March 31, 1959 H. P. G. A. R. VON ZBOROWSKI 2,879,955

AIRBORNE BODIES, AND IN PARTICULAR SELF PROPELLED MISSILES

Filed July 22, 1952 2 Sheets-Sheet 1

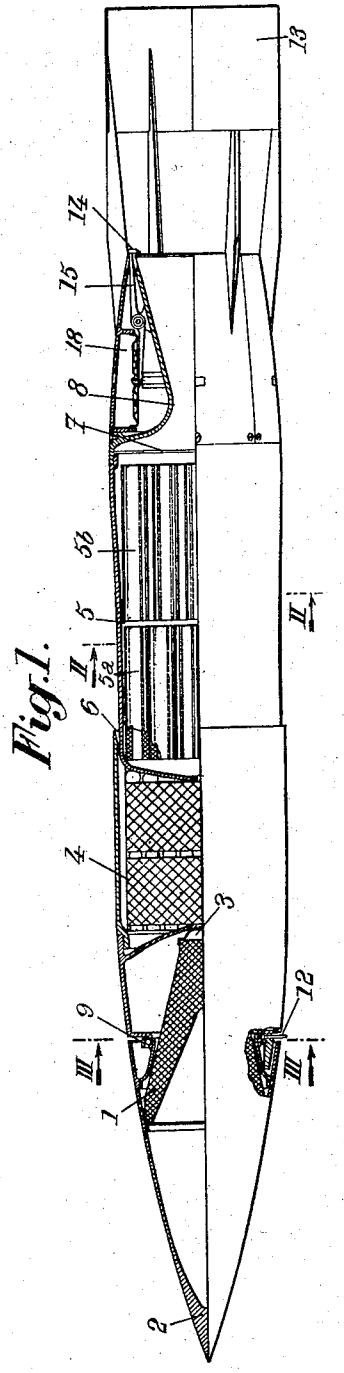


Fig. 1.

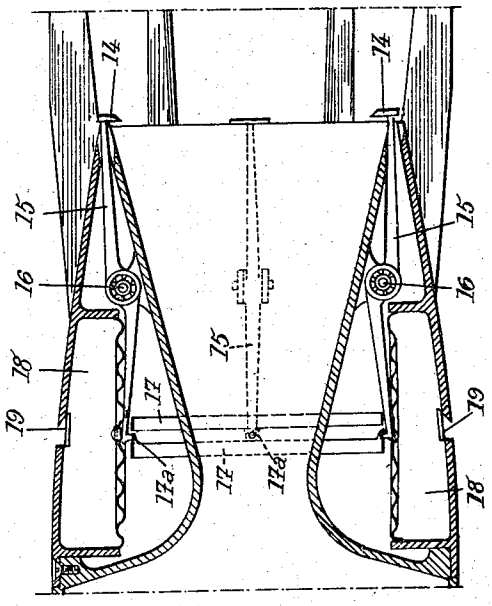


Fig. 4.

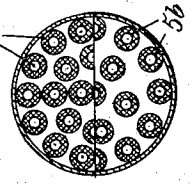


Fig. 2.

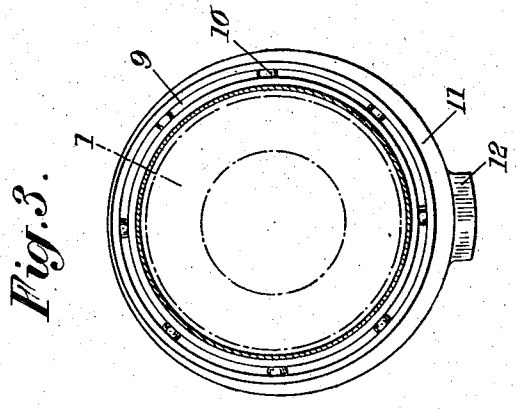


Fig. 3.

INVENTOR
HELMUT PH. G.A.R. VON ZBOROWSKI

BY Bailey, Stephens & Hunting

ATTORNEYS

March 31, 1959 H. P. G. A. R. VON ZBOROWSKI 2,879,955

AIRBORNE BODIES, AND IN PARTICULAR SELF PROPELLED MISSILES

Filed July 22, 1952 2 Sheets-Sheet 2

Fig. 5.

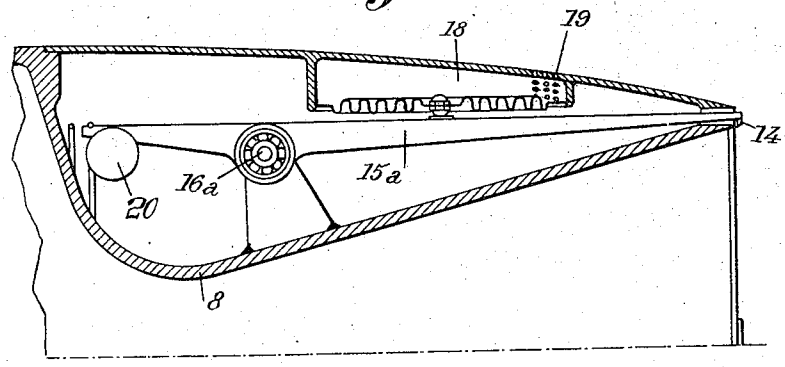


Fig. 6.

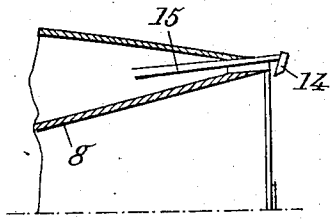


Fig. 7.

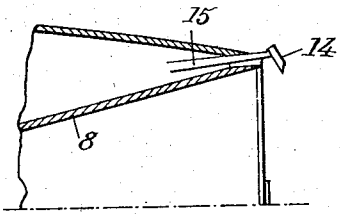


Fig. 8.

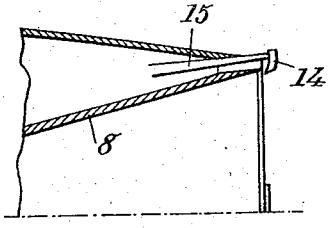
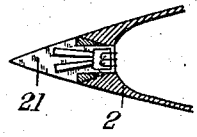


Fig. 9.



INVENTOR:
HELMUT PH. G.A.R. von ZBOROWSKI

BY
Richardson, David and Nordon
ATTORNEYS.

United States Patent Office 2,879,955 Patented Mar. 31, 1959

2,879,955

AIRBORNE BODIES AND IN PARTICULAR SELF PROPELLED MISSILES

Helmut P. G. A. R. von Zborowski, Brunoy, France

Application July 22, 1952, Serial No. 300,222

Claims priority, application France August 2, 1951

9 Claims. (Cl. 244—14)

The present invention relates generally to airborne bodies (this expression including all bodies travelling through air and having an aerodynamic lift) which carry a charge of matter (for instance a propellent, a fuel, etc.) which is being consumed as said body is travelling. My invention is more particularly concerned with rocket-propelled devices, and especially with missiles carrying a destructive explosive charge.

The object of my invention is to provide a body of this kind which is better adapted to meet the requirements of practice than those known at the present time.

According to my invention, such a body includes, in combination with aerodynamic control means for giving said body a positive incidence or upwardly inclined attitude with respect to its path of travel, so that an aerodynamic lift is constantly maintained which opposes the action of gravity on said body, means (which may be constituted by the above mentioned charge of matter itself, suitably arranged for this purpose) for automatically varying this lift in accordance with the consumption of said matter so as to compensate, either fully or partly and in accordance with a predetermined law, for the variation of weight of this body resulting from the consumption of its charge of matter.

Other features of my invention will become apparent in the course of the following description thereof with reference to the accompanying drawings, given merely by way of example, and in which:

Fig. 1 shows an anti-tank missile according to my invention, the top part being in axial section and the lower part in elevation, with portions cut away;

Fig. 2 is a cross section on the line 11—11 of Fig. 1;

Fig. 3 is an enlarged section on the line III—III of Fig. 1;

Fig. 4 is a sectional view on an enlarged scale of a detail of Fig. 1;

Fig. 5 is a diagrammatical view illustrating a modification of the same detail;

Figs. 6 to 8 are diagrammatical views showing different arrangements of a spoiler included in the device shown by the above mentioned figures;

Fig. 9 shows a modification of the armored head of the missile.

The following description relates to an anti-tank projectile. This projectile includes the following elements:

(*a*) A war head including a hollow charge 1, a hollow armored point 2 located ahead of said hollow charge and capable of opening a passage for said hollow charge in any protective structure located in front of the tank armor wall proper, and charge igniting means 3 such for instance as a delayed action detonator capable of starting the explosion of the hollow charge 1 after the armor point 2 has already opened a passage through the protective structure of the tank;

(*b*) A main propelling system 4, advantageously of the powder rocket type;

(*c*) A starting or launching propelling system 5 fixed on the projectile and which is also preferably of the powder rocket type; and

(*d*) Means for enabling the projectile to have, and keep, along its path of travel, a lift such that at least a portion of its trajectory is nearly rectilinear.

Preferably, the main propelling system is disposed in line with and ahead of the starting propelling system and I provide, for the jet of combustion gases issuing from the main propelling system, an annular nozzle or outlet 6 (or a plurality of outlet orifices disposed annularly).

Furthermore, according to my invention, account being taken of the fact that the weight of the engine and the position of its center of gravity vary as a consequence of the consumption of powder, means are provided for causing the ratio of the total weight of the projectile to the aerodynamic lift thereof (controlled through means which will be hereinafter described) to comply with a predetermined law fixed in accordance with the desired path of travel of the projectile.

If the path of travel is to be substantially rectilinear (which is desirable in order to increase the probability of striking a given target), this weight to lift ratio should remain substantially equal to 1.

For this purpose, the propelling system 4 may be arranged so that the variation of its thrust and/or the displacement of the center of gravity of the projectile resulting from the consumption of the powder used for this propelling system comply with the above mentioned law.

Concerning the "thrust" factor, the propelling system should be arranged in such manner that this thrust decreases as more and more powder has been consumed so that, for a constant incidence or attitude of flight, the lift decreases simultaneously with the total weight and at the same rate, whereby the ratio of weight to lift remains constant.

As for the factor concerned with the position of the center of gravity of the projectile, it is controlled in such manner that the couple of forces due to the fact that the center of lift and the center of gravity do not coincide, and which assists in producing the angle of inclination, decreases as the total weight decreases. Thus, the incidence, and therefore the lift of the projectile will decrease as the total weight decreases as a consequence of the consumption of powder. It will be possible, by a suitable choice of the law determining the relative displacement (due to the consumption of powder) of the center of gravity with respect to the center of lift, to obtain such conditions that the weight to lift ratio remains substantially constant as the projectile is travelling.

In both cases, it will be advantageous to give the powder bars which constitute the reserve of propulsive energy a suitable shape to obtain the desired result.

As the propulsive thrust depends upon the area of the surface of each bar that is burning, it will be readily understood that non cylindrical bars of revolution give a law of variation of the thrust which depends upon the shape of their generatrices.

As for the displacement of the center of gravity, it is determined by a law which depends upon the shape of the bars and their positions. It is possible to so arrange the device that the center of gravity of the main propelling system is located, after combustion of the powder of the starting or launching propelling system, at the rear of the center of gravity of the whole projectile, combustion of the powder of the main propelling system then producing a frontward displacement of said total center of gravity and therefore a decrease of the angle of incidence.

It should be noted that it will be advantageous to arrange the main propelling system 4 so that it keeps the speed substantially constant during the duration of the flight (balancing of the drag), a speed of about 500

metres per second being considered as favorable for this kind of projectile, because it makes it possible to use a launching propelling system of relatively small weight, to obtain a sufficient perforating power of the armored point 2 and to reduce the duration of flight to values compatible with the destruction of moving targets (from 2 to 3 seconds for targets located at 1000–1500 metres).

Concerning the launching propelling system 5, it is arranged, as already indicated, in such manner that its envelope is incorporated in the projectile body, to avoid the dangers which would be run by troops located ahead of the launching station, if this launching system were detached after it has played its part.

On the other hand, it is advantageous to distribute the powder bars of the launching propelling system in at least two groups, disposed in tandem-like fashion with respect to each other, the bars 5*b* of the rear group being fewer in number and at a greater distance from each other than the bars 5*a* of the front group.

This propelling system further includes a frangible rear diaphragm 7 of a resistance such that it is destroyed only when the internal pressure of the system, after igniting thereof (preferably electrical igniting), has reached a predetermined value, for instance about 100 kgs. per square centimeter, the combustion gases then escaping through nozzle 8.

Advantageously, the envelope of the auxiliary propelling system is given a slightly convergent shape toward the front, which facilitates the arrangement of the outlet nozzle 6 of the main propelling system (without increasing the maximum diameter of the projectile), and is further favorable for aerodynamic stability.

Such an auxiliary propelling system achieves a high stability of combustion and an improved safety concerning the critical internal pressure not to be exceeded.

To give the projectile a positive or upwardly inclined incidence on its trajectory and to maintain this incidence, the projectile is fitted with an aerodynamic control system subjected to the action of a weighted or pendular device so that the incidence remains constantly positive and of the same value regardless of the position of the projectile when it turns about its longitudinal axis.

Such a control system is for instance constituted, as shown by Figs. 1 and 3, by a ring 9 freely rotatable in the interval between the hollow charge 1 and the main propelling system (advantageously with the interposition of a ball bearing 10), a counterweight 11 and a spoiler 12 projecting slightly from the outline of the projectile cross section, these two elements being located on the same side of ring 9, so that said spoiler always projects from the lower portion of the projectile and creates in this region a zone of aerodynamic over-pressure capable of producing the desired positive incidence. Although the pressure of the air on the spoiler will have some tendency to exert a downward torque on the nose of the missile, the dimension of the spoiler is such that this torque is much less than the upward aerodynamic pressure created in front of the spoiler, so that the resultant thrust on the nose of the missile is upward.

A tail unit, preferably constituted by a rear annular wing of a diameter equal to the caliber of the projectile, is advantageously provided for stabilizing said projectile on its trajectory.

But if this tail unit is adapted to work satisfactorily at the supersonic speed for which the projectile is designed, it might happen that, during the launching period (where the speed is subsonic and the stabilizing effect of the tail unit is relatively small), the axis of the projectile should assume the wrong direction. In particular, when the projectile is passing from subsonic to supersonic speed, it could be stabilized only by means of a tail unit of a diameter greater than that of said projectile.

In order to obviate this difficulty, I make use of an arrangement illustrated by Figs. 1 and 4.

I provide, at the outlet of the nozzle 8 of the launching propelling system, adjustable deflectors, for instance a plurality of spoilers 14 (four in the example illustrated), distributed at equal angular intervals along the periphery of the nozzle and capable, when they are made to project into the gas jet (as shown for the lower spoiler in Fig. 4), of deflecting said jet and therefore of modifying the direction of the propulsive thrust.

These spoilers are operated by a system, for instance including dynamic air intakes, sensitive to angular displacements of the axis of the projectile so as to exert a correcting effect tending to return the projectile axis into its initial direction.

Preferably, I couple diametrically opposed spoilers with each other through a device having some flexibility, so that the operation of one causes the other to be brought into retracted position. For this purpose, for instance, every spoiler 14 is mounted at one end of a lever 15 pivoted in its middle part about an axis 16, the other end of this lever being coupled with the corresponding end of the diametrally opposed lever through a ring element 17, which is made flexible in order to avoid play.

It is therefore necessary, in the example shown by the drawing, to provide two flexible rings 17, disposed one behind the other. However, the points where the respective levers 15 are in contact with these rings must all be located in the same plane at right angles to the axis of the projectile. For this purpose, every lever 15 bears against a small projection 17*a* of the edge of the corresponding ring 17, this projection extending toward the rear for the front ring 17 and toward the front for the rear ring 17, whereby the centers of these four projections are located in the same transverse plane.

The dynamic air intake control means may be constituted, as shown by the drawing, by four manometric boxes 18 the inner walls of which are flexible and bear respectively against the forward ends of levers 15 (which forward ends in turn bear against elastic rings 17) and the outer walls of which, constituted by the envelope of the projectile, are provided with respective air intakes 19.

If it is desired to collect a portion of the dynamic pressure when the projectile gets slightly inclined on its trajectory, it is advantageous to give a sharp bevelled shape to the rear edge of each orifice 19, as shown by Fig. 4. This rear edge might be made to project from the wall of the projectile to increase the air inflow.

On the contrary, if it is desired merely to utilize the variations of static pressure taking place on the rear part, of smaller diameter, of the projectile body, when said projectile assumes an undue oblique position on its trajectory, I may, as shown by Fig. 5, provide holes 19 having straight edges and locate the point where the flexible walls of boxes 18 act upon levers 15*a* between the fulcrums 16*a* of these levers and the corresponding spoilers.

Preferably, in order to take into account the fact that the counterweight 11 of the rotary control member (spoiler 12) tends to bring the center of gravity of the projectile away from the axis of symmetry thereof, means will be provided for slightly deflecting the thrust so that it passes exactly through this center of gravity. Such means may be constituted, as shown by the drawings, by applying a small gravity load on the levers 15 which control spoilers 14, this load being constituted, for instance, by the weight of rings 17 in the construction of Fig. 4 and by a special counterweight 20 in the construction of Fig. 5.

It should be noted that, in all cases, the reaction of the propulsion jet on the spoiler in active position interferes with the actuation of this spoiler, due to the reaction component exerted perpendicularly to the direction of said jet.

In order to eliminate this drawback, or at least to reduce it considerably, the spoilers are made in such manner as to reduce the importance of this transverse component.

For this purpose, in the construction of Fig. 6, the

spoilers are inclined toward the front with respect to the jet and in this case the residual transverse component facilitates the displacements of the spoiler toward its active position under the action of its manometric box.

In the construction of Fig. 7, the spoilers are inclined toward the rear, in which case it is the displacement toward retracted position which is facilitated.

In the construction of Fig. 8, the spoilers have a curved shape (determined by experiments and calculation) such that the transverse component is reduced or eliminated.

A projectile such as above described may have its main elements made of a light metal or alloy so that it can be easily carried by an infantry man. It can be launched by means of a very simple tube. It will comply with the above stated conditions of velocity and straight trajectory.

It may be fitted with a target-seeking head, as shown at 21 in Fig. 9, for correcting its trajectory at the end of its travel, this head being preferably housed in an axial recess provided for this purpose in the armored point 2. This head will operate supplementary control members (for instance spoilers) distributed regularly over the periphery of the projectile body.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiment of my invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

What I claim is:

1. A rocket propelled device of the class described, comprising: a smooth elongated hollow body of generally circular cross-section, said body defining a combustion chamber; directing means carried by said device and maintaining said body in an upwardly inclined attitude during flight thereof through the atmosphere for producing an aerodynamic lifting force acting on the surface of said body; a combustible propellant charge disposed in said combustion chamber, said charge being formed to produce gaseous products of combustion at a varying rate, the manner of variation of said rate being predetermined by said formation of said charge; and nozzle means communicating with said chamber for directing said gaseous combustion products rearwardly to produce a thrust for forward propulsion of said device, the magnitude of said thrust being controlled by said formation of said charge to maintain said lifting force continuously at a value which decreases in accordance with the loss of total weight of said device accompanying combustion of said charge.

2. A device according to claim 1, in which lifting force is maintained at a value substantially equal to said total weight.

3. A device according to claim 1, wherein said directing means maintains said upward inclination unchanged and in which the relationship between said lifting force and said total weight of said device is determined solely by said formation of said charge.

4. A device according to claim 1, wherein said combustible charge has its own center of gravity disposed rearwardly of the center of gravity of said entire device including said charge, whereby combustion of said charge will cause the center of gravity of said device to move forwardly during the course of said combustion and decrease the angle of said inclination to decrease said lifting force in accordance with the decrease in the total weight of said device.

5. A rocket propelled device of the class described, comprising a body defining a combustion chamber; nozzle means communicating with said chamber for directing gases formed therein rearwardly to produce a thrust for propelling said device forwardly; means for causing said body to assume an upwardly inclined angle for producing an aerodynamic lifting force during flight of said device through the atmosphere; a propellant charge disposed in said combustion chamber, said propellant charge being shaped to expose a continuously decreasing area for combustion, thereby producing gaseous products of combustion at a continuously decreasing rate, said rate of combustion decreasing in a structurally predetermined manner in accordance with the loss of weight of said device caused by combustion of said charge, said charge being so positioned with respect to the center of gravity of said device and the line of action of the force produced by said aerodynamic deflecting surface, that the angle of said inclination is controlled during the course of said combustion directly and solely as a concurrent result of said decreasing rate of combustion, together with the decrease in the weight of said device accompanying said combustion of said propellant charge and any displacement of the center of gravity of said device accompanying said combustion.

6. A device according to claim 5, wherein the angle of said inclination is continuously controlled to maintain the lift produced by said aerodynamic support substantially equal to the decreasing total weight of said device.

7. A self-propelled flying device which comprises, in combination, a streamlined body, a jet propulsion system for said body including a main propulsion engine and a launching propulsion engine located behind said main engine, a charge of fuel for each of said propulsion engines, the mass of the full charge of fuel of the main propulsion engine having its center of gravity located rearwardly of the center of gravity of said entire device, both of said engines being arranged to operate from the starting of said flying device but the mass of fuel of said launching engine being determined to last for only a fraction of the time of operation of said main engine, and aerodynamic means carried by said body for giving it a positive incidence position relatively to its trajectory.

8. A self-propelled flying device which comprises, in combination, a streamlined body, a jet propulsion system for said body including a main propulsion engine and a launching propulsion engine located behind said main propulsion engine, said launching propulsion engine including a rearwardly directed nozzle at the rear end of said body, a charge of fuel for each of said propulsion engines, the mass of the full charge of fuel of the main propulsion engine having its center of gravity located rearwardly of the center of gravity of said entire device, both of said engines being arranged to operate from the starting of said flying device but the mass of fuel of said launching engine being determined to last for only a fraction of the time of operation of said main jet engine, aerodynamic means carried by said body for giving it a positive incidence position relatively to its trajectory, deflector means movably supported by said body inside said nozzle for controlling the mean direction of the jet issuing therefrom, and aerodynamic means carried by said body and responsive to angular displacements, away from a predetermined position, of the axis thereof with respect to the direction of its trajectory for controlling said deflector means in response to said displacements to vary the direction of the jet to tend to restore said axis into said predetermined position with respect to said trajectory.

9. A self-propelled flying device which comprises, in combination, an aerodynamic streamlined body, vanes at the rear end of said body in planes substantially radial to the longitudinal axis thereof, a jet propulsion system carried by said body, said body having two jet passages opening rearwardly thereof, said jet propulsion means including means to supply propelling fluid to a first of said passages during launching only and to a second of said passages during a longer period at least after launching, deflector means movable with respect to said first passage for varying the mean direction of the fluid issuing therefrom during launching, and aerodynamic means carried by said body and responsive to angular displacements, away from a predetermined position, of the axis thereof with respect to the direction of its trajectory for controlling

said deflector means in response to said displacements to vary the direction of the fluid in said first passage during launching to tend to restore said axis into said predetermined position with respect to said trajectory.

References Cited in the file of this patent

UNITED STATES PATENTS

826,293	Unge	July 17, 1906
1,043,074	Davis	Nov. 5, 1912
1,459,198	Dunajeff	June 19, 1923
1,879,187	Goddard	Sept. 27, 1932
2,183,311	Goddard	Dec. 12, 1939
2,368,059	White	Jan. 23, 1945
2,395,809	Goddard	Mar. 5, 1946
2,420,932	Cornelius	May 20, 1947
2,421,522	Pope	June 3, 1947
2,426,239	Renner	Aug. 26, 1947
2,462,099	Hickman	Feb. 22, 1949
2,504,648	Chandler	Apr. 18, 1950
2,516,142	Nissen	July 25, 1950
2,520,433	Robinson	Aug. 29, 1950
2,594,766	Goddard	Apr. 29, 1952
2,605,607	Hickman	Aug. 5, 1952
2,621,873	Gordon	Dec. 16, 1952
2,724,237	Hickman	Nov. 22, 1955
2,816,721	Taylor	Dec. 17, 1957

FOREIGN PATENTS

797,933	France	Mar. 6, 1936
832,427	France	July 4, 1938