March 10, 1970 C. L. D'OOGE 3,499,364

APPARATUS FOR SUBMERGED LAUNCHING OF MISSILES

Filed Nov. 19, 1959 3 Sheets-Sheet 1

FIG. 1.

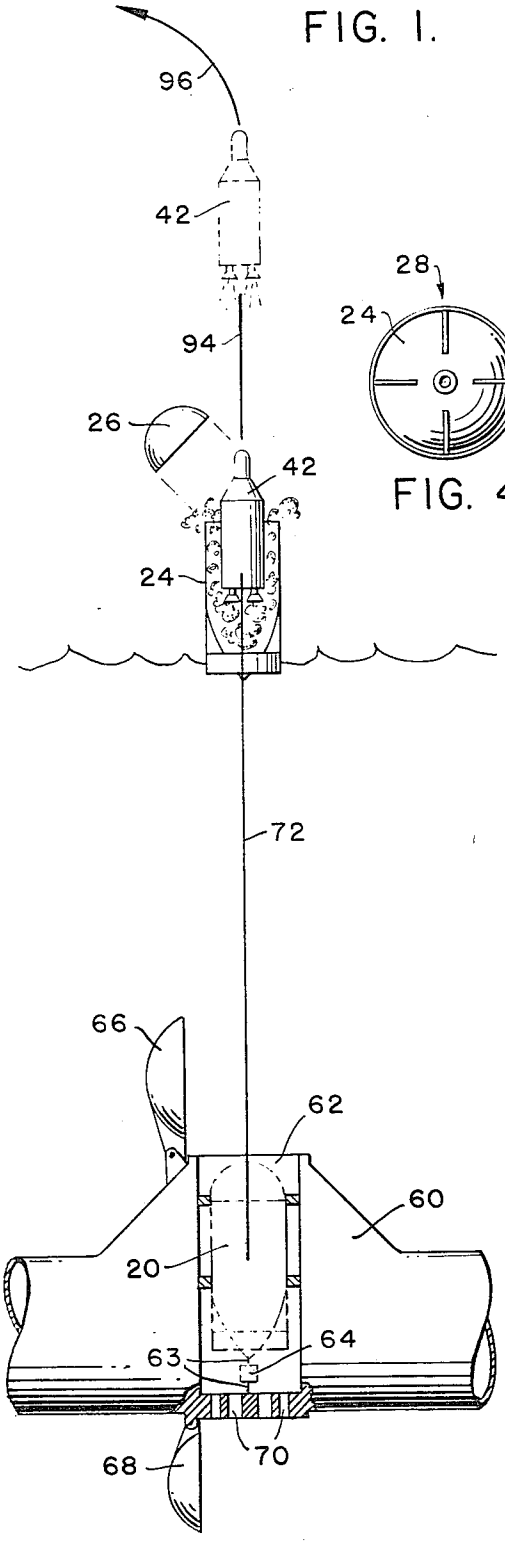
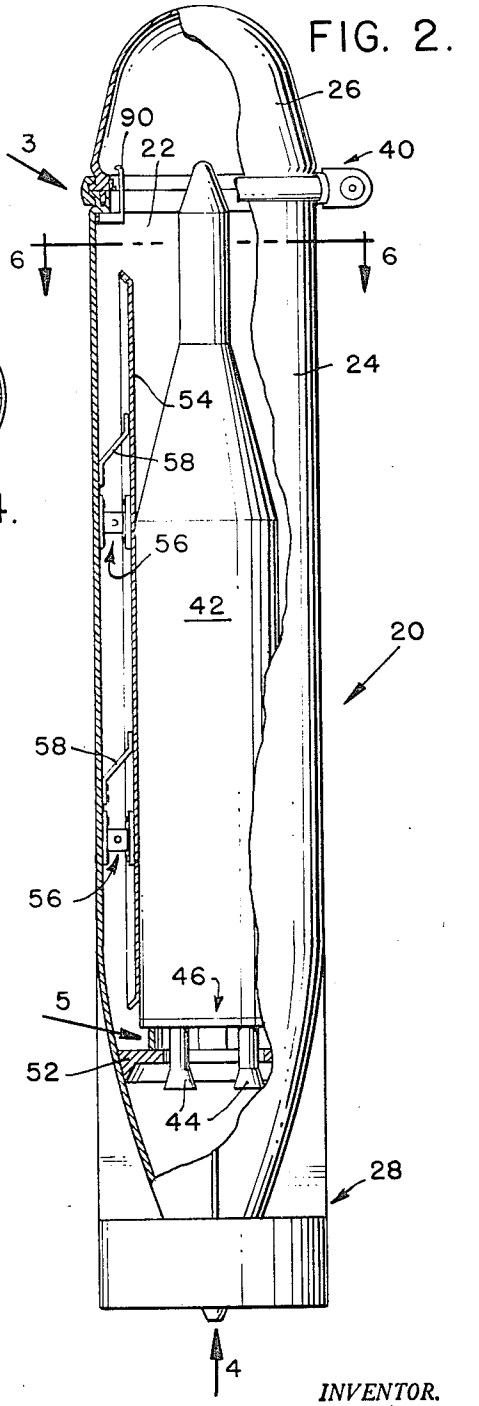


FIG. 4.

FIG. 2.



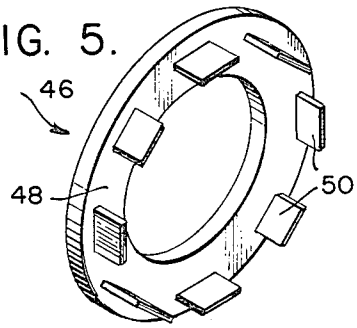
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APPARATUS FOR SUBMERGED LAUNCHING OF MISSILES

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FIG. 5.



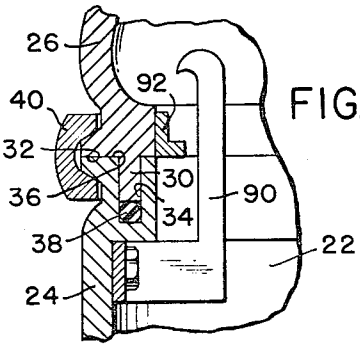
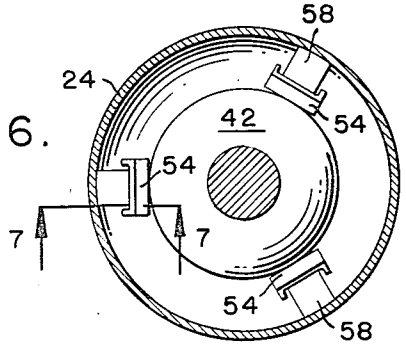


FIG. 3.

FIG. 6.



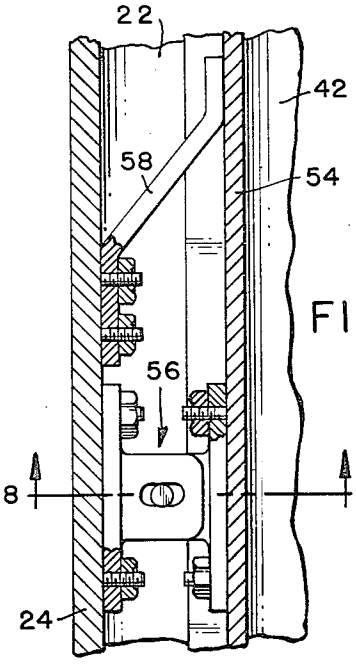


FIG. 7.

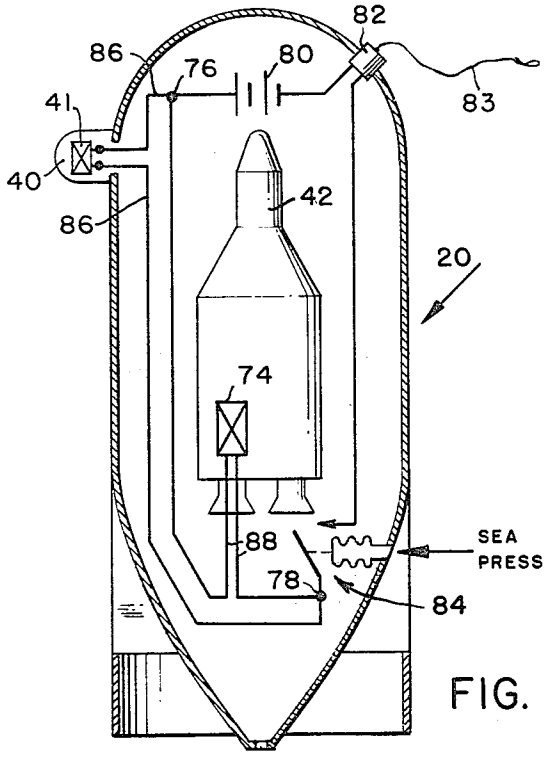


FIG. 9.

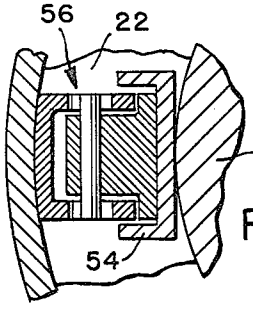


FIG. 8.

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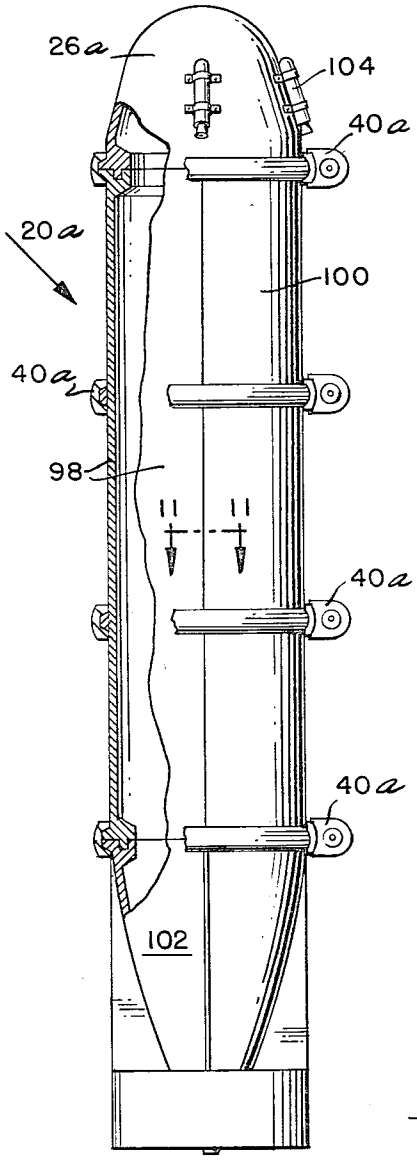


FIG. 10.

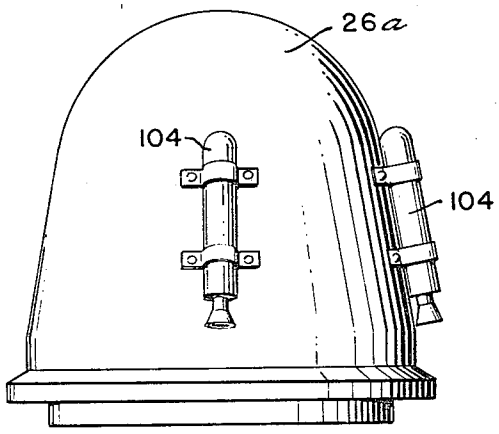


FIG. 12.

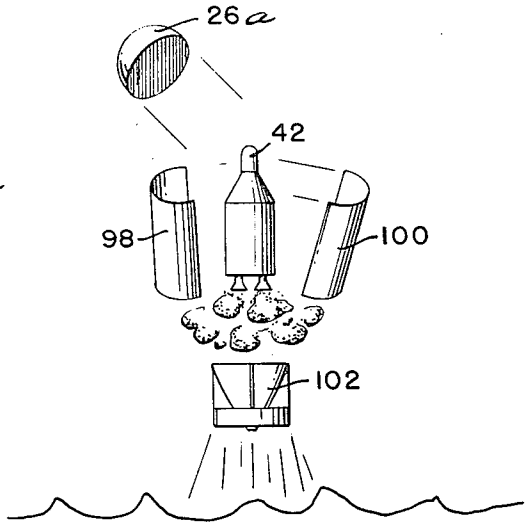


FIG. 13.

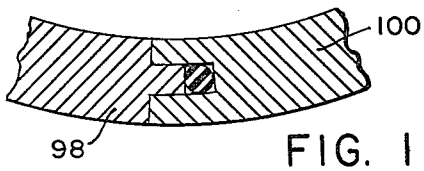


FIG. 11.

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APPARATUS FOR SUBMERGED LAUNCHING OF MISSILES

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Int. Cl. F41f 3/00, 3/04
U.S. Cl. 89—1.81 7 Claims

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 devices for launching airflight missiles.

One of the objects of the present invention is to provide method and apparatus for launching an airflight missile from a position below the surface of the water.

Another object is to achieve the aforesaid objective independent of the suitability of the missile for waterflight.

Another object is to provide a device for launching an airflight missile from a position below the surface of the water into a substantially vertical airflight trajectory.

Other objects and many of the 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 drawings wherein:

FIG. 1 is a schematic illustration of the operation of the device of FIG. 2;

FIG. 2 is a partially broken away side elevation of a device representing one form of the present invention;

FIG. 3 is an enlarged detail indicated by arrow 3, FIG. 2;

FIG. 4 is a reduced bottom plan of FIG. 2 as viewed in the direction of arrow 4;

FIG. 5 is a perspective detail indicated by arrow 5, FIG. 2;

FIG. 6 is a section taken along line 6—6, FIG. 2;

FIG. 7 is a section taken along line 7—7, FIG. 6;

FIG. 8 is a section taken along line 8—8, FIG. 7;

FIG. 9 is a schematic diagram of the electrical circuitry of the device of FIG. 2;

FIG. 10 is a partially broken away side elevation of another form of the invention;

FIG. 11 is an enlarged section taken along line 11—11, FIG. 10;

FIG. 12 is an enlarged side elevation of a portion of FIG. 10, and

FIG. 13 illustrates the operation of the device of FIG. 10.

Referring to the drawing and in particular of FIGS. 1 and 2, a capsule 20 comprises a main body section having a chamber 22 formed therein, a separable nose section 26 and a fin and shroud ring assembly 28 affixed to the tail end of the main body section. As best shown in FIG. 3, body section 24 and nose section 26 are secured together by a slip joint comprising an annular pilot portion 30 formed on edge portion 32 of the nose section which fits into matching annular pilot groove 34 formed in edge portion 36 of body section 24, which annular groove contains an O-ring 38 to seal the joint against entry of water. Nose section 26 is releasably fastened to body section 24 by a detachable connector ring assembly 40, such as disclosed in U.S. Patent No. 2,809,584, which assembly contains an electrically detonated explosive device 41, shown schematically in FIG. 9, which when actuated forces segments of the connector ring outward and away from one another freeing nose section 26. A self propelled airflight missile 42 having a rocket motor with exhaust nozzles 44 projecting from the tail end of the misile is disposed within chamber 22, the missile being supported therein in spaced relationship to the capsule structure to permit exhaust gases emanating from nozzles 44 to flow between the missile and the capsule. A base ring assembly 46, as best shown in FIG. 5, comprising an annular ring 48 having angularly spaced steel plates 50, 50 welded to one face thereof, is adapted to provide a footing for standing the missile on a supporting ring 52 affixed to the inner wall of the capsule, there being sufficient area between the plates 50, 50 to permit the flow of rocket exhaust gases therebetween when the rocket motor is ignited. Lateral support is provided by three equiangularly spaced guide rails 54, FIG. 6, connected to the inner wall of the capsule by support fixture assemblies 56 best shown in FIG. 7, adapted to permit a small amount of lateral movement, which guide rails are spring urged against the missile by flat spring elements 58 each having one of its ends secured by the capsule wall.

As best shown in FIG. 1, the capsule is launched from a submarine 60 having a fixed vertical tube 62. Prior to launching, the capsule 20 is held in tube 62 in the phantom line position shown in FIG. 1 by a connecting cable 63 having any suitable explosive bolt device 64 therein which when actuated severs the connection. Shortly before launching, the tube is flooded and a top hatch 66 and a bottom hatch 68 are opened, as shown, the bottom hatch being opened to provide communication between the sea and inlet ports 70, 70 at the bottom of tube 62 to permit water inflow as the capsule rises. Launching is initiated by actuation of explosive bolt device 64 releasing capsule 20 and allowing buoyant forces to act thereon as will hereinafter be described.

Capsule 20 is so chosen to displace a sufficient volume of water relative to the combined weight of the capsule and missile to provide positive buoyancy for projecting the capsule vertically upward. Accordingly, when released, the capsule rises in response to force of buoyancy from its phantom line position, FIG. 1, to the surface of the water, that it, the position whereat the capsule nose first breaks the surface of water, and further rises at least in part in response to the momentum theretofore acquired by the capsule, beyond the surface reaching at some time its full line position shown in FIG. 1. The capsule's configuration and drag characteristics, the distribution of the weight of the capsule and the missile, and the configuration of fin and shroud ring assembly 28, are so chosen to provide hydrodynamic and hydrostatic forces to cause the capsule to follow a vertical trajectory represented by solid line 72 in a nose up attitude while the encapsulated missile is rising. In particular, the velocity of rising is determined by the magnitude of buoyancy and the capsule drag characteristics; the configuration is so chosen to provide hydrodynamic stability; the capsule is caused to remain in a nose up attitude by distributing the weight of the capsule, missile and ballast if necessary along the longitudinal axis of the capsule with the center of gravity behind the center of buoyancy and center of pressure; and fin and shroud ring

assembly 28 provides sufficient stabilizing surface area at the tail end of the capsule, which remains submerged as the nose emerges from the water, to cause the missile to follow a stable vertical trajectory in rising beyond the surface of the water, overcoming surface wave effects and other effects tending to overturn the capsule during such portion of its trajectory.

Shortly before the capsule reaches its full line position of FIG. 1, a squib 74, adapted to fire the rocket motor, and the explosive element 41 of connector ring 40 are simultaneously ignited, initiating a sequence of events which are effective to permit egress of missile 42 from capsule 20. An electrical circuit shown in FIG. 9 is adapted to energize the explosive element 41 of the detachable connector ring assembly 40 and squib 74 when the capsule reaches a desired position relative to the surface of the water, as for example, the position whereat the fin and shroud assembly breaks the water, such circuit comprising a series network extending between terminal points 76 and 78 including a battery 80, a safety switch 82 which is operated by removal of a safety pin carried on the outer wall of the capsule, not shown, attached to a lanyard 83, and a hydrostatic switch 84 adapted to close when the capsule reaches the aforesaid position, with leads 86, 86 of the explosive element of the connector ring and leads 88, 88 of squib 74 connected in parallel between terminal points 76 and 78. It is to be understood that any suitable device adapted to operate in response to the capsule reaching a desired position relative to the surface of the water may be employed in place of a hydrostatic switch, as for example a double integrating accelerometer adapted to sense capsule displacement from its initial position. Accordingly, connector ring assembly 40 is broken away releasing its restraining effects on nose section 26 and the rocket motor is ignited generating gases which are expelled out of exhaust nozzle assembly 44 and which flow into the space between the missile and capsule communicating with all the portion of the latter through the gas venting area provided between plates 50, 50 and through the annular space between the lateral surface of the missile and the inner wall of the capsule. The capsule is rapidly pressurized projecting nose section 26 in a forward direction ahead of the capsule and the missile, the previously described slip joint between nose section 26 and main body 24 serving to maintain capsule pressurization during the initial displacement of nose section 26 to augment the accelerating effect of the gases on the nose section. Ejection of nose section 26 permits the rocket exhaust gases to vent out of the nose end of main body section. When nose section 26 is projected a short distance ahead of the capsule, a hook element 90 affixed to capsule 20, as best shown in FIG. 3, pivotally engages a hook engaging element 92 affixed to nose section 26 laterally deflecting the nose section 26 to clear the desired airflight trajectory of the missile, permitting free egress of the missile.

The rocket motor of missile 42 is adapted to project the missile in a direction along its longitudinal axis and shortly after it is ignited missile 42 travels forward relative to the capsule along guide rails 54, 54 reaching at some instant of time its full line position shown in FIG. 1 whereat the missile has partially emerged from the capsule. At this instant the rocket gases are partially contained by main body section 24 of the capsule augmenting their normal jet reaction effects. The gases also work against main body section 24 of the capsule tending to decelerate its motion in an upward direction, and when the direction of motion of the section is reversed, the gases force the section downward against the water. After leaving the capsule, missile 42 continues along a substantially vertical airflight trajectory, represented by solid line 94, until commanded by suitable guidance control means to follow a desired trajectory other than vertical, represented by solid line 96.

FIG. 10 illustrates an alternative form of invention differing from the device of FIG. 2 in that the capsule is adapted to more fully rupture, as is desirable in some instances where the skin of the missile is relatively fragile, to avoid prolonged contact between the exhaust gases and the skin of the missile. A capsule 20*a* comprises four separable shell sections. A pair of half cylindrical shell sections 98, 100 having slip joints along their longitudinal edge portions as shown in FIG. 11, like the previously described slip joint between main body section 24 and nose section 26 of the device of FIG. 2, are releasably fastened together to form a cylindrical main body portion by detachable connector ring assemblies 40*a* of which the two central assemblies are employed solely as banding. A nose section 26*a* and a tail section 102 are releasably fastened to the respective ends of the main body portion also by the connector ring assemblies at the ends. As best shown in FIG. 12, nose section 26*a* has several small auxiliary rocket motors 104, 104 nonsymmetrically mounted thereto to provide a laterally deflecting thrust. In launching, the detachable bands and connector ring assemblies, the auxiliary rocket motors, and the rocket propulsion motor of the missile are simultaneously actuated when the capsule reaches a predetermined position along its trajectory causing the four sections of capsule 20*a* to separate after the tail section 102 has completely emerged from the water as shown in FIG. 13, relieving the exhaust gases almost immediately after the rocket motor is ignited to avoid prolonged contact between the exhaust gases and the skin of the missile, as occurs in the device of FIG. 2 where the exhaust gases are partially contained by main body portion 24 as the missile emerges.

From the above it should be evident that the invention provides a device for launching an airflight missile from a position below the surface of water and that this result has been achieved independent of the suitability of the airflight missile for water flight and without the assistance of catapult means or auxiliary propulsion motor means for underwater flight. It has been found that the water exit trajectory of the capsule is sufficiently stable to launch a missile along a substantially vertical trajectory and that the invention may be employed to launch missiles having inertially guidance system which requires an initial vertical trajectory having relatively small pitch and yaw error angles.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. 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. Water exit capsule apparatus, for use in conveying an air flight rocket from a position beneath the water to a position above the water and for launching the rocket into rocket propulsion flight, said apparatus comprising:

(a) an elongated capsule for containing the rocket and forming a buoyancy impelled vehicle for conveying the rocket in a nose up attitude along a vertical trajectory to the surface of the water and therebeyond to a position in which the capsule is fully emerged from the water,

(b) means disposed in the capsule for supporting said rocket in spaced relationship to the interior wall of the capsule,

(c) means for firing the rocket at a moment when the capsule is fully emerged from the water to thereby pressurize the space between the rocket and interior wall of the capsule and rupture the capsule to permit egress of the rocket,

(d) the construction and arrangement of the capsule being such that it ruptures along predetermined rupture lines, said predetermined rupture lines including a plurality of longitudinally extending ruputre lines substantially co-extensive with the length of the rocket in its supported position within

the capsule, said plurality of rupture lines being disposed around the lateral wall of the capsule in angularly spaced relationship about the capsule axis, whereby the pressurized rocket propulsion gases which rupture the capsule are momentarily released along the length of the rocket to prevent damage to the rocket by the gases, and

(e) releasable means for circumferentially fastening said capsule against rupture along said longitudinally extending rupture lines, said releasable means being actuable to release the capsule for rupturing in timed relationship to the firing of the rocket.

2. Water exit capsule apparatus, for use in launching an air-flight rocket from a submerged position, comprising:

(a) an elongated capsule for containing the rocket and forming a buoyancy impelled vehicle for conveying the rocket in a nose up attitude along a vertical underwater trajectory to the surface of the water and therebeyond to a position in which the capsule is fully emerged from the water,

(b) means disposed in the capsule for supporting the rocket in spaced relationship to the interior wall of the capsule,

(c) said capsule being formed from a plurality of separable capsule sections, said sections being so constructed and arranged that the capsule sections part along a plurality of longitudinally extending parting lines co-extensive with the length of the rocket in its supported position within the capsule, said plurality of parting lines being disposed around the lateral wall of the capsule in angularly spaced relationship about the capsule axis,

(d) releasable means for fastening said separable capsule sections together, said releasable means being actuable to release the caspule sections thereby permitting them to part,

(e) means operative at a moment when the capsule is fully emerged from the water to simultaneously actuate the releasable means and fire the rocket, and

(f) adjoining edges of said capsule sections forming a cooperating slip joint adapted to retain pressure within said capsule during finite initial parting movement of said separable section to impart effective separating acceleration to the separable sections, whereby the separable sections are forced apart to permit egress of the rocket from the capsule in response to pressurization of the space between the rocket and the interior wall of the capsule by rocket propulsion gases and in a manner releasing the pressurized gases adjacent the rocket before they damage same.

3. Apparatus in accordance with claim 2, wherein:

(g) said capsule comprises three axial sections consisting of an integral nose section, an integral tail section and a composite central cylindrical section therebetween, said composite central section being composed of a plurality of separable longitudinally extending arcuate sections, and

(h) means for controlling the path of separation of said nose section to ensure that it travels clear of the air flight trajectory of the rocket.

4. Apparatus in acordance with claim 3,

(i) the adjoining edge portions of the nose section and the composite central section being adapted to be fastened by an exterior mounted connector ring, and the adjoining edge portions of the central section and the tail section being adapted to be fastened by an exterior mounted connector ring,

(j) said releasable means comprising first and second explosively sunderable connector rings for fastening the nose section and the central section and for fastening the central section and the tail section, respectively, and a plurality of axially spaced explosively sunderable bands disposed about the central section for fastening said arcuate sections together.

5. Apparatus in accordance with claim 2,

(k) said slip joint being of the type in which one of the adjoining edges forms a linearly extending protuberance and the other edge forms a groove for receiving the protuberance, and

(l) a rubbery seal is disposed at the bottom of the groove.

6. Apparatus in accordance with claim 3, wherein

(m) said means for controlling the path of the nose section comprises one or more lateral thrust rockets carried by the nose section and fired is simultaneous relation to actuation of the releasable means and firing of the rocket.

7. Airflight missile water exit apparatus, for use in launching a ballistic missile from an underwater position, said missile being of the type propelled by a rocket motor and having a guidance system including an inertial device which is referenced relative to a vertical take-off trajectory, said water exit apparatus comprising:

(a) an elongated capsule for sealing the missile against water prior to its emergence from the water, said capsule having front and rear ends,

(b) means for supporting said missile in said capsule in coaxial alignment with the capsule with the missile nose adjacent the front end of the capsule, and with the missile in axially spaced relationship from both the front and rear ends of the capsule, and in radially spaced relation to the interior lateral wall of the capsule, threby forming a buoyancy chamber about the missile,

(c) said capsule being formed from a plurality of separable capsule sections, said sections being so constructed and arranged to separate to permit egress of the missile from the capsule and with the capsule sections forming a plurality of longitudinaly extending parting lines co-extensive with the length of the missile in its supported position within the capsule, said plurality of parting lines being disposed around the lateral wall of the capsule in angularly spaced relationship about the capsule axis,

(c') releasable means for fastening said separable capsule sections together, said releasable means being actuable to release the capsule sections thereby permitting them to part,

(d) said capsule forming a hydrodynamic nose at its front end having ballast means, said buoyancy chamber, ballast means, and hydrodynamic nose being such that the force of buoyancy of the capsule impels same along a vertical underwater trajectory with the capsule in a vertical attitude during travel along the trajectory, and provides the capsule with sufficient momentum energy when the capsule reaches the surface that the capsule breaks through the surface and fully emerges from the water.

(e) said capsule forming a rearwardly tapering tail cone at its rear end, said tail cone being provided with appendant stabilization surfaces adapted to provide sufficient stabilizing force during the time the capsule breaks through the water to resist the overturning moment acting on the capsule as it emerges from the water, irrespective of wave motion at the surface of the water, whereby the capsule is conveyed to a position fully emerged from the water in vertical alignment with the vertical underwater trajectory,

(f) means for firing the rocket motor of the missile and actuating the releasable means when the capsule reaches said fully emerged position, whereby there sequentially occurs pressurization of the capsule, sudden release of the gases adjacent the missile by the parting of the sections along the longitudinal parting lines, separation of the capsule sections to permit egress of the missile, and upward movement

of the missile under force of its own rocket motor from its position of vertical alignment to thereby provide the necessary vertical take-off trajectory needed to provide reference for the missile guidance system.

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SAMUEL W. ENGLE, Primary Examiner

U.S. Cl. X.R.

89—1.817