AERODYNAMIC ROTATIONAL STABILIZATION TECHNIQUES FOR PROJECTILES

(21) Appl. No.: 11/551,688
(22) Filed: Oct. 20, 2006

Correspondence Address:
KLEINBERG & LERNER, LLP
2049 CENTURY PARK EAST
SUITE 1080
LOS ANGELES, CA 90067 (US)

Related U.S. Application Data
(60) Provisional application No. 60/730,345, filed on Oct. 27, 2005.

Publication Classification
(51) Int. Cl.
F42B 10/24 (2006.01)
(52) U.S. Cl. .......................... 102/501; 102/439; 244/3.23

(57) ABSTRACT

A pliant projectile is provided with a plurality of I-shaped grooves in the circumference thereof. The grooves are at an angle with the axis of the projectile and, in flight, will, through interaction with the air, cause the projectile to rotate about its axis, thereby stabilizing the flight path. The projectile may be provided with an additional stabilizing member extending from its tail which member includes a plurality of tabs each having a fin that can interact with the air, in flight, to add additional rotational forces to the projectile.
AERODYNAMIC ROTATIONAL STABILIZATION TECHNIQUES FOR PROJECTILES

This is a continuation-in-part of my provisional application for letters patent Ser. No. 60/730,345, filed Oct. 27, 2005.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to special purpose projectiles, and, more specifically to novel techniques to significantly improve the accuracy and consistency of projectiles fired from smooth bore weapons, such as shot guns and mortar launchers.

2. Description of the Related Art

U.S. Pat. No. 6,782,828 B2, issued to the present inventor, discloses novel techniques for discharging elastic projectile from fire arms without risk of the soft projectiles jamming or lodging in the barrel of the weapon. Although these unique cartridges have been widely acclaimed by both law enforcement and various branches of the government and the Department of Defense, better accuracy and consistency, particularly at extended range, were sought after by some of these same users. Border patrol, prison guards, wildlife management and control and riot control officers in particular, require rounds that they could use at distances from 50 to 100 yards, for successfully engaging a human or animal sized target consistently and meaningfully, without lethality.

As a result of several years of development and testing of this type of less lethal, very soft projectile, it was recognized that to achieve that range with consistent accuracy, some additional in-flight stabilization techniques would have to be developed. Extensive development effort has resulted in a preferred embodiment for a technique and design for what will now be referred to as aerodynamic rotational stabilization or “aerodynamic rifling”.

SUMMARY OF THE INVENTION

A significant reason that rifle and pistol ammunition is extremely accurate at close range as well as extended range is the presence of rifling in the bore of the weapon. Rifling is a series of alternate “lands” and “grooves” that are machined longitudinally into the bore of the barrel in a helical pattern. This slight “twist” imparts a spin to the solid lead or copper projectile as it is forced through the bore of the weapon and subsequently provides a remarkable stability to the projectile in flight.

Because shot guns and mortar launchers, for example, are not provided normally with rifled barrels and the soft, less lethal projectile of the aforementioned and present invention, require minimum contact with a smooth bore for their best performance, it becomes the challenge to impart some slight rotation or “spin” to the projectile during flight giving rise to the term “aerodynamic rifling”.

During the compression or injection molding process of the soft elastomer projectile, a multiplicity of generally “L” shaped grooves are placed at a slight angle to the horizontal axis, around the periphery of the projectile. As the projectile passes through the air at high velocity, the raised “lands” which are positioned at a slight angle with respect to the air stream, cause the projectile to rotate around its horizontal axis from the influence of the air stream through which the projectile passes.

How and why the projectile rotates is a function of a combination of many interrelated factors such as the initial muzzle velocity, the number of “lands” and “grooves” on the projectile, the depth of the grooves and equally important, the angle of the “lands” with respect to the horizontal axis of the projectile. The optimum angle, however, can only be determined and is affected by, the values of the other aforementioned parameters, which may also vary themselves, depending upon the range required of the round and even the durometer of the elastomeric projectile.

However, the novel feature that contributes most to the aerodynamic rotational performance of the design is the configuration of the rifling profile itself. In order to allow the air stream maximum access to the angled vertical surfaces of the “lands”, the profile must take more of an “L” shaped configuration with one surface of the vertical leg of the “L” radiating from the center axis of the projectile and the other leg surface positioned at up to a 90 degree angle with respect to the first vertical leg surface. This configuration provides maximum access of the air stream to the vertical angled surface of each “land”.

There exists an additional novel feature incumbent with aerodynamic rifling that is only possible with a very soft projectile that is disclosed in the aforementioned patent and in the present invention. As stated earlier, the interrelationship of many variables combined in numerous ways, all contribute to the rotation of the projectile as it passes through the air. One difficulty encountered, especially in the longer range versions which require a higher initial velocity, was the increased aerodynamic drag, resulting from the elevated rotational speed produced at these higher initial velocities.

With reference to the structure described and shown in the patent, by extending the length of the transfer rod, or by the addition of one or two more buffer pads in front of the transfer rod (extending the same result), the projectile, during the initial acceleration phase, is permitted to elongate even further than normal before its rear portion is contacted by the accelerating front surface of the piston. By this additional stretching of the projectile, the original angle of the surface of the rifling “lands” on the projectile is decreased slightly during the projectile’s exit from the barrel of the weapon and for a period of time during its initial flight to the target, thus reducing its rotational velocity.

During flight, the elastic memory of the projectile causes it to retract, assuming a configuration close to the original angle of the rifling. During this same period of time, the projectile’s speed is deteriorating from its original muzzle velocity. Within certain limits, the rotational velocity of the projectile is inversely proportional to the forward velocity of the projectile. Therefore, as the projectile slows as it approaches target, the more unstable it would become were it not for the greater stability provided by the increased rotational velocity resulting from the restored angle of the rifling.

This unique self compensating feature, although it exists to some extent in all aerodynamic rifling versions, is particularly beneficial, if not required, in all extended range
configurations of aerodynamic rifling rounds. The unique configuration of the "aerodynamic rifling" provides an additional significant enhancement pertaining to the manufacturability of the projectile.

[0016] Normally the design of an injection or rubber compression mold to produce a sophisticated part such as this would require the incorporation of "slides" in to the mold cavities to facilitate the release prior to ejection of the finished part from the mold. Slides are complicated and expensive and decrease the mold cavity density. This projectile, due in part to the low durometer of the elastomer and in part due to the modest angle of the rifling, but mostly due to the substantial included angle between the two surfaces of the "L", may be removed easily from the mold cavity without the aid of slides. This moldability significantly increases the production rate and lowers the initial cost of the molds.

[0017] Testing this design in a 12 gauge shotgun with an initial muzzle velocity of approximately 700 f.p.s. at a range of 75 yards, resulted in most all projectiles impacting within a man sized target profile—unheard of for a soft elastomeric less lethal shotgun projectile.

[0018] An additional feature of this configuration is that the multiplicity of "aerodynamic rifling" grooves around the periphery of the projectile, which, in the preferred embodiment, are approximately 8 or more and, on average, 0.040 to 0.060 of an inch or more deep, tend to weaken the cross section of the projectile, allowing it to more readily expand radially upon impact with the target to deliver, at higher velocity, more kinetic energy onto the target body surface while remaining within acceptable kinetic energy density limits of approximately 100 to 125 ft. lbs/sq. in.

[0019] While considering additional stabilizing techniques for this projectile, which would further complement the aerodynamic rifling feature, a design for an improved transfer member for shotguns and other smooth bore weapons evolved. The new design consists of a piece assembly including the transfer rod, the piston or wad and a multiplicity of tabs added around the periphery of the rear of the piston.

[0020] Affixed to the outer surface of each tab may be vertical fins. The tabs contribute additional in-flight stability to the projectile assembly by effectively improving the ratio of the length to the diameter (the L/D ratio), which ideally should be approximately 3 to 1. The optional tapered vertical fins which may be affixed to the top surface of the tabs contribute additional stability. More importantly, these fins can provide a slight amount of drag stabilization, if needed, for a more aerodynamically stable projectile.

[0021] Also contemplated, but not included in the preferred embodiment, is the concept of substituting an angled fin for the straight vertical fin. This angled fin can be in lieu of, or in addition to, the "aerodynamic rifling" on the projectile. For example, at very slow projectile velocities, as in a less lethal mortar round, the additional rotational force provided by the angled fins, might optimize its performance as well as that of small caliber land gun projectiles where aerodynamic rifling molded into the projectile might not be practical. Again, mold release consideration and airstream aerodynamics dictate the shape of the solid angled fin.

[0022] It should be noted that although all of the aforementioned concepts are primarily directed toward launching soft projectiles from smooth bore weapons, nothing stated herein precludes launching these type of projectiles from rifled bores. It would be highly advantageous, however, to have the induced rotational motion from the aerodynamic rifling compatible with the twist of the rifled bore.

[0023] Forward of the piston section, an annular cup was added to receive the rear section of the projectile, which was also lengthened, in a manner that more properly contains the back of the projectile during the initial rapid forward acceleration of the transfer member. This feature reduces the friction between the soft projectile and the shell casing and also provides an improved, less disruptive air flow between the lengthened rear portion of the projectile and the transfer member during flight. A rim or collar was added around the rear perimeter of the rifling on the projectile to provide a more substantial surface with which the forward rim portion of the annular cup interfaces during the initial acceleration phase of the transfer member.

[0024] We now have an improved projectile and transfer member, which working in concert with the novel aerodynamic rifling feature provides a less lethal 12 gauge point round for law enforcement and the military, capable of both pinpoint accuracy at close range and the ability to engage a man sized target at ranges of from 50 to 100 yards, simply by adjusting the initial muzzle velocity and possibly the durometer of the projectile.

[0025] Although the aerodynamic rifling disclosures in the present invention were developed and mainly directed towards applications involving very soft (25 to 35 Shore "A") projectiles, it should be noted that the same technology might well be applied to the so called "rubber bullets", that, of necessity, are much harder, being in the range of 60 to 90 shore "A" in order to safely transit the barrel of the weapon.

[0026] Although the concepts disclosed herein have been primarily directed to less lethal applications, they are all directly applicable to various other aerodynamic objects, either self propelled or inertia devices, which may benefit from the disclosed methods of aerodynamic stabilization. Applications as widely diversified as toys to less lethal and malodorant mortar rounds are all potential candidates that could benefit from this technology.

[0027] An additional specific application for this present technology exists in an area referred to as shotgun "slugs" which are single projectiles for shotguns. These heavy projectiles are usually made of lead and are used for hunting big game animals and dangerous game such as wild boar and bear. Many states require by law, the use of shotguns and slugs or buckshot for hunting deer and other seasonal game animals.

[0028] Most attempts to improve the accuracy of shotgun slug type projectiles at extended range, has been directed towards inducing some limited rotational velocity into the projectile prior to its exiting the bore of the weapon. The preferred and most pervasive method has been to cast or mold the lead projectile with angular "lands and grooves" around its periphery. These rectangular cross sectional shaped "lands" are basically a mirror image of the rifling on the inside of a rifled gun barrel. The outside diameter of these "lands" is typically slightly larger than the inside diameter of a smooth bore of a shot gun barrel, so in transiting the bore, the projectile supposedly is caused to
rotate. The effectiveness of this approach is questionable because there is very little improvement in the accuracy of "rifled slugs" over most non-rifled slugs in actual practice.

[0029] All of the aforementioned technology and design pertaining to less lethal projectiles is applicable to solid projectiles. The design and specifications, however, incorporated in a preferred embodiment of a solid projectile will differ from those selected for a low durometer (soft) less lethal projectile. The initial muzzle velocity can be almost three times that of a less lethal projectile and the number of "grooves", their depth and angle, will be consequently affected.

[0030] However the technical challenges associated with the successful design of a soft lead or copper slug incorporating "aerodynamic rifling" for smooth bore shot guns or mortars or the like is much less demanding if the techniques disclosed in the present invention are used. A great many of the overlapping and variable parameters associated with low durometer projectiles are minimized or completely eliminated with a solid projectile design.

[0031] Accordingly, it is an object of the present invention to provide a less lethal projectile with improved stability in flight. It is an additional object of the invention to provide a soft (low durometer) projectile that can transit the bore of a weapon without contact and have improved accuracy over ranges up to 100 yards. It is a still further object of the invention to apply the same principles to metal projectiles for smooth bore weapons that will exhibit improved in flight stability and greater accuracy at greater ranges.

[0032] The novel features which are characteristic of the invention, both as to structure and method of operation thereof, together with other objects and advantages thereof, will be understood from the following description, considered in connection with the accompanying drawings, in which the preferred embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only, and they are not intended as a definition of the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] FIG. 1 is a side view of a projectile according to the present invention;
[0034] FIG. 2 is a front view of the projectile of FIG. 1;
[0035] FIG. 3 is a sectional view of the projectile of FIG. 1 taken along the line 3-3 in the direction of the appended arrows;
[0036] FIG. 4 is a transfer rod, suitable for use with the projectile of FIG. 1;
[0037] FIG. 5 is a sectional view of a fin of the transfer rod of FIG. 4, taken along line 5-5 in the direction of the appended arrows;
[0038] FIG. 6 is an alternative embodiment of a transfer rod;
[0039] FIG. 7 is a sectional view of a fin of the transfer rod of FIG. 6, taken along line 7-7 in the direction of the appended arrows; and

[0040] FIG. 8 is a partial view of an alternate embodiment of transfer rod fins.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0041] Turning first to FIG. 1, there is shown a projectile 10 according to a preferred embodiment of the present invention. Molded into the body of the projectile 10 are a plurality of L shaped grooves 12 which create a plurality of raised lands 14 around the outer circumference of the projectile 10. As shown, the grooves 12 and associated lands 14 are at an angle to the axis of the projectile 10.

[0042] FIGS. 2 and 3 give a better view of the grooves 12 and the lands 14 created when the grooves 12 are formed in the outer surface of the projectile 10. In flight, the wall of the land 14 provides aerodynamic resistance to the flow of air and causes the projectile 10 to rotate in flight.

[0043] Turning next to FIG. 4, there is shown an improved transfer member 20 which combines a transfer rod 22 with a piston element 24. Extending from the rear of the piston element 24 is a plurality of tabs 26, each with a stabilizing fin 28. FIG. 5 shows the shape of the fin 28 relative to the tab 26.

[0044] FIG. 6 shows an alternative embodiment of an improved transfer member 40. In this embodiment, the tabs 42 are provided with angled stabilizing fins 44 that are as wide as the tab 42 at the base of the tab 42 but taper to a point at the outer end of the tab 42. A cross section of the tab 42, showing the fin 44 is shown in FIG. 7. Yet another embodiment of a transfer member 50 is shown in FIG. 8. In this embodiment, a plurality of tabs 52 are provided. Each tab 52 has a fin 54 of uniform width, but which angles, diagonally across the width of the tab 52.

[0045] Thus there has been shown an improved projectile with a grooved surface that can rotate in the flight to a target. The rotation stabilizes the projectile and increases its accuracy. As part of the improved projectile, an improved transfer member is provided which combines a transfer rod with a piston and which can remain with the projectile throughout the flight. For added stabilization, the piston is provided with a plurality of stabilizing tabs, each with a fin. The net effect is rotating projectile with finned tabs that help resist pitch and yaw.

[0046] The scope of protection of my invention should be limited only by the scope of the claims appended hereto.

1. A pliant projectile to be deployed from a weapon comprising:
   a. A nose portion;
   b. A tail portion; and
   c. A substantially cylindrical body portion having a plurality of substantially L-shaped grooves formed therein, said grooves generally paralleling the cylindrical axis of said body portion but at a slight angle thereto.

2. The pliant projectile of claim 1 wherein each of said L-shaped grooves includes a substantially radial surface and a substantially circumferential surface, said radial surface being inclined at an angle with respect to a radius of said cylindrical body portion.
3. The pliant projectile of 1 wherein each of said L-shaped grooves includes a substantially radial surface and a substantially circumferential surface, said circumferential surface being inclined at an angle with respect to the circumference of said cylindrical body portion.

4. The pliant projectile of 3 wherein said radial surface is inclined at an angle with respect to a radius of said cylindrical body portion.

5. The pliant projectile of 1 further including a stabilizing member extending from said tail portion, said stabilizing member having a plurality of axially extending tabs each with a tapered fin orthogonally extending therefrom.

6. The pliant projectile of 1 further including a stabilizing member extending from said tail portion, said stabilizing member having a plurality of axially extending tabs each with a tapered fin extending therefrom at an acute angle.

7. A projectile comprising:
   a. A nose portion;
   b. A tail portion; and
   c. A substantially cylindrical body portion having a plurality of substantially L-shaped grooves formed therein, said grooves generally paralleling the cylindrical axis of said body portion but at a slight angle thereto.

8. The projectile of claim 7 wherein each of said L-shaped grooves includes a substantially radial surface and a substantially circumferential surface, said radial surface being substantially aligned with a radius of said cylindrical body portion.

9. The projectile of claim 7 wherein each of said L-shaped grooves includes a substantially radial surface and a substantially circumferential surface, said radial surface being inclined at an angle with respect to a radius of said cylindrical body portion.

10. The projectile of claim 7 wherein each of said L-shaped grooves includes a substantially radial surface and a substantially circumferential surface, said circumferential surface is substantially orthogonal to a radius of said cylindrical body portion.

11. The projectile of claim 7 wherein each of said L-shaped grooves includes a substantially radial surface and a substantially circumferential surface, said circumferential surface is inclined at an angle to a radius of said cylindrical body portion.

12. The projectile of claim 11 wherein said radial surface is inclined at an angle with respect to a radius of said cylindrical body portion.

13. The projectile of claim 7 further including a stabilizing member extending from said tail portion, said stabilizing member having a plurality of axially extending tabs.

14. The projectile of claim 7 further including a stabilizing member extending from said tail portion, said stabilizing member having a plurality of axially extending tabs each with a tapered fin orthogonally extending therefrom.

15. The projectile of claim 7 further including a stabilizing member extending from said tail portion, said stabilizing member having a plurality of axially extending tabs each with a tapered fin extending therefrom at an acute angle.