a perspective view showing an optional bench top accessory for use with the skiver herein.

[0028] FIG. **15** is an enlarged cross-sectional view taken along lines **15**-**15** of FIG. **14** in the direction of the arrows.

[0029] FIG. **16** is an exploded view of an optional table or bench top accessory.

[0030] FIG. **17** is another embodiment of the invention.

[0031] FIGS. **18**A and **18**B are another embodiment of the device shown in

[0032] FIGS. **12** and **13**.

[0033] FIG. **19** is another embodiment of the invention.

[0034] FIG. **20** is a view of an embodiment of the invention.

[0035] FIGS. **21**A and **21**B are cross sections of the embodiment shown in FIG. **19**.

[0036] FIGS. **22**A, **22**B, and **22**C are views of a tooling apparatus.

[0037] FIG. **23** is a view of a component of a tooling apparatus.

[0038] FIG. **24** is a view of another component of a tooling apparatus.

[0039] FIG. **25** is a view of the removable cover.

[0040] FIG. **26**A and **26**B are views of a skiver for a product with a pointed edge.

[0041] FIGS. **27**A and **27**B are another embodiment of the invention.

[0042] FIGS. **28**A, **28**B, and **28**C shows the results of skiving a device.

DETAILED DESCRIPTION

[0043] Referring now to the Drawings, wherein like reference numerals designate like or corresponding elements throughout the views, FIGS. **1**-**10** show a skiver **10** incorporating a first embodiment of the invention. The skiver **10** can be used to remove a thin layer of material **12**, such as plastic heat shrink, from the outside of a catheter or other device **14**. A longitudinal recess **11** is provided in the bottom of skiver **10** for receiving the catheter **14**. While the recess **11** is shown as a semicircular cross section, other cross sections, including oval or square (a 90° angle or flat), can be used. As the skiver **10** is advanced along the length, the material **12** is lifted off the catheter **14** by the blade and removed in a strip **16** that curls out of an opening **17** in the top of the skiver **10**, leaving a longitudinal opening or slot **18** so that the rest of the outer layer of material can then be easily stripped away prior to next process during manufacturing.

[0044] When the skiver is used, the catheter **14** can be supported either on a flat work surface **20**, or in a separate accessory as described below for better precision and in order to avoid possible injury to the user. As the tools of the present invention are safer than prior art skivers and the accessory can aid in the training of the people who will use the skiver by holding the tool at the correct angle while applying no (or very little) downforce.

[0045] The skiver **10** includes a body with handle **22** extending from its back end. The surface of handle **22** may be ribbed or textured to facilitate secure gripping by the user. The front end of the body of skiver **10** is relatively wider than handle **22**, with a substantially flat or planar bottom surface **24** and an inclined flat front surface **26** in which the longitudinal recess **11** is located. Front surface **26** is preferably angled upward at an acute angle from surface **24**. While various shapes can be used, the recess **11** is preferably semi-cylindrical in shape. The recess is dimensioned in accordance with the size of catheter **14** but the inventions herein allow some leeway. In a non-limiting example, the cross section can have a semicircle diameter of 0.185 inches. This cross section will accommodate a catheter or other device with diameters ranging from 0.075 to 0.18 inches. The catheter has to be slightly smaller than the cross section so that the surface of the material to be removed can touch the blade but can also be substantially smaller than the cross

section. If the catheter is sized too much smaller than the cross section, the catheter may be unstable when moving past the blade.

[0046] A blade **28** is disposed in a transverse recess in the top of the front end of handle **22**, the middle front position of which top recess intersects bottom recess **11**, forming a small opening **30**. The cutting edge of blade **28** extends into the opening **30**, as best seen in FIG. **9**. As shown, blade **28** can be a single edge safety razor of the type used in shaving, although other types of blades could also be used, if desired.

[0047] The blade **28** is preferably set at an angle of about 30 degrees from horizontal as shown, plus or minus about three to five degrees. From the view in FIG. **1**, to operate the skiver, the user will push on handle **22** so that catheter **14** and material **12** move toward the blade end of skiver **10**. Of course, the skiver can be held stationary, and the catheter moved toward the blade end of the skiver, or both can be moved at the same time.

[0048] The blade **28** is secured beneath a removable cover **32** by a thumb screw **34** to the front end of handle **22** so that it can be replaced as necessary. A pair of laterally spaced apart dowel pins **36** are provided in the top recess for accurate alignment of blade **28**.

[0049] The depth of extension of blade **28** into the opening **30**, and thus the depth and width of the cut can be adjusted by means of shims or height adjustment elements **38**, two of which are shown for purposes of illustration, although any suitable number can be used. The shims **38** can be made from stainless steel or any other suitable material in thicknesses ranging from two to ten thousandths of an inch each. In some embodiments, the shims have a small notch located on the side that is adjacent to the sharp end of blade **28**. See FIGS. **9** and **10**. Therefore, depending upon the thickness of outside material **12**, the blade **28** can be set precisely to remove material to a depth of less than one to more than fifteen thousandths of an inch of material.

[0050] FIG. **10**B is similar to FIG. **10**A with the exception of magnets **37**. The one or more magnets **37** are placed in the raised section of handle **22** that extends under removable cover **32**. When placing (or replacing) blade **28** and optional shims **38** onto skiver **10**, the openings in option shims **38** and blade **28** are aligned with dowel rods **36**. Due to manufacturing tolerances, the blade may not be in its optimal position and must be pushed toward the opening that extends into recess **11** before attaching removable cover **32**. As the position of the magnets is toward one end of optional shims **38** and blade **28**, the magnetic force will pull optional shims **38** and blade **28** toward the opening as the magnets try to move toward the middle of the overlying structures. This force pulls the blade to be centered on the magnets which automatically loads it to the correct position. In some embodiments, the openings in shims **38** and blade **28** are such that, when the openings therein are positioned around dowl rods **36**, they cannot be placed in the incorrect orientation as they will not fit.

[0051] FIG. **11** shows an optional way of using skiver **10** instead of directly on a work surface **20**. A separate mount **40** is shown which can be either handheld or placed in a bracket **42** attached to a wall or the side of a table. The mount **40** includes a generally rectangular hollow base **44** with an opening **41** in one of the walls. A slidable jaw **46** is provided in an opening in the top of base **44**, biased toward skiver **10** by magnets **48** in slidable jaw **46** and base **44**. The magnets are positioned so that opposite poles face each other. The aligned magnets are offset to induce a force that moves jaw **46** toward skiver **10**. Bolt **50** extends through the end of mount **40** and through an opening in jaw **46** and is threaded into knob **56**. These threads do not engage base **44** or jaw **46**. The head of bolt **50** can be used to set a limit how close jaw **46** can get to skiver **10**. The end of jaw **46** that faces the skiver **10** has an angled flat surface **52** complementary to surface **26** of handle **22**.

[0052] Optional set screws **54** can also be used along with screw **50** to set gap to a known distance for skiving a device with a consistent cross-sectional diameter.

[0053] Button **56** can be used to move jaw **46** away from skiver **10** to aid in inserting a catheter or other device into the skiver. If not attached to bracket **42**, the user can hold the assembly in one hand while pulling the catheter or other object through the skiver and out opening **60**.

[0054] After the blade depth has been adjusted as desired, the skiver **10** can then be secured within mount **40** by bolts **62** before or after being secured to bracket **42** by bolts **64**, as desired.

[0055] FIGS. **12** and **13** show a skiver **66** incorporating a second embodiment of the invention for removing a thin layer of plastic heat shrink material **68** from the outside of a relatively short elongate device, such as a battery **70**. In this embodiment, the elongate product or battery is slidable along a semi-cylindrical top recess **72**.

[0056] Skiver **66** includes a raised body **74** supported on legs **76** secured thereto by screws **78**. Rubber feet **80** are provided on at least the bottom ends of legs **76**.

[0057] The underside of body **74** includes a slidable adjustment block **82** guided within recesses and biased by magnets **84**, as shown in FIG. **13**. A screw **86** is provided for fine adjustment. Screw **86** extends through a block **88** secured by bolts **90** to the bottom of body **74**.

[0058] A blade **91** is provided on the angled side of an opening **92**

[0059] extending through body **74**, held in place by a cover **94** secured with screws **96**. A portion of opening **92** intersects with the longitudinal recess **72**. With screw **86**, the blade **92** and cover **94** can be set in the desired position with the edge of the blade extending though opening **92** and into recess **72**, after which the adjustment block **82** is locked in place with screw **98**.

[0060] Again, blade **91** is preferably set at an acute angle of about 30 degrees, or about 25 to 35 degrees, of inclination so that battery **70** can then be advanced across skiver **66** to quickly cut a longitudinal section in the heat shrink material **68** and thus facilitate its removal from the battery.

[0061] FIGS. **18**A and **18**B show an alternative to the embodiment shown in FIGS. **12** and **13**. Here, instead of a slidable adjustment block **82** and adjustment screw **86**, a block **122** is secured to the bottom of body **74** adjacent to opening **92**. A portion of opening **92** intersects with the longitudinal recess **72**. A blade **91** is provided on the angled side of an opening **92** extending through body **74**, held in place by a cover **124**. Both blade **91** and cover **124** have openings that are aligned with dowls **128** to hold the blade and cover in the proper orientation. The depth that the blade **91** extends into recess **72** can be controlled by using shims or spacer elements (not shown) positioned between blade **91** and the surface of opening **92**. A screw, not shown, will extend through opening **132** in removeable cover **124** and into opening **130** of block **122** to hold the removable cover, blade, and spacing elements (if any) in position. While not

shown, the embodiments of FIGS. **17**, **18**A, and **18**B can be constructed with one or more magnets similar to magnet(s) **37** of FIG. **10**B or magnet(s) **157** of FIG. **22**C

[0062] FIGS. **14-16** show another optional way of using skiver **10** instead of directly on a work surface **20**. The skiver **10** can be used with a mount **100** that includes a generally rectangular body **102** with a raised step at one end. A pair of upright pins **104** are provided on the top of body **102** behind the front step for slidably supporting a block **106** with linear bearings **108** therein on the mount body.

[0063] A longitudinal recess **109** is provided in the underside of block **106** for receiving the catheter or other device **14**.

[0064] The skiver **10** is threadedly secured to block **106** by screws **110** extending upwardly through openings in the block into holes **112** in the underside of the skiver, as best shown in FIG. **7**, for secure positioning as the catheter **14** is advanced under the skiver, over body **102** and underneath block **106** of mount **100**.

[0065] Rubber feet **114** are preferably provided on the bottom of body **102** to resist sliding of the mount **100**. An optional hole **116** can also provide to facilitate positively securing mount **100** to work surface **20** with a bolt (not shown) or the like, if desired.

[0066] A set screw **118** is provided for fine adjustment of the angle of the skiver **10** when used with mount **100**. The set screw **118** extends upwardly through an opening in block **106** into engagement with the underside of skiver **10** after attachment to the block.

[0067] FIG. **17** shows an embodiment of the invention that comprises two skiving locations. This embodiment is similar to the embodiment shown in FIGS. **1-10** except that here there are two recesses **11**, two openings for the blade to extend into the recesses, and two openings **17** in the removable cover **32**. This embodiment allows the user to form one or two longitudinal openings or slots **18**. As shown, the recesses **11** do not line up with the material to be skived-in this case a package of batteries. In some embodiments, the two recesses can be spaced to line up with batteries or other devices in the pack.

[0068] FIGS. **19** to **24** show a mechanically driven or automatic skiver. FIG. **19** is a top view of this embodiment which shows automatic skiver **130** covered by top plate **132**. The tooling apparatus **134** is also shown. FIG. **20** shows automatic skiver **130** with the top plate removed. Here four rollers, **136**, are shown, with one pair of rollers positioned at the inlet to tooling apparatus **134** and one pair of rollers positioned at the outlet. Rollers **136** function to draw the catheter or other device into skiver **130**, to push the catheter or other device through the tooling apparatus **134**, and to pull the catheter or other device out of the tooling apparatus and out of skiver **130**. In some embodiments the rollers **136** are no-crush rollers so that the distance between the pairs of rollers does not need to be adjusted. In other embodiments, the distance between the pairs of rollers can be adjusted to accommodate catheters or other devices of different sizes. The rollers can be driven by one or multiple motors. In some embodiments, the skiver will include a power source such an electric cable/plug (not shown) and an on/off switch **137**. While not shown in these drawings, in some embodiments a round belt is used to drive the rollers **136**. In this embodiment, in the event that the catheter or other device gets stalled or stuck while being skived, the rollers are likely to stop rotating to prevent damage to the catheter or other device. The round belt will slip on a pully that is attached to each roller **136**.

[0069] FIGS. **21**A and **21**B show a cross section of FIG. **19** taken at A-A. In **21**A, lumen **138** is shown. Lumen **138** is used to feed a catheter or other device through the skiver **130** to remove an external heat shrink or other thin layer of material. Recess **159**, discussed below, is aligned with lumen **138** to provide a pathway for the catheter or other device through skiver **130**. FIG. **21**B is a detailed view of the tooling apparatus shown in **21**A. In FIG. **21**B, it can be seen that the tooling apparatus comprises a removable cover **140** secured to body **150** by screw **146**. Blade **142** is positioned between cover **140** and body **150**. Body **150** has an opening **152** which extends in to recess **159** so that the blade **142** can extend into the recess. In some embodiments, not shown, shims or spacer elements can be positioned between blade **142** and body **150** to control the depth that blade **142** extends into recess **159**. Guide **144** is positioned on top of body **150**. It 'floats' on body **150** in that it is not attached to the body. As will be discussed later, it rides on a pair of guide pins and is held down only by gravity.

[0070] FIG. **22**A is a side view and FIG. **22**B is a front view of on embodiment of tooling apparatus **134**. In this view tooling guide pins, **154**, can be seen extending below body **150**. When positioned in skiver **130**, these guide pins extend into lumens which hold tooling apparatus **134** in place within skiver **130**. The guide pins extend upwardly through body **150** and through guide **144**. The body is fixed to the guide pins but guide **144** is allowed to float or move up and down on the guide pins. In some embodiments a top hat **156** is positioned on top of guide **144** to provide additional downward force onto guide **144**. Top hat **156** has lumens to allow guide pins **154** to extend through the top hat. In some embodiments, top hat **156** is secured to guide pins **154** to provide a top limit to the distance that guide **144** can travel upward on guide pins **154**. In some embodiments, top hat **156** includes screw **158**. The bottom of screw **158** touches guide **144**. By rotating screw **158**, the user of skiver **130** can adjust how far up guide **144** can travel. In other embodiments, disc or other magnets are positioned in the top surface of guide **144** and the bottom surface of hat **156**. The magnets are positioned such that a pole on one magnet faces a common pole on the opposite magnet. The force of the magnets repelling each other adds a downward force on guide **144**. In other embodiments, the force from the top hat **156** onto guide **144** can be adjusted by adjusting the distance from the top hat **156** to the guide **144**. The repelling magnetic force between the top hat **156** and guide **144** will be greater the closer top hat **156** is positioned relative to guide **144**.

[0071] FIG. **22**C is a bottom view of an alternative embodiment for tooling apparatus **134**. In this view, removable cover **140**, screw **146**, and blade **142** are removed. Shown here are dowl rods **155** (one is hidden by one of guide pins **154**) and one or more magnets **157**. The one or more magnets **157** are positioned in the raised section of body **150** that is covered by the removable cover **140**. The one or more magnets **157** are positioned near the edge of the raised section that is closest to opening **152**. As the magnets are positioned near one end of any optional shims and blade **142**, the magnetic force will pull the optional shims and blade toward opening **152** and properly position the blade

142 within the opening 152. To aid in positioning, openings in the optional shims and blade 142 are aligned with dowl rods 155.

[0072] FIG. 23 is a top view of body 150 showing recess 159, opening 152, and holes 160. Holes 160 are sized and positioned so that body 150 can be positioned on guide pins 154. The blade (not shown) extends through opening 152 and into recess 159. In some embodiments of the invention, recess 159 is shaped with a semicircle cross section with a constant diameter of the semicircle. In other embodiments, recess 159 includes first section 162, first taper 164, landing zone 166, second taper 168, and second section 170. In some embodiments, first and second sections 162 and 170 have a larger diameter than landing pad 166 with the first and second taper sections 164 and 168 providing a smooth transition between the two sections and the landing pad. In designing skiver 130, first section 162 should be as large as possible so that the first end of a catheter or other devices that is fed through skiver 130 finds its way into the recess 159. However, having too large a diameter can lead to instability when using skiver 130. In some instances, the first end of the catheter will pass the blade at an angle. In other instances, if skiving a long catheter or other device that has a diameter smaller than the diameter of recess 159, the catheter or other device will become unstable and move back and forth when being propelled through the skiver by the rollers 136. To balance these competing needs, in one embodiment the recess 159 has a changing diameter. The first section 162 has a larger diameter to enable the first end of the device to be skived to enter the recess. To provide stability for the skiving process, the landing zone 166 has a smaller diameter to help stabilize the skived device as it moves through the skiver. The second section 170 can also have a larger diameter to reduce the friction between the skived device and the skiver.

[0073] The smaller diameter at the landing pad 166 as compared to sections 162 and 170 allows heat shrink removal from tapered parts. A catheter with a construction changing from a smaller diameter to a larger diameter will not lift the catheter out of the blade due to the short length of the landing pad. The same concept applies for a catheter design with a diameter changing from a larger first diameter and tapering down to a smaller diameter. Without the smaller diameter landing pad 166 guide 144 would be held open by the larger catheter until it left body 150 at the exit of section 170. The maximum size of a device to be skived is limited by the size of landing zone 166; the device must be slightly smaller than the size of opening 166 so that it can access the blade.

[0074] FIG. 24 is a perspective view of guide 144 and shows slanted surface 172, bottom surface 176, and two holes 174. The holes 174 are positioned so that the guide 144 can be positioned on guide pins 154. In some embodiments, guide 144 includes slanted surface 172. Slanted surface faces the direction that the catheter of skived device comes from. When the skived device is fed into skiver 130, the slanted surface helps guide the skived device into recess 159. For the embodiments shown in FIGS. 19 to 24, only one pair of rollers may be used in some embodiments. In some embodiments, rollers that pull the device through the skiver may be used. In other embodiments, rollers that push the device through the skiver may be used. In many embodiments, recess 159 is shown as a surface channel. In some embodiments, the recess may be a bore or other opening.

[0075] FIG. 25 is a perspective view of removable cover 180. The functions of the removable cover include providing access to the blade and shims or spacer elements (if any) and for stabilizing the sharp end of the blade. As seen in FIG. 25, the depth of the blade is more in the region of the cutting end of the blade 182 as compared to the non-cutting end 184. Movement of the device to be skived past the blade can cause instability and movement of the blade. As explained earlier, the blade is set to a depth of less than one to fifteen thousandths of an inch or more. Movement of the blade can result in a damaged skived device or in incomplete skiving. By extending the cover in the region of the cutting end of the blade 182, the cover provides a holding force that minimizes instability in the blade during the skiving process. In some embodiments, it has been determined that the edge of section 182 that is adjacent to section 184 acts as the point of pressure on the blade. As a result, the width of section 182 should be limited so that the point of pressure is close to the sharp end of the blade but needs to have sufficient width to provide stability to the blade.

[0076] FIG. 26 is another embodiment of the invention. In this embodiment, the recess 192 is shaped to receive a device to be skived that is square, rectangular, or one that has a 90° or other angled edge. In this embodiment, the recess 192 comprises two flat surfaces, joined at one end, resulting in an opening of approximately 90° or another angle as desired. As seen in the detail, blade 194 extends across the peak of recess 192.

[0077] FIGS. 27A and 27B are another embodiment of the invention. In this embodiment, skiver 200 is designed to track a substrate that may be curved. Fig, 27A is a bottom view of skiver 200 including handle 212, bottom surface 216, and bottom projection 214. Recess 202 extends through projection 214 and includes opening 204 and blade 206. Blade 206 extends through opening 204 and into recess 202. FIG. 27B is a side view of skiver 200. In this view screw 210 holds removable cover 208 against blade 206. Spacer elements (not shown) can be used to adjust the depth that blade 206 extends into recess 202. As can be seen from this view, bottom surface 216 and bottom projection 206 have approximately the same angle relative to the longitudinal axis of skiver 212. Recess 202 primarily extends only through projection 206 and has a shorter landing zone for the device to be skived than other embodiments. This shorter landing zone allows the user to more easily skive substrates that are curved.

[0078] When using a blade such as a razor blade on an object, the blade has a tendency to 'dive' into the object. In the embodiments of this invention, the blade and object are relatively held in place, so this does not happen to a large extent. Applicant has found, however, when using the skiver on a device that has only a thin layer of material to be removed, the layer to be removed will pull away from the device and toward the blade. This will cause a vacuum to be formed under the material. As the device continues to move over the skiver, often the material to be removed will move so far away from the device that the blade will extend all the way through the material. However, since the blade and the device are held a constant distance apart, the blade will not damage the device. This is shown in FIGS. 28A, 28B, and 28C. FIG. 28A is a cross section of a catheter or other device to be skived. It is shown with shrink wrap (or other material to be removed) layer 12 on catheter or device 14. FIG. 28B shows blade 28, with the sharp end interfacing with the

product to be skived, picking up layer **12** off of device **14**. FIG. **28**C is a post skiving view. Here, opening or slot **18** has been formed in shrink wrap layer **12** and there is no damage to device **14**.

[0079] The embodiments described herein have wide applicability to a variety of catheters and other devices which have a layer of material to be removed. In some embodiments, FEP (fluorinated ethylene propylene) is removed from the outside of a medical catheter. In some instances, the FEP has a thickness of 0.009 +/−0.002 inches. In this instance, the blade of the skiver will be set to a depth of about 0.0045 inches, or about 50% of the depth of the FEP. In other instances, a polyolefin with a thickness of about 0.009 inches is removed from the outside of a device. In this instance, the blade is set to a depth of 0.006 inches, or about ⅔ of the thickness of the polyolefin. These dimensions are merely examples. Applicant has found that setting the blade depth between ¼ and ¾ of the thickness of the material to be removed is generally acceptable.

[0080] Many of the recesses shown herein has a semicircular cross section. However, the invention is not limited to semicircular cross sections. In some embodiments, the cross section can be oval, an arc of a circle less than 180°, a flat surface, or a cross section with straight sides that join together at a peak in the area of the blade.

[0081] Many of the embodiments described herein have been described as being directed to a catheter or other round medical device or to a pack of batteries. The inventions, however, are not so limited. The devices of the invention can be used to open packaging (for example surgical scissors with heat shrink over the tips) and on fiber optics and other types of cables with a thin plastic exterior.

[0082] In many of the embodiments herein, the catheter or other device to be skived does not need to be of constant diameter. For example, the skiver of FIG. **1** can be used on a substrate of changing diameters provided the user keeps sufficient pressure on the skiver **10** such that blade **28** stays engaged with the device. The slidable jaw **46** shown in FIG. **11** is biased toward the skiver **10**. In the event that the device being skived changes dimension, the slidable jaw will keep it firmly in position so that the skiving will continue over the changed dimension of the product being skived. The floating guide **144** shown for example in FIGS. **22**A and **22**B, will put sufficient pressure on the device being skived such that a change in dimension will not affect the skiving.

[0083] As discussed above, prior art skiving apparatus and methods can include the use of a blade to cut the material that is to be removed. In the embodiments herein, the skive operator is protected from the blade and is much less likely to be injured during the skiving process. In the automatic skiver operation, it is very unlikely that the skiver operator can be injured as the blade is not readily accessible.

[0084] From the foregoing, it will be appreciated that the present invention comprises an improved skiver having several advantages over the prior art. The skiver herein is adjustable and precise. It facilitates removal of thin material from the outside of a product while minimizing if not avoiding possible damage to the product and/or injury to the user. It can also be used to cut a precise longitudinal slot in the wall of a product. The skiver herein can be handheld, used with a separate mount or automated. Other advantages will be apparent to those skilled in the art.

[0085] In the detailed description of the present disclosure, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration how one or more embodiments of the disclosure may be practiced. These embodiments are described in sufficient detail to enable those of ordinary skill in the art to practice the embodiments of this disclosure, and it is to be understood that other embodiments may be utilized and that process, electrical, and structural changes may be made without departing from the scope of the present disclosure.

[0086] As used herein, designators such as "X", "Y", "N", "M", etc., particularly with respect to reference numerals in the drawings, indicate that a number of the particular feature so designated can be included. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used herein, the singular forms "a", "an", and "the" can include both singular and plural referents, unless the context clearly dictates otherwise. In addition, "a number of", "at least one", and "one or more" (e.g., a number of pivot points) can refer to one or more pivot points, whereas a "plurality of" is intended to refer to more than one of such things. Furthermore, the words "can" and "may" are used throughout this application in a permissive sense (i.e., having the potential to, being able to), not in a mandatory sense (i.e., must). The term "include," and derivations thereof, means "including, but not limited to". The terms "coupled" and "coupling" mean to be directly or indirectly connected physically or for access to and movement of the movable handle member, as appropriate to the context.

[0087] Although specific embodiments have been illustrated and described herein, those of ordinary skill in the art will appreciate that an arrangement calculated to achieve the same results can be substituted for the specific embodiments shown. This disclosure is intended to cover adaptations or variations of one or more embodiments of the present disclosure. It is to be understood that the above description has been made in an illustrative fashion, and not a restrictive one. Combination of the above embodiments, and other embodiments not specifically described herein will be apparent to those of skill in the art upon reviewing the above description. The scope of the one or more embodiments of the present disclosure includes other applications in which the above structures and processes are used. Therefore, the scope of one or more embodiments of the present disclosure should be determined with reference to the appended claims, along with the full range of equivalents to which such claims are entitled.

[0088] In the foregoing Detailed Description, some features are grouped together in a single embodiment for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the disclosed embodiments of the present disclosure have to use more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate embodiment.

What is claimed is:

1. A skiver comprising:

a body having front and back ends and top and bottom surfaces; a longitudinal recess of a predetermined cross section in the body; an opening in the body extending from the bottom to the recess; a blade disposed in the opening; and

a first pair of motorized rollers, wherein the rollers are configured to move an object through the recess.

2. The skiver of claim **1** further comprising a removable cover for securing the blade in the opening of the recess and wherein the recess is positioned in the top surface of the body.

3. The skiver of claim **2** further comprising a guide positioned on top of the body and having a top and bottom surface, wherein a portion of the bottom surface is slanted to aid in the feeding of an object into the recess.

4. The skiver of claim **2** further comprising a second pair of rollers, wherein the first pair of rollers are configured to feed an object through the recess and the second pair of rollers are configured to pull an object out of the recess.

5. The skiver of claim **2**, the predetermined cross section of the recess is a semicircle, with a diameter.

6. The skiver of claim **5** wherein the diameter of the recess is varying along its length.

7. The skiver of claim **6** wherein the diameter of the recess at the location of the opening in the recess is smaller than the diameter of the recess before and after the location of the opening.

8. The skiver of claim **7** wherein the recess gradually transitions from the larger diameter on one side of the recess to the diameter of the recess at the location of the opening and gradually transitions to the larger diameter recess on the other side of the opening.

9. The skiver of claim **1** further comprising a spacer element positioned between the blade and the body to adjust a depth that the blade extends into the recess.

10. A skiver comprising:

a body comprising a top surface, a bottom surface and a magnet, the bottom surface comprising a longitudinal recess, the top surface defining a blade recess, the magnet adjacent to the blade recess, the body comprising an opening between the longitudinal recess and the blade recess;

a blade oriented in the blade recess, the blade comprising a cutting edge, a portion of the cutting edge positioned in the opening; and

a cover attached to the body, the cover comprising a lower surface;

wherein the top surface of the body and the lower surface of the cover secure the blade directly adjacent to the cutting edge.

11. The skiver of claim **10**, comprising a shim adjacent to the blade, the magnet attracting the shim to the body.

12. The skiver of claim **11**, the shim comprising a notch positioned in the opening.

13. The skiver of claim **11**, the body comprising an alignment pin, the shim engaging the alignment pin.

14. The skiver of claim **13**, the blade comprising a notch, the alignment pin oriented in the notch.

15. The skiver of claim **13**, the body comprising a second alignment pin, the cover positioned between the alignment pin and the second alignment pin.

16. The skiver of claim **10**, the top surface of the body and the lower surface of the cover securing the blade at a first location to a first side of the opening and at a second location to a second side of the opening.

17. The skiver of claim **10**, the blade recess comprising a first portion and a second portion offset from the first portion, the blade comprising a back portion opposite the cutting edge, the back portion oriented in the second portion of the blade recess.

18. The skiver of claim **10**, the lower surface of the cover comprising a first portion and a second portion offset from the first portion, the first portion contacting the blade, the second portion positioned over the blade and spaced apart from the blade.

19. The skiver of claim **10**, wherein the body comprises a central axis and wherein the longitudinal recess is laterally offset from the central axis.

20. A skiver comprising:

a body comprising a longitudinal recess, a blade recess and an opening between the longitudinal recess and the blade recess;

a blade oriented in the blade recess, the blade comprising a cutting edge, a portion of the cutting edge positioned in the opening;

a cover attached to the body, the cover arranged to secure the blade; and

a guide member moveable with respect to the body.

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