May 7, 1963 M. SIEGEL 3,088,377

MECHANICAL PROGRAMMED GAS GENERATOR

Filed June 1, 1962 2 Sheets-Sheet 1

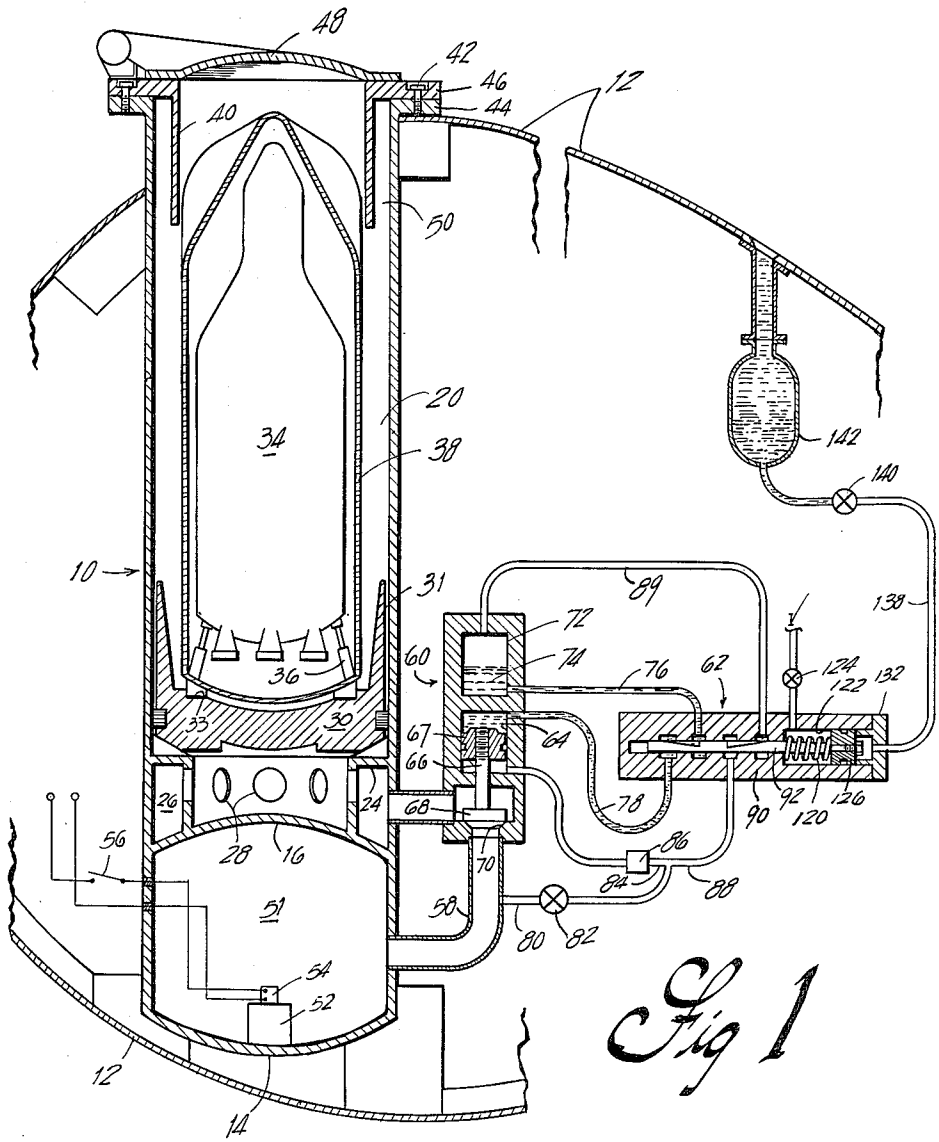


Fig 1

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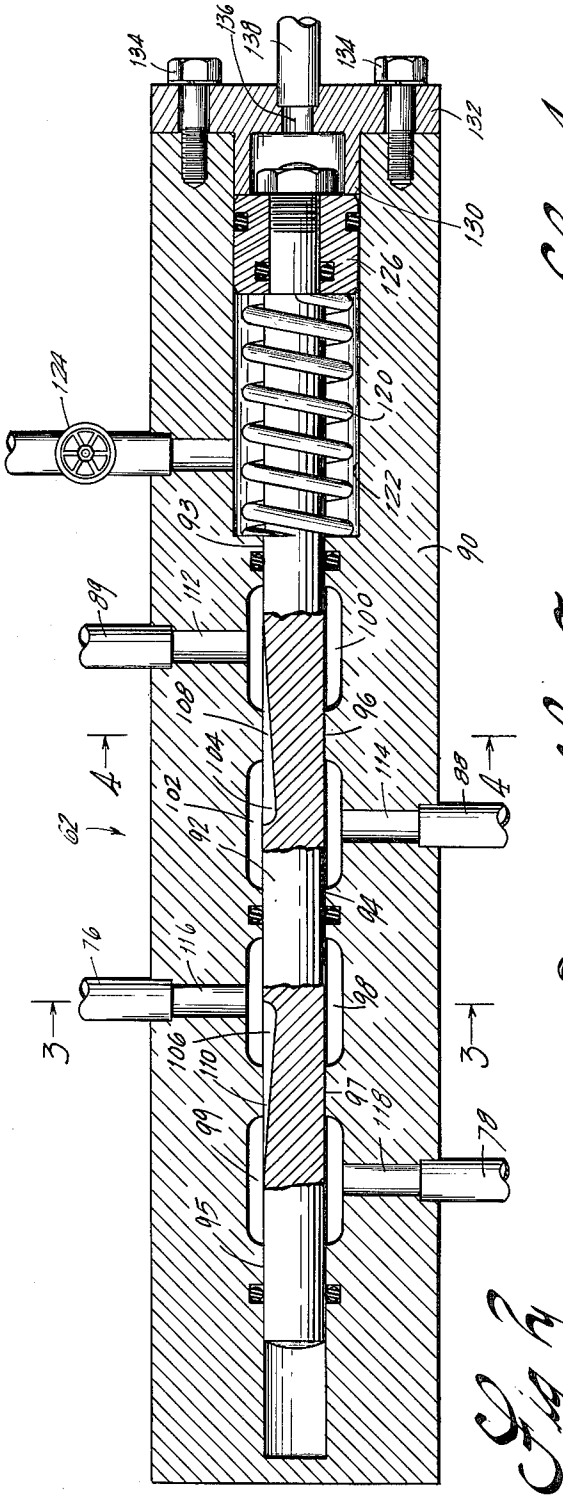


Fig 1

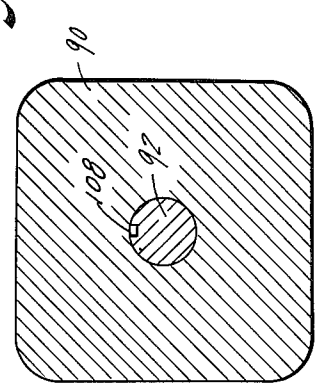


Fig 3

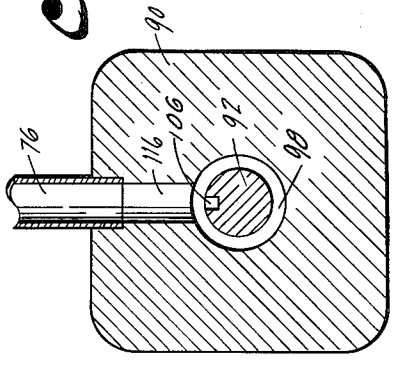


Fig 2

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3,088,377

MECHANICAL PROGRAMMED GAS GENERATOR

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5 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 royalities thereon or therefor.

This invention relates to launchers for catapulating missiles, particularly from submerged positions, to a height at which their engines may be started with safety.

The invention employs a firing tube from which a missile is ejected by the expanding force of a pressurized gas. It is a single capacity launcher adapted for use in batteries on submarines, and is complete in itself in that it has its own power plant and firing controls.

Among the features of the invention is the provision of a source of gas pressure which has the simplicity and reliability of pressurized gas stored in a flask and yet is smaller and more compact, making it suitable to the limited space offered by a submarine. Furthermore, it is equipped with a valving system which automatically adjusts to the demands of the firing conditions, in a manner that more force is supplied in a launch at deeper depths and less at shallow depths. Also, the firing tube is constructed so that there is a minimum of gas leakage and little likelihood of water spout produced by escaping gas.

The way in which the invention functions and realizes various objects and advantages will become clearer in the following description when it is read with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic view of the missile launcher ready for launch and with some parts shown on section;

FIG. 2 is an enlarged longitudinal sectional view of the selector valve; and

FIGS. 3 and 4 are cross-sectional views taken along lines 3—3, and 4—4, respectively, of FIG. 2.

Referring to the drawing, the launcher is illustrated as having a tubular member 10 vertically disposed within a submarine, only a portion of which is shown at 12, FIG. 1. The upper end of tubular member 10 is open and terminates at about the top of the submarine; whereas, its lower end is closed, at 14. Within, there is a partition 16. This divides tubular member 10 into a closed compartment or flask 18 superposed by a open-topped firing tube 20. An annular plate or diffuser 22 is secured on partition 16 that has an outward flange 24 extending to the inner wall of the firing tube and defines an annular diffuser chamber 26. A plurality of annularly arranged apertures or injectors 28 connect diffuser chamber 26 with the firing tube bore.

Seated upon diffuser 22 is a cup-shaped piston or sabot 30 capable of sliding movement up and down the firing tube; it has a brake rim 31, wedged shaped in cross-section, projecting upwardly and a groove 33 for positioning the missile to be launched. As shown, missile 34 is supported on conventional shock mounts 36 within a capsule 38 and the latter element is seated on the sabot. Upward movement of the sabot 30 raises the encapsuled missile. However, the missile, without the capsule may be placed directly on the sabot without any change in construction or operation of the launcher being required. The purpose of the capsule 38 or the manner in which the missile leaves it is not a part of this invention and will not, therefore, be described. The launcher's function is to merely provide an impetus to the missile through the sabot by which it is lifted to a desired height, through

water, so that its engine can be started with safety. The diffuser 22 spaces the sabot 30 from the partition 16, permitting access to its bottom side to the gas issuing from the injectors 28. Although a launch may be made without a sabot by seating the missile directly on the diffuser, the use of the sabot eliminates the requirement of a close fit between the missile and the firing tube's inner wall which would be needed to prevent gas leakage between them and to obtain maximum power from the ejecting gas.

The sabot 30 does not leave the firing tube with the missile and to halt its upward movement after a launch is made, a brake 40 is fastened to the top of the firing tube. It is a short tube extending partially into the firing tube 20 and secured to it by bolts 42 through flanges 44 and 46, on each of them respectively. Brake 40 is concentrically spaced from the inner wall of firing tube 20, and the annular cavity 50 formed by this spacing receives the sabot brake rim 31 in frictional engagement. A hatch 48, pivotally connected to flange 46, normally covers the open end of the firing tube and is manipulated by a conventional hatch operator, not shown.

The gas which ejects the missile is produced in flask 18. Within the flask there is a quantity of stored gas 51, such as air or helium, a solid fuel or propellant 52, for instance, one known as b.m.p. containing nitrocellulose, nitroglycerin, triacetin and n-diphneyl-amine, and a resistance-type igniter mechanism 54. A switch 56 connects the igniter with a source of electrical energy, not shown. Closing switch 56 combusts the propellant 52 and causes its products of combustion to mix with the stored gas 51. A high temperature, high pressure gas, on the order of 5,000° F. and 10,000 p.s.g.i., results.

The transfer of the gas from flask 18 to firing tube 20 is by way of a conduit 58 which leads to diffuser chamber 26 through a launch valve 60. The gas flow is regulated by launch valve 60 which in turn is programmed by a depth selector valve 62 so that proper force is delivered in view of the launching conditions.

Launch valve 60, FIG. 1, has a cylinder 64 with a piston 66 having a piston head 67 to which pressure may be applied from opposite directions for reciprocable movement. One end, 68, of the piston is frusto conically shaped and projects from the cylinder into a mating seat 70 within conduit 58 for blocking the passageway therethrough. Above cylinder 64 there is a reservoir 72 carrying pressurized hydraulic fluid 74 with access to cylinder 64. This is through conduits 76 and 78 which connect the cylinder and reservoir by way of a variable fluid orifice 40 in depth selector valve 62. Hydraulic fluid 74 in reservoir 72 is in communication with cylinder 64 at all times, but its flow is varied by the depth selector valve 62 in accordance to the depth from which a launch is to be made as will be explained hereafter. The downward force of the hydraulic fluid on piston head 67 keeps the valve end 68 seated, closing the gas passage through conduit 58.

The ejection gas generated in flask 18 opens and, together with the hydraulic fluid, closes launch valve 60. For these operations, there is a conduit 80 that connects flask 18 through a conventional, manually operated shut-off valve 82 and a conduit 84 connected to the underside of piston head 67, that is the side opposite to the one on which the hydraulic fluid force is exerted. There is a fixed restricting orifice 86 in conduit 84, and a branch line 88 leads from conduit 84 through a variable gas orifice 108 in selector valve 62 into conduit 89 to the hydraulic fluid reservoir 72. When shut-off valve 82 is open, gas from flask 18 passes through conduit 84 to the underside of piston head 67 overcoming the hydraulic fluid's force and driving it back to reservoir 72 through conduits 78, variable gas orifice 110 and conduit 76. Gas also passes

through the selector valve 62 to reservoir 72 at all times, and its flow is restricted by the variable gas orifice 108 within the selector valve. The fixed restricting orifice 86 and the variable orifices 108 and 110 in the selector valve 62 determine the proportional quantity of gas flow to the launch valve 60 relative that into reservoir 62 as well as the quantity and direction of hydraulic fluid flow, as will be explained more clearly hereinafter; this sets the speed with which the launch valve is opened and closed.

Selector valve 62 includes a body 90 with an axial bore 91 in which a piston 92 is supported for reciprocable movement by three axially spaced annular ridges 93, 94 and 95. Two similar ridges or orifice lands 96 and 97 between the support ridges 93, 94 and 95 separate a pair of chambers on either side of each land; gas chambers 98 and 99 flank the land 96; whereas, land 97 separates fluid chambers 100 and 102. At least one axial groove, 104 and 106, of graded depth is present in the surface of piston 92 in the area beneath each of the orifice lands 96 and 97. These grooves, 104 and 106, have sufficient length to always have a portion beneath their respective orifice lands regardless of the position of piston 92, but are not so long as to extend at any time under one of the adjacent support ridges. The portion of groove 104 beneath orifice land 96 defines the variable gas orifice 108 between gas chambers 99 and 98; and likewise variable fluid orifice 110 is defined by groove 106 under orifice land 97. Shifting piston 92 places different depths of the grooves beneath the orifice lands and thus varies the size of the variable orifices 108 and 110 connecting the chambers on opposite sides of the orifice lands.

An external port is provided to each of the chambers flanking the orifice lands. Thus, ports 112 and 114 furnish an inlet and outlet through the selector valve for hydraulic fluid passage between reservoir 72 and the launch valve 60. The course of the hydraulic fluid, when the launch valve is closing, is through port 112 into fluid chamber 100, through variable orifice 100 into fluid chamber 102, and out gas port 114 through conduit 78 to the launch valve. The hydraulic fluid flow is the same but reversed when the launch valve 60 is opening. Gas ports 116 and 118 are placed similarly to fluid ports 112 and 114 but with respect to orifice land 96 and furnish a like passageway for gas flow between conduit 88 from flask 18 through the selector valve 62, and conduit 89 to reservoir 72.

Although orifice grooves 104 and 106 in piston 92 are alike in construction and function, it should be observed that their grades are in opposite directions. With movement of piston 92, the variable fluid orifice 110 formed by groove 106 will decrease in size while gas orifice 108 is increasing, and vice versa.

Movement of selector valve piston 92 is through the exertion of the pressure of sea water countering the force of a spring 120 within the valve body 90. For this function, a portion of piston 92 is housed in a body cylinder 122, adjacent support ridge 93. Cylinder 122 is vented through a check valve 124 even through seals may be provided in the support ridges etc., as shown, to eliminate gas that leaks into it and would increase the force needed to displace piston 92. Spring 120 is mounted on piston 92 and abuts the support ridge 93 and a sleeve 126 held on the piston by a nut 128. Piston 92 is normally urged by spring 84 to the right, as viewed in FIGS. 1 and 2, into abutting relationship with a stop flange 130 extending from an end plate 132 secured to the end of the body 90 by bolts 134. In this position of piston 92, variable gas orifice 108 is larger relative variable fluid orifice 110 as would be required for a launch from the surface or at a shallow water depth.

The variable orifices, 108 and 110, proportioned as described above cause the launch valve 60 to open slowly and close within a short time, so that a minimum of gas, and impact, is delivered to the missile. This happens because gas leaving flask 18 through conduit 88, after an ignition, will pass more easily thorugh the widely opened variable gas orifice 108 than through the fixed restriction 86 toward launch valve 60. The gas reaching the launch valve will raise the valve piston 67, but its upward movement is restrained by the constricted condition of variable fluid orifice 110 in the path of the hydraulic it forces back toward reservoir 72. As a result, the launch valve is laggardly in opening. Furthermore, it does not remain open very long, since the gas reaching reservoir 72, through gas orifice 108 quickly builds up pressure and forces the hydraulic fluid flow to reverse, that is, flow back to the launch valve, and seat the launch valve piston.

When the launcher is submerged, more gas force is needed to eject it; the launch valve must open quickly and stay open longer. This requires a larger variable fluid orifice 110 and smaller gas orifice 108 to inhibit the gas flow to reservoir 72 and increase the hydraulic fluid flow. To accomplish this, sea water is allowed to enter cylinder 122 through an inlet 136 in end plate 132 from a conduit 138 that is connected from a open-ended flask 142 by a manual cut-off valve 140. Sea water in flask 142, when cut-off valve 140 is open, enters cylinder 122, counters the force of spring 120, and displaces the selector valve piston 92 a distance dependent upon the force differential which depends upon the depth to which the launcher is submerged. Displacement of piston 92 is to the left, as viewed in FIGS. 1 and 2, and variable gas orifice 108 thereby is contracted while fluid orifice 110 is enlarged. As a result, there is a delay in gas pressure build up in reservoir 72, and at the same time hydraulic fluid is readily forced through the enlarged fluid orifice 110 from above the launch piston to the reservoir 72. Launch valve 60 therefore is opened quicker and closes later.

Considering the whole operation of the launcher, normally the end, 68, the launch valve piston is seated, valve 82 is closed, so that there is no exit from gas flask 18, and sea water cut-off valve 140 is opened to allow displacement of selector valve piston 92. For a launch, water cut-off valve 140 and switch 56 are closed and propellant of high temperature. Gas shut-off valve 82 is then opened. The gas in flask 18 passes through the opened shut-off valve 82, conduit 84, into the launch valve under piston head 67 forcing it upward at a speed determined by the setting of piston 92 in selector valve 62; some of the gas passes through the branch conduit 82, the selector valve 62 and into the hydraulic fluid reservoir 72. The rising launch valve piston 66 forces hydraulic fluid from above it back to the reservoir 72.

When the launch valve is opened, the gas passes through it into diffuser chamber 24 and under sabot 30, whereupon it rises and lifts the missile with it. Hatch 48 is opened by the rising missile or an operator and brake 46 halts the sabot 30 at the top of the firing tube 20.

After a launch, sea water in contact with the sabot 30 cools the gas beneath it. The gas flask pressure drops and permits the sabot to settle to its original position. The decay of gas pressure in flask 18 and build-up of pressure in reservoir 72 causes the launch valve to close.

Gas cooling may be enhanced by water sprayed into flask 18 by conventional spray means, not shown, to permit the sabot to return more quickly.

The use of the sabot, 30, besides eliminating water spout through escaping gas, has the additional function of stabilizing the missile when it is partially out of the firing tube 20. This results because of the support the sabot 30 offers the missile against the force of moving water which tends to rotate it. The sabot holds the missile against this rotation and, therefore, permits launchings from submarines moving at relatively high speeds under water.

The capsule, 38, although as pointed out heretofore is not necessary, nevertheless, its use for launches from submarines moving underwater is advantageous. The

skin of the missile to be launched by the invention is thin and structurally relatively delicate. It can resist little static or dynamic sea pressure; whereas, the converse is true for the capsule. The protection offered by the capsule enables launching from submarines moving underwater.

Even though one embodiment of the invention has been shown and described, it is subject to various modifications without departure from its spirit. In this regard, for one thing, valves **82** and **140** may be connected to operate with closing of switch **56** which ignites the propellant. Accordingly, what is desired to be covered by Letters Patent is set out in the following claims.

What is claimed is:

1. A missile launcher comprising a firing tube for ejecting a missile therefrom by a gas, a flask for containing a hot pressurized gas, a launch valve connecting said flask to said firing tube for throttling gas flow thereto having a bore and a piston, a reservoir for containing a pressurized fluid, a selector valve having a body with a bore carrying a piston and a gas orifice and a fluid orifice that are varied with displacement of said piston, means connecting said reservoir through said selector valve fluid orifice to one side of said launch valve piston for urging it into a closed position, means connecting said gas flask through said selector valve gas orifice to said reservoir, means connecting said flask to the other side of said launch valve piston for urging thereof into an open position, means for introducing ambient pressure into said selector valve for displacing the piston therein and varying said gas and fluid orifices accordingly a shut-off valve in said means connecting said flask through said selector valve gas orifice and means connecting said flask to the other side of said launch valve piston for opening and closing the passage therethrough, and a cut-off valve in said means for introducing ambient pressure to said selector valve.

2. The launcher of claim 1 including a piston reciprocably mounted in said firing tube for carrying a missile and preventing the escape of gas from said firing tube.

3. The launcher of claim 2 including a brake means

secured in said firing tube for restricting upward movement of said piston in said firing tube.

4. The launcher of claim 3 including a solid propellant fuel in said flask for generating said hot pressurized gas.

5. A missile launcher comprising a firing tube for ejecting a missile therefrom by a gas, a flask disposed beneath said tube, a solid propellant in said flask for creating a high temperature, high pressure upon combustion, means for igniting said propellant, an annular diffuser disposed in said firing tube for passing gas thereinto, a piston reciprocably mounted in said tube for supporting a missile, a launch valve having a bore and a piston therein connecting said flask to said diffuser, a reservoir containing a pressurized fluid, a selector valve with a piston and a gas orifice and a fluid orifice that are varied by movement of said piston, first conduit means connecting said reservoir through said selector valve fluid orifice to one side of said launch valve piston for urging it into a closed position, second conduit means connecting said flask to the other side of said launch valve for urging thereof into an open position, third conduit means connecting said flask through said selector valve gas orifice to said reservoir, a shut-off valve in said second and third conduit means, resilient means in said selector valve for urging said piston therein into a first position whereupon said gas orifice is increased and said fluid orifice is decreased, a fluid passage conduit connected to said selector valve for introducing ambient fluid pressure urging said piston toward a second position whereupon said fluid orifice is increased and said gas orifice is increased, and a cut-off valve in said fluid passage.

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