SUSPENDED WATER-LAUNCHED MISSILE

Filed April 29, 1963 2 Sheets-Sheet 1

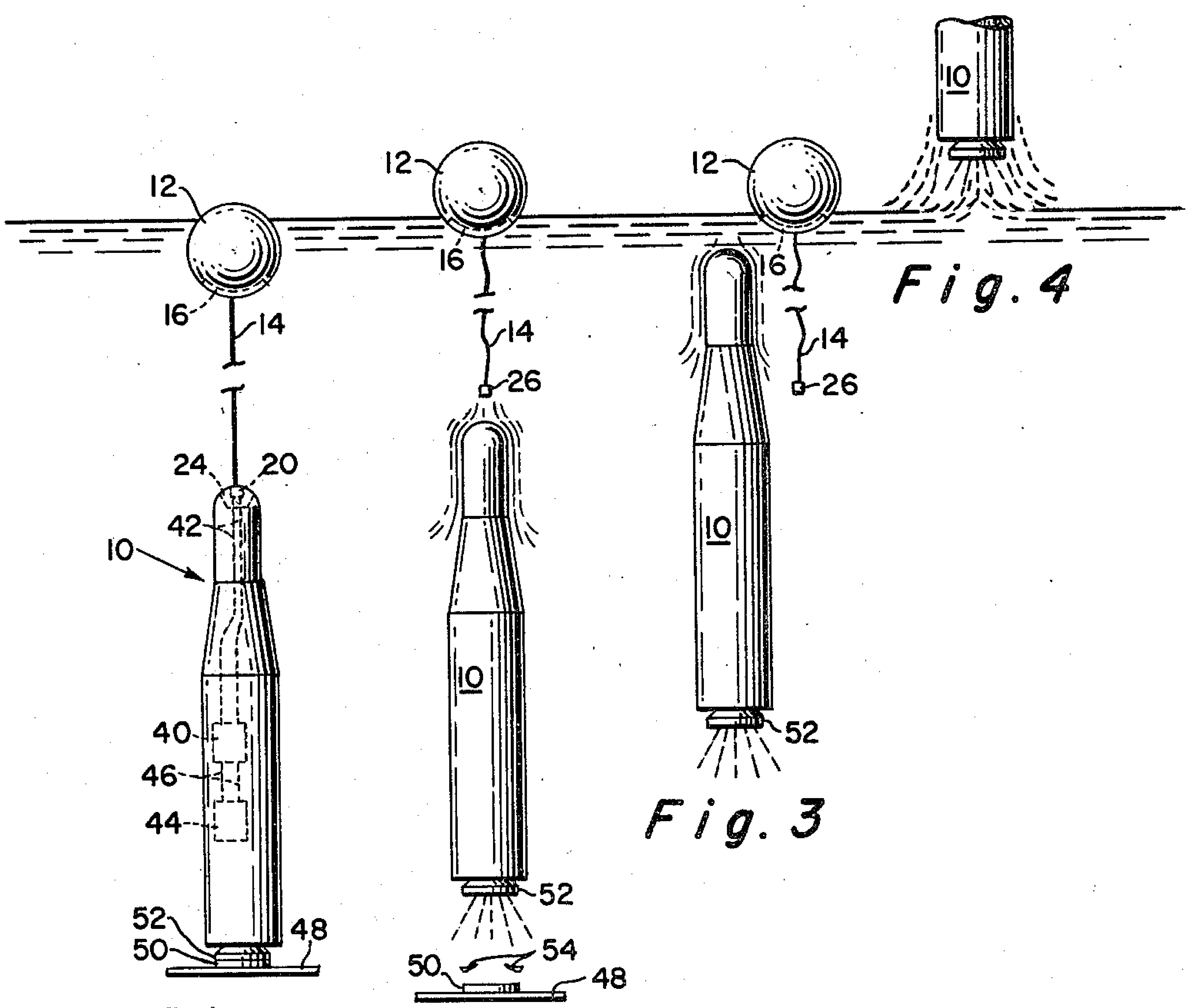

Fig. 1

Fig. 2

Fig. 3

Fig. 4

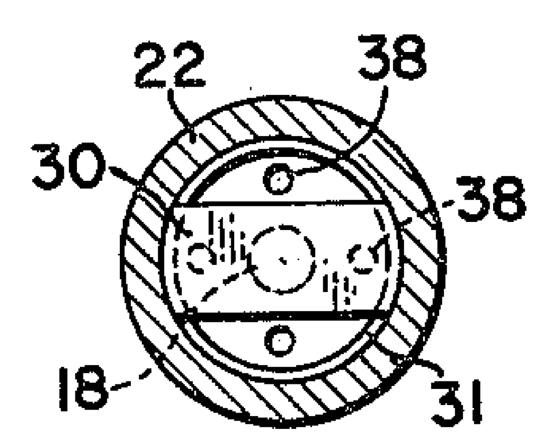

Fig. 6

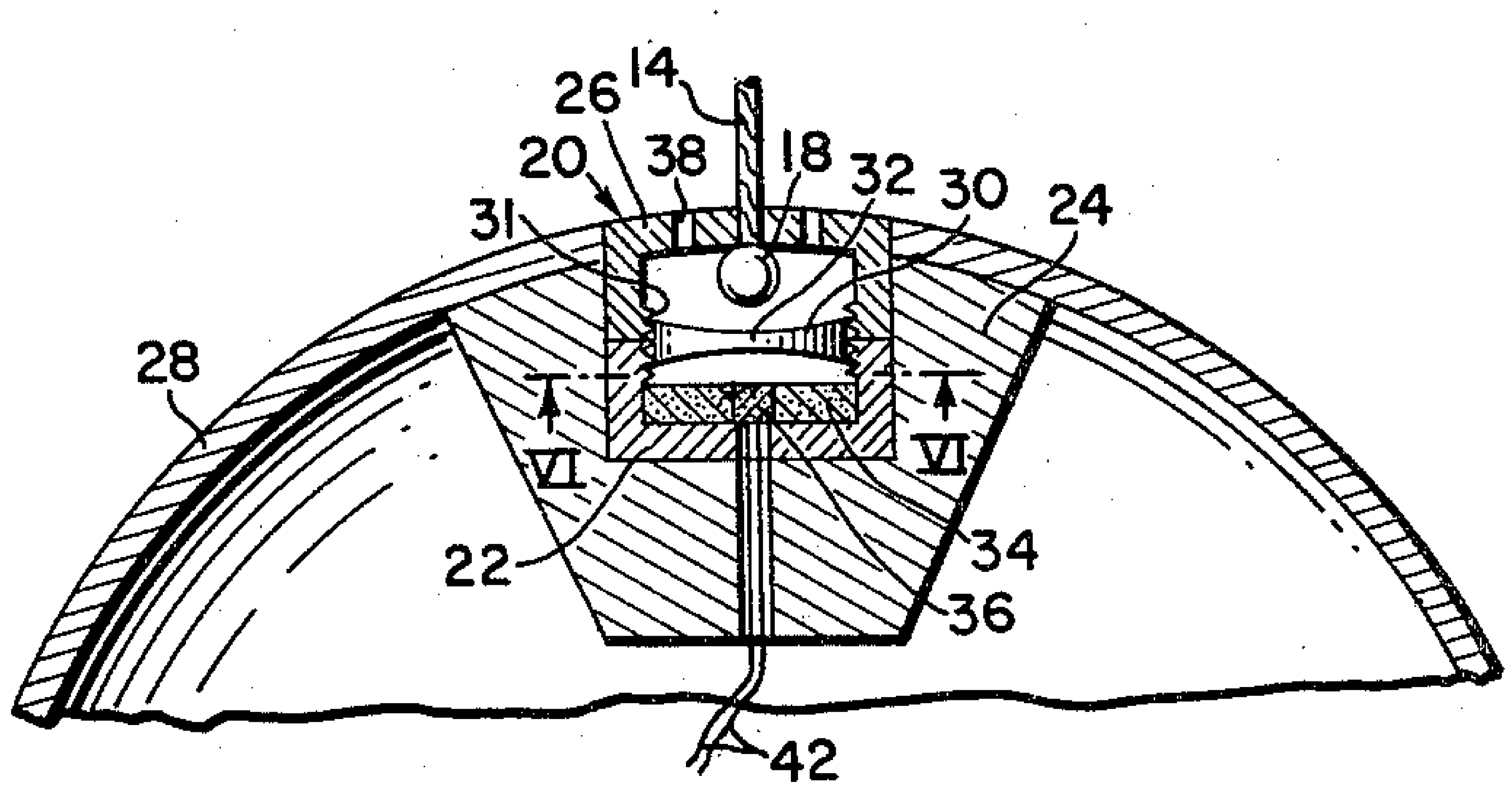

Fig. 5

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SUSPENDED WATER-LAUNCHED MISSILE

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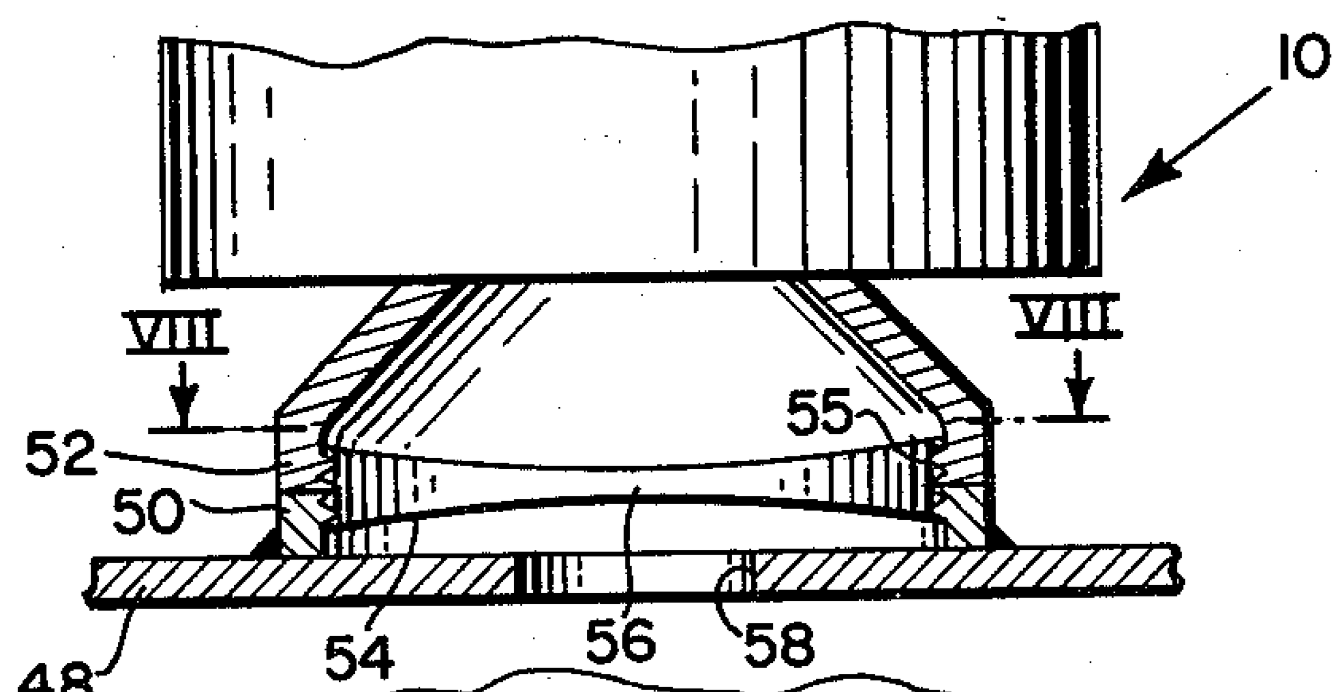


Fig. 7

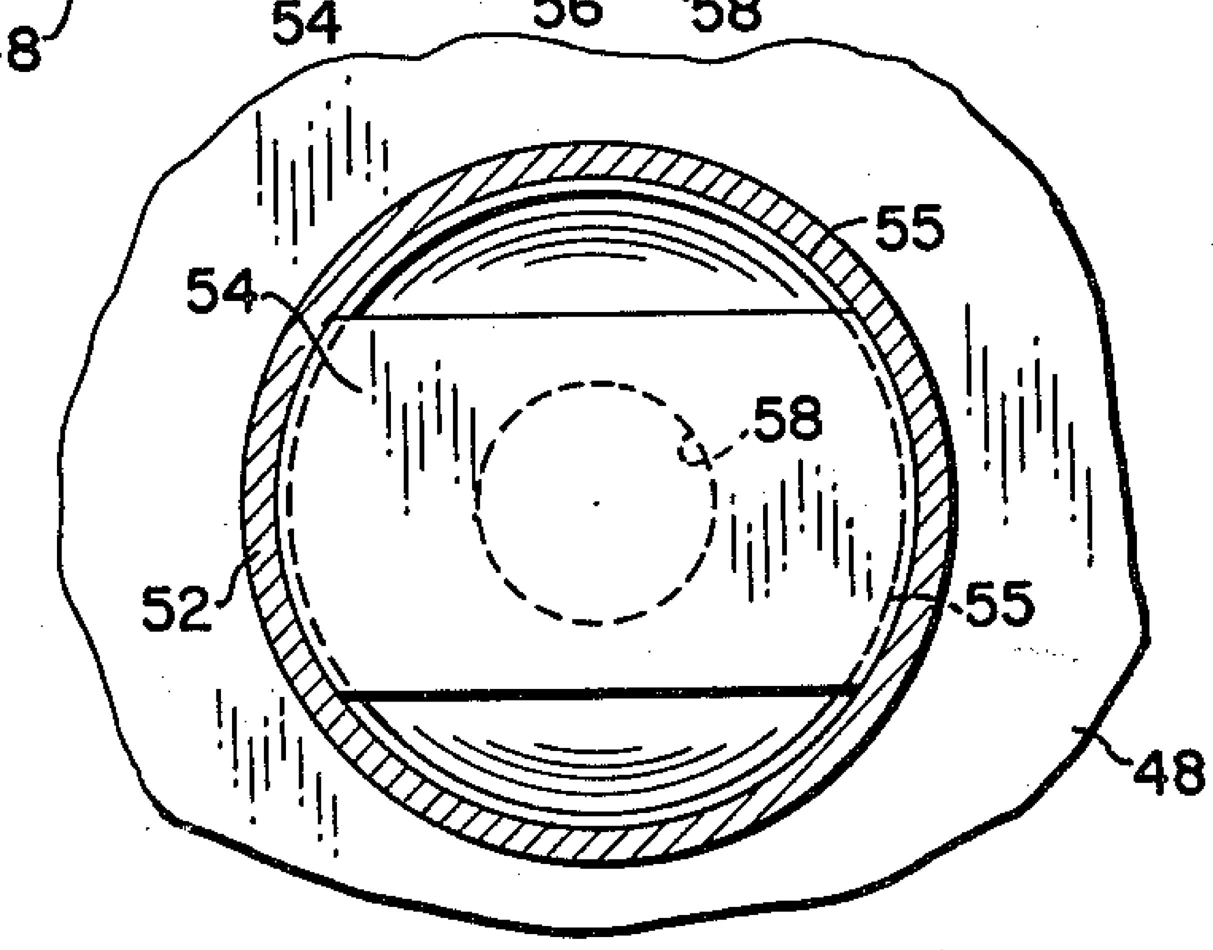
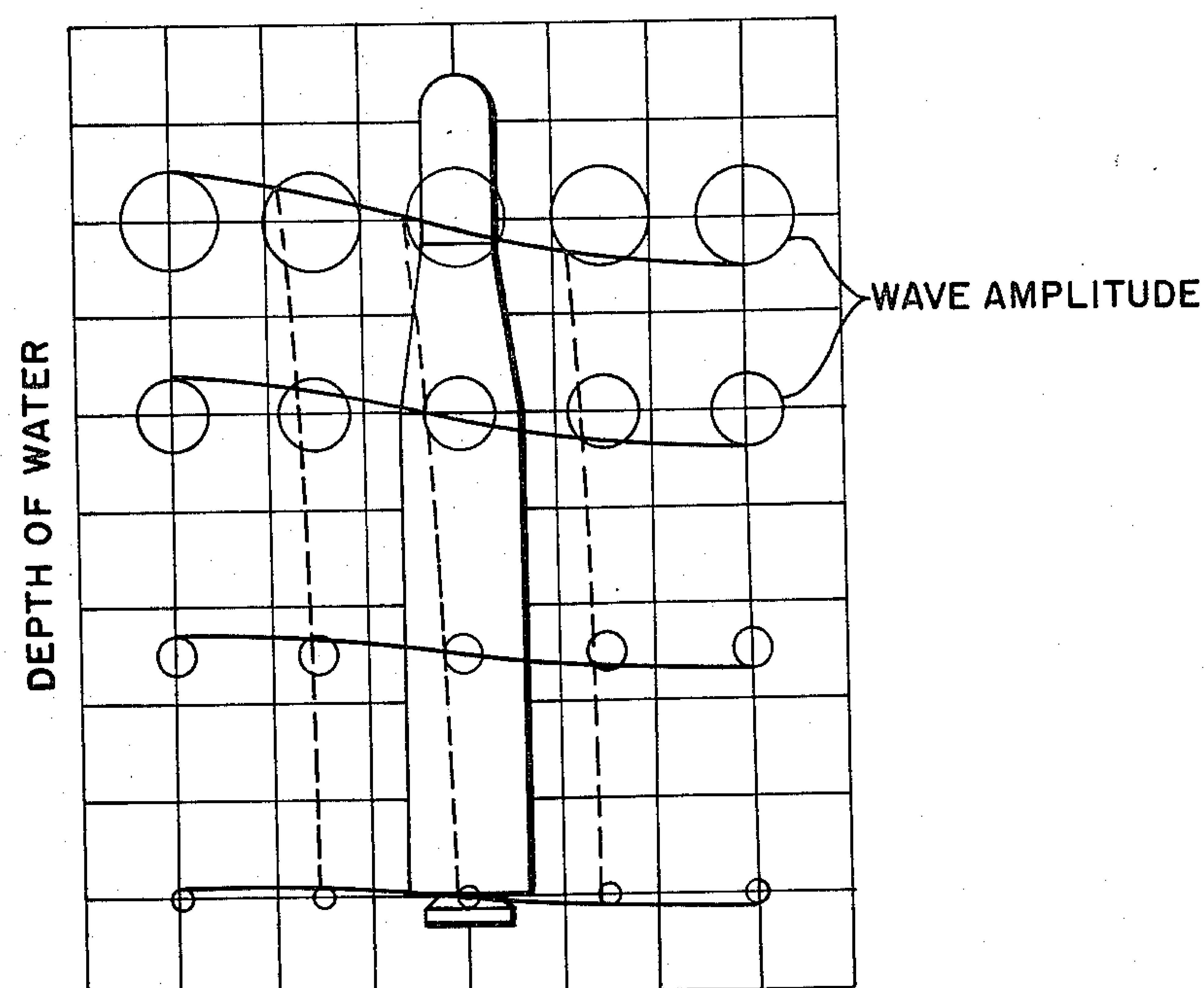


Fig. 8



WAVE PROFILE

Fig. 9

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United States Patent Office 3,180,225 Patented Apr. 27, 1965

3,180,225

SUSPENDED WATER-LAUNCHED MISSILE

John Emery Draim, Sanford, Fla., assignor to the United States of America as represented by the Secretary of the Navy

Filed Apr. 29, 1963, Ser. No. 277,416
8 Claims. (Cl. 89—1.7)
(Granted under Title 35, U.S. Code (1952), sec. 266)

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 application is a continuation-in-part of application Serial No. 72,805, filed November 30, 1960, now abandoned for "Suspended Water-Launched Rocket Vehicle."

The present invention relates to an apparatus including a suspended water-launched missile and more particularly to a missile which is launched from a body of water while it is suspended below the surface of the water so as to attain launching stability.

The present method of launching large payloads into earth-centered orbits or deep-spaced missions is from a land based facility requiring expensive support equipment costing three to five times as much as the missile itself. The present invention eliminates equipment such as fuel and oxidizer storage facilities, cryogenic systems, concrete launching pads, large steel gantries and armoured block houses by providing an apparatus wherein a missile can be launched from water. The seas enable 70% of the earth's surface to become a potential launch site since the missile can be towed or carried literally anywhere therein as described in a U.S. Patent No. 3,077,143. Phenomenal safety is inherent in a water-launched missile since any explosion due to a malfunctioning of the missile will be absorbed by the surrounding water, thereby eliminating injuries to personnel and eliminating replacement or repairing of support equipment. According to the invention the mass of water surrounding the sides of a water-launched missile will act as semi-rigid launch rails replacing all of the above equipment required for a land launch.

The present invention contemplates launching a missile by freely suspending it entirely below the surface of the water so as to minimize the effect of wave action on the missile prior to launch. The depth of suspension is, of course, variable depending upon the magnitude of the wave action at the surface of the water. The proper depth can be easily determined if the amplitude of the wave action at the surface of the water is known. When the wave length is small compared to the depth, which is a typical condition of most locations at sea, the wave action diminishes rapidly from the surface downwards. Thus, at a depth equal to a wave length the diminution of wave amplitude is $e^{-2\pi}$ or $1/535$ of the amplitude of the wave at the surface (Hydrodynamics, page 366 by Sir Horace Lamb, Dover Press, 1945). In FIG. 9 there is shown a wave profile of a trochoidal ocean wave having a wave length of 500 ft., a wave height of 20 ft., a wave depth of 1000 ft., and a state 6 sea (winds of 40 knots). The profile characterizes wave motion as a series of circular motions which rapidly decrease exponentially with increasing depth. Since the wave decay with increasing depth is exponential, it is apparent that a missile floating at the surface of the water as described in U.S. Patent No. 3,077,143 would be subjected to maximum rolling moments because of the differential in forces existing between an upper portion of the missile at the surface of the water and a lower portion thereof submerged in the water. By suspending the missile entirely below the surface of the water to a sufficient depth, the differential of

these forces will be lessened and the missile will have improved stability over a missile floating at the surface of the water.

The invention further contemplates that the missile will be suspended from a buoyant member which is floating at the surface of the water and that at or near the time of firing this buoyant member will be released from the missile. Still further, the invention contemplates dampening vertical motion of the missile by attaching a plate dampener to the exhaust end of the missile which can be released from the missile at or near the time of firing. While suspended the missile will have good launching stability and after firing the missile will ascend with increasing velocity toward the surface of the water, thus spending a relatively short period of time at or near the surface of the water where the wave motion is located. Accordingly, the launching stability of the suspended missile will be improved over the launching stability of a missile launched from a floating position at the surface of the water.

An object of the present invention is to provide an apparatus wherein a missile can be launched from a body of water with improved stability.

Another object is to provide an apparatus wherein a missile can be stably launched from a body of water regardless of the degree of wave motion of the water.

A further object is to provide an apparatus wherein a missile can be stably launched from the high seas in which normal depths and high sea states are encountered.

Still a further object is to provide an apparatus wherein a missile will have improved vertical stability in a body of water.

Yet another object is to provide a method of launching a missile from a body of water with improved stability.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the disclosure is made in the following detailed description of a preferred embodiment of the invention as illustrated in the accompanying sheet of the drawing in which:

FIG. 1 is a side view of the apparatus with the missile suspended within a body of water.

FIG. 2 is a side view of the missile being fired while sususpended in the water.

FIG. 3 is a side view of the missile ascending in the water after being fired.

FIG. 4 is a side view of the missile commencing its journey into space.

FIG. 5 is an enlarged cross-sectional side view of the nose end of the missile.

FIG. 6 is a view taken along line VI—VI of FIG. 5.

FIG. 7 is an enlarged side view of the nozzle end of the missile with the rocket nozzle and dampener plate shown in cross section.

FIG. 8 is a view taken along VIII—VIII of FIG. 7; and

FIG. 9 is a wave profile of a trochoidal ocean wave.

Referring now to the drawings wherein like reference numerals designate like or corresponding parts throughout the several views, there is shown in FIG. 1 an apparatus including a rocket powered missile **10** which is suspended directly within and below the surface of a body of water by a spherical shaped inflated balloon **12**, the latter being constructed of a light-weight resilient material such as thin rubber. The missile **10** is connected to the balloon **12** by a line **14**, an upper end of which is attached to a pad **16** molded within the balloon **12** and a lower end of which is attached to the nose end of the missile. The lower end of the line is attached to the missile by a bulb **18** located within a releasable connector **20**.

The releasable connector **20** is divided into a lower part **22** which is press fitted in a plug **24** and an upper part

26 which is slidably mounted within the plug 24 and skin 28 of the missile 10. The upper part 26 and the lower part 22 are connected together by a membrane retainer 30, the latter being threaded by sectors of threads 31 into each part and having a thinned medial portion 32. The retainer 30 will be fractured at the thinned portion 32 when an explosive charge 34 is ignited by an igniter 36. The fracture of the retainer 30 breaks the threaded connection between the upper part 26 and the lower part 22 causing the upper part 26 to slidably disengage the missile 10. In order to prevent any sideways explosion upon the ignition of the explosive charge 34, the upper part 26 is provided with ports 38 which will allow gases of the explosive charge to escape in an upward direction.

The igniter 36 is electrically connected to a receiver atcuator 40 by lead wires 42, the receiver actuator 40 sending an electrical pulse to the igniter 36 when a proper signal is received from a transmitter (not shown). A rocket igniter 44 for igniting a rocket motor (not shown) is electrically connected to the receiver actuator 40 by lead wires 46 and receives an electrical pulse from the receiver actuator 40 when the latter receives the signal from the transmitter thereby causing the rocket igniter 44 and the igniter 36 to be operated simultaneously.

As shown in FIG. 7, a circular plate dampener 48 has a circular flange or collar 50 which is releasably connected to a rocket nozzle 52 of the missile 10 by a membrane retainer 54, the latter being threaded by sectors of threads 55 into both the flange 50 and the rocket nozzle 52. Upon ignition of the igniter 44 the rocket motor is fired and exhausts through the rocket nozzle 52 to fracture the membrane retainer 54 at a thinned medial portion 56. This causes separation of the rocket nozzle 52 and the plate dampener 48 by breaking the threaded connection therebetween. The dampener plate 48 is provided with a circular opening 58 so as to allow the rocket exhaust gases to exhaust downwardly and thus pervent any sideways explosion. The plate 48 is to extend a designed distance beyond the sides of the missile 10 to provide a desired dampening action.

In order that the missile 10 will be suspended within the water it is required that all of that portion of the apparatus (including the missile 10) that is connected to the balloon 12 have an aggregate specific gravity greater than one with respect to the water. In some embodiments the missile 10 will have a specific gravity greater than one whereas in other embodiments the weight of the dampening plate 48 or some other component will be required to be added to the missile to provide an aggregate specific gravity greater than one.

The line 14 is to have a length which is sufficient to suspend the missile 10 in a completely submerged state (as shown in FIG. 1) with the nose end of the missile located a predetermined distance below the surface of the water and the nozzle end of the missile spaced above the bottom of the body of water. The suspension of the missile any depth below the surface of the water will, of course, increase the stability of the missile, however, in the preferred embodiment the line 14 is to have a length such that the missile 10 is suspended at a depth where the wave motion in the water will have substantially no effect on launching stability of the missile 10.

In the operation of the device, the missile 10 is freely suspended directly in the water by the balloon 12 to the predetermined depth below the surface of the water as shown in FIG. 1. If there is a heavy wave motion or a heavy sea state at the surface of the water, the missile will be suspended at a greater depth, whereas when the wave motion or the sea state is slight at the surface of the water the missile can be suspended at a lesser depth below the surface of the water. Assuming a launch of the missile at sea and that the wave length and wave amplitude of a surface wave are known, the wave amplitude at a depth equal to the surface wave length, can be found by multiplying the surface wave amplitude by $e^{-2\pi}$ or $\frac{1}{535}$. Knowing the length of the missile, the wave amplitudes therealong can be determined for a particular suspended depth, and further knowing the upward force component due to the line 14 on the missile the combination of these forces will be determinative in designing a proper depth. Assuming a length of 40 ft. of the missile and a state 6 sea, an ordinary missile would be suspended at a depth of 80 ft. below the surface of the water in order to insure a practical and stable suspended condition. Of course, another factor bearing on the depth required for stability is the type of guidance system employed by the missile. When the guidance system has a maximum allowable inclination before becoming erratic this must be considered as a design factor.

After the missile 10 is suspended at the proper depth and it is time for launching, the transmitter sends a signal to energize the receiver/actuator 40, whereupon the receiver/actuator sends an electrical current simultaneously to the igniter 36 and the rocket igniter 44, the igniter 36 causing the explosive charge to separate the line 14 from the missile and the igniter 44 causing the rocket motor to be fired. The firing of the rocket motor causes the plate dampener 48 to be separated from the rocket nozzle 52 by the fracture of the membrane retainer 54. While the missile 10 has been operated by a transmitter, it is to be understood that other means may be employed, such as running a direct line to the missile. Further, while the line 14 is released from the missile, the rocket motor is fired and the dampener plate 48 is released all substantially simultaneously, it is further to be understood that these steps can be done at different intervals. For instance, the line 14 and dampener plate could each be separated by a separate explosive squib at various intervals before the firing of the rocket motor.

After the rocket motor is fired the missile ascends vertically in the water as shown in FIG. 3 and breaks through the surface of the water to commence its journey into space as shown in FIG. 4. It is to be noted that since the missile 10 assumes a dynamic condition upon firing that its stability will be maintained as it transcends that portion of the water having wave motion. Since the balloon 12 is constructed of a light-weight resilient material, there will be no effect on the stability of the missile as it breaks the water if it should accidentally strike the balloon. To insure that the line 14 and the pad 16 within the balloon 12 do not affect the stability of the missile, if contact should be made, the former should be constructed of a flexible material such as manila and the latter should be constructed of a resilient material such as rubber.

Neglecting the weight of the balloon 12 and the line 14, the amount of water to be displaced to suspend the missile below the surface of the water can be easily found by using the formula

$$V_c=(S_b-1)V_b$$

where

V_c=volume of water displaced by a submerged portion of the balloon in cubic feet

S_b=average specific gravity of the missile

V_b=volume of the missile in cubic feet

If a spherical balloon 12 is used as described in the preferred embodiment, it is desirable that the portion of the balloon above the water have a volume less than 25% of the total volume of the balloon so that the balloon will provide a good vertical stability (that is, it will not readily follow the wave motion at the surface of the water). Many other various-shaped buoyant members can be used in lieu of the balloon. For instance, a vertically disposed elongated buoyant member with the line 14 attached at one end thereof would be very effective in maintaining vertical stability of the missile since the lateral distribution of such a buoyant member with respect to the surface of the water would be small compared to the vertical distribution of the buoyant member. If the lateral distribution is in order of 1:1 with respect to the vertical distribution, good vertical stability can still be maintained if the volume of the portion of the buoyant member above the water is small (in the order of 10%) with respect to the total volume of the buoyant member. Regardless of the type of buoyant member used, the vertical stability of the suspended missile will be improved by the plate damper **48** which resists vertical movement of the missile in the water.

While the specification describes the missile **10** as being propelled by a rocket motor it is to be understood that the term "missile" is to include any reaction type of power plant such as solid or liquid rocket, jet, ram jet or nuclear power.

While the specification describes the missile as being connected to the balloon **12** by the line **14** it is to be understood that the missile **10** could in some instances be connected directly to the balloon **12** without the use of the line **14**.

The reference in this specification to suspending the missile **10** at a depth where wave motion will have substantially no effect on launching stability means that the missile is suspended at a depth where the parameters for the launch are not exceeded, these parameters being governed by the characteristics of the missile such as the maximum allowable inclination dictated by the guidance system upon launch.

It is now apparent that the invention provides a simple device for launching a missile from water regardless of the severity of the wave motion at the surface of the water. There are many other inherent advantages such as built-in safety. Should there be a malfunctioning or explosion of the missile, its force would be contained below the surface of the water and thereby would not endanger nearby surface ships.

Obviously many modifications and variations of the present invention are possible in light of the above teachings. For instance, the release of the line **14** from the missile could be accomplished by providing a weakened portion in the line near the missile. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. An apparatus comprising:
(*a*) a reaction powered missile which is to be launched from a body of water having wave motion;
(*b*) said missile having a nose end and an exhaust nozzle end;
(*c*) a buoyant member having sufficient buoyancy to float the entire apparatus in the water with a portion of the buoyant member extending above the surface of the water;
(*d*) means connecting said missile to said buoyant member; said means including a member which is releasably mounted in said missile; said member adapted to be forcibly expelled from said missile upon launch thereof;
(*e*) all of that portion of the apparatus which is connected to said buoyant member having an aggregate specific gravity greater than one with respect to the water;
(*f*) said means for connecting being capable of supporting the missile in a freely suspended position directly within the water with the nose end above the nozzle end;
(*g*) said position being at a depth where the nose end is a predetermined distance below the surface of the water and the nozzle end is spaced above the bottom of the body of water; and
(*h*) the missile when suspended being at a depth where the wave motion will have substantially no effect on its launching stability, whereby prior to launch and while suspended the missile has sufficient stability for launch, and upon launch the missile assumes a dynamic condition to maintain its stability while transcending that portion of the body of water having wave motion.

2. An apparatus comprising:
(*a*) a reaction powered missile capable of being launched from a body of water having wave motion;
(*b*) said missile having a nose end and an exhaust nozzle end;
(*c*) a buoyant member connected to said missile and having sufficient buoyancy for supporting the missile in a freely suspended position in the water;
(*d*) all that part of the apparatus supported by the buoyant member having an aggregate specific gravity greater than one with respect to the water;
(*e*) said position being at a depth where the nose end is a predetermined distance below the surface of the water and the nozzle end is spaced above the bottom of the body of water;
(*f*) the missile when suspended being at a depth where the wave motion will have substantially no effect on its launching stability;
(*g*) means connected to and extending transverse the missile beyond its sides for dampening vertical movement of the missile when suspended in the water; said means adapted to be forcibly separated from said missile upon launch thereof; said means having a passage therein to provide for dispersion of gases generated upon launch of the missile; and
(*h*) means for expelling the dampening means upon firing the missile, whereby prior to launch and while suspended the missile has sufficient stability for launch, and upon launch the missile assumes a dynamic condition sufficient to maintain its stability while transcending that portion of the body of water having wave motion.

3. An apparatus comprising:
(*a*) a reaction powered missile which is to be launched from a body of water having wave motion;
(*b*) said missile having a nose end and an exhaust nozzle end;
(*c*) a buoyant member having sufficient buoyancy to float the entire apparatus in the water with a portion of the buoyant member extending above the surface of the water;
(d) a flexible line connecting said missile to said buoyant member;
(*e*) all of that portion of the apparatus which is connected by said line to the buoyant member having an aggregate specific gravity greater than one with respect to the water;
(*f*) said line being capable of supporting the missile an aggregate specific gravity greater than one with water with the nose end above the nozzle end;
(*g*) said line having a length which is capable of positioning the nose end a predetermined distance below the surface of the water with the nozzle end spaced above the bottom of the body of water; said line being releasably attached to said missile through a member slidably mounted therein; said member adapted to be forcibly expelled from said missile upon launch thereto;
(*h*) the length of said line further being such that the missile will be suspended at a depth where wave motion will have substantially no effect on launching stability of the missile, whereby prior to launch and while suspended the missile has sufficient stability for launch, and upon launch the missile assumes a dynamic condition to maintain its stability while transcending that portion of the body of water having wave motion.

4. An apparatus comprising:
(*a*) a reaction powered missile which is to be launched from a body of water having wave motion;
(*b*) said missile having a nose end and an exhaust nozzle end;

(c) a buoyant member having sufficient buoyancy to float the entire apparatus in the water with a portion of the buoyant member extending above the surface of the water;

(d) means connecting said missile to said buoyant member;

(e) all of that portion of the apparatus which is connected to said buoyant member having an aggregate specific gravity greater than one with respect to the water;

(f) said means for connecting being capable of supporting the missile in a freely suspended position directly within the water with the nose end above the nozzle end; said means including a member slidably mounted in said missile; said member adapted to be forcibly expelled from said missile upon launch thereof; and

(g) said position being at a depth where the nose end is a predetermined distance below the surface of the water and the nozzle end is spaced above the bottom of the body of water;

(h) the missile when suspended being at a depth where the wave motion will have substantially no effect on its launching stability;

(i) means for firing the missile when suspended at said depth; and

(j) means for expelling the buoyant member from the missile upon firing, whereby prior to launch and while suspended the missile has sufficient stability for launch, and upon launch the missile assumes a dynamic condition to maintain its stability while transcending that portion of the body of water having wave motion.

5. An apparatus comprising:

(a) a reaction powered missile capable of being launched from a body of water having wave motion;

(b) said missile having a nose end and an exhaust nozzle end;

(c) a buoyant member connected to said missile and having sufficient buoyancy for supporting the missile in a freely suspended position in the water;

(d) a flexible line which is connected at one end to the buoyant member and connected at the other end to the nose end of said missile;

(e) said position being at a depth where the nose end is a predetermined distance below the surface of the water and the nozzle end is spaced above the bottom of the body of water;

(f) the missile when suspended being at a depth where the wave motion will have substantially no effect on its launching stability;

(g) means connected to and extending transverse the missile beyond its sides for dampening vertical movement of the missile when suspended in the water;

(h) means for releasing the dampening means upon firing the missile;

(i) means for firing the missile when suspended at said depth; and

(j) means for releasing the buoyant member from the missile upon firing, whereby prior to launch and while suspended the missile has sufficient stability for launch, and upon launch the missile assumes a dynamic condition sufficient to maintain its stability while transcending that portion of the body of water having wave motion.

6. An apparatus comprising:

(a) an elongate reaction powered missile which is capable of being launched from a body of water having wave motion;

(b) said missile having a nose end and an exhaust nozzle end;

(c) a circular plate connected to the nozzle end and extending transverse the missile beyond its sides so as to dampen vertical movement of the missile when it is disposed upright within the water;

(d) the missile and said circular plate having an aggregate specific gravity greater than one with respect to the water;

(e) a spherical float constructed of a resilient material which has sufficient buoyancy to float the entire apparatus in the water with a portion of the float extending above the surface of the water;

(f) an elongate flexible line connected at one end to the float and connected at the other end to the nose end of said missile;

(g) said line being capable of supporting the missile in a freely suspended position directly within the water with the nose end above the nozzle end;

(h) said line having a length which is capable of positioning the nose end a predetermined distance below the surface of the water with the nozzle end spaced above the bottom of the body of water;

(i) the length of said line further being such that the missile will be suspended at a depth where wave motion will have substantially no effect on launching stability of the missile;

(j) means for firing the missile when suspended at said depth;

(k) means responsive to the firing means for releasing the line and the plate from the missile at the time of firing, whereby prior to launch and while suspended the missile has sufficient stability for launch, and upon launch the missile assumes a dynamic condition to maintain its stability while transcending that portion of the body of water having wave motion.

7. An apparatus comprising:

(a) a reaction powered missile which is capable of being launched from a body of water having wave motion;

(b) said missile having a nose end and an exhaust nozzle end;

(c) means for positioning the missile in the water with its nose end above its nozzle end;

(d) means separably attached to the missile for dampening vertical movement of the missile when it is positioned within the water; said means for dampening having an opening therein to permit escape of exhaust gases emanating from said missile upon launch thereof;

(e) means for firing the missile while positioned in the water; and

(f) means for separating the dampening means at the time of firing, whereby the dampening means minimizes vertical movement of the missile while positioned in the water and is separated from the missile upon firing so as to increase efficiency of the missile after launch.

8. An apparatus comprising:

(a) a reaction powered missile which is capable of being launched from a body of water having wave motion;

(b) said missile having a nose end and an exhaust nozzle end;

(c) means for positioning the missile in the water with its nose end above its nozzle end;

(d) a plate mounted at the nozzle end of the missile and extending transverse beyond the sides of the missile for dampening vertical movement of the missile when the missile is positioned in the water; said plate separably attached to said missile in watertight relationship therewith; said plate having an opening to permit discharge of exhaust gas gases upon launch of said missile;

(e) means for firing the missile while positioned in the water; and

(f) means for separating the dampening means at the time of firing, whereby the dampening means minimizes vertical movement of the missile while positioned in the water and is separated from the missile upon firing so as to increase efficiency of the missile after launch.

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BENJAMIN A. BORCHELT, *Primary Examiner.*

SAMUEL W. ENGLE, *Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,180,225 April 27, 1965

John Emery Draim

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 52, strike out "an aggregate specific gravity greater than one with" and insert instead -- in a freely suspended position directly within the --.

Signed and sealed this 5th day of October 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents