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(54) **Title:** POLYMER AMMUNITION HAVING AN ALIGNMENT AID, CARTRIDGE AND METHOD OF MAKING THE SAME

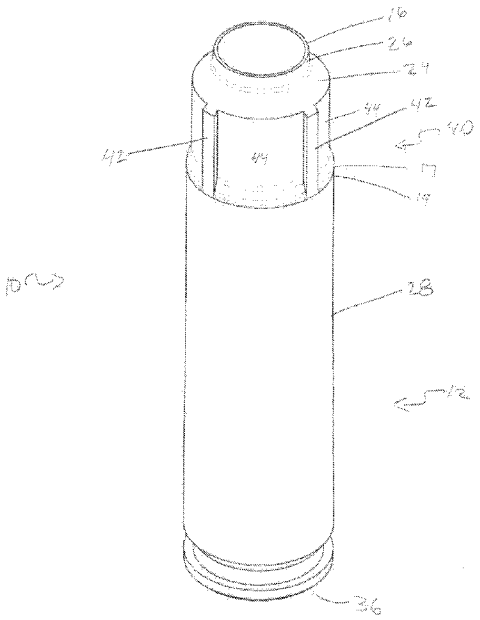

FIGURE 2a

(57) **Abstract:** One embodiment of the present invention provides a polymeric ammunition cartridge and methods of making and using the same. The cartridge includes a substantially cylindrical insert connected to a substantially cylindrical polymeric middle body. The substantially cylindrical insert includes a top surface opposite a bottom surface and a substantially cylindrical coupling element that extends from the bottom surface, a primer recess in the top surface that extends toward the bottom surface, a primer flash hole positioned in the primer recess to extend through the bottom surface, and a flange that extends circumferentially about an outer edge of the top surface. The substantially cylindrical polymeric middle body includes a substantially cylindrical polymeric bullet-end and a substantially cylindrical polymeric coupling end connected by a powder chamber, wherein the substantially cylindrical polymeric coupling end extends over the substantially cylindrical coupling element and covers a circumferential surface of the primer flash hole.

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POLYMER AMMUNITION HAVING AN ALIGNMENT AID, CARTRIDGE AND METHOD OF MAKING THE SAME

Technical Field of the Invention

The present invention relates in general to the field of ammunition, specifically to compositions of matter and methods of making and using polymeric ammunition, polymer cartridges and methods of making the same.

Background Art

Without limiting the scope of the invention, its background is described in connection with lightweight polymer cartridge casing ammunition. Conventional ammunition cartridge casings for rifles and machine guns, as well as larger caliber weapons, are made from brass, which is heavy, expensive, and potentially hazardous. There exists a need for an affordable lighter weight replacement for brass ammunition cartridge cases that can increase mission performance and operational capabilities. Lightweight polymer cartridge casing ammunition must meet the reliability and performance standards of existing fielded ammunition and be interchangeable with brass cartridge casing ammunition in existing weaponry. Reliable cartridge casings manufacture requires uniformity (e.g., bullet seating, bullet-to-casing fit, casing strength, etc.) from one cartridge to the next in order to obtain consistent pressures within the casing during firing prior to bullet and casing separation to create uniformed ballistic performance. Plastic cartridge casings have been known for many years but have failed to provide satisfactory ammunition that could be produced in commercial quantities with sufficient safety, ballistic, handling characteristics, and survive physical and natural conditions to which it will be exposed during the ammunition's intended life cycle; however, these characteristics have not been achieved.

For example, U.S. Patent Application Serial No. 11/160,682 discloses a base for a cartridge casing body for an ammunition article, the base having an ignition device; an attachment device at one end thereof, the attachment device being adapted to the base to a cartridge casing body; wherein the base is made from plastic, ceramic, or a composite material.

Shortcomings of the known methods of producing plastic or substantially plastic ammunition include the possibility of the projectile being pushed into the cartridge casing, the bullet pull being too light such that the bullet can fall out, the bullet pull being too insufficient to create sufficient chamber pressure, the bullet pull not being uniform from round to round, and portions of the cartridge casing breaking off upon firing causing the weapon to jam or damage or danger when subsequent rounds are fired or when the casing portions themselves become projectiles. To overcome the above shortcomings, improvements in cartridge case design and performance polymer materials are needed.

Disclosure of the Invention

One embodiment of the present invention provides a polymeric ammunition cartridge. The cartridge includes a substantially cylindrical insert connected to a substantially cylindrical polymeric middle body. The substantially cylindrical insert includes a top surface opposite a bottom surface and a substantially

cylindrical coupling element that extends from the bottom surface, a primer recess in the top surface that extends toward the bottom surface, a primer flash hole positioned in the primer recess to extend through the bottom surface, and a flange that extends circumferentially about an outer edge of the top surface. The substantially cylindrical polymeric middle body includes a substantially cylindrical polymeric bullet-end and a substantially cylindrical polymeric coupling end connected by a powder chamber, wherein the substantially cylindrical polymeric coupling end extends over the substantially cylindrical coupling element and covers a circumferential surface of the primer flash hole. Other embodiments include the primer inserted into the primer recess, the charge located in the powder chamber, and/or a bullet or projectile.

The present invention provides a polymeric ammunition cartridge having an alignment aid comprising: a substantially cylindrical insert comprising a top surface opposite a bottom surface and a substantially cylindrical coupling element that extends from the bottom surface, a primer recess in the top surface that extends toward the bottom surface, a primer flash hole positioned in the primer recess to extend through the bottom surface, and a flange that extends circumferentially about an outer edge of the top surface; and a substantially cylindrical polymeric middle body comprising a substantially cylindrical polymeric coupling end connected by a powder chamber, wherein the substantially cylindrical polymeric coupling end extends over the substantially cylindrical coupling element and covers a circumferential surface of the primer flash hole; and a substantially cylindrical polymeric nose comprising a projectile aperture formed in a neck, a shoulder extending from the neck and nose junction adapted to connect to the substantially cylindrical polymeric middle body and an alignment aid positioned on the substantially cylindrical polymeric nose to align the substantially cylindrical polymeric nose in a bore. The polymeric ammunition cartridge, wherein the neck is shorter than a normal cartridge neck, e.g., 0.02, 0.021, 0.022, 0. 023, 0. 024, 0. 025, 0. 026, 0. 027, 0.028, 0.029, 0.030, 0.031, 0.032, 0.033, 0.034, 0.035, 0.036, 0.037, 0.038, 0.039, 0.040, 0.041, 0.042, 0.043, 0.044, 0.045, 0.046, 0.047, 0.048, 0.049, 0.05, 0.051, 0.052, 0.053, 0.054, 0.055, 0.056, 0.057, 0.058, 0.059, 0.06, 0.061, 0.062, 0.063, 0.064, 0.065, 0.066, 0.067, 0.068, 0.069, 0.07, 0.071, 0.072, 0.073, 0.074, 0.075, 0.076, 0.077, 0.078, 0.079, 0.08, 0.081, 0.082, 0.083, 0.084, 0.085, 0.086, 0.087, 0.088, 0.089, 0.09, 0.091, 0.092, 0.093, 0.094, 0.095, 0.096, 0.097, 0.098, 0.099, 0.1, 0.11, 0.12, 0.13, 0.14, 0.15, 0.16, 0.17, 0.18, 0.19, 0.2, 0.21, 0.22, 0.23, 0.24, 0.25, 0.26, 0.27, 0.28, 0.29, 0.3 0.31, 0.32, 0.33, 0.34, 0.35, 0.36, 0.37, 0.38, 0.39, 0.4, 0.41, 0.42, 0.43, 0.44, 0.45, 0.46, 0.47, 0.48, 0.49, 0.5, 0.51, 0.52, 0.53, 0.54, 0.55, 0.56, 0.57, 0.58, 0.59, 0.6, 0.61, 0.62, 0.63, 0.64, 0.65, 0.66, 0.67, 0.68, 0.69, 0.7, 0.71, 0.72, 0.73, 0.74, 0.75, 0.76, 0.77, 0.78, 0.79, 0.8, 0.81, 0.82, 0.83, 0.84, 0.85, 0.86, 0.87, 0.88, 0.89, 0.9, 0.91, 0.92, 0.93, 0.94, 0.95, 0.96, 0.97, 0.98, 0.99, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, or 2 inches. The polymeric ammunition cartridge, wherein the alignment aid comprises 3 of more vertical ridges. The polymeric ammunition cartridge, wherein the 3 of more vertical ridges includes 3, 4, 5, 6, 7, 8, 9, 10 or more vertical ridges. The polymeric ammunition cartridge, wherein the 3 of more vertical ridges have a profile that is generally square, generally rectangular, generally round, generally oval, generally triangular, generally rounded triangle, or a combination thereof. The polymeric ammunition cartridge, wherein the substantially cylindrical polymeric middle body is formed from a ductile polymer. The polymeric ammunition cartridge, wherein the substantially cylindrical polymeric middle body comprise a nylon polymer. The polymeric ammunition

cartridge, wherein the substantially cylindrical polymeric middle body is formed from a fiber-reinforced polymeric composite. The polymeric ammunition cartridge, wherein the fiber-reinforced polymeric composite contains between about 10 and about 70 wt % glass fiber fillers, mineral fillers, or mixtures thereof. The polymeric ammunition cartridge, wherein the substantially cylindrical polymeric bullet-end and bullet are further welded or bonded together and a bullet is fitted to the forward opening end. The polymeric ammunition cartridge, further comprising a groove positioned around the primer flash aperture in the primer recess. The polymeric ammunition cartridge, wherein the alignment aid is positioned below the shoulder. The polymeric ammunition cartridge, wherein the alignment aid comprises one or more first tabs surface each separated by a second cut surface. The polymeric ammunition cartridge, wherein the alignment aid comprises at least four first tabs surface each separated by a second cut surface. The polymeric ammunition cartridge, wherein the substantially cylindrical polymeric middle body comprise a polymers selected from the group consisting of polyurethane prepolymer, cellulose, fluoro-polymer, ethylene inter-polymer alloy elastomer, ethylene vinyl acetate, nylon, polyether imide, polyester elastomer, polyester sulfone, polyphenyl amide, polypropylene, polyvinylidene fluoride or thermoset polyurea elastomer, acrylics, homopolymers, acetates, copolymers, acrylonitrile-butadinen-styrene, thermoplastic fluoro polymers, inomers, polyamides, polyamide-imides, polyacrylates, polyatherketones, polyaryl-sulfones, polybenzimidazoles, polycarbonates, polybutylene, terephthalates, polyether imides, polyether sulfones, thermoplastic polyimides, thermoplastic polyurethanes, polyphenylene sulfides, polyethylene, polypropylene, polysulfones, polyvinylchlorides, styrene acrylonitriles, polystyrenes, polyphenylene, ether blends, styrene maleic anhydrides, polycarbonates, allyls, aminos, cyanates, epoxies, phenolics, unsaturated polyesters, bismaleimides, polyurethanes, silicones, vinylesters, urethane hybrids, polyphenylsulfones, copolymers of polyphenylsulfones with polyethersulfones or polysulfones, copolymers of poly-phenylsulfones with siloxanes, blends of polyphenylsulfones with polysiloxanes, poly(etherimide-siloxane) copolymers, blends of polyetherimides and polysiloxanes, and blends of polyetherimides and poly(etherimide-siloxane) copolymers. The polymeric ammunition cartridge, wherein the forward opening end comprises a neck with a plurality of internal structures for supporting a bullet. The polymeric ammunition cartridge, wherein the substantially cylindrical coupling element is a male coupling element with a straight skirt interlock surface that tapers to a smaller diameter at the forward portion on the skirt tip to mate with a female coupling element of the substantially cylindrical polymeric coupling end. The polymeric ammunition cartridge, further comprising a diffuser positioned in the primer recess comprising a diffuser flash hole aligned with the primer flash hole. A chamber adapted to accept the ammunition cartridge. A reamer adapted to form a chamber to accept the ammunition cartridge.

Description of the Drawings

For a more complete understanding of the features and advantages of the present invention, reference is now made to the detailed description of the invention along with the accompanying figures and in which:

FIGURE 1 depicts a side, cross-sectional view of a polymeric cartridge case according to one embodiment of the present invention;

FIGURES 2a-2b depict perspective views of a polymeric cartridge case according to one embodiment of the present invention.

FIGURE 3 depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention.

FIGURES 4a-4i depict a top down views of the nose of the polymeric cartridge case according to different embodiment of the present invention.

Description of the Invention

While the making and using of various embodiments of the present invention are discussed in detail below, it should be appreciated that the present invention provides many applicable inventive concepts that can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative of specific ways to make and use the invention and do not delimit the scope of the invention.

To facilitate the understanding of this invention, a number of terms are defined below. Terms defined herein have meanings as commonly understood by a person of ordinary skill in the areas relevant to the present invention. Terms such as "a", "an" and "the" are not intended to refer to only a singular entity, but include the general class of which a specific example may be used for illustration. The terminology herein is used to describe specific embodiments of the invention, but their usage does not delimit the invention, except as outlined in the claims.

Reliable cartridge manufacture requires uniformity from one cartridge to the next in order to obtain consistent ballistic performance. Among other considerations, proper bullet seating and bullet-to-casing fit is required. In this manner, a desired pressure develops within the casing during firing prior to bullet and casing separation. Historically, bullets employ a cannelure, which is a slight annular depression formed in a surface of the bullet at a location determined to be the optimal seating depth for the bullet. In this manner, a visual inspection of a cartridge could determine whether or not the bullet is seated at the proper depth. Once the bullet is inserted into the casing to the proper depth, one of two standard procedures is incorporated to lock the bullet in its proper location. One method is the crimping of the entire end of the casing into the cannelure. A second method does not crimp the casing end; rather the bullet is pressure fitted into the casing.

The polymeric ammunition cartridges of the present invention are of a caliber typically carried by soldiers in combat for use in their combat weapons. The present invention is not limited to the described caliber and is believed to be applicable to other calibers as well. This includes various small and medium caliber munitions, including 5.56 mm, 7.62 mm and 0.50 caliber ammunition cartridges, as well as medium/small caliber ammunition such as 227, 338, 380 caliber, 38 caliber, 9 mm, 10 mm, 20 mm, 25 mm, 30 mm, 40 mm, 45 caliber and the like. The cartridges, therefore, are of a caliber between about 0.05 and about 5 inches. The polymeric ammunition cartridge wherein the polymeric ammunition cartridge has a caliber selected from .223, .243, .25-06, .270, .300, .308, .338, .30-30, .30-06, .45-70 or .50-90, 50 caliber, 45 caliber, 380 caliber or 38 caliber, 5.56 mm, 6 mm, 7 mm, 7.62 mm, 8 mm, 9 mm, 10 mm, or 12.7 mm. The polymeric ammunition cartridge wherein the polymeric ammunition cartridge has a caliber selected from .308, .338, 50 caliber, 5.56 mm, 7.62 mm, or 12.7 mm. In addition, the present invention is also applicable to the sporting goods industry for use by hunters and target shooters.

The polymeric ammunition cartridge wherein the substantially cylindrical polymeric middle body is formed from a ductile polymer, a nylon polymer or a fiber-reinforced polymeric composite. The polymeric ammunition cartridge wherein the substantially cylindrical polymeric bullet-end upper portion comprises a ductile polymer, a nylon polymer or a fiber-reinforced polymeric composite. The polymeric ammunition cartridge wherein the substantially cylindrical polymeric middle body comprise a polymers selected from the group consisting of polyurethane prepolymer, cellulose, fluoro-polymer, ethylene inter-polymer alloy elastomer, ethylene vinyl acetate, nylon, polyether imide, polyester elastomer, polyester sulfone, polyphenyl amide, polypropylene, polyvinylidene fluoride or thermoset polyurea elastomer, acrylics, homopolymers, acetates, copolymers, acrylonitrile-butadinen-styrene, thermoplastic fluoro polymers, inomers, polyamides, polyamide-imides, polyacrylates, polyatherketones, polyaryl-sulfones, polybenzimidazoles, polycarbonates, polybutylene, terephthalates, polyether imides, polyether sulfones, thermoplastic polyimides, thermoplastic polyurethanes, polyphenylene sulfides, polyethylene, polypropylene, polysulfones, polyvinylchlorides, styrene acrylonitriles, polystyrenes, polyphenylene, ether blends, styrene maleic anhydrides, polycarbonates, allyls, aminos, cyanates, epoxies, phenolics, unsaturated polyesters, bismaleimides, polyurethanes, silicones, vinylesters, urethane hybrids, polyphenylsulfones, copolymers of polyphenylsulfones with polyethersulfones or polysulfones, copolymers of poly-phenylsulfones with siloxanes, blends of polyphenylsulfones with polysiloxanes, poly(etherimide-siloxane) copolymers, blends of polyetherimides and polysiloxanes, and blends of polyetherimides and poly(etherimide-siloxane) copolymers. The polymeric ammunition cartridge wherein the substantially cylindrical polymeric bullet-end upper portion comprise a polymers selected from the group consisting of polyurethane prepolymer, cellulose, fluoro-polymer, ethylene inter-polymer alloy elastomer, ethylene vinyl acetate, nylon, polyether imide, polyester elastomer, polyester sulfone, polyphenyl amide, polypropylene, polyvinylidene fluoride or thermoset polyurea elastomer, acrylics, homopolymers, acetates, copolymers, acrylonitrile-butadinen-styrene, thermoplastic fluoro polymers, inomers, polyamides, polyamide-imides, polyacrylates, polyatherketones, polyaryl-sulfones, polybenzimidazoles, polycarbonates, polybutylene, terephthalates, polyether imides, polyether sulfones, thermoplastic polyimides, thermoplastic polyurethanes, polyphenylene sulfides, polyethylene, polypropylene, polysulfones, polyvinylchlorides, styrene acrylonitriles, polystyrenes, polyphenylene, ether blends, styrene maleic anhydrides, polycarbonates, allyls, aminos, cyanates, epoxies, phenolics, unsaturated polyesters, bismaleimides, polyurethanes, silicones, vinylesters, urethane hybrids, polyphenylsulfones, copolymers of polyphenylsulfones with polyethersulfones or polysulfones, copolymers of poly-phenylsulfones with siloxanes, blends of polyphenylsulfones with polysiloxanes, poly(etherimide-siloxane) copolymers, blends of polyetherimides and polysiloxanes, and blends of polyetherimides and poly(etherimide-siloxane) copolymers. The polymeric ammunition cartridge wherein the substantially cylindrical polymeric bullet-end and the substantially cylindrical polymeric bullet-end upper portion are welded or bonded together. The polymeric ammunition cartridge wherein the substantially cylindrical polymeric bullet-end coupling element is welded or bonded to the substantially cylindrical polymeric bullet-end upper portion.

FIGURE 1 depicts a side, cross-sectional view of a polymeric cartridge case according to one embodiment of the present invention. A cartridge 10 suitable for use with high velocity rifles is shown manufactured with a

polymer casing 12 showing a powder chamber 14 with projectile (not shown) inserted into the forward end opening 16. Polymer casing 12 has a substantially cylindrical open-ended polymeric nose 18 extending from forward end opening 16 rearward to opposite end 17. The nose 18 may be formed with nose junction 19 formed on opposite end 17 to connect to the body component 28. Nose junction 19 is shown as a female element, but may also be configured as a male element in alternate embodiments of the invention. The forward end of nose 18 has a shoulder 24 forming chamber neck 26. The nose 18 typically has a wall thickness between about 0.003 and about 0.200 inches and more preferably between about 0.005 and more preferably between about 0.150 inches about 0.010 and about 0.050 inches.

The middle body component 28 is connected to a substantially cylindrical coupling element 30 of the substantially cylindrical insert 32. Coupling element 30, as shown may be configured as a male element, however, all combinations of male and female configurations is acceptable for coupling elements 30 and coupling end 22 in alternate embodiments of the invention. During over molding the coupling end 22 molds over the coupling element 30 of a substantially cylindrical insert 32. The substantially cylindrical insert 32 includes a substantially cylindrical coupling element 30 extending from a bottom surface 34 that is opposite a top surface 36. Located in the top surface 36 is a primer recess 38 that extends toward the bottom surface 34. A primer flash aperture 35 extends through the bottom surface 34 into the powder chamber 14. The coupling end 22 extends the polymer through the primer flash aperture 35 to form a flash hole 37 while retaining a passage from the top surface 36 through the bottom surface 34 and into the powder chamber 14 to provide support and protection about the primer flash hole 40. A groove 39 is formed in the primer recess 38 around the primer flash aperture 35 and is over molded with the polymer to complete the formation of the flash hole 37. When contacted the coupling end 22 interlocks with the substantially cylindrical coupling element 30, through the coupling element 30 that extends with a taper to a smaller diameter at the tip 44 to form a physical interlock between substantially cylindrical insert 32 and middle body component 28. Polymer casing 12 also has a substantially cylindrical open-ended middle body component 28. The middle body component 28 extends from the nose junction 19 to the coupling element 22. The middle body component 28 typically has a wall thickness between about 0.003 and about 0.200 inches and more preferably between about 0.005 and more preferably between about 0.150 inches about 0.010 and about 0.050 inches.

The nose 16, middle body 18 and bottom surface 34 define the interior of powder chamber 14 in which the powder charge (not shown) is contained. The interior volume of powder chamber 14 may be varied to provide the volume necessary for complete filling of the chamber 14 by the propellant chosen so that a simplified volumetric measure of propellant can be utilized when loading the cartridge. Either a particulate or consolidated propellant can be used.

The substantially cylindrical insert 32 may be a one piece unit formed by MIM, casting forging, machining, etc.; a two piece insert made as individual pieces casting, pressing, stamping, MIM, machining, etc. and combined to form a unitary piece; in other embodiments the substantially cylindrical insert 32 may be a multi-piece insert made as individual pieces casting, pressing, stamping, MIM, machining, etc. and combined to form a unitary piece. The substantially cylindrical insert 32 also has a flange 46 cut therein and a primer recess 38 formed therein for ease of insertion of the primer (not shown). The primer recess 38 is sized so as

to receive the primer (not shown) in an interference fit during assembly. A primer flash hole 40 communicates through the bottom surface 34 of substantially cylindrical insert 32 into the powder chamber 14 so that upon detonation of primer (not shown) the powder in powder chamber 14 will be ignited.

Projectile (not shown) is held in place within chamber case neck 26 at forward opening 16 by an interference fit. Mechanical crimping of the forward opening 16 can also be applied to increase the bullet pull force. The bullet (not shown) may be inserted into place following the completion of the filling of powder chamber 14. Projectile (not shown) can also be injection molded directly onto the forward opening 16 prior to welding or bonding together using solvent, adhesive, spin-welding, vibration-welding, ultrasonic-welding or laser-welding techniques. The welding or bonding increases the joint strength so the casing can be extracted from the hot gun casing after firing at the cook-off temperature.

The bullet-end and bullet components can then be welded or bonded together using solvent, adhesive, spin-welding, vibration-welding, ultrasonic-welding or laser-welding techniques. The welding or bonding increases the joint strength so the casing can be extracted from the hot gun casing after firing at the cook-off temperature. An optional first and second annular grooves (cannelures) may be provided in the bullet-end in the interlock surface of the male coupling element to provide a snap-fit between the two components. The cannelures formed in a surface of the bullet at a location determined to be the optimal seating depth for the bullet. Once the bullet is inserted into the casing to the proper depth to lock the bullet in its proper location. One method is the crimping of the entire end of the casing into the cannelures.

The nose and middle body components can then be welded or bonded together using solvent, adhesive, spin-welding, vibration-welding, ultrasonic-welding or laser-welding techniques. The welding or bonding increases the joint strength so the casing can be extracted from the hot gun casing after firing at the cook-off temperature.

FIGURES 2a and 2b depict perspective views of a polymeric cartridge case according to one embodiment of the present invention. A cartridge 10 suitable for use with high velocity rifles is shown manufactured with a polymer casing 12 showing a powder chamber (not shown) with projectile (not shown) inserted into the forward end opening 16. Polymer casing 12 has a substantially cylindrical open-ended polymeric nose 18 extending from forward end opening 16 rearward to opposite end 17. The nose 18 may be formed with nose junction 19 formed on opposite end 17 to connect to the body component 28. Nose junction 19 is shown as a female element, but may also be configured as a male element in alternate embodiments of the invention. The forward end of nose 18 has a shoulder 24 forming chamber neck 26. The nose 18 typically has a wall thickness between about 0.003 and about 0.200 inches and more preferably between about 0.005 and more preferably between about 0.150 inches about 0.010 and about 0.050 inches.

The nose 18 includes the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition 10 in the chamber (not shown). The alignment aid 40 includes at least a first tab surface 42 adjacent to a second cut surface 44 in an alternating configuration. In its simplest form the alignment aid 40 may have a curved first tab surface 42 with the second curved cut surface 44 flanking each side of the curved first tab surface 42. This alignment aid 40 is related to a diamond locating pin. A diamond locating pin uses

a cut a small amount on four sides, forming a diamond with the original curved section on two opposite sides. This unique shape allows the pin to contact the locating hole with a smaller surface area that prevents movement in one direction (left/ right) while allowing a small change in the other direction (up/ down). Similarly, the present invention uses the alignment aid 40 having a curved first tab surface 42 with the second curved cut surface 44 flanking each side of the curved first tab surface 42 this unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown).

The middle body component 28 is connected to a substantially cylindrical coupling element (not shown) of the substantially cylindrical insert (not shown). Coupling element (not shown), as shown may be configured as a male element, however, all combinations of male and female configurations is acceptable for coupling elements (not shown) and coupling end (not shown) in alternate embodiments of the invention. During over molding the coupling end (not shown) molds over the coupling element (not shown) of a substantially cylindrical insert (not shown). The substantially cylindrical insert (not shown) includes a substantially cylindrical coupling element (not shown) extending from a bottom surface 34 that is opposite a top surface (not shown). Located in the top surface 36 is a primer recess (not shown) that extends toward the bottom surface (not shown). A primer flash aperture (not shown) extends through the bottom surface (not shown) into the powder chamber (not shown). The coupling end (not shown) extends the polymer through the primer flash aperture (not shown) to form a flash hole (not shown) while retaining a passage from the top surface 36 through the bottom surface (not shown) and into the powder chamber (not shown) to provide support and protection about the primer flash hole (not shown). A groove (not shown) is formed in the primer recess (not shown) around the primer flash aperture (not shown) and is over molded with the polymer to complete the formation of the flash hole (not shown). When contacted the coupling end (not shown) interlocks with the substantially cylindrical coupling element (not shown), through the coupling element (not shown) that extends with a taper to a smaller diameter at the tip (not shown) to form a physical interlock between substantially cylindrical insert (not shown) and middle body component 28. Polymer casing 12 also has a substantially cylindrical open-ended middle body component 28. The middle body component 28 extends from the nose junction 19 to the coupling element (not shown).

The nose 16, middle body 18 and bottom surface 34 define the interior of powder chamber 14 in which the powder charge (not shown) is contained. The interior volume of powder chamber 14 may be varied to provide the volume necessary for complete filling of the chamber 14 by the propellant chosen so that a simplified volumetric measure of propellant can be utilized when loading the cartridge. Either a particulate or consolidated propellant can be used.

Projectile (not shown) is held in place within chamber case neck 26 at forward opening 16 by an interference fit. Mechanical crimping of the forward opening 16 can also be applied to increase the bullet pull force. The bullet (not shown) may be inserted into place following the completion of the filling of powder chamber 14. Projectile (not shown) can also be injection molded directly onto the forward opening 16 prior to welding or bonding together using solvent, adhesive, spin-welding, vibration-welding, ultrasonic-welding or laser-

welding techniques. The welding or bonding increases the joint strength so the casing can be extracted from the hot gun casing after firing at the cook-off temperature.

The bullet-end and bullet components can then be welded or bonded together using solvent, adhesive, spin-welding, vibration-welding, ultrasonic-welding or laser-welding techniques. The welding or bonding increases the joint strength so the casing can be extracted from the hot gun casing after firing at the cook-off temperature. An optional first and second annular grooves (cannelures) may be provided in the bullet-end in the interlock surface of the male coupling element to provide a snap-fit between the two components. The cannelures formed in a surface of the bullet at a location determined to be the optimal seating depth for the bullet. Once the bullet is inserted into the casing to the proper depth to lock the bullet in its proper location. One method is the crimping of the entire end of the casing into the cannelures.

The nose and middle body components can then be welded or bonded together using solvent, adhesive, spin-welding, vibration-welding, ultrasonic-welding or laser-welding techniques. The welding or bonding increases the joint strength so the casing can be extracted from the hot gun casing after firing at the cook-off temperature.

FIGURE 3 depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention. The nose 18 includes the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition (not shown) in the chamber (not shown). The alignment aid 40 includes first tab surfaces 42a, 42b, 42c, and 42d adjacent to second cut surfaces 44a, 44b, 44c, and 44d in an alternating configuration. The alignment aid 40 includes first tab surfaces 42a which is adjacent to second cut surfaces 44a which is adjacent to first tab surfaces 42b which is adjacent to second cut surfaces 44b which is adjacent to first tab surfaces 42c which is adjacent to second cut surfaces 44c which is adjacent to first tab surfaces 42d which is adjacent to second cut surfaces 44d which is adjacent to first tab surface 42a. This unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown). In another embodiment the chamber (not shown) may be adapted to mate to the polymeric cartridge case. The alignment aid 40 includes first tab surfaces 42a, 42b, 42c, and 42d adjacent to second cut surfaces 44a, 44b, 44c, and 44d in an alternating configuration may be mirrored in the chamber to provide mirror and allow a fixed mating of the polymeric cartridge case and the chamber. In another embodiment, the chamber may include features that aid in the mating of the alignment aid 40 and the polymeric cartridge case without being a mirror image.

FIGURE 4a depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention. The nose 18 includes the forward opening 16 and the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition (not shown) in the chamber (not shown). The alignment aid 40 includes first tab surfaces 42a and 42b adjacent to second cut surfaces 44a, 44b, 44c, and 44d in an alternating configuration. The alignment aid 40 includes first tab surface 42a which is adjacent to second cut surfaces 44a which is adjacent to second cut surfaces 44b which is adjacent to first tab surface 42b which is adjacent to second cut surfaces 44c which is adjacent to second cut surfaces 44d which is

adjacent to first tab surface 42a. This unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown).

FIGURE 4b depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention. The nose 18 includes the forward opening 16 and the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition (not shown) in the chamber (not shown). The alignment aid 40 includes first tab surfaces 42a, 42b, 42c, and 42d adjacent to second cut surfaces 44a, 44b, 44c, and 44d in an alternating configuration. The alignment aid 40 includes first tab surface 42a which is adjacent to second cut surfaces 44a which is adjacent to first tab surface 42b which is adjacent to second cut surfaces 44b which is adjacent to first tab surface 42c which is adjacent to second cut surfaces 44c which is adjacent to first tab surface 42d which is adjacent to second cut surfaces 44d which is adjacent to first tab surface 42a. This unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown).

FIGURE 4c depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention. The nose 18 includes the forward opening 16 and the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition (not shown) in the chamber (not shown). The alignment aid 40 includes first tab surfaces 42a, 42b, and 42c adjacent to second cut surfaces 44a, 44b, and 44c in an alternating configuration. The alignment aid 40 includes first tab surface 42a which is adjacent to second cut surfaces 44a which is adjacent to first tab surface 42b which is adjacent to second cut surfaces 44b which is adjacent to first tab surface 42c which is adjacent to second cut surfaces 44c which is adjacent to first tab surface 42a. This unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown).

FIGURE 4d depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention. The nose 18 includes the forward opening 16 and the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition (not shown) in the chamber (not shown). The alignment aid 40 includes first tab surfaces 42a and 42b adjacent to second cut surfaces 44a and 44b in an alternating configuration. The alignment aid 40 includes first tab surface 42a which is adjacent to second cut surfaces 44a which is adjacent to first tab surface 42b which is adjacent to second cut surfaces 44b which is adjacent to first tab surface 42a. This unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown).

FIGURE 4e depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention. The nose 18 includes the forward opening 16 and the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition (not shown) in the chamber (not shown). The alignment aid 40 includes first tab surfaces 42a, 42b, 42c, 42d, 42e and 42f adjacent to second cut

surfaces 44a, 44b, 44c, 44d, 44e and 44f in an alternating configuration. The alignment aid 40 includes first tab surface 42a which is adjacent to second cut surfaces 44a which is adjacent to first tab surface 42b which is adjacent to second cut surfaces 44b which is adjacent to first tab surface 42c which is adjacent to second cut surfaces 44c which is adjacent to first tab surface 42d which is adjacent to second cut surfaces 44d which is adjacent to first tab surface 42e which is adjacent to second cut surfaces 44e which is adjacent to first tab surface 42f which is adjacent to second cut surfaces 44f which is adjacent to first tab surface 42g which is adjacent to second cut surfaces 44g which is adjacent to first tab surface 42h which is adjacent to second cut surfaces 44h which is adjacent to first tab surface 42a.

FIGURE 4f depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention. The nose 18 includes the forward opening 16 and the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition (not shown) in the chamber (not shown). The alignment aid 40 includes first tab surfaces 42a, 42b, 42c, and 42d (shown as angles) adjacent to second cut surfaces 44a, 44b, 44c, and 44d in an alternating configuration. The alignment aid 40 includes first tab surface 42a which is adjacent to second cut surfaces 44a which is adjacent to first tab surface 42b which is adjacent to second cut surfaces 44b which is adjacent to first tab surface 42c which is adjacent to second cut surfaces 44c which is adjacent to first tab surface 42d which is adjacent to second cut surfaces 44d which is adjacent to first tab surface 42a. This unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown).

FIGURE 4g depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention. The nose 18 includes the forward opening 16 and the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition (not shown) in the chamber (not shown). The alignment aid 40 includes first tab surfaces 42a, 42b, 42c, and 42d (shown as half circles) adjacent to second cut surfaces 44a, 44b, 44c, and 44d in an alternating configuration. The alignment aid 40 includes first tab surface 42a which is adjacent to second cut surfaces 44a which is adjacent to first tab surface 42b which is adjacent to second cut surfaces 44b which is adjacent to first tab surface 42c which is adjacent to second cut surfaces 44c which is adjacent to first tab surface 42d which is adjacent to second cut surfaces 44d which is adjacent to first tab surface 42a. This unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown).

FIGURE 4h depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention. The nose 18 includes the forward opening 16 and the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition (not shown) in the chamber (not shown). The alignment aid 40 includes first tab surfaces 42a, 42b, 42c, and 42d (shown as 2 adjacent half circles) adjacent to second cut surfaces 44a, 44b, 44c, and 44d in an alternating configuration. The alignment aid 40 includes first tab surface 42a which is adjacent to second cut surfaces 44a which is adjacent to first tab surface 42b which is adjacent to second cut surfaces 44b which is adjacent to first tab surface 42c which is adjacent to second cut surfaces 44c which is adjacent to first tab surface 42d which is adjacent to second cut

surfaces 44d which is adjacent to first tab surface 42a. This unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown).

FIGURE 4i depicts a top down view of the nose of the polymeric cartridge case according to one embodiment of the present invention. The nose 18 includes the forward opening 16, shoulder 24 forming chamber neck 26. and the alignment aid 40 that aid in the alignment of the nose 18 and in turn the ammunition (not shown) in the chamber (not shown). The alignment aid 40 is positioned on the neck 26 and includes first tab surfaces 42a, 42b, 42c, and 42d adjacent to second cut surfaces 44a, 44b, 44c, and 44d in an alternating configuration. The alignment aid 40 includes first tab surface 42a which is adjacent to second cut surfaces 44a which is adjacent to first tab surface 42b which is adjacent to second cut surfaces 44b which is adjacent to first tab surface 42c which is adjacent to second cut surfaces 44c which is adjacent to first tab surface 42d which is adjacent to second cut surfaces 44d which is adjacent to first tab surface 42a. This unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown). Although the first tab surface is shown as squares it may be any shape e.g., first tab surface shown in FIGURES4a-4i.

This unique configuration allows the nose 18 to contact the bore (not shown) of the chamber (not shown) with a smaller surface area that prevents movement in one direction to align the nose 18 in the bore (not shown).

It is understood that the FIGURES 4a-4i are meant for illustration and are not bound to any lengths. As such, the length of the first tabs surface and the second cut surfaces may be of any length necessary provided they form a aperture. In addition, the first tabs surface and the second cut surfaces may be uniformed in length and curvature or may be asymmetric depending on the specific application.

Polymer casing 12 also has a substantially cylindrical open-ended middle body component 28. Located in the top surface 36 is a primer recess 38 that extends toward the bottom surface 34 with a diffuser 50 positioned in the primer recess 38. The diffuser 50 includes a diffuser aperture 52 and a diffuser aperture extension 54 that aligns with the primer flash hole 40. The diffuser 50 is a device that is used to divert the affects of the primer (not shown) off of the polymer. The affects being the impact from igniting the primer as far as pressure and heat to divert the energy of the primer off of the polymer and directing it to the flash hole. The diffuser 50 can be between 0.004 to 0.010 inches in thickness and made from half hard brass. For example, the diffuser 50 can be between 0.005 inches thick for a 5.56 diffuser 50. The OD of the diffuser for a 5.56 or 223 case is 0.173 and the ID is 0.080. The Diffuser could be made of any material that can withstand the energy from the ignition of the primer. This would include steel, stainless, cooper, aluminum or even an engineered resin that was injection molded or stamped.

The polymeric and composite casing components may be injection molded. Polymeric materials for the bullet-end and middle body components must have propellant compatibility and resistance to gun cleaning solvents and grease, as well as resistance to chemical, biological and radiological agents. The polymeric

materials must have a temperature resistance higher than the cook-off temperature of the propellant, typically about 320°F. The polymeric materials must have elongation-to-break values that to resist deformation under interior ballistic pressure as high as 60,000 psi in all environments (temperatures from about -65 to about 320°F and humidity from 0 to 100% RH). According to one embodiment, the middle body component is either molded onto or snap-fit to the casing head-end component after which the bullet-end component is snap-fit or interference fit to the middle body component. The components may be formed from high-strength polymer, composite or ceramic.

Examples of suitable high strength polymers include composite polymer material including a tungsten metal powder, nylon 6/6, nylon 6, and glass fibers; and a specific gravity in a range of 3-10. The tungsten metal powder may be 50%-96% of a weight of the bullet body. The polymer material also includes about 0.5-15%, preferably about 1-12%, and most preferably about 2-9% by weight, of nylon 6/6, about 0.5-15%, preferably about 1-12%, and most preferably about 2-9% by weight, of nylon 6, and about 0.5-15%, preferably about 1-12%, and most preferably about 2-9% by weight, of glass fibers. It is most suitable that each of these ingredients be included in amounts less than 10% by weight. The cartridge casing body may be made of a modified ZYTEL resin, available from E.I. DuPont De Nemours Co., a modified 612 nylon resin, modified to increase elastic response.

Examples of suitable polymers include polyurethane prepolymer, cellulose, fluoro-polymer, ethylene inter-polymer alloy elastomer, ethylene vinyl acetate, nylon, polyether imide, polyester elastomer, polyester sulfone, polyphenyl amide, polypropylene, polyvinylidene fluoride or thermoset polyurea elastomer, acrylics, homopolymers, acetates, copolymers, acrylonitrile-butadinen-styrene, thermoplastic fluoro polymers, inomers, polyamides, polyamide-imides, polyacrylates, polyatherketones, polyaryl-sulfones, polybenzimidazoles, polycarbonates, polybutylene, terephthalates, polyether imides, polyether sulfones, thermoplastic polyimides, thermoplastic polyurethanes, polyphenylene sulfides, polyethylene, polypropylene, polysulfones, polyvinylchlorides, styrene acrylonitriles, polystyrenes, polyphenylene, ether blends, styrene maleic anhydrides, polycarbonates, allyls, aminos, cyanates, epoxies, phenolics, unsaturated polyesters, bismaleimides, polyurethanes, silicones, vinylesters, or urethane hybrids. Examples of suitable polymers also include aliphatic or aromatic polyamide, polyeitherimide, polysulfone, polyphenylsulfone, poly-phenylene oxide, liquid crystalline polymer and polyketone. Examples of suitable composites include polymers such as polyphenylsulfone reinforced with between about 30 and about 70 wt %, and preferably up to about 65 wt % of one or more reinforcing materials selected from glass fiber, ceramic fiber, carbon fiber, mineral fillers, organo nanoclay, or carbon nanotube. Preferred reinforcing materials, such as chopped surface-treated E-glass fibers provide flow characteristics at the above-described loadings comparable to unfilled polymers to provide a desirable combination of strength and flow characteristics that permit the molding of head-end components. Composite components can be formed by machining or injection molding. Finally, the cartridge case must retain sufficient joint strength at cook-off temperatures. More specifically, polymers suitable for molding of the projectile-end component have one or more of the following properties: Yield or tensile strength at -65°F > 10,000 psi Elongation-to-break at -65°F > 15% Yield or tensile strength at 73°F > 8,000 psi Elongation-to-break at 73°F > 50% Yield or tensile strength at

320°F>4,000 psi Elongation-to-break at 320°F>80%. Polymers suitable for molding of the middle-body component have one or more of the following properties: Yield or tensile strength at -65°F > 10,000 psi Yield or tensile strength at 73°F > 8,000 psi Yield or tensile strength at 320°F > 4,000 psi.

Commercially available polymers suitable for use in the present invention thus include polyphenylsulfones; copolymers of polyphenylsulfones with polyether-sulfones or polysulfones; copolymers and blends of polyphenylsulfones with polysiloxanes; poly(etherimide-siloxane); copolymers and blends of polyetherimides and polysiloxanes, and blends of polyetherimides and poly(etherimide-siloxane) copolymers; and the like. Particularly preferred are polyphenylsulfones and their copolymers with poly-sulfones or polysiloxane that have high tensile strength and elongation-to-break to sustain the deformation under high interior ballistic pressure. Such polymers are commercially available, for example, RADEL R5800 polyphenylesulfone from Solvay Advanced Polymers. The polymer can be formulated with up to about 10 wt % of one or more additives selected from internal mold release agents, heat stabilizers, anti-static agents, colorants, impact modifiers and UV stabilizers.

The polymers of the present invention can also be used for conventional two-piece metal-plastic hybrid cartridge case designs and conventional shotgun shell designs. One example of such a design is an ammunition cartridge with a one-piece substantially cylindrical polymeric cartridge casing body with an open projectile-end and an end opposing the projectile-end with a male or female coupling element; and a cylindrical metal cartridge casing head-end component with an essentially closed base end with a primer hole opposite an open end having a coupling element that is a mate for the coupling element on the opposing end of the polymeric cartridge casing body joining the open end of the head-end component to the opposing end of the polymeric cartridge casing body. The high polymer ductility permits the casing to resist breakage.

One embodiment includes a 2 cavity prototype mold having an upper portion and a base portion for a 5.56 case having a metal insert over-molded with a Nylon 6 (polymer) based material. In this embodiment the polymer in the base includes a lip or flange to extract the case from the weapon. One 2-cavity prototype mold to produce the upper portion of the 5.56 case can be made using a stripper plate tool using an Osco hot spur and two subgates per cavity. Another embodiment includes a subsonic version, the difference from the standard and the subsonic version is the walls are thicker thus requiring less powder. This will decrease the velocity of the bullet thus creating a subsonic round.

The extracting inserts is used to give the polymer case a tough enough ridge and groove for the weapons extractor to grab and pull the case out the chamber of the gun. The extracting insert is made of 17-4 ss that is hardened to 42-45rc. The insert may be made of aluminum, brass, cooper, steel or even an engineered resin with enough tensile strength.

The insert is over molded in an injection molded process using a nano clay particle filled Nylon material. The inserts can be machined or stamped. In addition, an engineered resin able to withstand the demand on the insert allows injection molded and/or even transfer molded.

One of ordinary skill in the art will know that many propellant types and weights can be used to prepare workable ammunition and that such loads may be determined by a careful trial including initial low quantity

loading of a given propellant and the well known stepwise increasing of a given propellant loading until a maximum acceptable load is achieved. Extreme care and caution is advised in evaluating new loads. The propellants available have various burn rates and must be carefully chosen so that a safe load is devised.

The description of the preferred embodiments should be taken as illustrating, rather than as limiting, the present invention as defined by the claims. As will be readily appreciated, numerous combinations of the features set forth above can be utilized without departing from the present invention as set forth in the claims. Such variations are not regarded as a departure from the spirit and scope of the invention, and all such modifications are intended to be included within the scope of the following claims.

It will be understood that particular embodiments described herein are shown by way of illustration and not as limitations of the invention. The principal features of this invention can be employed in various embodiments without departing from the scope of the invention. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, numerous equivalents to the specific procedures described herein. Such equivalents are considered to be within the scope of this invention and are covered by the claims.

The use of the word "a" or "an" when used in conjunction with the term "comprising" in the claims and/or the specification may mean "one," but it is also consistent with the meaning of "one or more," "at least one," and "one or more than one." The use of the term "or" in the claims is used to mean "and/or" unless explicitly indicated to refer to alternatives only or the alternatives are mutually exclusive, although the disclosure supports a definition that refers to only alternatives and "and/or." Throughout this application, the term "about" is used to indicate that a value includes the inherent variation of error for the device, the method being employed to determine the value, or the variation that exists among the study subjects.

As used in this specification and claim(s), the words "comprising" (and any form of comprising, such as "comprise" and "comprises"), "having" (and any form of having, such as "have" and "has"), "including" (and any form of including, such as "includes" and "include") or "containing" (and any form of containing, such as "contains" and "contain") are inclusive or open-ended and do not exclude additional, unrecited elements or method steps.

What is claimed is:

1. A polymeric ammunition cartridge having an alignment aid comprising:

a substantially cylindrical insert comprising a top surface opposite a bottom surface and a substantially cylindrical coupling element that extends from the bottom surface, a primer recess in the top surface that extends toward the bottom surface, a primer flash hole positioned in the primer recess to extend through the bottom surface, and a flange that extends circumferentially about an outer edge of the top surface; and

a substantially cylindrical polymeric middle body comprising a substantially cylindrical polymeric coupling end connected by a powder chamber, wherein the substantially cylindrical polymeric coupling end extends over the substantially cylindrical coupling element and covers a circumferential surface of the primer flash hole; and

a substantially cylindrical polymeric nose comprising a projectile aperture formed in a neck, a shoulder extending from the neck and nose junction adapted to connect to the substantially cylindrical polymeric middle body and an alignment aid positioned on the substantially cylindrical polymeric nose to align the substantially cylindrical polymeric nose in a bore.

2. A chamber adapted to accept the ammunition cartridge of claim 1.

3. A reamer adapted to form a chamber to accept the ammunition cartridge of claim 1.

4. The polymeric ammunition cartridge of claims 1 to 3, wherein the neck is 0.02, 0.021, 0.022, 0. 023, 0. 024, 0. 025, 0. 026, 0. 027, 0.028, 0.029, 0.030, 0.031, 0.032, 0.033, 0.034, 0.035, 0.036, 0.037, 0.038, 0.039, 0.040, 0.041, 0.042, 0.043, 0.044, 0.045, 0.046, 0.047, 0.048, 0.049, 0.05, 0.051, 0.052, 0.053, 0.054, 0.055, 0.056, 0.057, 0.058, 0.059, 0.06, 0.061, 0.062, 0.063, 0.064, 0.065, 0.066, 0.067, 0.068, 0.069, 0.07, 0.071, 0.072, 0.073, 0.074, 0.075, 0.076, 0.077, 0.078, 0.079, 0.08, 0.081, 0.082, 0.083, 0.084, 0.085, 0.086, 0.087, 0.088, 0.089, 0.09, 0.091, 0.092, 0.093, 0.094, 0.095, 0.096, 0.097, 0.098, 0.099, 0.1, 0.11, 0.12, 0.13, 0.14, 0.15, 0.16, 0.17, 0.18, 0.19, 0.2, 0.21, 0.22, 0.23, 0.24, 0.25, 0.26, 0.27, 0.28, 0.29, 0.3 0.31, 0.32, 0.33, 0.34, 0.35, 0.36, 0.37, 0.38, 0.39, 0.4, 0.41, 0.42, 0.43, 0.44, 0.45, 0.46, 0.47, 0.48, 0.49, 0.5, 0.51, 0.52, 0.53, 0.54, 0.55, 0.56, 0.57, 0.58, 0.59, 0.6, 0.61, 0.62, 0.63, 0.64, 0.65, 0.66, 0.67, 0.68, 0.69, 0.7, 0.71, 0.72, 0.73, 0.74, 0.75, 0.76, 0.77, 0.78, 0.79, 0.8, 0.81, 0.82, 0.83, 0.84, 0.85, 0.86, 0.87, 0.88, 0.89, 0.9, 0.91, 0.92, 0.93, 0.94, 0.95, 0.96, 0.97, 0.98, 0.99, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, or 2 inches.

5. The polymeric ammunition cartridge of claims 1 to 4, wherein the alignment aid comprises 3 of more vertical ridges and preferably the 3 of more vertical ridges includes 3, 4, 5, 6, 7, 8, 9, 10 or more vertical ridges.

6. The polymeric ammunition cartridge of claim 1, wherein the 3 of more vertical ridges have a profile that is generally square, generally rectangular, generally round, generally oval, generally triangular, generally rounded triangle, or a combination thereof.

7. The polymeric ammunition cartridge of claim 1, wherein the substantially cylindrical polymeric middle body is formed from a ductile polymer.

8. The polymeric ammunition cartridge of claim 1, wherein the substantially cylindrical polymeric middle body comprise a nylon polymer.

9. The polymeric ammunition cartridge of claim 1, wherein the substantially cylindrical polymeric middle body is formed from a fiber-reinforced polymeric composite.

10. The polymeric ammunition cartridge of claim 4, wherein the fiber-reinforced polymeric composite contains between about 10 and about 70 wt % glass fiber fillers, mineral fillers, or mixtures thereof.

11. The polymeric ammunition cartridge of claim 1, wherein the substantially cylindrical polymeric bullet-end and bullet are further welded or bonded together and a bullet is fitted to the forward opening end.

12. The polymeric ammunition cartridge of claim 1, further comprising a groove positioned around the primer flash aperture in the primer recess.

13. The polymeric ammunition cartridge of claim 1, wherein the alignment aid is positioned below the shoulder.

14. The polymeric ammunition cartridge of claim 1, wherein the alignment aid comprises one or more first tabs surface each separated by a second cut surface.

15. The polymeric ammunition cartridge of claim 1, wherein the alignment aid comprises at least four first tabs surface each separated by a second cut surface.

16. The polymeric ammunition cartridge of claim 1, wherein the substantially cylindrical polymeric middle body comprise a polymers selected from the group consisting of polyurethane prepolymer, cellulose, fluoro-polymer, ethylene inter-polymer alloy elastomer, ethylene vinyl acetate, nylon, polyether imide, polyester elastomer, polyester sulfone, polyphenyl amide, polypropylene, polyvinylidene fluoride or thermoset polyurea elastomer, acrylics, homopolymers, acetates, copolymers, acrylonitrile-butadinen-styrene, thermoplastic fluoro polymers, inomers, polyamides, polyamide-imides, polyacrylates, polyatherketones, polyaryl-sulfones, polybenzimidazoles, polycarbonates, polybutylene, terephthalates, polyether imides, polyether sulfones, thermoplastic polyimides, thermoplastic polyurethanes, polyphenylene sulfides, polyethylene, polypropylene, polysulfones, polyvinylchlorides, styrene acrylonitriles, polystyrenes, polyphenylene, ether blends, styrene maleic anhydrides, polycarbonates, allyls, aminos, cyanates, epoxies, phenolics, unsaturated polyesters, bismaleimides, polyurethanes, silicones, vinylesters, urethane hybrids, polyphenylsulfones, copolymers of polyphenylsulfones with polyethersulfones or polysulfones, copolymers of poly-phenylsulfones with siloxanes, blends of polyphenylsulfones with polysiloxanes, poly(etherimide-siloxane) copolymers, blends of polyetherimides and polysiloxanes, and blends of polyetherimides and poly(etherimide-siloxane) copolymers.

17. The polymeric ammunition cartridge of claim 1, wherein the substantially cylindrical coupling element is a male coupling element with a straight skirt interlock surface that tapers to a smaller diameter at the forward portion on the skirt tip to mate with a female coupling element of the substantially cylindrical polymeric coupling end.

18. The polymeric ammunition cartridge of claim 1, further comprising a diffuser positioned in the primer recess comprising a diffuser flash hole aligned with the primer flash hole.

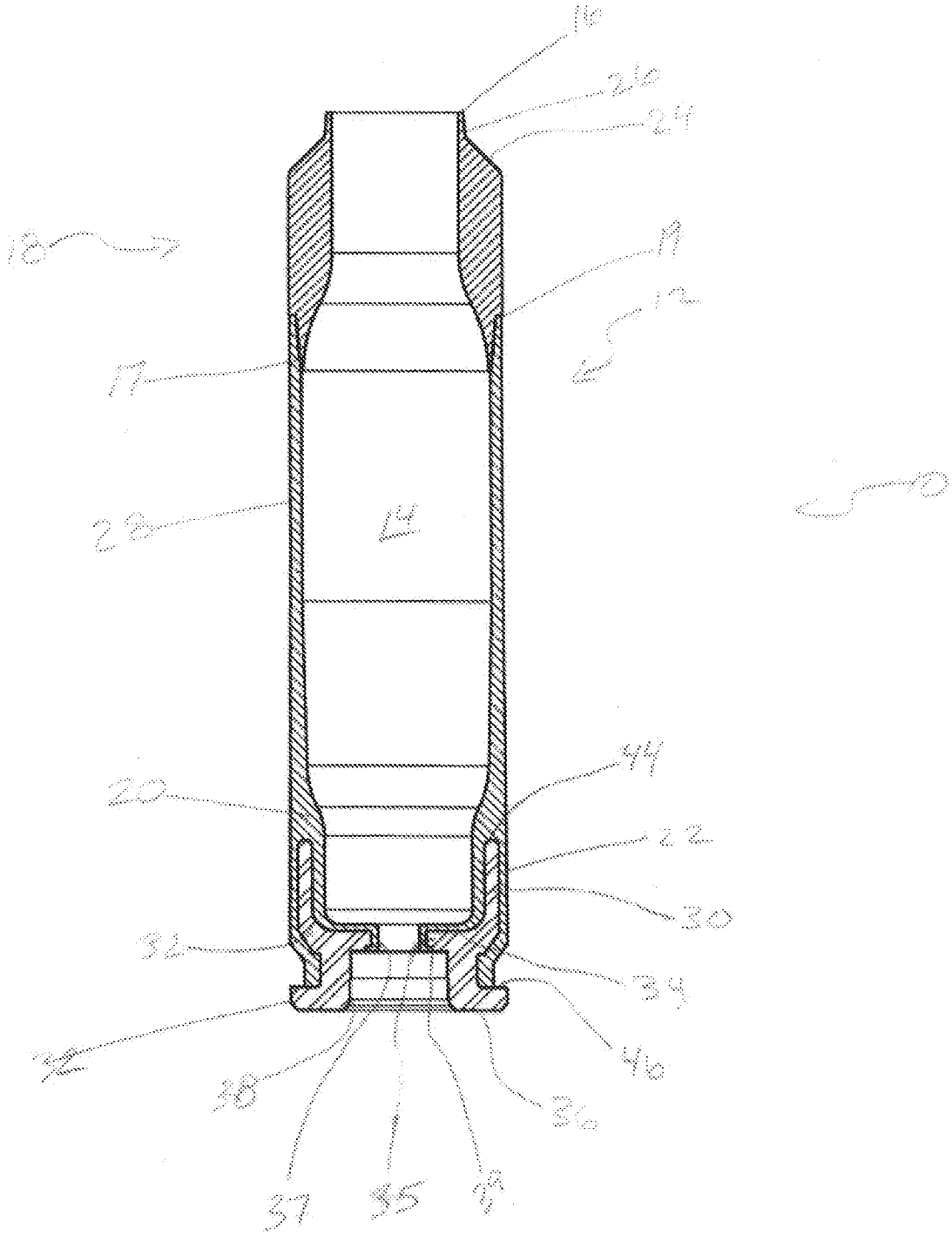

FIGURE 1

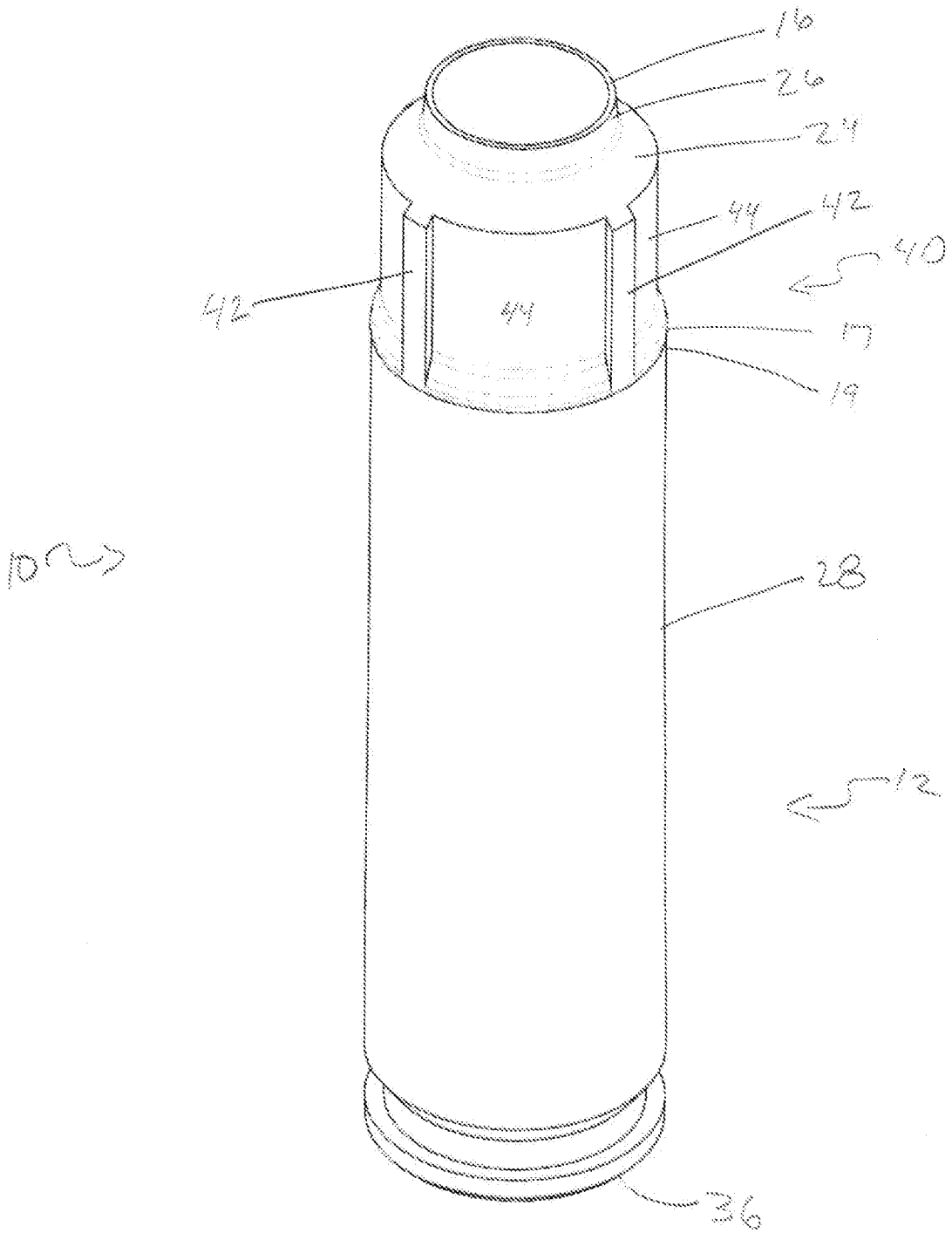

FIGURE 2a

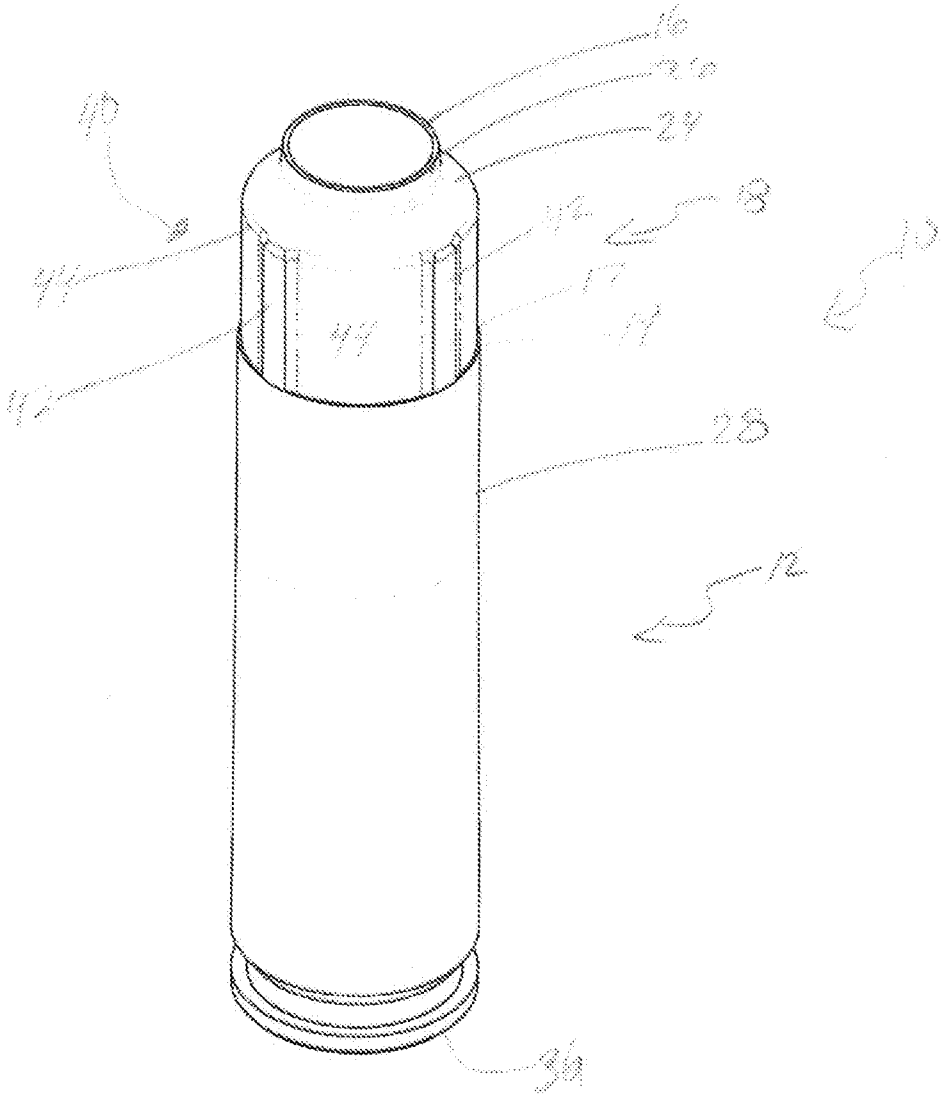

FIGURE 2b

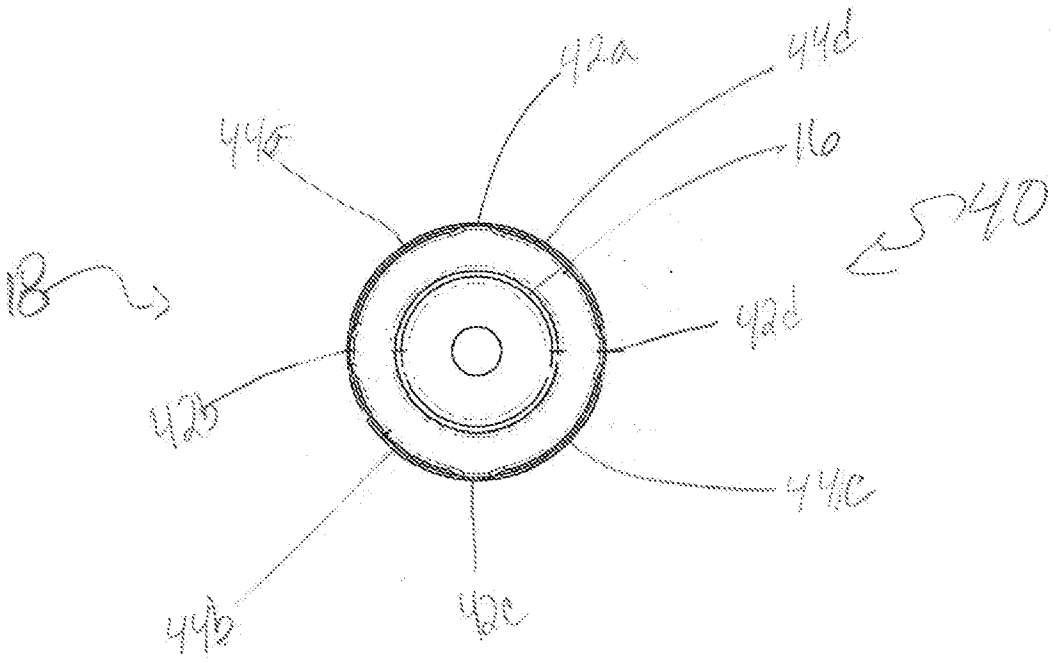

FIGURE 3

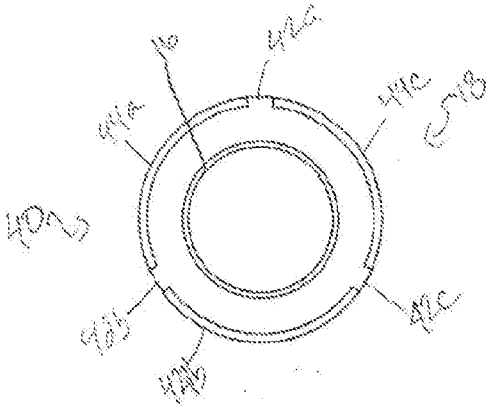

FIGURE 4c

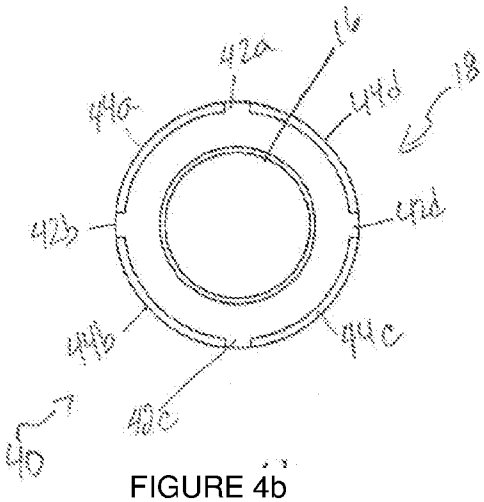

FIGURE 4b

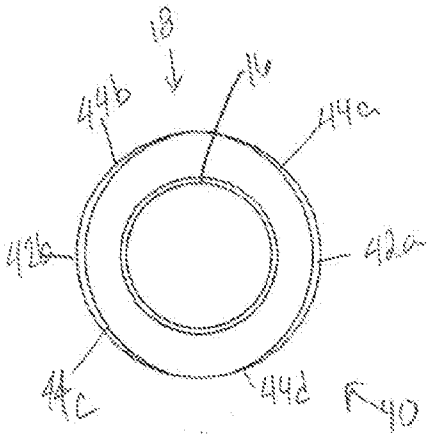

FIGURE 4a

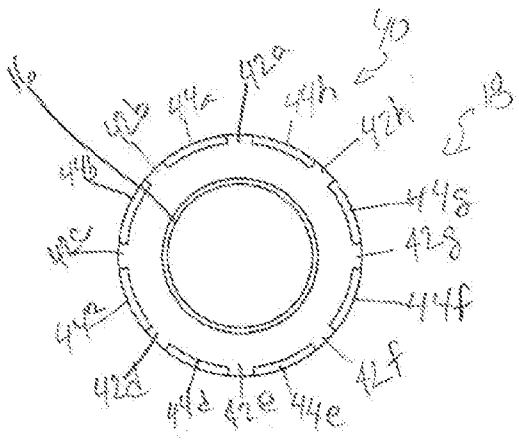

FIGURE 4e

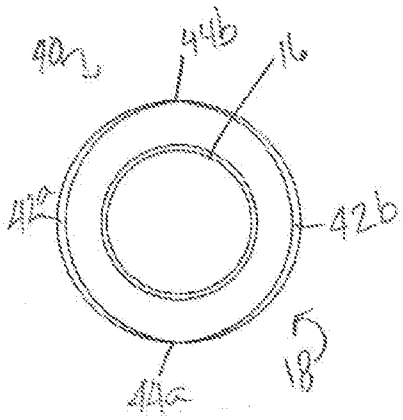

FIGURE 4d

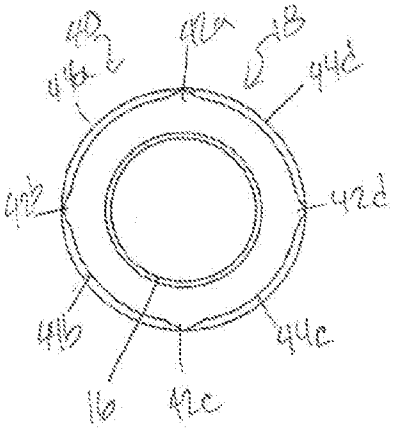

FIGURE 4f

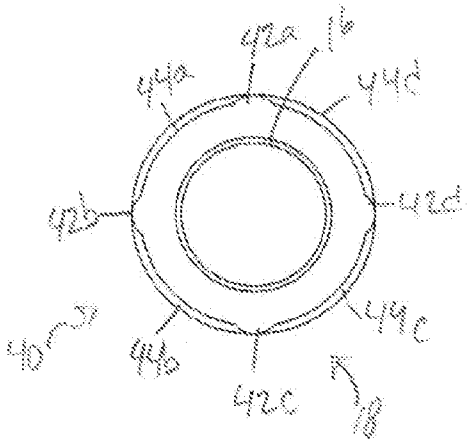

FIGURE 4g

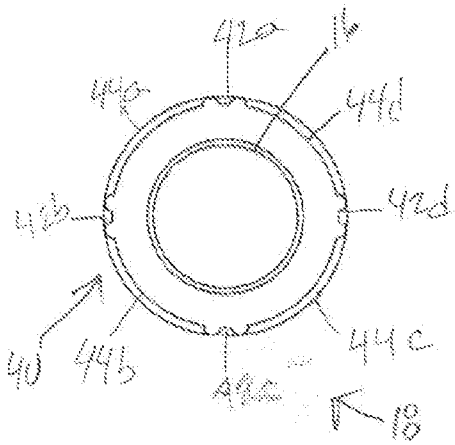

FIGURE 4h

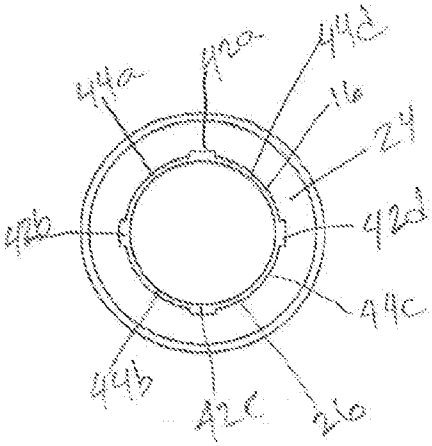

FIGURE 4i