

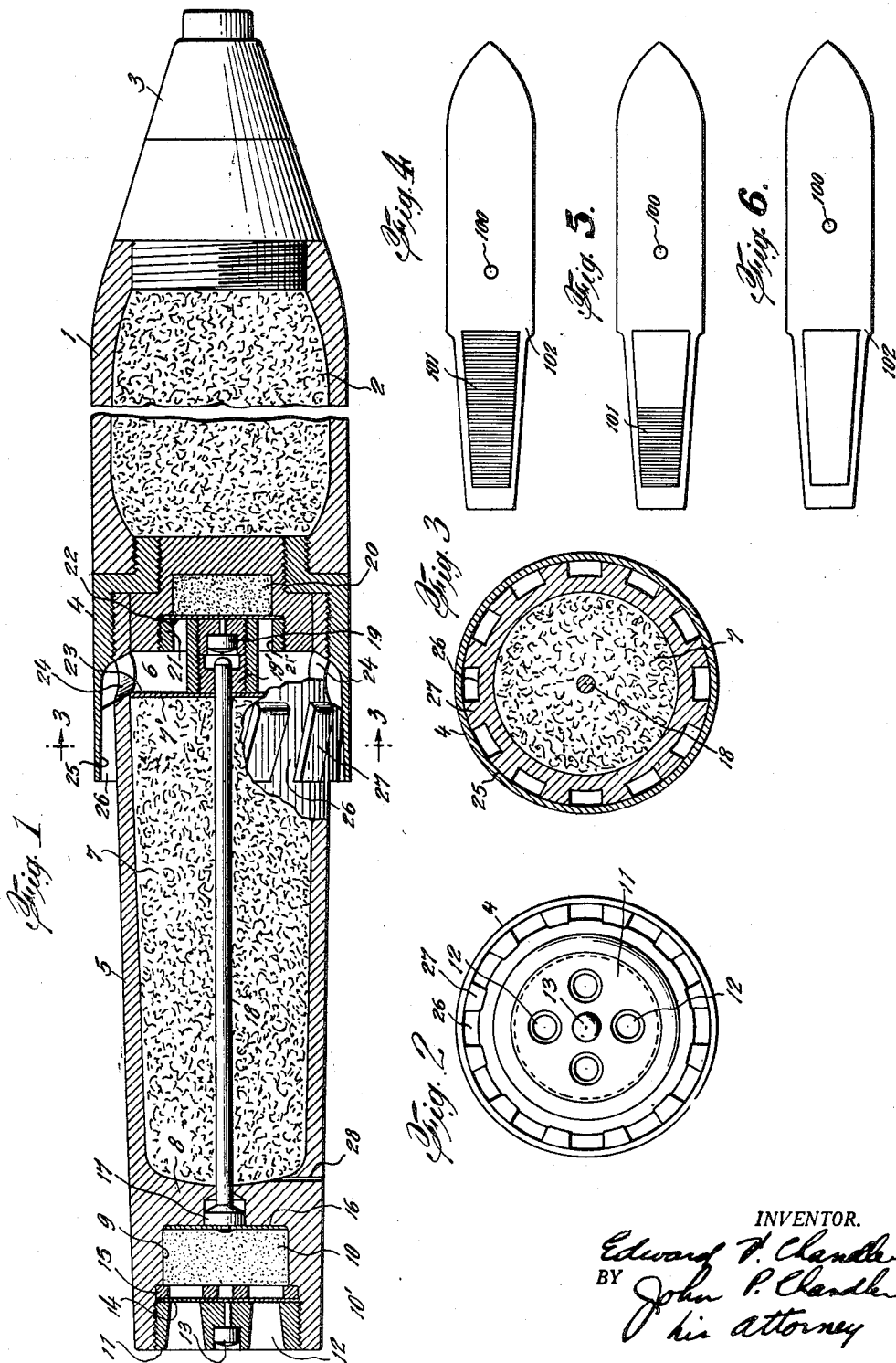
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ROCKET PROJECTILE

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ROCKET PROJECTILE

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This invention relates to projectiles of the automotive or rocket type, as well as to improved manners of firing reaction or rocket-type projectiles.

One of the objects of the present invention is to provide an improved rocket projectile of simple, inexpensive design which may be fired from a closed-breech, smooth-bore gun with results which are comparable with those obtained with regular ammunition and rifled guns, so far as accuracy and range are concerned. Another object of the invention is to provide a rocket projectile which is self-contained, and which may be manufactured, shipped, stored and handled in the field like ordinary fixed ammunition.

A further object is to provide a projectile of the reaction type which may be fired substantially without danger to the operator of the gun. Yet another important object of the present invention is the provision of a manner of firing rocket projectiles wherein the inertia of the projectile is instantaneously overcome, and the projectile is started upon its course when the firing operation is initiated.

It is an object, also, to provide means whereby, upon firing, the projectile, while still within the aiming influence of the launching means, is subjected to a spinning action for the purpose of stabilizing its velocity. It is a further object of the invention to continue the spinning of the projectile at a constant or an accelerating rate to afford gyro-stability to the projectile while in flight.

Other objects and advantages of the invention will be hereinafter pointed out in the following specification, or will become apparent.

Rockets constructed in accordance with the present invention can be fired accurately, in rapid succession, from smooth-bore guns of light weight and inexpensive construction. The gun may be breech-loaded, and the breech may be closed during firing. This is made practical by certain principles upon which the design of the projectile is predicated and the manner of utilizing the same in the operation of the device.

In the usual form of rocket device, after the rocket propellant charge has been ignited, there is a considerable time lag before the generation of gas at sufficient pressure and velocity to start the projectile on its course has developed. During this period, the gases which are generated are permitted to blast rearwardly from the rocket nozzle and from the open breech of the launching means, at about substantially the pressure at which said gases are being generated. This

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manner of launching is inefficient and dangerous to the operator. Because of the fire hazard, the use of such a weapon for other than open field service is greatly limited. Furthermore, the flame blast is easily spotted by an enemy, which necessitates the changing of position after each shot. A rocket of this type cannot be successfully fired from a closed-breech gun, because, during the time-lag period referred to, the generation of gas pressure within the gun is relatively sufficiently slow so that the projectile will be driven from the gun at such low velocity as to be devoid of aim and be virtually certain to follow an erratic course. In the present invention this and other disadvantages heretofore encountered are met and overcome.

Among other improvements, the present invention embraces means for starting the projectile, in a spinning condition, immediately upon its course at substantially the instant the firing operation is initiated. The projectile is fired from a smooth-bore gun, preferably while the breech is closed. Upon firing the projectile, it is subjected to an ejecting impulse of sufficient force to drive the same from the gun at a relatively high muzzle velocity. This impulse may be sufficient to afford a muzzle velocity of the order of from 150 to 300 ft. per second.

By igniting the rocket propellant charge simultaneously with the firing operation, however, it is only necessary that the initial impulse drive the projectile over a short distance in order to permit the rocket propellant charge to become fully active. By this means it will be seen that the time lag previously referred to has been absorbed while the rocket device is in flight under the impulsion of the initial ejecting or launching action. Thus, the projectile is started upon its course by one means, and continued thereon by another means. The initial ejecting force comes either from a source of energy carried by the projectile, or from means independent of the projectile. This initial ejecting force directly or indirectly starts the operation of the rocket propellant means. The two effects are preferably so timed and correlated that the driving of the projectile is transferred from the impulse action to the rocket action without disturbing the aimed direction originally impressed thereon.

It is important that the projectile, when freed from the directing influence of the gun, should spin on its longitudinal axis at sufficient velocity to insure directional stability. It is also important that this rotational velocity be continued or accelerated during the power flight of the pro-

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jectile. The projectile may be started spinning previous to firing to insure the desired rotational velocity upon launching. For example, the projectile may be spun by suitable means while within the gun barrel, or the gun barrel containing the projectile may be spun. The spinning of the projectile may, on the other hand, be initiated at the instant of firing by so positioning the reaction jets of the projectile as to establish rotary action while within the gun barrel. This manner of operation is described in detail hereinafter.

If the projectile is to be fired from a rapidly-moving platform, such as from an aircraft, it is desirable that the gun barrel be relatively short in order that the aim of the projectile should not be disturbed by the changing position of the gun subsequent to the moment of firing. In such application of rocket ordnance, there is an important advantage in pre-spinning the projectile. The spinning operation may, for example, be started as the plane enters the target area, and thus be ready for immediate release and be stabilized at a rotational velocity practically unobtainable by other means. Where projectiles are fired from more stable platforms, however, and from guns having relatively long barrels, or from smaller caliber arms, a high degree of accuracy of fire is obtainable with the ammunition embodying the features herein described and illustrated, wherein both the initial driving and rotating action is imparted by the self-contained propelling means.

In the preferred form of projectile embodying features of the present invention, two powder charges are employed. One of these charges may serve to afford the initial impulse for driving and rotating the projectile upon firing. The other may serve to take over and continue said driving and rotating during the power flight of the projectile. The initial impulsion charge is preferably a quick-burning, gas-evolving powder, or an explosive adapted to suddenly provide the heat and pressure required to start the projectile on its course. The driving or propelling charge, which may be a typical propellant rocket charge, is preferably a slower-burning powder especially adapted to be gradually and uniformly consumed while generating a relatively steady volume of gas under pressure.

In one form of the invention, the two charges are preferably isolated, each charge being in gas discharge communication with a separate set of driving nozzles. The initial impulse charge may be adapted to energize a set of nozzles employed exclusively for launching the projectile, and the second set of nozzles adapted to be energized exclusively by the rocket propellant charge for accelerating the flight of the projectile subsequently. If the projectile, upon firing, has been pre-spun, as hereinbefore discussed, the nozzles for affording the initial impulse may be positioned parallel with respect to the longitudinal axis of the projectile. In that case, the spinning may be assumed and accelerated by the rocket propulsion nozzles, which, for the purpose, may be obliquely positioned and rearwardly directed so that part of their driving energy sets up a rotational torque. If desired, both sets of nozzles may be obliquely positioned so that the initial impulse establishes the rotary action which will be maintained at an accelerating velocity by the other set of nozzles.

In order to produce a sharp, high-velocity impulse upon firing the projectile, the quick-burn-

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ing powder or explosive is preferably confined in such a manner within the projectile that, upon detonation thereof, the gases therefrom are not released to issue from the nozzles associated therewith until a predetermined pressure has been reached. This effect may be accomplished in any suitable manner. For instance, the explosive pressure may be utilized to burst a diaphragm, such as a thin metallic plate, when the desired pressure is developed. By such means, a relatively high initial velocity may be imparted to the projectile substantially without serious gun recoil, and practically without explosive noise, flash or smoke. It will be understood that if this initial impulse is depended on only for the purpose of starting the projectile from the gun, and not for the purpose of driving the projectile over its course, a comparatively small powder charge is required. Except for overcoming the inertia of the projectile, it is moved readily in the smooth bore of the gun and presents a much different problem from that of a shell which must be driven through a rifled gun barrel with sufficient energy to carry it over its entire range.

The manner of operating a rocket gun of the character disclosed herein is important from the standpoint of safety, both to the operator of the gun and to the craft or vehicle upon which the gun may be mounted. The gun being of the closed-breech type, there is no rearward flame blast and, also, due to the impulse launching method, the projectile is driven to a safe distance beyond the gun muzzle before the full jet action of the nozzles has been established. A further important feature of the present invention resides in the adaptability of the projectile for use in automatic arms. Rockets heretofore have not proven satisfactory as ammunition for gas-actuated automatic guns. One of the main objections to such use was in their sluggish initial action, i. e., time lag following detonation, and fouling of the mechanism of the gun from the propellant rocket discharge. A projectile constructed in accordance with the present invention is initially fast acting, develops sufficient primary gas pressure to actuate automatic gun mechanisms, and the operating explosive gas discharge does not seriously foul the gun parts. The rocket projectile of the type herein described is particularly well suited to automatic gun operation; the over-all length generally is less than a comparable cartridge case and shell, and cartridge-ejecting means are eliminated, thereby simplifying the construction of the operating apparatus.

The present application constitutes a continuation-in-part of my copending application Serial No. 416,442, entitled "Projectile and method of shell propulsion." It also contains certain improvements in the projectile described therein. The present application is also a continuation-in-part of my copending application Serial No. 430,978, now Patent No. 2,391,865, dated January 1, 1946, entitled "Self-propelled projectile."

In the drawings:

Fig. 1 shows a projectile, partly in longitudinal section, embodying features of the invention.

Fig. 2 is a rear-end view of the projectile shown in Fig. 1.

Fig. 3 is a transverse section taken on line 3-3 of Fig. 1.

Fig. 4 shows diagrammatically the position of the center of gravity of a projectile before the rocket propellant charge has been ignited.

Fig. 5 indicates diagrammatically the position

of the center of gravity when said charge is half consumed.

Fig. 6 shows diagrammatically the extreme forward position assumed by the center of gravity when said charge is entirely consumed.

The shell illustrated in Fig. 1 comprises a forward section 1 which may be of usual construction and design. An offensive charge 2 is carried within this section, such charge being adapted to be detonated by suitable fuse means, which may, for instance, be contained within head 3. Forward shell section 1 may be secured to, and carried by, mid-section 4 substantially in the manner shown. An afterbody section 5 is also secured to, and carried by, the mid-section 4. Afterbody section 5 is formed with a combustion chamber 6 which may be of tapered construction, having its smallest diameter at its rearward end. A propellant rocket charge 7 snugly fits the bore forming this combustion chamber as well as the inner face of rear wall 8 of this chamber.

In the butt section of afterbody 5, a cavity 9 is formed, such cavity containing a powder charge 10. An externally-threaded member 11 formed with nozzle openings 12, and carrying a primer or detonating cap 13, is adapted to be screwed into the rear of afterbody 5. This member also retains in place a thin plate 14 which is made preferably of copper, and which closes the nozzle openings by urging this plate into firm engagement with a perforated spacing disc 15 just to the rear of powder charge 10. A thin disc 16 is positioned at the forward end of cavity 9. The head 17 of a firing rod 18 is secured to disc 16. This firing rod is positioned axially within rocket charge 7 with its forward end resting in guide member 19, in which position it is adapted to be driven against a primer or detonating cap 19 carried by member 21 which retains the ignition powder charge 20 in place. Member 21 is provided with suitable openings 21' through which gases from the combustion of the powder 20 may escape to impinge against the face of rocket charge 7, which is desirably provided with a moisture-proof coating 7' which is readily burned away. Gas openings 21' in member 21 may be closed by a moisture-proof disc or coating 22 placed over the rear face of powder charge 20.

Adjacent its forward end, afterbody 5 is formed with a plurality of openings 24 which communicate with obliquely-disposed nozzles which may be formed as follows. The blank used in forming afterbody 5 may have, adjacent its forward end, an enlarged, annular shoulder whose outer periphery is defined by line 25, as shown in Fig. 1. A plurality of spaced, diagonally-disposed slots 26 may be milled into this shoulder, forming the nozzle openings which are defined by the intermediate portions 27. Gases generated within the combustion space 6, by the burning rocket charge 7, issue as power jets from the obliquely-formed nozzle openings 26 which drive and rotate the projectile.

To insure a uniform evolution of gas for driving the projectile, it is desirable that the combustion of the charge 7 be confined to the surface area of the forward face 23, and to prevent, as far as possible, erratic and uneven gas generation which might be caused by side burning. To that end, the pressure developed within the combustion chamber 6 is caused to act upon the exposed face of the charge 7, and thereby force the charge firmly against the inner surface of the charge-retaining cavity by providing a vent opening 28 in the wall of the combustion chamber

remote from the combustion area of said charge. This method of insuring the limiting of the combustion to a restricted area of a rocket charge is the subject of my copending application, Ser. No. 430,978, previously mentioned, and reference thereto may be had for a more detailed consideration of the same.

The operation of the invention as embodied in the design of the projectile shown in Fig. 1 is as follows. Preferably, this particular type of projectile would be fired from a gun in which the projectile is adapted to be spun prior to launching, so that, upon being fired, it would leave the gun rotating at high velocity. As already pointed out, this may be accomplished by rotating the gun barrel while the projectile is in place therein, as, for example, by an electric motor or a turbine driven by a jet of compressed air or gas, or similar means associated with the gun might be adapted to spin the projectile within the gun barrel. Or, as also heretofore pointed out herein, the rear nozzles 12 may be set obliquely so as to establish a torque about the longitudinal axis of the projectile to rotate the same at the time of firing.

In any event, when the primer 13 is struck by the firing pin of the gun, the charge 10 is detonated, and the pressure of the expanding gas is resisted by the plate 14 until the pressure becomes great enough to burst the diaphragm and issue through the nozzle openings 12. This sudden high-pressure blast of gas drives the projectile forward in the gun barrel at a high velocity. At the same instant, the exploding powder 10, reacting against the diaphragm 16, drives the firing pin 18 forward, causing the forward end of the firing pin to strike and detonate the primer cap 19, thereby igniting the powder 20. The heat and gases of this powder explosion create pressure within the combustion chamber 6 to energize the driving nozzles 26, and thus ignite the rocket propellant charge 7 at its face 23. The progressive, rearward burning of the charge 7 generates a relatively uniform evolution of gas of sufficient volume to maintain the high-velocity power jets 26 in operation to accelerate the flight and rotation of the projectile until said charge is consumed. The jets 26 preferably are equally spaced about the body of the projectile in a plane which cuts the longitudinal axis at or near the center of gravity of the projectile, and are positioned to discharge in the slipstream, thereby reducing the air resistance of a considerable area of the surface of the weapon.

A projectile of this design and driven in the manner described is inherently stable in flight. It is adapted to travel at unusually high velocities, and may be accurately directed over a relatively long range. The general appearance of the projectile, as viewed from the rear, is shown in Fig. 2, and the cross-section shown in Fig. 3 on the line 3-3 illustrates one method of forming the nozzles.

On of the advantages of progressively burning a rocket propellant charge rearwardly is indicated diagrammatically in Figs. 4, 5 and 6, in each of which the approximate center of gravity of the weapon is indicated by the numeral 100. In Fig. 4, the rocket charge 101 is shown as occupying its normal space in the afterbody of the weapon. As in Fig. 1, the nozzles 102 are at or near the mid-section, and in the vicinity of the center of gravity. In Fig. 5, the rocket charge 101 is indicated as half consumed, but because of the rearward, progressive consumption of the

charge, it has been found that the position of the center of gravity has shifted forward but approximately 30 to 33%, instead of 50%, as might be assumed in view of the consumption of 50% of the rocket charge. This is of importance, because it represents only a slight change in the longitudinal balance of the projectile during a critical phase of its total flight under power. And, this feature is seen to be of added importance when it is noted that, as the final half of the rocket charge is being consumed, the position of the center of gravity is moving through the greater distance, approximately 60% to 70% of the total shift, bringing the center of mass well forward at the time the projectile is traveling at a decelerating velocity. From research data obtained relating to this discovery, it is found that by suitably proportioning the weight and shape of the rocket charge in relation to other features of the general design, the accuracy, range and general performance can be brought to a high standard comparable with advances being made with rifled guns employing fixed ammunition.

Rockets of the type commonly in use, owing to their relatively low initial velocity, are usually projected from the launching means at a comparatively high angle of departure. The weight of the projectile is sufficient to retain the same in place in the launching mechanism in this method of firing. However, in the firing of rocket projectiles of the class described herein, in which a relatively high initial velocity is attained, it is possible to greatly reduce the angle of departure, and, in some cases, as for example on aircraft, to fire at angles below the horizontal, in which instance means must be provided to retain the projectile in place. In the launching means or gun until the projectile is fired. For this purpose, detent means, as described in my co-pending application Ser. No. 408,284, filed August 26, 1941, now Patent No. 2,391,864, may be employed for the purpose. It has been found advantageous, however, to employ magnetic means for retaining the projectile in position within the launching means or gun. A permanent magnet associated with the gun may be caused to retain the projectile, the launching impulse overcoming the holding force of the magnet. Also, electro-magnetic means may be employed in which the holding force is interrupted at the instant of firing. Such means are simple, rugged, and lend themselves well to cases wherein either the projectile, or the gun containing the projectile, is rotated for the purpose herein outlined.

While one form or embodiment of the invention has been shown and described herein for illustrative purposes, and the construction and arrangement incidental to one specific application thereof has been disclosed and discussed in detail, it is to be understood that the invention is limited neither to the mere details or relative arrangement of parts, nor to its specific embodiment shown herein, but that extensive deviations from the illustrated form or embodiment of the invention may be made without departing from the principles thereof.

What I claim is:

1. A rocket projectile having a plurality of charge-receiving cavities and a plurality of jet-forming nozzles communicating with each of such cavities and extending rearwardly of the projectile, a quick-burning powder charge in one of such cavities and a propellant rocket charge

in another of such cavities, a frangible closure plate separating the quick-burning powder charge from the external atmosphere adapted to be ruptured upon the generation of a predetermined amount of pressure from the burning of such charge, means for detonating such charge, and means associated with such charge for igniting the propellant rocket charge substantially simultaneously with the detonation of the quick-burning charge.

2. A rocket projectile having a plurality of charge-receiving cavities and a plurality of obliquely-set, jet-forming nozzles communicating with each of such cavities and extending rearwardly of the projectile, a quick-burning powder charge in one of such cavities and a propellant rocket charge in another of such cavities, a frangible element normally closing the quick-burning powder charge to the external atmosphere, such element being adapted to be ruptured upon the generation of a predetermined amount of pressure from the burning of such charge, means for detonating such charge, and means associated with such charge for igniting the propellant rocket charge substantially simultaneously with the detonation of the quick-burning charge.

3. A rocket projectile formed with a plurality of combustion chambers and having a plurality of jet-forming nozzles extending rearwardly from each of such chambers to the external atmosphere, a quick-burning powder charge in one of such combustion chambers, and a propellant rocket charge in another of such chambers, means for closing the nozzles communicating with the quick-burning powder charge, such means being adapted to be ruptured upon the generation of a predetermined pressure within the combustion chamber containing such charge, and means for igniting both charges substantially simultaneously.

4. A rocket projectile formed with a plurality of axially-aligned combustion chambers and having a plurality of jet-forming nozzles extending rearwardly from each of such chambers to the external atmosphere, a quick-burning powder charge in the rearward combustion chamber, and a propellant rocket charge in the forward chamber, means for closing the nozzles communicating with the quick-burning powder charge, such means adapted to be ruptured upon the generation of a predetermined pressure within the combustion chamber containing such charge, and means for igniting both charges substantially simultaneously.

5. A rocket projectile formed with a plurality of axially-aligned combustion chambers and having a plurality of jet-forming nozzles extending rearwardly from each of such chambers to the external atmosphere, the forward nozzles being obliquely set to impart rotation as well as forward movement to the projectile, a quick-burning powder charge in the rearward combustion chamber, and a propellant rocket charge in the forward chamber, means for closing the nozzles communicating with the quick-burning powder charge, such means adapted to be ruptured upon the generation of a predetermined pressure within the combustion chamber containing such charge, means for detonating the rearward charge, the forward charge having a longitudinal opening therein, a firing rod extending through said opening, and means associated with the forward end of the rod for igniting the propellant charge on detonation of the quick-burning charge.

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6. A rocket projectile having a plurality of spaced, axially-aligned combustion chambers, and a plurality of jet-forming nozzles extending rearwardly from such combustion chambers, a quick-burning powder charge in one of such chambers adapted to furnish initial impetus to the rocket projectile upon the detonation thereof and a propellant rocket charge in another of such chambers, means for detonating the quick-burning charge, and means associated with such charge for igniting the propellant rocket charge at substantially the same instant.

7. A rocket projectile having a plurality of axially-aligned, charge-receiving cavities, a plurality of jet-forming nozzles communicating with each of such cavities and extending rearwardly of the projectile, the forward nozzles being obliquely set to impart rotation to the projectile upon discharge of gas under pressure therethrough, a quick-burning powder charge in the rear cavity and a propellant rocket charge in the forward cavity, a frangible closure plate separating the

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quick-burning powder charge from the external atmosphere adapted to be ruptured upon the generation of a predetermined amount of pressure from the detonation of such charge, means for detonating such charge, and means associated with such charge for detonating the propellant rocket charge substantially simultaneously with the detonation of the quick-burning charge.

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