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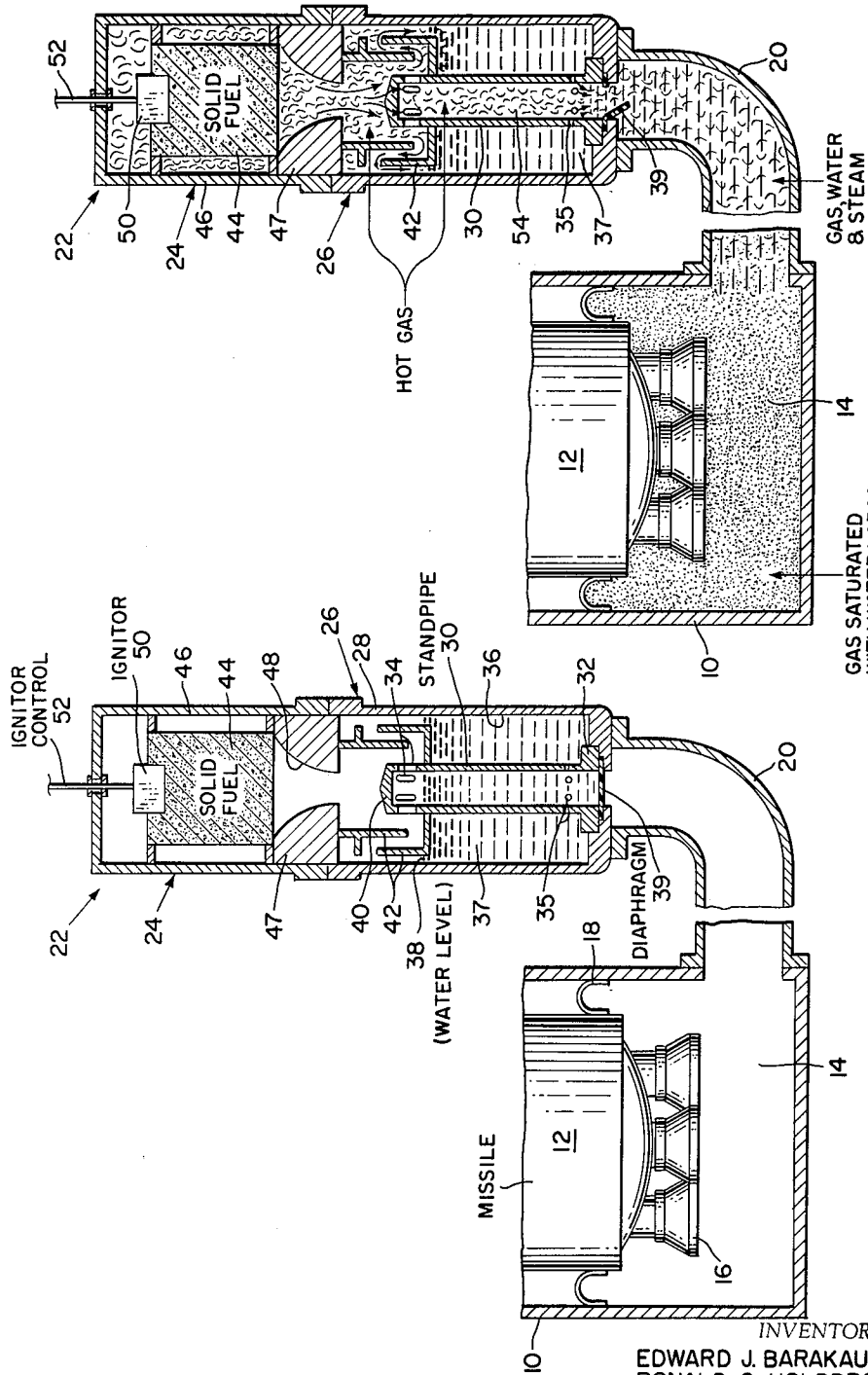


Fig. 2

Fig. 1

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METHOD OF EJECTING A MISSILE FROM A LAUNCHING TUBE

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1 Claim. (Cl. 60—39.05)

The present invention relates to a method for bringing about the substantially vertical ejection of a missile from a launching tube carried by a submarine or other underwater vessel.

At the present time it is strategically desirable to launch missiles from a vessel traveling below the surface of the ocean or other body of water. Numerous advantages accrue from such a procedure, since countermeasures cannot readily be taken by an enemy due to the mobile nature of the vessel on which the launching apparatus is carried.

One method by which a launching of this type may be effected includes the provision of a source of compressed air which is programmed into the launching tube at the time that ejection of the missile is to take place. Obvious drawbacks to this procedure include not only the considerable weight of the air storage equipment, but also the fact that extended periods of time may elapse between the installation of the apparatus on the vessel and the actual launching of the missile. This necessitates maintaining the pressure of the air during this interval as well as constantly checking the status of the equipment associated therewith.

The foregoing method, in which air under compression is stored in a tank or cylinder and then discharged into the missile launching tube through a programmed control valve, while yielding acceptable results, nevertheless is subject to the disadvantages mentioned above. It would be desirable if the compressed air source could be eliminated, as this would materially reduce the weight which the vessel must carry and thus add to its range and maneuverability.

In a co-pending U.S. patent application of the co-inventor Barakauskas, Serial No. 338,540 filed January 17, 1964, now U.S. Patent No. 3,182,554 (Navy Case No. 35,389) there is disclosed a system in which the compressed air source is replaced by a gas generator which preferably includes a fuel in solid form. This fuel is not ignited until the time when the launching is to be actually carried out. One advantage of such an arrangement is that the volume of this fuel is but a minor fraction of that represented by the compressed air source which it replaces. In addition there is no problem of maintaining air pressure over extended periods of time, nor of air leakage due to a malfunction of the storage or transfer equipment.

One necessary characteristic of a system such as set forth in the above-mentioned co-pending application is that the generated gas possess a temperature (in the region of the missile or in other words in the launching tube) below that at which the possibility of ignition of the missile propellant can take place. The disclosure of the co-pending application produces a working fluid at a temperature sufficiently low so that no such premature ignition of the missile propellant is possible. In addition the fluid described therein has relatively uniform characteristics when it pressurizes the launching tube chamber, and thus a successful launching operation is more likely to result.

Previous attempts have been made to utilize gas pressure generator to achieve an objective somewhat analogous to that of the mentioned co-pending application. One

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technique which has been so employed is to provide for the passage of gas from the generator to a tank of some coolant (such as water) to pressurize the latter. The coolant is then sprayed into the exhaust stream from the gas generator. This procedure, however, is not completely satisfactory, because the pressure tap significantly changes the exhaust nozzle area and thus the burning rate of the gas generator. In addition, it is necessary to form an effective seal for the water or other coolant within the nozzle or nozzles, and this seal must be of a type which completely disintegrates as soon as the gas generator becomes operative. Still further, the injection apparatus is frequently subject to malfunction by blockage of either the line employed to pressurize the water reservoir or by failure of the means used to seal the nozzles.

Another technique which has been subject to experiment is that designated as the so-called "puddle." In this system, the exhaust from the gas generator impinges directly upon the surface of a pool of water. The latter is vaporized and enters into the launching tube where it acts to eject the missile when a certain pressure level has been reached. While this method is not subject to serious malfunctions from a mechanical standpoint, nevertheless the vaporization action is irregular and the cooling characteristics are not uniform. Consequently, it is difficult to predict with accuracy the precise instant at which the missile will be ejected. Since the flight characteristics of the missile depend at least in part on its orientation on the vessel at the instant when it leaves the launching tube, it is extremely important that this time instant coincide with that programmed by the operator.

The concept of the co-pending application mentioned above does not include the undesirable features of the previously utilized techniques. Instead, it incorporates the production of a series of pressure drops, or steps, in the exhaust region of the gas generator. These pressure steps are made use of to establish a corresponding series of pressure variations for ejection of the coolant into the launching tube itself. In this fashion the coolant can be ejected at a substantially continuous rate into the region where it mixes with the pressurized gas from the source and thereby yields an essentially uniform mixture the characteristics of which can be predicted with a high degree of accuracy. Thus the launch point can be determined by the operator without introducing the possibility of sending the missile on an incorrect course due to a premature or delayed firing.

When the system set forth in the above-mentioned co-pending application is employed to launch a missile, it has been found that the mixture of hot gas and water vapor fed into the missile launching chamber varies considerably in its effectiveness as the amount of water present changes in relation to the volume of gas into which such water is ejected. It has been found that the most efficient proportion of water to gas is one in which sufficient liquid is supplied so that the resulting water-gas mixture is fully saturated. In other words, the vapor and liquid phases should be in equilibrium. By the use of such a saturated mixture, a constant reproducibility is achieved, since the excess water is only raised to the boiling point and hence does not absorb the large quantity of heat that would otherwise be necessary to vaporize the excess liquid if the mixture were allowed to reach the superheat region.

One object of the present invention, therefore, is to provide an improved method for launching a missile from an underwater vessel such as a submarine.

Another object of the invention is to provide a method for bringing about the substantially vertical ejection of a missile from a launching tube carried by an underwater vessel through the action of a pressurized mixture con-

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sisting of a gas and a liquid, the latter existing in a saturated state so that the two components of the mixture are in equilibrium.

An additional object of the invention is to provide a method for ejecting a missile from a launching tube by means of a pressurized mixture of gas and water vapor in a saturated condition, the temperature of such mixture being maintained at a point below that at which premature ignition of the missile propellant might otherwise occur.

Other objects, advantages, and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein;

FIG. 1 is a partly sectional view of a preferred form of missile ejection apparatus designed in accordance with the present invention, illustrating the condition thereof prior to the time that ejection of the missile is to take place; and

FIG. 2 is a view of the apparatus of FIG. 1, illustrating its condition when an ejection of the missile is taking place.

Referring now to the drawing, there is shown a launching tube which is carried by and mounted on some underwater vessel such as a submarine. This tube generally identified in the drawing by the reference numeral 10, is so oriented as to support therewithin a missile 12 in a generally upright or vertical position. As shown in the drawing, missile 12 is maintained within the launching tube 10 so as to create a lower chamber 14 which is initially at ambient temperature and pressure prior to the time that the ejection apparatus of the invention becomes operative. It should be noted that the missile 12 incorporates one or more exhaust nozzles 16 which lie within the chamber 14 and open directly thereinto. Missile 12 is held away from direct contact with the inner wall of tube 10 by an annular seal 18, which acts to preclude any fluid which may subsequently fill the chamber 14 from being exhausted therefrom through the opening between missile 12 and the inner wall of the launching tube.

As further illustrated, the lower chamber 14 of the launching tube is connected by a conduit 20 with the fluid-generating apparatus of the present invention. This apparatus is generally identified by the reference numeral 22, and consists of two basic parts—namely, a gas generator 24 and a mixing unit 26 by means of which some coolant such as water is added to the gas from the generator 24 prior to the time that such gas is supplied to the chamber 14 through the conduit 20.

Reference to FIG. 1 of the drawings will bring out the conditions which prevail in the system prior to a missile launching. At this time, the chamber 14 and the conduit 20 are each at ambient temperature and pressure and no gas is being generated by the device 24. Before discussing the function of the invention apparatus, it should be mentioned that the mixing device 26 comprises a generally tubular tank 28 which is secured to an open end of the conduit 20 by any suitable means such as welding or a plurality of bolts (not shown). The tank 28 is designed to include a tubular standpipe 30 which is mounted coaxially within the tank and is supported at its lower end by a retaining member 32. At the upper end of the standpipe 30 is formed a plurality of apertures 34 which are circumferentially spaced around the tube and which have a function which will later become apparent. The lower portion of standpipe 30 has formed therewith a further plurality of openings 35 which function as nozzles. These openings 35, like the openings 34, are circumferentially spaced, and provide communication between the interior of the standpipe 30 and that region 36 of the tank 28 which lies between the outer wall of the standpipe and the inner wall of the tank. Such region is filled with a liquid coolant 37 (such as water) to a level 38 below the openings 34. Nozzles 35 are designed to be continuously open, and to eject the coolant 37 therethrough

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when a pressure differential is created between two open ends of each nozzle. However, prior to the launching of missile 12, coolant 37 reaches the same level 38 in both the standpipe 30 and in the region exterior thereof.

The retaining member 32, in addition to supporting standpipe 30, also positions a diaphragm 39 which acts to seal the interior of the tank 28 from the conduit 20 prior to the time that the ejection apparatus is rendered operative. As shown in the drawing, this diaphragm 39 extends across the lower opening in the standpipe 30 below the region of the nozzles 36, and due to its presence the coolant 37 is precluded from entering into the conduit 20.

The upper end of the standpipe 20 is closed by a cap 40. Also supported by the upper end of the standpipe is one of a plurality of baffles 42 which lie intermediate the mixing unit 26 and the gas generator 24. The particular structure for supporting these baffles 42 in position forms no part of the present invention, and it is only necessary that the baffles be so spaced apart as to establish an indirect path for gas entering the tank region 36 from the generator 24.

This generator 24 is designed to contain therewithin a fuel 44 which is in solid form and of generally cylindrical shape. The fuel 44 may be similar in nature to a rocket propellant, and is enclosed within a tubular housing 46 which is attached to and supported by the tank 28. These two cylindrical containers 28 and 46 are secured together in any suitable fashion, such as by a plurality of bolts (not shown). The means for supporting and positioning the fuel 44 within the housing 46 is not fully illustrated, but includes a support 47 having an axial opening 48 extending therethrough by means of which gas can flow from the generator 24 to the interior region 36 of the tank 28 along a path established and defined by the baffles 42.

The fuel 44 is of a type the burning of which can readily be initiated by energization of an igniter 50. Such energization is brought about by means of a conductor 52 which leads to the ejection apparatus 22 from a point on the vessel from which the firing of the missile is programmed. However, it should be understood that any suitable means for bringing about a burning of the fuel 44 may be utilized as long as the action of this control mechanism is essentially instantaneous.

Prior to the time that the missile 12 is to be ejected from the launching tube 10, the chamber 14 is unpressurized, as is the conduit 20. Also devoid of any pressurized fluid is the interior of the fuel housing 46, the passageway 48, and the region between the baffles 42. This condition is illustrated in FIG. 1, which also shows the coolant 37 as reaching the common level 38 within both the tank 28 and the standpipe 30.

If it is now desired to eject the missile 12 from the tube 10, the control operator on the vessel gives a firing signal which brings about an energization of the conductor 52 and in turn activates the igniter 50. At this point, the fuel 44 begins to burn, and immediately forms gas under pressure within the housing 46. The gas thus produced flows through the passageway 48, and a portion 54 of this gas enters the standpipe 30 through the apertures 34 to create a pressure upon the surface of that portion of the coolant 37 which is within the standpipe. As soon as this pressure reaches a predetermined level determined by the characteristic of the diaphragm 39, the latter ruptures, and that portion of the coolant which is within the standpipe 30 is ejected into the conduit 20. At the same time, another portion of the gas from the generator 24 follows a path between the baffles 42 to come into contact with that portion of the coolant in the region 36 of tank 28. This gas pressure forces such coolant through the circumferentially-spaced nozzles 35, since the interior of the standpipe is now empty of liquid and hence a pressure differential is present between one end of each nozzle 35 and the opposite end thereof. Since the nature of the nozzle is such that liquid passes con-

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tinuously therethrough when a pressure drop exists thereacross, the amount of such liquid that enters the standpipe 30 is precisely controlled by the structural design of the nozzles. By properly sizing the openings 34 in the upper portion of the standpipe 30, a large pressure drop is created from the outside of the standpipe to the interior thereof.

When the actions just set forth have taken place, the condition of the system as described in the above-mentioned co-pending patent application is such as shown in FIG. 2. The standpipe 30, as illustrated, is filled with gas at high temperature, and the conduit 20 is filled with a mixture of gas and water at a lower temperature. This gas-water mixture is supplied to the chamber 14 of the launch tube 10, where it exerts a launching pressure against the lower surface of the missile 12 to eject it from the tube. The pressure build up in chamber 14 is made possible by the presence of the annular seal 18, which precludes any leakage of the pressurized mixture between the outer surface of the missile and the inner wall of the launch tube.

Whereas, in the mentioned co-pending application, that portion of the coolant 37 which is within the region 36 of tank 38 is ejected into the standpipe 30 through the nozzles 35 at an arbitrary rate to mix with the gas in the standpipe 30, it has now been found that this random process of forming a gas-water mixture seldom yields optimum results. This is due to the fact that the temperature of the mixture in conduit 20 is extremely sensitive to very minute variations in the amount of coolant which passes through the nozzles 35. In addition, it has been discovered that there is a certain ratio between the two constituents of the mixture, which, when present, produces a saturated condition of the material in the conduit. When this condition exists, the liquid and gaseous phases of the process are in equilibrium, and reproducibility is readily achieved. One reason for this condition is that any excess water which may be present is only heated to the boiling point, and consequently does not absorb the large quantity of heat that would otherwise be required to vaporize such excess water if the mixture were in the superheat region. It has been ascertained that a water-to-fuel ratio ranging from 2 to 1 produces a working mixture in chamber 14 at a temperature of approximately 300° F., this mixture being composed of one part gaseous fuel-combustion products, one part water vapor, and one part liquid water.

It has been stated above that one of the important characteristics of the present invention is that the pressurized mixture which comes into contact with the missile exhaust nozzles 16 is at a sufficiently low temperature so that it will not cause premature ignition of the missile propellant per se. The result has not been capable of achievement in systems heretofore employed for ejection purposes. In addition to this feature however, certain other important advantages of the present disclosure should be emphasized. These include (1) the major portion of the coolant is injected into the gas at a precisely-regulated continuous rate, so that the inconsistent action of previous arrange-

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ments which utilize a so-called "puddle" of liquid is no longer present, (2) the random selection of liquid and gaseous phases as described in the mentioned co-pending application is not a factor, (3) it is impossible with the present arrangement to inject gas at an excessively high temperature into the launching tube without rupturing the water seal, (4) the passage of hot gas through the water tank in itself creates the pressure which is utilized for injection of the coolant, and (5) the water injection nozzles are always open and hence any potential malfunction of a control valve cannot occur.

Although the invention method has been illustrated as being carried out through a particular physical association between the tank in which the coolant is contained and the gas generator, it should be understood that alternative forms of these structures may be substituted for the ones shown and their relationship modified without changing the steps by which the process is performed.

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 claim the invention may be practiced otherwise than as specifically described.

We claim:

A method of reducing the temperature of a generated gas, said method including:

burning a solid fuel in an enclosure so as to generate a pressurized gas at a relatively high temperature;
conducting one portion of the gas so generated into a mixing chamber;

conducting the remaining portion of the gas so generated to the surface of a body of water to pressurize the latter;

injecting the water so pressurized into the said mixing chamber so as to mix with that portion of the generated gas conducted therein;

maintaining a ratio between the amount of pressurized water injected into the mixing chamber and the volume of solid fuel burned so as to produce a saturated mixture in said chamber composed of one part solid fuel combustion products, one part water vapor, and one part liquid water.

References Cited by the Examiner

UNITED STATES PATENTS

886,199	4/1908	Flaig	60—39.57
1,828,784	10/1931	Perrin	60—35.59
2,644,364	7/1953	Nass	89—1.7
2,989,899	6/1961	Siegel et al.	89—1.7
3,064,902	11/1962	Moore et al.	60—39.48 X
3,066,485	12/1962	Bertin et al.	60—35.54
3,070,957	1/1963	McCorkle	60—35.55
3,083,527	4/1963	Fox	60—35.6
3,100,964	8/1963	Bervers et al.	60—39.3 X
3,133,413	5/1964	Lawrence	60—35.6

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