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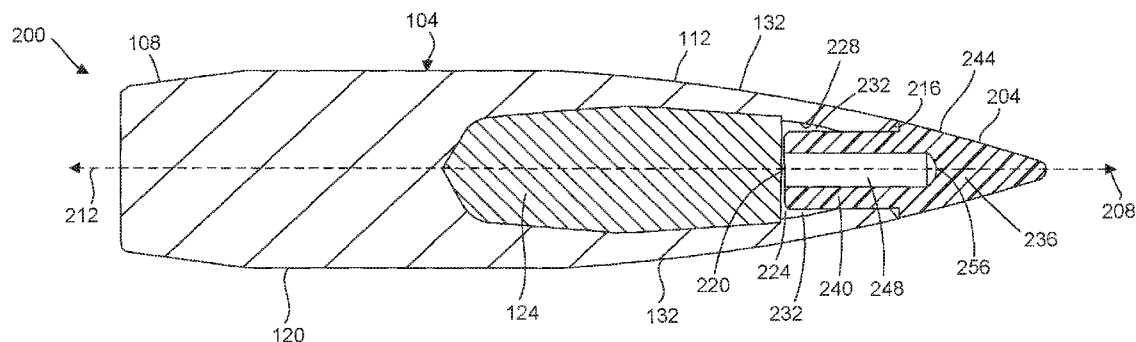


FIG. 2A

(57) Abstract: An expanding projectile including a projectile body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core. In one or more embodiments, a tip portion is mounted in an interior cavity and has an exterior surface substantially flush with an exterior surface of the metal jacket. In certain embodiments the tip portion has a main portion forward of the opening and a tip retention portion that at least partially fills the interior cavity. In certain embodiments the tip retention portion includes one or more a fracture regions configured to, upon impact of the expanding projectile with a target, fracture or deform to expose one or more fluid pathways into the interior cavity and to a forward facing interior surface for initiating expansion of the expanding projectile.

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PROJECTILE WITH TIP FOR FLUID BASED EXPANSION AT LOWER VELOCITIES

CROSS REFERENCE TO RELATED APPLICATION

5 This application claims priority to copending U.S. Provisional Application Numbers 62/445,697 filed January 12, 2017 to Fitzsimonds et al., entitled "Projectile Tip For Fluid Based Expansion At Lower Velocities," and 62/518,334 filed June 12, 2017 to Fitzsimonds et al., entitled "Projectile Tip For Fluid Based Expansion At Lower Velocities," which are both incorporated herein by reference.

FIELD OF THE DISCLOSURE

10 The present disclosure relates to firearm projectiles, and more specifically, to cartridges and bullets having a polymer tip.

BACKGROUND

15 In the sport of hunting, responsible hunters go to great lengths to ensure a quick, clean and humane kill. Hunters seek to select the best rifle, cartridge, bullet and optics for the particular species being hunted and the specific conditions likely to be encountered (e.g., rough terrain and thick underbrush). Hunters also practice marksmanship so that a shot can be
20 carefully placed even under challenging circumstances. If a bullet is poorly placed, the game animal may travel a long distance through rough terrain after having been shot. In these situations, there is a risk that the wounded game animal will not be recovered.

Firearm projectiles may be designed as "hollow-points", having a central pit or generally hollowed out frontal cavity that causes the projectile to expand upon impact with a
25 target. Expansion may decrease penetration and as a result, increase the amount of kinetic

energy transfer from the projectile to the target for improved stopping power. However, the central pit or hollowed out design may result in diminished aerodynamic characteristics. For example, the hollowed out design may increase axial drag which can reduce overall projectile accuracy.

- 5 To help counteract this, in some instances, hollow-point projectiles may have a converging polymer tip that is inserted into the frontal cavity to mimic the shape of a spritzer or pointed bullet.

SUMMARY

- 10 Embodiments of the disclosure are directed to an expanding projectile for firing from a gun, the projectile including a projectile body and an expansion configured tip. In one or more embodiments, the projectile body includes a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core. The metal jacket is tapered along the nose portion to an annular forward edge where the jacket defines an opening to an interior region
15 including a forward facing interior surface of the interior solid core. In one or more embodiments the expansion configured tip is positioned in the opening of the projectile and tapered forwardly from the annular forward edge to an ogive tip portion that defines a spitzer-type aerodynamic shape of the total projectile.

- Various embodiments of the disclosure provide benefits from improved expansion
20 characteristics for projectiles that impact a target at medium to lower impact velocities. In various instances, when a projectile is fired and begins to travel downrange, the forward velocity of the projectile will decay along over time and distance due to aerodynamic drag. As such, a projectile may fail to fully expand upon impact with a target at or beyond a certain range, as the projectile will lack the necessary velocity upon impact to cause projectile
25 expansion.

This can be particularly true for projectiles with polymer tips. For example, known projectiles with polymer tips generally include tips that, upon impact, are pushed axially rearward towards the tail end of the projectile and compressed within the interior region. As such, known projectiles with conventional polymer tips can impede the path of fluid into the interior of the projectile, in turn impeding projectile expansion. As such, known polymer tips typically result in a higher impact velocity threshold for expansion, as compared to un-tipped projectiles.

As such, certain embodiments are directed to an expansion configured tip for low impact velocity expansion of a projectile. In various embodiments, the expansion configured tip is configured to provide, upon impact, one or more fluid pathways into the interior region of the projectile for improved projectile expansion characteristics at medium to lower impact velocities. This results in a projectile with improved expansion characteristics at longer ranges or at reduced impact velocities compared to known expanding projectiles while still maintaining the aerodynamic improvements of a polymer tipped round.

In addition, certain embodiments are directed to an expansion configured tip formed using a relatively high density or high strength material such as a steel, tungsten, other metal, or ceramic material. In various embodiments, the expansion configured tip is formed from other materials that are stronger more dense or harder than polymer. As such, one or more embodiments provide benefits in an expanding projectile with improved munition durability before and after firing. For example, one or more embodiments provide improved resistance to rough product handling, violent magazine and feed ramp function, and excessive tip heating due to aerodynamic drag. In addition, one or more embodiments provide benefits in an expanding projectile with improved penetration characteristics. As such, certain embodiments provide an expanding projectile with improved terminal performance through barriers and that routinely break apart conventional bullets upon impact.

In addition, various embodiments can change the visual appearance of an expanding projectile. For example, one or more embodiments include geometric features, such as tip radii and/or angles, shown to have an effect on the light performance.

As such, one or more embodiments are directed to an expanding projectile including a
5 projectile body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core. In various embodiments, the metal jacket is tapered at the nose portion in a forward direction to an annular forward edge, the annular forward edge defining an opening in the metal jacket to an interior cavity extending from the opening in a rearward direction to a forward facing interior surface of the interior solid core.

10 In one or more embodiments, a tip portion is mounted in the interior cavity and has an exterior surface substantially flush with an exterior surface of the metal jacket. In certain embodiments the tip portion has a main portion forward of the opening and a tip retention portion that at least partially fills the interior cavity. In certain embodiments the tip retention portion includes one or more a fracture regions configured to, upon impact of the expanding
15 projectile with a target, fracture or deform to expose one or more fluid pathways into the interior cavity and to the forward facing interior surface for initiating expansion of the expanding projectile.

The above summary is not intended to describe each illustrated embodiment or every implementation of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

20 The drawings included in the present application are incorporated into, and form part of, the specification. They illustrate embodiments of the present disclosure and, along with the description, serve to explain the principles of the disclosure. The drawings are only illustrative
25 of certain embodiments and do not limit the disclosure.

FIG. 1 depicts an expanding projectile according to one or more embodiments of the disclosure.

FIGS. 2A-2C, depict cross section views of an expanding projectile and a tip portion, according to one or more embodiments of the disclosure.

5 FIGS. 3A-3C depict cross section views of an expanding projectile upon initial impact with a target, according to one or more embodiments of the disclosure.

FIGS. 4A & 4B depict cross section views of an expanding projectile, according to one or more embodiments of the disclosure.

10 FIGS. 5A & 5B depict cross section views of an expanding projectile upon initial impact with a target, according to one or more embodiments of the disclosure.

FIGS. 6A & 6B depict perspective and rear views of a tip portion for an expanding projectile, according to one or more embodiments of the disclosure.

FIG. 7A & 7B depict perspective and rear views of a tip portion for an expanding projectile, according to one or more embodiments of the disclosure.

15 FIG. 8A & 8B depict perspective and rear views of a tip portion for an expanding projectile, according to one or more embodiments of the disclosure.

FIG. 9A & 9B depict perspective and top down views of a tip portion for an expanding projectile, according to one or more embodiments of the disclosure.

20 FIG. 10A & 10B depict perspective and top down views of a tip portion for an expanding projectile, according to one or more embodiments of the disclosure.

FIG. 11A-11C depict perspective, top down, and side views of a tip portion for an expanding projectile, according to one or more embodiments of the disclosure.

FIG. 12A-12C depict perspective, top down, and side views of a tip portion for an expanding projectile, according to one or more embodiments of the disclosure.

FIG. 13 depicts a perspective view of an expanding projectile according to one or more embodiments of the disclosure.

FIG. 14A-14D depicts cross section views of tip portions, according to one or more embodiments of the disclosure.

5 FIG. 14E-14G depicts top down views of tip portions, according to one or more embodiments of the disclosure.

FIG. 15 depicts a cross section view of a cartridge for an expanding projectile, according to one or more embodiments of the disclosure.

10 FIGS. 16A-16B depict cross sectional views of tip portions, according to one or more embodiments of the disclosure.

FIG. 16C depicts a perspective view of a tip portion, according to one or more embodiments of the disclosure.

FIGS. 17A-17B depict cross sectional views of a tip portion, according to one or more embodiments of the disclosure.

15 FIG. 18 depicts a cross sectional view of a tip portion, according to one or more embodiments of the disclosure.

FIG. 19 depicts a cross sectional view of a tip portion, according to one or more embodiments of the disclosure.

20 FIGS. 20A-20B depict a cross sectional view and a rear view of a tip portion, according to one or more embodiments of the disclosure.

FIG. 21 depicts a cross sectional view of a tip portion, according to one or more embodiments of the disclosure.

FIG. 22 depicts a cross sectional view of a tip portion, according to one or more embodiments of the disclosure.

FIG. 23 depicts a cross sectional view of a tip portion, according to one or more embodiments of the disclosure.

While the embodiments of the disclosure are amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the disclosure to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the disclosure.

DETAILED DESCRIPTION

Referring to FIG. 1, a side view of an expanding projectile 100 is depicted according to one or more embodiments. The projectile 100 includes a projectile body 104 having a tail portion 108, a nose portion 112, and a tip portion 116 located forward of the nose portion 116.

In one or more embodiments, the projectile 100 is jacketed or plated, having a projectile body 104 composed of at least two parts including a metal jacket 120 that surrounds an interior solid core 124 depicted in FIG. 1 under a cutaway portion of the metal jacket 120. In various embodiments, the metal jacket 120 is a continuous piece of metal extending from the tail portion 108 to the nose portion 112, and defines the exterior of the expanding projectile 100.

Described further herein, in one or more embodiments the interior solid core 124, is composed of a malleable material, relative to the metal jacket 120 for expansion of the projectile body 104 upon impact with a target. In some embodiments, the interior solid core 124 is composed of lead, alloyed lead, or other suitable core material for expansion of the projectile body 104 upon impact. In various embodiments, the metal jacket 120 is composed of unalloyed copper, a copper alloyed with another metal, or other suitable projectile jacketing

or plating material. For example, the metal jacket 120 may be composed of a copper-zinc alloy for covering the interior solid core 124 while firing the projectile from a barrel.

In some embodiments, the projectile 100 is a lead-free projectile, where the projectile body 104 is a single, unitary piece of non-lead material. For example, in some embodiments, the body 104 is entirely composed of unalloyed copper, a copper alloyed with another metal, or other suitable non-lead material.

Described further herein, in one or more embodiments, the tip portion 116 defines a most forward portion for the projectile 100. In various embodiments, the tip portion 116 is a unitary structure having an exterior surface 128 that is substantially flush with an exterior surface 132 of the metal jacket 120 for forming a spitzer aerodynamic shape for the total projectile 100.

As such, in various embodiments, the exterior surface 128 of the tip portion 116 extends from a rearward portion 136, which is positioned directly adjacent to a forward portion 140 of the metal jacket 120, to a forward point 144 of the tip portion 116. In various embodiments, the tip portion 116 has a substantially pointed or ogive shape with a taper from the rearward portion 136 to the forward point 144 defined by an aspect ratio of the width 145 of the projectile 100 at the rearward portion 136 to the total length 146 of the projectile 100.

In various embodiments, the aspect ratio is in the range of 6.00 to 10.00. In certain embodiments the aspect ratio is in the range of 7.00 to 8.00. However, in various embodiments the aspect ratio can be higher or lower depending on the design and type of projectile 100.

In various embodiments, projectile 100 can be sized according to various different calibers. For example, in certain embodiments, the projectile could be a .308 Winchester round, .17 HMR, .22 Hornet, .223 Remington, .223 WSSM, .243 Winchester, .257 Roberts, .270 Winchester, 7mm Remington Magnum, .30-06 Springfield, .300 Winchester Magnum, .338 Winchester Magnum, .375 H&H, 45.70 Gov't, and .458 Winchester Magnum. However, in

certain embodiments, the projectile 100 could be sized to various other types of calibers not listed, but known in the art.

Referring to FIGS. 2A-2B, cross-section views of an expanding projectile 200 and a projectile tip 204 are depicted, according to one or more embodiments of the disclosure. In various embodiments, expanding projectile 200 shares one or more like elements with the expanding projectile 100 of FIG. 1. As such, like elements are referred to with the same reference numbers.

Expanding projectile 200 is jacketed, including a projectile body 104 composed of a metal jacket 120 extending from the tail portion 108 to the nose portion 116 and surrounding an interior solid core 124. The metal jacket 120 and nose portion 116 tapers in a forward direction, indicated by arrow 208 on a central axis 212. The metal jacket 120 extends to an annular forward edge 216 that defines an opening in the metal jacket 120 to expose a forward facing interior surface 220 of the interior solid core 124.

The interior solid core 124 is composed of a relatively malleable material so that, upon impact, the interior core material is compressed rearwardly, and the projectile 200 expands or mushrooms outward radially from the axis 212 for increased transfer of kinetic energy to a target. In certain embodiments, the forward facing interior surface 220 is a substantially flat surface normal to the central axis 212. However, in some embodiments, the forward facing interior surface 220 may be asymmetrical, have a central indentation or depression, or may have other shape based on the design of the projectile 200, on manufacturing variations, or on other factors.

In one or more embodiments, the expanding projectile 200 includes a central cavity 224 extending from the opening defined by the annular forward edge 216 to the forward facing interior surface 220. In some embodiments, the size and shape of the central cavity 224 is defined by the forward facing interior surface 220 and the interior surface 228 of the metal

jacket 120, forward of the forward facing interior surface 220. In various embodiments, the central cavity 224 has a conical shape or other shape in the interior of the projectile 200. In certain embodiments, the central cavity 224 can extend into the interior solid core 124 for enhancing mushrooming characteristics of the expanding bullet 200 upon impact.

5 In certain embodiments, the central cavity 224 has an undercut shape, as the metal jacket 120 tapers from the forward facing interior surface 220 to the opening such that the opening has a diameter smaller than that of the width of the forward facing interior surface 220 and defines undercut corner regions 232. As used herein, the undercut corner regions 232 are defined as the portion of the cavity 224 exterior to an axially extending cylinder with the radius
10 equal to the opening.

 In one or more embodiments, the tip portion 204 defines a most forward tip for the projectile 200. The tip portion 204 is a unitary structure including a main portion 236 and a tip retention portion 240 rearward of the main portion 236 and opening. The main portion 236 has an exterior surface 244 substantially flush with the exterior surface 132 of the metal jacket 120
15 for forming a relatively streamlined or spitzer aerodynamic shape.

 In various embodiments, the tip retention portion 240 is a plug element that, when assembled in the central cavity 224, resists axial movement of the tip portion 240 and retains it in place in the projectile body 104. In one or more embodiments, tip retention portion 240 is a cylindrical plug. In certain embodiments, tip retention portion 240 can have other shapes, for
20 example, tip retention portion 240 could be rectangular, hexagonal, or have other suitable shape.

 In one or more embodiments, the tip retention portion 240 includes a blind hole or axial recess 248 along the central axis of the tip portion 204 from a rear end 252 of the tip retention portion 204 to a recess end point 256 within the interior of the tip portion 204.

In certain embodiments, the axial recess 248 is cylindrical hole that defines a tubular sidewall 260 of the tip retention portion 240. In various embodiments, the axial recess 248 has a diameter 264 to define a thickness 268 of the sidewall 260. For example, in one or more embodiments, the diameter 264 of the axial recess 248 is approximately in the range of 10% to 5 70% of a total diameter 272 of the tip retention portion 240. As a result, in some embodiments, the sidewall 260 has a thickness 268 in the range of 45% to 15% of the total diameter 272 of the tip retention portion 240. In some embodiments, the axial recess 248 has a diameter 264 in the range of 80% to 60% of the total diameter 272 of the tip retention portion 240. As a result, in some embodiments, the sidewall has a thickness 268 in the range of 10% to 20% of the total 10 diameter 272 of the tip retention portion 240. However, in various embodiments, the diameter of the axial recess 248 and the corresponding thickness of the sidewall 260 can be selected as any suitable value, described further below.

In one or more embodiments, tip retention portion 240 includes a fracture region 266. Fracture region 266 is a portion of the tip portion 204 that is configured to fracture or deform 15 upon impact of the projectile 200 with a target, described further below. As such, the fracture region 266 provides a weak point, relative to other portions of the tip portion 204, for allowing the main portion 236 of the tip portion 204 to break off from the retention portion 240 upon impact with a target. However, in various embodiments, while the fracture region 266 provides a relatively weak portion of the tip portion 204, it still maintains enough structural integrity to 20 keep the tip portion 204 intact during firing and flight. As such, in various embodiments the main portion 236 maintains a solid attachment to retention portion 240 during handling, loading, firing, and during flight. As a result, the intact main portion 236 and retention portion 240 are capable as functioning as an aerodynamic element of the projectile 200, resisting the heating of air friction that occurs during projectile flight.

In various embodiments, the fracture region 266 includes portions of the tip retention portion 240 that are designed to fracture or deform at a particular impact velocity or impact force. For example, in one or more embodiments, the fracture region 266 is configured to fracture or deform at impact energies associated with velocities as low as 1500 feet per second.

5 In some embodiments, the fracture region 266 is configured to fracture or deform at impact energies associated with velocities as low as 1000 feet per second. For example, in certain embodiments, the fracture region 266 is configured to fracture or deform at impact energy as low as 800 foot pounds. However, in various embodiments, fracture regions can be designed to fracture at higher or lower impact velocities or with various energy requirements based on
10 the structural strength of the fracture region.

For example, depicted in FIG. 2B, fracture region 266 includes the sidewall 260. In various embodiments, due to the axial recess 248, the sidewall 260 forms the structurally weakest element of the tip portion 204. Described further below, upon impact with a target or object at sufficient speed or with sufficient force, the sidewall 260 will fracture or deform.

15 In one or more embodiments, the axial recess 248 extends from the rear end 252 to the recess end point 256 that is within the interior of the tip portion 204 and which is forward of the end 216 of the metal jacket 120. As such, in various embodiments, the tubular sidewall 260 is in contact with the metal jacket 120 at the annular forward end 216.

In certain embodiments, the axial recess 248 extends through at least 50% to 80% of
20 the total length 280 of the tip portion 204. For example, referring to FIG. 2B, the recess end point 256 is positioned at approximately 60% of the length 280 of the tip portion 204, measured from the rear end 252. Referring to FIG. 2C, in some embodiments, the recess end point 256 is positioned approximately 80% of the length 280 of the tip portion 204, as measured from the rear end 252. However, in various embodiments, the axial recess 248 can extend through
25 greater or lesser lengths.

Referring to FIGS 3A-3C, in operation, the projectile 200 is fired at a target 304. In various embodiments, the projectile 200 is spin stabilized due to being fired from a rifled barrel and has a rotating or spinning trajectory. FIGS. 3A and 3B depict the projectile 200 upon impact with the target 304. In various embodiments, the spinning trajectory of the projectile 200 results in a torqueing force, depicted as arrow 308, which is applied onto the tip portion 204 on impact with the target 304. As a result, in one or more embodiments, the torqueing force can cause deformation or fracturing in a lateral direction, substantially normal to the direction of the trajectory of the projectile 200. In addition, in certain embodiments, the tip portion 204 is constructed to have sufficient structural integrity to maintain its form during firing and projectile flight but is constructed to reliably deform or fracture upon impact. For example, depicted in FIGS. 3A-3C, in various embodiments the tip portion 204 is designed to reliably deform or fracture along one or more portions of the sidewall 260 of the tip retention portion 240 due to the axial recess 248 and the relatively thin material of the sidewall 260. Further, in various embodiments, the tip portion 240 is designed to, as a result of fracture or deformation, provide an opening or passageway for fluid to enter the interior of the projectile and to contact the forward facing interior surface 220.

In certain embodiments, the number of and location of fractures or deformation of the tip portion 204 can vary based on normal deviations in materials and manufacturing of the tip portions 204, the amount of and location of force on the tip portion 204 upon impact, and other various factors.

For example, depicted in FIG. 3A, due to the force generated on the tip portion 204 the tip portion 204 begins to fracture in one or more locations 312 in the tip retention portion 240 such that at least some of the main portion 236 separates from the tip retention portion 240. In various embodiments, this results because as the main portion 236 is torqued, the tip retention portion 240 is maintained within the interior of the projectile 200 and held by its fit within the

metal jacket 120. As such, the material of the tip retention portion 240 is strained and, with sufficient force, breaks or fractures the sidewall 260 of the tip retention portion 240.

In FIG. 3A, tip portion 204 includes fracture points 312 located at the annular end 216 of the metal jacket 120 while another part of the sidewall 260 at point 316 has warped and stretched under the strain of the torque. However, this part of the sidewall 260 has not fractured and maintains its connection with the main portion 236. As a result of the fracture, an opening 320 is created into the interior of the tip retention portion 240 providing access into the axial recess 248. As a result, a fluid pathway is created through the opening 320 and axial recess 248 to expose the forward facing interior surface 220 of the projectile 200 to aid projectile expansion.

Depicted in FIG. 3B, the tip portion 204 fractures at points 322 upon impact such that the main portion 236 is torn or fractured from the tip retention portion 240. As a result, opening 324 is created providing access into the axial recess 248. Thus, a fluid pathway is created through the opening 324 and axial recess 248 to the forward facing interior surface 220 of the projectile 200.

Depicted in FIG. 3C, the tip portion 204 deforms upon impact such that the main portion 236 and tip retention portion 240 are deformed. For example, in one or more embodiments, the main portion 236 and the tip retention portion 240 are compressed as a result of torquing forces on the tip portion 204. An opening 328 is therefore created from the deformed shape of the tip retention portion 240 providing access into the interior of the projectile 200 and to the forward facing interior surface 220.

In various embodiments, the torque or force required to fracture or deform the tip portion 204 is based on the materials used in the tip portion 204. For example, in one or more embodiments, the tip portion 204 can be constructed from polymer, elastomer, metal, ceramic or other material. In various embodiments, the energy required to fracture the tip portion 204

will depend upon the material used on and the design of the tip portion 204. For example, thinner or weaker structural portions of the tip portion 204 will have different energy requirements for deformation or fracture than thicker and stronger structural portions of the tip portion 204.

5 In some embodiments, the tip portion 116 could be constructed using a combination of materials. For example, in one or more embodiments, the tip portion 116 could be constructed from a combination of metal and polymer, with polymer portions located at strategic areas that are designed to fracture at lower energy requirements than a solid metal tip portion 116.

10 Referring to FIGS. 4A and 4B, cross-section views of an expanding projectile 400 are depicted, according to one or more embodiments of the disclosure. In various embodiments, expanding projectile 400 shares one or more like elements with the expanding projectile 200 of FIGS. 2A and 2B. As such, like elements are referred to with the same reference numbers.

15 For example, expanding projectile 400 is jacketed, including a metal jacket 120 defining a projectile body 104 extending from the tail portion 108 to a nose portion 112 and surrounding an interior solid core 124. The metal jacket 120 extends to an annular forward edge 216 that defines an opening in the metal jacket 120 to expose an interior solid core 124 and a forward facing interior surface 220. In one or more embodiments, the expanding projectile 400 includes a central cavity 224 extending from the opening defined by the annular forward edge 216 to the forward facing interior surface 220.

20 In one or more embodiments, the expanding projectile 400 includes a tip portion 404 defining a most forward tip for the projectile 400. The tip portion 404 is a unitary structure including a main portion 408 and a tip retention portion 412 rearward of the main portion 408 and opening. The main portion 412 has an exterior surface 414 substantially flush with an exterior surface 132 of the metal jacket 120 for forming a relatively streamlined or spitzer
25 aerodynamic shape.

In various embodiments, the tip retention portion 412 is a plug element that, when assembled in the central cavity 232, resists axial movement of the tip portion 404 and retains it in place in the projectile body 104. In various embodiments, tip retention portion 412 is a cylindrical plug. In certain embodiments, tip retention portion 412 can have other shapes, for example, tip retention portion 412 could be rectangular, hexagonal, or have other suitable shape.

In one or more embodiments, the tip retention portion 412 includes a shoulder portion 414 and a neck portion 416 that is connected to the main portion 408. In various embodiments, the neck portion 416 defines a generally thinner and structurally weaker portion of the tip retention portion 412 having a thinner area of material for connection to the main portion 408. For example, in one or more embodiments, the neck portion 416 has a thickness 424 and a width 428 compared to a shoulder width 432 of the shoulder portion 414. In certain embodiments, the neck portion 416 has a thickness 424 approximately in the range of 33% to 10% of the width 432 of the shoulder portion 420. In some embodiments the neck portion 416 has a thickness 428 approximately in the range of 5% to 20% of the total length 437 of the tip portion 404.

In one or more embodiments, tip retention portion 412 includes a fracture region 434. Similarly as described above with reference to FIGS. 2A-3C, fracture region 434 is a portion of the tip portion 404 that is configured to fracture or deform upon impact of the projectile 400 with a target, described further below. In various embodiments, the fracture region 434 includes portions of the tip retention portion 412 that are designed to fracture or deform at a particular impact velocity or impact force. For example, in one or more embodiments, the fracture region 434 is configured to fracture or deform at impact velocities as low as 1500 feet per second. In some embodiments, the fracture region 434 is configured to fracture or deform at impact energies associated with velocities as low as 1000 feet per second. For example, in certain

embodiments, the fracture region 434 is configured to fracture or deform at impact energy as low as 800 foot pounds. However, in various embodiments, fracture regions can be designed to fracture at higher or lower impact energies or velocities or based on the structural strength of the fracture region 434.

5 For example, depicted in FIG. 4B, fracture region 434 includes the neck portion 416. In various embodiments, due to the generally reduced width 428 and thickness 424 of the neck portion 416, as compared to the main portion 408 and the shoulder portion 414, the neck portion 416 forms the structurally weakest element of the tip portion 404. Described further below, upon impact with a target or object at sufficient speed or with sufficient force, the neck portion
10 416 will fracture or deform.

In various embodiments, the shoulder portion 420 includes one or more axial recesses 432. As used herein, axial recess refers to any hole or cut out portion in the tip portion 404 that extends lengthwise or substantially parallel to the central axis of the tip portion 404. For example, axial recesses 432 are offset from the central axis of the tip portion, but extend
15 lengthwise from the rear end 435 to a recess end point 436. In certain embodiments, the axial recess 432 extends through at least 40% to 80% of the total length 437 of the tip portion 404. For example, referring to FIG. 4B, the recess end point 436 is positioned at approximately 50% of the length 437 of the tip portion 404, measured from the rear end 435. However, in various embodiments, the axial recess 432 can extend through greater or lesser lengths of the tip portion
20 404.

Referring to FIGS. 5A-5B, in operation, the projectile 400 is fired at a target 304. In various embodiments, the projectile 400 is spin stabilized due to being fired from a rifled barrel and has a rotating or spinning trajectory. FIGS. 5A-5B depict the projectile 400 upon impact with the target 304. In various embodiments, the spinning trajectory of the projectile 400 results
25 in a torqueing force, depicted as arrow 308, which is applied onto the tip portion 404 on impact

with the target 304. As a result, in one or more embodiments, the torquing force can cause deformation or fracturing of the fracture region 434 in a lateral direction, substantially normal to the direction of the trajectory of the projectile 400.

In addition, in certain embodiments, the fracture region 434 is constructed to have sufficient structural integrity to maintain its form during firing and projectile flight but is constructed to reliably deform or fracture upon impact. For example, depicted in FIGS. 5A-5B, in various embodiments the fracture region 434 is designed to reliably deform or fracture in the neck portion 416 due to the relatively thin material compared to the shoulder portion 420 of the tip retention portion 412.

Further, in various embodiments, the tip portion 404 is designed to, as a result of fracture or deformation, provide an opening 440 or passageway for fluid to enter the interior of the projectile and to contact the forward facing interior surface 220.

For example, depicted in FIG. 5A, due to the force generated on the tip portion 404, the neck portion 416 of the tip retention portion 412 begins to fracture in one or more locations such that the main portion 408 is separated from the tip retention portion 412. In various embodiments, this results because as the main portion 408 is torqued, the tip retention portion 412 is maintained within the interior of the projectile 400 and held by its fit within the metal jacket 120. As such, the fracture region 434 of the tip retention portion 412 is strained and, with sufficient force, fractures or deforms the neck portion 416.

In FIG. 5A, the tip portion 404 fractures upon impact such that the main portion 408 is torn or fractured from the tip retention portion 412. As a result, opening 440 is created into the interior of the tip retention portion 412 and provides access to axial recesses 432. Thus, a fluid pathway is exposed through the opening 440 and fluid passageways 432 to the forward facing interior surface 220 to aid projectile expansion.

Depicted in FIG. 5B, the tip portion 404 deforms upon impact such that the main portion 408 and tip retention portion 412 are deformed. For example, in one or more embodiments, the main portion 408 and the tip retention portion 412 are compressed together in a lateral direction as a result of torqueing forces on the tip portion 404. An opening 440 is therefore created from the deformed shape of the tip retention portion 400 providing access to one or more of the axial recesses 432.

As described above, in various embodiments, the torque or force required to fracture or deform the tip portion 404 is based on the materials used in the tip portion 404. For example, in one or more embodiments, the tip portion 404 can be constructed from polymer, elastomer, metal, ceramic or other material. In various embodiments, the energy required to fracture the tip portion will depend upon the material used on and the design of the tip portion 404. For example, thinner or weaker structural portions of the tip portion 404 will have different energy requirements for deformation or fracture than thicker and stronger structural portions of the tip portion 404. In some embodiments, the different portions of the tip portion 404 can be constructed from different materials. For example, in some the main portion 408 or other elements of the tip portion 404 could be constructed from at least one of metal or ceramic and the fracture region 434 could be constructed from a polymer material.

In certain embodiments, the number of and location of fractures or deformation of the tip portion 404 can vary based on normal deviations in materials and manufacturing of the tip portions 404, the amount of and location of force on the tip portion 404 upon impact, and other various factors.

Referring to FIGS. 5A-12B, various tip portions are depicted, according to one or more embodiments of the disclosure.

For example, referring to FIGS. 6A & 6B, a tip portion 500 is depicted having a main portion 504 and a tip retention portion 508. In various embodiments, the tip retention portion

508 can be constructed with various designs. For example, tip retention portion 508 is cross shaped or tee-shaped having a widthwise portion 512 and a crosswise portion 516 that intersect along a central axis 520. Crosswise portion 516 and widthwise portion 512 provide a plurality of outwardly facing surfaces 518 that allow for frictional mounting the tip portion 500 within
5 an interior of an expanding projectile. Further, as a result of the crosswise and widthwise portions 512, 516, four axial recesses 524 are defined extending from a rear end 528 of the tip retention portion 508 to a rear end 532 of the main portion 504. Further, a fracture region is defined in the tip retention portion 508 by the widthwise and the crosswise portions 512, 516 as the tip portion 500 is configured to either deform or fracture upon impact to expose one or
10 more openings into the axial recesses 524 which would in turn provide a fluid passageway to interior surfaces of an expanding projectile, as described above.

Referring to FIGS. 7A & 7B, a tip portion 700 is depicted having a main portion 704 and a tip retention portion 708. In one or more embodiments, tip retention portion 708 includes one or more splines 712 which extend radially from a central axis 720 and extend along the
15 length of the tip retention portion 708. Depicted in FIGS. 7A & 7B, four splines 712 are shown, however, in various embodiments fewer or greater amounts of splines 712 could be included in the tip retention portion 708 based on the preferred design. In various embodiments, the one or more splines 712 provide a plurality of outwardly facing surfaces 718 that allow for frictional mounting of the tip portion 700 within an interior of an expanding projectile.

20 As a result of the splines 712 four axial recesses 724 are defined extending from a rear end 728 of the tip retention portion 708 to a rear end 732 of the main portion 704. Further, a fracture region is defined in the tip retention portion 708 by the splines 712 as the tip retention portion 708 is configured to either deform or fracture upon impact to expose one or more openings into the axial recesses 724, which would expose interior surfaces of an expanding
25 projectile, as described above.

Referring to FIGS. 8A & 8B, a tip portion 800 is depicted having a main portion 804 and a tip retention portion 808. In one or more embodiments, tip retention portion 808 includes a plurality of splines 812 which extend outwardly radially along a central axis 820. Depicted in FIGS. 8A & 8B, ten splines 812 are shown, however, in various embodiments fewer or
5 greater amounts of splines 812 could be included in the tip retention portion 808 based on the preferred design. In various embodiments, the plurality of splines 812 provide a plurality of outwardly facing surfaces 818 that allow for frictional mounting of the tip portion 800 within an interior of an expanding projectile.

As a result of the splines 812 ten axial recesses 824 are defined extending from a rear
10 end 828 of the tip retention portion 808 to a rear end 832 of the main portion 804. Further, a fracture region is defined in the tip retention portion 808 by the splines 812 as the tip retention portion 808 is configured to either deform or fracture upon impact to expose one or more openings into the axial recesses 824, which would expose interior surfaces of an expanding projectile, as described above.

Referring to FIGS. 9A-10B, in one or more embodiments, a tip portion can include a
15 one or more axial recesses that extend through both the tip retention portion and a substantial portion of the main portion. For example, referring to FIGS. 9A-9B, a tip portion 900 is depicted having a main portion 904 and tip retention portion 908. In addition, a plurality of axial recesses 912 extend from a rear end 914 of the tip portion to a recess end point 916
20 positioned in the main portion 904 and define a splined shape for the tip portion 904, depicted in the top down profile view in FIG. 9B. Further, when mounted in an expanding projectile, the tip portion 900 includes one or more openings into the axial recesses 912 without fracture or deformation, to ensure exposure of interior surfaces of an expanding projectile, as described above.

Similarly, FIG. 10A-10B depicts a tip portion 1000 having a main portion 1004 and tip retention portion 1008 with a plurality of axial recesses 1012 extend from a rear end 1014 of the tip portion 1000 to a recess end point 1016 positioned in the main portion 1004. As such, when mounted in an expanding projectile, the tip portion 1000 includes one or more openings
5 into the axial recesses 1012 without fracture or deformation, to ensure exposure of interior surfaces of an expanding projectile, as described above.

Referring to FIGS. 11A-12C, in one or more embodiments, a tip portion can include one or more axial recesses in a main portion for improved fracturing or deformation of a fracture region.

10 For example, referring to FIGS. 11A-11C, in one or more embodiments a tip portion 1100 having a main portion 1104 and tip retention portion 1108. A plurality of axial recesses 1112 extend from a rear end 1113 of the main portion to a recess end point 1114 in the main portion 1104. In addition, tip retention portion 1108 includes a fracture region 1116 in the tip retention portion 1108 from a neck portion that connects a wider shoulder portion to the main
15 portion 1104. In various embodiments, axial recesses 1112 provide an opening exposing the fracture region 1116 for increased aerodynamic friction on the fracture region 1116 to assist in deformation or fracture upon impact, as described above.

In FIGS. 12A-12C a tip portion 1200 is depicted having a main portion 1204 with a plurality of axial recesses 1212 extend from a rear end 1213 of the main portion to a recess end
20 point 1214. In addition, a tip retention portion 1208 includes a fracture region 1216 in the tip retention portion 1208 from a neck portion that connects a wider shoulder portion to the main portion 1204. In various embodiments, axial recesses 1212 provide an opening exposing the fracture region 1216 for increased aerodynamic friction on the fracture region 1216 to assist in deformation or fracture upon impact, as described above.

Referring to FIG. 13, a top perspective view of a nose of an expanding projectile 1300 is depicted, according to one or more embodiments. In various embodiments, expanding projectile 1300 can share one or more like elements with expanding projectile 100 of FIG. 1. As such, like elements are referred to with the same reference numbers. For example, expanding projectile 1300 is jacketed, including a projectile body 104 composed of a metal jacket 120 extending from a tail portion to an annular forward end 1304 and surrounding an interior solid core. In various embodiments, the forward end 1304 of the metal jacket 120 includes one or more skives 1308 or longitudinal cuts for improved expansion upon projectile impact.

In one or more embodiments, projectile 1300 includes a tip portion 1312. In various embodiments, tip portion 1312 can include a forward central opening 1316 defined by an annular forward edge 1320 at a forward most portion of the tip portion 1312. Described further below, in various embodiments the central opening 1316 of the tip portion 1312 is a recess end point for an axial recess that extends through the tip portion 1300 to expose a forward facing interior surface of the projectile 1300.

For example, referring to FIGS. 14A-14G, various designs of a tip portion including one or more axial recesses that extend through the length of the tip portion are depicted, according to one or more embodiments. Referring to FIG. 14A-14C, a tip portion 1400A, 1400B, 1400C includes a centrally located axial recess 1404, 1405, 1406 that extends from a rear end 1408 of a tip retention portion 1412 to a recess end point 1416 at the forward most point of the tip portion 1400A, 1400B, 1400C. As such, axial recess 1404, 1405, 1406 defines a central through-hole in the tip portion 1400A, 1400B, 1400C that, when mounted in an expanding projectile, provides a fluid passageway through to various interior surfaces.

Referring to FIG. 14D, in various embodiments, a tip portion 1400D, includes a plurality of axial recesses 1418 that extends from a rear end 1408 of a tip retention portion 1412 to a recess end point 1420 at the forward most point of the tip portion 1400D. As such,

axial recess 1418 defines a central through-hole in the tip portion 1400D that, when mounted in an expanding projectile, provides a fluid passageway through to various interior surfaces. Depicted in FIGS. 14E-14G, in various embodiments, the tip portion 1400D can include a variety of axial recesses. For example, tip portion 1400E includes four axial recesses 1418, while tip portions 1400F and 1400G includes three and six axial recesses 1418 respectively. In various embodiments the tip portion 1400D can include fewer or greater number of axial recesses 1418.

Referring to FIG. 15 a cartridge 1500 including an expanding projectile 100 is depicted, according to one or more embodiments of the disclosure. In various embodiments, the cartridge 1500 includes casing 1504, propellant 1508, separation plate 1510, and a primer 1512. Seen in FIG. 15, casing 1504 is sized to contact a portion of projectile 100, such that when fired, the projectile 100 is launched from the casing 1504 and directly engages with a rifled barrel of a projectile delivery system.

In addition, in some embodiments, the projectile 100 includes a crimped portion 1514 and a band 1516 for coupling with the casing 1504 of the cartridge 1500. Additionally, the necked casing 1500 can be crimped on recesses provided by the crimped portion 1514. In certain embodiments, the band 1516 provides material such as nylon, plastic, copper, or other suitable material on the projectile 100 allowing for a secure sealing engagement with the rifled barrel upon firing.

Referring to FIGS. 16A-16C, cross-section views and a perspective view of an expanding projectile 1600 and a projectile tip portion 1604 are depicted, according to one or more embodiments of the disclosure. In various embodiments, expanding projectile 1600 shares one or more like elements with the expanding projectile 200 of FIG. 2A. As such, like elements are referred to with the same reference numbers. Expanding projectile 1600 is jacketed, having a metal jacket 120 extending from the tail portion 108 to the nose portion 116

and surrounding an interior solid core 124. The metal jacket 120 extends to an annular forward edge 216 that defines an opening in the metal jacket 120 to expose a forward facing interior surface 220 of the interior solid core 124.

In one or more embodiments, the expanding projectile 1600 includes a central cavity 224 extending from the opening defined by the annular forward edge 216 to the forward facing interior surface 220. In certain embodiments, the central cavity 224 has an undercut shape, as the metal jacket 120 tapers from the forward facing interior surface 220 to the opening such that the opening has a diameter smaller than that of the width of the forward facing interior surface 220 and defines undercut corner regions 232.

In one or more embodiments, the tip portion 1604 defines a most forward tip for the projectile 1600. The tip portion 1604 is a unitary structure including a main portion 1608 and a tip retention portion 1612 rearward of the main portion 1608 and opening. As described above, in various embodiments the tip retention portion 1612 is a plug element that, when assembled in the central cavity 224, resists axial movement of the tip portion 1604 and retains it in place in the projectile 1600.

In one or more embodiments, tip retention portion 1612 tapers rearwardly from a forward portion 1616, adjacent to the main portion 1608, to a rearward portion 1618 adjacent a rearwardly facing end surface 1620 of the tip portion 1604. For example, tip retention portion 1612 has a first width 1624 at the forward portion 1616 and a second smaller width 1628 at the rearward portion 1618. In various embodiments the second width 1628 is approximately 10% smaller than the first width 1624. In certain embodiments the second width 1628 is approximately 5% to 20% smaller than the first width 1624. In certain embodiments the first width is approximately 20% to 50% smaller than the first width 1624. In various embodiments, the first width 1624 defines the outermost width of the tip portion. In addition, in certain embodiments the first width 1624 is sized such that the tip portion fits or couples to the

remainder of the projectile 1600 via a friction fit or interference fit with the metal jacket 120 at the opening.

As such, in one or more embodiments, tip retention portion 1612 includes a fracture region 1632 defined by the tapered shape of the tip retention portion 1612. Fracture region 1632 is a portion of the tip portion 1604 that is configured to fracture or deform upon impact of the projectile 1600 with a target, as described above, thereby providing a fluid pathway into the central cavity 224 and exposing the forward facing interior surface 220. In various embodiments the fracture region 1632 is defined by the tapered shape of the tip retention portion 1612. For example, the tapered shape provides a weak point in the coupling between the tip portion 1604 and the remainder of the projectile 1600 in the form of a void 1636 between the metal jacket 120 and the tip retention portion 1612 for the main portion 1608 of the tip to deform or break off.

In one or more embodiments, the fracture region 1632 is configured to fracture or deform at impact energies associated with velocities as low as 1500 feet per second. In some embodiments, the fracture region 1632 is configured to fracture or deform at impact energies associated with velocities as low as 1000 feet per second. For example, in certain embodiments, the fracture region 1632 is configured to fracture or deform at impact energy as low as 800 foot pounds. However, in various embodiments, fracture regions can be designed to fracture at higher or lower impact velocities or with various energy requirements based on the structural strength of the fracture region.

Referring to FIGS. 17A-17B, cross-section views of an expanding projectile 1700 and a projectile tip portion 1704 are depicted, according to one or more embodiments of the disclosure. In various embodiments, expanding projectile 1700 shares one or more like elements with the expanding projectile 200 of FIG. 2A. As such, like elements are referred to with the same reference numbers. In one or more embodiments, the expanding projectile 1700

includes a central cavity 224 extending from the opening defined by the annular forward edge 216 to the forward facing interior surface 220. In certain embodiments, the central cavity 224 has an undercut shape, as the metal jacket 120 tapers from the forward facing interior surface 220 to the opening such that the opening has a diameter smaller than that of the width of the forward facing interior surface 220 and defines undercut corner regions 232.

In one or more embodiments, the tip portion 1704 defines a most forward tip for the projectile 1700. The tip portion 1704 is a unitary structure including a main portion 1708 and a tip retention portion 1712 rearward of the main portion 1608 and opening. As described above, in various embodiments the tip retention portion 1612 is a plug element that, when assembled in the central cavity 224, resists axial movement of the tip portion 1704 and retains it in place in the projectile 1700.

In various embodiments the tip retention portion 1712 is shortened, having a first length 1716 that is between 10% to 40% of a total length 1720 of the tip portion 1704. In various embodiments, this shortened tip retention portion 1712 provides a void 1724 between the forward facing interior surface 220 and the tip portion 1704. As a result, the tip portion 1704 is not supported axially by the interior surface 200 and is supported solely by the metal jacket of the projectile 1700. In various embodiments this allows the tip portion to, upon impact, telescope into the central cavity 224 upon impact with a target, thereby providing a fluid pathway to the central core 124.

Referring to FIG. 18 a cross-section view an expanding projectile 1800 and projectile tip portion 1804 is depicted, according to one or more embodiments of the disclosure. In various embodiments, expanding projectile 1800 share one or more like elements with the expanding projectile 200 of FIG. 2A. As such, like elements are referred to with the same reference numbers. Expanding projectile 1800 is jacketed, having a metal jacket 120 extending

to an annular forward edge 216 that defines an opening in the metal jacket 120 to expose a forward facing interior surface 220 of the interior solid core 124.

In one or more embodiments, the expanding projectile 1800 includes a central cavity 224 extending from the opening defined by the annular forward edge 216 to the forward facing interior surface 220. In certain embodiments, the central cavity 224 has an undercut shape, as the metal jacket 120 tapers from the forward facing interior surface 220 to the opening such that the opening has a diameter smaller than that of the width of the forward facing interior surface 220 and defines undercut corner regions 232.

In one or more embodiments, the tip portion 1804 defines a most forward tip for the projectile 1800. The tip portion 1704 is a unitary structure including a main portion 1808 and a tip retention portion 1812 rearward of the main portion 1808 and opening. As described above, in various embodiments the tip retention portion 1812 is a plug element that, when assembled in the central cavity 224, resists axial movement of the tip portion 1804 and retains it in place in the projectile 1600.

In one or more embodiments, tip retention portion 1812 at a forward portion 1816, adjacent to the main portion 1808. As a result, tip retention portion 1812 has a reduced width at the forward portion 1816. In various embodiments the width at the forward portion is reduced approximately 10% as compared to the wider portions of the tip retention portion 1812. In certain embodiments the reduced width is approximately 5% to 20% smaller. In certain embodiments the reduced width is 20% to 50% smaller.

In various embodiments, the width at the forward portion 1816 defines a fracture region 1832 defined by the tapered shape of the tip retention portion 1812. Fracture region 1832 is configured to fracture or deform upon impact of the projectile 1800 with a target, as described above, thereby providing a fluid pathway into the central cavity 224 and exposing the forward facing interior surface 220. In one or more embodiments, the fracture region 1832 is configured

to fracture or deform at impact energies associated with velocities as low as 1500 feet per second. In some embodiments, the fracture region 1832 is configured to fracture or deform at impact energies associated with velocities as low as 1000 feet per second. For example, in certain embodiments, the fracture region 1832 is configured to fracture or deform at impact energy as low as 800 foot pounds. However, in various embodiments, fracture regions can be designed to fracture at higher or lower impact velocities or with various energy requirements based on the structural strength of the fracture region.

Referring to FIG. 19 a cross-sectional view of an expanding projectile 1900 with tip portion 1904 is depicted, according to one or more embodiments. In certain embodiments, projectile 1900 includes an interior solid core 124 having a forwardly extending central stub 1906. In various embodiments, the central stub 1906 is axially centered and extends forward to the forward opening of the projectile 1900 as defined by the metal jacket 120. In certain embodiments the central stub extends to be flush with the forward opening.

In various embodiments the tip portion 1904 is injection molded or insert molded onto the projectile 1900. As a result the polymer material of the tip portion 1904 fills the area surrounding the central stub 1906 as well as the volume outside of the bullet – to form the tip 1904. As a result, the tip portion 1904 defines an annular tip retention portion 1912 surrounding the central stub 1906 and that is rigidly locked to the bullet. In addition, as a result of the tapered shape of the metal jacket at the nose portion 116, the molding process defines a fracture region 1932 of thinner material near the main portion 1908. In various embodiments the fracture region 1932 is thinner to promote breakage upon impact, as described above.

Referring to FIGS. 20A-20B a tip portion 2000 is depicted having a main portion 2004 and a tip retention portion 2008. In one or more embodiments, tip retention portion 808 includes a plurality of axially extending recesses 2012 which are distributed circumferentially about the exterior of the tip retention portion 2008. Depicted in FIGS. 20A & 20B, six recesses 2012 are

shown, however, in various embodiments fewer or greater amounts could be included in the tip retention portion 2008 based on the preferred design.

As a result of the recesses 2012, a fracture region is defined in the tip retention portion 2008, as the tip retention portion 808 is configured to either deform or fracture upon impact to
5 expose one or more openings into the axial recesses 2012, which would expose interior surfaces of an expanding projectile, as described above.

Referring to FIGS. 21-22 tip portions 2100, 2200 are depicted having a main portion 2104, 2204 and a tip retention portion 2108, 2208. In one or more embodiments, tip portion 2100, 2200 are constructed using multiple materials. For example, tip retention portion 2108,
10 2208 is constructed, in certain embodiments, of a first material, while the main portion 2104, 2204 is constructed from a first material. In various embodiments the main portion and tip retention portion are constructed using a two-shot mold. In certain embodiments the first material is a generally harder material for resisting heat and providing robustness, while the second material is a softer material configured to fail upon impact and provide fluid
15 passageways into the projectile as described above.

As a result of the molding processes, a fracture region 2112, 2212 is defined in the tip retention portions 2108, 2208, as the tip retention portion is configured to either deform or fracture upon impact.

Referring to FIG. 23 a tip portion 2300 is depicted having a main portion 2304 and a
20 tip retention portion 2308. In one or more embodiments, tip portion 2300 includes a recesses 2316 defining a fracture region 2312 in the tip retention portion 2308 from structurally weakened areas resulting from the reduction of materials in the recess 2316. As a result of the fracture regions 2312 the tip retention portion 2308 is configured to either deform or fracture upon impact, as described above.

The descriptions of the various embodiments of the present disclosure have been presented for purposes of illustration, but are not intended to be exhaustive or limited to the embodiments disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the described
5 embodiments. The terminology used herein was chosen to explain the principles of the embodiments, the practical application or technical improvement over technologies found in the marketplace, or to enable others of ordinary skill in the art to understand the embodiments disclosed herein.

CLAIMS

What is claimed is:

1. An expanding projectile comprising:

a projectile body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core, the metal jacket tapered at the nose portion in a forward direction to an annular forward edge, the annular forward edge defining an opening in the metal jacket to an interior cavity extending from the opening in a rearward direction to a forward facing interior surface of the interior solid core;

a tip portion mounted in the interior cavity and having an exterior surface substantially flush with an exterior surface of the metal jacket, the tip portion having a main portion forward of the opening and a tip retention portion at least partially filling the interior cavity, the tip retention portion including one or more fracture regions configured to, upon impact of the expanding projectile with a target, fracture or deform to expose one or more fluid pathways into the interior cavity and to the forward facing interior surface for initiating expansion of the expanding projectile.

2. The expanding projectile of claim 1, wherein, the tip retention portion includes one or more recesses extending axially in the forward direction from a rear end of the tip retention portion to a recess end point.

3. The expanding projectile of claim 2, wherein the one or more recesses include an axially centered recess extending from the rear end of the tip retention portion to a recess end point within the interior of the tip portion.

4. The expanding projectile of claim 3, wherein the axially centered recess defines a tubular sidewall for the tip retention portion surrounding the axially centered recess and having a sidewall thickness in the range of 33% to 10% of a total width of the tip retention portion.
5. The expanding projectile of claim 3, wherein the axially centered recess defines a tubular sidewall for the tip retention portion surrounding the axially centered recess and having a sidewall thickness in the range of 20% to 10% of a total width of the tip retention portion.
6. The expanding projectile of claim 3, wherein the axially centered recess extends from the rear end of the tip retention portion and to the recess end point through at least 50% to 80% of a total length of the tip portion.
7. The expanding projectile of claim 1, wherein the tip retention portion includes a shoulder portion and a neck portion connected to and between the main portion of the tip portion and the shoulder portion.
8. The expanding projectile of claim 7, wherein the neck portion has a width in the range of 33% to 10% of a total width of the shoulder portion.
9. The expanding projectile of claim 7, wherein the fracture region is the neck portion.
10. The expanding projectile of claim 7, wherein the main portion is constructed from at least one of metal or ceramic and wherein the fracture region of the tip retention portion is constructed from a polymer material.

11. The expanding projectile of claim 1, wherein the expanding projectile has a caliber selected from at least one of a group consisting of .308 Winchester, .17 HMR, .22 Hornet, .223 Remington, .223 WSSM, .243 Winchester, .257 Roberts, .270 Winchester, 7mm Remington Magnum, .30-06 Springfield, .300 Winchester Magnum, .338 Winchester Magnum, .375 H&H, 45.70 Gov't, and .458 Winchester Magnum.

12. The expanding projectile of claim 1, wherein the one or more fracture regions are configured to fracture or deform to expose one or more fluid pathways into the interior cavity upon impact of the expanding projectile at an impact energy at least as large as 800 foot pounds.

13. The expanding projectile of claim 1, wherein the one or more fracture regions are configured to fracture or deform to expose one or more fluid pathways into the interior cavity upon impact of the expanding projectile at an impact velocity at least as large as 1000 feet per second.

14. A tip portion for mounting in an opening of a forward end of an expanding projectile, the tip portion comprising:

a main portion and a tip retention portion, main portion having an ogive shape extending from wider rearward portion to a tapered forward most tip, the tip retention portion connected to the rearward portion and extending in a rearward direction to a rearmost end of the tip portion; and

one or more a fracture regions defined in the tip retention portion, the one or more fracture regions configured to, when the tip portion is mounted in an expanding projectile, fracture or deform upon impact with a target and expose one or more fluid pathways into an interior cavity of the expanding projectile.

15. The tip portion of claim 14, wherein, the tip retention portion includes one or more recesses extending axially in the forward direction from a rear end of the tip retention portion to a recess end point.

16. The tip portion of claim 15, wherein the one or more recesses include an axially centered recess extending from the rear end of the tip retention portion to a recess end point within the interior of the tip portion.

17. The tip portion of claim 16, wherein the axially centered recess defines a tubular sidewall for the tip retention portion surrounding the axially centered recess and having a sidewall thickness in the range of 33% to 10% of a total width of the tip retention portion.

18. The portion of claim 16, wherein the axially centered recess defines a tubular sidewall for the tip retention portion surrounding the axially centered recess and having a sidewall thickness in the range of 20% to 10% of a total width of the tip retention portion.

19. The tip portion of claim 16, wherein the axially centered recess extends from the rear end of the tip retention portion and to the recess end point through at least 50% to 80% of a total length of the tip portion.

20. The tip portion of any one of claims 14-19, wherein the tip retention portion includes a shoulder portion and a neck portion connected to and between the main portion of the tip portion and the shoulder portion.

21. The tip portion of claim 20, wherein the neck portion has a width in the range of 33% to 10% of a total width of the shoulder portion.

22. The tip portion of any one of claims 20-21, wherein the fracture region is the neck portion.

23. A cartridge comprising, a casing, propellant, and an expanding projectile, the expanding projectile comprising:

a projectile body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core, the metal jacket tapered at the nose portion in a forward direction to an annular forward edge, the annular forward edge defining an opening in the metal jacket to an interior cavity extending from the opening in a rearward direction to a forward facing interior surface of the interior solid core;

a tip portion mounted in the interior cavity and having an exterior surface substantially flush with an exterior surface of the metal jacket, the insert-molded polymer tip having a main portion forward of the opening and a tip retention portion at least partially filling the interior cavity, the tip retention portion including one or more a fracture regions configured to, upon impact of the expanding projectile with a target, fracture or deform to expose one or more fluid pathways into the interior cavity and to the forward facing interior surface for initiating expansion of the expanding projectile.

24. The cartridge of claim 15, wherein the cartridge is a centerfire cartridge.

25. The cartridge of claim 15, wherein the expanding projectile has a caliber selected from at least one of a group consisting of .308 Winchester, .17 HMR, .22 Hornet, .223 Remington, .223 WSSM, .243 Winchester, .257 Roberts, .270 Winchester, 7mm Remington Magnum, .30-06 Springfield, .300 Winchester Magnum, .338 Winchester Magnum, .375 H&H, 45.70 Gov't, and .458 Winchester Magnum.

26. An expanding projectile comprising:

a projectile body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core, the metal jacket tapered at the nose portion in a forward direction to an annular forward edge, the annular forward edge defining an opening in the metal jacket to an interior cavity extending from the opening in a rearward direction to a forward facing interior surface of the interior solid core;

a tip portion mounted in the interior cavity and having an exterior surface substantially flush with an exterior surface of the metal jacket, the tip portion having a main portion forward of the opening and a tip retention portion at least partially filling the interior cavity, the tip retention portion including:

fracture region means to fracture or deform, upon impact of the expanding projectile with a target, and expose one or more fluid pathways to the forward facing interior surface of the interior solid core for initiating expansion of the expanding projectile.

27. The expanding projectile of claim 1, wherein, the fracture region means are defined by one or more axial recesses that extend from a rear end of the tip portion to a recess end point within the interior of the tip portion.

28. An expanding projectile comprising:

a projectile body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core, the metal jacket tapered at the nose portion in a forward direction to an annular forward edge, the annular forward edge defining an opening in the metal jacket to an interior cavity extending from the opening in a rearward direction to a forward facing interior surface of the interior solid core;

a tip portion mounted in the interior cavity and having an exterior surface substantially flush with an exterior surface of the metal jacket, the tip portion having a main portion forward of the opening and a tip retention portion at least partially filling the interior cavity, the tip portion including:

fluid pathway means for exposing the forward facing interior surface of the interior solid core for initiating expansion of the expanding projectile upon impact of the expanding projectile with a target.

29. An expanding projectile comprising:

a projectile body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core, the metal jacket tapered at the nose portion in a forward direction to an annular forward edge, the annular forward edge defining an opening in the metal jacket to an interior cavity extending from the opening in a rearward direction to a forward facing interior surface of the interior solid core; and

tip portion means for, upon impact of the expanding projectile with a target, telescoping into the interior cavity and providing one or more fluid pathways to the interior surface of the interior solid core;

wherein the tip portion means is mounted in the interior cavity and has an exterior surface substantially flush with an exterior surface of the metal jacket, the tip portion having a

main portion forward of the opening and a tip retention means at least partially filling the interior cavity.

30. An expanding projectile comprising:

a projectile body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core, the metal jacket tapered at the nose portion in a forward direction to an annular forward edge, the annular forward edge defining an opening in the metal jacket to an interior cavity extending from the opening in a rearward direction to a forward facing interior surface of the interior solid core; and

tip portion means for, upon impact of the expanding projectile with a target, initializing expansion of the expanding projectile by providing one or more fluid pathways to the interior surface of the interior solid core.

31. The expanding projectile of claim 5, wherein the tip portion means is mounted in the interior cavity and has an exterior surface substantially flush with an exterior surface of the metal jacket, the tip portion means having a main portion forward of the opening and a tip retention means at least partially filling the interior cavity.

32. The expanding projectile of any one of claims 30-31, wherein the one or more fluid pathways is defined by one or more axial recesses that extend from a rear end of the tip portion means to a recess end point at a forward most point of the tip portion means.

33. The expanding projectile of any one of claims 30-32, wherein the tip portion means includes one or more fracture regions configured to, upon impact of the expanding projectile with the target, fracture or deform to expose the one or more fluid pathways.

34. The expanding projectile of any one of claims 30-33, wherein the tip portion means, upon impact of the expanding projectile with the target, telescope into the interior cavity to provide the one or more fluid pathways to the interior surface of the interior solid core.

35. A tip portion for mounting in an opening of a forward end of an expanding projectile, the tip portion comprising:

a main portion and a tip retention portion, main portion having an ogive shape extending from wider rearward portion to a tapered forward most tip, the tip retention portion connected to the rearward portion and extending in a rearward direction to a rearmost end of the tip portion; and

fracture region means to, when the tip portion is mounted in an expanding projectile, fracture or deform upon impact with a target and expose one or more fluid pathways into an interior cavity of the expanding projectile;

wherein the fracture region means are defined in the tip retention portion.

36. A cartridge with an expanding bullet comprising:

a casing with a rearward primer, propellant, and the bullet, the bullet comprising:

a bullet body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core, the metal jacket tapered at the nose portion in a forward direction to an annular forward edge, the annular forward edge defining an opening in the metal jacket to an interior cavity extending from the opening in a rearward direction to a forward facing interior surface of the interior solid core;

a polymer tip mounted in the interior cavity and having an exterior surface substantially flush with an exterior surface of the metal jacket, the tip having a main portion forward of the opening and a tip retention portion configured as a stem at least partially filling the interior

cavity, the tip retention portion having an aft face confronting the interior solid core, the tip retention portion having an axially extending central cavity extending through the tip retention portion and into the main portion, a rearwardly facing surface of the tip confronting a forward facing surface of the core.

37. The cartridge of claim 36 wherein the polymer tip is frangible upon impact with a target such that the main portion separates from the stem.

38. The cartridge of any of claims 36-37, wherein main portion is one of conically or ogive shaped.

39. The cartridge of any of claims 36-38, wherein the axially extending cavity in the stem portion of the tip extends forward through the main portion of the tip.

40. The cartridge of any of claims 36-39, wherein the core extends rearwardly from the nose portion an axial length that is 45 to 65% of a length of the bullet body.

41. The cartridge of any of claims 36-40, wherein the metal jacket defines a core cavity and the core cavity extends 45 to 65% of a length of the bullet body.

42. An expanding projectile comprising:

a projectile body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core, the metal jacket tapered at the nose portion in a forward direction to an annular forward edge, the annular forward edge defining an opening in the metal

jacket to an interior cavity extending from the opening in a rearward direction to a forward facing interior surface of the interior solid core;

a tip portion mounted in the interior cavity and having an exterior surface substantially flush with an exterior surface of the metal jacket, the tip portion having a main portion forward of the opening and a tip retention portion at least partially filling the interior cavity, the tip portion including one or more fluid pathways defined by one or more axial recesses that extend from a rear end of the tip portion to a recess end point at a forward most point of the tip portion;

wherein the one or more fluid pathways expose the interior surface of the solid core for, upon impact of the expanding projectile with a target, initializing expansion of the expanding projectile.

43. An expanding projectile comprising:

a projectile body including a metal jacket extending from a tail portion to a nose portion and surrounding an interior solid core, the metal jacket tapered at the nose portion in a forward direction to an annular forward edge, the annular forward edge defining an opening in the metal jacket to an interior cavity extending from the opening in a rearward direction to a forward facing interior surface of the interior solid core;

a tip portion mounted in the interior cavity and having an exterior surface substantially flush with an exterior surface of the metal jacket, the tip portion having a main portion forward of the opening and a tip retention portion at least partially filling the interior cavity, the tip portion including one or more fluid pathways defined by one or more axial recesses that extend from a rear end of the tip portion to a recess end point at a forward most point of the tip portion;

wherein the one or more fluid pathways expose the interior surface of the solid core for, upon impact of the expanding projectile with a target, initializing expansion of the expanding projectile.

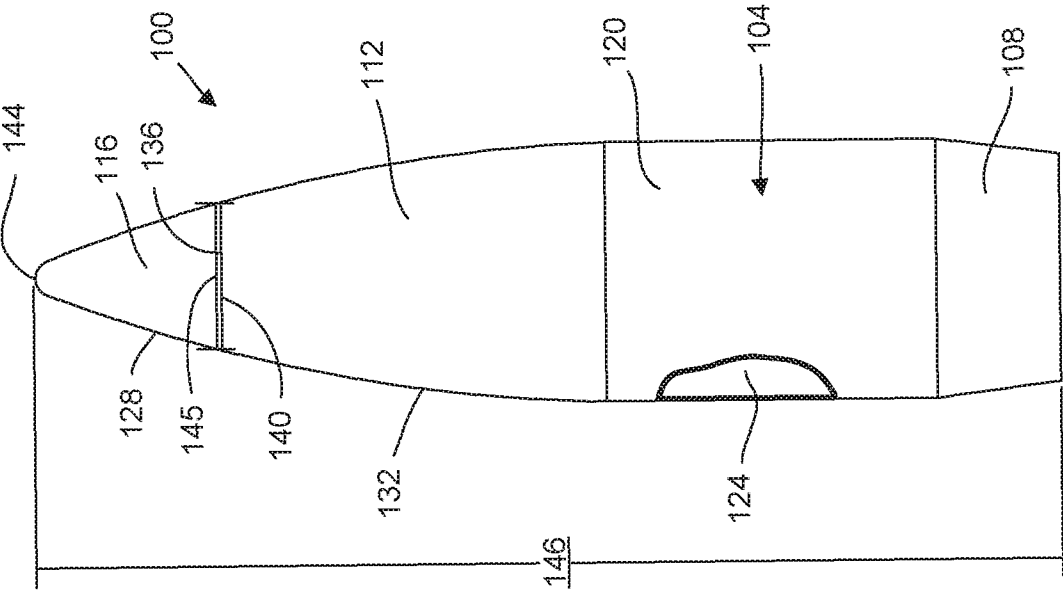


FIG. 1

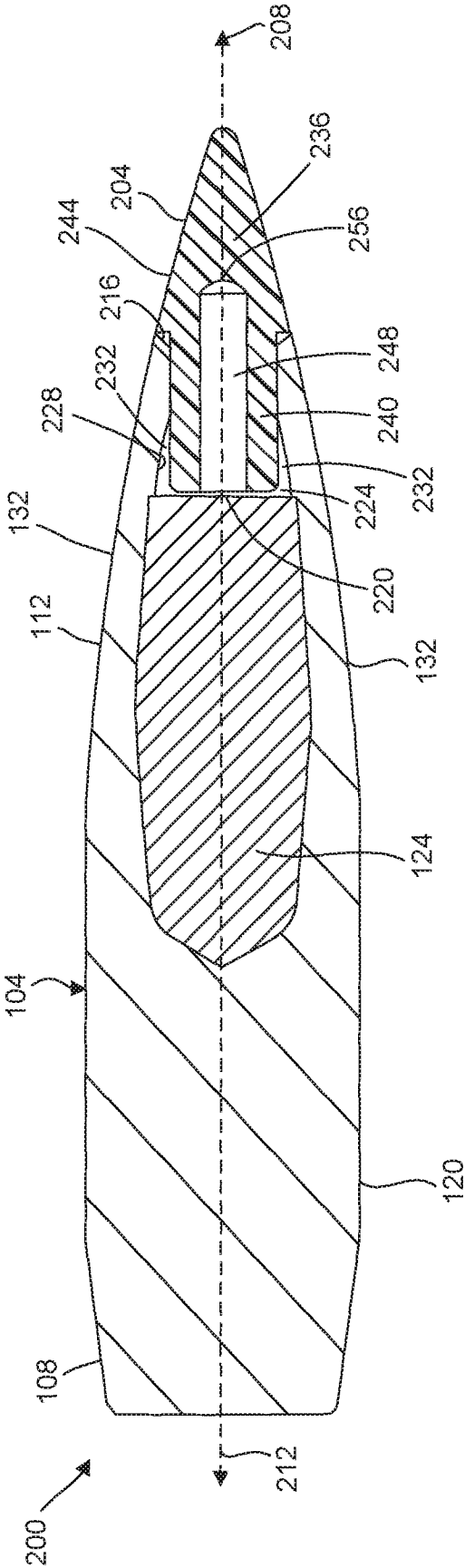


FIG. 2A

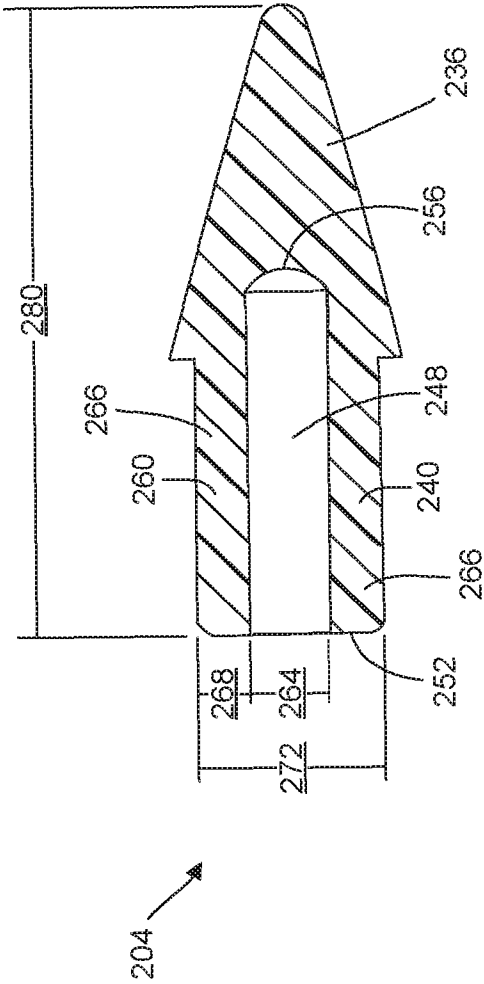
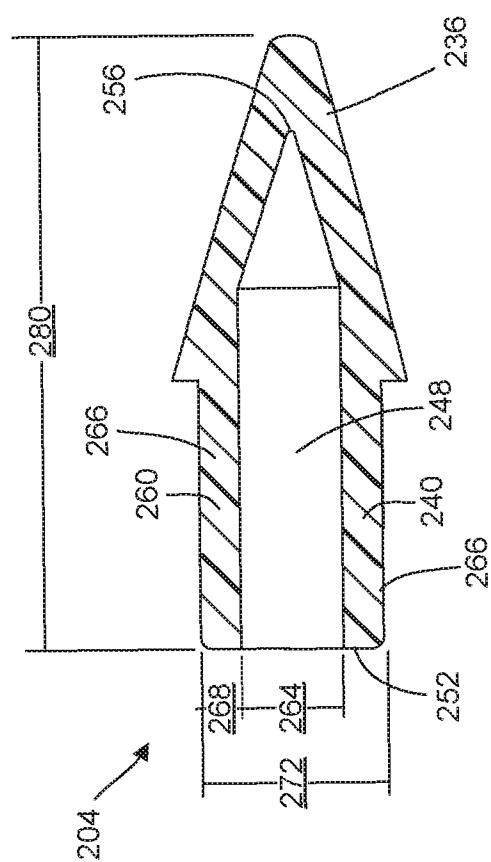


FIG. 2B



2025

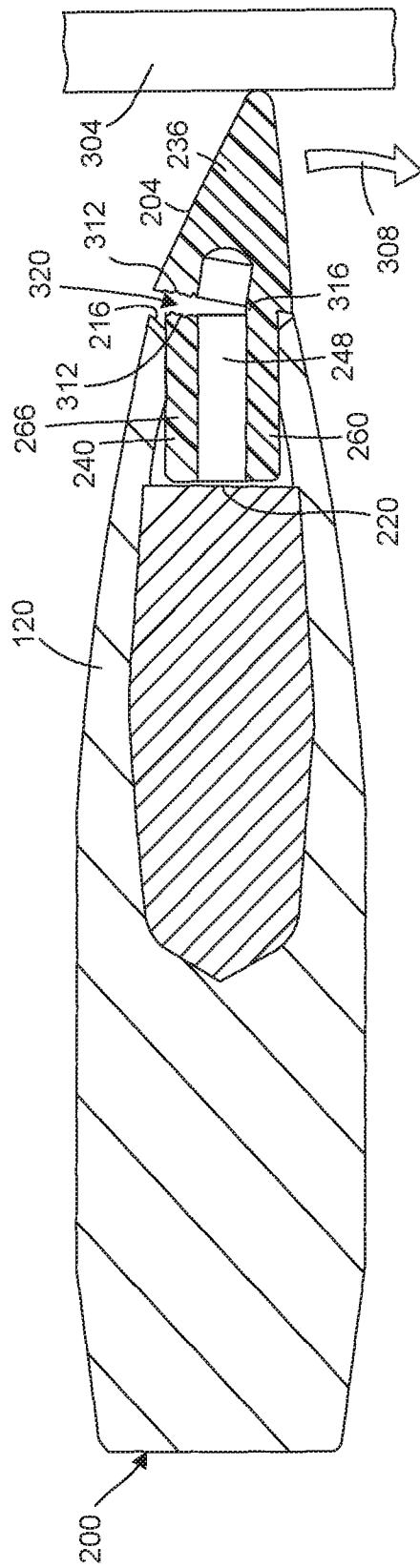
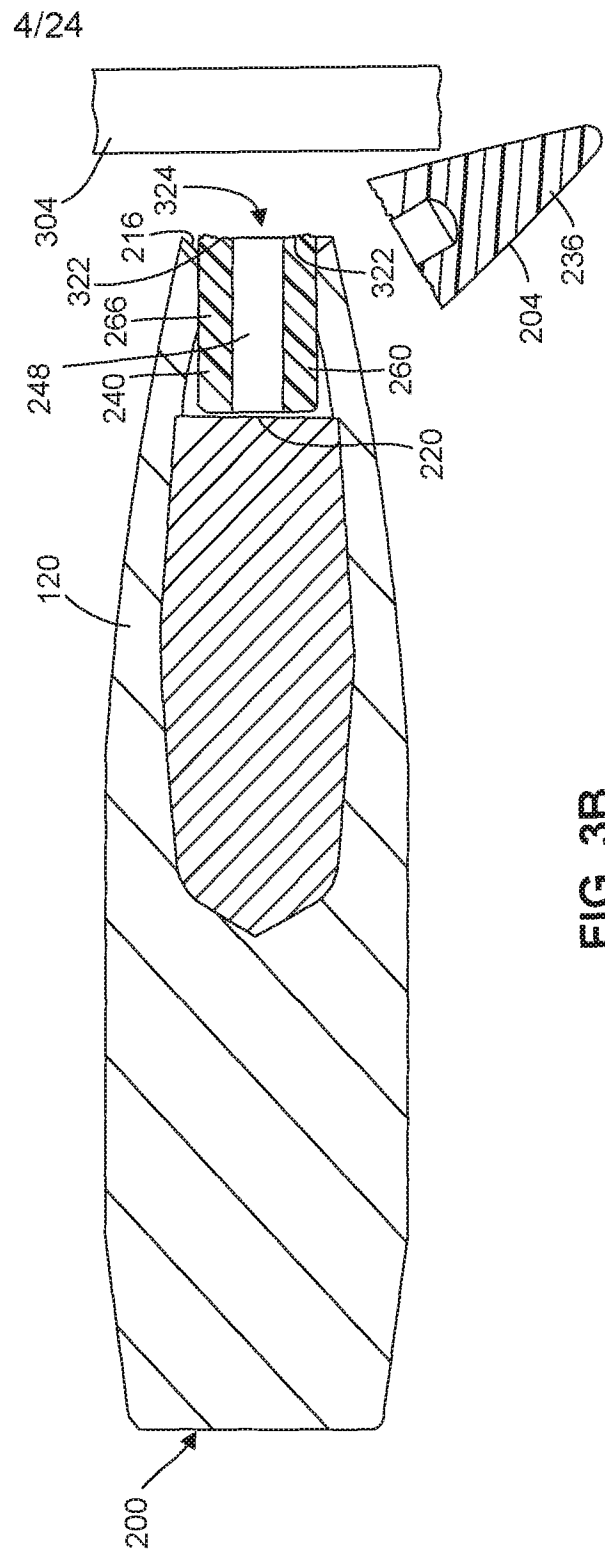


Fig. 3A



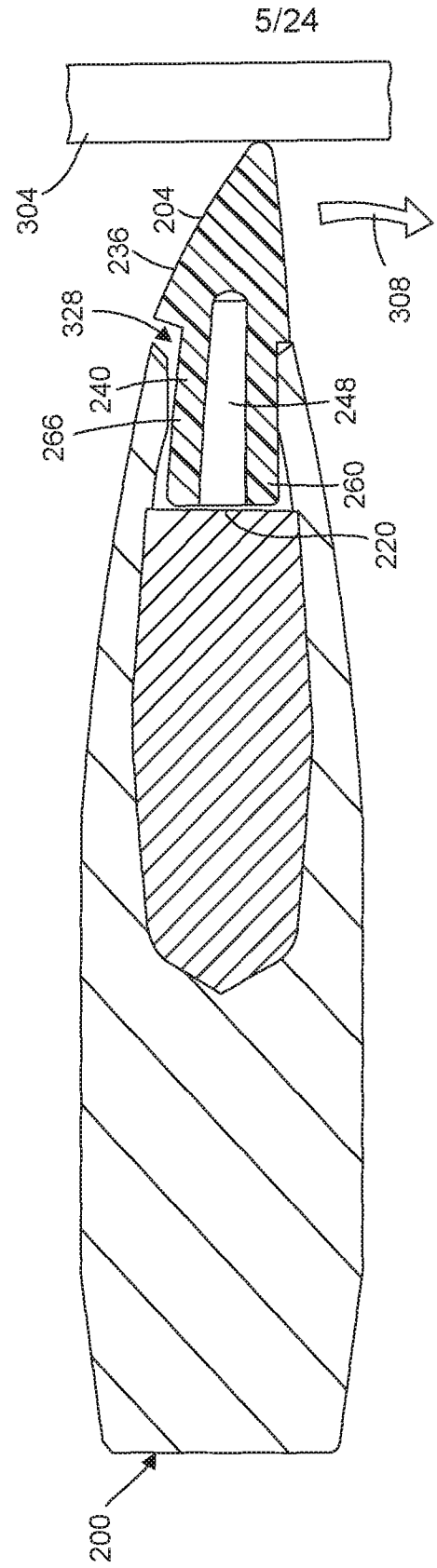
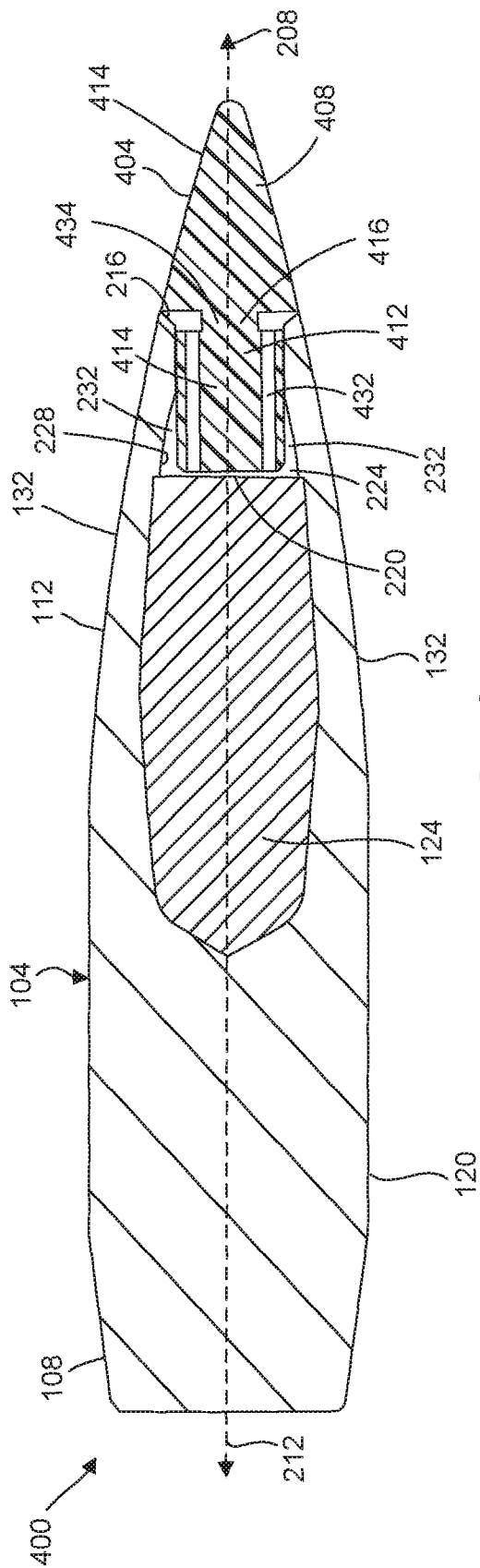
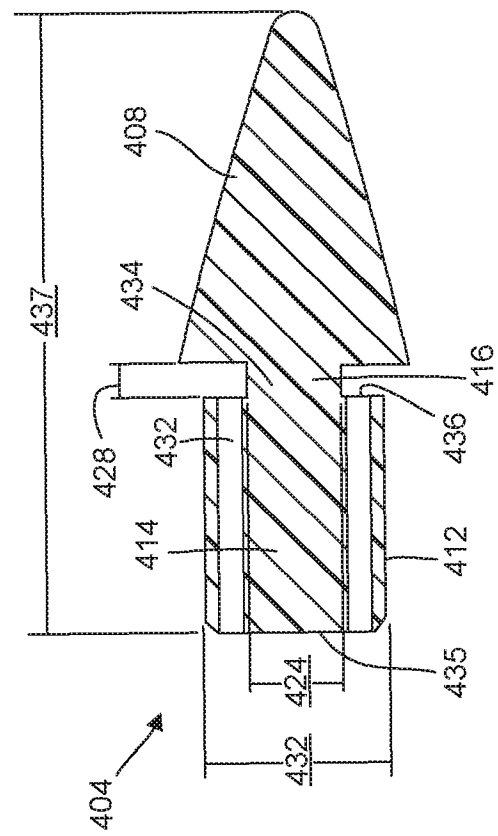


FIG. 3C



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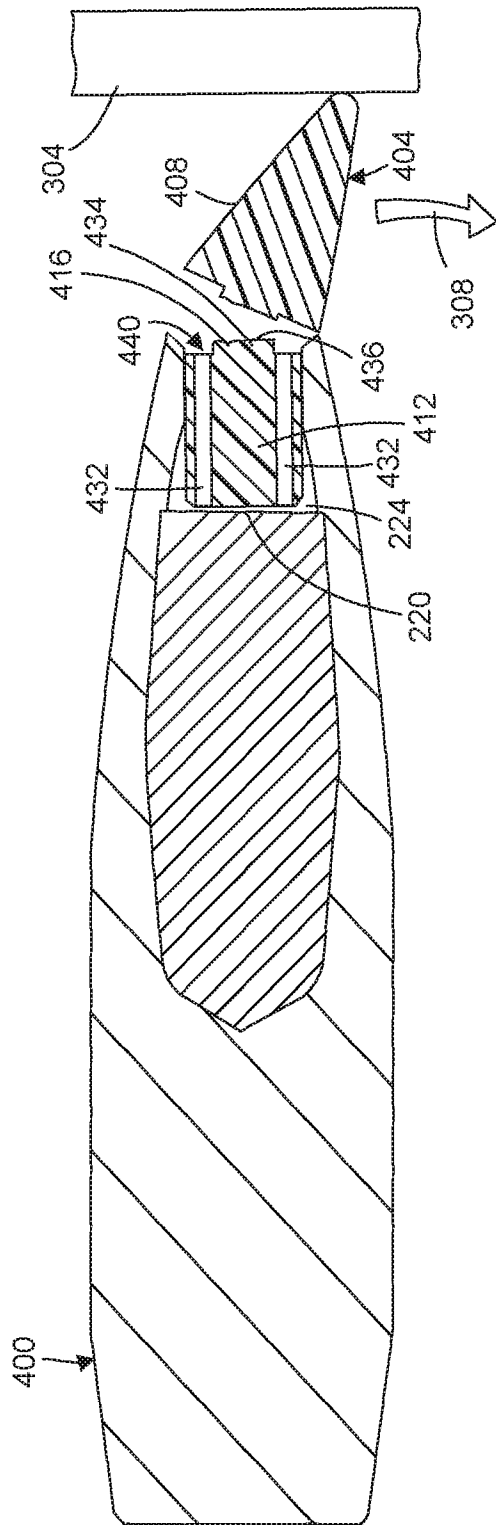


FIG. 5A

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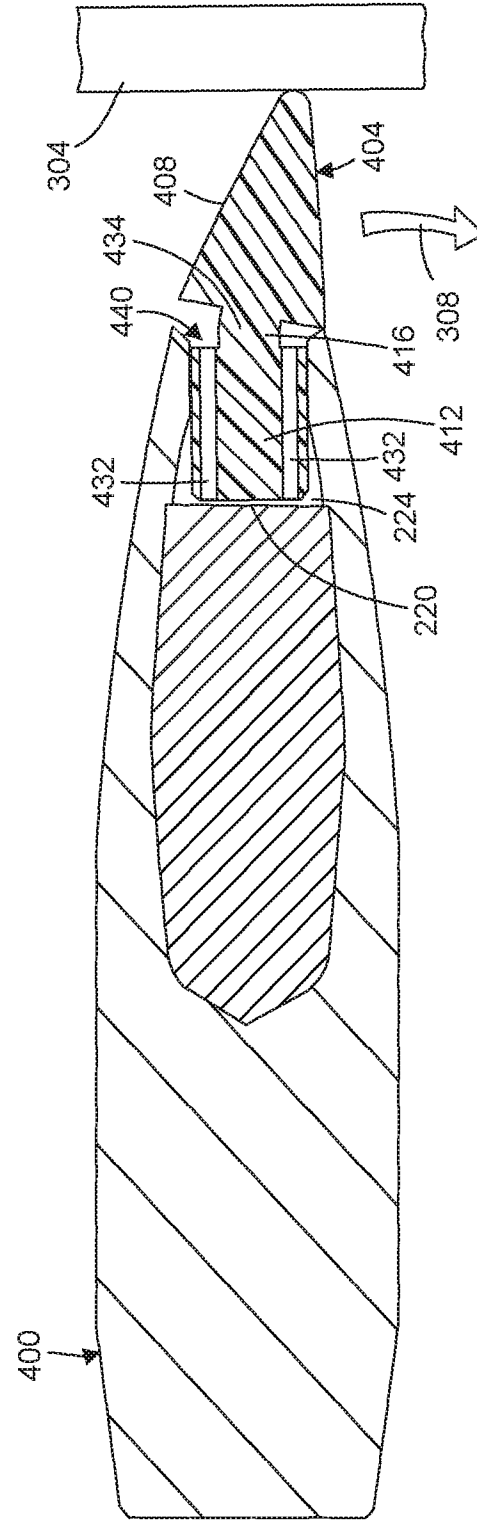


FIG. 5B

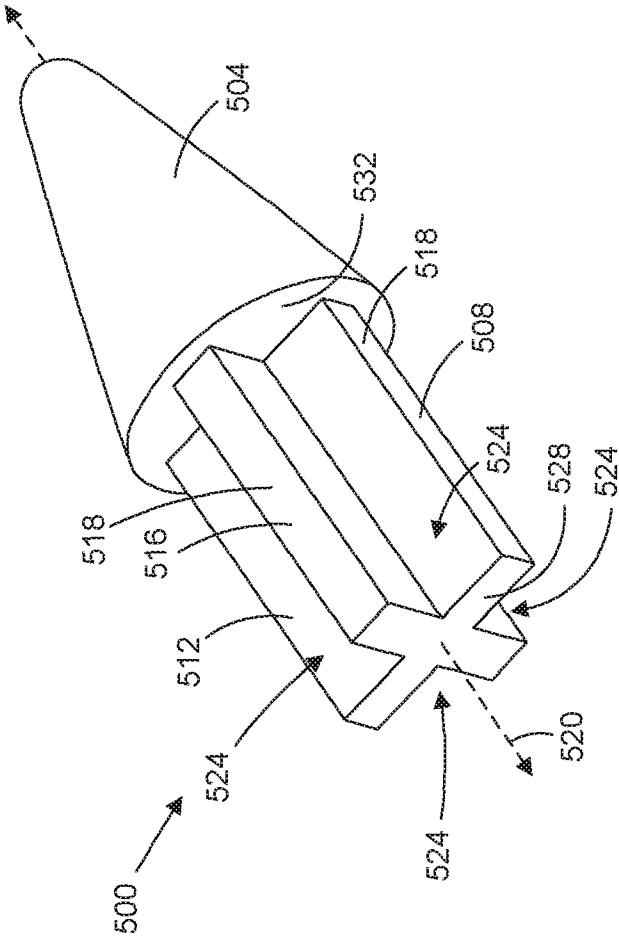


FIG. 6A

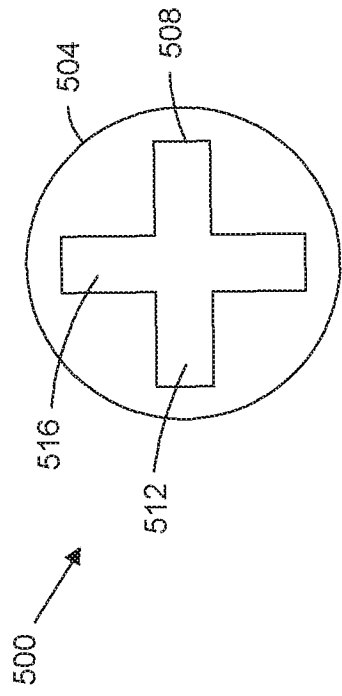


FIG. 6B

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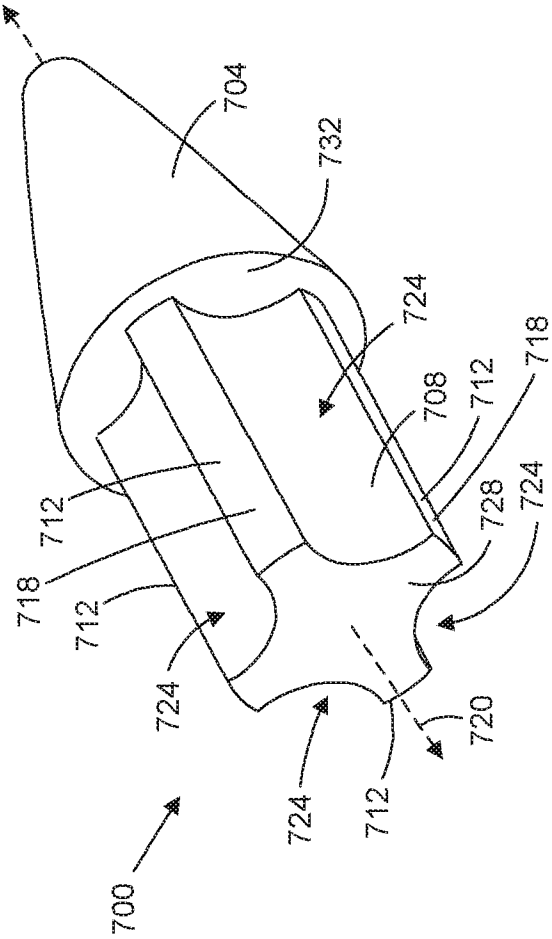


FIG. 7A

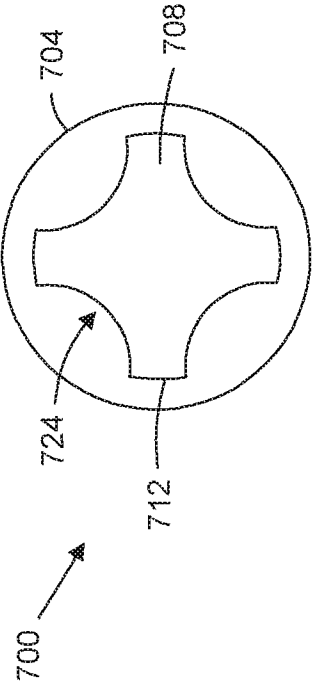


FIG. 7B

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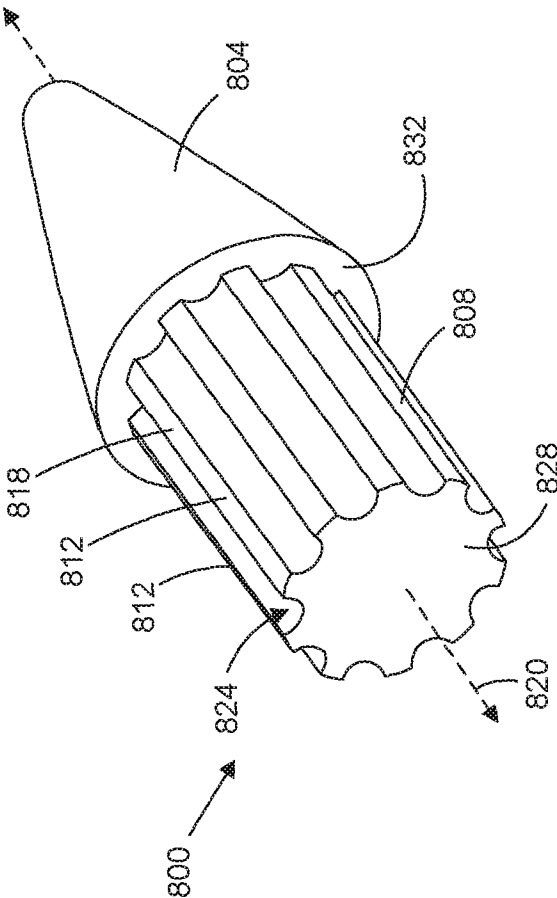


FIG. 8A

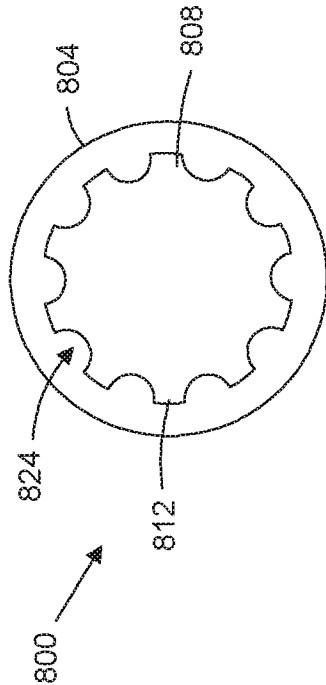


FIG. 8B

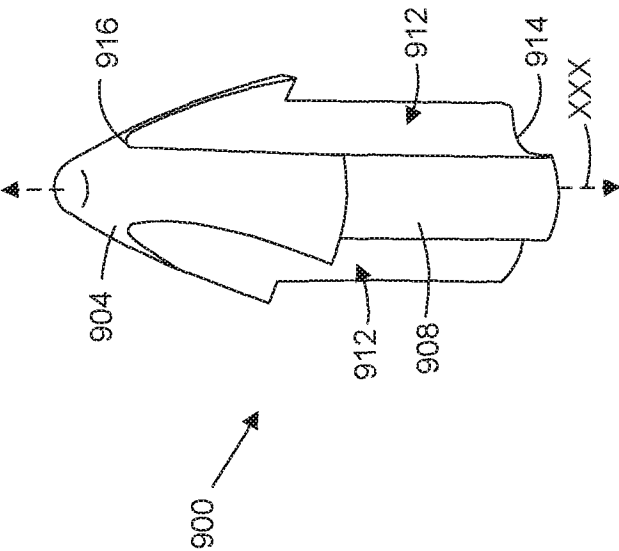


FIG. 9A

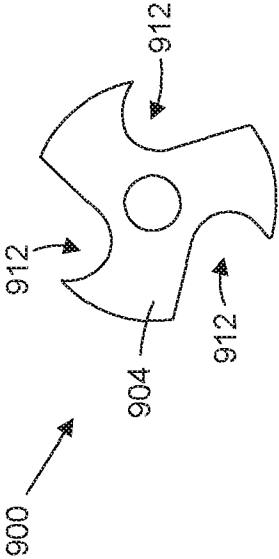


FIG. 9B

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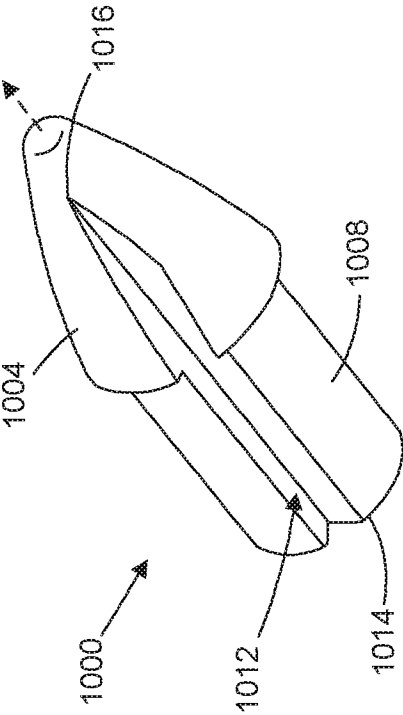


FIG. 10A

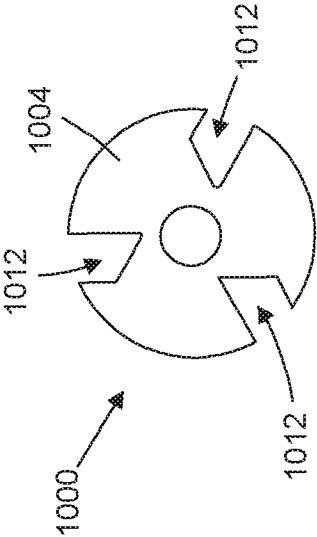


FIG. 10B

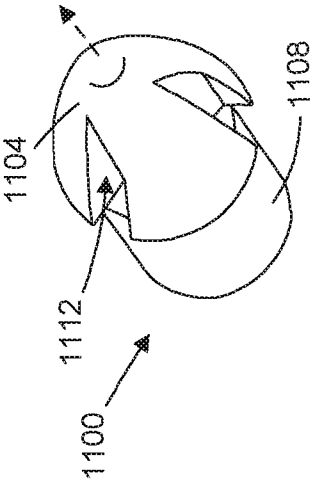


FIG. 11A

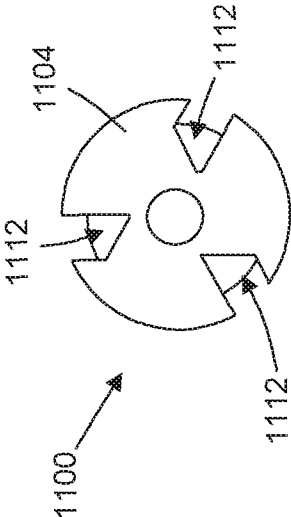


FIG. 11B

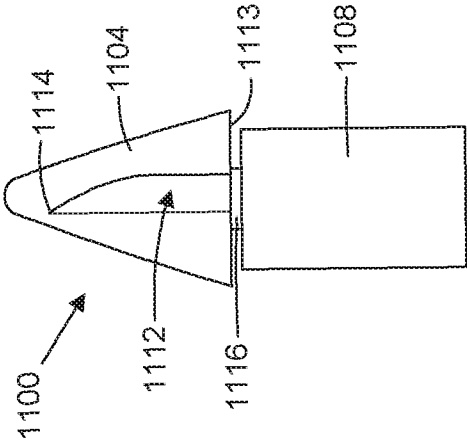


FIG. 11C

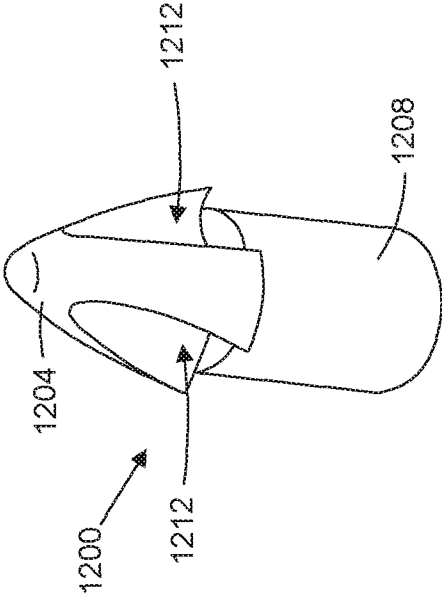


FIG. 12A

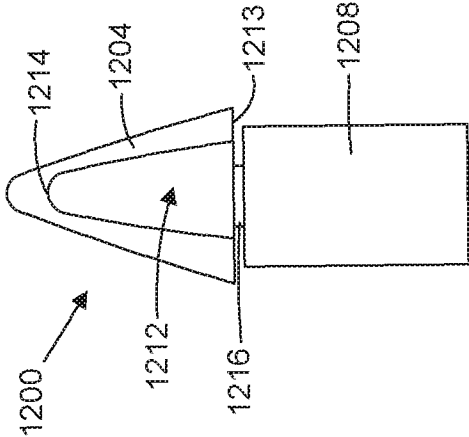


FIG. 12C

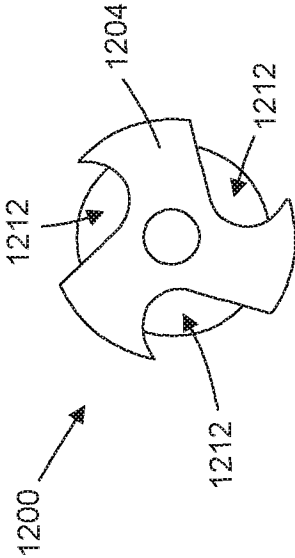


FIG. 12B

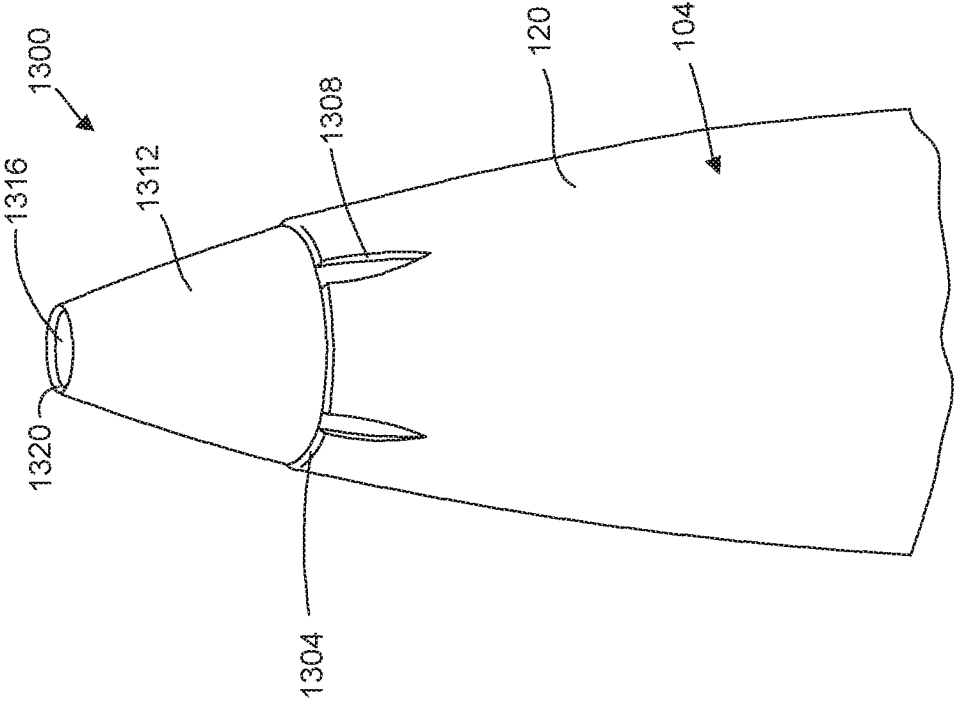


FIG. 13

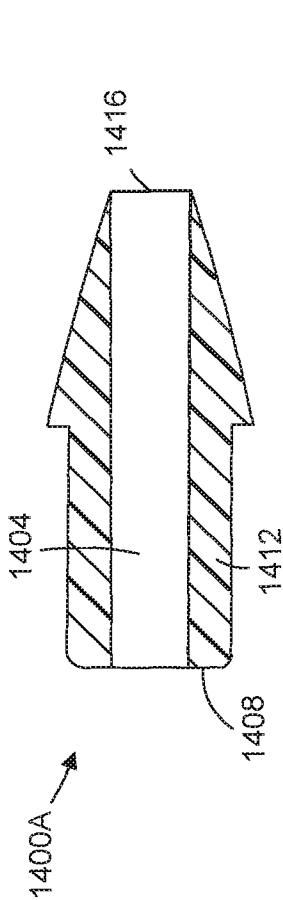


FIG. 14A

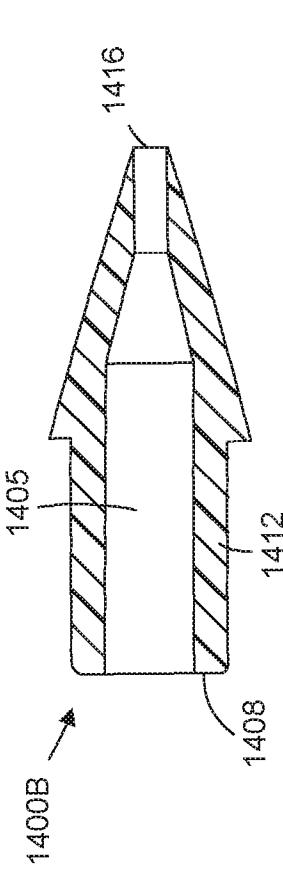


FIG. 14B

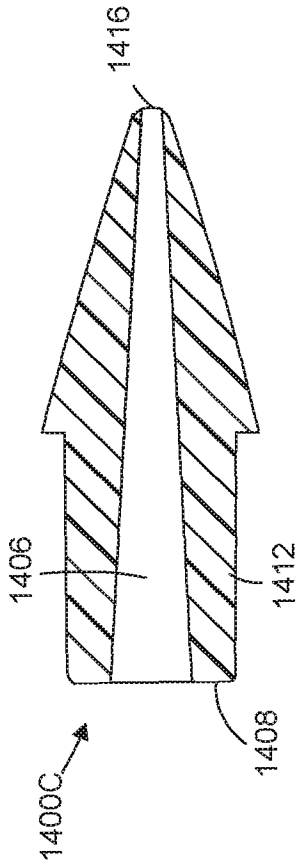


FIG. 14C

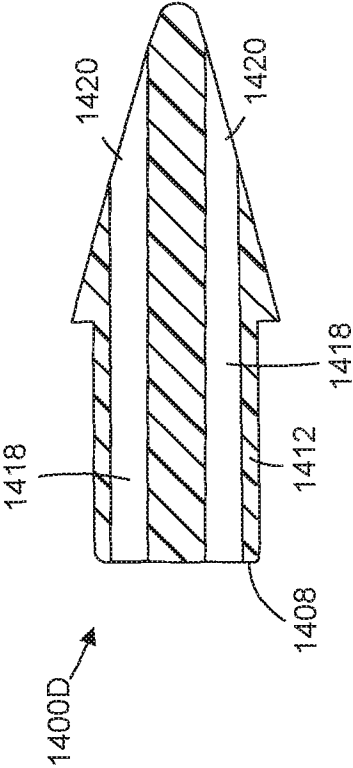


FIG. 14D

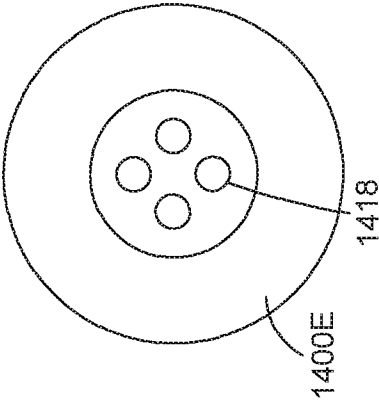


FIG. 14E

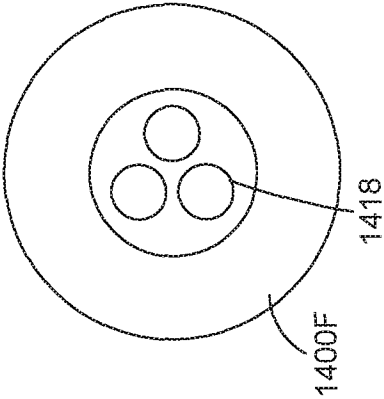


FIG. 14F

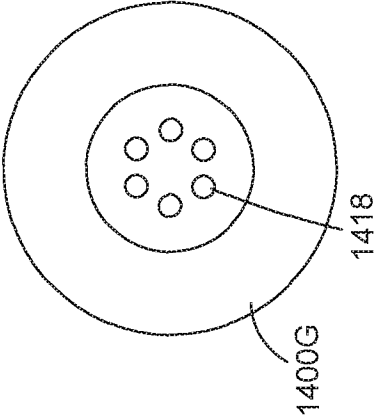


FIG. 14G

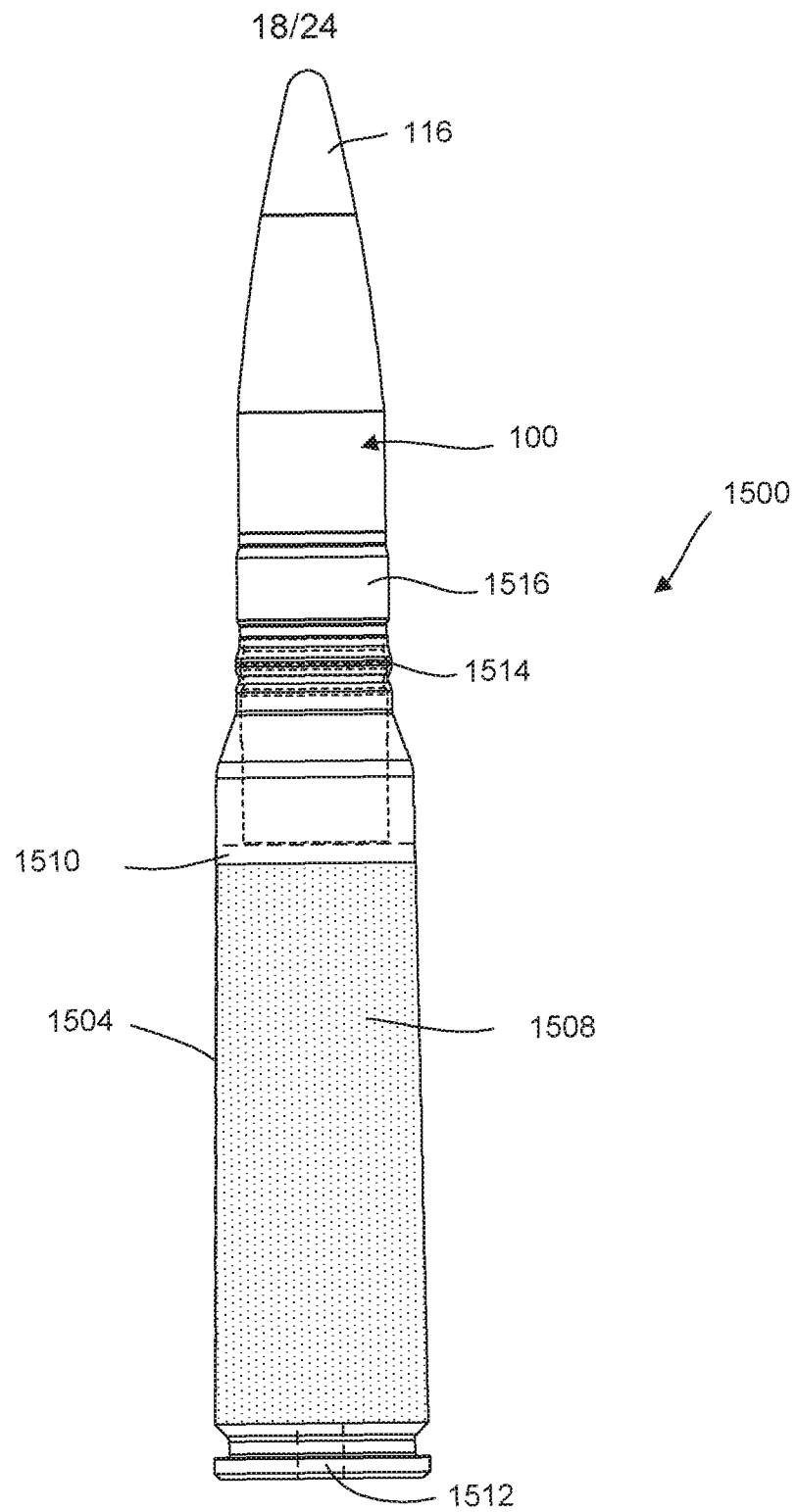


FIG. 15

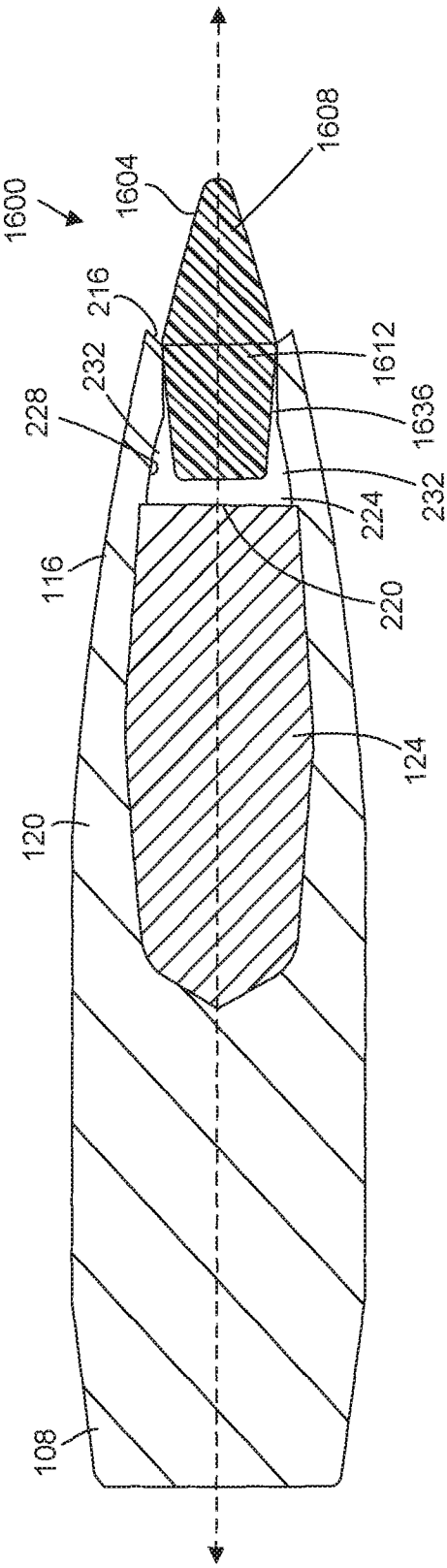


FIG. 16A

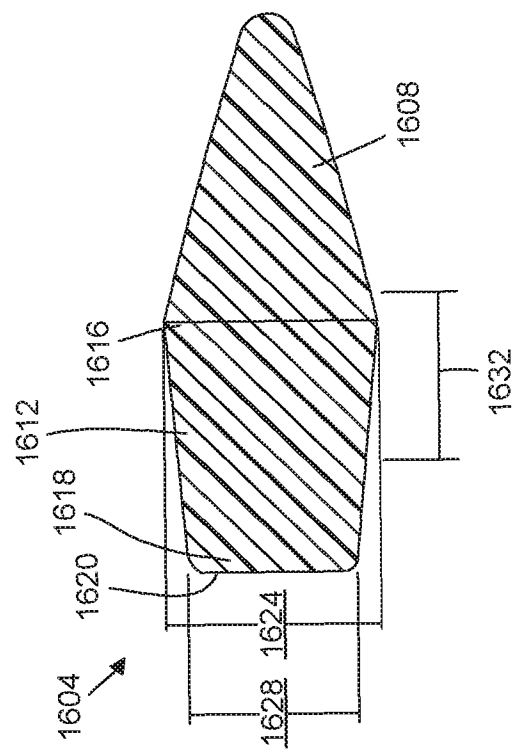


FIG. 16B

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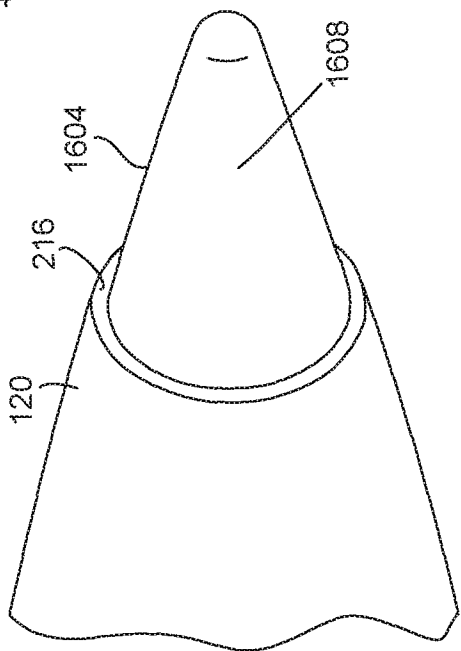


FIG. 16C

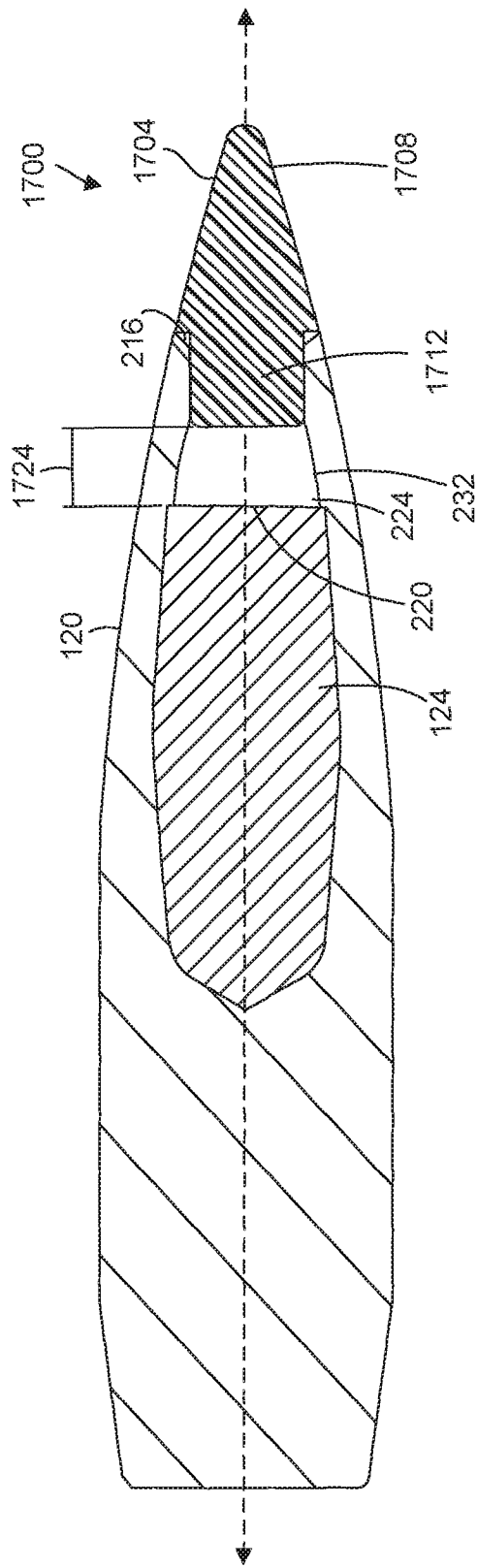


FIG. 17A

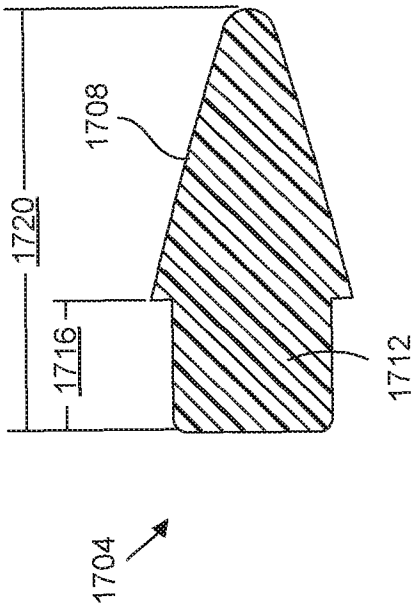


FIG. 17B

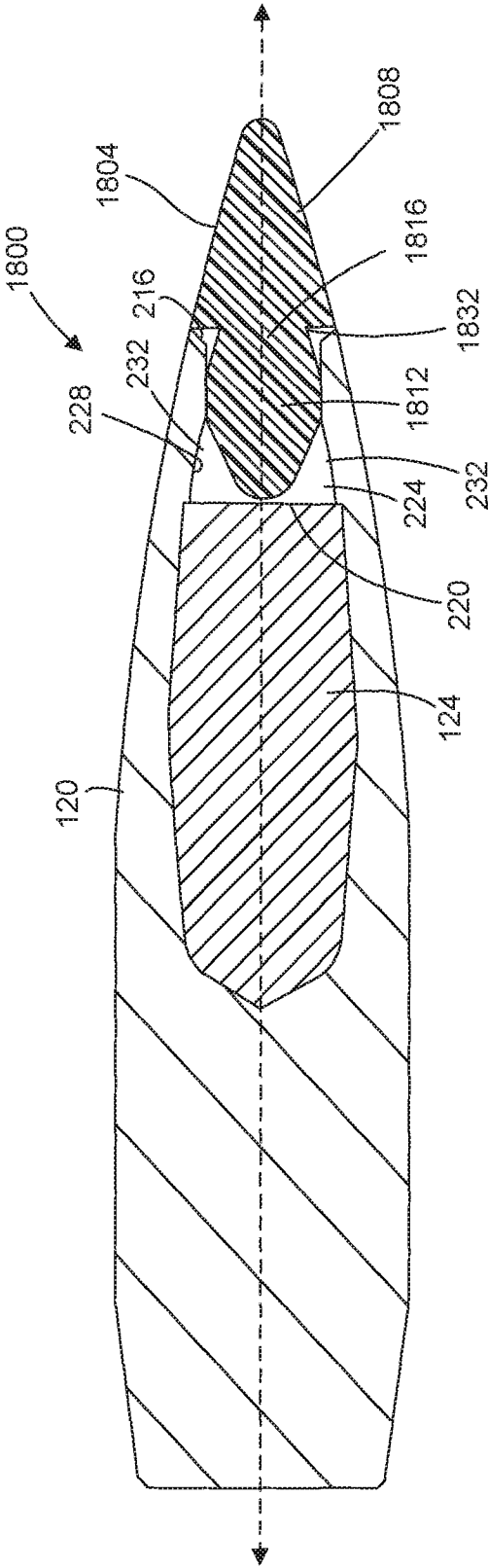


FIG. 18

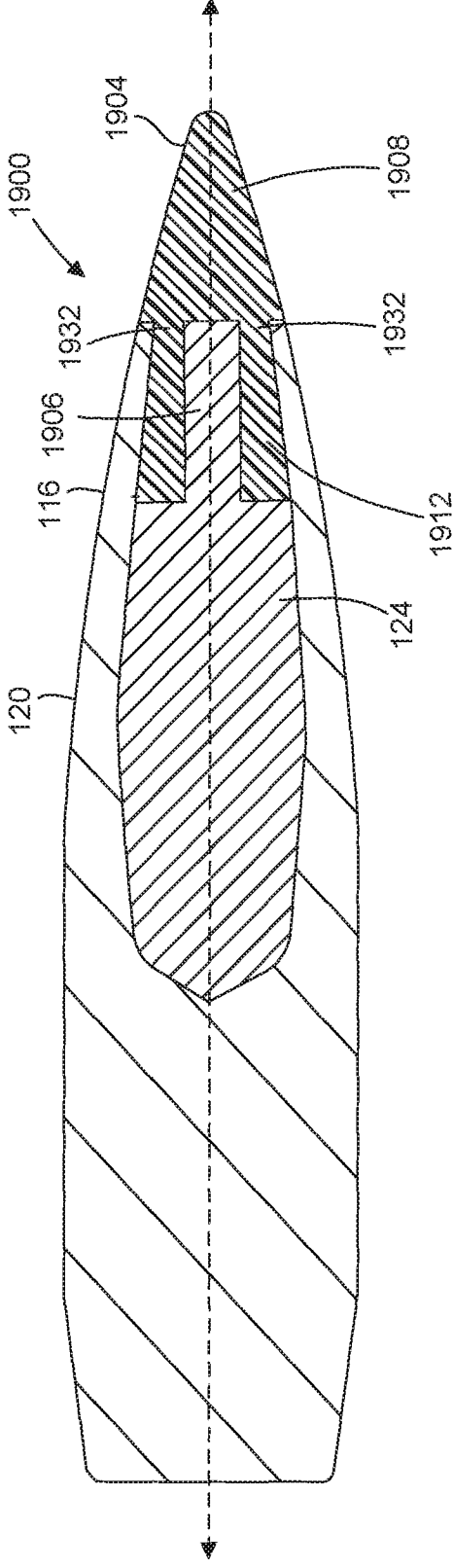


FIG. 19

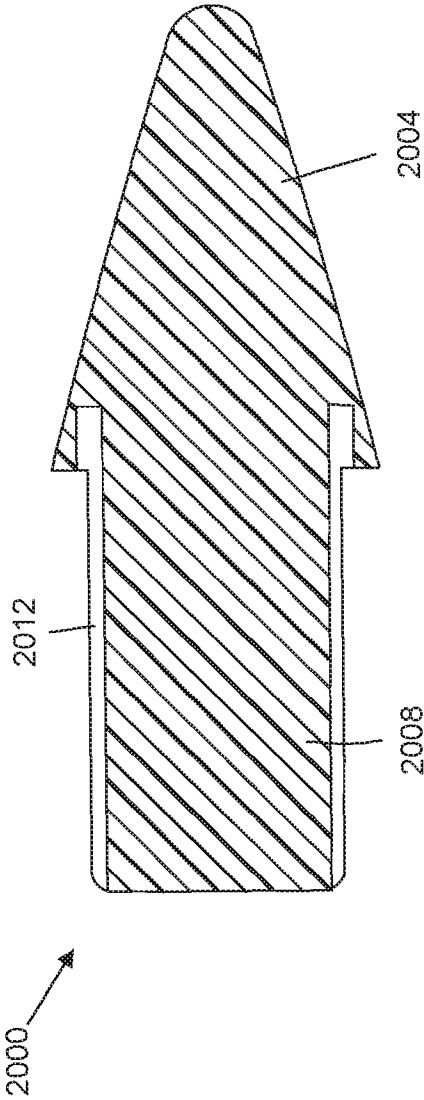


FIG. 20A

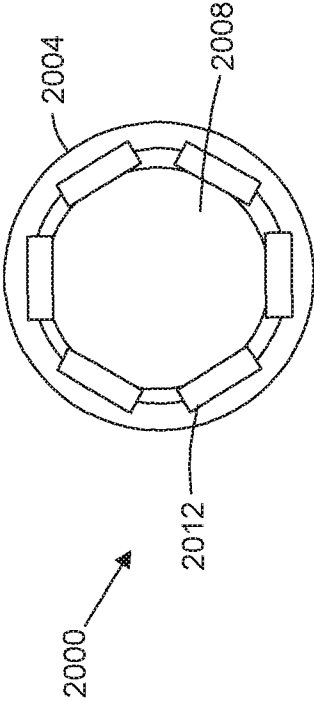


FIG. 20B

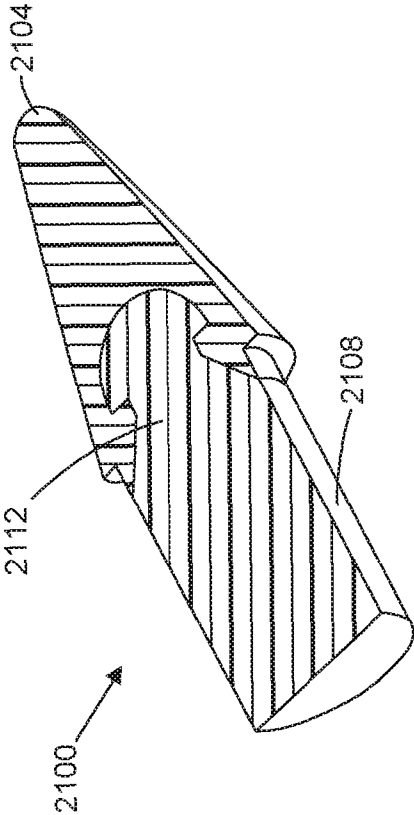


FIG. 21

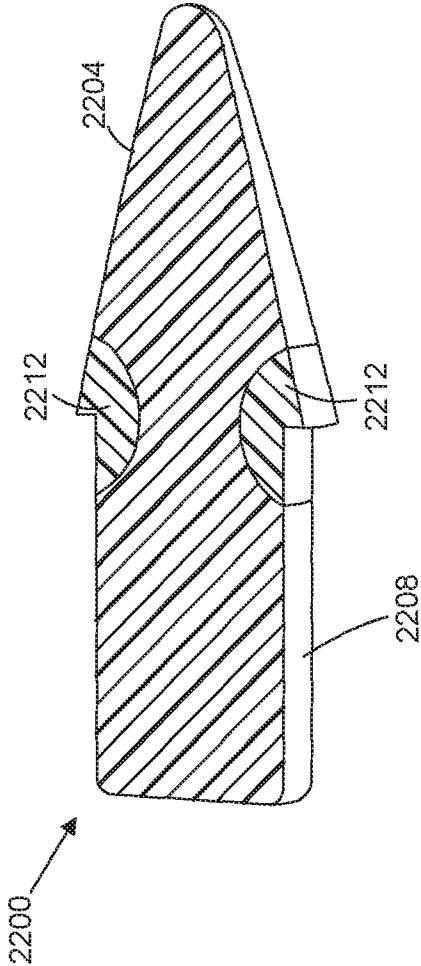


FIG. 22

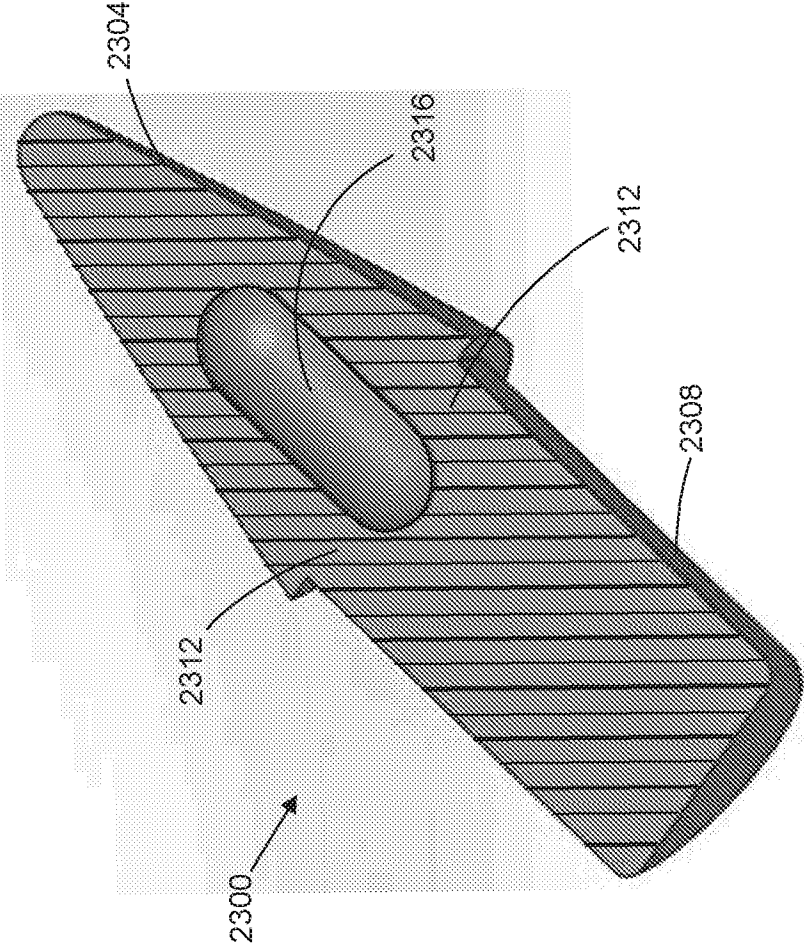


FIG. 23