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MULTIPLE PROPELLANT BILLET GAS GENERATOR

STATEMENT OF GOVERNMENT INTEREST

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.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a multiple propellant billet gas generator for ejecting payloads from an underwater hull.

2. Description of the Prior Art

The design of gas generators for countermeasure deployment has focused on the implementation of a single chemical propellant to launch devices underwater, as well as the implementation of a single billet of propellant where the entire billet is consumed during operation. Lacking in the art are attempts to segregate multiple billets and/or to utilize multiple propellant types in a single gas generator.

Launch of a torpedo using multiple charges has been disclosed in United States Patent No. 6,418,870 to Lanowy et al., entitled "Torpedo Launch Mechanism and Method". In the '870 patent, surface ship torpedo launch, i.e., launch from an above water torpedo system, is disclosed using an initiation of a fixed number of identical automotive airbag gas generator inflators. Although Lanowy et al. '870 discloses that "gas generators 106 could be fired sequentially, simultaneously, or in any combination thereof as is necessary to produce the desired exit velocity and acceleration forces for torpedo 18", this disclosure appears to simply teach various testing protocols for individual torpedo launches for launch profile comparison. Additionally, the energy density associated with airbag gas generator inflators is much less than what is required for underwater launch, due to the need to overcome depth pressure, muzzle cap retention forces, and the like.

As such, there is a need to provide increased launch options for underwater payload deployments. The present invention addresses this and other needs.

SUMMARY OF THE INVENTION

The present invention includes a multiple propellant billet gas generator for ejecting payloads from an underwater hull having a housing, a plurality of billet holding chambers within said housing, wherein each of said billet holding chambers include at least one exhaust nozzle effective to expel a generated gas product from a designate of said plurality of billet holding chambers, a plurality of gas generating billets with each of said plurality of gas generating billets held within a individual billet holding chamber of said plurality of billet holding chambers, a release mechanism operationally connected to said at least one exhaust nozzle and an initiator system operationally connected to said at least one plurality of gas generating billets, said initiator system capable of selecting various patterns of use from said plurality of gas generating billets for an initiated burn leading to an ejecting action by exhaust of the initiated burn.

The present invention also includes a method for ejecting payloads from an underwater hull comprising the steps of providing a multiple propellant billet gas generator for ejecting payloads from an underwater hull, said multiple propellant billet gas generator having a housing with a plurality of billet holding chambers that are capable of expelling a generated gas product through a designated exhaust nozzle, a release mechanism for each and controlling each of said exhaust nozzles with an initiator system capable of selecting various burn patterns of gas generating billets for an initiated burn, selecting a burn pattern of gas generating billets and initiating burn in the selected burn pattern leading to an ejecting action by exhaust of the selected burn pattern.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a side cut away view of a multiple propellant billet gas generator of the present invention; and

FIG. 2A is a side cut away view of a launch tube that houses the payload, ram plate, and multiple propellant billet gas generator shown in FIG. 1, having a payload of an anti-submarine countermeasure, anti-torpedo torpedo, communication array or other maritime device, and FIG. 2B is a magnified view of the multiple propellant billet gas generator arrangement shown in FIG. 2A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Generally, underwater hull-mounted deployable systems, such as countermeasures, anti-torpedo torpedoes, and communication arrays, are "single shot" units. As such, the system payload is fixed to a set gas generating billet, or billet series, for ejection. The present invention provides a multiple propellant billet gas generator for increasing the firing options of individual billets therein. The present invention also allows a variety of ejection modes for single shot systems by providing a single energy source to support variable payloads using a single gas generator with multiple chambers to accept varying number of billets, types of chemical propellant, propellant grain geometries, exhaust nozzle geometries, burst disk pressures, and timing between propellant billet initiations.

By isolating the propellant billets from each other, each billet can be consumed independently and at varying times. Segregation of the billets also provides the ability to implement multiple types of chemical propellants, as well as varying grain geometries (where the grain geometry governs the burn rate for a given chemical propellant). By implementing a multiple billet design, the gas generators of the present invention are not limited to producing a single launch energy profile. By varying the number of billets, type of chemical propellant, propellant grain geometry, and timing between billet initiations, the launch energy profile can be varied to meet the required exit velocity for safe platform separation for a given payload. With the variability of a multiple billet design, a single gas generator can launch a large number of diverse payloads. The present invention further may reduce the acceleration loads imparted on the payload during launch. The selection of various gas generator profiles of the present invention eliminates requirements on submarine operating envelopes (maximum speed, minimum depth, etc.) during launch.

As seen in FIGS. 1 and 2, the multiple propellant billet gas generator 100 of the present invention includes a housing 10 that includes a plurality of billet holding chambers 12 within the structure. The housing 10 includes an electrical feed (not shown) through to the payload and an anode 36 to provide cathodic protection when the gas generator 100 is submerged in seawater.

The housing 10 has appropriate structural integrity and holding components, such as O-ring gaskets 14 and locking features 16 that allow the gas generator to be secured inside a launch tube 90 (shown in FIGURE 2), and other such appropriate configurations that allow an underwater launch, with selection of such components determinable by those skilled in the art.

Within each of the billet holding chambers 12, a gas generating billet 20 is positioned. The composition of the housing 10 is sufficiently resilient to contain the evolving gases from the gas generating billets 20, once the billets are ignited. The billets 20 include those gas generating compositions, generally non-replaceable, self contained, sealed devices. Preferably, the billets 20 generate one or more non-toxic, non-corrosive gases under pressure in a known controlled manner, such as through the release of a by-product of a chemical reaction or through release of a stored compressed gas, or both. Generally, the billets 20 are initiated through a response to an electrical signal, passing through a connector 32, to an initiator. The billets 20 may include for example, without limitation, hybrid, gas, propellant, pyrotechnic, etc., with such compositions well-known in the art. Additionally, the billet holding chambers 12 are exhausted through an exhaust nozzle 18, located at one end of the billet holding chamber 12 and preferably located in the direction of the payload (see FIGURE 2). The exhaust nozzles 18 effectively expel a generated gas product from the billet holding chambers 12 when the generated gas from the billets 20 flow through a release mechanism 50, such as a burst disk, within the exhaust nozzle 18. The release mechanism 50 is used to contain or cap the pressure within the billet holding chambers 12 as gas is generated to provide a pulsed exhaust of the generated gases.

As further seen in FIGS 1 and 2, the electrical feed through to the payload 80 has several components. In contrast to the numerous operational limitations in electrical systems that initiate singular (non-variable) programmed billet burn for underwater hull ejection systems, the present invention incorporates an initiator system 30 capable of selecting among various patterns of initiated burn throughout the plurality of gas generating billets 20. As such, the initiator system 30 of the present invention receives an input that causes the initiator system to select, or originate, the best of several billet burn patterns tailored to operational criteria. Once a specific burn pattern has been selected, the initiator system 30 implements this burn pattern of the gas generating billets 20 for an initiated burn. For example, without limitation, the initiator system 30 may select one or more given gas generating billets 20 by location and timing of burn relative to the timing of burn in other gas generating billets 20, and/or other like criteria that impart a specific ejection profile onto a given payload.

Within the initiator system 30, burn pattern selection is formulated by one or more computation devices 40 that preferably receive data related to the operational environment of the underwater hull. Such data may include speed of the underwater hull, turning forces, locations of fixed objects within the water, locations and/or speed of moving objects within the water, depth readings, operational limitations for payload launch and other such data that may be applicable to payload launch from an underwater hull. The computation devices 40 of the initiator system 30 are used to select firing methodologies of the billets 20, individually, in combination, in sequence, etc. that best address the operational environment of the underwater hull.

The initiator system 30 includes a connector 32, in combination with a relay 34, and an initiator 38 adjacent or imbedded in the gas generating billets 20. The initiator system 30 allows selection of various burn patterns of the gas generating billets 20 for an initiated burn. For example, without limitation, the initiator system 30 may provide a selection of various time patterns of an initiated burn. Once the computation devices 40 select the burn pattern of the gas generating billets 20, a signal is sent from the computational devices 40, passing through an electrical feed through 42, to a connector 32. The connector 32 is mounted to the housing 10 to provide electrical signals to both the relay 34 and payload 80. The relay 34 in turn is connected to the initiators 38. In combination with the connector 32,the relay 34 receives a signal from the connector 32 and provides a signal at varying time instances to a select number of initiators 38, sending the signal to initiators 38 of the gas generating billets 20 that are to be fired. The relay 34, being electrically attached to the initiator 38, provides a carrier for a signal from the connector 32 for commanding ignition of designated gas generating billets 20. This "ignition" signal is sent from the connector 32 only to those gas generating billets 20 that are to burn; these signals are sent with the proper timing for each gas generating billet 20 burn. When the initiator 38 receives an electrical signal it ignites its designated propellant billet 20. The initiator 38, being adjacent to or imbedded within each of the gas generating billets 20, once activated, provides an electrical current that has sufficient voltage and heat to initiate burn within the contacted gas generator billets 20. Depending upon the chemical composition of the billet 20 and its geometry, the billet 20 will burn at a predetermined rate thus producing exhaust gasses that pressurize the billet holding chamber 12 that the billet 20 resides in.

As the billet holding chamber 12 pressure increases, the burst disk 50 ruptures and the gas is allowed to escape through the exhaust nozzle 18. The escaping gases develop pressure between the gas generator 100 and ram plate 60 (see FIGURE. 2). The ram plate 60, which is located aft of the payload 80 and forward of the gas generator 100, acts as a pushing device by creating a closed volume behind the payload 80. As pressurized gas accumulates between the gas generator 100 and ram plate 60, the ram plate 60 is propelled forward making contact with the payload 80, thus pushing the payload 80 forward as well, until the point where the payload 80 is expelled from the launch tube 90.

By varying the number of initiators 38 that are triggered, i.e., the number of billets 20 that are used as well as the time between activation, a distinct pressure profile is generated between the gas generator 100 and the payload 80. This pressure profile governs the acceleration rate of the payload 80 and thus the resulting exit velocity. By varying the geometry of the billet 20 and exhaust nozzle 18, additional variability of the launch energy profile is achieved. The initiator system 30 provides variable energy profiles for launch depending on calculated operational considerations, described below.

The multiple propellant billet gas generator 100 may include any appropriate number of billets 20 for a given payload and/or launch profile for that payload 80. Representative numbers of the billets 20 include for example, without limitation, from about 2 to about 10, more preferably from about 3 to about 8, and most preferably from about 3 to about 5 gas generating billets 20. With the burn pattern selection, any number of billets 20 may be used over any given period of time. An initial burn of four billets may be used, although eight billets are available. Staggered initiated burn may progress through a plurality of billets 20, such as initiating separate burn throughout all twelve billets in a given system to minimize thrust forces on the payload 80. Different billets 20 may incorporate different burn rates, compositions, and the like and selection of burn may maximize these differences for a given situation. The multiple propellant billet gas generator 100 of the present invention may include gas generating billets 20 having different physical characteristics appropriate to given payloads 80, such as different sizes, chemical compositions, burn rates, etc. Additionally, the billet holding chambers 12 may include various or different internal geometries.

As seen in FIGS 2A and 2B, the multiple propellant billet gas generator 100 is combined with a specific maritime payload 80, such as an anti-submarine countermeasure, anti-torpedo torpedo, communication array, or other like device, for ejection. Although the initiator system 30 shown in FIGURE 1 is designed to a specific payload 80, the initiator system 30 may be varied or changed for specific real-time operational parameters.

The present invention provides launch energy profiles that may be varied with operational consideration for maximum ejection benefit, such as for examples without limitation, changes in payload weight, launch depth, submarine speed, submarine acceleration, submarine bearing, etc. This expands the application of the gas generator 100 of the present invention to numerous types and sizes of payloads, and increases the submarine's operating envelope during launch by increasing the safe launch envelope for device launch for effective separation from the submarine at given launch platform conditions.

In operation, the above-described multiple propellant billet gas generator 100 ejects payloads 80 from an underwater hull by selecting a burn pattern of gas generating billets 20 and initiating burn in the selected burn pattern. The selection of the burn pattern allows an appropriate ejection of the payload 80 for a given circumstance. For example in a system that included six billets, selection of all billets to burn immediately would provide the greatest ejection force for the payload at the fastest time. Alternatively, selection of two billets for immediate burn with another two billets after 0.05 seconds would provide a payload ejection with a smaller initial thrust that may be appropriate for delicate sensory electronics. Burn patterns preferably include calculation of an operational parameter, such as the type and location of an external threat parameters, payload parameters such as electronic sensitivity and susceptibility to propulsion forces, and other like payload equipment and operational parameters. Operational parameter may include the location of nearby underwater structures, incoming torpedo location or tracking methodologies, target location and/or track, etc. The ejected payload may include countermeasures, anti-torpedo torpedoes, communication arrays, and other like maritime objects particularly those related to submarine operations.

By implementing a multiple billet design, gas generators of the present invention is not limited to producing a single launch energy profile. By varying the number of billets, type of chemical propellant, propellant grain geometry, and timing between billet initiation, the launch energy profile can be varied to meet the required exit velocity for a given payload to achieve safe separation from the launching platform. With the variability of a multiple billet design a single gas generator can launch a large number of diverse payloads, which eliminates the need to develop a new gas generator for each new payload. This minimizes development costs and reduces constraints on payload design. The present invention reduces the acceleration loads imparted on the payload during launch, when needed. The implementation of variable gas generator functions eliminates submarine operating restrictions for maximum speed, minimum depth, etc. during launch.

EXAMPLE 1 (prophetic)

A submarine maintaining silent running conditions is operating in 500 feet of water and turning at 5 knots in a gentle turn to port. A second submarine is operating at 500 feet within 20000 yards off the first submarine's starboard beam heading aft of the first submarine. The first submarine launches a communications array from a multiple propellant billet gas generator during the turn. The initiator system of the multiple propellant gas generator selects those gas generating billets of the generator that best maintains quite conditions of the submarine while effectively launching the payload.

EXAMPLE 2 (prophetic)

In example 1, the first submarine, during a hard turn at 15 knots, launches a torpedo against the second submarine. The initiator system of the multiple propellant gas generator selects those gas generating billets of the generator that allows the torpedo to be launched without imparting critical stress forces to the torpedo while best positioning the torpedo to seek the second submarine.

The foregoing summary, description, examples and drawings of the invention are not intended to be limiting, but are only exemplary of the inventive features which are defined in the claims.

nearby underwater structures, incoming torpedo, target location, target track and combinations thereof.

11. The method of claim 10, wherein said selecting step further includes calculation of the resultant thrust from different billet burn compositions.

12. The method of claim 10, wherein said selecting step further includes a staggered burn of different billets.

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MULTIPLE PROPELLANT BILLET GAS GENERATOR

ABSTRACT OF THE DISCLOSURE

A multiple propellant billet gas generator, and method for using the gas generator, for ejecting payloads from an underwater hull. The gas generator includes a housing having a plurality of billet holding chambers, a plurality of gas generating billets held within individual billet holding chambers, an initiator system capable of selecting various patterns of gas generating billets for an initiated burn with a release mechanism controlling exhaust from the initiated burn.

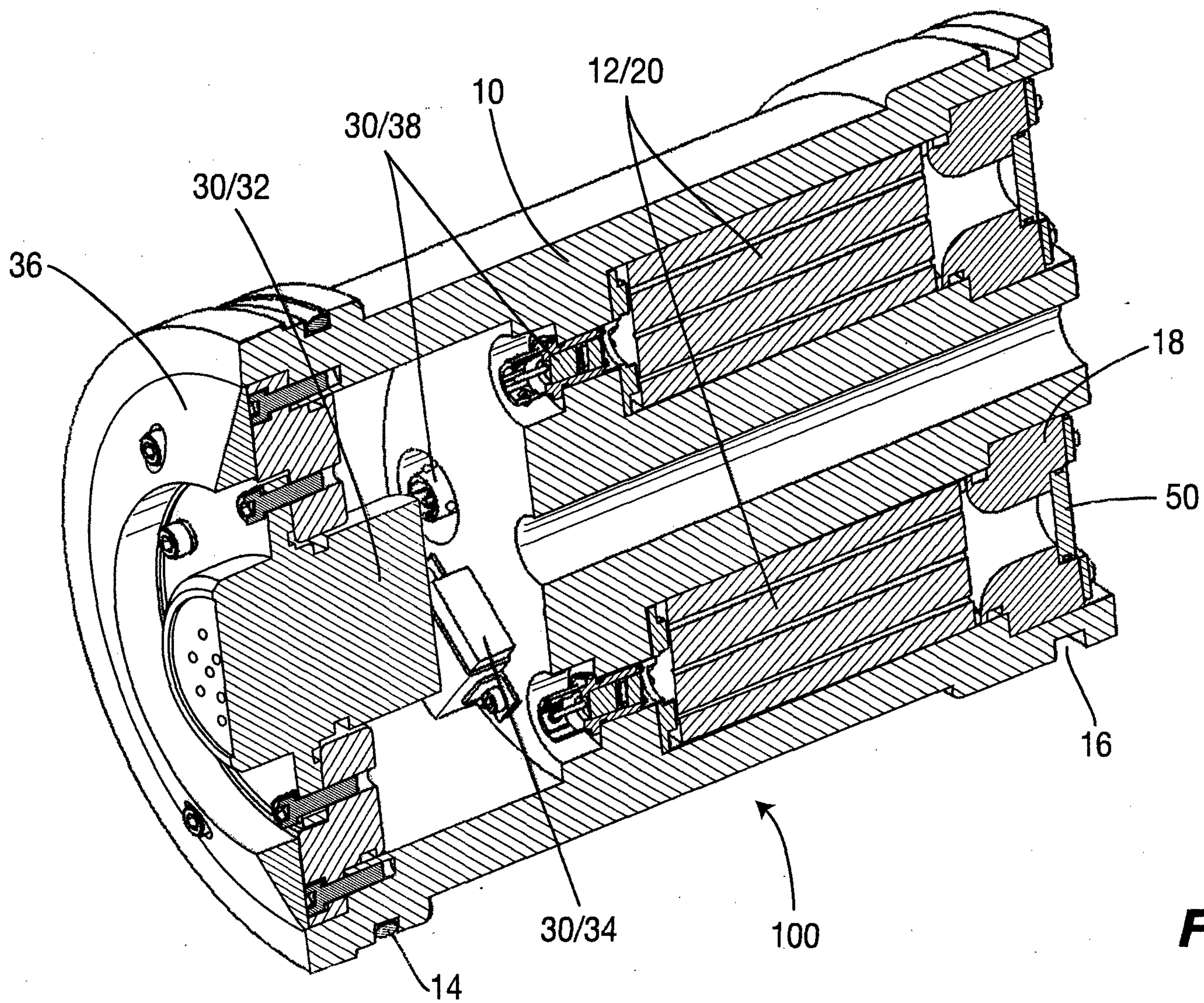

FIG. 1

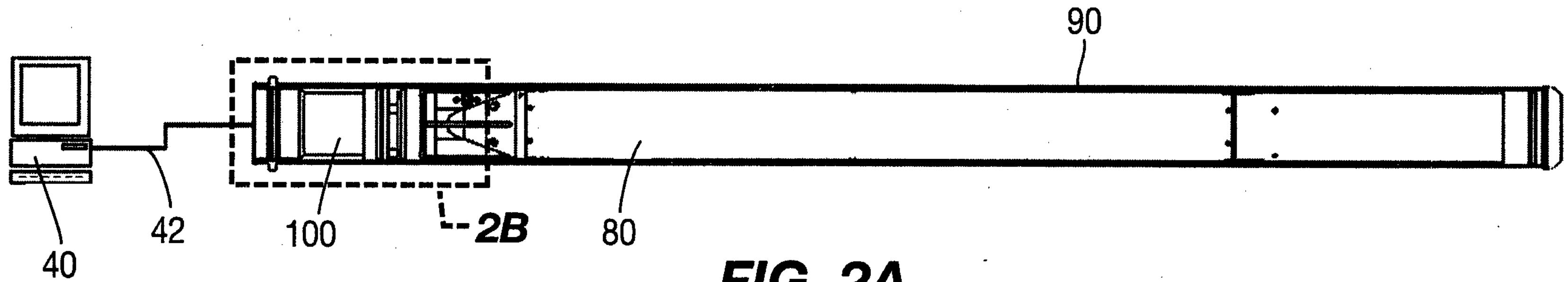

FIG. 2A

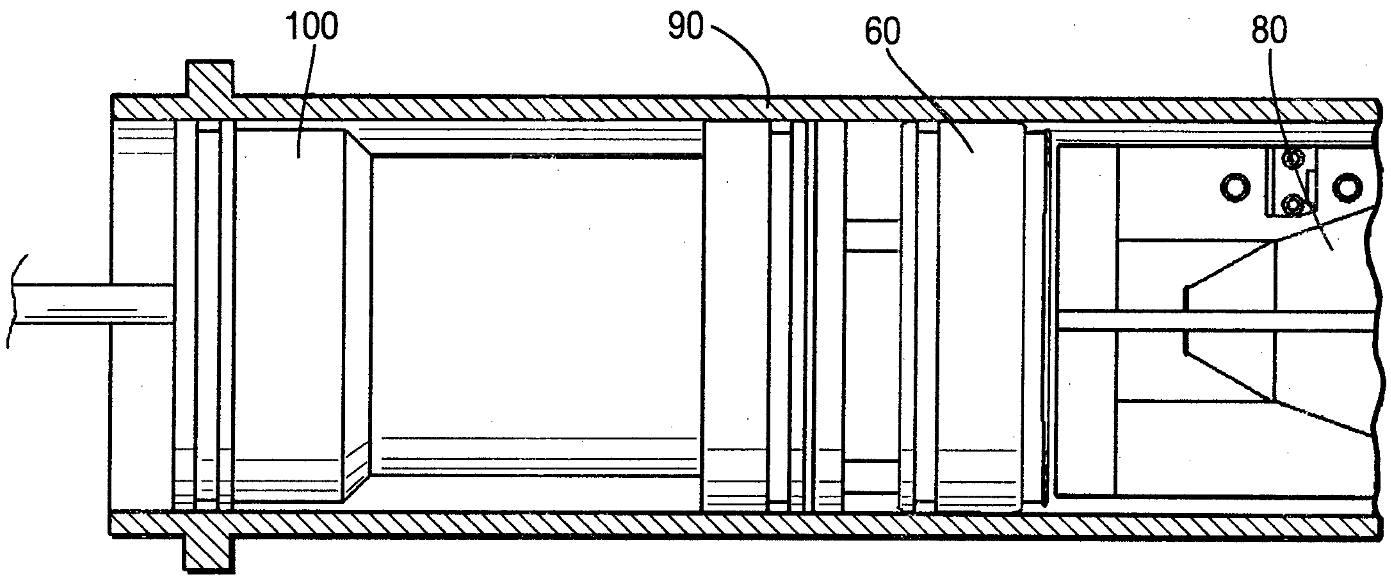

FIG. 2B