July 27, 1954 K. M. NORDFORS 2,684,570

ROCKET-ENGINE AND REACTION-MOTOR MISSILE

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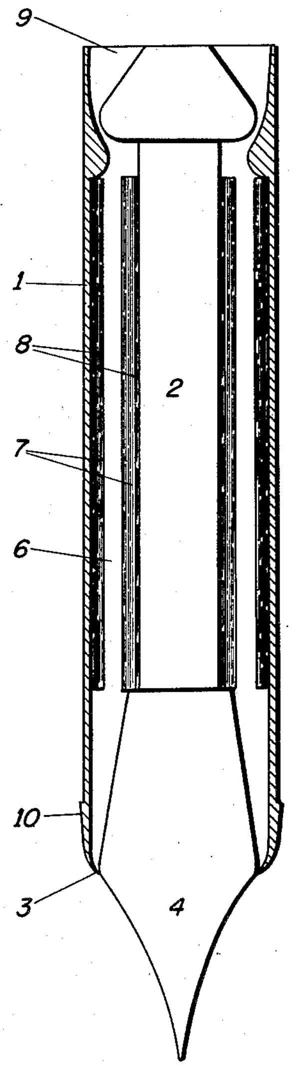

Fig. 1

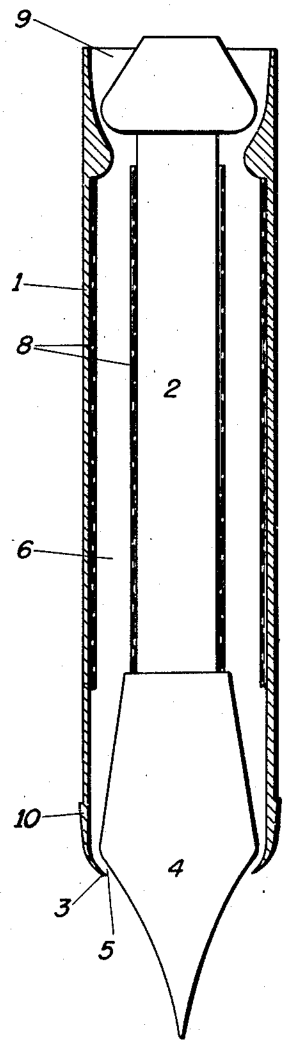

Fig. 2

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ROCKET-ENGINE AND REACTION-MOTOR MISSILE

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4 Claims. (Cl. 60—35.6)

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This invention relates to projectiles and generally comparable missiles and is particularly directed to an improvement in missiles of the type of that disclosed in my application Serial No. 166,593 for United States Letters Patent entitled Reaction-Motor Missile executed and filed in the United States Patent Office concurrently herewith.

In the said concurrently executed application there is disclosed a missile comprising an inner body which if desired may carry a bursting charge or the like and a coaxial outer casing forming therewith the principal components of a reaction-motor or ram jet engine which is automatically operative to impel the missile forward in its flight after there has been imparted to it by a gun or other appropriate launching means an initial velocity adequate to permit effective operation of the said engine. But such missiles require an initial velocity of considerable magnitude to make the engine work satisfactorily and these are bulky and expensive because of the service required of them.

The present invention relates to an improvement in missiles of this class in that in combination with a generally similar engine there is embodied auxiliary propulsion means of so-called rocket characteristics whereby the missile may be launched from a gun or the like at lower initial or muzzle velocity and then attain the velocity requisite for operation of the ram jet engine under the impulse of a rocket charge carried inside the missile; after the exhaustion of such charge the ram jet is automatically brought into play to further propel the missile at the velocity then attained or a higher one until exhaustion of the ram jet fuel or arrival at a target, whichever first occurs.

It is therefore a principal object of the invention to provide in a projectile or other missile having reaction propulsion means, auxiliary rocket type propulsion means in which rocket fuel is initially consumed in a combustion chamber and the exhaust gases discharged through an exhaust nozzle and after combustion of said fuel is automatically further propelled by a ram jet using the same combustion chamber and exhaust nozzle to afford greatly increased range while the necessity of initially discharging it at very high velocity is obviated.

Another object is to provide a projectile or missile of the character aforesaid wherein the pressures generated by the combustion of the rocket fuel automatically maintain the ram jet engine air intake port closed during flight until exhaustion of the rocket fuel and then allow the said port to open for intake of air to support combustion of the ram jet fuel and thereby supply further impulse to the travel of the missile.

Other objects, purposes and advantages of the invention will hereinafter more fully appear or

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will be understood from the following description of a preferred embodiment of it diagrammatically illustrated in the accompanying drawing, in which

Fig. 1 is an axial section partly in elevation of a missile embodying the invention as it appears prior to its discharge from a gun or the like; and

Fig. 2 is a corresponding view showing the missile as it appears in flight after exhaustion of the rocket fuel and upon initiation of the operation of its contained ram jet engine.

Referring now more particularly to the drawing the missile illustrated therein comprises an outer casing or shell 1 of generally cylindrical form within which is coaxially disposed an inner body 2 which may carry a bursting charge or the like. The leading end of the outer casing is curved inwardly and feathered as at 3 for snug engagement with the substantially conoidal nose 4 of the inner body 2 and adapted to form therewith an annular port 5 when the casing 1 and body 2 are moved axially relatively to each other from the relative positions shown in Fig. 1 to those shown in Fig. 2. Within the outer casing rearwardly of the port 5 the inner surface of the outer casing and the outer surface of the inner body are substantially cylindrical and form between them a combustion chamber 6 the walls of which initially are defined by a layer 7 of rocket fuel overlying a subjacent layer 8 of ram jet fuel which may be applied in any suitable manner to the opposed walls of the casing and body. At their rear ends these parts are formed to provide an exhaust nozzle 9 the conformation of which is appropriately designed to produce a reaction impelling the missile forward as combustion products are discharged through it at high velocity.

The outer casing at a suitable position is desirably provided with an annular sealing or packing ring 10 adapted for cooperation with the bore of a gun barrel or other suitable launching mechanism to prevent escape through said bore around the missile of the gases emanating from the initial propulsive charge while it is in the bore, the ring also serving to impart axial rotation to the missile in the ordinary manner if the bore is rifled.

The missile is initially charged into the gun or other launching apparatus in the condition shown in Fig. 1, that is, with port 5 closed by tight engagement of nose 4 of the inner body with feathered edge 3 of the outer casing, and this gas seal combined with the seal between the missile as a whole and the gun barrel afforded by packing ring 10 enables the full propulsive effect of the launching charge to react against the missile on discharge. The pressure of the gases produced by the discharge instantaneously increases the pressure of the air in combustion chamber 6 and the rocket fuel 7 is ignited thereby. After the missile has been ejected from the

muzzle of the firing mechanism a discharge of combustion products through port 9 resulting from combustion of rocket fuel 7 imparts additional impetus to the missile and further accelerates its flight, resultant pressure in the combustion chamber retaining an effective seal between the leading feathered edge 3 of the outer casing and nose 4 of the body until exhaustion of the rocket fuel. Thereafter, upon decline of this pressure the atmospheric air pressure on nose 4 tends to retard the inner body and permit the outer casing to move forwardly relatively thereto, admitting air under pressure to combustion chamber 6 through the now open port 5. The ram jet fuel 8 is thereupon ignited and products of its combustion are discharged at high velocity through exhaust nozzle 9 which is so designed as to afford a larger opening during the ram jet operation than during combustion of the rocket fuel as a result of the above described relative axial movement of the parts. The missile is therefore further propelled by the action of the ram jet to greatly increase its range and velocity as compared with comparable missiles depending for their range entirely upon the propulsive force imparted by the initial charge of the gun or other launching device.

The missile described herein is of course adapted to be operated with the aid of liquid or gaseous as well as solid fuel or any desired combination of fuels in these several phases and since the rocket fuel requires no air to support its combustion it is obvious the entire space between the outer casing and inner wall may entirely be filled with this and other fuel, consumption of the rocket fuel during the initial stage of flight evacuating space for the passage of air through the interior of the outer casing during subsequent ram jet operation.

Of course it is obvious that means may be provided for holding the front and rear portions of the inner body in coaxial relation with the outer shell while permitting their relative axial movement, for example, a plurality of radial stays fixed to the inner body, slidably engaging the inner wall of the outer shell and where the rear stays are preferably arranged to engage the constricted rear portion of said wall adjacent the exhaust nozzle or some other suitable abutment at maximum operative open position of port 5 at the limit of relative axial movement between the inner body and the shell.

While I have herein described one embodiment of the invention with considerable particularity it will be understood I do not desire or intend thereby to be limited or confined in any way as changes and modifications in the form, construction and relationship of the several parts and instrumentalities employed other than as herein suggested will readily occur to those skilled in the art and may be made if desired without departing from the spirit and scope of the invention as defined in the appended claims.

Having thus described my invention, I claim and desire to protect by Letters Patent of the United States:

1. A missile comprising coaxial relatively movable parts including a substantially cylindrical hollow outer casing having a constriction at its forward end and a substantially cylindrical inner body having a conoidal nose of greater maximum diameter than the minimum diameter of said constriction cooperative with said constriction to provide an annular port adapted to be closed by relative axial movement of the parts,

the rear ends of said parts forming a reactive discharge nozzle, ram jet engine fuel disposed interiorly of the casing, and rocket-engine fuel adjacent thereto, the reaction of combustion of said rocket-engine fuel maintaining said parts in relative positions closing said annular port and the resistance of the atmosphere in flight inducing relative movement of the parts to open said port on exceeding said reaction.

2. A missile as defined in claim 1 in which said ram jet engine fuel comprises a layer of combustible material proximate the inner wall of the casing between said port and said nozzle and said rocket-engine fuel comprises material adapted for self-sustaining combustion proximate the inner surface of said first material whereby in flight of the missile internal pressure generated by combustion of said last mentioned material reacts against said parts to maintain said port closed and on decrease in said pressure reaction of atmospheric pressure against said conoidal nose effects relative movement of said parts to open said port for passage of atmospheric air under pressure therethrough to support combustion of the first mentioned material.

3. A missile as defined in claim 1 in which said ram jet engine fuel comprises a combustible material forming layers adherent respectively to the opposed surfaces of said parts within the missile and said rocket-engine fuel comprises material adapted for self-sustaining combustion interposed between opposed surfaces of said layers whereby in flight of the missile internal pressure generated by combustion of said last mentioned material reacts against said parts to maintain said port closed and on decrease in said pressure reaction of atmospheric pressure against said conoidal nose effects relative movement of said parts to open said port for passage of atmospheric air under pressure therethrough to support combustion of the first mentioned material.

4. A missile comprising coaxial relatively movable parts including a substantially cylindrical hollow outer casing having a constriction at its forward end and a substantially cylindrical inner body having a conoidal nose normally engaged therewith adjacent its zone of maximum diameter, said maximum diameter being greater than the minimum diameter of said constriction, the rear ends of said parts defining between them a discharge nozzle, ram jet fuel disposed in the casing intermediate said nose and said nozzle and rocket-engine fuel likewise in the casing proximate the ram jet fuel whereby following discharge of the missile and subsequent combustion of the rocket-engine fuel the parts remain in normal position but thereafter move axially relative to each other to simultaneously open a passage for air between the nose of the body and the forward end of the casing and enlarge the effective area of the discharge nozzle preparatory to combustion of the ram jet fuel.

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(3rd addition to No. 779,655)