United States Patent [19]

Flatau

[11] **3,877,383**

[45] **Apr. 15, 1975**

[54] **MUNITION**

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[22] Filed: **July 17, 1972**

[21] Appl. No.: **272,252**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 105,751, Jan. 6, 1971, abandoned.

[52] **U.S. Cl.** **102/93;** 102/56; 102/67; 102/92.1; 244/3.1

[51] **Int. Cl.** **F42b 13/12**

[58] **Field of Search** 102/2, 6, 7.2, 38, 56, 102/64–67, 92.1, 93; 244/3.23, 3.1

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[57] **ABSTRACT**

A rotatable airfoil munition comprising a hollow closed circular ring surrounding a central open area with the detonation system and military filling material positioned within the hollow ring. the munition projectile consists of an aerodynamic lifting body of a thick ring wing geometry which uses spin imparted to it from a launching means for its gyroscopic stability, thus permitting a relatively flat trajectory as compared with the prior art munitions which require a loft trajectory for substantially the same range.

The combination of aerodynamic stability characteristics and high spin rate (e.g. above 2,000 rpm) results in both a flat trajectory and extended range capability as compared to a conventional ballistic projectile for the same initial subsonic launch velocity.

14 Claims, 9 Drawing Figures

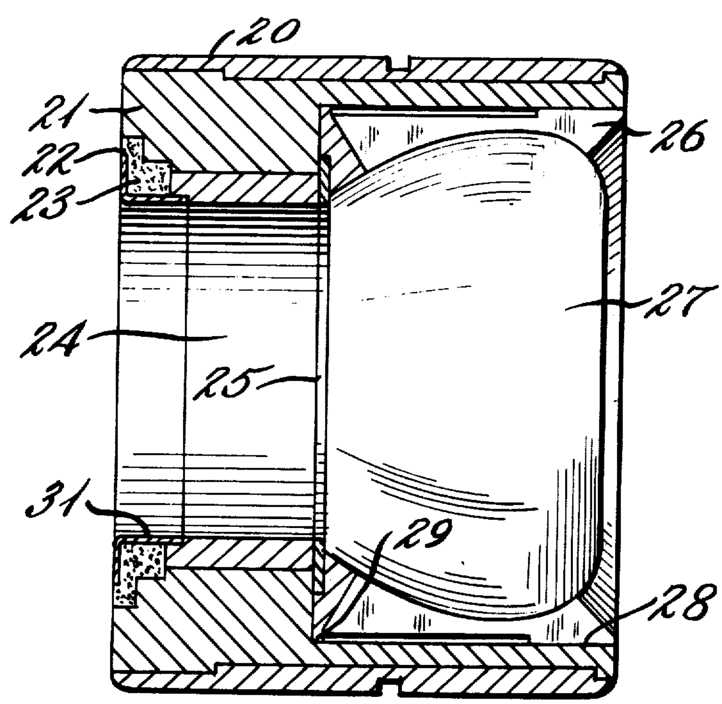


FIG. 1

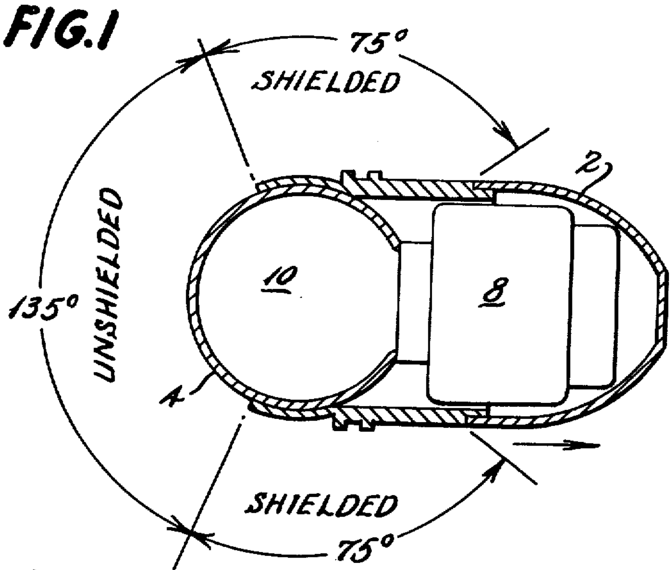
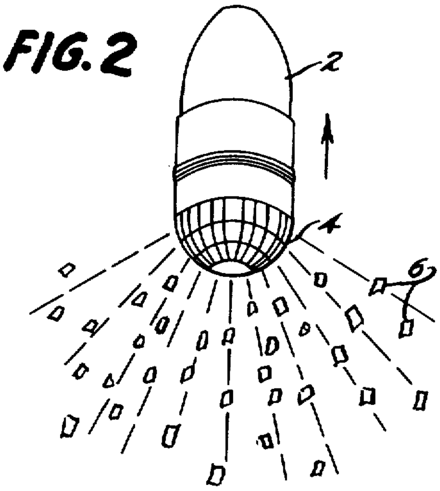


FIG. 2



PRIOR ART

FIG. 3

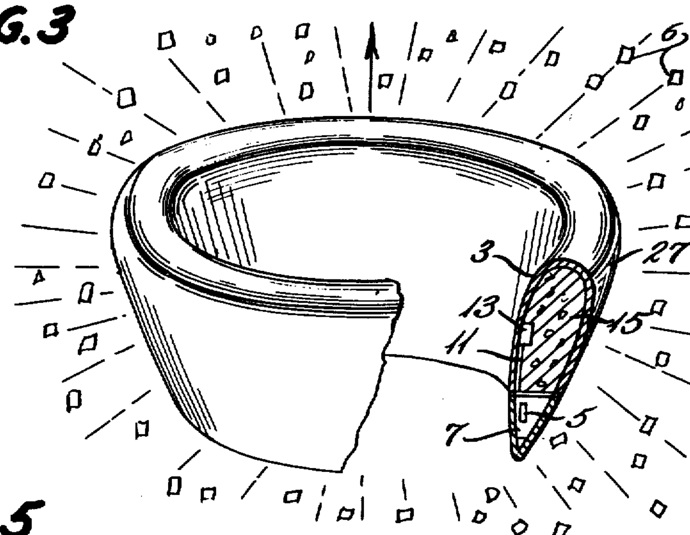


FIG. 4

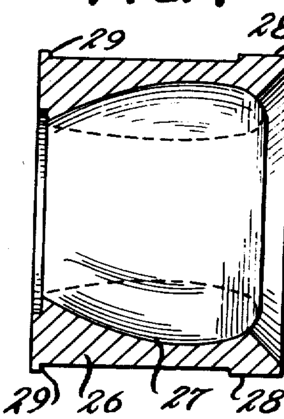


FIG. 5

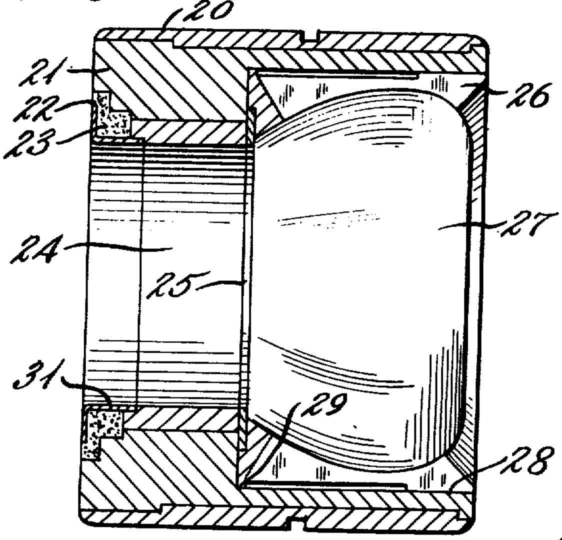


FIG. 7

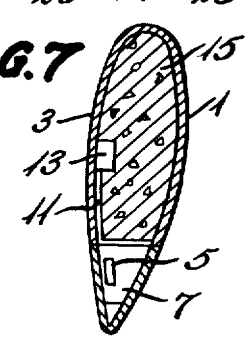


FIG. 6

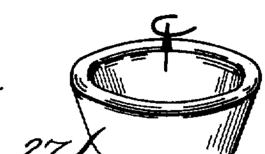


FIG. 8

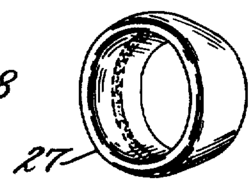
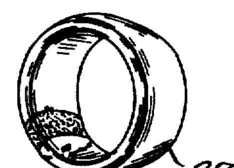


FIG. 9



MUNITION

This application is a continuation-in-part of Ser. No. 105,751, filed January, 6, 1971, and now abandoned.

The invention described herein may be manufactured, used and licensed by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to significant improvement in the range of munition projectiles while providing a relatively flat trajectory as compared to the conventional ballistic trajectory.

To obtain extended range, current projectiles, from shoulder fired grenades to artillery munitions, have been using a rocket boost which has been added to the basic munition projectile. The rocket motor arrangement has increased the range approximately one-third more than is obtained without the rocket.

The object of this invention is to provide an extended range capability without the need for the additional weight and cost of the rocket motor arrangement.

A further object of this invention is to provide a munition projectile whose terminal ballistics capability, on a lethality per pound munition basis, represents a significant increase over conventional projectiles.

This invention is directed to a body of revolution forming a closed circular airfoil warhead, Ring Airfoil Munition, with a hollow configuration surrounding a central opening rotating about an axis in the general direction of its trajectory toward the impact area. The hollow section houses the payload and explosive train.

This invention relates to a new munition configuration based on a ring airfoil or ring wing whereby a body of revolution generated by the airfoil cross section rotated 360° about an axis beneath and parallel to the longitudinal direction of the airfoil cross section.

The principal object of this invention is to provide a munition which will be more effective to overcome enemy resistance.

Another objective is to provide a munition which will be more effective in utilizing direct-in-line fire trajectory.

Another objective is to provide a means for greater destruction of the target area without materially increasing the payload.

Another object is that the inventive warhead may be fired from any conventional launcher which utilized a sabot cartridge.

Still a further objective is to provide a ring airfoil munition with a low angle of elevation for its primary trajectory.

Various developments have been made in the art of warfare for destroying materiel and personnel by means of bullets, mortars, and grenades. These means have a range that is limited to their ballistic properties. Many of these means have necessitated the use of launching systems requiring the projectile to have an angle of elevation above the ground level up to about 45° in order to achieve maximum range. In most instances for maximum range, the conventional projectile cannot be fired on a direct line or even at small elevation angles such as 6°.

The conventional projectiles have a basic deficiency in that mid to maximum ranges cannot be achieved without resorting to the normal loft trajectories resulting from relatively high elevation angles, for example 30° to 45°.

The Army's standard shoulder-fire grenade launcher (M-79) and the 40mm (M-406) shoulder-fired grenade cannot be fired for maximum range at small angles of elevation.

In heavy overhanging jungle canopy, the soldier in attempting to hit the target from a medium to maximum range must fire with the normal arch or loft trajectory. This has resulted, in many instances, in the projectile striking or grazing this foliage and being deflected from the desired trajectory. In other words, a relatively flat trajectory would have been desirable to avoid the interference effects of this environment.

The aeroballistic configuration of the present warhead overcomes the former limitations of the loft trajectory and permits a 5° to 7° angle of elevation of the launcher for substantially the same range as the 35° angle of elevation required for the 40mm M-39 grenade system. Additionally, the inventive warhead may also be launched for a loft trajectory if desired.

The inventive projectile warhead provides major improvements in trajectory capability with increased range by a factor of 2 or more for the same launch velocity and weight of the projectile as the M-406 grenade. The inventive warhead has demonstrated a significant increase in lethality for the same amount of HE (high explosive) as used in the conventional 40mm grenade (M-406).

The unique aerodynamic characteristics of the ring airfoil configuration results in permitting the soldier to fire on a substantially direct line to the target area.

The configuration of the present invention possesses aerodynamic properties which are not available in conventional ballistic projectiles. In flight, the munition is rotating about its axis of symmetry which is central to the body of revolution formed by rotating the airfoil cross section about the same axis. The spin rate should exceed about 2,000 rpm, and preferably should far exceed 2,000 rpm. The rotational motion produces gyroscopic stability so that although the attitude of the projectile tends to remain relatively constant, the angle of the ring airfoil projectile along the trajectory produces a lift force which partly offsets the influence of gravity. This is achieved by using an essentially neutral static aerodynamic moment or stability characteristic $C_{m\alpha}$. Additionally, the ring airfoil projectile has much lower drag than the conventional M-406 grenade. Thus the combination of lift and low drag produces a relatively flat trajectory and an extended range for any given (sub-sonic) launch velocity while firing at low launch angles.

The airfoil cross-sectional contour and ring arrangement result in more uniform fragment distribution over a larger area than can be achieved with the M-406 grenade. The ring airfoil configuration can therefore be utilized in a tactical role wherein it may be either exploded in air in the proximity of the target or exploded by direct impact with the target.

The fragment spray pattern of the M-406 grenade is generally limited to the rearward direction only and totals approximately 135°. The arena tests indicated directly the fragment spray patterns and distribution resulting from the Ring Airfoil Grenade, inventive structure, with a notched wire warhead. The lethality as developed from the arena data results in a substantial increase for the inventive warhead as compared to the M-406. This is due, in part, to both the increase in the number of available fragments resulting from the ring airfoil geometry and the absence of any shielding in the structure, which provides the inventive munition with a significant increase in fragment distribution as compared to the M-406. FIGS. 1 and 3 illustrate the spray patterns and distribution of fragments resulting from the arena tests.

FIG. 1 is a longitudinal sectional view of FIG. 2;

FIG. 2 is an elevated view of the prior art grenade;

FIG. 3 is a perspective view partially broken away exposing the cross-sectional view of the structure of this invention;

FIG. 4 is a cross-sectional view of the projectile and sabot;

FIG. 5 is a cross-sectional view of the sabot and cartridge;

FIG. 6 is a perspective view of the inventive projectile;

FIG. 7 is an enlarged cross-sectional view of the inventive structure;

FIG. 8 and FIG. 9 are perspective views illustrating an inner ring fuze and a sector fuze, respectively.

In FIGS. **1, 2, 3** and **6**, the straight arrows indicate the path of flight. In FIG. **6**, the curved arrow indicates the direction of rotation.

The warhead is a self-contained unit and the configuration, rather than being provided with any specific payload, is adaptable to the various military filling material useful in warfare. Further, as is conventional with such military hardware, the warhead, in accordance with this invention, FIGS. 3 and 7, is provided internally with a fuze **7**, position in the aft fuze ring **5**, initiating the booster lead **11**, then the booster **13**, which sets off the explosive fill **15**, and this in turn produces the force that breaks up the exterior surface of **1** and expels the preformed fragments. These aforesaid internally functional elements are conventional and the purpose and manner of operation thereof are well known to those skilled in the art. Other fuse locations are contemplated including for example, an inner ring fuze such as is illustrated in FIG. **8** and sector fuzing as is illustrated in FIG. **9**.

It is within contemplation of this invention that other internal conventional elements emloyed for initiating detonation of military hardware can be utilized in the structure of this invention.

Contemplated in this invention are the other various state-of-the-art fuzes functioning with time, impact, proximity, or command, providing safe separation from the launcher prior to arming in flight.

The present invention is superior to prior art devices for destroying or incapacitating military objectives by means of high explosive-fragmentation, incendiary materials, or incapacitating matter.

The projectile may be filled with chemical materials which will yield a vapor when released from the projectile structure. Examples of well known agents are phosgene, mustard, α-chloroacetophenone. Other projectile filling components may yield a smoke, for example, white phosphorus, sulfur trioxide with chlorosulfonic acid, or incendiary material such as thermit which is black non-oxide mixed with aluminum or white phosphorus.

The airfoil cross-sectional utilized in the ring airfoil sagrenade is rather thick; that is, in order of 25% to 35% of the chordal dimension, preferably about 25–30%, at its point of maximum thickness. The emphasis on this amount of thickness is to allow sufficient explosive to be loaded within the airfoil warhead and obtain a relatively high charge to mass ratio. This is the ratio by means of which the basic explosive and fragment velocity characteristics may be predicted as well as provide a basis for performance comparison with other warheads. The ring airfoil's forward (leading) and rearward (trailing) edges are shaped so that the leading edge radius is noticeably greater in radius than the trailing edge which forms part of the aft fuze ring in the fuzing mode illustrated by FIG. **7**. More specifically, the airfoil cross section depicted in FIG. **7** is substantially an enlargement of the cutout section of FIG. **3**, wherein the lead line of numeral **1** engages the major outer surface of the airfoil cross section and the lead line of numeral **3** engages the major inner surface of the airfoil cross section. The leading edge of the airfoil cross section is that uppermost portion shown in FIG. **7** where the major surfaces smoothly join. The trailing edge is that portion of the airfoil cross section, lowermost in FIG. **7**, where the major surfaces converge to a small radius.

Fabrication and arena testing of explosive items utilizing the steel notched wire fragments has shown that overall diameters of 2 to 2.75 inches and chordal dimensions of 1 to 1.4 inches produced desired results. Low aspect ratios, that is, span or diameter to chordal value, that are near unity do not result in good aerodynamic properties.

FIG. **2** is an elevated view of the prior art grenade (40mm, M-406) with **2** designating the exterior casing, the notched wire ball for fragmentation **4**, and the fragments **6** expelled upon detonation of the projectile.

FIG. **1**, the longitudinal view of FIG. **2**, illustrates the fragment spray pattern with the exterior case **2**, fuze **8**, explosive **10**, notched wire ball for fragmentation **4**, illustrating the shielding effect over at least 60% of the fragmenting ball. This shielding effect reduces both the fragment velocity, lethal radius, and area of destruction of the projectile outside of the unshielded 135° zone.

In FIG. **3**, numeral **27** designates the warhead exposing a cross-sectional view of the internal structure. FIG. **3** illustrates the spray pattern to be 360° rotational, that is, no shielding effect, of the entire exterior surface of the warhead expelling the preformed fragments in all directions.

FIG. **7** is an enlarged cross-view more clearly revealing the internal components and the three major portions forming the warhead, fragmenting outer unit **1**, inner unit **3**, and aft fuze ring **5** located in the trailing edge of the warhead. The outer unit is internally preformed for more precise fragmentation. The three portions are joined together by conventional means such as epoxy bonding agents or other metal to metal binding agents which will cause these portions to be structurally integral under the conditions of use. If desired, the warhead can be unitized by conventional metal joining processes.

FIGS. **8** and **9** illustrate ring and sector fuzing, respectively, which fuzing systems might be incorporated into the warhead, the structural components of the warhead being always appropriate to the fuzing selected and, of course, consistent with aerodynamic stability requirements.

FIG. **5** is a cross-sectional view of cartridge and sabot, which is loaded into a conventional sabot launcher sized for this projectile. The circular cartridge-sabot comprises an outer wall housing **20**, a casing **21**, circular primer **22**, which is in alignment with the firing pin of the trigger mechanism of the launcher, not shown, ignites the circular propellant **23** developing a sufficient amount of power actuating the circular piston **24,** driving the ring **25,** which is attached to the sabot **26** containing the inventive warhead **27.** The inner portion **31** of the casing encloses aforesaid primer, propellant and a portion of the piston, so that upon the forward motion of the piston, the warhead will not rotate within the sabot as it moves down the barrel of the launcher, not shown. The sabot contains projections **29** and **28,** FIG. **4,** which engage the rifling section of the launcher's barrel as the sabot is propelled toward the muzzle of the launcher.

In use, the firing pin will hit directly the primer and in turn ignites the propellant powder. The igniting powder moves the piston forward giving the sabot containing the munition **27** the initial push forward and engaging the rifling band along the barrel of the launcher thereby rotating the sabot and munition. As the spinning sabot leaves the launcher, the centrifugal forces generated by the spin act on the multiple partially split forward sabot section and together with air drag rapidly separate the sabot from the projectile, thus allowing the projectile to fly on its designated trajectory.

Although the sabot has been illustrated and described, it should be appreciated that the present invention relates entirely to the minition projectile; other means of obtaining the desired launch velocity and spin rate are contemplated, including for example, an integrated rifling band in the area of maximum projectile diameter, the band being contoured to the airfoil cross-section. Other alternative methods may include preengraved (rifling) surfaces, again in the area of maximum rifling surfaces.

In any event, the munition projectile of the present invention is launched with a conventional propellant at sub-sonic velocities beyond 200 ft/sec at spin rates well exceeding those of comparable munitions. In an absolute sense, the initial spin rate will always exceed about 2,000 rpm. For specific sizes and applications, an optimum spin may be selected based on a flight dynamics analysis which includes such parameters as projectile mass, launch velocity, range, and deflection. During the flight of the munition along its trajectory its rotating motion produces gyroscopic stability. The attitude of the projectile along the trajectory and its airfoil shaping produces lift to partially offset gravity. This results in a flatter trajectory as compared to the conventional ballistic trajectory. When the munition explodes, the forces within the rupturable surfaces cause the prescored outer casing or exterior wall to fragment resulting in expelling the small fragments outward at high initial velocity distributing the fragments. In the use of incapacitating agents as the payload, the agents will engulf the military target.

The assembly of the finalized airfoil warhead (shown in FIG. 7) comprises the steps of joining units **1** and **3,** thus forming a forward portion and hollow section of the partial airfoil configuration, filling the formed cavity with the desired filling material **15,** positioning the detonation system comprising the booster, booster lead, stab detonator and fuze, and joining the rear section by means of the aft fuze ring **4,** thus completing the trailing edge of the airfoil configuration and obtaining a structurally integral unit. Other structural arrangements and assembly techniques are, of course, required

for other fuzing arrangements, such as for example, the fuzing modes of FIGS. **8, 9.**

The munition may be launched or directed toward its impact area in a hand-held weapon, shoulder-fired or motorized mounted weapon system, or from a low speed airborne vehicle.

The warhead is fabricated from substances conventional in military hardware, for example, steel, aluminum, magnesium, or alloys. For use with certain agents such as O-chlorobenzilidene malononitrile, a soft material such as rubber or soft plastic may be used for forming the warhead. The sabot-cartridge may be constructed from high density polymeric material such as polyethylene or polypropylene. The cartridge casing may be aluminum or other light-weight material, for example, high density polyethylene or polypropylene.

It is also within the scope of this invention that the fragmentation portion of the warhead comprises the spirally wound notched wire as found in the prior art structure of the M-406 grenade. However, it was found that utilizing the notched wire results in the outer surface of the inventive airfoil grenade having surface irregularities thus effecting aerodynamic characteristics. The preformed fragments of the warhead are accomplished by prescoring or engraving the inner surface of unit **1,** FIGS. 3 and **7,** thus achieving a smooth exterior surface resulting in the desired aerodynamic properties giving rise to the required stability and range while obtaining the desired fragment size and configuration.

The above description, including exemplary size ranges, has largely been directed to what constitutes an antipersonal munition. However, within contemplation of this invention is usage of the munition in an antimaterial role, for which larger diameter sizes may be preferred, and also usage therein with specific warheads adapted thereto such as mass focus, or High Explosive Plastic (HEP). However, some warheads, though feasible, may not be superior to conventional projectiles, for example, shaped charges. To obtain a meaningful armor penetration capability for a shaped charge (hollow charge) warhead within the ring airfoil, it would be necessary to have ring airfoil units of outside diameter in excess of 8 inches, thus making for an unwieldy size as well as the increased weight. Comparatively, this large a ring airfoil munition could not nearly equal the penetration capability of a conventional shaped charge projectile having the same weight.

What is claimed is:

1. A ring shaped airfoil munition projectile to be launched from a gun comprising: a means of producing high lift, low drag, and extended range, said means consisting of an annulus having essentially a continuous unbroken exterior airfoil cross section, said annulus having major annular outer and inner substantially curvilinear surfaces which form the diametrical extents of said projectile with at least one of said curvilinear surfaces so configured to provide aerodynamic lift for said projectile, and said annulus having leading and trailing edges joining said major outer and inner surfaces defining the longitudinal extent of said projectile; and means for rotating said projectile.

2. The projectile of claim **1** wherein same is hollow and has fuse means and is filled with material selected from the group consisting of explosives, incendiary agents and incapacitating agents.

3. The munition of claim **2** wherein the internal surface of said projectile is scored.

4. The munition of claim 1 wherein the projectile exterior is metal.

5. The munition of claim 1 wherein the projectile exterior is of polymeric material.

6. The munition of claim 1 wherein both the major outer and inner surfaces are configured to provide aerodynamic lift for said projectile.

7. The munition of claim 1 wherein the rotating means is transmitted by means of a sabot.

8. The munition of claim 1 wherein the rotating means is an integrated rifling band imposed upon a portion of the lifting body outer surface.

9. The munition of claim 1 wherein the rotating means is a preengraved rifling surface on the lifting body.

10. A ring shaped airfoil munition projectile to be launched from a gun having means for producing high lift, low drag, and extended range, said means consisting of: an annulus having essentially a continuous unbroken exterior airfoil cross section, said annulus having annular major outer and inner substantially curvilinear airfoil surfaces defining the dimetrical extent of said projectile, with at least one of said surfaces so configured to provide aerodynamic lift, and said surfaces concentrically defining an axis serving in common as the axis of symetry and the axis of gyroscopic rotation, and said annulus having leading and trailing edges joining said surfaces and defining the longitudinal extent of said projectile; so that upon rotating said projectile on said axis at at least 2000 RPM and propelling it from said gun, leading edge first, in the direction of said axis through the atmosphere the said at least one of said surfaces causes lift which together with low drag airfoil shaping results in a relatively flat trajectory and extended range.

11. The munition of claim 10 wherein it is made from the group consisting of metals, alloys thereof and polymer materials.

12. The munition of claim 10 wherein the projectile is hollow and has an interior provided with means and filling material selected from the group consisting of explosives, incendiary agents and incompacitating agents.

13. The munition of claim 12 wherein the projectile interior surface is scored for fragmentation purposes.

14. A munition to be fired by a gun means comprising a tube-like casing having at one end thereof a ring shaped airfoil projectile concentrically disposed in said casing and said projectile having means of producing high lift, low drag, and extended range, said means consisting of an annulus having essentially a continuous unbroken exterior cross section airfoil, said annulus having major outer and inner airfoil surfaces at least one configured for providing aerodynamic lift and joined by leading and trailing edges with said surfaces being substantially concentric with said casing and said leading edge being outermost relative to said casing, and having near the other end (thereof) of said casing detonation and propelling means for rotating said projectile in the plane of its annulus and ejecting it from said casing and allowing it to enter into trajectory.

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