

Dec. 19, 1967

A. J. GRANDY

3,358,559

WIRE-GUIDED PROJECTILE PROPELLING SYSTEM

Filed Dec. 9, 1965

2 Sheets-Sheet 1

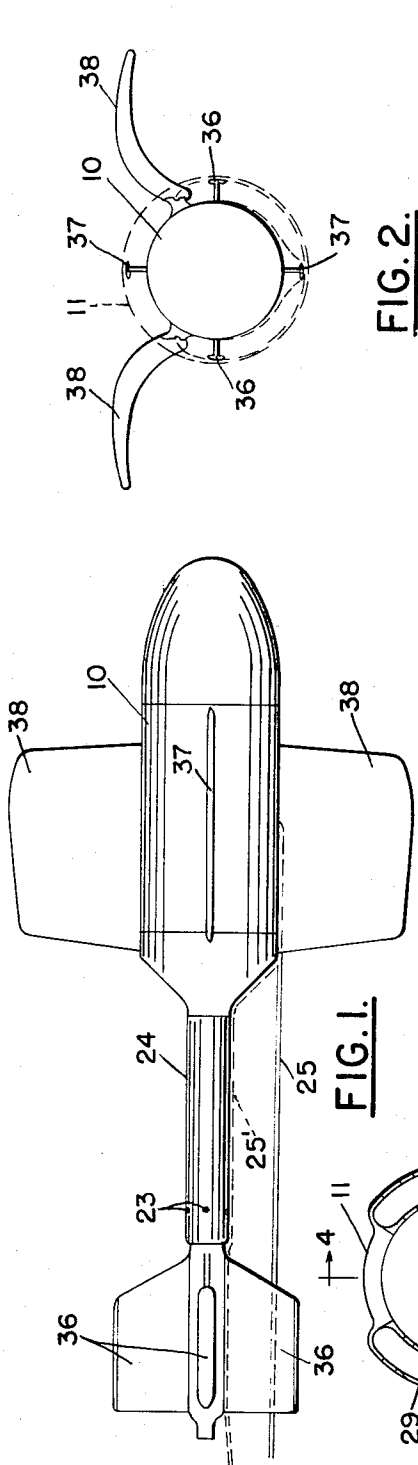


FIG. 2.

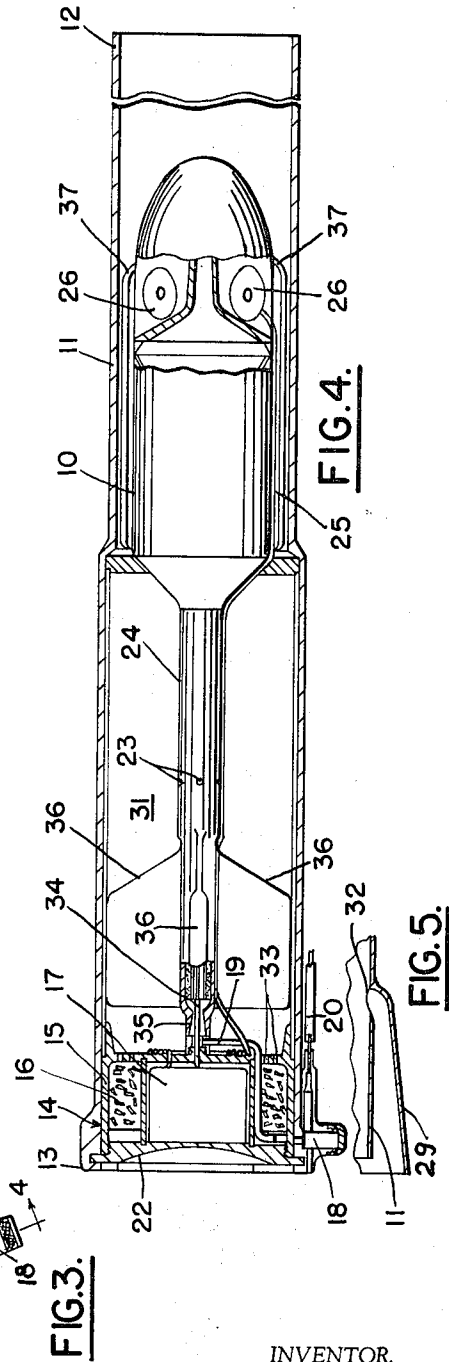


FIG. 4.

FIG. 5.

INVENTOR
ANDREW J. GRANDY

BY: *Harry M. Saragovitz,*
Edward J. Kelly,
Habot Paul &
S. Dubroff
ATTORNEYS.

Dec. 19, 1967

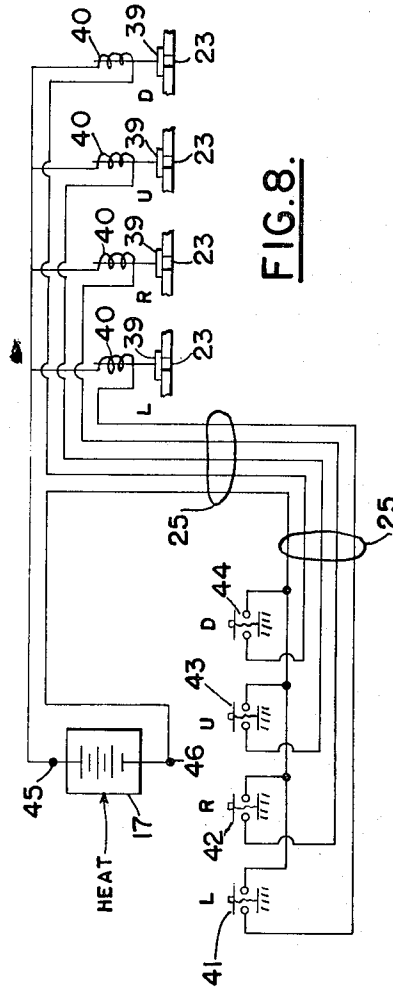
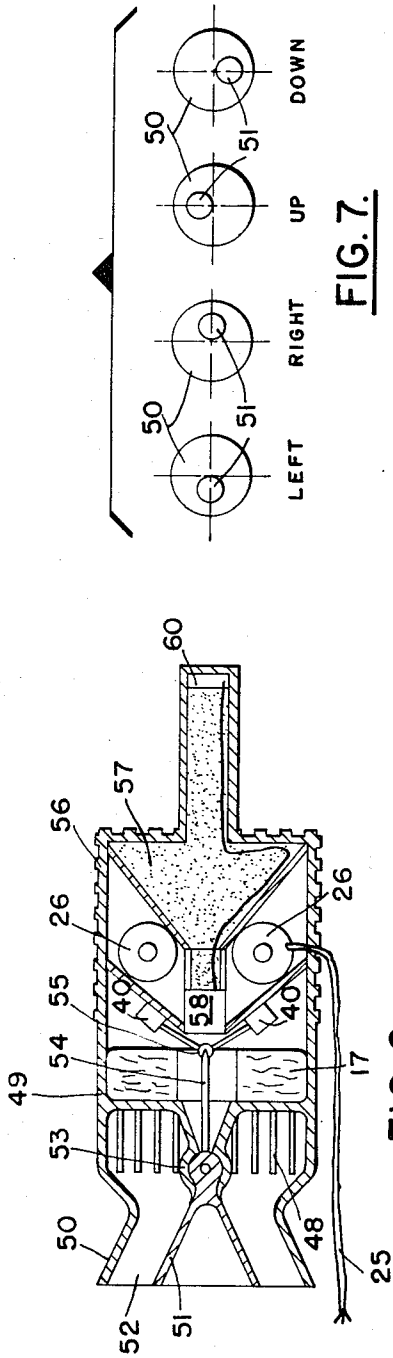
A. J. GRANDY

3,358,559

WIRE-GUIDED PROJECTILE PROPELLING SYSTEM

Filed Dec. 9, 1965

2 Sheets-Sheet 2



Inventor
ANDREW J. GRANDY

By: *Harry M. Saragovitz,*
Edward J. Kelly,
Herbert Paul &
S. Dubroff

Attorneys.

1

2

3,358,559

WIRE-GUIDED PROJECTILE PROPELLING SYSTEM

Andrew J. Grandy, North Hills, Pa., assignor to the United States of America as represented by the Secretary of the Army

Filed Dec. 9, 1965, Ser. No. 512,832

7 Claims. (Cl. 89—1.818)

ABSTRACT OF THE DISCLOSURE

A wire guided projectile propelling system is provided wherein a projectile is ballistically launched from a recoilless launcher and receives control and guidance information electrically through a wire or cable attached thereto and payed out therefrom to either a ground point or mobile or portable reference point. The system is capable of producing projectile speeds of both less and greater than Mach 1 and with various short and intermediate launching ranges that may vary from substantially less than 600 meters to 2000 meters or more under the influence of a rocket engine adapted to fire at a predetermined time after the initial ballistic launch.

The present invention relates to projectile propelling systems of the wire-guided type in which the projectile in flight is connected to a control point, usually at the ground, by a thin, light cable or guide wire of high tensile strength which carries control conductors for the guidance system.

More particularly, the present invention relates to a projectile propelling system of the above type which is recoilless-launched into flight from the control point at a comparatively low velocity for a relatively short flight range or distance, normally within 100 meters for example. Controlled guidance of the projectile is accomplished with aid of the multi-conductor guide wire or cable which transmits the control or intelligence signals to the projectile.

Since the original part of the trajectory is a ballistic launch essentially on a line-of-sight with the receiving objective, no problems are involved at close ranges up to, for example, the 100 meters above referred to and longer, even up to 600 meters, depending upon the strength of the launch. These distances are usually associated with present air-foil, controlled, wire-guided projectiles which are recoilless launched into flight at low velocities. In such cases the guide wire is generally payed out from a reel at the ground or control point.

It is an object of this invention to provide a wire-guided projectile adapted to be initially launched into relatively short range ballistic flight by propellant forces externally applied thereto, with improved guidance control and a forward axial thrust for extending the flight range beyond the initial launch range, thereby to reach objectives over greater distance than prior wire-guided projectiles of this type.

It is a further object of this invention to provide an improved guided projectile system in which the projectile is launched at a relatively low velocity and in which its velocity is increased to extend the range far beyond the initial launch range, and in which the combined weight and size of the launcher and projectile is relatively low and adapted for portability by the user thereof.

In accordance with the invention, a guided projectile system consists of a relatively light-weight, twin nozzle, recoilless launcher of the tubular or rifle type which fires a projectile at a comparatively low muzzle velocity, for example 300 f.p.s., for a short range or distance, approximately 100 meters for example, after which a rocket en-

gine carried by the projectile is used to propel it to maximum range which may be of approximately 2000 meters or more. This is an extremely long distance for wire-guided projectiles of this type and can be controlled in accordance with the invention to this distance or more from a central or fixed control point.

Further in accordance with the invention, the controlled guidance of the projectile is accomplished with the multi-conductor cable or guide wire carried in and extending from the projectile itself in flight and being fixed at the control point. The conductor is self energized in that a battery of the thermal type is energized by the heat of combustion which results from the launching and propelling of the projectile in flight. This heat is directly received by the battery which is either mounted in a launcher or, in a second embodiment, is likewise carried by the projectile. In the latter case, the battery is subjected to both the heat of the rocket motor which carries the projectile in the extended flight and the heat from the initial ballistic launch.

The invention will further be understood from the following description of certain embodiments thereof, when considered with reference to the accompanying drawings, and its scope is pointed out in the appended claims.

In the drawings:

FIG. 1 is a plan view of a wire-guided projectile adapted to be initially launched into ballistic flight by propellant forces externally applied thereto,

FIG. 2 is a front end view of the projectile shown in FIG. 1,

FIG. 3 is a cross sectional view of a recoilless launcher taken through the nozzle for the projectile of FIGS. 1 and 2,

FIG. 4 is a further cross-sectional view of the launcher of FIG. 3 taken on the section line 4—4 thereof and further is a cross-sectional view of the projectile of FIGS. 1 and 2, showing said projectile in place for propulsion in the launcher and certain details thereof along with details of the launcher in accordance with the invention,

FIG. 5 is a further cross-sectional view of the launcher of FIGS. 3 and 4 taken on the section line 5—5 of FIG. 3, showing a further detail of construction thereof in accordance with the invention,

FIG. 6 is a cross-sectional view of a modification of the projectile of FIGS. 1, 2 and 4, whereby it is adapted for supersonic flight following the ballistic launch, and shows further details thereof in accordance with the invention,

FIG. 7 shows, in diagrammatic form, operating details of an improved guidance means for the projectile of FIG. 6 adapted for more effective control at supersonic speeds in accordance with the invention, and

FIG. 8 is a schematic diagram of an electrical control system in accordance with the invention for selectively operating the projectile guidance means.

Referring to the drawings wherein like elements throughout the various figures are designated by like reference numerals, and referring particularly to FIGS. 1-5 inclusive, the guided projectile system in accordance with the invention includes an elongated cylindrical projectile adapted for free ballistic flight in space, and to be initially launched into flight by propellant forces externally applied thereto.

Preferably the launching means is a light-weight portable tubular launcher 11 of the twin-nozzle forward-throat recoilless guide-tube type, having an open forward end or muzzle 12 and a closed rear end or breech 13. The projectile fits the bore of the launcher and is thus supported and guided thereby during the firing cycle. In the present example, and by way of example, the launcher is adapted to propel a relatively light projectile, of 20 pounds for example, into an initial limited ballistic flight range at a

relatively low velocity, for example, such as 300 ft. per second.

To provide this relatively low initial velocity, a high-low ballistic cartridge 14 is provided for the launcher and consists of a cartridge base 15 which houses the high-side chamber and propellant 16. It also contains a thermal type battery 17 connected to transmit control intelligence to the projectile in flight.

The launcher is provided with a remote-controlled firing pin mechanism 18 and an ignition transmission line 19 therefrom to the propellant 16, the firing mechanism is controlled through a suitable remote-control cable connection 20 to a control point (not shown). The cartridge is replaceable through the breech end 13 of the launcher, which may be provided with a detachable breech closure means comprising a removable cover plate 22 which rotates and locks in place, as indicated, behind the cartridge. Alternatively, the cartridge may itself form the breech closure by being appropriately seated therein thereby eliminating the need for the cover plate 22.

Guidance means for the projectile in flight is provided with directional remote-control elements selectively responsive to applied electric control currents. In the present example this includes four jet openings 23 positioned 90° apart about the outer casing of a rocket motor 24 which extends rearwardly from the projectile 10 along the axis thereof. The jets receive gas through suitable valves solenoid-controlled, or the like, by currents transmitted thereto through the guide wire or cable indicated at 25. This may payout from a reel in the launcher or from reel elements as indicated at 26 in the projectile. This control system will further be described hereinafter.

The operating current supply means includes the thermal electric battery 17 which is positioned to be self-energized in response to applied heat of combustion in the launching and/or ballistic flight of the projectile. In the present example it is located in the launcher whereas it may, in other forms of the invention, be included in the projectile and energized in response to the heat applied thereto from the rocket engine in operation. The guide wire 25 includes a plurality of conductors and is an effective electric cable connected to transmit control currents from the battery to selectively operate the guidance means and effect remotely guided flight of the projectile.

The axially-extending rocket engine 24 is connected with and carried by the projectile for applying thrust thereto to propel the projectile to an extended range in a trajectory path beyond the initial limited ballistic flight range. In the present example it also applies fluid operating pressure to the directional guidance means, such as the jet nozzles, through the said remote control elements.

As has been noted, the elongated tubular launcher, while being of the recoilless type, is closed at the breech end either by releasable closure means or by the appropriately seated cartridge itself, and thereby adapted for loading the chamber with successive ballistic cartridge loads. Thus to provide for recoilless operation, other means are provided for venting the combustion chamber or interior of the launcher. Presently on opposite sides of the rear end, two rearwardly-discharging nozzle elements 29 and 30 are shown in FIGS. 3 and 5. Thus the breech end of the launcher can be closed during the firing cycle and the low side of the high-low ballistic launching system, as provided by the chamber 31 in the present example forward of the high-pressure chamber, may be placed in communication with the jet nozzles through suitable orifice openings 32 in the walls thereof.

The high-pressure chamber 16 discharges through suitable gas discharge ports or openings 33 into the low-pressure or low-side chamber 31, thereby gradually pressurizing the chamber and discharging through the launcher nozzles 29 and 30 to start the projectile into its forward accelerating movement, unreeling the guide-wire as it goes. Upon firing of the launching propellant and activa-

tion of the thermal battery, a time delaying ignition train 34 for the rocket engine is started, whereby the engine may come into operation at the proper time beyond the initial ballistic flight range as heretofore referred to. Upon movement forward the rocket nozzle end 35 separates from the cartridge as the projectile moves forward in the launcher under propelling force of the low pressure gas in the chamber 31.

All stabilization of the projectile in flight is provided by four radial wings 36 positioned around the rocket casing and two corresponding shorter wings 37 along the top and bottom surfaces of the projectile. The projectile is carried in ballistic flight further stabilized by two wing elements 38 which unfold from the positions indicated in dotted outline in FIG. 2 as the projectile emerges from the launcher muzzle. Thus the completely packaged projectile, including the high-low ballistic system, the wire package, and power source, is inserted and rotatively positioned in the launcher. Actuation of the firing mechanism 18 simultaneously ignites the body of launching propellant 16 and activates the thermal battery 17. Upon pressurization of the low chamber side of the launcher, the projectile activates or initiates the time delay firing for the rocket engine and commences unreeling the guide wire.

Upon emergence from the launcher the two sections 38 of the single wing are forced outward and upward due to their shape and air drag and are locked in a flight position as shown in FIG. 2. The projectile then tends to fly approximately 100 to 600 meters, or in that range presently in a flight trajectory path as a ballistically launched mass. At that point sufficient time has elapsed and the rocket engine fires to provide thrust to the full range which may extend as far as 2000 meters or more. In flight corrections are made via the high tensile guide wire and control currents conveyed therethrough to the guidance means in the projectile.

As indicated hereinbefore, the guidance elements in the present construction include the jet openings 23 which are supplied individually with controlled gas pressure from the rocket engine through suitable valve means indicated in the present example with reference to FIG. 8 and the circuit diagram therein schematically showing valve closure elements 39 for the gas ports or jet openings 23 in the rocket engine casing 24. As is understood, the jet openings 23 preferably are placed in equal angularly-spaced relation or 90° intervals, as indicated in FIG. 4 for example. The valves or valve elements 39 are normally closed as indicated and are opened under control of solenoid elements 40. The latter are connected through the cable 25 with corresponding remote control switch buttons 41-44 inclusive for controlling left, right, up, and down directional flight movement. The solenoid elements 40 are thus energized through the push-button switch means from a common supply source comprising the thermal battery 17 which, in turn, is activated by heat resulting from the initial flight or rocket engine operation depending upon its position in the system. One terminal 45 of the battery 17 is connected with and common to all of the solenoid wirings or elements 40 while the opposite terminal 46 is connected in common, through the cable 25, with each of the switch elements 41-44 to provide the selective push-button operation and circuit completion through each of the solenoid elements selectively and thereby to operate the different directional valves as desired from the control station at which the switch elements 41-44 are located. Generally this is at the ground station from which the rocket is launched. Other forms of control may be provided, as is understood. The present circuit and operating means are shown only by way of example as being adapted for the rocket engine control of directional flight through jet openings in accordance with the embodiment of FIGS. 1 to 5 inclusive. As is understood this embodiment is adapted for relatively low speed

5

flights of the projectile below the ultra-sonic levels at which some projectiles are driven.

For ultra-sonic flight and effective directional control with cable or guide-wire control, the rocket engine itself is provided with directional control means in the jet nozzle at the rear end thereof for rapid gimballed action and movement by suitable means such as solenoid elements as shown in FIG. 8 and adapted for applying movement in four different directions to a single multiple control element. A rocket engine construction suitable for this purpose is indicated in FIG. 6 and the control action thereof is as indicated in FIG. 7, to both of which figures attention is now particularly directed.

In this embodiment of the invention, the rocket engine 48 is mounted at the rear end of the projectile casing 49 and is provided with a bell shaped rear nozzle 50 having a central gimballed nozzle cone 51 which provides an annular nozzle opening 52 which is variable as the cone is moved on its gimballed bearing indicated at 53. The gimballed bearing is connected with a control rod 54 which is then connected with a control mechanism as indicated at 55 and by which the nozzle cone 51 is moved to the left, right, up or down to provide variations in the symmetry of the normally angular nozzle opening 52 and thereby to provide directional control of the projectile in flight. In the present example the control mechanism 55 may be connected with controlling elements such as the solenoids 40 only two of which appear in the figure.

As in the preceding embodiment, the cable 25 is connected with supply reels 26 carried by the projectile whereby the cable is payed out from the projectile as it moves in flight. The projectile in this case may have a casing which is adapted to fragment in the forward portion 56 thereof as an explosive charge 57 is detonated by a fuse element 58 upon impact and firing voltage delivered by a crystal generator 60 in the forward end of the projectile. The control circuit as indicated in FIG. 8 for the control elements is provided by the battery 17 which in this case is mounted adjacent to the rocket engine to be activated by the heat of combustion therefrom as the projectile is in flight.

This form of nozzle control of the rocket engine by a gimballed central cone element is believed to be highly effective for projectile directional control and effective positive action under conditions of high-speed flight above the speed of Mach 1. This is at a rate of over 1000 ft. per second, a speed which the projectile attains after its initial slow-speed launch under the impelling action of the larger and more efficient rocket engine.

From the foregoing description it will be seen that in accordance with the invention, a recoilless-launched wire-guided, rocket-assisted, projectile propelling system is provided which may be effectively operated at relatively low speeds or may be made to attain relatively high speeds from an initial slow launch. The slow launch permits the use of a directional guidance means for a projectile that is wire-guided in flight and that can be launched through the medium of a light-weight portable tubular launcher adapted for use by an individual operator with the same effectiveness as a powerful and more highly-charged gun or the like.

A guided projectile system, in accordance with the invention, thus includes a combination of various cooperative light-weight and simple elements adapted for initial launching of the projectile into a relatively short range ballistic flight by relatively low-pressure propellant forces externally applied thereto, and then boosted to the full length of its desired travel by an attached rocket element, with the heat of combustion in the launching or propelling of the projectile serving to activate and operate the energy source for the control system so that it is self-contained and self-energizing in operation. Control of the rocket engine exhaust or gas pressure serves to control the direction of flight of the projectile and

6

this may be accomplished by a variety of means, two of which have been shown in the present example. Others are easily applicable and adapted for the same type of remote control by currents transmitted through a guide wire.

I claim:

1. In a guided projectile system, the combination of an elongated cylindrical projectile adapted to be initially launched into relatively short-range ballistic flight by propellant forces externally applied thereto, a cartridge having a combustible propellant charge, rocket engine means connected with and carried by said projectile for applying a forward axial thrust thereto and extending the flight range thereof beyond an initial range, means for delaying the ignition of said last-named means for a predetermined time interval wherein said interval begins after said initial launch,

directional guidance means for said projectile in flight having remote-control elements carried thereby and selectively responsive to applied electric control currents,

operating current supply means including a thermal battery positioned to be energized in response to the heat of combustion of said cartridge during launching and to the heat of combustion of said rocket engine propelling said projectile in flight, and mean including a flexible multi-conductor electric cable connected as a guide wire to transmit control currents from said battery to said projectile for selectively operating said guidance means.

2. In a guided projectile system, the combination as defined in claim 1, wherein the rocket engine means includes a rocket engine provided with a rearward extending thrust nozzle having a central gimballed annular cone element in connection with said remote control elements for effecting directional control of the engine thrust as part of the directional guidance means for the projectile.

3. In a guided projectile system, the combination as defined in claim 1, wherein a tubular launcher is provided for said projectile and adapted for high-low recoilless ballistic operation with a high-side chamber and propellant charge therefor, and wherein a low chamber-side is provided forward of said high-side chamber and vented on opposite sides thereof by two rearwardly discharging nozzle elements, thereby to simplify the construction and operation of said launcher.

4. In a guided projectile system, the combination as defined in claim 1, wherein the guide wire is carried by and dispensed to extend from the projectile in flight, thereby to extend the control connection with the guidance means, and wherein the thermal battery is carried by said projectile.

5. In a projectile propelling and directing system, the combination as defined in claim 4, wherein the guide wire is carried by and extended from a reel element in the projectile.

6. In a guided projectile system, the combination of, an elongated cylindrical projectile adapted for free ballistic flight in space,

a light-weight portable tubular launcher for said projectile,

a high-low ballistic cartridge for said launcher having a combustible propellant charge for launching said projectile into an initial limited ballistic flight range, guidance means for the projectile in flight having directional remote control elements selectively responsive to applied electric control currents,

an axially extending rocket engine connected with and carried by said projectile for applying a forward thrust to propel said projectile to an extended range in a trajectory path beyond said initial limited ballistic flight range and for applying gas operating pressure to said remote control elements,

operating-current supply means including a thermal

7

electric battery positioned to be self energized in response to applied heat of combustion in the launching and the heat of combustion of the rocket engine during ballistic flight of said projectile, and means including a multi-conductor electric cable connected to transmit control currents from said battery to selectively operate said guidance means and effect remotely-guided flight of said projectile.

7. In a guided projectile system, the combination as defined in claim 6, wherein the elongated tubular launcher is open at the forward end and closed at the breech end by releasable closure means adapted for loading said launcher with successive ballistic cartridge loads, and wherein means are provided for venting the interior of

8

said launcher on opposite sides thereof including two rearwardly-discharging nozzle elements.

References Cited

UNITED STATES PATENTS

2,421,522	6/1947	Pope	89—1.818
2,981,061	4/1961	Lilligren	244—3.22 X
2,986,973	6/1961	Waxman	89—1.703
3,088,988	5/1963	Menke	102—49 X
3,096,616	7/1963	Edman	102—49 X
3,156,185	11/1964	Hermann et al.	89—1.8 X

SAMUEL W. ENGLE, *Primary Examiner.*