FIN STABILIZED PROJECTILE

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The present invention relates to a fin stabilized artillery projectile. More particularly, the invention relates to a fin stabilized artillery projectile provided with a compact, foldable fin arrangement receivable within a standard artillery cartridge case and which will travel through a gun tube without appreciable damage to the bore.

Ammunition of this type generally is spin stabilized, and though originally intended for anti-aircraft defense, has also been adapted for use against tanks and other ground targets as well as water borne targets by virtue of the incorporation of armor-piercing and high explosive substances.

For certain specific purposes, experience has indicated that better armor penetration, jet formation and more effective destruction of a selected target is possible for fin stabilized (essentially non-rotating) rather than the usual stabilized projectiles, there being imparted to the projectile, if desired, only sufficient rotation of the order of 10 K. P. S. to correct for manufacturing inaccuracies. An important design consideration of any projectile in flight is its stability, and in a fin stabilized projectile a prime design factor is the fin area since stabilization of the projectile in flight depends to a large degree upon the amount of air rushing past the fins. In projectiles of the nature contemplated, where fixed fins are used the outer diameter of the fin assembly is governed by the diametral limitation imposed by the tapered forward end of the cartridge case, hence in order to achieve more effective fin area, the projectile is provided with a tapered boom section and decreased hub diameter. Consequently in the above described design the rear larger diameter of the cartridge case is usually provided with guide rails to engage the longitudinal edge of each fin in order (1) to prevent the tail fins from bearing against the side wall of the tapered cartridge case, (2) to guide the projectile as it leaves the case, and (3) to cut down windage and yaw to obtain less departure of the projectile from true trajectory thereby insuring less dispersion in firing.

The foldable fin type projectile may be designed to achieve all the accuracy obtained by the prior art projectile without the use of guide rails. At the same time greater stabilization of the projectile in flight is possible since the area of the fins in unfolded position may be increased considerably over the corresponding area of a fixed fin projectile.

It is accordingly an important aim of this invention to provide a projectile having a compact, foldable fin arrangement receivable in a standard artillery cartridge case.

It is also an important object of this invention to provide a projectile having a compact, foldable fin arrangement receivable in a standard artillery cartridge case, and which dispenses with the usual guide rails to center the projectile within the case, and to guide the projectile as it commences its flight in the gun barrel.

Another paramount purpose of this invention is to provide a projectile having compact foldable fins pivotably mounted on the boat-tail of the projectile, a differential pressure hollow piston translatable in the boat tail of the projectile and a chamber to trap some of the propellant gases which in turn are released as the projectile is exposed to atmosphere to cause the piston to move rearwardly to thereby unfold the fins to fully open position.

A further consideration impelling the conception of this invention is the provision of a projectile having a compact, foldable fin arrangement receivable in a standard artillery cartridge case, and wherein the foldable fins in fully open position present a larger fin area to atmosphere than normally prevalent in a projectile of a similar type using fixed fins, wherefore greater stability of the projectile in flight or the same degree of stability with a shorter, more compact projectile is achieved.

It is also in mind to provide a projectile having the above advantages, and also constructed and arranged to insure ease of assembly, handling and storing.

Additional objects, advantages and features of the invention reside in the construction, arrangement and combination of parts involved in the embodiment of the invention as will appear from the following description and accompanying drawings, wherein:

Figure 1 is a side elevation, partly in section of an artillery projectile contained within a cartridge case.

Figure 2 is a longitudinal sectional view illustrating the projectile per se, the fins shown in folded position.

Figure 3 is an enlarged fragmentary sectional view, the fins shown in extended position.

Figure 4 is a cross section view taken on the line 4—4 of Figure 2.

Referring more particularly to the drawing wherein like reference characters have been used to designate similar or corresponding parts throughout the several views, reference character 10 generally represents an artillery shell having its rearward end receivable within a standard artillery cartridge case 12.

The projectile details per se form no part of the present invention and may be briefly described as comprising a central tubular portion 13, forwardly threaded internally at 14 to screw threadedly receive the reduced rear end of a forwardly tapering nose 16, into the forward end of which is screwed a spilt back point detonating fuse 18 to complete the forward ogive of the projectile. The forward end of tubular portion 13 approximately coextensively with its threaded portion 14 is seen as a slightly enlarged cylindrical annulus forming the forward bourselet 20. Tubular portion 13 is also provided with a thickened rear wall 22 centrally apertured at 24 to screw threadedly receive a closure plug 26, and extending axially forwardly into the shell 10 formed by rear wall 22 and tube 13 is a detonator 28 provided with the usual arming mechanism (not shown). Shell 10 is filled with a suitable high explosive 30 which is provided in its forward face with a conical shaped cavity 32 extending rearwardly from the forward bourselet, and an axial flash passage 34 extending between the apex of the conical cavity 32 and the base detonator 28. The shaped cavity 32 is provided with a liner 36 in the well known manner, the liner being extended at 38 to line the passage 34. The shell 10 is also provided with a second bourselet 40 spaced forwardly of the rear end of the shell to provide guidance for the shell as it traverses the barrel bore as is well known. The operation of this portion of the device is readily apparent from the above description. As the shell is traversed the arming mechanism of the non-rotating type (not shown) in base detonator 28 is the fully armed position, i. e., in axial alignment with flash passage 34. Upon impact the point fuse 18 is initiated and the
flash, and concussion of the detonating wave travels rearwardly through the hollow space formed by nose 16 and conical cavity 32, then through the flash passage 34 to set off the base detonator 25 which in turn is in flash communication with the high explosive 30 to explode the desired muzzle.

The fin assembly and fin actuating mechanism forming the hub of the invention is mounted upon the boatail 42 of the projectile modified to accommodate the necessary elements. This modified boatail is seen as a spool like member 44 having a rear rim or flange 46, and a forward rim 18 made integral with a form-gated sleeve or cylindrical wall 50 adapted to snugly and tightly encompass the rear end of shell 10 which is reduced in diameter rearwardly of rear bourrelet 40 as at 52, cylindrical wall 50 also presenting an outer diameter slightly smaller than bourrelet 40 to enable bourrelet 40 to engage the barrel bore. The boat tail 42 is secured to shell 10 so as to provide a chamber 54 between the rear wall 22 and the forward face of rim 48, chamber 54 in turn communicating with a reduced axial bore 56 extending through spool 44, and into which is received differential pressure piston 60.

As clearly seen in Figure 2 hollow piston 60 is a two part member comprising a forward sleeve 62 which in stowed fin position is arranged so that a portion of its rear surface slidingly engages the wall of bore 56, and its forward portion annularly flanged at 64 to extend parabolically into chamber 54. Flanging of forward stop ring 50 limits the rearward travel of piston 60 in a manner to be later described. The rear end of sleeve 62 is provided with a threaded tenon 68 for screw threadedly receiving the forward end of a second sleeve 70 of piston 60 which also slidingly engage the wall of bore 56, there being an annular space 71 provided between the rear and forward ends of sleeves 62 and 70 respectively, to receive an annular shear ring 72 integral with the wall of bore 56 and extending radially into space 71, wherefore sleeves 62 and 70 are normally locked against translation.

To limit forward movement of piston 60, sleeve 70 is provided with an annular flange 61 which engages a shoulder 57 formed by enlarging the rearmost end of bore 56 in spool 44. Sleeve 70 is in turn provided rearwardly with a rearwardly extending conical wall 74 terminating in a rearwardly extending reduced bore 75 which is also provided with an outwardly struck rear flange 77, having front and rear beveled surfaces 80, 82 respectively for a purpose to be later described, there being an axial reduced bore or orifice 84 extending through boss 76 as plainly seen in Figure 2. A plurality of bifurcated rearwardly extending lugs 66 are secured in any convenient manner in circumferential array to the rear flat face of rim or flange 46 of spool 44, there being circumferentially aligned bores formed in each bifurcated lug 66 to receive pins 88 for pivotally mounting a fin 90 (see Figure 4), each fin 90 being an elongated fin section having a forward flat end 92 adapted to abut the rear flat face of flange 46 and to extend radially inwardly to partially overlie bore 56 in spool 44 when the fins are in stowed position.

In this same stowed position the fins 90 are arranged so that a circumference corresponding to the leading edge of each fin is slightly less than the maximum circumference of flange 46, and the forward outer corner of each fin is truncated as at 94 so that the fins may be free to pivot outwardly by the rearward movement of piston 60 as later to be described. The forward trailing edge of each fin (the inner edge in stowed position as seen in Figure 2) normally abuts the side wall of boss 76, there being recesses 96 formed in each said trailing edge in registry with the flange 78, the recesses 96 being beveled to permit a predetermined rotation or folding outward of each fin wherein there is engagement between flange 78 and the beveled surfaces of recess 96 to hold the fins in this position. As shown in Figure 3 the unfolded position of the fins results in approximately a 25 degree inclination between the leading edge and the longitudinal axis of the projectile.

The cartridge case 12 is provided with a large diameter elongated cylindrical rear portion 102, a forward tapering portion 104 which in turn meets a smaller diameter cylindrical extension 104. In assembly extension 104 snugly engages the outer periphery of cylindrical wall 50 of spool member 44, and the outer periphery of rear bourrelet 46, the forward end of extension 104 being crimped over the shoulder formed between bourrelet 40 and forward stop ring 50. The forward end of extension 104 is stowed or folded position with hollow piston 60 held in its forward position by shear ring 72. The cartridge case 12 has been filled with propellant 106 in the accepted manner, and the fins 90 are completely embedded within the loosely packed propellant.

It is important to note at this time that forward sleeve 62 of piston 60 is provided with an outwardly flared or tapered surface 108 extending between the respective forward and rear opposed faces of rim or flange 48 of spool 44 and annular flange 64 of piston sleeve 62.

In operation the propellant powder 106 is ignited and the resulting pressure acts to propel the projectile. As this pressure increases and the shell travels the length of the gun tube, orifice 84 admits some of the powder gas by way of hollow piston 60 into chamber 54 in the boatail. At the same time the high differential pressure acting on the rear surface of piston 60 holds the fin and inner assembly in place together with shear ring 72, thereby counteracting the effects of set back forces. As the projectile leaves the muzzle of the gun the external pressure drops rapidly to atmosphere while the gas pressure in the chamber of the boatail remains relatively high. The entrapped pressure causes piston 60 to move rearwardly shearing annular shear ring 72 and causing tapered surface 108 to engage the wall of bore 56 in spool 44. As piston 60 moves rearwardly the beveled surfaces 82 of flange 78 which are in continuous engagement with the beveled edges of recesses 96 in the fins 90 cause the fins 90 to pivot and move outwardly, the high pressure in chamber 54 exerting an accelerating force on the piston and fins before the interference resistance of the taper becomes sufficient to noticeably counteract the forces tending to move the piston. As the piston 60 continues to move rearwardly the resistance offered by tapered surface 108 increase to effect deceleration of the piston and fins to an extent to prevent over stressing of the mechanism when stop ring 64 seats against the rear face of flange 48 on spool 44. Also instrumental in easing the load on the stop ring is the decrease in energy by the trapped gases due to the work spent in moving the piston, and the pressure drop in the boatail chamber due to the simultaneous escape of gases through orifice 84. As clearly seen in Figure 3, in the fully opened position, there is an angle of approximately 25 degrees between the leading edge of each fin and the longitudinal axis of the projectile.

The fins are locked in this fully opened position by the keying action between the beveled surfaces of flange 78 and the beveled edges of recesses 96 in the fins, and the interference fit between surface 108 of forward sleeve 62 and the inner surface of axial bore 56, thus preventing the fins from folding inward while the projectile is in flight.

From the foregoing it is apparent that there has been described a projectile having a compact, foldable fin arrangement receivable in a standard artillery case, wherein the foldable fins in fully open position extend over the forward end of the projectile's flight area to atmosphere than normally obtainable in a projectile having a fixed fin arrangement, thereby achieving greater stability in flight, and wherein a novel rack and pinion mounting for each fin enables the fins to unfold positively and without the risk of over-stressing the mechanism by virtue of the co-action of the fins with a differential pressure piston received in the modified boatail.
tail of the projectile, and movable in response to the pressure of the gases formed by the detonation of the propellant charge.

While a specific embodiment of the invention has been shown and described, it will be understood that various alterations may be made without departing from the spirit of the invention as indicated by the sub-joined claims.

We claim:

1. A projectile of the type having a cartridge casing and shell portion comprising a boat-tail fixed to the rear end of said shell and carrying a plurality of nested extensible stabilizing fins, said boat-tail and said fins inclosed within said cartridge casing, said fins being embedded in the propelling charge, an axial bore formed in said boat-tail, a chamber formed in said boat-tail in axial alignment with said bore forwardly thereof and communicating therewith, a hollow piston having a restricting orifice therein slidingly fitting said bore, there being a shear pin means holding said piston in a forward position whereby the forward portion of said piston extends within said chamber, the forward end of said piston within said chamber being tapered to an enlarged diameter at its forward end, said piston communicating fluid under pressure to said chamber upon ignition of said propelling charge, means at the rear end of said piston operatively associated with said fins to extend said fins radially outwardly upon rearward movement of said piston in response to differential pressure between said chamber and the atmosphere, said piston being locked in rearward position by said tapered portion and said borne.

2. A projectile comprising a hollow body and a boat-tailed rear end, a hollow piston having a restrictive orifice therein slidable in an axial bore formed in said boat-tail, a plurality of foldable stabilizing fins hinged securely to the rear face of said boattail and overlying said axial bore, said fins adapted to nestle in folded position to present no protrusion beyond the outside diameter of said hollow body, there being a chamber formed in said boattail concentric about the forward end of said hollow piston, a cartridge casing and propelling charge therein for injecting fluid under pressure through said hollow piston and into said chamber, said piston adapted to slide axially rearwardly in response to differential pressure between said chamber and atmosphere while said projectile is in flight, whereby said piston pivots said fins outwardly to unfolded stabilizing position and means to lock said piston in said rearward position.

3. A projectile adapted to be fired from a smooth bore weapon and comprising, a hollow body having a boat-tailed rear end, a plurality of radially disposed unfolding vanes pivotally mounted on pins secured in circumferential array on the bottom of said boattail, said vanes adapted in folded position to enter the casing of a cartridge case forming part of said projectile, there being an axial bore formed in said boat-tail in open communication with an enlarged chamber concentric about the forward end thereof, a differential pressure piston in engagement with an overlying portion of each said vane, said piston having an axial bore therethrough with a restrictive orifice therein being axially rearwardly slidable to unfold said vanes, releasable means retaining said piston in vane folded position, a propellant charge in said cartridge case injecting a fluid under pressure into said chamber through said piston bore and adjacent the forward end of said piston to release said piston for movement into vane unfolding position and means to lock said piston in said vane unfolded stabilizing position.

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