United States Patent [19]

Saholt et al.

[11] **3,867,893**

[45] **Feb. 25, 1975**

[54] **ROCKET-THROWN MISSILE**

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[22] Filed: **Feb. 11, 1960**

[21] Appl. No.: **8,201**

[52] **U.S. Cl.** .... **114/20 R,** 102/7, 102/49.5, 102/4, 244/3.25

[51] **Int. Cl.** **F42b 15/22**

[58] **Field of Search** 102/1.7, 4, 7, 13, 19, 102/49, 49.5; 244/14; 114/22, 20

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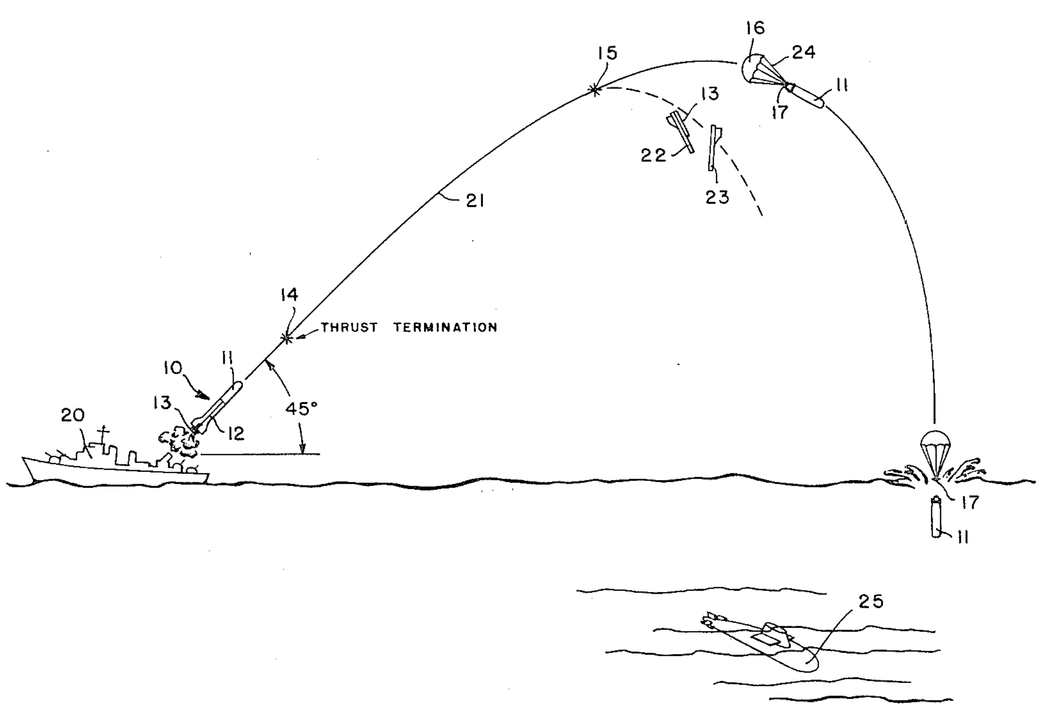
EXEMPLARY CLAIM

1. An anti-submarine weapon comprising, in combination: a payload apparatus effective to operate offensively against a target submarine when delivered to a suspect target area; an airframe separably joined to said payload apparatus; propulsion means carried by said airframe and operative to generate thrust to project said weapon into a ballistic airflight trajectory, said propulsion means having a characteristic maximum period of thrust generation; means including a first pre-settable control apparatus for effecting thrust termination at a first instant prior to expiration of said characteristic maximum period; means including a second presettable control apparatus for effecting separation and jettisoning of the airframe from said payload apparatus at a preselected later instant during ballistic airflight of said weapon; deceleration apparatus separably secured to said payload apparatus and arranged to become operative during separation and jettisoning of the airframe; and releasing means operative to effect jettisoning of said deceleration apparatus upon water-entry of said payload apparatus.

7 Claims, 9 Drawing Figures



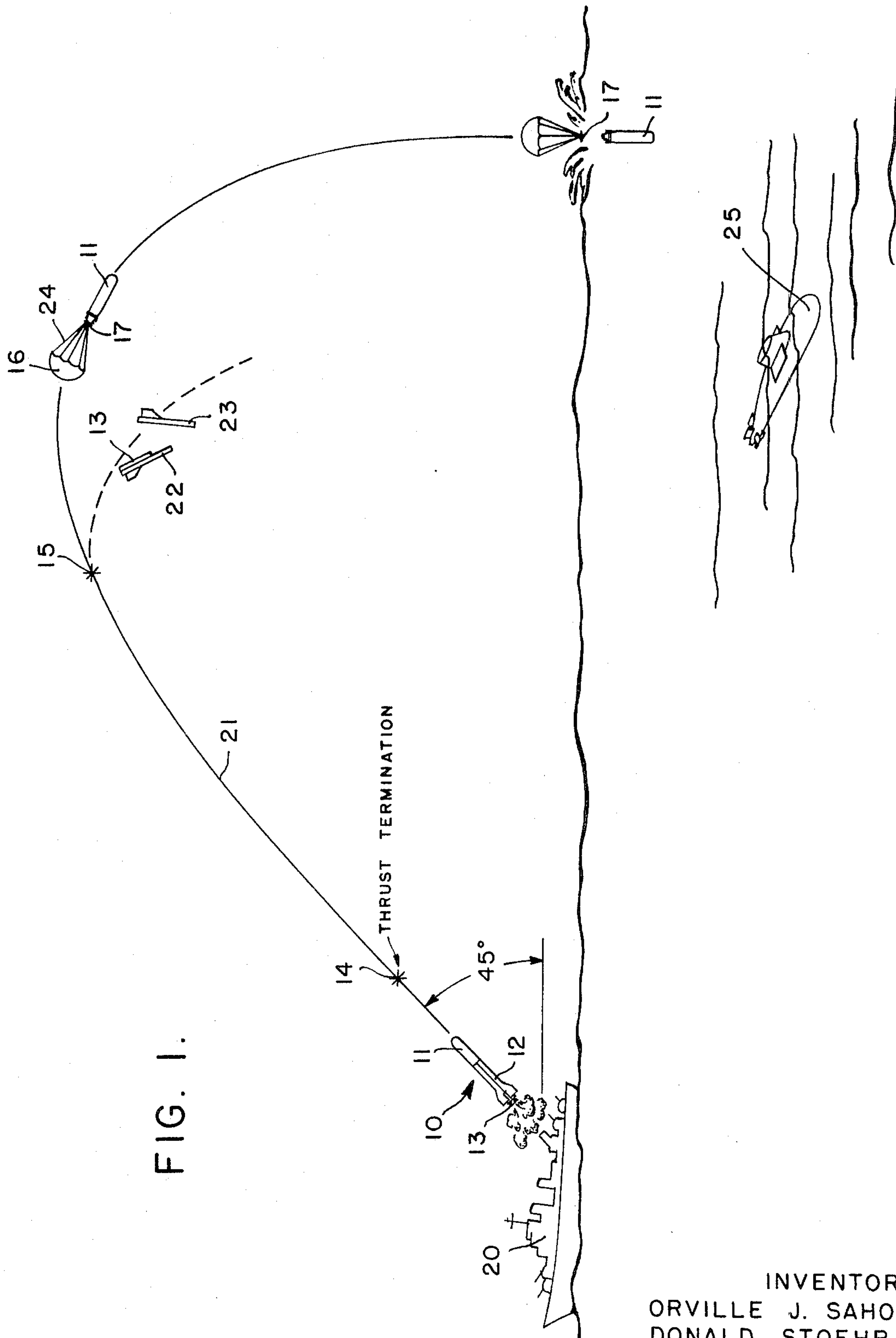


FIG. I.

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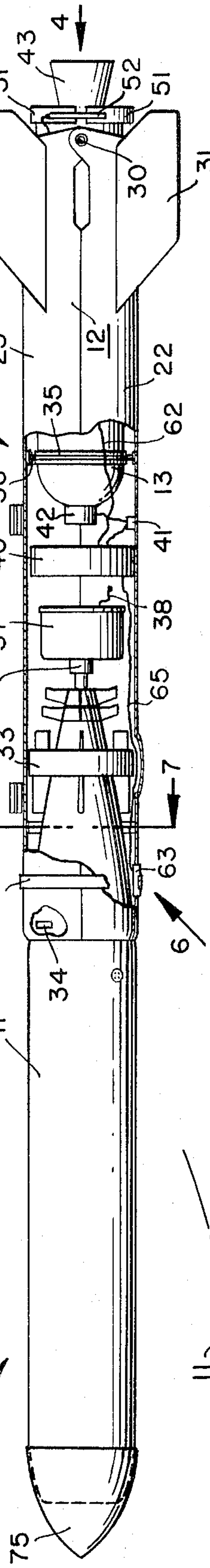

FIG. 2.

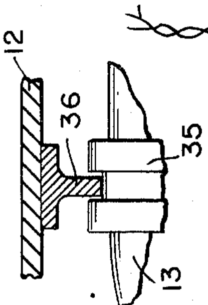

FIG. 3.

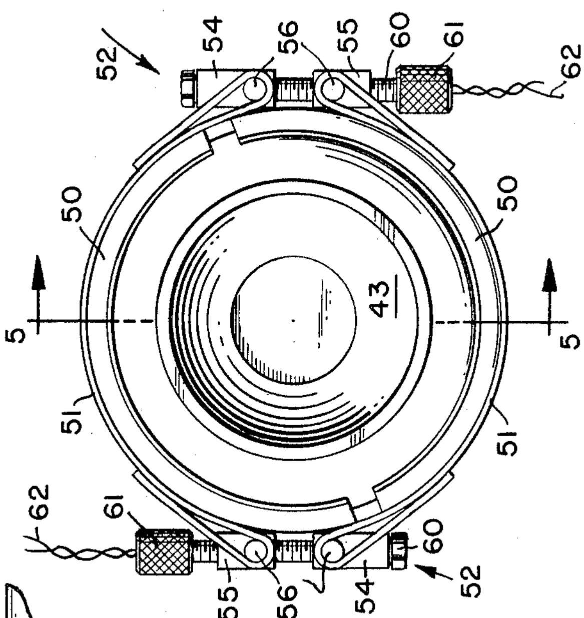

FIG. 4.

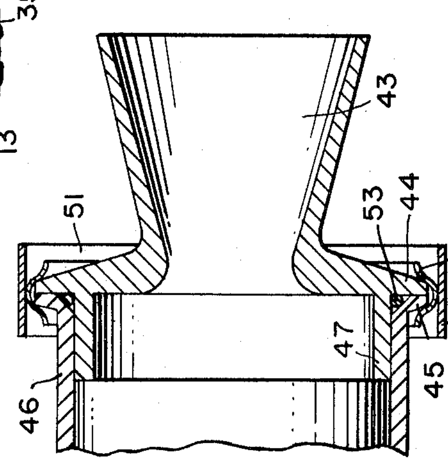

FIG. 5.

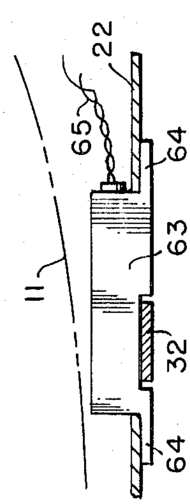

FIG. 6.

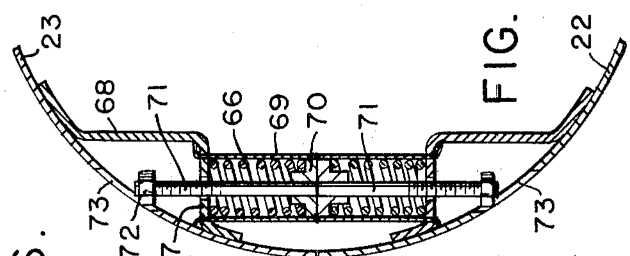

FIG. 7.

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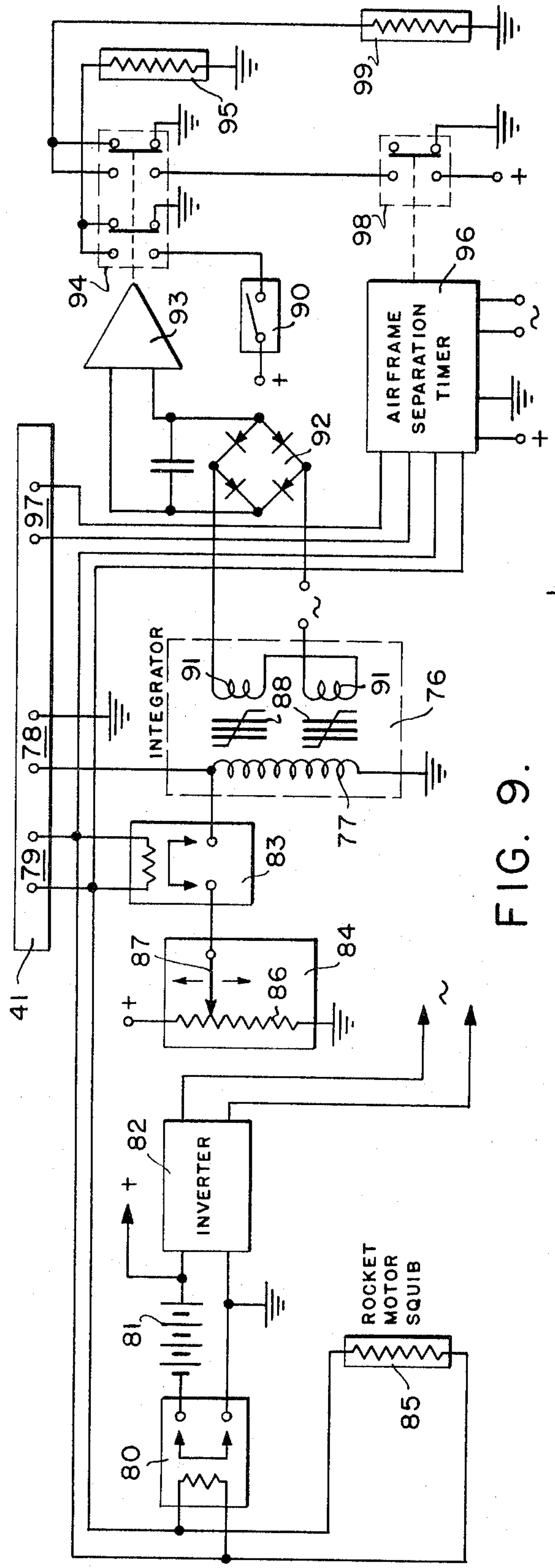

FIG. 9.

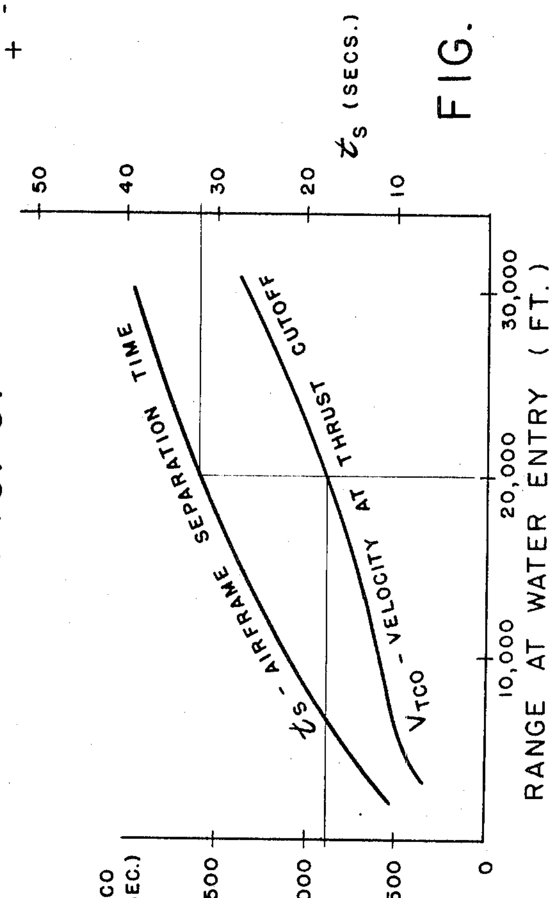

FIG. 8.

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ROCKET-THROWN MISSILE

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to ordnance equipment, and more particularly to recently developed rocket-thrown weapons of a type carrying an anti-submarine payload and characterized by a high-speed airflight phase but safely-reduced payload water-entry speed.

As disclosed in copending an commonly assigned patent applications Ser. No. 790,976 of H. G. Johnson et al. for "Missile," filed Feb. 3, 1959, and now U.S. Pat. No. 3,727,569, and Ser. No. 816,008 of J. T. Bartling et al. for "Rocket-Assisted Torpedo," filed May 26, 1959, and now U.S. Pat. No. 3,088,403, such type of anti-submarine weapon provides a practicable solution to the problem of effecting undamaged delivery of special payloads, such as homing torpedoes, to comparatively distant underwater target areas and in shorter times, thus with greater kill probability than is possible with earlier ship-borne homing torpedoes having principally an underwater mode of transport to the target area. In these recently developed weapons, the homing torpedo or other anti-submarine payload is carried by a rocket-powered airframe which is launched at substantially a 45° elevation angle. The rocket motor burns out after a comparatively short interval; the weapon continues at high speed in a substantially ballistic trajectory; the airframe separates, and a drag parachute secured by shroud-lines to the payload deploys, at a preselected time corresponding to the desired range; and the payload thereafter enters a descending path toward the suspect water area but under deceleration as imposed by the drag parachute. A parachute release coupling automatically separates the parachute from the payload, upon water entry thereof, in response to reduction in pull force. In accordance with prior art characteristics of such weapons, and within their adjustable-range capabilities, the water-entry range is dependent principally upon airframe separation time as measured from the weapon launching instant.

While it has become possible in recent years to detect submerged target submarines at comparatively long range, the rocket-thrown weapons disclosed in the previously mentioned copending applications and briefly described above are in actual practice limited to a maximum water-entry range of about 5,000 yards. This limitation stems from the requirement that, to find actual utility for fleet use, anti-submarine weapons must also be capable of attacking their targets at lesser ranges down to at least a minimum of the order of 1,500 yards. In the particular combination characterizing the above-described prior art rocket-thrown weapons, such minimum range requirement dictates limiting upper values upon the distance traversed and upon the velocity acquired by the weapon at the time of motor burnout, correspondingly forcing a limiting value upon the total impulse rating of the rocket motor and thus upon the maximum water-entry range attainable.

Proposals to employ a rocket motor of greater total impulse in the above-described prior art rocket-thrown weapons, in order to extend the maximum range thereof, and to then obtain lesser ranges down to the desired minimum simply by operational changes such as by setting airframe separation time to a lesser value than motor burnout time, perhaps in combination with launching at other than a 45° elevation angle, have been found impractical.

It is accordingly the principal object of the present invention to provide a practical adjustable-range rocket-thrown weapon carrying an anti-submarine payload and having improved capabilities as to upper and lower range limits at which delivery and undamaged water-entry of its anti-submarine payload can be effected.

It is another object of the present invention to provide a practical rocket-thrown weapon carrying an anti-submarine payload and effecting delivery and undamaged water-entry thereof at a range preselectedly variable between a desired lower limit and an extended upper limit and with improved range accuracy.

Other objects and attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

FIG. 1 depicts diagrammatically and in general manner the above-water operational characteristics of the improved anti-submarine weapon;

FIG. 2 illustrates the overall configuration of the improved weapon and the stationing of various components therein;

FIG. 3 is a sectional view taken in the region indicated by arrow 3 in FIG. 2, detailing the rocket motor supporting and retaining structure;

FIG. 4 is an end view taken along arrow 4 in FIG. 2, detailing the rocket motor nozzle-dropping arrangement employed for thrust termination;

FIG. 5 is a sectional view of the motor nozzle and holding structure taken along the line 5—5 in FIG. 4;

FIG. 6 is a detail view of the rupturable banding arrangement for the airframe, taken in the region indicated by arrow 6 in FIG. 2;

FIG. 7 is a sectional view taken along line 7—7 in FIG. 2, detailing an ejection spring arrangement employed in the airframe;

FIG. 8 is a composite graph illustrating typical combinations of thrust-termination velocities and airframe-separation times for providing desired water-entry ranges of the disclosed weapon; and

FIG. 9 is a schematic circuit diagram of the thrust termination and airframe separation control circuits.

The improved rocket-thrown anti-submarine weapon provided in accordance with the present invention is based upon the concept of making the water-entry range of the weapon a function not simply of airframe separation time as heretofore, but also strongly dependent upon still another factor, specifically upon rocket motor thrust termination earlier than normal burnout time and in response to preselected elapsed time, distance traversed, or velocity acquired. The rocket-thrown anti-submarine weapon here disclosed thus presents a novel combination employing, in concert, two principles each effecting large control over water-entry range and in a manner making it possible to satisfactorily and reliably achieve an extended maximum water-entry range and a heretofore incompatible minimum water-entry range.

FIG. 1 of the drawing illustrates diagrammatically and in general manner the airflight path of the improved anti-submarine weapon 10 embodying the present invention, and the sequence of events which lead to delivery of the weapon's payload 11 to a suspect water area at a safely reduced water-entry speed. Described later in greater detail, the weapon **10** comprises an airframe **12**; the payload **11** extending from the forward end of the airframe and severably joined thereto; reaction propulsion means which is preferably a solid propellant rocket motor **13** carried in the stern portion of the airframe **12**; means for terminating rocket motor thrust prior to burnout and at a point **14**, along the airflight path, preferably corresponding to a preselected velocity acquired; means for separating the airframe from the payload at a preselected later point **15** along the airflight path; a parachute pack secured to the stern end of the payload and arranged to deploy its parachute **16** very soon after airframe separation; and a parachute coupling release mechanism **17** which frees the payload from the parachute at water entry.

Impelled by rocket propulsion, the weapon **10** projects itself from any suitable launcher (not shown), carried by say a destroyer or other warship **20** and trained at an angle of substantially 45° for maximum range capability. The weapon accelerates and its velocity increases until rocket motor thrust is terminated, as at point **14**, under control of preset programming apparatus and in response preferably to sensing of a velocity of predetermined magnitude, which velocity is related to a predetermined but later occurring airframe separation instant and in accordance with the particular range desired. Following thrust termination, the weapon continues at high speed along an essentially ballistic trajectory **21** until, at a point **15** corresponding to and reached at the airframe-separation instant determined by the preset programming apparatus, explosive separation devices carried by the weapon are detonated to rupture a banding arrangement and to thus release hinged members **22, 23** of the airframe from engagement with the payload **11.** The hinged members then open away from the payload, and in so doing serve as airbrakes to retard the airframe assembly relative to the payload. In the course of such retardation, a parachute-opening lanyard, extending from the packed parachute and secured to the airframe, comes under tension and breaks as the parachute canopy **16** pulls out, the airframe then tumbling free as indicated. The payload **11** continues in airflight toward the suspect area but along a non-ballistic path because of parachute drag, the payload descending at an increasingly steep angle, as indicated, and with decrease in speed to a safe water-entry value. At water entry of the payload **11**, the reduction in pull force then experienced by the shroud-lines **24** causes the coupling mechanism **17** to unlock, releasing the parachute **16** and enabling the payload **11** to proceed umimpeded in its underwater phase of attack against the target submarine **25.**

In view of the foregoing, it will be understood that the anti-submarine weapon disclosed herein is intended for use with a fire control system such that the training direction of the weapon launcher and the thrust cutoff and airframe separation control circuits in the weapon itself may be suitably set in accordance with target information to result in delivery of the weapon to the suspect or predicted target area. This presetting may be accomplished simply by manual control before launching; in its most advanced version, such a system may be fully automatized to continuously provide training orders for the weapon launcher, and thrust cutoff and airframe separation orders for the weapon itself, so that the weapon is always suitably set and ready to be fired at any instant in the period during which the launching vessel is at suitable position and range relative to the target submarine to be attacked. Further description of suitable fire control systems, however, is not included herein since details thereof are unnecessary to an understanding of the present invention which is concerned with the weapon per se. It should also be understood that the representation in FIG. 1 is simply schematic, and that the anti-submarine weapon **10** therein is shown in exaggerated relative size for ease of illustration.

FIG. 2 illustrates in greater detail the type of construction which may be employed for the improved rocket-thrown weapon **10,** and typical stationing of certain components therein. Payload **11** in the illustrated embodiment is a homing torpedo, in this instance having a shroud ring type of tail section structure. Airframe **12** is essentially a bivalvular structure, comprising a pair of semi-cylindrical shell members **22, 23** formed of suitably strong sheet material and hinged together at their rearmost extremities by pivot bolts **30.** A cruciform configuration of fins **31** secured to airframe **12** serves to provide aerodynamic stability and to reduce ballistic dispersion of the weapon.

When closed against payload **11** and rocket motor **13,** and so maintained by a metal band **32** as shown, the bivalvular members **22, 23** bear tightly against shroud ring **33,** and securely grasp the payload **11** by any suitable means such as thrust lugs (not shown) secured to the inner surfaces of bivalvular members **22, 23** and mating with recesses **34** provided in payload **11** as indicated. Rocket motor **13** may be supported and maintained in aligned position, within the airframe, by means of say a pair of thrust rings **35** (one hidden from view in FIG. 2) secured to the rocket motor, and channeled, as detailed in FIG. **3,** to mate with flanges of a corresponding pair of rib members **36** having upper and lower arcuate sections secured to the inner surfaces of the bivalvular members. Rocket motor **13** may further be secured to the lower bivalvular member **22,** for example simply by strap means (not shown).

Canister **37,** secured to a stub extension of the torpedo propeller shaft by means of a releasable couple mechanism **17,** encases the parachute which after deployment effects payload deceleration. This canister pack is of the type used with aircraft launched torpedoes, wherein the parachute canopy shroud lines are secured to the canister, and wherein the canopy is arranged to be withdrawn by means of static line **38.** Static line **38** is anchored by any suitable means to the lowermost member **22** of the airframe, and extraction and deployment of the parachute canopy is thus accomplished automatically when the airframe separates from the payload at a predetermined instant after launching. Coupling mechanism **17** is an automatic release device such as that described in U.S. Pat. No. 2,880,687 to C. A. Kilvert, dated Apr. 7, 1959, functioning to jettison the canister **37** and its attached parachute in response to reduction in pull force experienced by the coupling mechanism upon water impact of the payload.

Container **40,** stationed within the airframe as shown, and secured by any suitable means to the lower airframe member **22,** encases programming apparatus which operates to provide properly timed squib-firing voltages to effect thrust cutoff and airframe separation. Electrical connector **41,** mounted upon the airframe **12** and cabled to the rocket motor igniter assembly 42 and to the programming apparatus as indicated, may be of any type adapted for use with a mating break-away connector (not shown) through which programmer setting and rocket motor firing orders are supplied by the fire control system.

In the prototype weapon embodying the present invention as disclosed herein, thrust termination prior to rocket motor propellant burnout is accomplished by use of a separable motor nozzle arrangement, as detailed in FIGS. 4 and 5. Nozzle member 43 is provided with a circumferential flange 44 for abutting a like flange 45 formed upon the motor tube 46, and further provided with a short annular extension 47 which fits into motor tube 46 without binding action. The nozzle member us maintained in operative association with the motor tube, until the instant at which thrust cutoff is to be effected, by means of a clamping assembly including clamping ring segments 50, strap members 51, and a pair of explosive bolt devices 52. An annular groove is provided between flanges 44 and 45 as shown to accommodate an O-ring seal 53 to precent leakage of the pressurized gas produced by the burning propellant of the rocket motor.

The explosive bolt devices each comprise a ferrule 54 and a nut 55 each having laterally extending studs 56 which engage the looped ends of strap members 51, and a bolt 60 which slidingly fits through the ferrule and threadedly engages the nut to tension the strap members and thus clamp the nozzle member 43 into operative engagement with motor tube 46. These explosive bolt devices are of a conventional type wherein an electrical squib is accommodated within an axial bore formed in the bolt shaft to extend into the bolt section between ferrule and nut 55 in order to effect rupture of that section when the squib is fired. The squibs are held in place by capped members 61 which are apertured to pass the squib leads 62 which connect to the programming apparatus.

Upon firing of the electrical squibs of explosive bolt devices 52 and resultant release of strap members 51 and clamping ring segments 50, nozzle member 43 is expelled due to internal motor pressure. Not only is the propellant grain (not shown) of the motor then substantially extinguished due to the decreased and insufficient pressure at the fully open mouth of motor tube 46, but the propellant grain itself is then also ejected because of the differential pressure within the motor tube 46; thrust cutoff is thus effected as a result of nozzle separation.

Airframe release, at a predetermined instant during airflight of the missile, is effected by use of one or more explosive block devices 63 which, when fired, rupture the banding 32. A suitable arrangement is illustrated in FIG. 6, a cross-sectional view taken at the point indicated by arrow 6 in FIG. 2, F.-250°F. explosive block device 63, fitting into a corresponding opening in airframe 12, is provided with lugs 64 restraining it from displacement, and further provided with a recess accommodating banding 32. As in the rocket-thrown weapons described in the previously mentioned copending applications, explosive block device 63, containing an electrical squib (not shown) having leads 65 extending therefrom to the programmer as indicated in FIG. 2, may be of basically conventional type adapted to direct the squib explosion force against the banding 32.

FIG. 7 illustrates an ejection spring arrangement which may be employed at each side of the airframe to insure that the bivalvular members 22, 23 of the airframe will begin opening away from payload 11 immediately after banding 32 has been ruptured. In this arrangement, ejection springs 66 are under compression between seats 67 of the brackets 68 bonded to the bivalvular members. Spring-guide tubes 69 may be included and secured to brackets as shown. The inner ends of the ejection springs bear against plugs 70 which are secured to guide rods 71, the latter extending through clearance holes formed in the preparation seats 67. The outer ends of the guide rods thread into nuts 72 as shown, and access holes 73 are provided in the 28, 1974. members, for the purpose of enabling springs 66 to be initially constrained in a compacted condition by tightening nuts 72, in order to facilitate assembly and copending of the bivalvular members 22, 23 against the payload 11.

It will be understood that the anti-submarine payload 11 may be conventional in all respects except for adaptive modification such as provision of recesses 34 to engage with thrust lugs of the airframe as has been described. For example, where the anti-submarine payload is a homing torpedo as in the illustrated embodiment, the torpedo may be of aircraft launched type in which arming, self-energization and other functions may be controlled by timing mechanisms, or by means of hydrostat switch assemblies, or by any other conventional techniques. As indicated, the torpedo may also be fitted with a frangible nose cap 75, such as described in U.S. Pat. No. 2,889,772 to E. A. Howard, dated June 9, 1959, entitled "Protective Nose Cap for Torpedoes," to reduce water entry shock and to provide a more favorable aerodynamic configuration during weapon airflight.

Referring now to the programming apparatus which has been mentioned under description of FIG. 2 as encased in container 40, this may be of any type suitable to provide squib-firing voltages for thrust cutoff and airframe separation at sequential instants corresponding to pre-adjusted settings and predetermined to provide any desired water-entry range, in accordance with the present invention. Rocket motor thrust termination, in particular, may for example be effected in response to elapsed time or to distance traversed or any other selected factor, but is preferably made dependent upon the sensing or determination of an acquired velocity of predetermined magnitude, which factor or velocity must be related to a predetermined but later occurring airframe separation instant, for a given water entry range. By way of example, the graph given in FIG. 8 illustrates typical combinations of thrust cut-off velocities and airframe separation times corresponding to desired water entry ranges, say for a weapon as described having a total weight of approximately 900 pounds, powered by a rocket motor having a burning time of about 4 seconds and developing a total impulse of approximately 40,000 pound-seconds. In such instance, referring to the graph, a water-entry range of 20,000 feet would be obtained by terminating rocket motor thrust when the weapon acquires a velocity of 850 feet per second, and separating the airframe and developing the retardation parachute 32 seconds after launching.

The thrust cutoff and airframe separation control circuits, for use in the programming apparatus of the weapon disclosed herein, may be of any type adapted to deliver timed sequential squib firing voltages as described. The circuits should preferably be of a type which may be pre-adjusted continuously by a remotely located fire control system up to the instant of weapon launching. A simplified version of equipment particularly suitable for such use, employing principles described in copending and commonly assigned U.S. Patent application Ser. No. 784,002, entitled "Settable Magnetic Integrator," filed Dec. 30, 1958 by D. H. Wheeler, now U.S. Pat. No. 3,011,714, is illustrated schematically in FIG. **9.** It will be understood that all presetting, adjusting and firing orders are applied to the FIG. **9** circuit in the form of currents or voltages delivered by a suitable fire control system through a breakaway connector (not shown) to terminal pairs in electrical connector **41.**

In this instance motor thrust is terminated in response to a predetermined weapon velocity, the latter in effect being determined by integration of weapon acceleration. Integrator **76** is a reactor device which is first brought to a core saturation condition and then, until the weapon launch instant, continuously adjusted as to the extent of core desaturation, corresponding to the desired weapon velocity at which motor thrust is to be terminated. Such adjustment is made by control of the magnitude of current delivered to the integrator input winding **77** through terminal pair **78.** At the instant at which the weapon is to be launched, a firing voltage is delivered by the fire control system (not shown) to terminal pair **79,** actuating squib switch **80** which connects battery **81** in circuit to deliver voltage to circuit components as indicated, also placing inverter **82** in operation, actuating aquib switch **83** which connects accelerometer **84** in circuit, and igniting rocket motor squib **85** which effects launching of the weapon. Accelerometer **84** in this instance may be of any type which provides a d.c. output proportional to acceleration, for example comprising a linear potentiometer **86** connected as shown and having an arm **87** which is subjected to displacement in accordance with the acceleration experienced by the weapon along its line of flight. Accelerometer **84** accordingly delivers to integrator input winding **77** a voltage corresponding to weapon acceleration and tending to resaturate reactor cores **88.** The reactor cores **88** reach a resaturation condition at the instant that the time integral of the input voltage, (corresponding to the time integral of the weapon acceleration and therefore to the weapon velocity), overcomes the particular core desaturation condition (corresponding to the desired thrust-cutoff velocity) which was set in just prior to the launching instant.

At arming switch **90** may if desired be included in the circuit, as shown, this switch being operated by a conventional acceleration-sensitive safety and arming mechanism (not shown), and remaining in open condition until the weapon (and said mechanism) experience rocket motor thrust of predetermined magnitude and for a predetermined time during the thrust period, to insure against possible premature thrust cutoff at an unsafe distance from the launching warship.

At the instant of resaturation of cores **88,** the series impedance presented by output windings **91** changes to such low value that substantially the full magnitude of a.c. voltage input, applied from inverter **82** to the series circuit including output windings **91,** appears across bridge rectifier **92,** amplifier **93** then operating switch mechanism **94** to close the circuit which fires the electrical squib **95,** the latter representing the explosive elements of the explosive bolts **52** employed in the thrust cutoff separable nozzle arrangement as has been described.

Airframe separation timer **96** may be of any conventional type, and may for example be adapted to be preset by electrical order applied thereto via terminal pair **97** prior to the weapon launching instant, to be triggered into operation by the voltage applied to terminal pair **79** at the launching instant, and to effect operation of switch mechanism **98** when a predetermined time (corresponding to the electrical order) has elapsed as measured from the launch instant. The airframe separation timer **96** may, if desired, be of a type employing basically the same integrating and amplifier control technique as described above in connection with the thrust cutoff control circuitry, except that in such instance a predetermined constant voltage would be applied to the integrator input winding, during weapon flight, in place of the accelerometer-controlled voltage. Operation of switch mechanism **98** completes the firing circuit to the electrical squib **99,** which squib represents the explosive elements of the explosive block devices **63** (FIGS. **2** and **6**) employed to initiate airframe separation as has been described. In the illustrated instance the airframe separation firing circuit is interlocked with the thrust cutoff control circuit through normally open contacts of the switch mechanism **94,** as another safety measure to prevent possible occurrence of improperly early airframe separation and payload delivery.

It will now be understood that the novel combination as described herein yields a significantly improved rocket-thrown anti-submarine weapon which provides the long-sought capability of both greatly increased maximum range of attack and adjustability for attack against closer targets down to heretofore incompatible necessary minimum ranges. It will also be appreciated that while the detailed description of the invention has been given in terms of an embodiment specifically employing a conventional homing torpedo, other types of anti-submarine payloads may be used, e.g., of depth charge type having extremely high yield and adapted to detonate at a predetermined instant or at a predetermined depth or in response to others factors, details of the particular payload, however, forming no part of the present invention. In instances wherein the depth charge payload or other payloads are inherently sufficiently rugged to withstand water entry shock, it becomes feasible to eliminate the deceleration parachute and the associated automatic release device. Further, it will also be appreciated that thrust termination and airframe separation may if desired be effected in response to factors other than velocity and time, respectively, which were employed in the specific embodiment described herein, or effected by use of other control circuits, without departing from concepts of the present invention.

Obviously many modifications and variations of the described embodiment are thus possible, and it is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An anti-submarine weapon comprising, in combination: a payload apparatus effective to operate offensively against a target submarine when delivered to a suspect target area; airframe separably joined to said payload apparatus; propulsion means carried by said airframe and operative to generate thrust to project said weapon into a ballistic airflight trajectory, said propulsion means having a characteristic maximum period of thrust generation; means including a first presettable control apparatus for effecting thrust termination at a first instant prior to expiration of asid characteristic maximum period; means including a second pre-settable control apparatus for effecting separation and jettisoning of the airframe from said payload apparatus at a preselected later instant during ballistic airflight of said weapon; deceleration apparatus separably secured to said payload apparatus and arranged to become operative during separation and jettisoning of the airframe; and inches +means operative to effect jettisoning of said deceleration apparatus upon water-entry of said payload apparatus.

2. An anti-submarine weapon as defined in claim 1, wherein said airframe comprises hinged bivalvular members folded into clamping engagement with said payload apparatus and so maintained by banding means until severed at said preselected instant during ballistic airflight.

3. An anti-submarine weapon as defined in claim 1, wherein said payload apparatus is a homing torpedo for underwater search, pursuit and attack against a target submarine.

4. An anti-submarine weapon as defined in claim 1, wherein said deceleration apparatus comprises a packed parachute having its opening-lanyard anchored to said airframe to effect parachute canopy deployment during airframe separation and jettisoning.

5. An anti-submarine weapon as defined in claim 1, wherein said propulsion means is a solid-propellant rocket motor.

6. An anti-submarine weapon as defined in claim 1, wherein said propulsion means is a solid-propellant rocket motor including a motor tube of uniform diameter fitted with a separable nozzle structure, and wherein thrust termination is effected by jettisoning said nozzle structure.

7. An anti-submarine weapon comprising, in combination: a payload apparatus effective to operate offensively against a target submarine when delivered to a suspect area; an airframe separably joined to said payload apparatus; propulsion means carried by said airframe and operative to generate thrust to project said weapon into a ballistic airflight trajectory, said propulsion means having a characteristic maximum period of thrust generation; means including a first pre-settable control apparatus for effecting thrust termination at a first instant prior to expiration of said characteristic maximum period, in response to a preselected value of a first variable substantially corresponding to velocity acquired means including a second pre-settable control apparatus for effecting separation and jettisoning of the airframe from said payload apparatus at a preselected later instant during ballistic airflight of said weapon; and deceleration apparatus secured to said payload apparatus and arranged to become operative during separation and jettisoning of the airframe.

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