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T. J. LONG ET AL

3,229,583

GUN FLARED PROJECTILE

Filed Jan. 29, 1964

2 Sheets-Sheet 1

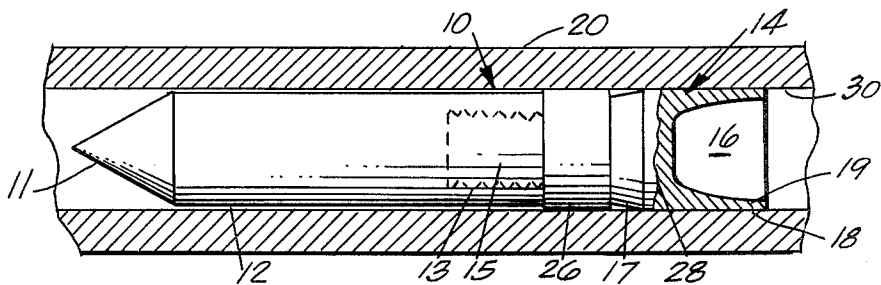


Fig. 1

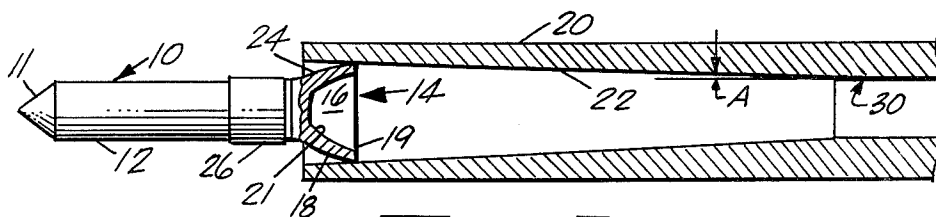


Fig. 2

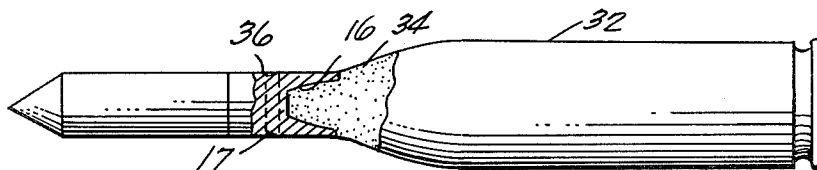


Fig. 3

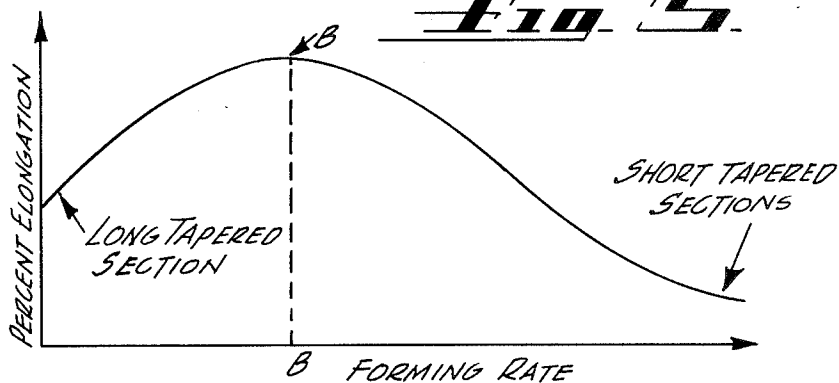


Fig. 4

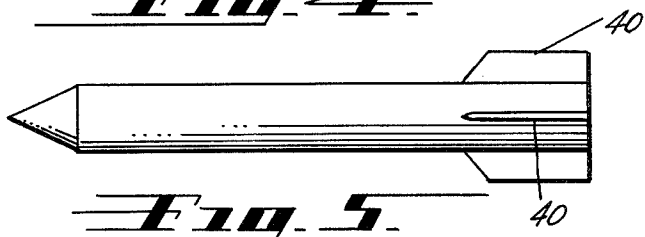


Fig. 5

INVENTORS
THOMAS J. LONG
JOE C. McCASLIN
BY
Leon D. Rosen
ATTORNEY

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2 Sheets-Sheet 2

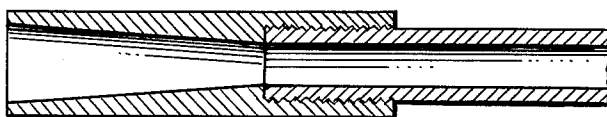


Fig. 6

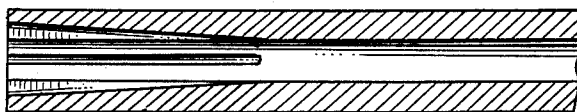


Fig. 7

INVENTORS
THOMAS J. LONG
JOE C. McCASLIN

Leon D. Rosen
- ATTORNEY -

3,229,583

GUN FLARED PROJECTILE

Thomas J. Long and Joe C. McCaslin, Charlotte, N.C.,
assignors to Douglas Aircraft Company, Inc., Santa
Monica, Calif.

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9 Claims. (Cl. 89—14)

This invention relates to gun fired projectiles and more particularly to stabilizing means for stabilizing elongated projectiles in flight.

Gun launched projectiles or bullets generally have the form of elongated cylinders, and must be stabilized in flight so that they fly like arrows instead of turning end over end. One method very commonly used to stabilize relatively short projectiles is to spin them by providing rifled gun barrels. However, in many projectile applications a very large length to diameter ratio is desirable, as for example, in armor penetration wherein penetration depth is proportional to projectile length. If the length to diameter ratio is large, spin stabilization is not sufficient to prevent tumbling.

In the present invention, stabilization of long projectiles is achieved by providing a flaring portion at the rear of the projectile so that the center of wind pressure is located toward the rear of the projectile and the projectile is stable. The flared projectile is fired from an ordinary gun in which a small muzzle portion of the bore is enlarged. Before firing, the projectile is a long cylinder with a hollow tail end. When it is fired it proceeds down the gun barrel like an ordinary bullet. However, when it reaches the enlarged portion of the gun barrel the pressure of the propelling gas causes the hollowed tail or rear portion to expand and form a stabilizing flare.

Accordingly, one object of the present invention is to provide a simple and reliably formed wind stabilized projectile.

Another object of the present invention is to provide a gun and projectile system wherein a projectile fired through the gun forms a flared portion which insures its stability during flight.

A further object of the present invention is to provide a gun barrel portion which forms wind stabilized projectiles in a simple and efficient manner.

These and other objects of the present invention and a more complete understanding thereof may be had by reference to the following description and claims taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a partially sectional view of a projectile constructed in accordance with the present invention shown positioned in a gun barrel;

FIG. 2 is a partially sectional view of a projectile in the tapered portion of a gun barrel, both constructed in accordance with the present invention;

FIG. 3 is a partially sectional side elevation view of a projectile and cartridge assembly constructed in accordance with the present invention;

FIG. 4 is a graph showing the typical elongation characteristics as a function of forming rate for materials suitable for use in the tail section of the projectile;

FIG. 5 is a side elevation view of an additional embodiment of the invention which provides for the forming of fins on a projectile to assure stabilization with a minimum of drag;

FIG. 6 is a partial sectional elevation view of a flaring attachment constructed in accordance with the invention, shown threadably attached to the muzzle of a gun; and

FIG. 7 is partial sectional elevational view of the muzzle of a gun with tapered slots for forming fins on a projectile, to obtain the projectile of FIG. 5.

Referring now to the figures wherein like parts are identified by like reference numerals, the invention com-

prises an armor piercing projectile 10 of generally large length to diameter ratio such as 7 to 1, composed of a nose section 12 and a tail section 14. The nose section 12 is a cylinder of metal such as steel, having a pointed front end 11 and a hollow, threaded aft end 13.

The tail section 14 is constructed of a soft material such as aluminum or copper, which can be formed into a flared shape. It includes a threaded stud 15 adapted to be screwed into the threaded aft end 13 of the nose section 12, in order to hold the nose and tail sections together. The tail section 14 includes a recess or groove 17 extending circumferentially around the section, for holding the crimped end of a cartridge case. The groove 17 divides the tail section into a forward skirt 26 and rearward skirt 28.

The diameter of the forward skirt 26 is about the diameter of the inside of a bore 30 comprising the major length of the gun through which the projectile is fired. The diameter of the rearward skirt 28 is slightly smaller, so that the thin cartridge case fitting over it will increase the diameter to the diameter of the bore and the projectile and cartridge assembly can be inserted in an ordinary gun barrel. The diameter of the nose section 12 is slightly less than the minimum diameter of the bore to allow free spinning of the nose portion and thus, to minimize projectile wobble as it passes down the bore. As is the case with ordinary bullets, the outer diameter at various portions can be fabricated with clearances, positive or negative, within a range of values depending on the gas tightness required, the particular material of the bullets, and other factors.

The manner of attachment of the projectile 10 to a cartridge case 32, illustrated in FIG. 3 is similar to the joining of an ordinary bullet to a cartridge case. The entire hollowed portion 16 of the projectile tail is filled with gun powder 34. The joining is accomplished by crimping the end 36 of the cartridge case in the groove 17 of the projectile.

The gun through which the projectile is fired, shown in FIG. 2, is similar to an ordinary gun except that it includes a tapered bore portion 22 at the muzzle of the gun barrel 20. The angle of taper of the bore, which governs the forming rate of the projectile skirt, and the maximum diameter of the bore, which governs the diameter of the flared portion, can be designed within wide limits as will be explained hereinafter.

The projectile 10 is fired from a gun having a barrel with a tapered muzzle portion, in the same manner as the firing of an ordinary bullet. The projectile is propelled down the bore 30 of the gun barrel 20 by gas pressure without substantial deformation until it reaches the tapered portion 22 of the bore. When the tail section 14 reaches the tapered portion, the high pressure gases tend to expand the walls 18 of the hollowed tail. Until the tail section 14 of the projectile reaches the beginning of the taper, the gas pressure within the hollow portion 16 merely causes the walls 18 to seal tightly against the walls of the bore 30 and prevent gas leakage. When the tail section 14 reaches the taper portion 22, the high pressure gases cause the walls 18 to continuously expand to fit the continuously increasing diameter of the bore 22. The original dimensions, and especially thicknesses, of the walls 18, before firing, are such that when the projectile passes through the tapered portion 22 the aft portions 19 of the walls receive stresses that exceed the yield strength of the tail section material while the forward portions 21 of the walls 18 receive stresses which approach yield strength. These stresses cause the tail portion to form a flare shape which will stabilize the projectile in flight.

After the formed projectile leaves the gun barrel 20 and enters the free atmosphere, wind pressure is applied to

the nose portion 12 and the flared skirt 24 formed by the expanded walls 18. The diameter of the flared skirt 24, which is governed by the maximum diameter of the tapered portion of the gun bore, is made sufficient to provide the aerodynamic drag required to assure stability of the projectile. The shape of the flare also has some effect on the drag, though this is usually minor as compared to the effect of the diameter of the flare. The stabilization resulting from the flared skirt 24 is in addition to any stabilization provided through spinning the projectile by utilizing a rifled gun barrel. Of course, the amount of stabilization required, and thus the diameter of the skirt 24 required, depends to a large extent on the length of the projectile.

The angle of taper of the bore is chosen largely on the basis of the rate of forming desired. The maximum elongation, and thus, the maximum diameter of flare obtainable, depends on the rate of forming. A typical plot of percent elongation as a function rate of forming is shown in FIG. 4. It can be seen that there is generally an optimum forming rate B, at which the maximum deformation of material is obtainable without rupture.

Longer tapered sections 22 of the gun barrel and smaller angles, A, of taper are equivalent to smaller forming rates, while larger angles, A, and shorter lengths of the tapered section signify larger forming rates. As the plot of FIG. 4 shows, where short tapered sections and large forming rates are encountered, the percent elongation becomes very small. The amount of deformation required is generally substantially less than the maximum obtainable percent deformation, and the forming rate is generally not critical. However, a critical minimum length of taper is required to assure that a flare will be formed without rupture. It should be noted that a very long tapered section and thus a low forming rate, results in less permissible deformation than a shorter, optimum length of taper, such as the taper which yields a deformation rate corresponding to point B on the curve of FIG. 4.

It is generally desirable to provide as short a taper as possible, especially where the tapered section 22 is a separate piece of equipment which must be carried separately from the gun and which is attached only when special projectiles of the described type are to be fired. The minimum of length which can be used for the tapered section 22 is generally governed by the required increase in diameter of the flared portion or the maximum percent elongation, and the maximum forming rate for a given material. For a given muzzle velocity and given maximum forming rate and required diameter of the flared portion of the skirt, a certain length of the tapered section 22 of the gun barrel is required. The muzzle velocity is largely determined by the weight of the projectile 10 and the amount of the powder charge.

The optimum diameter of flare and length of taper can be found largely by experimentation for a given application and length of projectile nose portion. However, it is generally found that significant wind stabilization is not obtained unless the diameter of the flare is more than about 10 percent greater than the diameter of the nose portion while it is generally difficult to form a flare of more than about twice the diameter without metal rupture. It has been found that satisfactory flare-skirt stabilized projectiles can be obtained using a nominal 8 millimeter bore diameter rifle, modified by machining a conical taper in the muzzle. The taper was formed at an angle of $1^{\circ}20'$ with the axis of the bore and extended approximately 2 inches into the muzzle end. For a copper tail portion 14 used on the projectile, and a muzzle velocity of about 2,500 feet per second a maximum flare diameter was obtained which was of the order of magnitude of 40 percent greater than the original tail diameter. Projectiles found satisfactory have included those composed of nose portions of annealed steel and tail portions of copper and aluminum. The nose and tail sections

of experimental projectiles were threaded together and machined to the final form shown in FIG. 1. Copper was chosen for the tail section because of its low yield strength (typically 10,000 p.s.i.) and relatively high percent elongation (45-50 percent). Projectile tail portions of aluminum or other materials could be used instead.

Although the simple flared skirt stabilizes the projectile, it produces considerable drag. A stabilizing structure of smaller drag is shown in FIG. 5. It includes fins 40 formed by a gun barrel muzzle portion which includes tapered slots instead of a conically tapered bore. Fins stabilize a projectile by providing large drag at the tail end when the projectile begins to tumble, but relatively small drag when the projectile is flying straight. Of course, other shapes than the simple flare of FIG. 2 or the fins of FIG. 5 may be formed to stabilize a projectile, the forming being accomplished by providing a tapered forming portion at the muzzle of a gun.

While particular embodiments of the invention have been chosen for illustration, it will be understood by those skilled in the art that various changes and modifications therein can be made without departing from the scope of the invention as defined in the appended claims.

We claim:

1. A gun for producing flared projectiles comprising: a barrel having a longitudinal bore, said barrel including a muzzle end portion having a bore section tapered so as to expand toward the extreme muzzle end of said gun, the largest transverse dimension of said tapered bore section being at least 10 percent greater and no more than about 100 percent greater than the smallest dimension of said bore at said tapered muzzle portion.
2. A gun as defined in claim 1 wherein said tapered bore portion is essentially conical in form.
3. A gun as defined in claim 1 wherein said tapered bore portion includes at least two tapered slots and bore portions between said slots having substantially less taper than said slots, whereby fin-like flares may be formed on projectiles.
4. A gun and projectile system for projecting flare stabilized projectiles comprising:
 - a gun means having a bore including a muzzle portion which includes a taper of no more than several degrees having larger transverse dimensions at the extreme muzzle end than at the beginning of said taper; and
 - a cartridge assembly including a projectile and a powder filled case;
 - said projectile including a nose portion of approximately the same diameter as the minimum diameter of said bore and a hollowed tail portion of deformable material;
 - said powder filled case containing sufficient powder to produce gases which will expand the walls of said hollowed tail portion when it passes through said tapered portion of said muzzle portion.
5. A flaring means for enabling the firing of flared projectiles comprising:
 - an attachment having a tapered bore, said attachment adapted to be fitted over the muzzle of a gun and secured thereto with said tapered bore aligned with the bore of said gun and with the end of said tapered bore having the smallest transverse dimension positioned against the muzzle end of said gun, and wherein said smallest transverse dimension is the same as the transverse dimension of the bore of said gun at the muzzle end thereof.
6. A projecting apparatus comprising:
 - a gun means having a bore with a tapered muzzle portion including an inner end and an exit end, said exit end having a transverse dimension between 10 percent and 100 percent greater than the transverse dimension of said inner end; and

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- a projectile having a nose portion and tail portion, each of said portions being of a diameter approximately equal to said transverse dimension of said inner end of said muzzle portion, said tail portion being hollow to enable its expansion during projection through said tapered muzzle portion. 5
7. A projecting apparatus as defined in claim 6 wherein: 10
- the length of said muzzle portion is of the order of magnitude of six times the transverse dimension of said inner end.
8. A projectile system comprising:
- a gun having an elongated bore of the order of magnitude of 8 millimeters in diameter; and
- a taper formed in the muzzle portion of said bore of no more than several degrees taper and extending from a point no more than several inches from the exit end of said gun to the exit end thereof, said taper increasing in cross-section with decreasing distance from said exit end. 20
9. A projectile system comprising:
- a gun having an elongated bore of the order of magnitude of 8 millimeters in diameter;
- a conical taper formed in the muzzle portion of said bore of no more than several degrees taper and extending from a point no more than several inches from the exit end of said bore to the exit end thereof, 25

said taper increasing in cross-section with decreasing distance from said exit end; and

a cartridge assembly including a cartridge case, propellant in said case, and a projectile; said projectile having a nose portion of approximately the same diameter as said bore and a hollow tail section with an outside diameter of approximately the diameter of said bore, whereby to enable forming of a wind-stabilizing flare at the tail portion of said projectile in the firing thereof.

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BENJAMIN A. BORCHELT, *Primary Examiner.*

FRED C. MATTERN, *Examiner.*