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(54) Title: SHAPED PROJECTILE PROPELLANT

(57) Abstract: A projectile load, such as a projectile cartridge, can include a propellant within the case. The propellant may include a first face, and the projectile load may include a form having a predefined set form shape that holds the first face in a first face shape that is uneven, which may include one or more protrusions and may define one or more hollows. The projectile load can also include a projectile at least partially within the case and different from the form, with the first face of the propellant facing toward the projectile. The projectile load can be configured so that an ignition of the propellant will force the projectile out of the case.

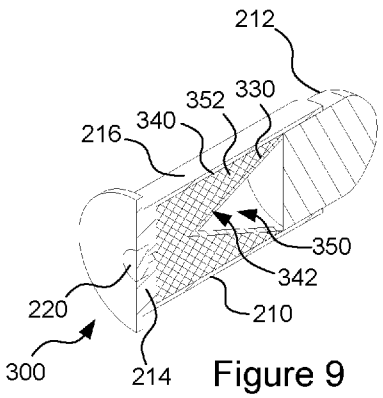


Figure 9

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SHAPED PROJECTILE PROPELLANT

RELATED APPLICATIONS

[0001] The present application claims the benefit of the filing date of United States Provisional Patent Application No. 62/920,563, filed 5/7/2019, which is incorporated herein by reference. If any disclosures are incorporated herein by reference and such incorporated disclosures conflict in part or whole with the present disclosure, then to the extent of conflict, and/or broader disclosure, and/or broader definition of terms, the present disclosure controls. If such incorporated disclosures conflict in part or whole with one another, then to the extent of conflict, the later-dated disclosure controls.

BACKGROUND

[0002] Chemical explosive propellants have been used to propel projectiles in many different projectile load configurations. Such loads typically include a propellant that is contained in a case, such as a cartridge case that is configured to be inserted in a gun (such as a firearm or a non-portable gun), or directly in the barrel of a gun. A projectile is also seated at least partially within the case. In use, the propellant is ignited to increase pressure that forces the projectile out of the case.

[0003] Shaped charges have been used in some applications. For example, shaped charges have been used for destroying structures. Shaped charges have also been included in projectiles, so that the directional power of the ignited shaped charge can help the projectile to penetrate armor.

SUMMARY

[0004] Whatever the advantages of previous projectile loads, they have neither recognized the shaped projectile propellant features described and claimed herein, nor the advantages produced by such features.

[0005] According to one embodiment, a projectile cartridge can include a case and a propellant that may include a chemical explosive within the case, where the propellant may include a face, and the face may be held in a predefined set face shape that is uneven. The projectile cartridge may also include a projectile at least partially within the case. A side of the projectile can be gripped by the case, with a front of the projectile facing out of the case, a rear of the projectile facing toward the propellant, and the face of the propellant facing toward the projectile. The gripping of the projectile by the case can be configured to keep the projectile at least partially within the case until ignition of the propellant forces the projectile from the case, and the projectile cartridge can be configured to be inserted into a gun.

[0006] According to another embodiment, a projectile load can include a case. The projectile load can also include a propellant that may include a chemical explosive within the case. The propellant may include a first face, and the projectile load may include a form (such as an insert or at least a portion of the propellant itself) having a predefined set form shape that holds the first face in a first face shape that is uneven. The propellant can have a second face that faces away from the first face. The second face can have a second face shape that does not match the first face shape, so that the first face shape and the second face shape are not symmetrical about a plane that is perpendicular to the longitudinal axis of the projectile load. The projectile load can also include a projectile at least partially within the case and different from the form, with the first face of the propellant facing toward the projectile. The projectile load can be configured so that an ignition of the propellant will force the projectile out of the case.

[0007] According to yet another embodiment, a method of loading a projectile load can include loading a propellant, which may include a chemical explosive, into a projectile cartridge case that is configured to be inserted into a gun after the projectile cartridge case is loaded to form the projectile load. The method may further include, using a form having a set shape (such as an insert that remains in the case until the propellant is ignited, or a pressing form that presses the propellant into the face shape so that the surface of the propellant is pressed into its own holding form and the pressing form is then removed from the propellant with a binding agent in the propellant holding the propellant in the desired shape) to form a face shape on a face of the propellant, with the face shape being uneven. The method may further include loading a projectile at least partially into the projectile cartridge case. The loading may include fixing the projectile to the projectile cartridge case to inhibit removal of the projectile from the projectile cartridge case until ignition of the propellant forces the projectile out of the projectile cartridge case (as opposed to a removable projectile, where the projectile is loaded in a way that facilitates removal of the projectile from the case prior to the projectile being fired from the case of the projectile cartridge due to ignition of the propellant). The method may further include holding the face of the propellant in the face shape.

[0008] According to yet another embodiment, a method of firing a projectile load may include inserting a projectile load into a gun. The projectile load may include a propellant that may include a chemical explosive in a case. The propellant may include a set face shape that is uneven, the set face shape being held in place by a form, and the form having a set shape and holding the set face shape in place until the propellant is ignited. The projectile load may also include a projectile that is separate from the form. The method may also include igniting the propellant, the igniting of the propellant causing the form to collapse

and causing the projectile to be fired from the gun, with the projectile being separate from the form after the projectile is fired from the gun.

[0009] This Summary is provided to introduce a selection of concepts in a simplified form. The concepts are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter. Similarly, the invention is not limited to implementations that address the particular techniques, tools, environments, disadvantages, or advantages discussed in the Background, the Detailed Description, or the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Fig. 1 is a cut-away side sectional view illustrating a shaped projectile load.

[0011] Fig. 2 is a side view of an insert from the projectile load of Fig. 1.

[0012] Fig. 3 is a side view of a projectile cartridge.

[0013] Fig. 4 is a side sectional view taken along line A-A of Fig. 3.

[0014] Fig. 5 is an illustration of a gun and a projectile cartridge, schematically illustrating the projectile cartridge being configured to be inserted into the gun and fired.

[0015] Fig. 6 is a rear-side-top perspective view of the projectile cartridge of Fig. 5.

[0016] Fig. 7 is a side view of the projectile cartridge of Fig. 5.

[0017] Fig. 8 is a side sectional view taken along line B-B of Fig. 7.

[0018] Fig. 9 is a rear-side-top perspective sectional view of the projectile cartridge of Fig. 8.

[0019] Fig. 10 is a rear-side-top perspective sectional view of the propellant of the projectile cartridge of the sectional view of Fig. 9.

[0020] Fig. 11 is a side view of another projectile cartridge.

[0021] Fig. 12 is a side sectional view taken along line C-C of Fig. 11.

[0022] Fig. 13 is a rear-side-top perspective view of the propellant of the projectile cartridge of the sectional view of Fig. 12.

[0023] Fig. 14 is a side view of another projectile cartridge.

[0024] Fig. 15 is a sectional view taken along line D-D of Fig. 14.

[0025] Fig. 16 is a rear-side-top perspective sectional view of the propellant of the projectile cartridge of the sectional view of Fig. 15.

[0026] Fig. 17 is a side view of another projectile cartridge.

[0027] Fig. 18 is a sectional view taken along line E-E of Fig. 17.

[0028] Fig. 19 is a rear-side-top perspective view of the propellant of the projectile cartridge of the sectional view of Fig. 18.

[0029] Fig. 20 is a front-side-top perspective view of the propellant of the projectile cartridge of the sectional view of Fig. 18.

[0030] Fig. 21 is a sectional view taken along line K-K of Fig. 17, illustrating a cross section along a plane that is perpendicular to the longitudinal axis, which extends along line E-E, of the cartridge of Fig. 17.

[0031] The description and drawings may refer to the same or similar features in different drawings with the same reference numbers.

DETAILED DESCRIPTION

A. Shaped Projectile Propellant Features

[0032] Referring to Fig. 1, a shaped projectile load **100** will be discussed. The projectile load **100** can include a case **110** and a projectile **112** that is at least partially within the case **110** (the shape of the projectile **112** is shown cut away so that the entire projectile **112** is not shown, but the projectile **112** could have a shape similar to the projectile illustrated

in Figs. 3-4 and other subsequent figures, or it could be some other projectile shape) For example, the case **110** may be a barrel of a gun, and the projectile **112** may be entirely within the case **110**, such as with a muzzle-loading gun. Alternatively, the case **110** may be a case of a projectile cartridge that is configured to be inserted into a gun, as is discussed more below with reference to Fig. 5. The case **110** can have a rear wall **114** and a tube **116** extending forward from the rear wall **114**. Also, a projectile load may include only a single projectile that does not separate into multiple projectiles when fired and that fills an opening of the case as illustrated herein, or multiple projectiles, such as with the shot of a shotgun shell. For example, the projectile **112** may be a projectile that is not entirely made of polymer or wood-based materials such as a projectile made partially or fully of a pure metal or metal alloy, such as a projectile that includes metal and stays together after being fired from the projectile load **100**. Like the projectile **112**, the rear wall **114** and a primer **120** are cut away to simplify the illustration. For example, the tube **116** can be a hollow cylinder, and it may include additional shapes or features, such as rifling if it is a barrel of a gun, or a narrowed section, such as for some cartridges that narrow as they extend forward toward the projectile, as in a shouldered or bottlenecked cartridge.

[0033] The projectile load **100** can also include the primer **120**, such as a primer seated in a projectile cartridge or a cap on a muzzle-loading gun.

[0034] An insert **130** (also illustrated in Fig. 2) can be positioned in the case **110** and can act as a form for a charge of propellant **140**. The propellant **140** can be a chemical explosive such as gunpowder, smokeless powder, or some other chemical explosive. The propellant **140** can be positioned against the rear wall **114** of the case **110** and can extend forward therefrom, toward the projectile **112**. For example, the propellant **140** can abut the rear wall **114**, and the propellant **140** can also abut the tube **116**. In other examples, one or more layers of material may be positioned between the propellant **140** and the case **110**, such

as between the propellant **140** and rear wall **114** and/or the tube **116**. The primer **120** can be positioned so that activation of the primer can in turn ignite the propellant **140** (such as via fire and/or sparks moving from the primer **120** to the propellant **140** through a passageway into the case **110**).

[0035] The propellant **140** can include a first face **142** that faces away from the rear wall **114** of the case **110** and toward the projectile **112**. The propellant **140** can also include a second face **144** that faces toward the rear wall **114** of the case **110** and away from the projectile **112**. The first face **142** can have a set uneven shape, such as a shape that defines one or more hollows **150** and/or includes a one or more protrusions **152**. The set uneven shape can be held in place by the insert **130** that is separate from the propellant **140** and separate from the projectile **112**, by the propellant itself, or even by a rear-facing face (i.e., facing toward the propellant) of a projectile. For example, where the shape is formed by the projectile, the rear face of the projectile may be shaped as a cone, a convex curved shape, or some other shape that can be pressed against the propellant to form the uneven set shape of the propellant. Where the shape of the first face of the propellant is formed by the rear face of the projectile, the projectile can simply extend back farther to abut the propellant, so that there is no free space between the projectile and the propellant. The hollows and/or protrusions can each have circular symmetry around an axis of the projectile load, where the axis extends from the rear wall **114** to the projectile **112** in the direction in which the projectile is to be fired. For example, a hollow and/or a protrusion can have a circular cross section, such as a solid circular cross section or a ring-shaped circular cross section, in a plane that is perpendicular to a longitudinal axis of the projectile load. For example, the front-most portion **156** of the first face **142**, which is closest to the projectile **112**, can be spaced an axial distance from a rear-most portion **158** of the first face **142**, which is closest to the projectile **112**. As used herein, an uneven face of the propellant refers to the propellant

including one or more projections defining one or more hollows in the propellant that are more than mere side effects of the materials or manufacturing of the projectile load **100** and its components. For example, such side effects may include projections and hollows that are the mere result of typical grains of the propellant.

[0036] The axial distance from the front-most portion **156** to the rear-most portion **158** of the of the first face **142** of the propellant **140** may be at least five percent of the value of the diameter of the projectile **112** (the caliber of the projectile). As another example, the axial distance from the front-most portion **156** to the rear-most portion **158** of the first face **142** may be at least ten percent of the value of the diameter of the projectile **112**. For example, for a nine millimeter load, the axial distance from the front-most portion **156** of the propellant **140** to the rear-most portion **158** of the of the first face **142** of the propellant **140** may be at least 0.9 millimeter (at least ten percent of the caliber). As other examples, the axial distance from the front-most portion **156** to the rear-most portion **158** of the first face **142** of the propellant **140** may be at least twenty percent of the value of the diameter of the projectile **112**, at least thirty percent of the value of the diameter of the projectile **112**, at least forty percent of the value of the diameter of the projectile **112**, at least fifty percent of the value of the diameter of the projectile **112**, at least sixty percent of the value of the diameter of the projectile **112**, at least seventy percent of the value of the diameter of the projectile **112**, at least eighty percent of the value of the diameter of the projectile **112**, at least ninety percent of the value of the diameter of the projectile **112**, at least one hundred percent of the value of the diameter of the projectile **112**, or at least one hundred and ten percent of the value of the diameter of the projectile **112**.

[0037] In the example illustrated in Fig. 1, the axial distance from the front-most portion **156** to the rear-most portion **158** of the first face **142** of the propellant **140** can be between one-hundred and ten percent and one-hundred and fifteen percent of the value of the

diameter of the projectile **112**. Specifically, in the example illustrated in Fig. 1, the first face **142** defines a hollow **150** that is a conical shape surrounded by a protrusion **152** that is annular and extends between the hollow **150** and the tube **116** of the case **110**. Thus, the protrusion **152** has an annular circular cross section and the hollow **150** has a solid circular cross section in a plane that extends perpendicular to a longitudinal axis of the projectile load **100**.

[0038] Also, in the example of Fig. 1, the set shape of the first face **142** can be formed and maintained by an insert **130**. The insert **130**, also illustrated in Fig. 2, can define the first face **142** of the propellant **140** to form the set uneven shape of the first face **142** and to maintain that set shape. The insert **130** can be a hollow conical shape, where a base **164** of the insert **130** can rest against the projectile **112**, and the insert **130** can extend away from the base **164** and the projectile **112** to an apex **162** of the insert **130** that is distal from the projectile **112**. Thus, the insert **130** can extend into the propellant **140**, with an outer surface of the insert **130** abutting the first face **142** of the propellant **140**, so that the insert **130** forms and maintains the shape of the first face **142** of the propellant.

[0039] The insert **130** can be made of any of various materials, so long as the insert **130** is able to fit into the case **110** and so long as it is sufficiently rigid to maintain its shape and thereby maintain the shape of the first face **142** of the propellant **140** prior to ignition of the propellant **140**. For example, the insert **130** may be made of paper material, polymer material, metal material, and/or composite material. For example, in low volume applications, the insert **130** may be made of paper that is formed into a shape, such as the shape of the cone of Figs. 1-2. It has been found that a paper cone (or a thin polymer cone) may collapse upon ignition of the propellant **140**, and it is believed that such a collapse of the insert **130** may be helpful to inhibit interference of the insert **130** with the process of gases and resulting pressure from the ignition of the propellant forcing the projectile out of the case **110**.

[0040] As illustrated in Fig. 2, the insert **130** can be a conical shape that has a height **H** extending from the base **164** to the apex **162** in a direction perpendicular to the base **164** of the insert **130**. The insert **130** can also have a slant height **SH** extending in a line along the outer surface of the cone from the base **164** to the apex **162**.

[0041] Different inserts can be different shapes from the insert **130** illustrated in Figs. 1-2, so long as they form and maintain the first face of the propellant (the face that is facing toward the projectile) in a set uneven shape. Additionally, the insert can participate in the projectile load **100** maintaining a space **168** between the propellant and the projectile, although part or all of that space may be filled with the insert and/or some other member that is separate from the projectile (so that the other member would not be attached to the projectile while the projectile is in flight after being fired from the projectile load due to the propellant being ignited).

[0042] Referring now to Fig. 3, a reference projectile load that is a projectile cartridge **200** is illustrated. Such a reference projectile cartridge **200** can be useful in illustrating a technique for calculating dimensions for an insert to be used in forming and maintaining a shape of a face of a propellant. The projectile cartridge **200** can include a case **210** and a projectile **212** seated partially within the case **210**. The case **210** can include a rear wall **214** and a tube **216** extending axially from the rear wall **214** to the projectile **212**, with the case **210** extending around sides of the projectile **212**. A primer **220** can be seated in the rear wall **214**, with the rear wall **214** defining a passageway between the primer **220** and an internal cavity **222** of the case **210**. Propellant **240** can be housed in the cavity **222** of the case **210** between the rear wall **214** and the projectile **212**. The propellant **240** may not fill the entire cavity **222** between the rear wall **214** and the projectile **212**, leaving a free space **224** within the cavity **222** between the propellant **240** and the projectile **212**. The insert, such as the insert **130**, can have a volume slightly less than or equal to the typical free space between the

propellant and the projectile (for the same amount of projectile, the same case, the same projectile, and the same position of the projectile).

[0043] For example, in this illustration a distance **A** can be an overall axial length of the projectile cartridge **200**, including the case **210** and the projectile **212**. A distance **B** can be an axial length of the projectile **212**. A distance **Y** can be an axial length of the case **210**. A distance **X** can be a distance between the rear of the case **210** and the rear of the projectile **212,** which can be calculated as a difference between the distance **A** and the distance **B** (**A-B**). A distance **C** can be an axial distance that the projectile **212** extends into the case **210**, which can be calculated as a difference between the distance **Y** and the distance **X** (**Y-X**). A distance **D** can be an axial distance to the propellant **240** from a front of the case **210** (the open end of the case **210**, opposite from the rear wall **214** of the case **210**). A distance **E** can be a distance from the front of the case to a front side of the rear wall **214** (a side of the rear wall **214** against which the propellant can rest). A distance **F** can be an axial depth of the propellant **240** inside the case **210**. The distance **F** can be an axial depth of the propellant **240**, which can be a difference between the distance **E** and the distance **D** (**E-D**). A distance **G** can be an axial depth of the free space **224** between the propellant **240** and the projectile **212**. For example, the distance **G** can be calculated as the difference between the distance **D** and the distance **C, or** the difference between the distance **E** and the sum of the distances **F** and **C** (**E-(F+C)**). Additionally, the volume of the free space **224** can be a cylinder having a length **G** and a diameter equal to the caliber of the projectile cartridge, which is termed a distance **CB**. Thus, the radius **R** of the cylinder of the free space **224** can be half the caliber distance **CB**.

[0044] For an insert, such as insert **130** of Fig. 1, to rest against the projectile and to abut the face of the propellant that faces the projectile, the volume of the insert can be equal to or slightly less than the volume of the free space **224**. This relationship of volumes can be

used to calculate an appropriate volume for an insert. For example, where the insert is to be a cone like the insert **130** of Fig. 1, the height of the cone can be calculated using equations 1 and 2 below. Equation 1 simply equates the volume of the cylinder (V_{cyl}) for the free space with the volume of the cone (V_{cone}) for the insert to fill the same amount of volume with the same radius and diameter. Equation 2 substitutes the values of the distances discussed above in the standard equations for the volume of a cylinder and a cone.

$$\text{Equation 1: } V_{Cyl} = V_{Cone}$$

$$\text{Equation 2: } \pi R^2 G = \frac{1}{3}\pi R^2 H$$

Solving Equation 2 for **H** yields the following Equation 3 for the height of the insert **130** that is conical shaped:

$$\text{Equation 3: } H = 3G$$

Thus, for an insert **130** that is conical shaped, the height **H** of the cone can be three times (or slightly less than three times) the depth **G** of the free space **224** that would have been present with the propellant having a flat face that faces the projectile.

[0045] Of course, the concept involved in the calculation above includes the dimensions of the insert being calculated so the insert rests against the projectile and rests against the face of the propellant that is facing the projectile. With this concept in mind, different shapes of inserts, cases, and projectiles can be considered. For example, if the rear of the projectile is rounded, the volume of the rounded portion of the projectile may be included as part of the volume of the free space in the calculation, so that the insert will abut the projectile where the projectile meets the surrounding tube of the case (with the rounded portion of the projectile extending back within the space of the insert). Alternatively, the insert could include a solid front wall that would abut the rear-most point of the projectile even if the solid rear of the projectile is rounded or cone shaped. Also, different shapes of

inserts can be used, and the volumes of such different shapes can be calculated or at least estimated using standard geometric calculations.

[0046] Referring now to Figs. 5-10, an example of a projectile load that is a projectile cartridge **300** will be discussed. The projectile cartridge **300** can be configured as a standard projectile cartridge that can be loaded in a standard gun **302** and fired from the gun **302** in a standard manner. The gun **302** can include typical features such as a clip (not shown) for loading cartridges and a barrel **304** through which the projectiles (bullets) of the cartridges are fired.

[0047] Features of the projectile cartridge **300** are illustrated in more detail in Figs. 6-10. The projectile cartridge **300** can be like the projectile cartridge **200** discussed above, and individual features that are the same include the same numbers as for the projectile cartridge **200** discussed above. Indeed, the projectile cartridge **300** can include the same case **210**, the same primer **220**, and the same projectile **212**. The projectile cartridge **300** can include an insert **330**, which can be the same as the insert **130** discussed above. The insert can abut the projectile **212** and propellant **340** to form and maintain a first face **342** of the propellant **340** that faces toward the projectile **212** in a set uneven shape, and can maintain the first face **342** in the uneven shape until the propellant **340** is ignited. Specifically, the propellant **340** can include an annular protrusion **352** that extends forward along the tube **216** of the case **210** and forms the first face **342** facing toward the projectile **212** and defines a conical hollow **350** in the propellant **340**. Accordingly, the annular protrusion **352** can have an annular circular cross section and the hollow **350** can have a solid circular cross section along a plane extending perpendicular to the longitudinal axis of the projectile cartridge **300**.

[0048] Alternative propellant face shapes will be discussed with reference to Figures 11-20. In the examples of these figures, the insert is omitted. This can be done if the propellant itself, or at least the face of the propellant that faces the projectile, is formed into a

sufficiently rigid shape so the shape is maintained until the propellant is ignited to fire the projectile from the case of the propellant cartridge. For example, the propellant may be compressed into a sufficiently rigid shape using a removable form, and/or some other process may be performed to produce the desired face shape. Also, the different shapes illustrated in the figures can include different amounts of propellant compared to each other. The shapes can be varied from those illustrated to vary how much propellant is used. Also, these different shapes and other shapes can be formed using inserts that are sized and shaped as discussed above. In each of Figs. 11-20, the projectile cartridges can be like the cartridge **300** discussed above, and similar reference numbers will be used for the features of the case **210**, the primer **220**, and the projectile **212**.

[0049] Referring now to Figs. 11-13, an example of a projectile cartridge **400** will be discussed. The projectile cartridge **400** can be similar to the projectile cartridge **300** discussed above, except that the set shape of the first face **442** of the propellant **440** can be a different shape, and the shape can be formed and maintained by the propellant **440** itself being sufficiently rigid, rather than including an insert to hold the shape of the first face **442**. In this example, the first face **442** can form a concave shape of the propellant **440** that defines a convex hollow **450** within the propellant, surrounded by an annular protrusion **452**. Specifically, the hollow **450** can extend into the propellant **440** farther as it extends inward toward the axial center of the projectile cartridge **400**, forming a central apex **454** of the hollow that is distal from the projectile **212**. Thus, the annular protrusion **452** can have an annular circular cross section and the hollow **450** can have a solid circular cross section along a plane that extends perpendicular to the longitudinal axis of the projectile cartridge **400**.

[0050] Referring now to Figs. 14-16, another example of a projectile cartridge **500** will be discussed. The projectile cartridge **500** can be like the projectile cartridge **300** discussed above. However, rather than the first face of the propellant defining a hollow in the

propellant, the propellant **540** can include a first face **542** that faces toward the projectile **212** and defines a protrusion **552** in a set conical shape. The conical shape can include a central apex **562** proximal to the projectile **212** and a base **564** that is distal from the apex **562** and distal from the projectile **212**. Thus, the propellant **540** and the case **210** can define an annular hollow **550** between the propellant **540** and the tube **216** of the case **210**, instead of the propellant **540** defining a hollow within the propellant **540** as in the examples of Figs. 1 and 5-13. The protrusion **552** can have a solid circular cross section and the hollow **550** can have an annular circular cross section along a plane that extends perpendicular to the longitudinal axis of the projectile cartridge **500**.

[0051] Referring now to Figs. 17-20, yet another example of a projectile cartridge **600** will be discussed. The projectile cartridge **600** can be like the projectile cartridge **300** discussed above. However, the propellant **640** can define a first face **642** that faces toward the projectile **212** and defines a central conical protrusion **652** as well as an annular protrusion **653** that extends around a periphery of the propellant **640** against the tube **216** of the case **210**. The propellant **640** can define an annular hollow **650** within the propellant **640** that extends back into the propellant between the conical protrusion **652** and the annular protrusion **653**. Thus, the conical protrusion **652** can have a solid circular cross section, the annular protrusion **653** can have an annular circular cross section, and the annular hollow **650** can have an annular circular cross section, all along a plane extending perpendicular to a longitudinal axis of the projectile cartridge **600**. When compared to some other shapes discussed above, the shape of the first face **642** can require less free space volume between the propellant **640** and the projectile **212** to produce a given amount of increase in the surface area of the first face **642**.

[0052] In making a projectile load with a shaped propellant charge like those discussed above, the shape of the first face of the propellant can be formed by the shape of an

insert, or by the propellant holding its own shape. For either type, a standard case and projectile can be used.

[0053] If an insert is to be used, the insert can be formed. As discussed above, different types of materials can be used, and different manufacturing techniques can be used. For example, if a paper insert is to be used, the paper can be formed into a shape, such as a hollow cone shape. For example, this may include cutting paper to have a correct dimension and then forming and securing the paper into a conical shape. This forming and securing may be done manually or using mass production techniques that are currently used for forming paper into shapes such as conical cups. If a polymer is to be used, a shape may be formed using additive and/or subtractive manufacturing techniques for polymers such as 3D printing or injection molding. The dimensions and material properties of the insert can be such that the insert is sufficiently rigid or unbending to hold its shape over time until ignition causes its catastrophic failure, such as by causing the insert to collapse. Some examples of materials include paper, pressed cardboard, polymers of various thicknesses or flexibilities, and metals. Construction of inserts can use materials that can hold their shape until ignition of the propellant and then collapse under pressure.

[0054] For assembling a projectile load that uses an insert, the primer can be seated in the case, and a desired amount of propellant can be inserted into the case. For example, for a projectile cartridge, smokeless powder may be used, or for an example where a barrel forms the case black powder may be used. Other types of propellants may alternatively be used. The insert can then be inserted and pressed against the propellant, so that the insert forms the uneven face shape in the face of the propellant. The projectile can be inserted against the insert, so the insert is positioned to abut the projectile and the propellant. The projectile can be secured to the case, such as by crimping the case inwardly so that the case grips the sides of the projectile, thereby fixing the projectile to the case so the projectile is rigidly held in

place relative to the case. In this manner, the projectile load can be configured so the projectile, the insert, and the propellant remain in this loaded configuration with the projectile not being configured to be removable from the case until the propellant is ignited to fire the projectile from the case. In other words, the projectile load is not designed to have the projectile removed from the case other than by igniting the propellant, even if the projectile may be removed in unexpected or unintended ways such as by applying unexpected amounts of force to the projectile and/or the case, and/or cutting the projectile and/or the case.

[0055] For assembling a projectile load that does not use an insert, the primer can be seated in the case. A desired amount of propellant can be formed into a desired shape and inserted into the case. This may include forming the propellant into the shape before or after inserting the propellant into the case. For example, the propellant may be pressed to form a rigid body of propellant where a face of the propellant is set in an uneven shape, and that rigid body may then be inserted into the case with the uneven shaped face facing away from the rear wall of the case. As another example, the propellant may be inserted into the case, and then the face of the propellant may be pressed and set in the desired uneven shape while the propellant is within the case. In either situation, the projectile can be secured to the case, such as by crimping the case inwardly so that the case grips the sides of the projectile. In this manner, the projectile load can be configured so that the projectile and the propellant remain in this loaded configuration with the projectile not being configured to be removable from the case until the propellant is ignited to fire the projectile from the case.

[0056] Such projectile loads can be fired in conventional ways from conventional guns. For example, a projectile cartridge as described herein can be inserted into a gun. The primer can then be activated, such as by striking the primer with a hammer, striker or firing pin of the gun. The primer can then ignite or spark to ignite the propellant. That ignition of

the propellant within the case can generate a pressure increase that forces the projectile out of the case.

[0057] It is believed that projectile loads with propellant that has a set uneven face that faces toward the projectile can produce an increase in energy and velocity to the projectile that is shot from the projectile load, as compared to the same load with the same amount of propellant in the case that is not held with its projectile-facing face having an uneven set shape, such as where propellant powder may be loose within the case without having a set shape, with the propellant powder free to change its position and shape as the orientation of the projectile load changes.

[0058] Table 1 below shows velocities for different loads, including a standard load without holding the projectile-facing face of the propellant in an uneven set shape, and loads with cone-shaped inserts producing cone-shaped hollows in the projectile-facing face of the propellant (like the propellant face and insert shape illustrated in Fig. 1). The tests were performed using propellant cartridges in a 0.45 caliber handgun. The propellant was 11.4 grains of Blue Dot® powder, and a consistent one-half turn crimp with a cartridge reloading device was applied to crimp the case onto two-hundred and fifty grain jacketed hollow point projectiles. Multiple different types materials were used for the conical inserts. The projectiles were fired at a target fifty feet away and the velocities were measured with a chronograph. The measured velocities are in units of feet per second. The expected velocity was eight hundred feet per second.

Subtest	**Load A Std. Load**	**Load B Paper Cone**	**Load C Beer Case (Cardboard)**	**Load D OJ Cone (Cardboard)**	**Load E Plastic Cone**
1	773.2	1041	984.7	785.2	1081
2	688.5	1035	961.1	857.2	1135
3	657.9	1026	893.4	931.6	1017
4	790.8	1049	846.6	1052	978.1
5	761.3	1027	1024	1094	1116
6	931.9	989.9	1027	878.5	1167
7	749.0	914.6	1054	1037	1146
8	784.2	1086	1166	968	1085
Highest	790.8	1086	1166	1094	1167
Lowest	657.9	914.6	846.6	785.2	978.1
Average	**742.1**	**1,024.8**	**994.8**	**950.7**	**1,090**
Spread	132.9	171.4	320	309.7	189.2
Accuracy (Inches)	2 3/4	3	3 1/8	4 3/8	2 1/2
Average Velocity Minus Expected Velocity	-57.9	224.8	194.8	150.7	290

Table 1

[0059] Table 2 below shows similar results for a test that was done using a different chronograph to measure velocity. Again, the expected velocity was eight hundred feet per

second. In those velocity values marked with an X next to the number, the cone twisted sideways while being inserted.

Subtest	Load A Standard Load	Load B Paper Cond	Load E Plastic Cone	Load F Inverted Plastic Cone
1	620.5	815	986.7	718.6
2	756.2	858.3	1162	931.7
3	800.2	680.5	1050	764.5
4	770.2	876.9	1096	1130X
5	759.6	1103	902.9	1190X
Highest	8 00.2	1103	1162	1190X
Lowest	620.5	680.5	902.9	718.6
Average	**741.3**	**866.7**	**1039.5**	**946.9**
Spread	1 79.7	412.7	259.2	471.4
Accuracy (Inches)	4 3/4	2 1/4	2 1/2, 4 in 1 7/8	2 ½, 2 Touch
Average Velocity Minus Expected Velocity	-58.7	66.7	239.5	(No previous load to compare to produce expected velocity.)

Table 2 (Note that the entry of 680.5 had been 6980.5 in previous versions of this table. It is believed the 6980.5 number was a typographical error and should have been 680.5, which had been listed as the lowest value in previous versions of the table.)

[0060] As can be seen from these test results, the velocity of the projectiles fired from the projectile loads that included inserts to shape the faces of the charges had significantly higher velocities on average than the standard projectile loads without such shaping effects.

[0061] All the reasons for the increase in velocity and energy in the loads having propellant charges with uneven shaped faces may not be fully understood. However, it is believed that at ignition a pressure wave goes out equally in all directions until containment fails. Then pressure vents through the failure. It is believed that the area of the failing portion of the containment vessel may determine the amount or portion of energy vented through the failure. Without a cone or some other shape of the face of the charge that faces toward the projectile, the grip of the case on the projectile (the crimp) is the weak link. It fails to hold when the ignition of the propellant creates enough pressure to overcome the crimp and allows the pressure to send the projectile out of the barrel. The force involved may be determined at least in part by the ratio of the area of the projectile base to the surface area of the containment vessel, including the area of the projectile base.

[0062] With a cone or other shaped charge, the shape of the face (whether the insert or something else holding the shape of the charge's face) may be considered part of the containment vessel and also its weakest part. When the pressure of ignition causes the structure holding the face in its shape (whether an insert or something else) to fail, this allows the pressure to send the projectile out of the barrel, overcoming the crimp's grip in the process. The force involved may be determined at least in part by the ratio of the area of the lateral surface area of the cone or other shape to the surface area of the containment vessel, including the lateral surface area of the face shape.

[0063] Because the lateral area of the cone is greater than the area of the projectile base, the velocity can be expected to be higher than for a load without a cone. Consider a first ratio of the lateral area of the cone to the surface area of the containment vessel for the

conical shaped charge embodiment. Also consider a second ratio of the area of the projectile base to the surface area of the containment vessel for the non-shaped charge embodiment. In these ratios, the surface area of the containment vessel in the non-shaped embodiment can have two flat ends (assuming the rear wall of the case is flat), while the surface area of the containment vessel in the shaped embodiment has one end formed by the lateral surface of the cone and the other end flat (again, assuming the rear wall of the case is flat). The overall ratio of the first ratio value to the second ratio value may be used to predict an approximate percentage increase in velocity.

[0064] It is noted, however, that the invention herein does not rely upon the explanation above being correct. As noted above, it has been found that holding the face of the propellant charge that faces the projectile in an uneven shape can yield an increase in velocity of the fired projectile. This may be due to the surface area differences noted above, or it may be due to some other mechanism, whether in combination with the surface area differences noted above or without such differences having an effect.

[0065] The subject matter defined in the appended claims is not necessarily limited to the benefits described herein. A particular implementation of the invention may provide all, some, or none of the benefits described herein. Moreover, while operations for various techniques are described herein in sequential orders for the sake of presentation, this manner of description encompasses rearrangements in the order of operations, unless a particular ordering is required. For example, operations described sequentially may in some cases be rearranged or performed concurrently or in different orders.

B. Shaped Projectile Propellant Aspects

[0066] Multiple general aspects and multiple features of implementations of those aspects will now be discussed. Features described regarding one general aspect may be used with other general aspects.

[0067] A first general aspect can include a projectile cartridge, which can include a case. A propellant that may include a chemical explosive can be housed within the case. The propellant may include a face, and the face may be held in a predefined set face shape that is uneven. The projectile cartridge may also include a projectile at least partially within the case. A side of the projectile can be gripped by the case, with a front of the projectile facing out of the case, a rear of the projectile facing toward the propellant, and the face of the propellant facing toward the projectile. The gripping of the projectile by the case can be configured to keep the projectile at least partially within the case until ignition of the propellant forces the projectile from the case, and the projectile cartridge can be configured to be inserted into a gun.

[0068] Implementations of the first general aspect may include one or more of the following features in this paragraph in any combination, except that a configuration with a hollow having a central apex may not be combined with a configuration with a protrusion having a central apex. The projectile cartridge may include an insert between the propellant and the projectile. The insert can be an insert that holds its own shape and holds the face of the propellant in the face shape. The propellant can include a structure that holds itself in the face shape. The face shape can define a hollow extending into the propellant. The hollow may include a central apex, and the hollow may be conical. The face shape may define a protrusion, and the protrusion may include a central apex.

[0069] A second general aspect can include a projectile load including a case. The projectile load can also include a propellant that may include a chemical explosive within the case. The propellant may include a first face, and the projectile load may include a form (such as an insert or at least a portion of the propellant itself) having a predefined set form shape that holds the first face in a first face shape that is uneven. The propellant can have a second face that faces away from the first face. The second face can have a second face shape that

does not match the first face shape, so that the first face shape and the second face shape are not symmetrical about a plane that is perpendicular to an axis of the projectile load. The projectile load can also include a projectile at least partially within the case and different from the form, with the first face of the propellant facing toward the projectile. The projectile load can be configured so that an ignition of the propellant will force the projectile out of the case.

[0070] Implementations of the second general aspect may include one or more of the following features in this paragraph in any combination. The first face can have a surface area greater than a surface area of the second face. The form may include an insert between the propellant and the projectile, with the insert being an insert that holds its own shape and holds the first face of the propellant in the first face shape. The propellant may include a structure that holds the first face of the propellant in the first face shape (such as where the propellant may be pressed into a the first face shape so that the first face shape is held by the propellant itself, possibly with the inclusion of a binding agent mixed with the propellant to hold the propellant together in a way that the propellant maintains its shape until the propellant is ignited). The projectile load can be a projectile cartridge, where a side of the projectile is gripped by the case, a front of the projectile faces out of the case, and a rear of the projectile faces toward the propellant, with the projectile cartridge being configured to be inserted into a gun. The propellant may be shaped so that the propellant does not define a passageway between the first face and the second face. Also, the propellant can abut the case, with the propellant directly contacting the case.

[0071] A third general aspect may include a method of loading a projectile load. The method of loading can include loading a propellant that may include a chemical explosive into a projectile cartridge case that is configured to be inserted into a gun after the projectile cartridge case is loaded to form the projectile load. The method may further include using a

form having a set shape to form a face shape on a face of the propellant, with the face shape being uneven. The method may further include loading a projectile at least partially into the projectile cartridge case. The loading of the projectile at least partially into the projectile cartridge case may include fixing the projectile to the projectile cartridge case to inhibit removal of the projectile from the projectile cartridge case until ignition of the propellant forces the projectile out of the projectile cartridge case (as opposed to loading the projectile in a way that facilitates removal and reinsertion of the projectile prior to the projectile being fired from the case of the projectile cartridge due to ignition of the propellant). The method may further include holding the face of the propellant in the face shape.

[0072] Implementations of the third general aspect may include one or more of the following features in this paragraph in any combination. The form may include an insert having a set shape, and the method may include loading the insert between the propellant and the projectile, with the insert being an insert that holds its own shape and holds the face of the propellant in the face shape. The forming of the face shape may include forming the propellant into a structure that holds the face of the propellant in the face shape. The face shape may define a hollow. A side of the projectile may be gripped by the projectile cartridge case, with a front of the projectile facing out of the case, and a rear of the projectile facing toward the propellant. As used herein, directional terms such as front and rear are used for convenience in describing and claiming the features herein. However, they should not be construed to limit a projectile load to be in any particular orientation. For example, the projectile may be facing up, down, to one side, or at an angle that is neither vertical nor horizontal during use. Also, the loading may be performed with different orders of operations. For example, a projectile may be loaded first, followed by a powder charge, which can then be closed by a breech and fired or ignited from the rear, such as is done with a large diameter cannon (also known as artillery).

[0073] A fourth general aspect may include a method of firing a projectile load. The method may include inserting a projectile load into a gun. The projectile load may include a propellant that may include a chemical explosive in a case. The propellant may include a set face shape that is uneven, the set face shape being held in place by a form, and the form having a set shape and holding the set face shape in place until the propellant is ignited. The projectile load may also include a projectile that is separate from the form. The method may also include igniting the propellant, the igniting of the propellant causing the form to collapse and causing the projectile to be fired from the gun, with the projectile being separate from the form after the projectile is fired from the gun.

[0074] Implementations of the fourth general aspect may include one or more of the following features in this paragraph in any combination. The form may include an insert positioned in the case between the propellant and the projectile until the igniting of the propellant, with the insert being an insert that holds its own shape and holds the face of the propellant in the face shape until the igniting of the propellant. The form may include the face of the propellant holding itself in the face shape until the igniting of the propellant. The face shape may define a hollow. The projectile load may be a projectile cartridge and may include the case, the propellant, the form, and the projectile, where a side of the projectile is gripped by the case until the igniting of the propellant, where a front of the projectile faces out of the case until the igniting of the propellant, and where a rear of the projectile faces toward the propellant until the igniting of the propellant.

[0075] While particular embodiments are discussed above, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention. For example, many other different uneven shapes may be used for the face of the propellant facing the projectile.

CLAIMS

I/we claim:

1. A projectile cartridge comprising:

a case;

a propellant that comprises a chemical explosive within the case, with the propellant comprising a face, and with the face being held in a predefined set face shape that is uneven; and

a projectile at least partially within the case, a side of the projectile being gripped by the case, a front of the projectile facing out of the case, a rear of the projectile facing toward the propellant, the face of the propellant facing toward the projectile, the gripping of the projectile by the case being configured to keep the projectile at least partially within the case until ignition of the propellant forces the projectile from the case, the projectile cartridge being configured to be inserted into a gun, and the face of the propellant being held in the predefined set face shape by a form that is separate from the projectile.

2. The projectile cartridge of claim 1, wherein the projectile cartridge comprises an insert between the propellant and the projectile, with the insert being an insert that holds its own shape and comprises the form that holds the face of the propellant in the face shape.

3. The projectile cartridge of claim 1, wherein the propellant comprises the form so that the propellant holds itself in the face shape.

4. The projectile cartridge of claim 1, wherein the face shape defines a hollow extending into the propellant.

5. The projectile cartridge of claim 4, wherein the hollow comprises a central apex.

6. The projectile cartridge of claim 4, wherein the hollow is conical.

7. The projectile cartridge of claim 1, wherein the face shape defines a protrusion.

8. The projectile cartridge of claim 7, wherein the protrusion comprises a central apex.

9. A projectile load comprising:

a case;

a propellant that comprises a chemical explosive within the case, the propellant comprising a first face, and the projectile load comprising a form having a predefined set form shape that holds the first face in a first face shape that is uneven, the propellant having a second face that faces away from the first face, the second face having a second face shape that does not match the first face shape; and

a projectile at least partially within the case and different from the form, the projectile filling an opening of the case, the first face of the propellant facing toward the projectile, and the projectile load being configured so that an ignition of the propellant will force the projectile out of the case.

10. The projectile load of claim 9, wherein the first face has a surface area greater than a surface area of the second face.

11. The projectile load of claim 9, wherein the form comprises an insert between the propellant and the projectile, with the insert being an insert that holds its own shape and holds the first face of the propellant in the first face shape.

12. The projectile load of claim 9, wherein the propellant comprises the form that holds the first face of the propellant in the first face shape.

13. The projectile load of claim 9, wherein the projectile load is a projectile cartridge, wherein a side of the projectile is gripped by the case, a front of the projectile faces out of the case, and a rear of the projectile faces toward the propellant, with the projectile cartridge being configured to be inserted into a gun.

14. The projectile load of claim 9, wherein the propellant does not define a passageway between the first face and the second face.

15. The projectile load of claim 9, wherein the propellant abuts the case.

16. A method of firing a projectile load, the method comprising:

inserting a projectile load into a gun, the projectile load comprising:

a propellant that comprises a chemical explosive in a case, the propellant comprising a set face shape that is uneven, the set face

shape being held in place by a form, the form having a set shape and holding the set face shape in place until the propellant is ignited; and

a projectile that is separate from the form; and

igniting the propellant, the igniting of the propellant causing the form to collapse and causing the projectile to be fired from the gun, with the projectile being separate from the form after the projectile is fired from the gun.

17. The method of claim 16, wherein the form comprises an insert positioned in the case between the propellant and the projectile until the igniting of the propellant, with the insert being an insert that holds its own shape and holds the face of the propellant in the face shape until the igniting of the propellant.

18. The method of claim 16, wherein the form comprises the face of the propellant holding itself in the face shape until the igniting of the propellant.

19. The method of claim 16, wherein the face shape defines a hollow.

20. The method of claim 16, wherein the projectile load is a projectile cartridge comprising the case, the propellant, the form, and the projectile, wherein a side of the projectile is gripped by the case until the igniting of the propellant, wherein a front of the projectile faces out of the case until the igniting of the propellant, and wherein a rear of the projectile faces toward the propellant until the igniting of the propellant.

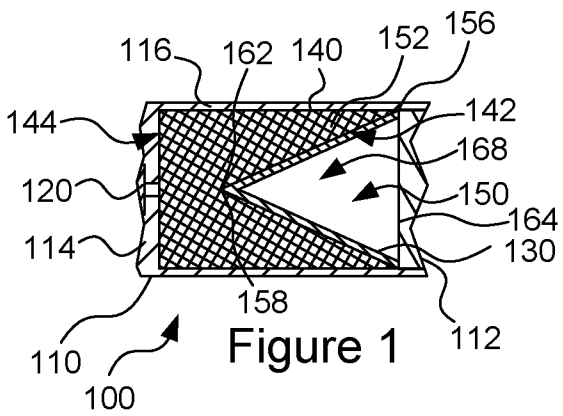


Figure 1

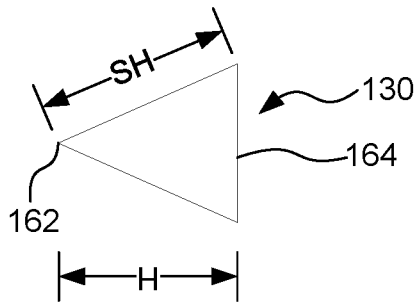


Figure 2

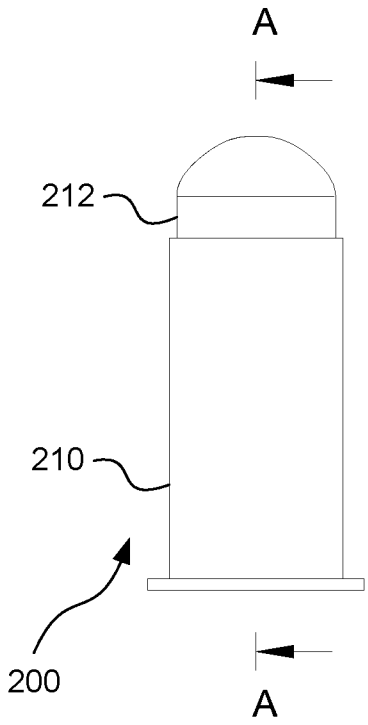


Figure 3

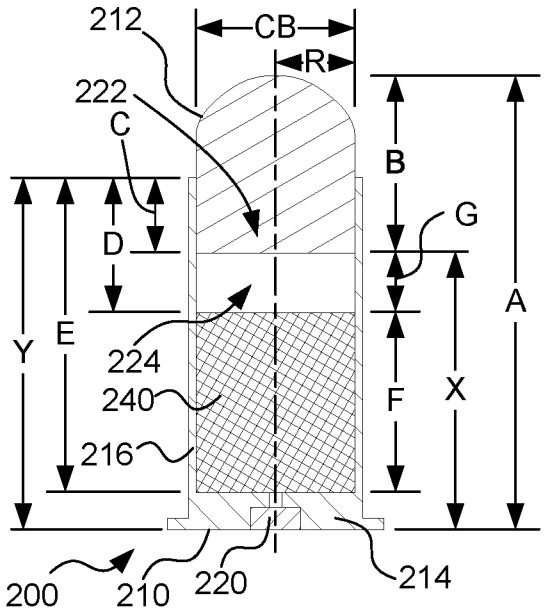


Figure 4

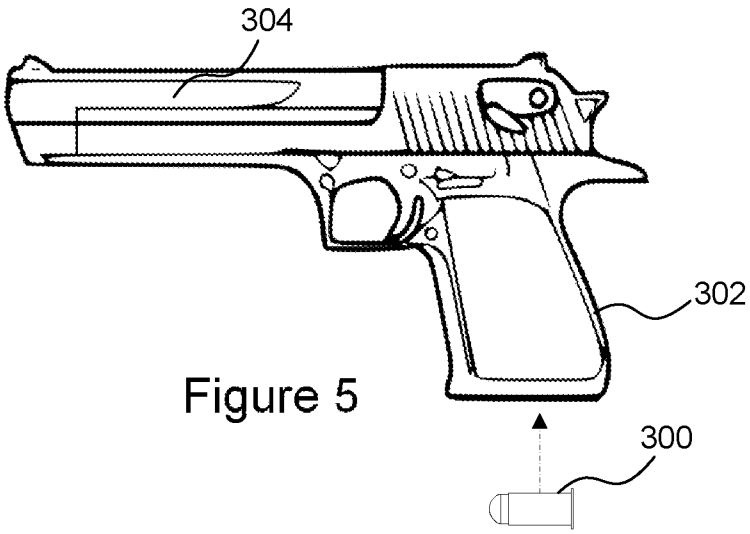


Figure 5

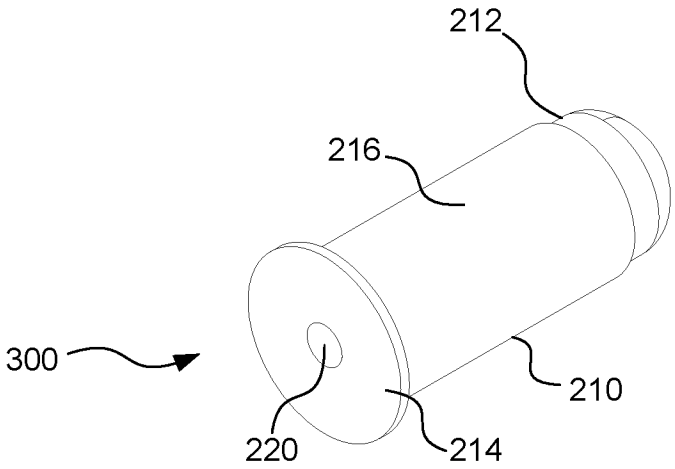


Figure 6

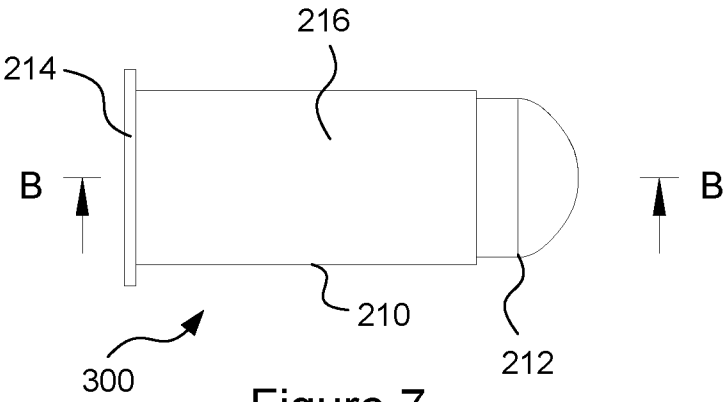


Figure 7

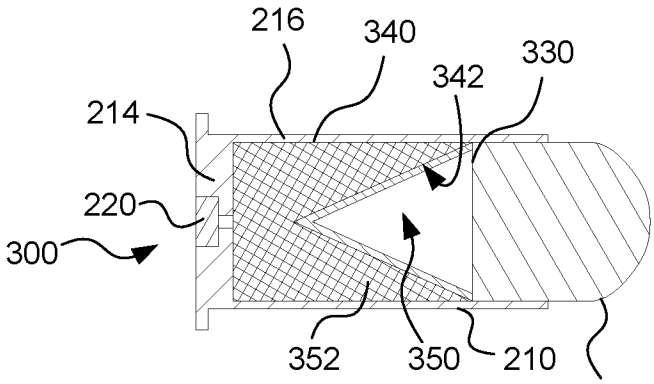


Figure 8

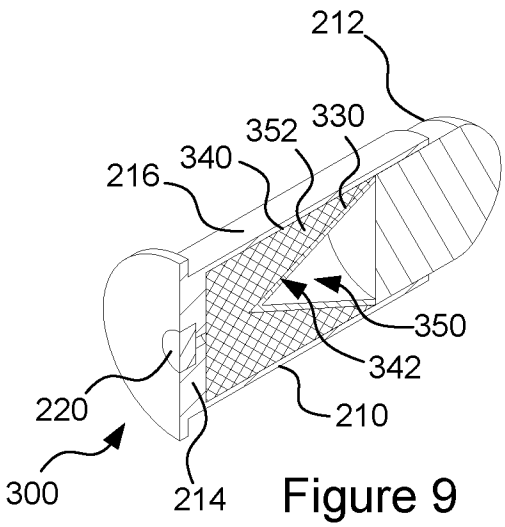


Figure 9

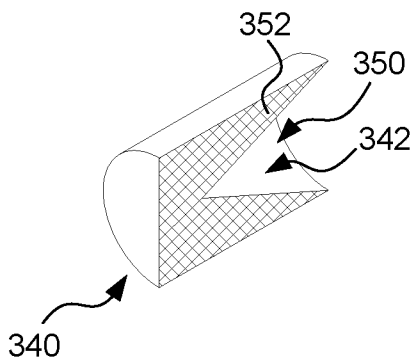


Figure 10

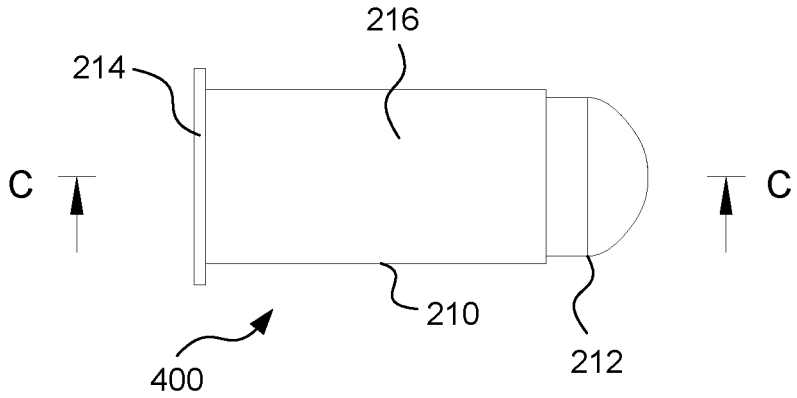


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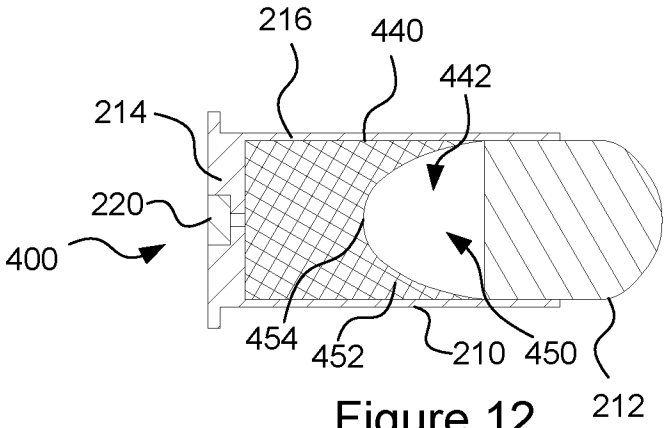


Figure 12

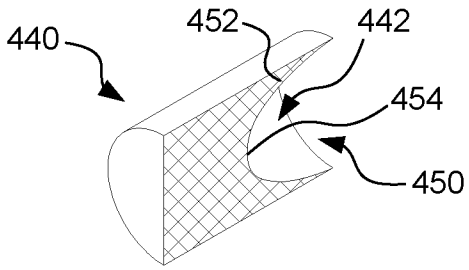


Figure 13

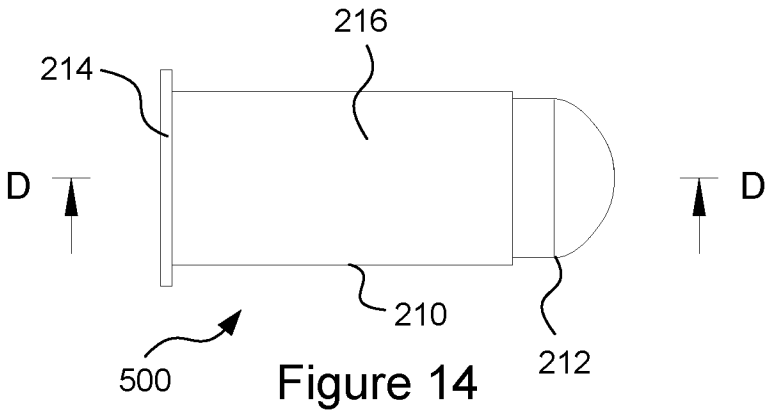


Figure 14

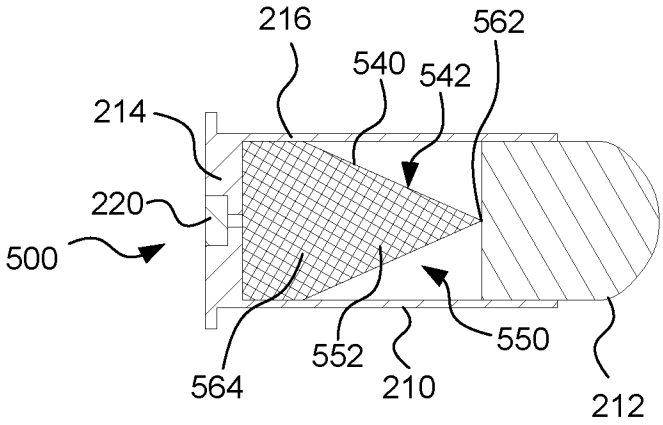


Figure 15

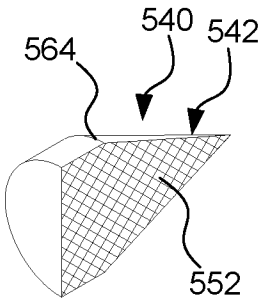


Figure 16

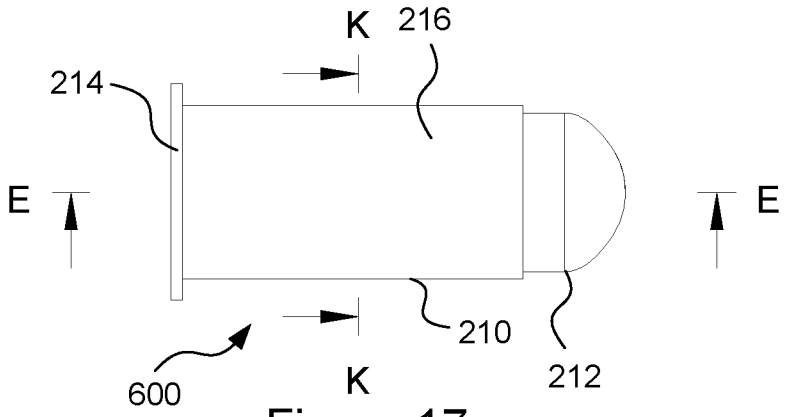


Figure 17

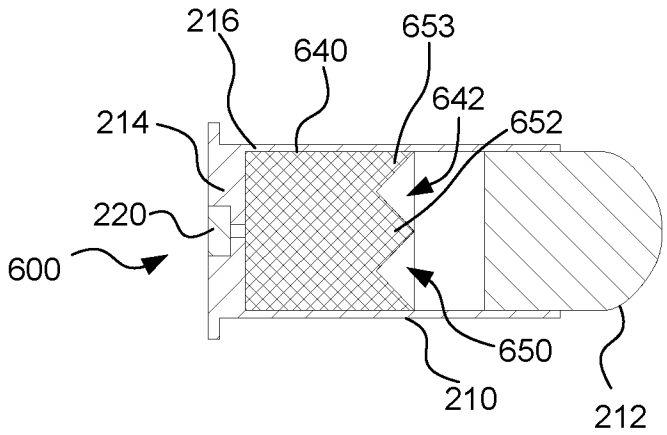


Figure 18

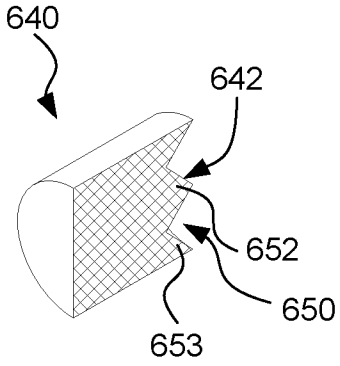


Figure 19

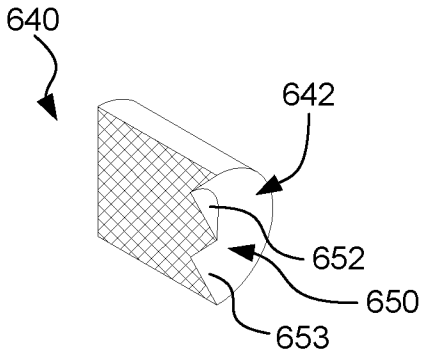


Figure 20

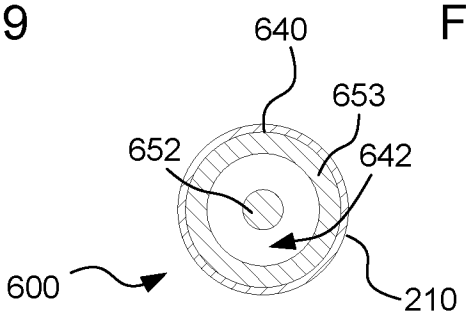


Figure 21