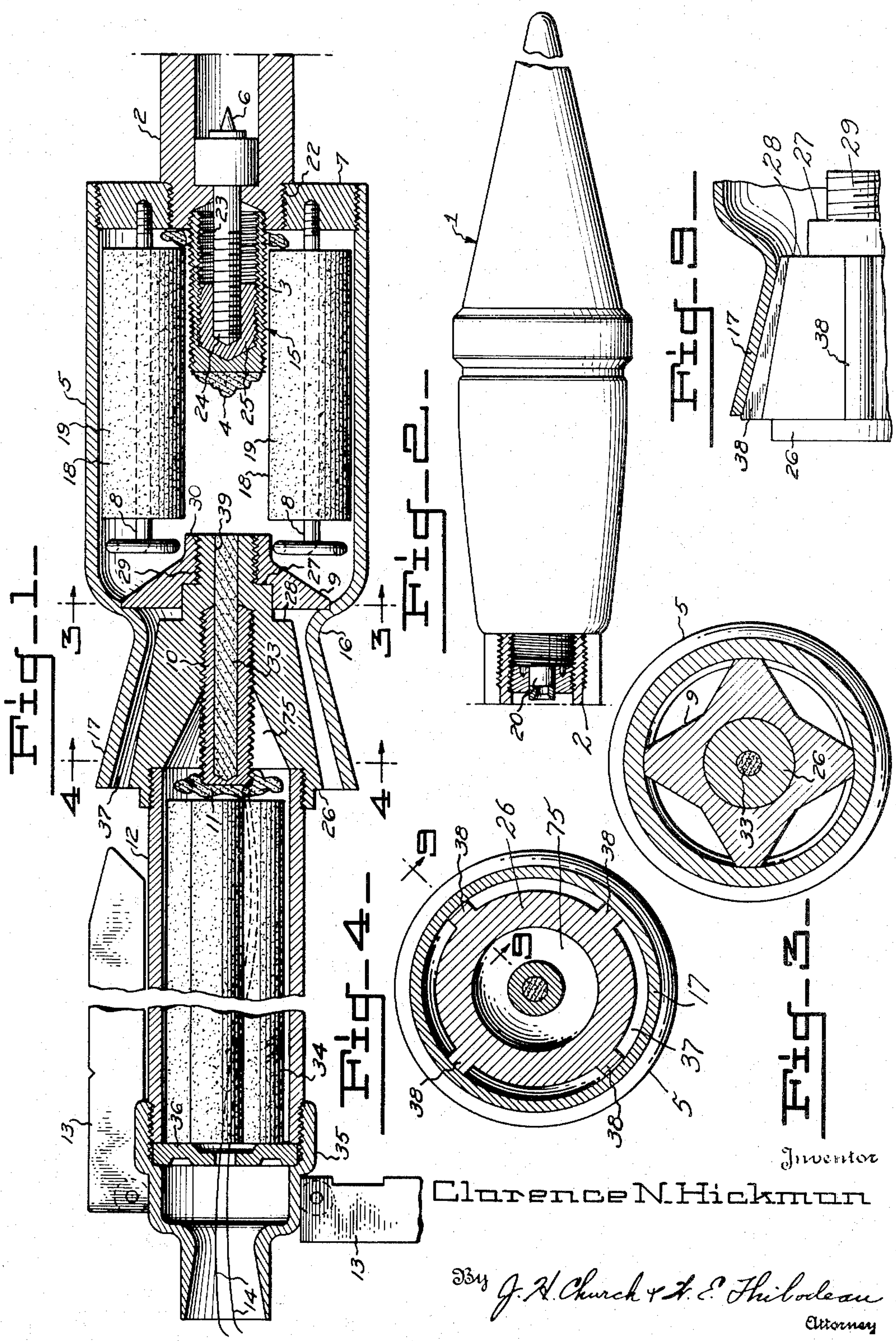
Nov. 22, 1955 C. N. HICKMAN 2,724,237

ROCKET PROJECTILE HAVING DISCRETE FLIGHT INITIATING AND SUSTAINING CHAMBERS

Filed March 5, 1946 2 Sheets-Sheet 1



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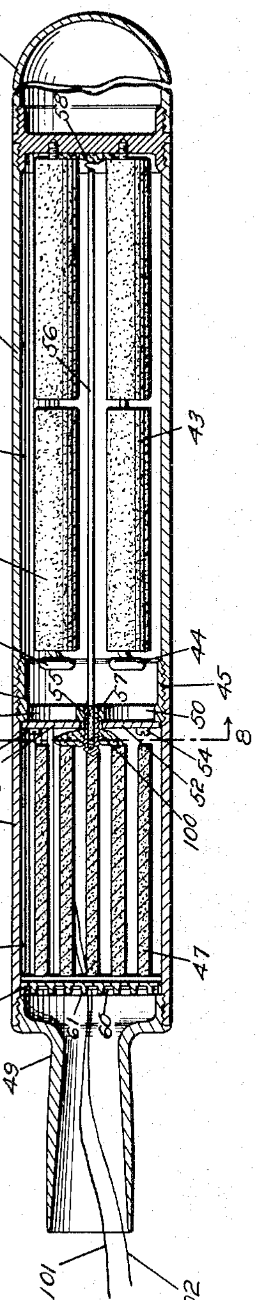

Fig_5_

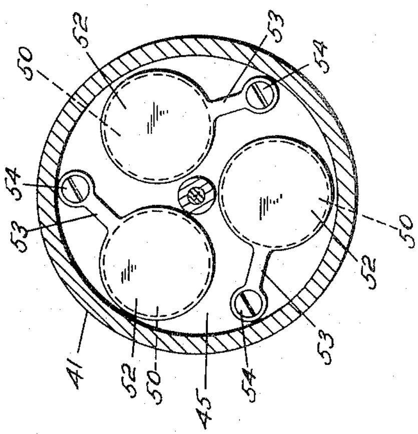

Fig_8_

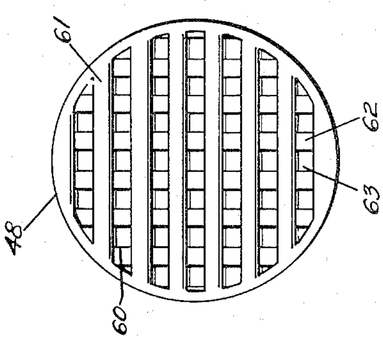

Fig_7_

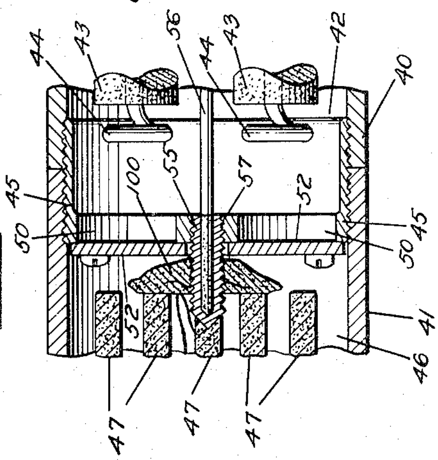

Fig_6_

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ROCKET PROJECTILE HAVING DISCRETE FLIGHT INITIATING AND SUSTAINING CHAMBERS

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Application March 5, 1946, Serial No. 652,206

2 Claims. (Cl. 60—35.6)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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

This invention relates to rocket propelled projectiles and more particularly to rocket propelled projectiles which are adapted to be fired from projectors held in the hands of ground troops.

One of the foremost obstacles to be overcome in perfecting this type of rocket propelled projectile is that of eliminating the presence of a blast from the jet, after the rocket has left the projector, without causing a material reduction in the rocket's final velocity. The presence of this jet blast is a serious source of annoyance to the firing personnel who must be stationed, during firing, at a position to the rear of the muzzle of the projector and in the direction of the line of flight of the rocket. Attempts have been made to protect the firing personnel from the effects of the jet blast by providing a disc shaped shield at the muzzle of the projector. It was found, however, that excessive recoil forces were produced by the gases of combustion striking the shield. Consequently, use of this shield as a means for protecting the firing personnel has been largely abandoned.

The blast which occurs after the projectile has left the firing tube can be eliminated only if the burning of the propellent is completed while the rocket is within the tube. If high velocity and long range are not required the annoyance caused by the jet blast may be easily avoided by selecting a powder of web thickness (distance between burning surfaces) sufficiently thin to have the burning completed during the time it takes the rocket to travel the length of the projector. It is when the velocity and range are to be increased that difficulties arise, since in order to increase the velocity, and still have the burning completed by the time the projector has left the tube, the powder charge must be increased. But, by increasing the powder charge, the quantity of gas ejected per unit time is also increased, with the result that higher pressures will be developed in the motor chamber unless the throat area of the nozzle is increased. It must be noted also that the total time for burning the propellent is decreased with an increase in velocity, since it takes less time for the rocket to travel the length of the tube. Therefore, on obtaining a higher velocity by increasing the charge, the web thickness must be further reduced to insure that the burning will be over by the time the rocket leaves the tube. This reduction in web thickness increases the burning area of the propellent with the result that still more gas is liberated per unit time. To provide for the ejection of this increase in gas liberation, the throat area must be again enlarged, otherwise higher pressures will be developed. Obviously, there is a limit to the amount the throat may be increased. It cannot be made larger than the chamber. In fact, for practical as well as theoretical reasons, the throat diameter should not be more than one-third to one-half the inside diameter of the combustion chamber.

In actual practice there is a limit to the amount the web thickness may be decreased without encountering difficulties in trapping the propellent. In contrast to the burning of a propellent in a gun, the propellent in a rocket combustion chamber is not entirely consumed, i. e., unburned particles escape from the trap after the web of the powder has been reduced to a certain thickness. The smaller the original web thickness, the larger is the percentage of unburned powder that escapes, consequently, decreasing the web thickness is uneconomical and inefficient.

There are certain advantages to be obtained by allowing the pressure to increase with increase in powder charge. The higher pressures cause an increase in burning rate and a reduction in total burning time. The foremost objection to a high gas pressure in rockets is that a heavy walled combustion chamber must be provided to withstand these pressures. Obviously, the weight of the chamber cuts down the efficiency and the ultimate range of the rocket.

Accordingly, it is an object of this invention to provide a rocket projectile which can be fired from a shoulder gun projector or other such projector adapted to be held in the hands of ground troops without having the initial jet blast continued after the projectile has left the projector. Furthermore, the velocity and range of the rocket projector of this invention are not limited by the burning time of the propellent utilized to start the rocket in flight.

A particular object of this invention is to provide an improved military rocket having two separate driving charges. The first driving charge is a relatively quick burning charge, which imparts to the rocket projectile a thrust sufficient to get the projectile out of the projector tube and started in the direction of its normal trajectory. After the rocket projectile has cleared the projector by a safe, precalculated distance, dependent upon the size of the rocket and its particular application, the second driving charge is set off. This second charge need not be quick burning but must be set off a predetermined interval after the burning of the first charge has been completed.

The specific nature of the invention as well as other objects and advantages thereof will clearly appear from a description of a preferred embodiment as shown in the accompanying drawings in which:

Fig. 1 is a fragmentary longitudinal sectional view of a rocket projectile embodying this invention;

Fig. 2 is a side elevational view of the explosive head partly broken away to show the fuse;

Fig. 3 is a cross sectional view taken along the line 3—3 of Fig. 1;

Fig. 4 is a cross sectional view taken along the line 4—4 of Fig. 1;

Fig. 5 is a view similar to Fig. 1 showing a modified form of the invention;

Fig. 6 is an enlarged detail view in longitudinal section showing the thermal igniter utilized to effect discharge of the propellent charge;

Fig. 7 is an enlarged detail view showing the unitary grid utilized to trap the secondary propellent charge;

Fig. 8 is a cross sectional view taken along the line 8—8 of Fig. 5; and

Fig. 9 is a fragmentary sectional view taken along line 9—9 of Fig. 4.

Referring now to Fig. 1, the high explosive and armor-piercing head **1** of the rocket has secured thereto a cylindrical sleeve **2** which is provided with an undercut threaded portion **22** for holding the head **1** to the trap plate **7** of casing **5**. The thermal arming device **15** for the impact fuze **20** is threaded into the cylindrical sleeve **2** at its forward end. A screw **3** which is provided with a tapped threaded axial opening **23** is threaded into the base of the cylindrical sleeve **2** so that the closed end of the screw **3** projects into the cylindrical casing **5** when the cylindrical sleeve **2** is threaded into the trap plate **7**. The firing pin **6** is provided with a cylindrical rod **24** of a diameter less than the diameter of the tapped opening **23**. The end of this rod is threaded and adapted to be inserted into the opening **23**. A small slug **25** of a low melting point alloy, such as Wood's metal, is placed in the opening **23** of screw **3** so that when the temperature of such screw is raised to the melting point of the metal **25** and the rod **24** is inserted into this opening, it will remain firmly in place after the metal **25** solidifies on cooling.

The cylindrical casing **5** has its forward end threaded onto the periphery of trap plate **7** and has the walls at its rear end swaged inwardly to form an inwardly flared entrance to a constricted throat portion **16** and then the walls taper outwardly in a rearward direction to provide a flared nozzle **17** for expanding the gases of combustion liberated by the propellent charge **18**. This propellent charge is made up of a plurality of cylindrical grains **19** of double-base powder, each having an axial cylindrical perforation. The grains are supported in the chamber in any suitable manner, such as by means of a plurality of "wormshead" trap wires **8**, similar to those described in my copending application, Serial No. 538,315 filed June 1, 1944, now abandoned, which have their forward ends threaded into trap plate **7** and upon which the propellent charges are strung.

An annular adapter **26** is provided having a generally frustro conical shape. This adapter has a plurality of radially divergent rib members **38** (Fig. 4) formed on its lateral surface which also have outer surfaces of frustro conical shape to conform to the shape of the nozzle flare **17**. It should be noted that while the outer surface of the radially divergent ribs conforms to the interior configuration of the nozzle, the slope of the conical sides of the portion of the adapter shown in section is less than the slope of the nozzle surface and thus provides an annular nozzle space **37** of increasing area in the direction of the exit gases. The forward portion of the adapter is reduced in diameter to form the shoulders **27** and **28** and the extreme forward end **29** is threaded to engage in a threaded axial hole **30** in a star-shaped guide **9** which centers and supports the adapter **26** within the nozzle of the combustion chamber.

The adapter **26** has a rearwardly opening, conical bore **75** communicating with an axial hole **39** therethrough. The rear end of hole **39** is threaded to receive a threaded delay type thermal igniter **10** which is preferably constructed in a manner similar to the thermal igniter disclosed in my copending application Serial No. 538,314, filed June 1, 1944, Patent No. 2,459,163, January 18, 1949. The igniter comprises a threaded element having a forwardly opening axial powder recess **33** therein which aligns with hole **39**. The powder recess **33** and hole **39** are filled with powder. A black powder primer **4** is suitably mounted within casing **5**, preferably opposite the forward open end of hole **39**.

The base of the adapter **26** is interiorly threaded to receive a secondary cylindrical casing **12**. The cylindrical casing **12** is threaded into the rear end of adapter **26**. This casing contains a relatively quick-burning propellent charge **34** and has a venturi nozzle **35** threaded on to an end thereof and supporting the flight stabilizing fins **13**. The nozzle **35** also holds the grid trap **36** in place between the end surface of the cylindrical casing **12** and the venturi nozzle **35**. An electrically fired squib igniter **11** is suitably mounted within secondary cylindrical casing **12** and wires **14** connect squib **11** to conventional external contacts.

It should be noted here that the rocket employs the principles of design described and claimed in my copending application, Serial No. 576,439, filed February 6, 1945, Patent No. 2,503,271, April 11, 1950, inasmuch

as the center of thrust, produced by the high velocity discharge of the gases of combustion through the expanding annular passage **37**, is substantially coincident with the center of gravity of the rocket. If any non-uniformity occurs in the discharge of gases through the nozzle **35**, no dispersion will result because the direction of its line of flight is restricted by the projector, since the burning of the propellent **34** within secondary casing **12** is completed within the projector tube.

The operation of the described rocket embodying this invention is as follows: the web thickness of the propellent **34** is selected so that, for the particular operating gas pressure within the casing **12**, the burning will be completed before the rocket leaves its projector tube. The weight of propellent **34** is just sufficient to give the rocket an initial thrust to get the rocket out of the projector and on its way toward the target. The heat generated by the burning propellent **34** will cause the black powder in the thermal igniter **10** to be ignited by thermal conduction through the walls of the thermal element. The time required for ignition is about 0.1 sec. in the embodiment illustrated. Due to the thrust produced by the charge **34**, the rocket will have traveled a distance of about 50 feet in such time interval. The igniter **10** thus sets off igniter **4** which in turn ignites the primary charge **18**. The gases produced by combustion of primary charge **18** discharge through annular nozzle space **37** and accelerate the projectile sufficiently to insure that it will reach the target. About 0.1 sec. after the ignition of charge **18**, sufficient heat is generated within casing **5** by the burning propellent to melt solder **25** contained within the opening **23** of the screw **3** to release the rod **24** and firing pin **6**. On impact the pin **6** and its inertia element are free to move forward, striking and exploding the percussion primer to set off a powder train leading to the high explosive in the head. The burning of the propellent **18** may be selected to give the rocket sufficient velocity for penetration of the target armor by the specially designed armor-piercing head **1**.

A modification of this invention is shown in Fig. 5. The rocket comprises an explosive head **70**, a primary combustion chamber **42** defined by a hollow, cylindrical, forward body member **40** and containing the primary propellent charge **43** strung upon the worm head trap wires **44**. A partition member **45** is threadably secured between forward body member **40** and a similar rear body member **41** and seals the main combustion chamber **42** from the fluid pressure developed in the secondary combustion chamber **46** by combustion of the quick burning secondary propellent **47**. The secondary propellent **47** is held in the secondary combustion chamber **46** by means of a grid trap **48**, which is retained against a shoulder formed at the rear end of chamber **46** by the nozzle **49** which is threadably secured thereto. The grid **48** is conveniently formed from a circular plate by milling parallel grooves **60** (Fig. 7) on one side of the plate in one direction to form the lands **61** and by milling parallel grooves **62** on the other side of the plate, in a direction at right angles to the direction of milling for the grooves **60**, to form the lands **63**. The result is a unitary grid member formed of cross bars having their surfaces projecting on opposite sides of a center line.

The partition member **45** is provided with a plurality of circular openings **50** for permitting the combustion gases liberated by the propellent **43** to pass rearwardly of the chamber for exit through the nozzle **49**. The openings **50** are of equal diameter and are equally positioned on equally spaced radii of the partition member **45**. In order to prevent ignition of the propellent **43** by the gases liberated from the quick burning propellent **47** in the combustion chamber **46**, individual plate members **52** are provided to cover each of the openings **50** in the partition member **45**. These plates each have a tab **53** formed integrally therewith for receiving a bolt **54** which screws into partition member **45** to retain the plate in place over the opening on the side of the partition facing the nozzle.

A thermal ignition device **55** is threaded into an axial hole **57** in the partition member **45** so that its closed end projects into the secondary combustion chamber **46**. An ignition train **56** is suitably supported within primary combustion chamber **42** extending forward along the axis of the rocket body and serves to ignite black powder igniter **58** which in turn ignites the main propellent **43**. A conventional electrically fired squib **100** surrounds thermal ignition device **55** to ignite such device as well as secondary charge **47**. Lead wires **101** and **102** connect squib **100** to the source of current (not shown).

In operation, the propellent charge **47**, which is of a selected thin web, is consumed by burning in a time interval less than that required for the projectile to travel the length of the projector tube. The heat generated by burning the propellent charge **47** causes ignition of the black powder in the thermal element **55** a predetermined interval after the burning of the propellent **47** has ceased sufficient to insure that the projectile is a safe distance away from the projector. The powder in thermal element **55** ignites train **56** which in turn ignites the black powder primer **58** for the primary propellent **43**. The gases liberated by the primary propellent build up a pressure sufficient to cause the plates **52** to be bent rearwardly of the combustion chamber at the tab portion **53** to uncover the openings and thereby permit exit of the gases into the second chamber for high velocity discharge through said nozzle.

I claim:

1. A rocket projectile comprising a body having a substantially cylindrical bore therein forming a main com-

bustion chamber and an auxiliary combustion chamber, said auxiliary chamber located rearwardly of the said main chamber and having a rearward outwardly flaring nozzle, a flight initiating propellant combustible to generate a gas under pressure supported within said auxiliary chamber, a sustained flight propellant combustible to generate a gas under pressure supported within said main chamber, means to ignite said flight initiating propellant, a plurality of valves for sealing said main chamber from the gas pressure generated in the said auxiliary combustion chamber during combustion of the said flight initiating propellant, and means to ignite said sustained flight propellant a predetermined time after the said ignition of the said flight initiating propellant, the said valves movable upon combustion of the sustained flight propellant to interconnect the said main chamber with the said auxiliary chamber, the said valves comprising a series of plates disposed in a plane at right angles to the longitudinal axis of the said body.

2. The combination defined in claim 1 characterized by the fact that the said plates are supported in the said plane by an integral and deformable tab element.

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