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(54) **NOISE CONTROL SYSTEM AND METHOD FOR SMALL CALIBER AMMUNITION**

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F42B 5/02 (2006.01)
F42B 10/40 (2006.01)

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

CPC ***F42B 10/34*** (2013.01); ***F42B 5/02*** (2013.01); ***F42B 10/40*** (2013.01)

(58) **Field of Classification Search**

CPC .. F42B 5/02; F42B 10/28; F42B 10/32; F42B 10/34; F42B 10/38; F42B 10/40; F42B 10/42; F42B 10/668; F42B 12/36; F42B 12/46

USPC 102/439, 503

See application file for complete search history.

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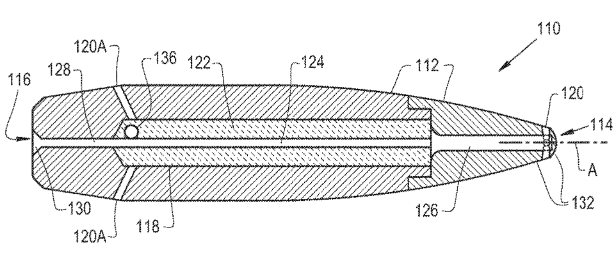
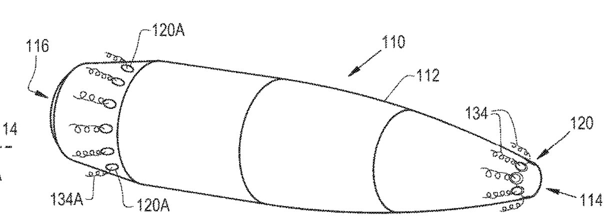
(57) **ABSTRACT**

A projectile including a body having a tip and a tail, the body also having an internal cavity. There is at least one plume aperture connected to the internal cavity, the plume aperture being positioned proximate to the tip of the body.

18 Claims, 2 Drawing Sheets





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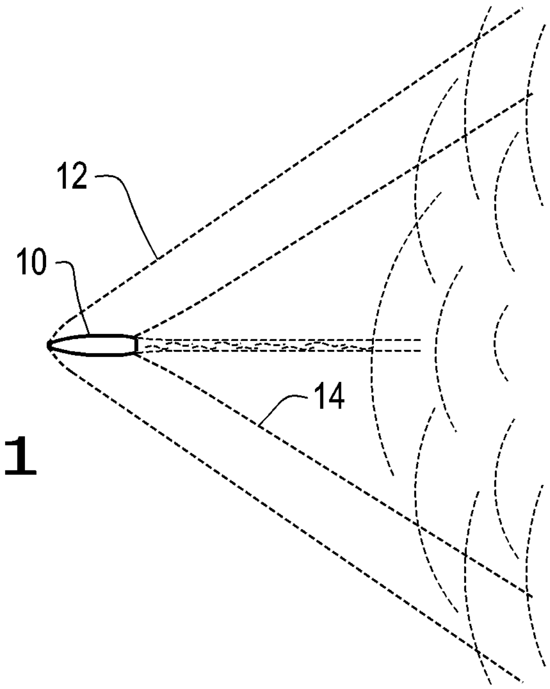
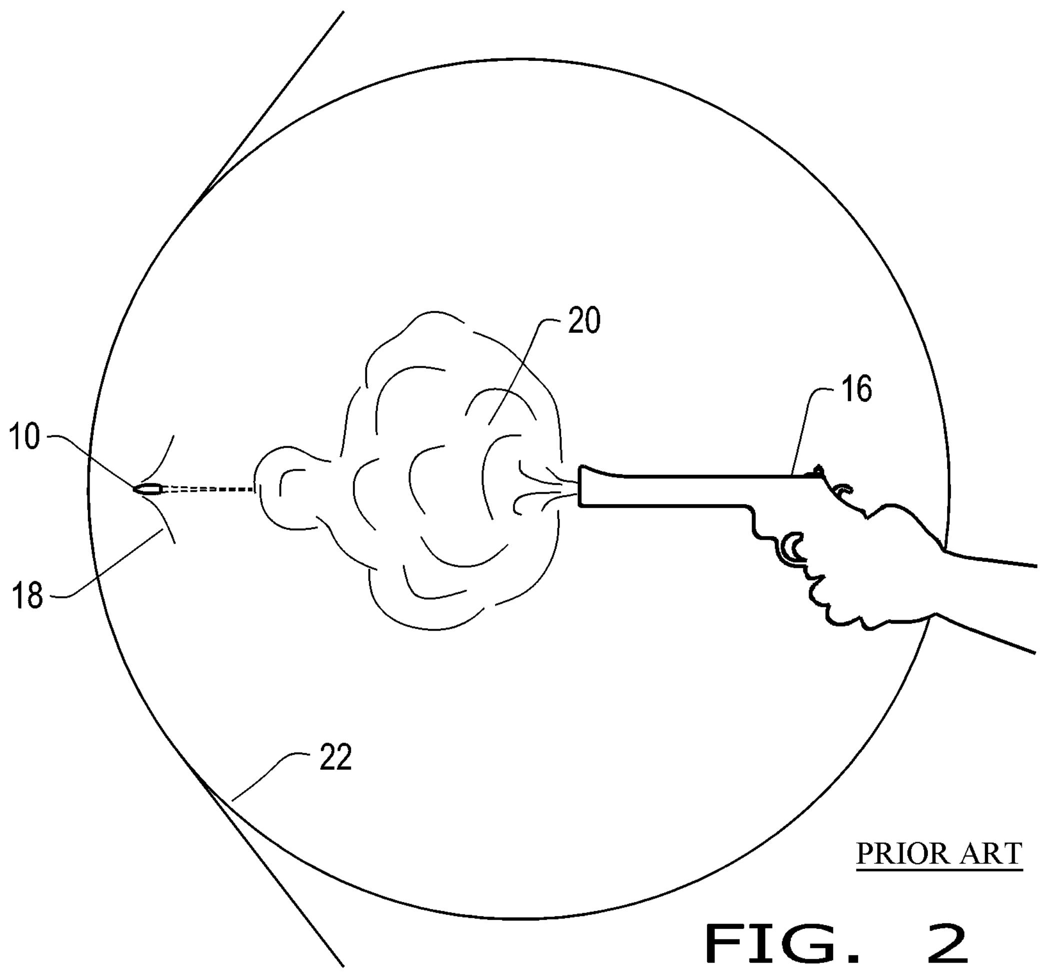


PRIOR ART

FIG. 1



PRIOR ART

FIG. 2

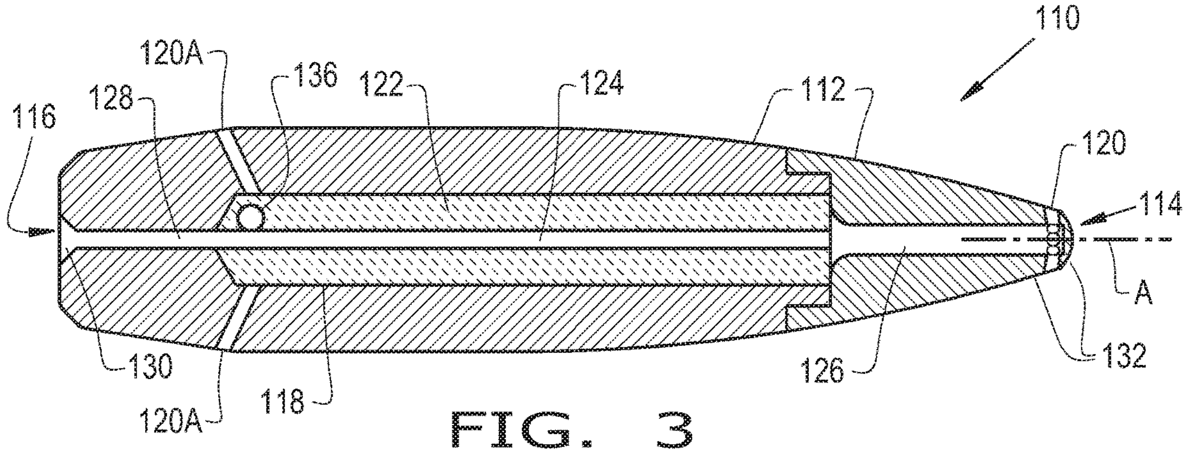


FIG. 3

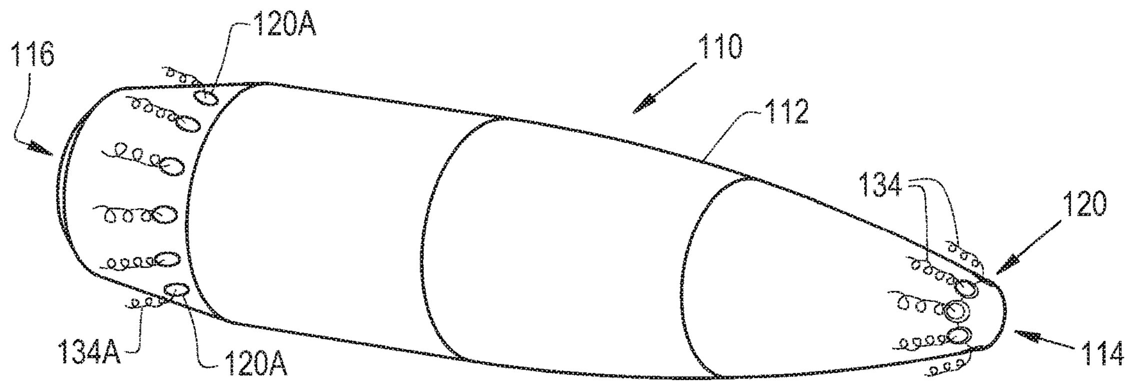


FIG. 4

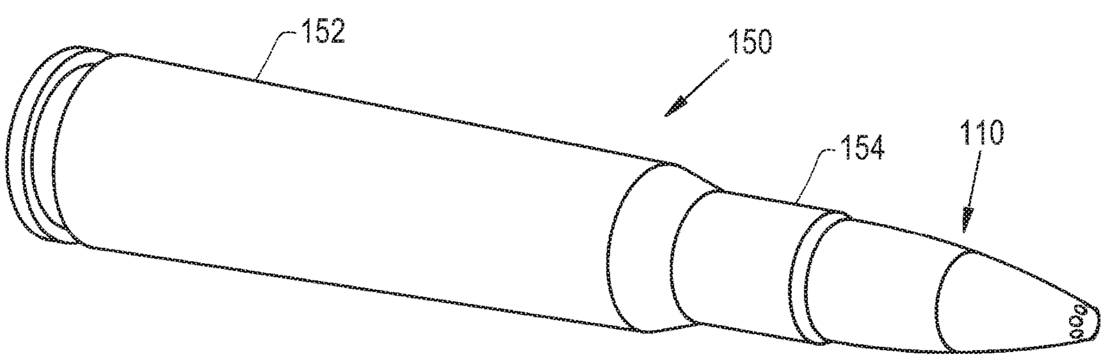


FIG. 5

NOISE CONTROL SYSTEM AND METHOD FOR SMALL CALIBER AMMUNITION

CROSS REFERENCE TO RELATED APPLICATIONS

This is a non-provisional application based upon U.S. provisional patent application Ser. No. 62/584,239, entitled "NOISE CONTROL SYSTEM AND METHOD FOR SMALL CALIBER AMMUNITION", filed Nov. 10, 2017, which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to ammunition and specifically to projectiles that travel faster than the speed of sound.

2. Description of the Related Art

Nearly all mechanical weapon systems require some form of ammunition in order to operate. The term "ammunition" is traced back to the mid-17th century, with the word coming from the French la munition, which can be understood to mean the material used for war. The term is now used to refer to the cartridges used in rifles, pistols, handguns, and machine guns and the like, regardless of the purpose for which it is used.

The purpose of ammunition is to project a kinetic force against a selected target to have an effect. The firearm cartridge is a single package that includes all of the components required for the firearm to deliver a projectile to a target.

Ammunition comes in a great range of sizes and types and is often designed to work only in specific weapons systems. This fact has allowed some manufacturers of thus control interchangeability of components. For example, Germany produced Mauser rifles (in the last century) that would accept unique cartridges that were sold to specific countries, thus allowing control of the other countries ability to easily interact with and exchange weapons with others. However, now there are internationally recognized standards for certain ammunition types that enable the use of the standardized ammunition across different weapons and by different users. Specific types of ammunition are designed to have a specialized effect on a target, such as armor-piercing shells to pierce armor and tracer ammunition to leave a visual trail for weapon aiming purposes.

The projectiles of the ammunition can be shaped and have various layers to enhance the expansion of the projectile inside the target, to maximizing the damage inflicted by a single round. Anti-personnel shells fragment into many pieces in the target and can affect a large area of a body. Armor-piercing rounds are specially designed to penetrate armor using a penetrator rod, or a shaped explosive or exothermic material to breach a layer of armor.

While not all ammunition types have a cartridge case. The discussion herein will assume that it does, with the focus of the invention being on the projectile.

The projectile is the part of the ammunition that leaves the barrel of a weapon and impacts the target. The effect on the target by the projectile is usually either kinetic (a standard bullet) or through the delivery of explosives in a portion of the projectile.

A bullet is the kinetic projectile, discussed above, and it is that component of ammunition that is expelled from the gun barrel during shooting. Bullets are made of a variety of materials such as copper, lead, steel, bismuth, polymer, rubber, wax or even special materials such as silver and

alloys. Bullets are manufactured in a large number of shapes and constructions depending on the intended applications, such as hunting, target shooting, training and combat. The shapes and materials impact the air drag, and flight characteristics of the bullet.

Though the word "bullet" is often used incorrectly to refer to a firearm cartridge, a bullet is not the complete cartridge, but rather a component of the cartridge. A round of ammunition or the cartridge is a combination package of the bullet (which is the projectile), the case (which holds everything together), the propellant (which provide the majority of the energy to launch the projectile) and the primer (which ignites the propellant in the case).

The bullets used in many weapon systems are fired at muzzle velocities that are faster than the speed of sound, which is about 1,130 ft./sec. (343 m/sec) in dry air at 68° F., at sea level air pressure, and thus can travel a substantial distance to a target before a nearby observer hears the sound of the shot. The sound of gunfire, sometimes referred to as the muzzle report, is often accompanied with a loud bull-whip-like crack as the bullet pierces through the air at a supersonic velocity to thereby create a sonic boom. The sonic boom is a combination of a compression of air and a rebounding partial vacuum that gives the noise the double crack sound. Bullet speeds at various stages of flight depend on intrinsic factors such as its sectional density, aerodynamic profile and ballistic coefficient, and extrinsic factors such as barometric pressure, humidity, air temperature and wind speed. One way of eliminating the sonic boom is to fire the projectile at a subsonic velocity so that there is no sonic boom. This means that a subsonic cartridge, such as .45 ACP, can be substantially quieter than a supersonic cartridge such as the .223 Remington, even without the use of a suppressor.

What is needed in the art is a way to reduce or eliminate the sonic boom for projectiles fired at high velocities.

SUMMARY OF THE INVENTION

The present invention provides a quieter version of a high speed projectile.

The present invention in one form is a projectile including a body having a tip and a tail, the body also having an internal cavity. There is at least one plume aperture connected to the internal cavity, the plume aperture being positioned proximate to the tip of the body.

The present invention in another form is directed to a firearm cartridge having a casing and a projectile including a body having a tip and a tail, the body also having an internal cavity. There is at least one plume aperture connected to the internal cavity, the plume aperture being positioned proximate to the tip of the body.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawing, wherein:

FIG. **1** is an illustration of a shock wave of a supersonic projectile;

FIG. **2** is an illustration of a flight path of another projectile;

FIG. **3** is a cross sectional view of an embodiment of a projectile of the present invention;

FIG. **4** is a perspective view of the projectile of FIG. **3**; and

FIG. **5** is a perspective view of a round of ammunition with the projectile of FIGS. **3** and **4**.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplification set out herein illustrates one embodiment of the invention, in one form, and such exemplification is not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, and more particularly to FIG. **1**, all common projectiles (such as projectile **10**) and bodies of mass travelling faster than the speed of sound generate an acoustic shockwave comprised of a high-pressure bow wave **12** and a low-pressure stern wave **14** of the body in motion through the air. FIG. **1** is a Schlieren image of a supersonic projectile **10**. The generated Shockwave is audible often times for miles and detrimental in many ways specifically in the use of small arms for covert applications due to the potential of observers or listening devices utilizing the sonic signature in an ability to detect and even localize the general or even direct position of the weapon used.

What is needed is a small arms projectile that can carry with itself a means to acoustically cloak, diminish or modify the shockwave **12**, **14** generated to make the resulting signature ambiguous in the environment or to create a further usable distance to an observer or sensor array before discovery and determination of localization can be made with efficient and accurate results.

Active and passive acoustic cancellation methodologies are well known in some markets specifically within fixed and captive acoustic fields such as localized headphones where an "active anti-phase source" can generate a near cancellation of the acoustic challenge up to some limit of frequency and amplitude which is generally processing power and time arrivals limited to about 15-265 hz based upon the general headphone applications this coupled with passive noise absorption provides a virtual area of silence for the user of the headset for comfort and better audibility of the music or voice source material listened to.

Due to the different conditions and dynamically changing phase relative to a position of an observer or sensor array of a bullet in motion the inability to utilize a similar active and or passive methodology is simply not likely due to limitations of 1. Size 2. Weight 3. Acoustic inefficiency of small transducers etc.

A better solution is to look at the mechanics of how such a shockwave **12**, **14** is generated with a high velocity projectile **10** and to modify the conditions of the mechanics of its acoustic signature generation process. It is widely known that the density of air (thus temp, humidity and air pressure) sets the speed of threshold for the on-set of the phenomena of shockwave generation, thus if one can modify the density of the envelope of air around the tip of the projectile in flight, a modification or even obfuscation of the acoustic signature is realizable.

In practical flight envelopes of aircraft/missiles/rockets it is known to the industry that at a very high-altitude flight-path and the resulting very low air density of such high altitudes produces greatly diminished shockwaves of a vehicle at supersonic speed, if one can replicate the conditions localized just around the projectile we can assume the conditions of the shockwave generation to be modifiable and not a fixed constant as is currently believed and expected.

Now, additionally referring to FIG. **2** there is shown a Schlieren image of a supersonic projectile **10**, having been fired from a weapon system **16**, exiting a high heat zone **20** and starting to develop a shockwave **18** as projectile **10** leaves heated area **20**. A muzzle blast concussion **22** can also be seen in FIG. **2**.

Now, additionally referring to FIG. **3**, there is illustrated an embodiment of a projectile **110** of the present invention shown in cross sectional form. Projectile **110** includes a body **112** having a tip **114** and a tail **116**. Body **112** also has an internal cavity **118** and plume apertures **120** connected to internal cavity **118**. Plume apertures **120** are positioned proximate to tip **114**.

Plume apertures **120** are equally spaced around the tip **114** and an axis A. There is a fluid connection or pathway the couples plume apertures **120** to an exothermic compound **122** in cavity **118**. Exothermic compound **122** is uniformly distributed in cavity **118** about axis A of body **112**. The exothermic compound **122** has an open core **124** that passes to plume apertures **120** by way of plume exhaust path **126**. Body **112** further includes an ignition port **128** extending from the open core **124** to tail **116** of body **112**. An ignition delay compound **130** is positioned in a portion of the ignition port **128** so that exothermic compound **122** will not be ignited until projectile **110** has traveled at least a portion of its path in the barrel of a weapon, and may even delay the ignition until projectile **110** has left the muzzle of the barrel.

Body **112** also has a laminar flow blending area **132** located between the tip and an area that extends toward tail **116** past the plume apertures **120**. Similar to plume apertures **120** that are proximate to tip **114**, at the aft end **116** plume apertures **120**A are positioned with passageways that extend to cavity **118**. Plume **134**A is formed to mitigate the formation of the trailing negative pressure wave **14** of the prior art. Both plumes **134** and **134**A are illustrated with curly lines, but a laminar smooth flow is what occurs.

It is contemplated that ports **120** and **120**A may have their positions shifted forward or aft along the outer surface of projectile **110** to optimize the effect of plumes **134** and **134**A depending on the shape of projectile **110**. It is also contemplated that only one set of plume apertures **120** or **120**A may be used in specific instances depending upon the acoustic signature modification needs.

Ball **136** is cast in place in exothermic compound **122**, as is shown in FIG. **3**, and is quickly freed as the exothermic compound **122** is converted to nitrogen gas allowing the ball **136** to move back to close off port **128** where it enters chamber **118**. Port **116** has a second compound filling the core burner design, which is ignited by the compound facing the gun powder in the case, this triggering compound, could be a black powder or equivalent other fast burn compound that provides the very brief delayed ignition to allow the bullet **110** to leave the barrel prior to outgassing of the exothermic gas from the compound core burner grain **122**. It is also contemplated that the inner portion of the passageway coupled to aperture **120**A would not be blocked by exothermic compound grain **122**.

Now, additionally referring to FIGS. **4** and **5**, Applicant has studied the challenge and has invented projectile **110** that contains a exothermic core burning gas generator section **122** that exhausts a super-heated plume **134** at or near the tip **114** of the projectile **110** at 90-120 degrees to the direction of flight. The present invention generates a symmetric plume, and a laminar flow shaped or sculpted blending area **132** is used around the bullet tip **114**, to create a virtual thin-walled 'straw' of super-heated air that envelopes the projectile **110** during flight and significantly raises the thermal constant within the envelope, which serves to replicate the conditions of lower air density "high altitude" flight producing a modified acoustic signature.

Many suitable exothermic materials are known to the industry, one possible choice could be a Sodium-Azide ($NaN3$) compound that is commonly used in vehicle airbags as the nitrogen gas generator for safe and nearly instant inflation of the airbags during a crash scenario. The Sodium-Azide compound is a complex chemical reaction resulting in its final stage as super-heated gas and it is non-toxic to the environment, the reaction resulting in silica glass and produces a nontoxic, no-smoke, no-flash, volume of Nitrogen gas that has a temperature of greater than 300° C. (572° F. degrees). The expansion volume formula for Sodium Azide or $NaN3$ is generally accepted to be 1 gram of solid compound produces 0.5-0.75 liter volume of superheated nitrogen gas.

A quick volume requirement calculation confirmation of a thin-wall straw of superheated nitrogen of 500 yds. in length to be within relevant terms of fractional volume occupancy within the projectile.

A firearm cartridge **150** is depicted in FIG. **5**, with projectile **110** positioned, as does any standard projectile, within the round's metallic casing **152** neck **154** with the propellant charge therein typical of standard rounds being captivated within the cartridge **150**. The assembled round **150** is housed in standard magazines and fed into a conventional weapons chamber.

The weapons trigger is pulled and the firing pin strikes the primer of cartridge **150** initiating the propellant to combust and burn. The resulting heated gas begins the bullet **110** acceleration down the weapon barrel and simultaneously initiates the rear facing ignition compound **130** with a fixed chemical reaction delay set to the time required for the bullet to leave the weapon's barrel.

The Exothermic core burner **122** is initiated just as bullet **110** emerges from the barrel producing a spherically symmetric plume **134** of super-heated nitrogen gas that due to the bullet **110** velocity produces a very thin-walled virtual straw within which bullet **110** travels, with the plume emanating from apertures **120**, **120**A modifying the effective air temperature at the bullet tip **114** and tail **116** to increase up to 500 degrees above the ambient temperature, which serves to create a significant decrease in the localized air density exactly where the shockwave would have been generated and modifies and diminishes the resulting acoustic shockwave (report) that corresponds to a high altitude (low air density) flight path all the while it is actually flying within typical air density and temperature of sea-level to its intended target. Further, the bullet **110** revolutions, caused by the rifling of the barrel, is contributory to the creation of the virtual heated gas straw sheath for the bullet **110** to travel within.

While in the present example the exothermic compound utilized produces a volume of super-heated nitrogen or other inert colorless gas, with Sodium-Azide, it is contemplated that other alternate chemistry exothermic compounds can be used to meet the objectives.

At the tip of the projectile a plume aperture array **120** is arranged around the tip **114** to produce a symmetric fully encompassing plume around the projectile **110**. The triggering of the exothermic compound **122** is delayed until the bullet **110** reaches the barrel muzzle by way of a delayed reaction if needed.

The bullet mass, as can be assumed from the view of FIG. **3**, is effected by the exothermic core burner **124** and plume passageways **126**, which will slightly decrease the bullet specific mass however a slightly longer bullet could be selected to allow for an identical bullet mass so as to not diminish or impact the trajectory or foot pounds of energy delivered to the target as a result.

While the Super-heated plume **134** may be discoverable with highly sensitive Infrared sensors, the super-heating of the plume has a very short lifetime (fractions of a second) with it being distributed over the trajectory of the projectile, and the air quickly returns to the ambient temperature.

The side aperture plume **134** generation over the bullet trajectory should remain constant as compared to an identical unmodified cartridge fired from the same weapons platform and minimal added drag from the shape of the bullet is realized. Compatibility with current weapon systems is achieved with the present invention, with FIG. **5** representing a configuration using a standard shell casing **152**.

It is also contemplated that a small non-combustible element **136**, such as a ball **136**, may be included in the aft portion of the exothermic core **122** so that once the material around the element **136** burns away the element **136** will move to plug the ignition port **128** as the projectile **110** is in flight.

There are several advantages of the present invention, which include an anticipated significant increase in the air temperature surrounding the tip of the air penetrating supersonic bullet, which could result in a lower intrinsic ballistic drag coefficient value of a projectile resulting in a longer than standard range as compared to a conventional shaped and weight bullet and cartridge power for the same weapons platform.

The cost per finished round could be similar to common tracer-rounds and a slight premium to conventional bullets; however, the baseline mechanics of the Thermal Acoustic Obfuscation (TAO) solution of the present invention should be relatively low-cost once production maturity is reached.

The cartridge of the present invention results in a round that is weapons platform compatible so no changes of the weapons platform or any already in use magazines or accessories need to be replaced or modified for use with the new round.

Range of the thermal obfuscation phenomena is limited to the duration of the exothermic reaction and volume of expendable compound material carried within the bullet, it is possible that the smaller bullet platforms can only carry enough exothermic compound to render the bullet thermally obfuscated for a range of 500-600 yds. beyond which the bullet would return to generating an acoustic signature from the naturally generated and un-modified shockwave.

Initial weapon calibers studied include the 5.56 mm and 7.62 mm, Larger weapons platform rounds such as the .50 BMG may have enough volume to accomplish miles of useable range in a Thermal Acoustic Obfuscated condition.

Advantageously the projectile solution of the present invention when combined with muzzle suppresser technology could render a high velocity weapons platform virtually covert.

While this invention has been described with respect to at least one embodiment, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

What is claimed is:

1. A projectile, comprising:

a body having a tip and a tail, the body also having an internal cavity and an ignition port;

at least one plume aperture connected to the internal cavity, the plume aperture being positioned proximate to the tip of the body;

an exothermic compound in the cavity; and

a non-combustible element positioned in the exothermic compound that releases therefrom to plug the ignition port after a portion of the exothermic compound is burnt away from the non-combustible element.

2. The projectile of claim **1**, wherein the at least one plume aperture is a plurality of plume apertures positioned around the body proximate to the tip.

3. The projectile of claim **2**, wherein the plume apertures are equally spaced around the tip.

4. The projectile of claim **1**, wherein the exothermic compound is uniformly distributed in the cavity about an axial axis of the body.

5. The projectile of claim **4**, wherein the exothermic compound has an open core passing to the at least one plume aperture.

6. The projectile of claim **5**, wherein the ignition port extends from the open core to the tail of the body.

7. The projectile of claim **6**, further comprising an ignition delay compound positioned in the ignition port.

8. The projectile of claim **6**, wherein the body has a plume exhaust pathway positioned between the cavity and the at least one plume aperture.

9. The projectile of claim **1**, further comprising a laminar flow blending area located between the tip and beyond the at least one plume aperture.

10. A firearm cartridge, comprising:

a casing having at least one opening;

propellant within the casing; and

a projectile extending from the opening in the casing, the projectile having:

a body having a tip and a tail, the body also having an internal cavity and an ignition port;

at least one plume aperture connected to the internal cavity, the plume aperture being positioned proximate to the tip of the body;

an exothermic compound in the cavity; and

a non-combustible element positioned in the exothermic compound that releases therefrom to plug the ignition port after a portion of the exothermic compound is burnt away from the non-combustible element.

11. The firearm cartridge of claim **10**, wherein the at least one plume aperture is a plurality of plume apertures positioned around the body proximate to the tip.

12. The firearm cartridge of claim **11**, wherein the plume apertures are equally spaced around the tip.

13. The firearm cartridge of claim **10**, wherein the exothermic compound is uniformly distributed in the cavity about an axial axis of the body.

14. The firearm cartridge of claim **13**, wherein the exothermic compound has an open core passing to the at least one plume aperture.

15. The firearm cartridge of claim **14**, wherein the ignition port extends from the open core to the tail of the body.

16. The firearm cartridge of claim **15**, further comprising an ignition delay compound positioned in the ignition port.

17. The firearm cartridge of claim **15**, wherein the body has a plume exhaust pathway positioned between the cavity and the at least one plume aperture.

18. The firearm cartridge of claim **10**, further comprising a laminar flow blending area located between the tip and beyond the at least one plume aperture.

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