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LAUNCHING PROCESS AND APPARATUS

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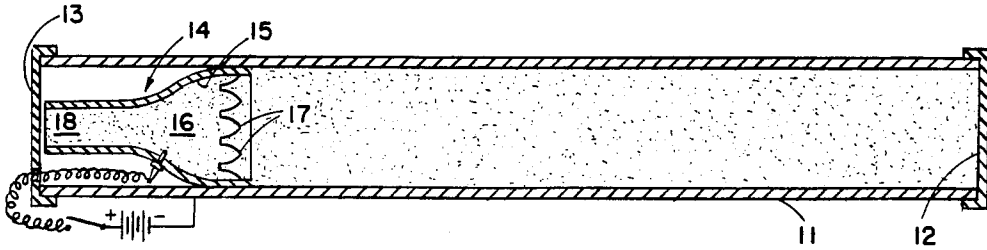


*Fig. 1*

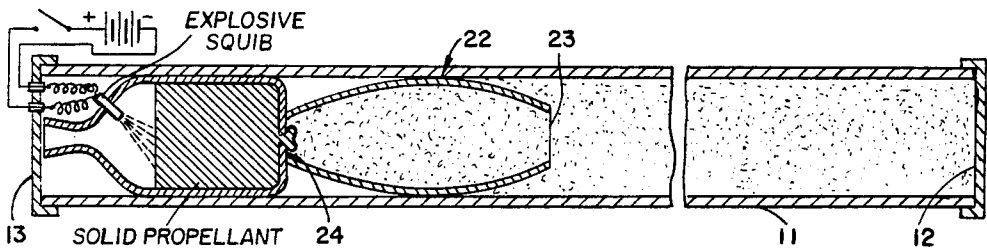


*Fig. 2*

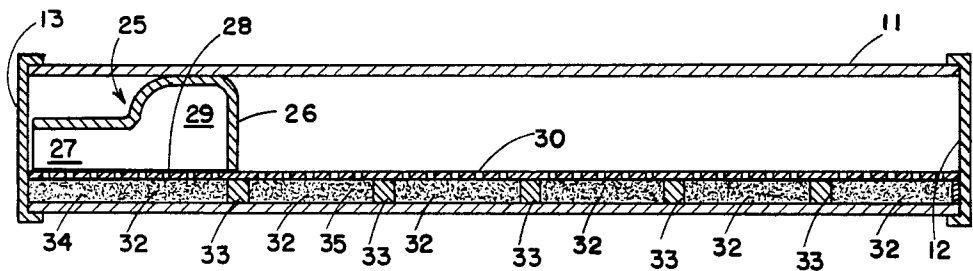


*Fig. 3*

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## LAUNCHING PROCESS AND APPARATUS

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5 Claims. (Cl. 89-1.7)

This invention relates to a method and apparatus capable of imparting continuous acceleration to objects such as projectiles, missiles and vehicles in general, and is particularly directed to the method and apparatus capable of achieving efficient use of the energy in the propellants made available to the system.

Heretofore the methods and apparatus used for the launching of either projectiles, rockets or vehicles have made poor conversion of the power available with the result that the thermopropulsive efficiency has been very low, hence the greater percentage of the power available, which could be supplied to a projectile, gun or to a rocket, is wasted. This is clearly illustrated by the fact that no matter how large a charge is used in a gun, the terminal velocity of the projectile never exceeds appreciably, the average thermomolecular velocity of the combustion gases, which is usually a maximum of two kilometers per second in the usual case. Likewise, although it is possible to impart any desired velocity to the terminal stage of a multistage rocket, such elevated velocities can only be attained at the expense of a tremendous waste of the total energy that is supplied to the first stages of the rocket. The thermopropulsive efficiency as used in this application is defined as the ratio between the kinetic energy of the ultimate stage of the rocket, and the free enthalpy of reaction that is present in the combined original propellants; heretofore the thermopropulsive efficiency has always been exceedingly poor.

My invention makes available a novel method and apparatus for efficiently producing continuous acceleration of various types of objects such as projectiles, missiles and other vehicles propelled by reaction, that is capable of overcoming the above mentioned disadvantages. A particular feature of my invention is that the propellants are not located behind a projectile, or in the rocket vehicle as is ordinarily the case, but are instead primarily located in front of the projectile or reaction vehicle. The body such as a projectile or reaction vehicle is located in an elongated tube in which it can slide easily yet fits closely enough to the inner wall to prevent ignition of the propellant ahead of the body or vehicle. The propellants are introduced into the elongated tube and are ignited or reacted within the thrust chamber of the reaction vehicle, or behind the projectile, as the vehicle or projectile passes through the propellants which are distributed along the entire length of the path along which acceleration of the particular body takes place.

A simple form of launcher according to my invention, consists of a tube into which there is introduced at one end a reaction vehicle or projectile, of the type described above. The vehicle has a reaction chamber which is provided with a suitable intake. Prior to the introduction of the propellants and before ignition, the ends of the launcher tube are normally closed by suitable sealing means to enable the tube to retain the propellants. The cap at the forward end is expellable when the vehicle or projectile leaves the launcher tube. The rear cap may be either permanent or it may be expelled during the initial propulsion of the vehicle or projectile depending on the type of operation desired.

A purpose of the present invention is to make available a launching method and apparatus capable of imparting greater terminal velocity to projectiles or vehicles

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than has heretofore been possible by the use of a conventional gun or canon.

Another purpose of this invention is to provide a launching apparatus and method that is capable of eliminating the tremendous waste of the kinetic energy and thermal energy of the propellants that occurs in the conventional first stages of a rocket of the multistage type.

A further object of this invention is to provide a launcher for projectiles or reaction vehicles capable of producing higher thermopropulsive efficiency and reduce the waste of the potential energy present in the original propellants.

The preceding and following detailed description of my invention will be better understood by referring to the accompanying drawings, in which:

FIGURE 1 shows a schematic representation of a tubular launcher filled with gaseous propellants through which the reaction vehicle such as an aeropulse or aeroresonator, or other type of pulsejet engine, will travel, before it escapes from the launching tube.

FIGURE 2 is a schematic representation of a tubular launcher similar to the one in FIGURE 1, filled with a gaseous propellant mixture through which a reaction vehicle such as a ramjet or aeroduct is propelled.

FIGURE 3 is a schematic representation of a launcher tube with a specially designed vehicle. On one side of the launching tube there is stored, along its entire length a liquid or solid propellant charge that is divided into sections, each section being reacted consecutively as the vehicle passes by that section. The reaction products are discharged into the launching tube and into the reaction chamber of the vehicle from which they are exhausted through the discharge orifice.

Referring to FIGURE 1, there is shown a launching tube 11 closed at the front end by a cap 12 and at the rear end by a cap 13. In some cases cap 13 will be expelled during the initial stages of the propulsion, while in other instances cap 13 will remain in place thereby confining all the products of reaction thereby applying the high gas pressure generated at the initial stages of the reaction, explosion or combustion to a properly shaped missile 14. The missile shown in the illustration is identified as an aeropulse or aeroresonator. Missile 14 is put into the launching tube at the rear end adjoining cap 13. Vehicle 14 has an enlarged forward portion 15 that fits snugly in the launching tube and serves to guide the missile while preventing the propellant gases present ahead of the vehicle from slipping past it before they are to be reacted. Forward portion 15 prizes an exhaust tube or nozzle 18 through which are of the missile houses a thrust or reaction chamber 16 and the missile is provided at its forward end with a valve system 17, for example a flapper valve system or other oscillatory valve. The rear end of missile 14 com-

discharged the reaction products. It is also intended that in place of the flapper valve system, a channel valve or even a rotating valve system could be substituted if desired.

The gaseous propellants could be a mixture of oxygen and hydrogen in stoichiometric proportions, or in any other practical proportion suitable for the type of operation required. Other examples of gaseous propellants would be  $\text{CH}_4$  plus  $\text{O}_2$ ,  $\text{SiH}_4$  plus  $\text{O}_2$ ,  $\text{Si}_2\text{H}_6$  plus  $\text{O}_2$ ,  $\text{H}_2$  plus  $\text{Cl}_2$ ,  $\text{H}_2$  plus  $\text{F}_2$ ,  $\text{NH}_3$  plus  $\text{O}_2$ , and  $\text{C}_2\text{H}_6$  plus  $\text{O}_2$ .

The operation of the launching device shown in FIGURE 1 is as follows:

Launching tube 11 is closed at both ends by caps 12 and 13. A predetermined gaseous mixture is introduced into the tube at any desired pressure. The gaseous

mixture will also fill the reaction chamber of missile 14 which was introduced into the rear end of the launching tube. The reactive mixture in chamber 16 is ignited by a suitable means, such as an igniter plug, causing it to explode. The sudden rise in pressure caused by the explosion will slam shut flapper valve 17 and send a stream of high pressure gas expanding through nozzle 18. This allows the high temperature gas to cool as it expands; the expansion being essentially an adiabatic expansion. As soon as the pressure in reaction chamber 16 becomes less than the pressure of the gas ahead of the missile, flapper valve 17 will open due to the stagnation pressure acting against it, and a fresh charge will be taken into the reaction chamber. The new charge is permitted to either ignite itself, as is the case in an aeroresonator or pulse jet engine or it can be artificially ignited by some suitable device, as is done in an aeropulse. The pressure and temperatures in thrust chamber 16 rise sharply on each explosion, closing flapper valve 17 and causing a high pressure jet of reaction products to expand through exhaust pipe 18. The reaction of the expanding reaction gases drives the missile toward the forward end leaving the expanded reaction products behind. The above process is repeated until the forward portion 15 of the missile reaches closure cap 12 which is then pushed out as the missile leaves the launching tube.

The above process differs from the launching of projectiles from the conventional gun barrel in that the reactive material is located ahead of the projectile but is reached in or behind the missile or projectile and the nozzle velocities reached will far exceed the thermomolecular velocities that have heretofore limited the propulsive efficiency of a gun. A still greater increase in velocity can be achieved by either lengthening launcher tube 11, or by introducing the propellant mixture in the launcher tube under higher and higher pressures.

It should be noted that in the process described, the thrust chamber becomes filled with unreacted gases that remain always at rest with reference to the launcher tube until it is scooped into the reaction chamber of the vehicle where it will then assume approximately, the forward speed of the vehicle. As a result of the explosion in the thrust chamber, the reaction products are ejected through exhaust nozzle 18 and the resulting reaction creates the forward thrust of the missile.

It is apparent that this process differs from the manner in which a rocket operates in that the propellant mixture is not carried by the missile and the charging of the thrust chamber occurs continuously and automatically during the time the missile is being accelerated.

Another important distinction between the process described and the operation of a multistage rocket is that it is not necessary to accelerate either the propellant or the first stage of the rocket to great velocities while jet-tisoning the kinetic energy of the propellant reaction products needlessly and wastefully into space without accomplishing any substantial work.

FIGURE 2 again shows launcher tube 11 which is initially closed in front by cap 12 and in back by cap 13. A barrel shaped or otherwise suitably shaped slidable object 22 is introduced into launcher tube 11 and the tube is filled with a propellant gas mixture. After the object has been accelerated to the desired velocity, rear cap 13 may be forced out or if desired the acceleration of object 22 may take place with cap 13 remaining in place.

Object or missile 22 is provided with a frontal opening 23 and a rear nozzle 24. This type of reaction vehicle is usually referred to as a ramjet or aeroduct in which the maximum diameter of the body of the object is always substantially larger in diameter than frontal opening 23, so as to permit creation of the stagnation pressure at the forward end of the reaction or thrust chamber of the ramjet that makes the operation of a ramjet pos-

sible. Here again the gaseous propellant introduced in launcher tube 11, fills it completely and also fills the reaction chamber of the aeroduct. Any propellant reacted in this type of vehicle will not burn or react in a pulsing manner as in the aeropulse, but instead the reaction will proceed in a uniform and continuous manner. To make a ramjet or aeroduct start operation, however, it is necessary that the vehicle be given a certain initial velocity before the gases in the reaction chamber are caused to react. This may be accomplished by any satisfactory means such as a spring, an explosive charge or a small rocket since the combustion of the charge in the reaction chamber while it is stationary would normally not generate any forward thrust and would probably set off the reaction of all the gases in the launcher tube. After the ramjet has been put in motion by the explosion of a charge or reaction of a rocket located at the rear of the ramjet, the charge within the duct is ignited and the front of the combustion wave which results from the ignition of the initial charge and subsequent ignition of the gaseous mixture scooped into the reaction chamber as the aeroduct moves forward, will never overshoot entrance 23 of the aeroduct and prematurely cause the reaction of the remaining gases stored in launching tube 11. The abrupt heating and pressure rise in the thrust chamber after it is once in motion causes the products of reaction to be ejected through nozzle 24 and the reaction of these expanding gases drives the missile forward at increasing velocity. The combustion process proceeds continuously in the reaction chamber as the missile advances into the gaseous mixture ahead. In this modification as previously stated in the operation of the aeropulse, the object or missile may be imparted any desired nozzle velocity simply by increasing the length of the launching tube, or by introducing the propellants under greater pressure.

While the construction of the missile shown in FIGURE 2 is simpler than that of the aeropulse shown in the previous operation, it must be remembered that the ramjet suffers from the disadvantage stated above, that it must be given an initial boost and be moving at a specified velocity before combustion can be started in the reaction chamber.

FIGURE 3 shows a type of launcher in which either a liquid or a solid propellant can be used. In this application both the front and the rear ends of the launcher could be left open if desired, however, in the interest of reducing the aerodynamic resistance to a minimum it would be advantageous to evacuate the launcher tube, in which case it would be necessary to close the front and rear ends. A slidable object or missile 25 is placed in the launcher tube 11 at the rear end 13. The projectile or missile could have a configuration such as shown schematically in FIGURE 3 where the object is closed at its forward end 26 while the rearward portion serves as an exhaust section 27. Object 25 is open at its lower side 28 which is adapted to admit the products of reaction as well as any unreacted substance into so-called thrust chamber 29. The reacted combustion products are expanded through nozzle 27. That portion of the wall circumference 30 of the launching tube, and extending the entire length of the launcher tube is in the form of a perforated wall having a space extending from the perforated wall that is charged with propellants. The propellants can be powder such as is used in guns and canons asphalt with ammonium perchlorate, a polyester with potassium perchlorate or any other suitable solid propellant. Examples of liquid propellants would be nitromethane, ethylene oxide, hydrogen peroxide, etc.

The propellant, whether liquid or solid is placed in space 31 and is conveniently divided into charges 32 that are separated from the adjoining reactive charges by a chemically inert separator 33. The manner in

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which the propellant charges are separated from each other and the type of separator used will depend on the nature of the propellant substances. In some cases the separators can be very thin. The launcher tube shown in FIGURE 3 may also employ closure members at each end if desired and the rear closure member can be of a permanent nature if this is required. The manner in which this apparatus functions is as follows: The object to be propelled, such as a missile or projectile 25 is inserted into the rear end of launching tube 11 in such a manner that the last propellant charge 34, located behind the perforated wall 30 will discharge the products of reaction into thrust chamber 29 when it is reacted through the orifices of wall 30. The reaction products as well as any unreacted propellant will enter thrust chamber 29 where any unreacted propellant will have the opportunity of reacting and the resulting pressure rise will cause the reaction products to expand through nozzle portion 27.

The reaction of the expanding gases causes object 25 to be propelled forward. As soon as object 25 has moved to the point where the next partial charge 35 is located below perforated wall 30 and now forms the new boundary of thrust chamber 29, this charge is reacted and the reaction products again enter the reaction chamber and expand through nozzle 27 thus imparting new thrust to object 25. The process is repeated until object 25 escapes from the forward end of launcher tube 11 after pushing out cap 12. Ignition of the partial charges may take place on contact by the object 25 by any suitable means such as spark ignition or other convenient form of igniter.

The launching apparatus that has been described in FIGURE 3 can be employed as a substitute for guns for military purposes, as a catapult for launching missiles or planes, or for the transportation of objects enclosed in sealed containers attached to object 25 which will impart the impulses of reaction resulting from the ignition of properly distributed partial propellant charges.

While the invention has been described in detail with respect to the illustrative examples and embodiments shown, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the spirit of the invention or the scope thereof, and it is intended therefore to cover all such changes and modifications in the appended claims.

I claim:

1. A projectile propulsion system comprising a launching tube having rear and forward ends and a removable closure member at the forward end, a projectile disposed at the rear end of said tube and having a reactant chamber with a forward entrance opening and a rearward nozzle

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opening, said openings communicating with said reactant chamber; said projectile having a sealingly movable fit in said tube; said tube being filled with a combustible propellant gas disposed to enter said reactant chamber through said entrance opening whereby reaction of said gas during combustion in said reactant chamber effects propulsion of said projectile by exhaust through said nozzle opening to move said projectile through said tube for emergence therefrom at said forward end thereof upon removal of said closure member, and a closure means for the rear end of said tube.

2. A projectile propulsion system as set forth in claim 1, said closure member being frangible so as to be broken away by said projectile.

3. A projectile propulsion system as set forth in claim 2, including means for effecting initial combustion of gas in said reactant chamber.

4. A projectile propulsion system as set forth in claim 1, including means for effecting initial combustion of gas in said reaction chamber.

5. A method of launching a projectile from a launching tube which comprises placing said projectile in said tube at a predetermined distance from the launching end of said tube, filling said tube and said projectile with a combustible gas under conditions such that there is direct gas flow of substantially all gas in the interior of said tube into the interior of said projectile when said projectile is moved to said launching end, igniting said gas in said projectile to effect emission of a burning propellant therefrom whereby the resulting thrust effects movement of said projectile through an atmosphere of unburned gas in said tube causing unburned gas to pass continuously into said projectile and burn therein during the course of such movement, thereby to effect continuous thrust accelerating said projectile to the launching end of said tube.

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