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(54) **EXPLODING PROJECTILE**

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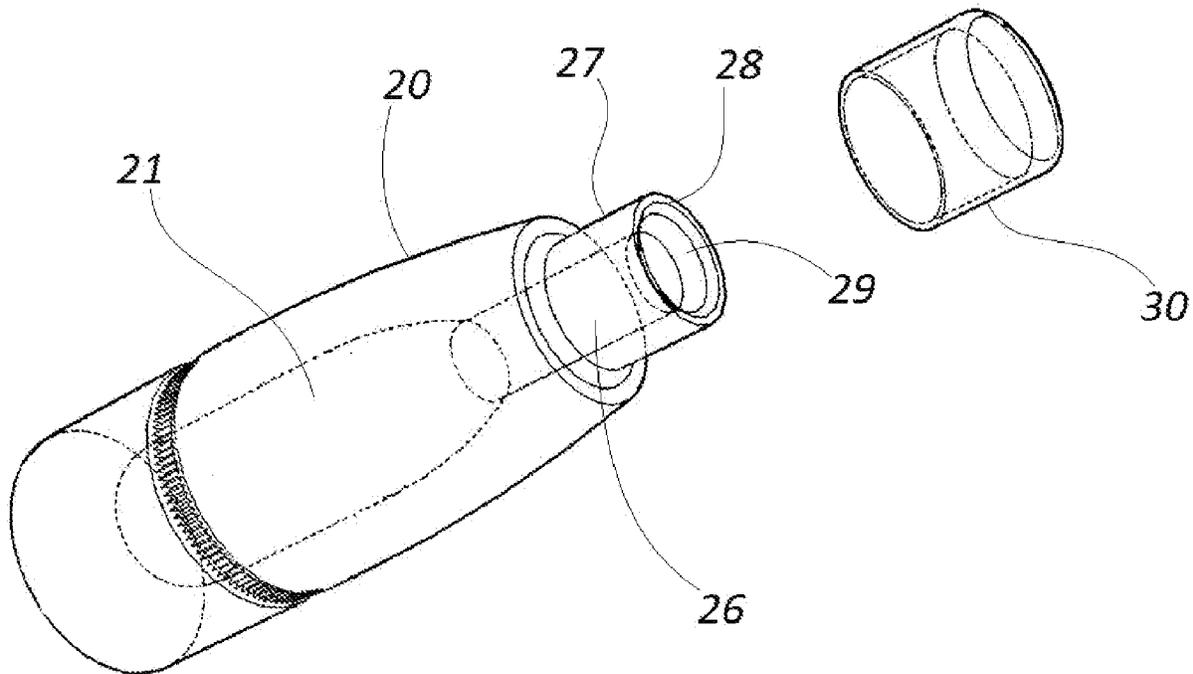
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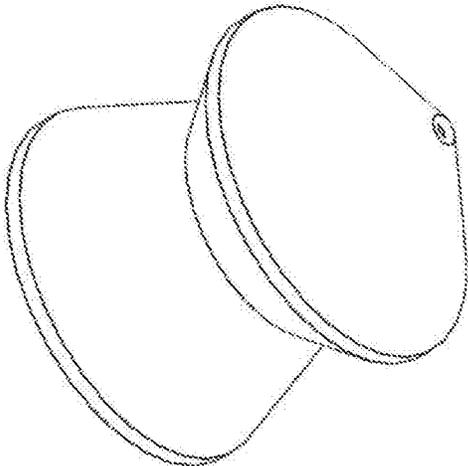
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(57) **ABSTRACT**

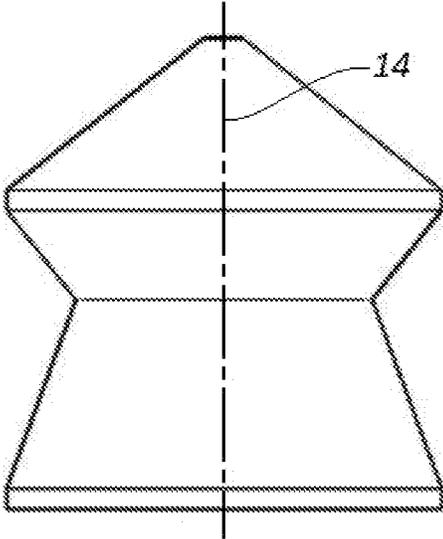
A projectile for conventional firearms includes a cavity with a conical or ogive surface, and an internal cavity into which is disposed an explosive material, such as a low explosive material. The tip of the projectile includes a reservoir into which is disposed an initiator, detonator, or primer material. According to some embodiments a pin is disposed ahead of the initiator, while according to others, deformable material is placed ahead of the initiator, so that impact of the projectile onto a target shocks the initiator into deflagration, which propagates into the explosive material, to fragment the projectile or for pyrotechnic effects, or both.

According to additional embodiments, the explosive may be a binary explosive activated by common substances available separately to a user, so that the product itself may be legally sold, shipped, and stored in a safe and stable state and thus incur fewer regulatory burdens.

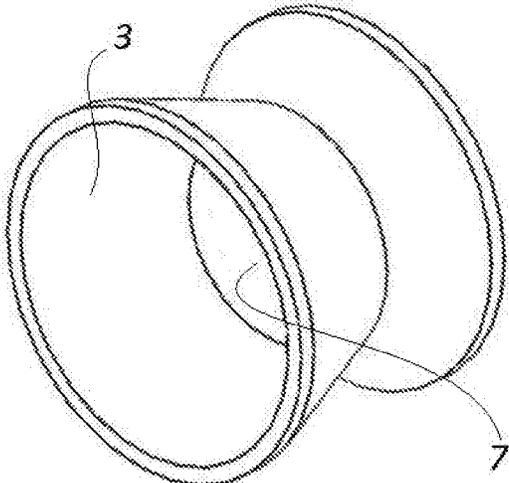




**Fig. 1**



**Fig. 2**



**Fig. 3**

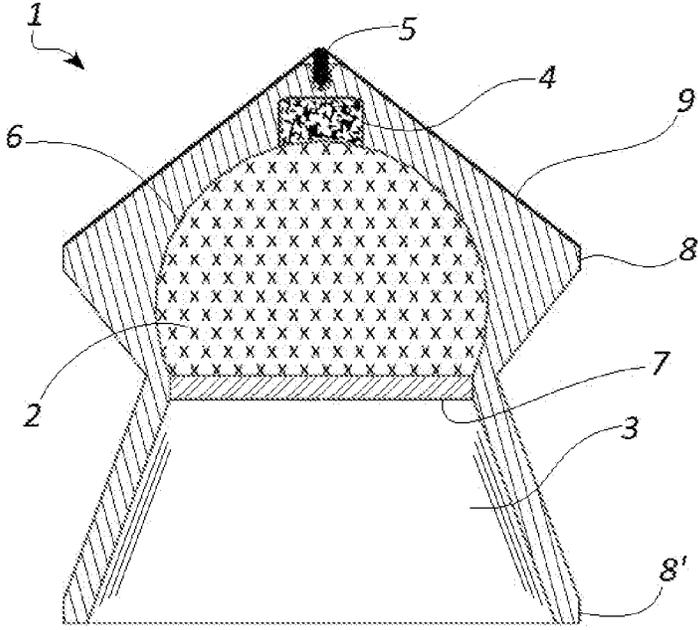


Fig. 4A

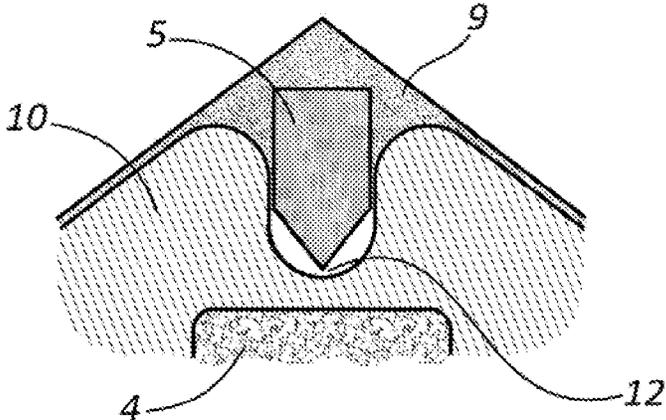
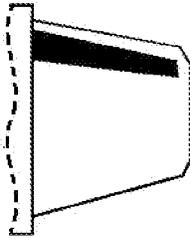
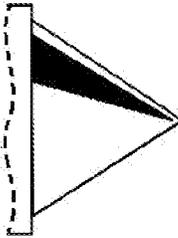


Fig. 4B



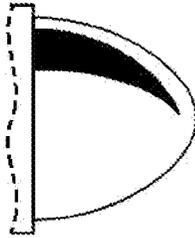
**Fig. 5A**



**Fig. 5B**



**Fig. 5C**



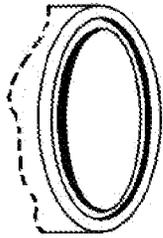
**Fig. 5D**



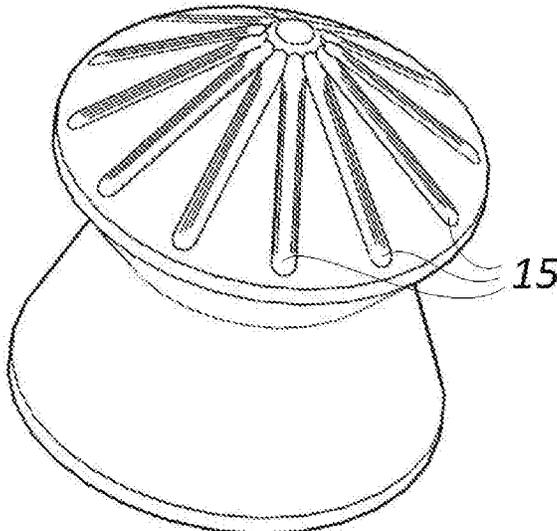
**Fig. 5E**



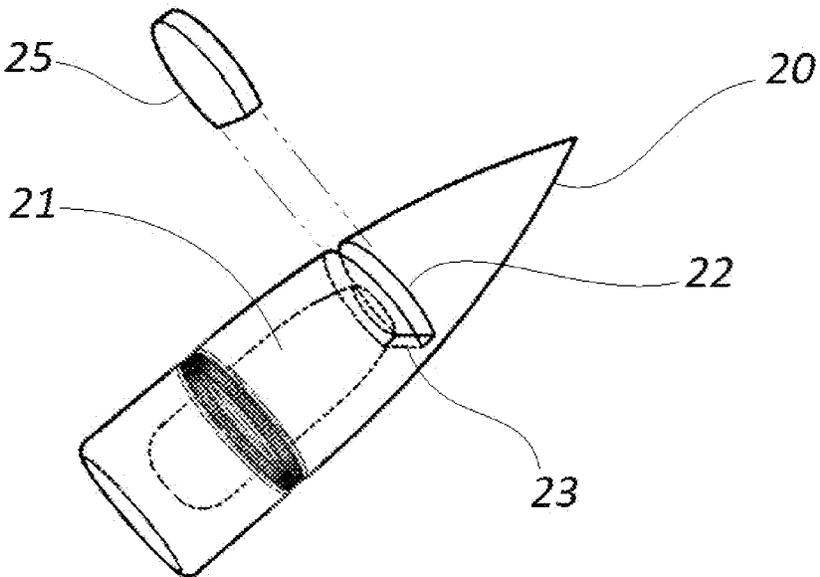
**Fig. 5F**



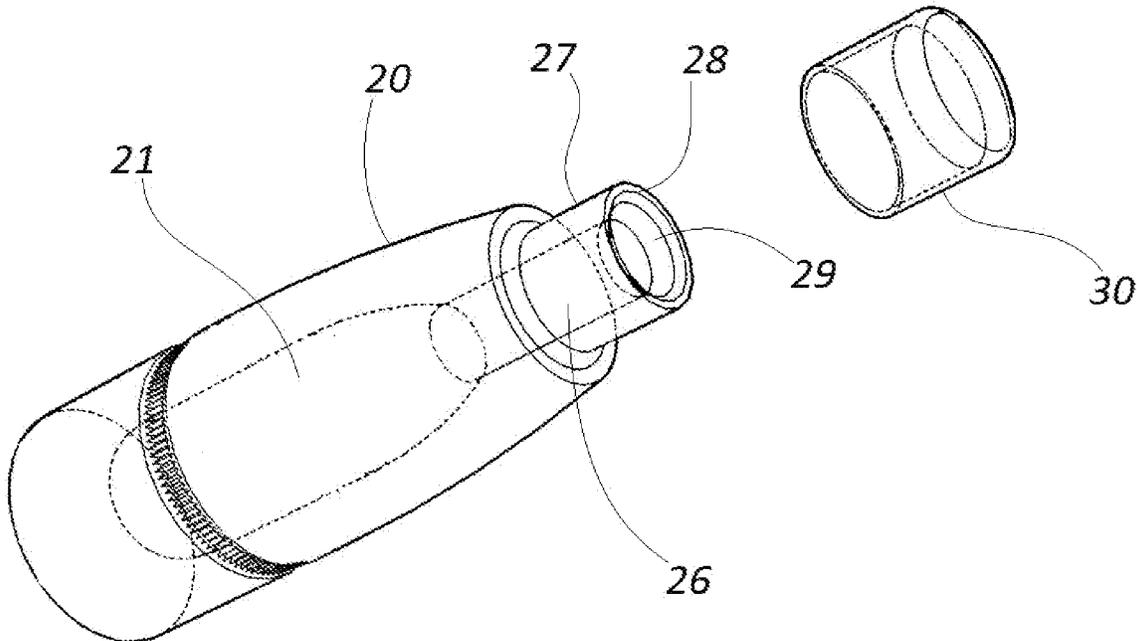
**Fig. 5G**



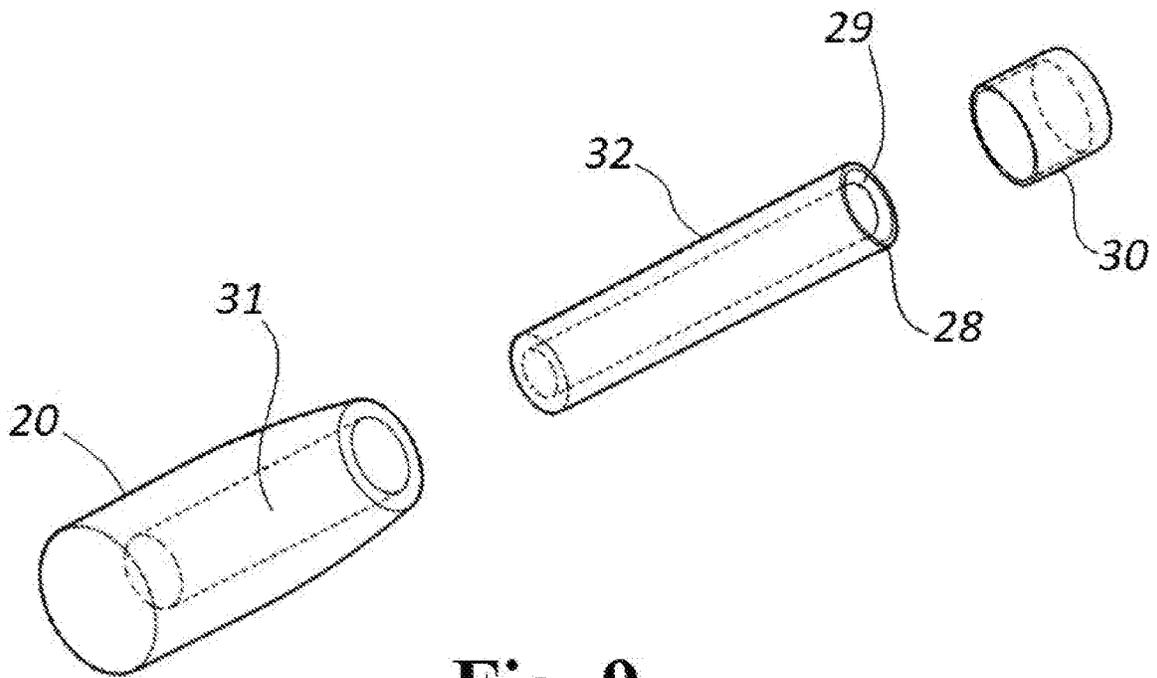
**Fig. 6**



**Fig. 7**

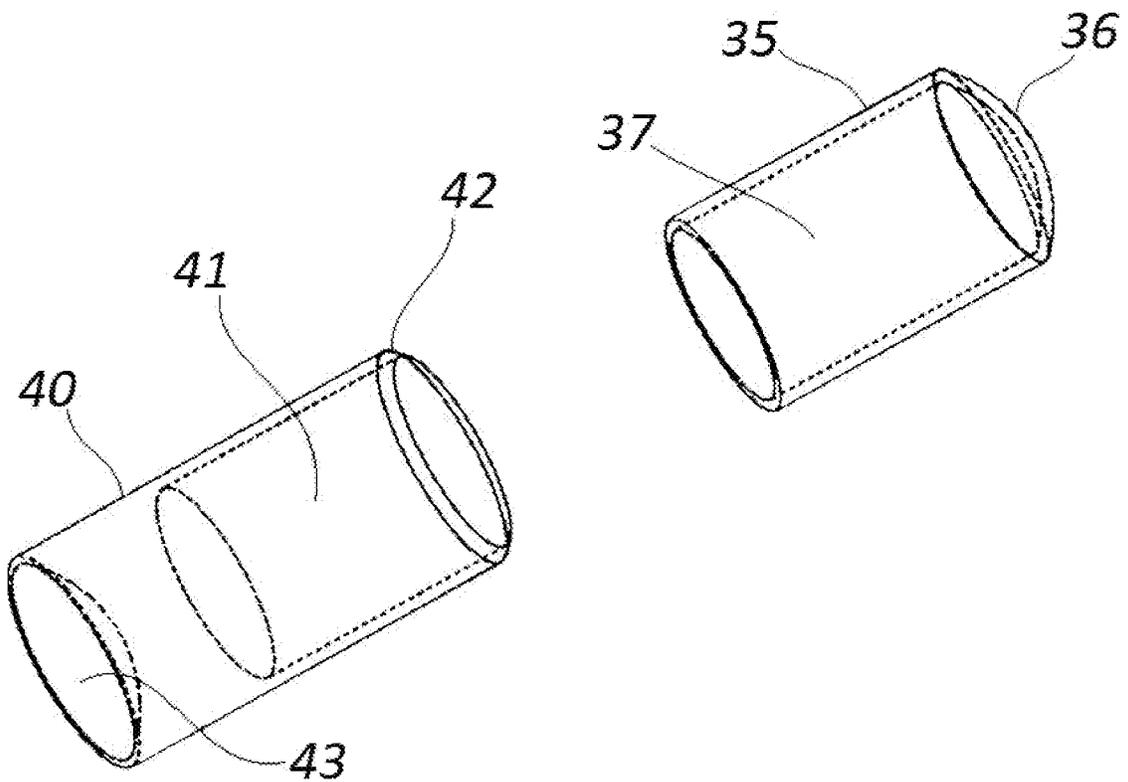


**Fig. 8**

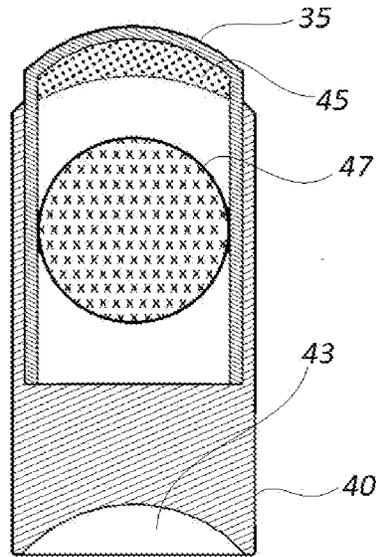


**Fig. 9**

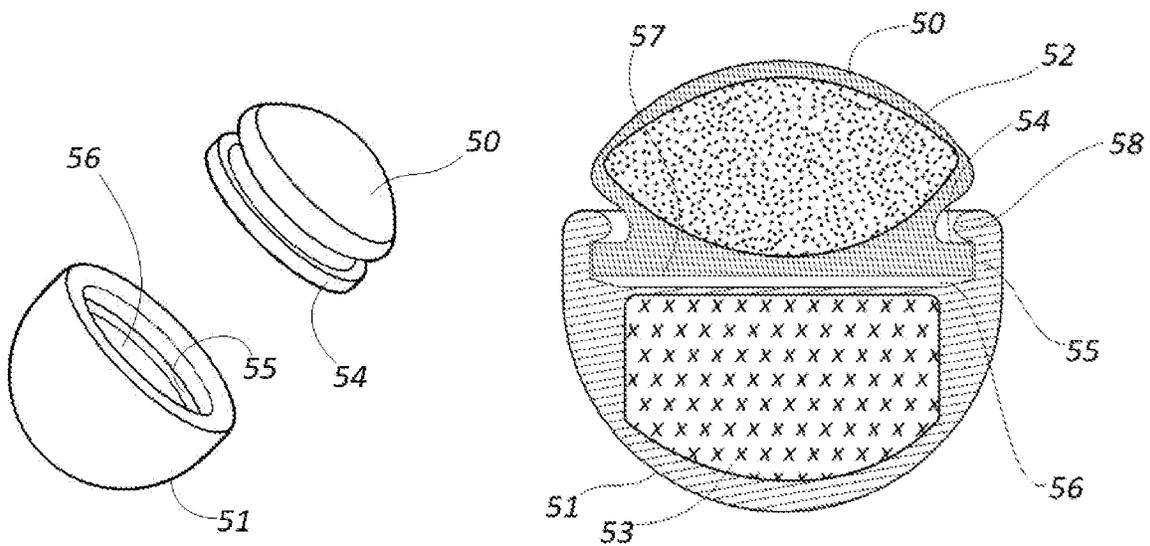
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**Fig. 10**



**Fig. 11**



**Fig. 12a**

**Fig. 12b**

## EXPLODING PROJECTILE

### CROSS REFERENCE TO RELATED APPLICATIONS

**[0001]** This non-provisional utility application claims the benefit of and priority to U.S. Provisional Application 62/742,327 “Exploding Projectile,” filed 6 Oct. 2018 also claims the benefit of and priority to U.S. Provisional Application 62/797,294 “Exploding Projectile” filed 27 Jan. 2019. The entire contents of U.S. Provisional Application 62/742,327 “Exploding Projectile,” filed 6 Oct. 2018 and U.S. Provisional Application 62/797,294 “Exploding Projectile” filed 27 Jan. 2019 are hereby incorporated into this document by reference.

### COPYRIGHT STATEMENT

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### FIELD

**[0003]** The invention relates to firearms projectiles that transport an explosive material within them so that upon impact a target may receive the kinetic energy of the projectile plus the physical energies released by the chemical decomposition of the explosive delivered.

### BACKGROUND

**[0004]** Firearms and especially small bore weapons deliver limited kinetic energies to a target.

### BRIEF SUMMARY

**[0005]** Sport shooting, including target shooting and hunting may have limited effects when using projectiles of smaller diameter and correspondingly smaller mass.

**[0006]** It is therefore an objective of the invention to offer a projectile delivering to the target a total energy greater than the kinetic energy or impulse energy imparted by mere impact onto or penetration into the target.

**[0007]** Another objective of the invention is to provide an energetic projectile that would allow a smaller bore weapon to deliver the effect of a larger bore weapon firing a conventional, inert projectile.

**[0008]** Another objective of the invention is to provide a projectile capable of emitting a smoke cloud of a distinct or discernable color upon impact with a target, and a corollary objective of the invention is to provide a projectile capable of marking a vicinity of its impact point with a pigment or discernable color.

**[0009]** A yet further objective of the invention is to render capable a weapon typically unfit for safely and humanely dispatching large game, large nuisance animals, or effectively neutralizing organisms presenting a threat to an armed person. A corollary objective of the invention is that a person possessing such a smaller bore weapon need not acquire a larger weapon and ammunition therefor, in order to achieve with the smaller weapon an effect typically available only with the larger weapon.

**[0010]** A yet further objective of the invention is to provide entertainment for a sport shooter who would enjoy observing in a projectile impact an effect greater than the customary material rupture or displacement of a target and would enjoy an additional energetic, physical, auditory, or pyrotechnic effect upon projectile impact.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0011]** A further understanding of the nature and advantages of particular embodiments may be realized by reference to the remaining portions of the specification and the drawings, in which like reference numerals are used to refer to similar components. When reference is made to a reference numeral without specification to an existing sub-label, it is intended to refer to all such multiple similar components.

**[0012]** FIG. 1 shows an oblique view of an embodiment of a projectile in accordance with the invention.

**[0013]** FIG. 2 shows an elevation view of an embodiment of a projectile in accordance with the invention.

**[0014]** FIG. 3 shows a rearward, oblique view of an embodiment of a projectile in accordance with the invention.

**[0015]** FIG. 4A shows a cross section view of an embodiment of a projectile in accordance with the invention.

**[0016]** FIG. 4B is an enlargement showing the tip portion of a projectile similar to the cross section view FIG. 4A.

**[0017]** FIGS. 5A through 5G show alternative embodiments of projectile tip styles in accordance with the invention.

**[0018]** FIG. 6 shows an alternative embodiment in accordance with the invention which includes fragmentation grooves.

**[0019]** FIG. 7 shows an alternate assembly of an exploding projectile in accordance with the invention.

**[0020]** FIG. 8 shows an alternate assembly of an exploding projectile in accordance with the invention.

**[0021]** FIG. 9 shows another alternative embodiment in accordance with the invention.

**[0022]** FIG. 10 shows another alternative embodiment in accordance with the invention.

**[0023]** FIG. 11 shows a cross section of another alternative embodiment in accordance with the invention.

**[0024]** FIG. 12a shows another embodiment within the scope of the invention.

**[0025]** FIG. 12b shows cross section of the embodiment of FIG. 12.

### DETAILED DESCRIPTION OF CERTAIN EMBODIMENTS

**[0026]** While various aspects and features of certain embodiments have been summarized above, the following detailed description illustrates a few exemplary embodiments in further detail to enable one skilled in the art to practice such embodiments. The described examples are provided for illustrative purposes and are not intended to limit the scope of the invention.

**[0027]** In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the described embodiments. It will be apparent to one skilled in the art, however, that other embodiments of the present invention may be practiced without some of these specific details. Several embodiments are described herein, and while vari-

ous features are ascribed to different embodiments, it should be appreciated that the features described with respect to one embodiment may be incorporated with other embodiments as well. By the same token, however, no single feature or features of any described embodiment should be considered essential to every embodiment of the invention, as other embodiments of the invention may omit such features.

**[0028]** In this application the use of the singular includes the plural unless specifically stated otherwise, and use of the terms “and” and “or” is equivalent to “and/or,” also referred to as “non-exclusive or” unless otherwise indicated. Moreover, the use of the term “including,” as well as other forms, such as “includes” and “included,” should be considered non-exclusive. Also, terms such as “element” or “component” encompass both elements and components comprising one unit and elements and components that comprise more than one unit, unless specifically stated otherwise.

**[0029]** The invention is an explosive projectile for a firearm, comprising a body symmetric about a central axis, which further defines forward and aft directions along the axis, wherein the word “aft” as used in this specification further defines terms such as “rear,” “behind,” and “rearward facing.” The term “caliber” in this specification related to bore or projectile diameters and is not used as a ratio of bore length divided by diameter as for large ordnance. Also in this specification, a firearm may mean a traditional weapon firing ammunition cartridges comprising chemical propellants, but may also include compressed gas rifles such as air rifles, CO<sub>2</sub> rifles, and also weapons that impel or accelerate a projectile by means of releasing energy stored in a compressed member such as a spring, stored in a tensioned elastic member such as a rubber band, or stored a torsionally distorted member such as a torsional spring, or a skein comprising a bundle of strands subject to twisting.

**[0030]** An embodiment directed to use in small bore pellet guns is depicted in FIG. 1. The major diameter of the bottom flanges of the conical sections of this pellet body may be 0.177 inches or slightly smaller. Other similar diameters of manufacture within this portion of the scope of the invention include .20 cal which is sometimes referred to nominally as 5 mm, and .22 cal, and 0.223 inch diameter which is also nominally referred to as 5.56 mm.

**[0031]** The invention may be manufactured in sizes appropriate for other small arms such as calibers .243, .30, .303, 308, and larger calibers such as .375 and .50 cal. Some metric calibers include 6.5 mm, 7.62 mm, and 7.92 mm which is sometimes nominally referred to as 8 mm. The invention may also be manufactured as an explosive slug for used in shotguns, wherein a wad or other shock absorbing material is interposed between the projectile and the propellant of the shotgun ammunition cartridge.

**[0032]** FIG. 2 shows an exterior elevation view of a pellet in accordance with the invention, with the central axis [14] defining a forward-facing conical tip. Materials for the pellet body may include lead, copper, antimony, tin, bismuth, aluminum, iron, steel, and depleted uranium, or alloys containing these material as constituents.

**[0033]** FIG. 3 is an oblique view of a rear aspect of a projectile in accordance with the invention. The pellet body further comprises an interior cavity and which is in part contoured to the exterior surfaces of the projectile. In this embodiment a conical after portion of the pellet body is matched by a conical portion [3] of the interior cavity. The exterior of the pellet body may be comprised of a number of

geometrically defined surfaces such as a cylinder, a frustum of a cone, a spherical surface, an ogive, an elliptical surface and a parabolic surface. Also visible in this figure is a seal [7] which isolates the explosive material inside the pellet from contact with atmosphere. Various embodiments of the seal will be discussed in further detail below.

**[0034]** FIG. 4A shows a cross section of an explosive pellet [1] structured in accordance with the invention. The pellet includes a recess at its forward facing tip, and a pin [5] received into the recess and retained therein by friction such as by press fit in manufacture, or by adhesive. Behind the pin is an initiator material [4,] which may also be called a primer. Typical initiator materials are shock or compression sensitive and may include phosphorous sesquisulfide, lead styphnate, or fulminates or silver or of mercury. Another usable chemical a compound called ‘dinol’, the chemical name of which is DDNP (diazodinitrophenol.)

**[0035]** Behind and in physical contact with the initiator is an explosive material [2] deposited within the interior cavity of the pellet body. The explosive may be a nitrogen-rich compound or it may be a binary explosive. The initiator material is thus interposed between the pin and the explosive material. The interior cavity of this particular embodiment includes a first spherical portion [6] forward of a second conical portion [3,] with the explosive material deposited within the spherical portion of the cavity.

**[0036]** At least one and preferably more than one external surface of the pellet body is a cylindrical surface [8, 8'] closely related to the bore diameter of the weapon which is to fire the pellet. For ductile materials, this or these diameters may be related to the groove diameter of the rifle bore. In a rifled bore, there are two dimensions: the land dimension and the groove dimension. In a rifled barrel, lands are the narrow, ridge-like features that run the full length of the barrel. The purpose of the land is to grip a bullet as it travels down the bore and impart a specified rate of spin designed to stabilize the bullet in flight. In a .30 caliber barrel, for example, the land dimension gages around 0.300 in, while the groove measures close to 0.308 in. For purposes of nomenclature and marketing, the groove dimension is typically taken as the size of a bullet that will pass through the barrel, with or without a press fit or interference fit causing the rifle lands to deform the periphery of the projectile in transit through the rifling.

**[0037]** The rearward facing surface of the explosive material [2] lodged in the interior cavity of the pellet may be left exposed or may be sealed by coating it with a material such as paint or varnish or epoxy, or a physical seal [7] such as a wafer or a membrane material may be pressed into the cavity of the pellet body. Sealing the explosive to isolate it from exposure to atmosphere may be preferred if the material is hygroscopic or has other properties which decrease its effectiveness over time when left in contact with atmosphere. Oxidation and water absorption are two of many processes which may degrade the intensity or rapid availability of the stored chemical energy over time.

**[0038]** For binary explosives, both materials are very inert while separate from each other, and then when combined in an appropriate ratio the compound becomes unstable. Some binary explosives consist of a solid and a liquid component, such as ammonium nitrate and a fuel oil (ANFO) mixture in which an optimum energy density and brisance may be found at 4% fuel oil by volume and the rest of the volume comprising pulverized ammonium nitrate crystals. Accord-

ing to an embodiment using a solid component installed in the pellet cavity by a manufacturer, the liquid component and optional wafers or plugs [7] may be sold and distributed separately in compliance with prevailing laws, so that neither product in itself incurs the legal and regulatory burdens of explosive rules and licensing requirements, especially those pertaining to finger printing and background checks, transport, hazardous cargo routes, reportable quantities (RQ) and storage in approved magazines designed to be vandal and bullet resistant. More people may enjoy using small amounts of explosives safely and in quantities which are below the legal requirements for a great deal of invigilation.

**[0039]** Immediately before shooting a pellet in a firearm, a user may activate the explosive by adding a liquid to the solid, waiting for the compound to energize, and then loading and firing the pellet. Optionally, especially if the activated binary compound dissolves into a paste or otherwise loses structural integrity, the plug [7] may be inserted to help retain the explosive contents within the interior cavity of the pellet. Although the conical after portion of the pellet has aerodynamic benefits of orienting the pellet tip to the direction of travel in flight, the interior conical surface [3] may also beneficially act as a funnel for leading a liquid component of a binary explosive into contact with a solid grain lodged within.

**[0040]** According to another embodiment within the scope of the invention, the material [2] housed within the pellet is selected or modified for reduced brisance and reduced deflagration so that it acts as a propellant rather than an explosive. Brisance of binary compounds may be reduced by including inert fillers in either or both reagents in the compound, or by including reaction damping agents such as ammonium sulfate or urea added to ammonium nitrate.

**[0041]** Many air-operated rifles and CO<sub>2</sub> rifles are designed for use novice shooters, children, and young adults, and these often achieve modest projectile velocities around 350 feet per second. Other more expensive, higher performance pneumatic rifles are available which are capable of projectile velocities of 900 to 1200 feet per second. By selecting a quantity of a binary compound which acts as a propellant rather than an explosive, the pneumatic shock of the rifle may act to initiate the propellant reaction so that the gas developed as a reaction product adds to the pressure behind the pellet, providing enhanced acceleration and higher muzzle velocity. Users of such a propellant-assisted pellet in a lower cost rifle may be thus able to achieve and enjoy the kinds of performance found in the more expensive rifles.

**[0042]** Lastly in this figure, the tip of the pellet or a forward facing surface of the pellet may have a coating of paint [9] for marking purposes to distinguish it from inert pellets of the same shape and size, or for ornamental purposes such as a distinctive color or mark.

**[0043]** FIG. 4B is an enlargement of a cross section of a tip of a pellet in accordance with the invention. The pin [5] is received into a recess at the tip of the pellet, and has a rearward facing point to puncture and concentrate mechanical shock acted upon a shock or compression sensitive initiator material [4.] According to an alternative embodiment in accordance with the invention, a portion of the pellet body [10] comprises a membrane interposed between the pin and the initiator material. The design and thickness of this intervening membrane of material is selected to prevent deflagration of the initiator until an impact occurs whereby

an impulse is imparted to the pin which is sufficient for it to rupture and the membrane and penetrate into the initiator so as to begin deflagration. The membrane may also isolate the initiator material from contact with atmosphere, which may be preferred for some compounds which are hygroscopic or which may oxidize, or break down with prolonged contact with atmosphere.

**[0044]** The forward end of pin is shown blunt in this figure, but it may also be pointed or rounded or have an elliptical tip or an ogive. Although the pin at the tip of the pellet may be retained in its recess by mechanical means such as a press fit or an adhesive, retention may be effected or abetted by a coating of paint or varnish or the like applied to a forward surface the pellet body. Optionally, the cured paint [9] remains in contact with the pin so that the pin may be isolated from atmosphere, and optionally, the recess for retaining the pin may communicate with the cavity within the pellet which retains the initiator material.

**[0045]** The pin may be comprised of any hard or hardenable material such as steel, and especially alloy steel or high carbon steel. Air-hardening steel alloy A2 may be used for the pin. Because many high alloy steels corrode readily, coating the pin with paint may be advantageous. Also optionally as shown in this figure, a gap [12] may be left between the pin tip and the membrane of pellet material between the pin and the initiator, or such a gap may be maintained between the pin and the initiator if there is no intervening membrane.

**[0046]** The forward surface of the pellet may comprise a number of contours or tip styles such as those illustrated in FIGS. 5A through 5G. FIG. 5A shows a tip style which is a frustum of a cone and is sometimes called a "Keith" tip style. FIG. 5B shows a conical point style. FIG. 5C shows a tip style which may be a spherical tip or a section of an oblate spheroid. FIG. 5D shows a tip style which may be a section of a prolate spheroid, an ellipse, or an ogive. FIG. 5E shows a short frustum section of a cone which may be called a "blunt wad cutter." FIGS. 5F and 5G depict the same tip style which is a squared-off cylinder end having a circular groove near its perimeter. FIG. 5F is a side view of the pellet tip showing the groove as dotted lines, and FIG. 5G is an oblique view of the cylinder end showing the groove. This type of tip style is called a "wad cutter" because of its ability to cut neat and sharply defined holes in paper targets.

**[0047]** FIG. 6 shows an alternate embodiment of a pellet in accordance with the invention wherein an exterior surface comprises a plurality of radially spaced apart grooves [15.] In this view the forward facing conical tip has a set of radial grooves. In context of impact of an inert projectile these grooves alter the progression of mechanical deformation of the projectile and allow its cross section to expand while traveling within a target medium. For an explosive pellet, such grooves may precipitate fragmentation of the pellet so that shrapnel may be dispersed within a larger volume of space at the impact area and the area denial of the projectile may be thus enhanced. Also, projectile fragmentation within a target medium may increase the effect on the target so that as stated above, effects typically reserved for larger-bore weapons may be achieved with smaller-bore systems.

**[0048]** Alternatively, the set of radial grooves may reside other exterior portions of the pellet body, such as along its flank or on a conical rear portion of a pellet. Grooves along the flank of a projectile help stabilize it during its travel within the firearm barrel and also in flight. If grooves in a

flank of a projectile are slightly helical, they may act as rifling and impart a spin during travel within a smooth bore weapon. A radial array of grooves residing on a conical rear portion of a pellet may improve stability in flight.

**[0049]** FIG. 7 shows an alternate assembly of an exploding projectile [20] in accordance with the invention. This projectile is formed as a rifle bullet with a cannelure to accept inward crimping of the rim of a case to form a rifle cartridge. The projectile includes an interior cavity [21] which holds an explosive agent deposited within it. The cavity may also be formed as a hole extending through the bottom of the bullet which is then plugged after filling. The interior cavity communicates with a transverse slot [22] which is cut mostly but not all the way through the bullet, so as to leave a hinge or pillar [23] of material connecting to the bullet tip. This embodiment has one offset pillar, but pluralities of compressible or deformable pillars, such as two symmetrical pillars diametrically opposed to each other, or a radial array of pillars are also within the scope of the invention. The one or more pillars are designed to be of sufficient strength so that acceleration of the bullet within the barrel is not sufficient to deform them so as to allow the initiator to be crushed during its travel.

**[0050]** An initiator [25] supplied separately is a percussion cap that fits closely within the slot. The initiator may be supplied separately so that regulations and laws defining the transport, possession, or sale or offers for sale of certain explosive assemblies, and laws limiting maximum quantities or reportable quantities may be complied with. The cap is inserted at shooting site such as a shooter's bench at a rifle range in the immediate context of shooting that particular round of ammunition.

**[0051]** Upon impact, the one or more pillars deform and allow the initiator to be crushed and to begin deflagration which propagates to the explosive agent in the cavity so that the projectile explodes.

**[0052]** FIG. 8 shows an alternate assembly of an exploding projectile [20] in accordance with the invention which is designed to cooperate with a standard percussion cap [30] readily available for muzzle loading sports, and which may be acquired separately by a user with little or no legal encumbrances, and while retaining substantial personal privacy and anonymity.

**[0053]** The projectile has a tubular projection [27] having a lumen [26] which communicates with a cavity [21] into which an explosive agent is disposed. Depending on prevailing laws and regulations and so as to remain in compliance with these, the explosive agent may be inserted by a manufacturer or may be acquired separately by a user who prepares the round on his own. The agent may also be a binary agent in which the two fractions are distributed and acquired separately to remain in compliance with law.

**[0054]** The tubular projection included a flat, annular face [28] perpendicular to said the axis of the projectile body and a lead-in [29] which may be a fillet or a chamfer or a combination of a chamfer and one or more fillets. The flat face acts as an anvil for the shock sensitive material in the percussion cap, so that when the projectile and cap strike a target, the shock sensitive material becomes violently compressed at its perimeter within the percussion cap. Deflagration initiates around the rim of the activated material and propagates to the center, typically creating a shower of sparks. The sparks are concentrated and funneled into the lumen by the lead-in features and travel down the lumen into

contact with the explosive agent contained within the cavity of the projectile, thus activating the explosive and deforming or rupturing the main body of the projectile.

**[0055]** FIG. 9 shows another alternative embodiment in accordance with the invention which includes a tube [32] which is pressed into a forward facing cylindrical cavity [31] within a projectile body [20.] As in FIG. 8, the tube includes lead-in features [29] and an annular face [28] which acts as an anvil to compress and activate the initiator material within a percussion cap [30.] In this embodiment the projectile may be copper jacketed lead and the tube may be of ductile or brittle material or a material such as A2 air hardening steel alloy, whereby the explosive may, where legal, induce the steel tube to behave as an armor piercing component or to induce spalling on the inside of an armor material when this projectile strikes the outside.

**[0056]** According to another alternate embodiment in accordance with the invention an explosive projectile may be ensconced within a sabot which protects the pin from impact if a loose cartridge is accidentally dropped. The sabot detaches from the projectile when flying at bullet speed thus exposing the pin to impact upon the target and initiation of the deflagration of the primer within.

**[0057]** FIG. 10 shows another alternative embodiment in accordance with the invention. The projectile is primarily intended for a gas-operated firearm such as a rifle powered by compressed air or carbon dioxide gas.

**[0058]** The projectile comprises two parts which may be acquired separately and assembled at the shooting site. The projectile has a body [40] which is symmetric about a central axis, and the central axis defines forward and aft directions. The body has a forward facing cylindrical cavity [41] and a chamfered annular surface [42] spanning between the exterior surface and the forward facing cylindrical cavity. The projectile body also has an aft facing cavity [43] which may comprise at least in part a concave spherical surface. According to an alternative embodiment, the outer cylindrical surface of the body may further comprise a plurality of longitudinal grooves to act as a pre-fragmented projectile.

**[0059]** A domed primer [35] is received within the forward facing cylindrical cavity of the projectile. The primer is formed as primer a tube closed at one end by a forward facing convex surface [36] to define an interior cavity [37] which contains percussion sensitive material disposed therein.

**[0060]** The projectile body may also accept commonly available primers such as item [30] of FIG. 8. The primer material may preferably comprise copper, and the percussion sensitive material may comprise a shock or compression sensitive material such as diazo, triazole, tetrazole or diazodinitrophenol.

**[0061]** FIG. 11 shows a cross section of an embodiment in accordance with the invention, which is a variant of that shown in FIG. 10. As above, the primer material may preferably comprise copper, and the percussion sensitive material [45] may comprise a shock or compression sensitive material such as diazo, triazole, diazodinitrophenol or tetrazole.

**[0062]** In this version, an explosive agent [47] is disposed within the primer [35.] The agent may be a solid grain and may be installed within the primer by a manufacturer or by an end user immediately before firing, depending on the requirements of prevailing law. The explosive agent may also be a binary explosive in which a first compound is solid

and a second compound is a liquid delivered into contact and mixing with the first compound. A binary explosive may comprise ammonium nitrate as an oxygen supplier having nitrogen bonds available to liberate heat and mechanical energy from expanding gases, and may use fuel oil, diesel oil, nitromethane, or a similar petroleum product or distillate as a fuel. Although shown as a round pellet, the explosive may be another shape conducive for retention within the primer and may also be a gel suspension of an energetic compound.

**[0063]** The primer and explosive agent are assembled into a forward facing cavity of a projectile body **[40]** which further comprises an aft facing concave surface **[43]** which may be in part a spherical surface.

**[0064]** FIG. **12a** shows another embodiment within the scope of the invention. An explosive projectile comprises a first body **[50]** symmetric about a central axis, and has a base further comprising a flange **[54]** with at least a portion of said flange extending in a radial direction. An initiator material is disposed within an internal cavity. A second body **[51]** is symmetric about its own central axis which also defines forward and aft directions along for the second body. The second body has a forward facing recess **[56]** defining an annular rim further comprising an internal annular groove **[55.]** The second body has an internal cavity with an explosive disposed within it.

**[0065]** The flange of the first body is complementary to and may be received into the annular groove of the second body so that it may keep both bodies together once the full circumference of the flange of the first is fitted into the groove in the rim of the second body. This assembly retains the initiator material within the first body in proximity with the explosive inside the second body so that an impact or shock sufficient to begin deflagration of the initiator material will propagate into the explosive and cause it to detonate sympathetically.

**[0066]** Although FIG. **12a** shows the two bodies spaced apart for clarity, FIG. **12b** shows cross section of the same embodiment of FIG. **12a** shown assembled and ready to be launched, shot, or thrown, by a weapon. The first body **[50]** includes an aft facing base **[57]** having a flange **[54.]** The first body has a deformable membrane which may be forward facing, and an internal cavity between the deformable membrane and the base which contains an initiator material **[52.]** Impact compresses or transmits a mechanical shock to the initiator material so that deflagration may begin.

**[0067]** The second body **[51]** includes a forward facing recess **[56]** and its own internal cavity which contains an explosive **[53.]** The forward facing recess defines an annular rim further comprising an internal annular groove **[55]** and may also have an annular bead **[58]** of a smaller diameter than the flange at the base of the first body, so that the flange may be received into the groove and hold the two mated bodies together in flight. The second body also includes an internal cavity which contains an explosive **[53]** which may also be a first compound of a binary explosive which is activated by a second compound of the binary explosive immediately before use. Thus the second body may be manufactured and distributed separately from the first body and also separately from the second compound of the binary explosive, so that prevailing laws and regulations regarding transport, storage and possession of regulated materials may be complied with and satisfied.

**[0068]** Another set of alternative embodiments within the scope of the invention include a projectile capable of emitting a smoke cloud of a distinct or discernable color upon impact with a target, and a projectile capable of marking a vicinity of its impact point with a pigment or discernable color. Recreational benefits for these sets of embodiments include events where more than one person is shooting at or near the same target. Multiple shooters may prepare their binary compounds with colorants unique to each shooter so that when a volley of shots from multiple shooters arrive on or near a target, the shooters may determine who shot what and where. Also, a one or more shooters delivering colorants or pigments onto a target may perform a novel artform by decorating according to a unique process whereby colors and color patterns may be applied to an object as delivered by firearm.

**[0069]** Colorants may color the smoke emitted by the binary reaction, or a vicinity of its impact point, or both. Smoke dyes may comprise homogeneous mixtures of azo and anthraquinone dyes, which are available in a variety of hues and colors. For blending between colors, a preferred ratio comprises a first part comprising the sum of all dyes and a second part comprising the reactants, with the first and second parts being substantially equal in mass.

**[0070]** A mixture used for producing colored smoke may comprise potassium chlorate oxidizer, lactose or dextrin as a fuel, and one or more dyes, with about 40-50% content of the dye by mass. Up to 2% sodium bicarbonate by mass may be also be added if it is desired to lower the reaction temperature during smoke generation.

**[0071]** Colorant materials may include but are not limited to: antimony trisulfide, barium carbonate, barium sulfate, calcium carbonate, finely ground charcoal, chlorinated rubber, copper carbonate, copper oxide, copper oxychloride, cryolite dextrin, lactose hexamine, copper acetate triarsenite, copper acetoarsenite, potassium benzoate, potassium hydrogen phthalate, finely ground polyvinylchloride, red iron oxide, sodium benzoate, stearic acid, strontium carbonate, strontium oxalate, strontium sulfate, and sulfur. Oxidizers for these colorants may include but are not limited to: ammonium perchlorate, barium chlorate, barium nitrate, copper nitrate, guanidine tirate, potassium chlorate, potassium dichromate, potassium nitrate, potassium perchlorate, potassium permanganate, sodium nitrate and strontium nitrate. Pigments include but are not limited to mercury sulfide, cadmium sulfide, anhydrous iron oxide, lead carbonate, euxanthic acid salts, phthalocyanine blue, ferrous ferrocyanide salts, chromium, cobalt, copper, lead, manganese, titanium, aluminum, quinacridone, and zinc.

**[0072]** The dye colorants may be used to apply color to the smoke, or to objects in the vicinity of the impact point of the projectile, or to both. The color may also be furnished as a third item set off by or dispersed by the action of the two compounds comprising the binary explosive, or it may be mixed into one or the other explosive agent. The dye component may be supplied as a third component besides the binary explosive agents to be installed by a user in projectile cavities such as cavity **[6]** of FIG. **4A**, cavity **[21]** of FIGS. **7** and **8**, or may be furnished as a rod to be inserted in the tube element **[32]** of FIG. **9**.

**[0073]** While certain features and aspects have been described with respect to exemplary embodiments, one skilled in the art will recognize that numerous modifications are possible. Further, while various methods and processes

described herein may be described with respect to particular structural and/or functional components for ease of description, methods provided by various embodiments are not limited to any particular structural and/or functional architecture.

**[0074]** Hence, while various embodiments are described with or without certain features for ease of description and to illustrate exemplary aspects of those embodiments, the various components and/or features described herein with respect to a particular embodiment may be substituted, added, and/or subtracted from among other described embodiments, unless the context dictates otherwise. Consequently, although several exemplary embodiments are described above, it will be appreciated that the invention is intended to cover all modifications and equivalents within the scope of the following claims.

What is claimed is:

1. A projectile for a firearm, comprising:
  - a body symmetric about a central axis, defining forward and aft directions along said axis, said body further comprising an interior cavity and a recess,
  - said body comprising a surface selected from the set of surfaces consisting of: a cylinder, a frustum of a cone, a spherical surface, an ogive, a section of a prolate spheroid, a section of an oblate spheroid, an elliptical surface and a parabolic surface,
  - a pin received into said recess,
  - an explosive material deposited within said interior cavity of said body and said initiator material is deposited between said pin and said explosive material, and a portion of said body comprises a membrane interposed between said pin and said initiator material, and
  - an initiator material disposed between said pin and said explosive material.
2. The projectile of claim 1, wherein said body comprises a material selected from the set of materials consisting of: lead, copper, tin, antimony, bismuth, aluminum, iron, steel, and depleted uranium.
3. The projectile of claim 1, wherein said interior cavity of said body comprises a first spherical portion forward of a second conical portion, with said explosive material deposited within said spherical portion of said cavity.
4. The projectile of claim 1, further comprising a seal deposited within said interior cavity and contacting a rear surface of said explosive material, such that said explosive material is isolated from exposure to atmosphere.
5. The projectile of claim 1, further comprising paint applied to a forward surface of said body and said paint in contact with said pin such that said pin is isolated from exposure to atmosphere.
6. The projectile of claim 1, wherein an exterior surface comprises a plurality of radially spaced apart grooves.
7. The projectile of claim 1, wherein said pin further comprises a rearward facing point.
8. The projectile of claim 1, wherein said point comprises steel.
9. The projectile of claim 1, wherein said initiator material comprises a material selected from the set of materials consisting of: diazo, triazole, tetrazole, and diazodinitrophenol.
10. A projectile for a firearm, comprising
  - a body symmetric about a central axis, defining forward and aft directions along said axis, said body further comprising an interior cavity,

- said body comprising an exterior surface which is a surface selected from the set of surfaces consisting of: a cylinder, a frustum of a cone, a spherical surface, an ogive, a section of a prolate spheroid, a section of an oblate spheroid, an elliptical surface and a parabolic surface, and

- said body further comprising a tubular projection extending forward; said tubular projection comprising
  - an annular face perpendicular to said central axis,
  - a lumen communicating with said interior cavity, and a chamfer between said lumen and said annular face, and

- an explosive material deposited within said interior cavity.

11. The projectile of claim 10, wherein said body comprises a material selected from the set of materials consisting of: lead, copper, tin, antimony, bismuth, aluminum, iron, steel, and depleted uranium.

12. A projectile for a firearm, comprising
 

- a body symmetric about a central axis, defining forward and aft directions along said axis, said body further comprising a forward facing cylindrical cavity,
- said body further comprising an exterior surface which is a surface selected from the set of surfaces consisting of: a cylinder, a frustum of a cone, a spherical surface, an ogive, a section of a prolate spheroid, a section of an oblate spheroid, an elliptical surface and a parabolic surface, and

- said body further comprising a tubular projection extending forward; said tubular projection comprising
  - an annular face perpendicular to said central axis,
  - a lumen communicating with said interior cavity, and a chamfer between said lumen and said annular face, and
- an explosive material deposited within said interior cavity.

13. The projectile of claim 12, wherein said point comprises steel.

14. The projectile of claim 12, wherein said body comprises a material selected from the set of materials consisting of: lead, copper, tin, antimony, bismuth, aluminum, iron, steel, and depleted uranium.

15. A projectile for a firearm, comprising:
 

- a body symmetric about a central axis, defining forward and aft directions along said axis, said body further comprising a forward facing cylindrical cavity,
- said body further comprising a chamfered annular surface spanning between said exterior surface and said forward facing cylindrical cavity, and

- said body further comprising an aft facing cavity, and
- a domed primer received within said forward facing cylindrical cavity, said primer comprising a tube closed at one end by a forward facing convex surface and comprising a percussion sensitive material disposed within said closed tube.

16. The projectile of claim 15, wherein said aft facing cavity comprises a concave spherical surface.

17. The projectile of claim 15, wherein said primer is a material that comprises copper, and said percussion sensitive material comprises a material selected from the set of materials consisting of: diazo, triazole, tetrazole and diazodinitrophenol.

18. The projectile of claim 15, wherein an explosive agent is disposed within the primer.

19. The projectile of claim 18, wherein said explosive agent is a binary explosive.

20. An explosive projectile comprising:

a first body symmetric about a central axis, defining forward and aft directions along said axis, said body further comprising an aft facing base and a deformable membrane defining a cavity therebetween, said base further comprising a flange with at least a portion of said flange extending in a radial direction,

an initiator material disposed within said cavity, and

a second body symmetric about a central axis, defining forward and aft directions along said axis, said second body further comprising

a forward facing recess defining an annular rim further comprising an internal annular groove,

an internal cavity with an explosive disposed there-within,

such that said flange of said first body may be received into said annular groove of said second body so as to retain said initiator material in proximity with said explosive.

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