May 10, 1960 E. A. GALLO ET AL 2,935,946

TELESCOPING RAM JET CONSTRUCTION

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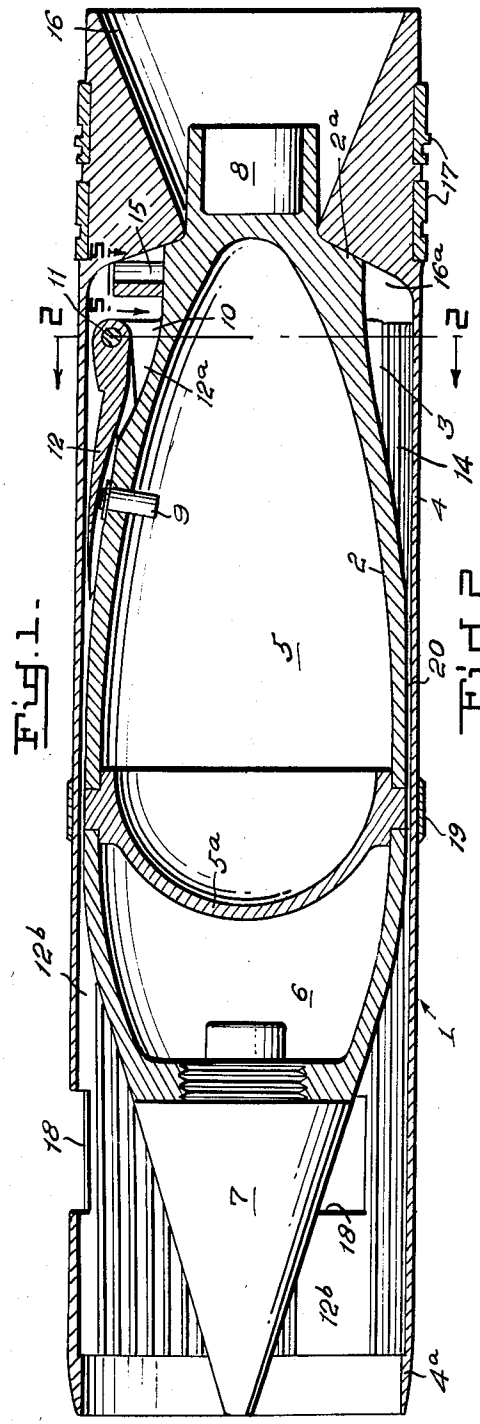


Fig. 1.

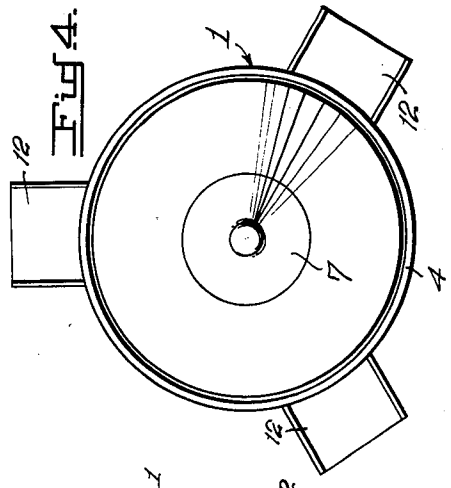


Fig. 4.

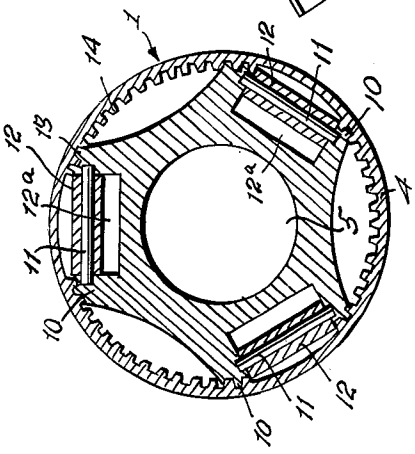


Fig. 2.

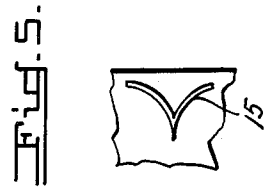


Fig. 5.

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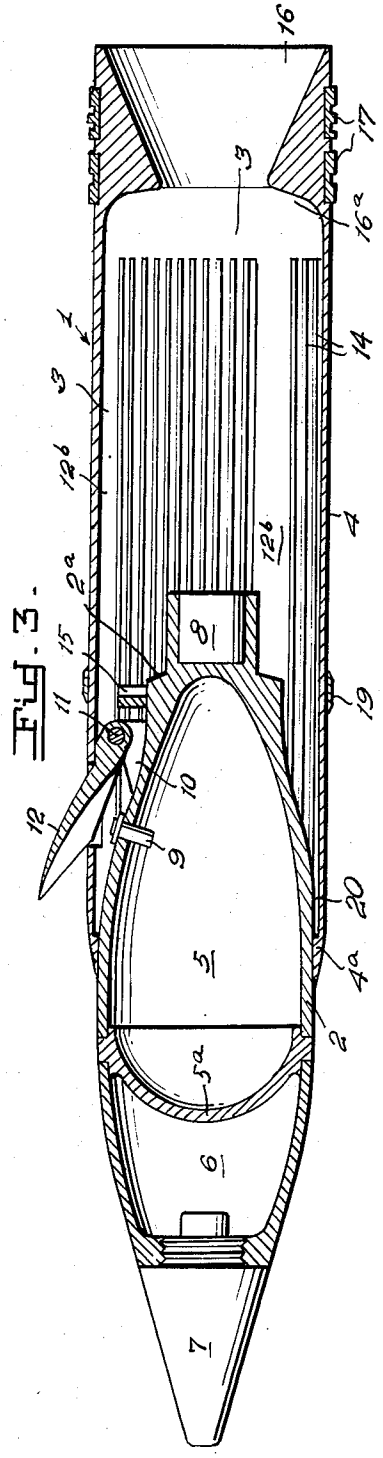


Fig. 3.

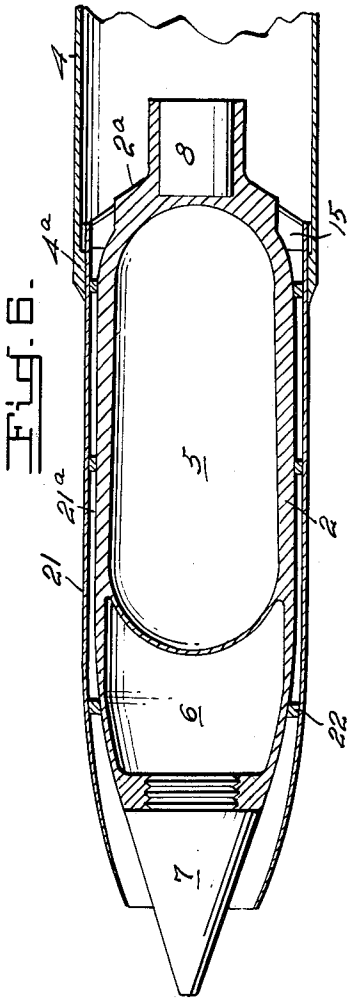


Fig. 6.

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TELESCOPING RAM JET CONSTRUCTION

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Application July 19, 1957, Serial No. 674,549

5 Claims. (Cl. 102—49)

This invention relates to gun launched, spin stabilized, ram jet powered projectiles and particularly to such projectiles having a telescoping construction.

Since the advent of high altitude high speed bombers it has been found increasingly difficult to produce a "kill" with present anti-aircraft guns and projectiles. One result is that offensive aircraft have a greater latitude of bombing altitudes. If anti-aircraft projectiles and guns can be made more accurate, offensive aircraft will be forced to operate at higher altitudes to prevent unreasonable losses, and thereby reduce the altitude range over which guided missiles must operate.

To increase the effectiveness of an anti-aircraft gun the time of flight to the target must be reduced.

Modern anti-aircraft computers predict the future position of a target by observation of the course and speed of the target over the immediate past and the assumption is made that the target will maintain this course and speed for the interval required for the projectile to reach the target. Since modern high speed bombers are within range for approximately 20 seconds, at altitudes in the vicinity of 40,000 feet, and since it takes a present day high velocity shell 12 to 20 seconds to reach such an altitude, it is obvious that the time of flight to target must be shortened if anti-aircraft fire is to be effective.

Though time of flight may be shortened by increasing the muzzle velocity of the gun, any increase in muzzle velocity results in increased gun weight and decreased mobility. It also results in greater wear on the gun barrel and produces muzzle yaw on the projectile which decreases accuracy. Further the rapidity with which the shell may be fired is decreased with an increase of muzzle velocity.

By the use of a ram jet projectile, a two fold advantage may be obtained, (*a*) short time of flight and (*b*) light weight highly mobile guns.

However to produce a rapid fire ram jet projectile the length of a round must be held to a minimum. Round length is a function of high rate of firing since gun loaders are normally limited to a total value of round length per unit time. If a high rate of firing is to be obtained it is mandatory that the length of each round be held to a minimum.

A self-propelled projectile having a combustion chamber will ordinarily be of greater length than the usual projectile. Therefore it is necessary to provide a projectile of the ram jet type with a telescoping feature to provide a round having a minimum length while being handled and loaded for firing, and which is automatically extended to operating position after having been launched for flight.

A further advantage of the telescoping feature of a ram jet projectile is that the combustion chamber is sealed from the propelling gases while traversing a gun barrel, which results in a lighter weight combustion chamber construction. In a non-telescoping ram jet the gas pressure generated by the propelling charge is equal, within and without the combustion chamber while the projectile is in the gun barrel. As the projectile leaves the gun barrel the pressure on the outside of the combustion chamber rapidly diminishes to atmospheric pressure, while the pressure within the chamber remains substantially equal to propelling pressure. As a result a non-telescoping combustion chamber must withstand a high pressure differential whereas in a telescoping projectile the combustion chamber can be of light weight construction since its interior is sealed from the propelling gases.

The projectile of this invention overcomes the above enumerated disadvantages of prior anti-aircraft projectiles; accomplishes the two fold improvement in anti-aircraft defense set out above, and is suitable for use in rapid fire guns, and is of minimum weight.

The unique design of this projectile allows the centerbody portion of the projectile to be telescoped within the combustion chamber when the combustion chamber is not in use. The centerbody portion houses the fuze, warhead, and fuel tank as well as the fuel metering valves and ignition means as will be more fully described hereinafter. When fired the combustion chamber shell is pushed to the rear by aerodynamic forces to expand the projectile to operating position.

The air inlets for the ram jet engine may be in the form of front opening air diffuser or of side opening air scoops. When the front opening diffuser is used the projectile of this invention is slightly longer than the projectile with side opening inlets. As a result the side opening inlets may be preferred to allow each gun of a battery to fire the maximum number of rounds per unit time.

In the side inlet construction the air scoops are retracted within the combustion chamber adjacent the centerbody in telescoped position. When the projectile is extended the air scoops are thrown out through openings in the forward end of the combustion chamber shell by centrifugal force.

Fuel pumping is accomplished by centrifugal force acting on the fuel in the tank due to rotation of the projectile.

In the front opening diffuser arrangement the fuel is discharged through nozzles, located in streamlined struts supporting the diffuser in spaced relation with the centerbody. With the side inlet arrangement the fuel is sprayed into the air passages formed between the air scoops and centerbody by a fuel metering valve which is the subject of a separate application by Howard D. Hoffman, Ser. No. 526,341, filed Aug. 3, 1955.

Therefore one object of this invention is to provide a gun fired ram jet projectile.

Another object is to provide a ram jet propelled gun fired projectile of minimum weight which is suitable for rapid loading and firing.

Another object of this invention is to provide a ram jet, gun fired, telescoping projectile which is automatically extended to operating position in flight.

Another object of this invention is to provide a two piece ram jet powered projectile in which a centerbody portion, having a fuze, warhead, fuel tank, fuel metering and ignition devices therein, is normally telescoped within a combustion chamber and extended to operating position after launching.

For a more complete understanding of the specific nature of this invention, as well as other objects and advantages, reference may be had to the accompanying drawings illustrating a preferred embodiment wherein like characters refer to like parts throughout and in which:

Fig. 1 is a longitudinal sectional view showing the projectile in firing or closed position.

Fig. 2 is a cross sectional view of the projectile of Fig. 1 along lines 2—2 thereof.

Fig. 3 is a longitudinal sectional view showing the projectile in expanded or operating position.

Fig. 4 is a front elevation showing the air scoops in their opened position during flight.

Fig. 5 is a plan view of one of the flame holders taken along a plane indicated by lines 5—5 of Fig. 1.

Fig. 6 is a partial cross sectional view of a front opening air diffuser type projectile.

As shown in Figs. 1 and 3 the projectile 1 comprises a centerbody 2 telescopically associated with the combustion chamber shell 4. Fig. 1 shows the projectile closed, or in loading and firing position, wherein the centerbody 2 occupies the combustion chamber 3 of shell 4, with the air scoops 12 in retracted position. The expanded or operating position of the centerbody is shown in Fig. 3.

The centerbody 2 is of a generally "tear drop" configuration having an ogive nose portion formed with a fuze 7, attached in the usual manner, and a high explosive chamber 6 to the rear of the fuze. The rear portion of the centerbody forms a fuel tank 5 sealed and separated from the explosive chamber 6 by an arched internal wall 5*a*. The downstream portion of the centerbody tapers rearwardly to an igniter squib 8. Forwardly of the squib 8 is annular shoulder 2*a* formed integral with the centerbody.

The shoulder 2*a*, best shown in Figs. 1 and 3, coacts with the forward converging portion of the nozzle 16 to provide a seal which prevents the escape of propelling gases past the centerbody to atmosphere through the front of the shell 4 and the gun barrel. If desired centrifugally operated locking pins (not shown) may be provided in the forward portion of the exhaust nozzle to engage that portion of the centerbody between the shoulder 2*a* and the squib 8. However set back forces on the heavy centerbody should be sufficient to make this seal.

As shown in Figs. 1 and 3 fuel metering valves 9 are provided for each air scoop 12. The valves are placed in the centerbody so as to communicate the fuel tank 5 with air passages 12*a* formed between the air scoop 12 and the tapered rear end of the centerbody 2. Since the inlet air scoops 12 are situated directly over the fuel valves 9 the fuel not carried downstream by the air will be directed to the combustion chamber 3 by the channelled underside of scoops 12. The fuel valves 9 operate to meter the fuel from the tank 5 when pressurized by centrifugal forces, due to projectile spin. As previously stated the fuel valve is the subject matter of the copending application noted above.

As best shown in Fig. 2 the air scoops 12 are pivotly mounted on pins 11 recessed into a series of built up bifurcated ridges, or lugs 10, formed integrally with the centerbody housing. The radial outward surface of the lugs 10 are longitudinally splined and grooved as at 13 to mesh with corresponding grooves and splines 14 formed internally of shell 4, thus preventing relative rotation between centerbody 2 and combustion chamber shell 4.

Flame holders 15 are provided in the downstream end of air passages 12*a* to the rear of air scoops 12 and forwardly of the annular shoulder 2*a*.

Igniter squib 8, formed integral with the centerbody, is held within the diverging portion of the nozzle 16 in the firing position shown in Fig. 1 to expose an igniter powder grain (not shown) to the launching gases. Once fired by the launching gases from the customary cartridge case the igniter grain continues to burn providing the igneous element for the fuel-air-mixture entering the combustion chamber when the projectile is expanded as shown in Fig. 3.

As best seen in Fig. 3 the combustion chamber shell 4 has internally longitudinally splined sections 14 separated by air scoop guided recesses 12*b*. The splined sections 14 run substantially the length of the combustion chamber 3 terminating a short distance forwardly of the nozzle 16 formed integrally with shell 4 at the exhaust end of chamber 3. At the forward end of shell 4 is annularly raised portion forming stops 4*a* which prevent the centerbody 2 separating from shell 4. The scoop guide recesses 12*b* extend forwardly of the opening 18 as well as rearwardly therefrom. The portion 20 of the centerbody 2 adjacent the scoop guides 12*b* is also recessed by the omission of splines to provide an air passage between the centerbody 2 and the shell 4 when the centerbody is in the firing position as shown in Fig. 1. This air passage provides air flow to the forward annular face 16*a* of the exhaust nozzle to apply a force to the shell 4 which will extend the projectile by pushing the shell rearwardly. These opening air passages become substantially cut off when the shell 4 is displaced to cause abutment of stop 4*a* and centerbody portion 20 due to the raised portion of the stop.

The automatic extention of the projectile is accomplished in the following manner.

When the shell clears the gun barrel a considerable ram pressure will be generated which will act over the entire surface of the inner portion of the shell 4. This ram pressure will also act on the up-stream face 16*a* of the exhaust nozzle while the downstream end of the exhaust nozzle will encounter low pressure as a result of base drag of the projectile. The drag on the outer surface of shell 4 will be appreciably larger than the one on the inner portion, or over the centerbody when the shell 4 first moves opening the seal between shoulder 2*a* and the exhaust nozzle 16 since air flow will be much greater over the outside of shell 4 than between shell 4 and centerbody 2. Also aiding in the extension of the projectile is the fact that the inertia of the centerbody is far greater, due to the weight differential between the shell 4 and centerbody 2, than the inertia of shell. A further aid in opening the projectile fully will be the escape of fuel to the partially opened combustion chamber as the fuel will be metered by valves 9 as soon as the projectile reaches its operating angular velocity or leaves the gun barrel.

When the projectile is fully extended the centerbody 2 rests against stops 4*a* and the scoops 12 are aligned with the slots 18 in the shell 4. The scoops 12 being extended through the slots due to centrifugal force due to projectile spin.

The centerbody is slidably mounted in the shell 4 and relative rotation prevented by the splines and grooves 14 mating with the splines and grooves machined in the lugs 10 as shown in Fig. 2. Centerbody 2 is further splined at 20, which is approximately at the center of gravity of the centerbody. The splines of the centerbody portion 20 ride in the grooves of section 14 of shell 4 to transmit torque from the rotating bands 17 to the centerbody 2.

Shell 4 is also provided with a bourrelet 19 on the outer periphery at approximately the center of gravity of the collapsed projectile.

Fig. 6 shows a modification of a ram jet projectile in which the centerbody 2 is surrounded by a front opening air diffuser 21. The centerbody of this projectile contains the fuze 7 explosive chamber 6, fuel tank 5, and igniter 8. Surrounding the centerbody is annular air passage formed by a cylindrical outer section 21 and centerbody 2. Fuel pumping is accomplished by centrifugal force on the fuel spinning in the tank 5. The fuel being discharged through nozzles (not shown) located in struts 22 supporting the cylindrical outer section 21.

The modified projectile of Fig. 6 is opened by aerodynamic pressure developed in the annular air inlet 21*a* acting on the upstream face of the nozzle of the shell 4 as previously described in connection with the side opening air scoop design shown in Figs. 1 and 3.

In view of the foregoing the operation of the device will be self evident to those skilled in the art. And while a preferred embodiment has been shown and described various modifications will become apparent in the light of the foregoing disclosure without departing from the

spirit and scope of the invention as set forth in the appended claims.

We claim:

1. In a spin stabilized ram-jet projectile, a cylindrical internally splined combustion chamber shell having a venturi nozzle in the aft end thereof, a centerbody having a series of spaced, radially extending, bifurcated lugs splined along their outer ends and adapted to mesh with said internal splines in said shell, said centerbody being telescopically mounted within said shell for linear movement along the longitudinal axis thereof and normally held against angular movement relative to said shell by said splines in said shell and on said lugs, said centerbody normally telescoped within said shell and adapted to slide forwardly into an operating position by aerodynamic forces during free flight thereof, a combustion chamber formed within said shell when said centerbody is in said operating position, a fuel tank and warhead housed within said centerbody, retractable ram air scoops pivotally mounted in said bifurcated lugs on said centerbody, ignition means integral with the rear end of said centerbody projecting into said combustion chamber, and means to inject fuel under pressure into said ram air inlets in extended position.

2. In a ram-jet projectile, a generally tear drop shaped centerbody including a fuze, a warhead, a fuel tank and an igniter, a tubular shell including a combustion chamber and a rearwardly disposed integral venturi nozzle, said shell adapted to receive said centerbody in telescoping relation therein, one or more valves piercing said fuel tank of said centerbody to supply fuel from said tank rearwardly into said combustion chamber of said shell, a plurality of air scoops pivoting upon the rearward portion of the outer peripheral surface of said centerbody and in longitudinal alignment with a series of slots in the forward portion of said shell, said air scoops normally held in closed position by the wall of said shell when said ram-jet construction is in collapsed position and designed to enter said slots and assure an open position upon extension of said projectile body in said shell to supply a flow of air to said combustion chamber in said shell, and a plurality of valves piercing said fuel tank to supply fuel into the air passage formed by said scoops.

3. In a ram-jet projectile, as claimed in claim 2, wherein means for pivoting said air scoops upon said centerbody comprise a series of rearwardly extending bifurcate lugs integral with and disposed rearwardly on the outer peripheral surface of said centerbody, a pivot mounting one of said air scoops in each of said bifurcations for rotation therein.

4. In a spin stabilized telescoping ram-jet projectile, a cylindrical combustion chamber shell having a venturi nozzle at its rearward end and a plurality of circumferentially disposed openings adjacent its forward end, there being splined and grooved areas formed on the inner peripheral wall of said shell extending substantially the longitudinal length thereof, a generally tear drop shaped centerbody telescopically received within said shell, said centerbody having splined and grooved areas formed on its outer periphery cooperating with said splines and grooves in said shell to guide said centerbody longitudinally within said shell and transmit torque from driving bands on said shell to said centerbody, a fuel tank housed within said centerbody, a plurality of side opening air scoops pivotally mounted on said centerbody and radially evenly spaced thereon, said scoops adapted to be received in said openings in said shell when said centerbody is in its fully extended forward position whereby said scoops are held in their opened positions, and said scoops normally overlying a plurality of fuel metering valves communicating said fuel tank with an air passage formed by said air scoops and said centerbody, an ignition squib integral with the centerbody and located downstream of said valves, means to seal the rear end of said combustion chamber from launching gases when said centerbody is telescoped within said shell including an annular shoulder formed integrally with said centerbody abutting the upstream face of said nozzle, ram air passage means formed by recesses on the outer periphery of said centerbody and inner wall of said shell, said air passage conducting ram air to the upstream face of said nozzle to initially move said shell rearwardly, said ram air passage means being shut off when said centerbody engages a built up annular stop at the forward end of said shell.

5. In a spin-stabilized ram-jet projectile, a tubular shell defining a stop member at its forward end thereof, a generally tubular air diffuser having a diameter substantially less than the diameter of said shell telescopically mounted within said shell, the forward movement of said air diffuser being limited by said stop member on said shell to prevent separation therefrom, a series of spaced struts carried by the inner peripheral surface of said shell, and a generally cylindrical centerbody having a diameter substantially less than the diameter of said air diffuser, fixed to said struts whereby there is an annular space between said air diffuser and said centerbody, said air diffuser and said centerbody moving as a unit to a fully extended position by aerodynamic pressure developed in said annular space.

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