May 7, 1963 J. J. GALLAGHER ET AL 3,088,407

GAS OPERATED MOVABLE MASS FOR BALLISTIC MODEL

Filed March 7, 1961

FIG.1.

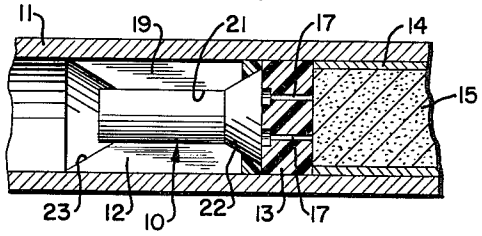


FIG.2.

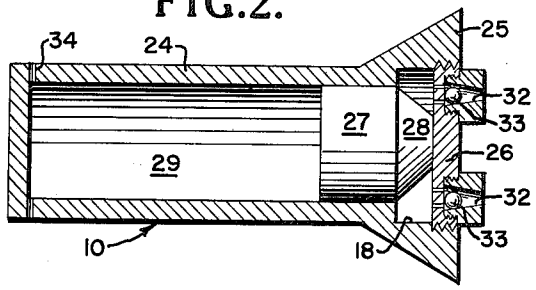


FIG.3.

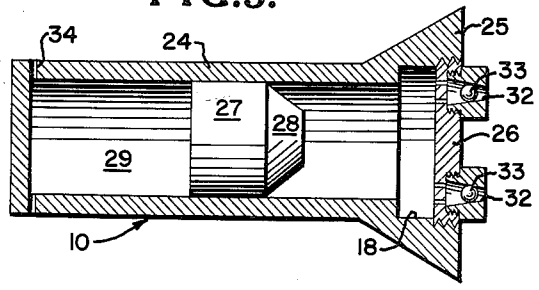
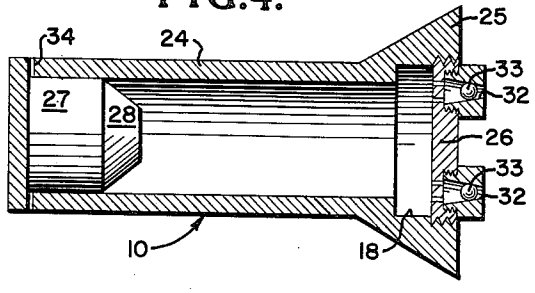


FIG.4.



INVENTORS.
J. J. GALLAGHER
W. R. WITT, Jr.

BY
W. D. Quesenberry
J. C. Hodges R. M. Hicks
ATTYS.

United States Patent Office

3,088,407

Patented May 7, 1963

3,088,407

GAS OPERATED MOVABLE MASS FOR BALLISTIC MODEL

John J. Gallagher, 5911 Anniston Road, Bethesda, Md., and William R. Witt, Jr., 1124 Cresthaven Drive, Silver Spring, Md.

Filed Mar. 7, 1961, Ser. No. 94,094
7 Claims. (Cl. 102—50)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates generally to a ballistic projectile with an in flight, mass distribution changing capability and more specifically to a gun launched missile model containing a mass plug which can be moved by propellant gas pressure after launching from a rearward to a forward position within the model.

In ballistic research, models are fired out of guns into instrumented ranges where their motion is recorded. In recent years it has become necessary to continually increase test velocities of gun fired missile models in order to keep abreast with the higher velocities attained by full scale missiles and space vehicles. To achieve aerodynamic stability in the design of these missile models, it is necessary to place the center of gravity of the system in a forward position in the model during flight. This has required a missile nose composed of a heavy material while the missile base must be made up of a lighter substance. Since these models are launched by a force exerted against the model base, the lighter and generally weaker base material must support the stress load for the entire model. When the flight velocity of these models is increased, the launching stresses are increased and a limit in flight velocity occurs when the base of the model deforms under launching load.

This invention provides a device which permits an increase in the limit of flight velocity by moving a mass plug of heavy material within a model from a forward position to the base for launching where it can support its own weight load, and then provides a means to move the plug forward from the base to its proper, aerodynamically necessary forward position after the model has been fired from a gun and the launching loads have terminated. It was found desirable to utilize trapped gases generated by the propellant to provide the necessary force.

It is an object of this invention to provide a new and improved gun fired projectile which can be launched at high velocities with a minimum of acceleration stress on its component parts by providing a center of gravity positioning mass which can be retracted from a forward position to the rear of the projectile during the launching operation and then achieve an aerodynamically stable configuration by moving this mass to a forward position once the projectile is in flight.

It is another object of this invention to provide a projectile which contains a movable plug which is repositioned while the projectile is in flight.

It is another object of this invention to provide a projectile which can be launched with a rearward mass distribution and which in flight changes its configuration to that of a forward mass distribution.

It is yet another object of this invention to provide a means to utilize gun propulsion gases to reposition a center of gravity locating plug within a projectile during the flight thereof.

It is a still further object of this invention to provide a movable plug within a projectile which may be utilized to alter the mass distribution of a projectile in flight to

make the projectile compatible with changes in the environment to which it may be subjected.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing in which like reference numerals designate like or similar parts throughout the figures thereof and wherein:

FIG. 1 is a view, partially in section and broken away, illustrating a projectile model employing the present invention and mounted in a gun;

FIG. 2 is a cross-sectional view of the projectile model of FIG. 1 with the center of gravity locating plug in the full rearward position;

FIG. 3 is a cross-sectional view of the projectile model with the center of gravity locating plug moved partially forward; and

FIG. 4 is a cross-sectional view of the projectile model with the center of gravity locating plug in the full forward position.

Referring now to FIG. 1 of the drawing, a model **10** is shown mounted in a gun barrel **11** and supported by sabot **12** having a base **13**. Shell casing **14** containing an explosive **15** is shown behind sabot base **13**. Sabot base **13** contains two holes **17** which provide a passage for explosion gases from explosive **15** into model chamber **18** (FIGS. 2, 3 and 4). Sabot **12** has a plurality of radially disposed slots **19** which serve to weaken the sabot in such a way that it will break apart and separate from the model after the model leaves the gun barrel. Sabot **12** is also provided with a cylindrical bore **21** and tapered bores **22** and **23**. Cylindrical and tapered bores designated **21** and **22** respectively conform to the outer surface of the model and serve to support the model centrally within gun barrel **11**. Tapered bore **23** serves to collect the oncoming air which acts to break sabot **12** apart soon after it leaves the gun. In ballistic research the model is launched from the gun by igniting explosive **15** which results in increased pressure behind sabot base **13**. This pressure accelerates sabot **12** and model **10** through gun barrel **11**. Upon leaving gun barrel **11**, the gas pressure behind base **13** dissipated and sabot **12** and sabot base **13** are separated from the model by aerodynamic force. Model **10** continues in free flight through an instrumented range where its motion and altitude are recorded. Aerodynamic drag on the model acts throughout the flight to decelerate the model, imposing a force in the direction opposite the original accelerating force on the model.

Referring now more particularly to FIG. 2 of the drawing, the projectile model is composed of a body **24** including a typical aerodynamically stabilizing skirt **25** and a base plate **26** threaded into the rear of skirt **25**. A cylindrical plug **27** composed of heavy material such, for example, as steel, iron or the like suitable for the purpose and having a tapered thrust director **28** fixedly attached to the rearward side is slideably disposed in cylinder **29** formed coaxially in body **24**. Gas chamber **18** is provided within skirt portion **25**. The forward portion of chamber **18** is formed by a tapered thrust director **28** extending rearwardly into chamber **18** with the smaller end of the taper in contact with base plate **26** which forms the rearward wall of chamber **18**. Gas ports **32** are situated around the center of base plate **26** in such a manner as to clear the smaller end of tapered thrust director **28**. Associated with each gas port is a ball check valve shown at **33**. These valves permit gas flow into chamber **18** and prevent flow in the opposite direction. The forward portion of body **24** is provided with ports **34** which allow a path of escape for air trapped in front of plug **27** as it moves forward.

In operation, when the projectile is fired from a gun, the acceleration of the model within the gun holds the plug 27 and tapered thrust director 28 back against the base plate 26. The ball check valves 33 are forced open by explosion gases and permit these gases to enter chamber 18. As the gas pressure in chamber 18 builds up and the pressure of the explosion gases in the gun dissipate, ball check valves 33 close trapping gas pressure in chamber 18, retaining peak pressure therein. Thrust director 28 serves to provide a momentary component of gas pressure force in the forward direction until plug 27 is lifted from plate 26.

Referring now to FIG. 3 of the drawing, the model is shown in flight and acceleration has terminated. The resultant gas pressure in chamber 18 acting through tapered thrust director 28 forces plug 27 partially forward. Ball check valves 33 are shown forced closed by the pressure within the model body. As plug 27 moves forward, the air in cylinder 29 in front of plug 27 is forced out of the model through ports 34. Plug 27 continues to move forward until it contacts the front wall of body 24.

Referring now to FIG. 4 of the drawing, plug 27 is shown in the extreme forward position in contact with the front wall of body 24. The plug is retained in this position for the remainder of the model flight by decelerating aerodynamic drag acting on the model body.

In order to obtain the most satisfactory results with this device, the plug 27 is preferably positioned in the extreme rearward location within body 24 before the model is loaded for firing.

It should be noted that the inclusion of skirt 25 demonstrates only one method by which the model may be stabilized in flight. Other methods of stabilization including fins, spin and body shape may be used, if desired.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A ballistic model projectile adapted to be propelled by the pressure of propellant gases from a gun as the gun is fired comprising an elongated circular body, a first cylindrical chamber situated in the base of said body, a port having check valve means therein in the rear of said first chamber to admit and trap a portion of the propellant gas in said first chamber when the projectile is fired thereby providing positive gas pressure therein, a second cylindrical chamber coaxially disposed within said body forward of and communicative with said first chamber, a relatively heavy mass slideably fitted within said second chamber, a tapered thrust director integral with said mass and having a circular flat surface normally abutting an inner rear surface of said first chamber to apply an initial thrust to the mass as the projectile is fired, said thrust director also providing a forward component of gas pressure against said mass, whereby said mass is moved within the second chamber from an initial rearward position abutting said inner rear surface of the first chamber to a final forward position by said gas pressure while said projectile is in flight.

2. A projectile comprising a ballistic model adapted to be propelled from a gun by explosion gas pressure as the gun is fired, a gas chamber within the rear portion of said model, a hollow cylinder disposed in the midportion of said projectile and communicative with said gas chamber, a relatively heavy plug mounted coaxially and sildeably within said hollow cylinder, said plug having a frusto-conical configuration on the read end portion thereof providing a flat end surface normally engaging a complementary inner surface of said gas chamber for imparting an initial forward thrust thereto as the model is fired from a gun and being movable from a rearward position to a forward position within said cylinder, said plug being in the rearward position in engagement with said complementary surface before said model is fired from a gun, a plurality of ports in the rear wall of said projectile communicative with said gas chamber to effect the passage of explosion gases into said chamber when said projectile is fired, a ball check means in each of said ports to prevent said gases from escaping from said chamber, the pressure of said explosive gases in said chamber being operative to drive said plug forward whereby said plug is moved to said forward position after said projectile is fired and forward acceleration thereof terminates.

3. A device for ballistic projectiles constructed and arranged to be fired from a gun, said device comprising a hollow cylinder, a relatively heavy cylindrical mass slideably fitted within said hollow cylinder and having a frustoconical configured rear end portion thereon, a gas chamber at the rear of said cylinder, a plurality of ports in the base of said chamber and in communication therewith, check valve means in each of said ports and operative to trap projectile propelling gases in said chamber as the gun is fired, the pressure of said gases being operative to move said mass from a rearward position with the rear surface of said rear end portion of the mass engaging a rear interior surface of said gas chamber to a forward position in said device, said device being effective when inserted in a projectile and fired from a gun to impart an initial thrust to said mass by said rear surface of the gas chamber as the gun is fired and, to trap propellant gases in said chamber and move said mass forward thereby changing the center of gravity of the projectile from an optimum position for launching to an optimum position for flight.

4. A gun fired projectile comprising a hollow cylindrical body having a forward wall and a rear wall at the end portions thereof respectively, a relatively heavy slideable inertial plug movable from a rearward position in engagement with said rear wall to a forward position in engagement with said forward wall within said body, said plug being mounted coaxially within said body, gas chamber means within said projectile having a plurality of ports in the rear wall thereof for establishing communication with the interior of the chamber means, and valve means in each of the ports adapted to trap explosion gases under pressure in said chamber means during the flight of said projectile, said plug adapted to be driven from the rearward position in engagement with a rear wall of said gas chamber means to the forward position during the flight of said projectile by the pressure of said trapped gases.

5. A gun fired cylindrical projectile comprising a cylindrical body secured coaxially therein, a first cylindrical chamber within said body and coaxial therewith, a relatively heavy mass slideably fitted within said first cylindrical chamber, said mass being positioned initially at the rear portion of said body before firing and moveable to the forward end of said body thereby to place the center of gravity of said projectile in an aerodynamically stable location, a second chamber in the base of said body with the rear inner surface thereof engaged by said mass when the mass is in the initial position for imparting an initial thrust thereto, said second chamber communicative to said first cylindrical chamber, a plurality of ports having check valve means therein in the rear of said second chamber for allowing propellant gases to enter said second chamber when the projectile is fired from a gun, said check valve means and said second chamber operative to collect and trap propellant explosion gases under pressure while said projectile is being fired from a gun, said gases being operative after said projectile has been fired and launching acceleration force terminates to move said mass from a rearward position in engagement with the rear wall of said second chamber to a forward location within said body thereby moving the center of gravity of said

projectile forward to increase the aerodynamic stability thereof.

6. An elongated stabilized gas propelled projectile comprising an elongated body member adapted to be fired from a gun, a cylindrical chamber within said body member and having an enlarged portion of said chamber disposed at the rear end of said body member, a relatively heavy piston having a base and being movably disposed within said chamber, means secured to and closing the rear end of said body for admitting and trapping a portion of the propellant gases under pressure within said chamber as the gun is fired, said piston being initially disposed adjacent said enlarged portion of said chamber, and a tapered thrust director integral with the base of said piston and projecting into the enlarged portion of said chamber into initial engagement with the rear wall thereof, said thrust director providing an axial component of force on said piston by said rear wall as the gun is fired and thereafter presenting a radial component of surface to said

trapped propellant gas pressure sufficient to move the piston to a forward position within the body during flight of the projectile.

7. A device as described in claim 6 further comprising, a series of tapered ports disposed through the one end of said body, ball check means disposed within each of said ports, said ports providing a path for entry of said propellant gases from the gun into the enlarged portion of said chamber, said ball check means providing a closure to prevent exit of said gases through said ports during flight of the projectile.

References Cited in the file of this patent

UNITED STATES PATENTS

36,686	Challender	Oct. 14, 1862
1,347,125	Schneider	July 20, 1920
2,324,346	Albree	July 13, 1943
2,872,869	Rasmussen	Feb. 10, 1959
2,936,710	Bollay	May 17, 1960