United States Patent

Galbraith et al.

[15] **3,640,083**

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[54] **GENERATOR OF COOL WORKING GASES**

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[73] Assignee: **Rocket Research Corporation,** Redmond, Wash.

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[21] Appl. No.: **23,154**

[52] **U.S. Cl.** **62/52,** 60/39.48
[51] **Int. Cl.** **F17c 7/02**
[58] **Field of Search** 239/129, 171; 62/52, 53; 60/39.48

[56] **References Cited**

UNITED STATES PATENTS

3,431,742 3/1969 Green 62/52
3,431,743 3/1969 Green 62/52

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[57] **ABSTRACT**

Hot pressure gases are generated by burning a solid fuel grain. A portion of the gases are used to pressure feed a liquid from its storage chamber into a mixing zone. The remainder of the hot gases are directed into the mixing zone for mixing with the liquid. The hot gases provide the heat of vaporization for, and cause the vaporization of, the liquid. The gas generator comprises a one-piece housing of composite welded construction, defining liquid storage, breech and mixing chambers. A control cartridge containing burst discs, flow control orifices and seals is inserted into the housing through the outlet passageway. A solid fuel cartridge is inserted into the breech through an opening at the opposite end of the housing.

26 Claims, 7 Drawing Figures

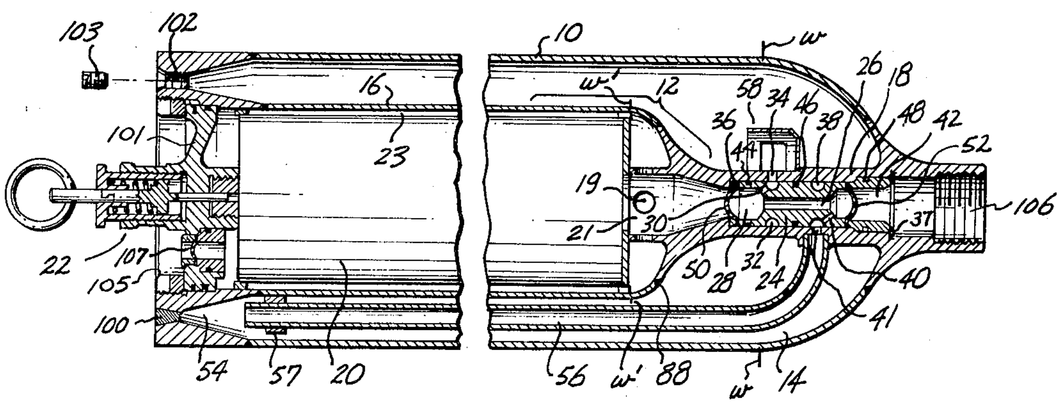


Fig. 1.

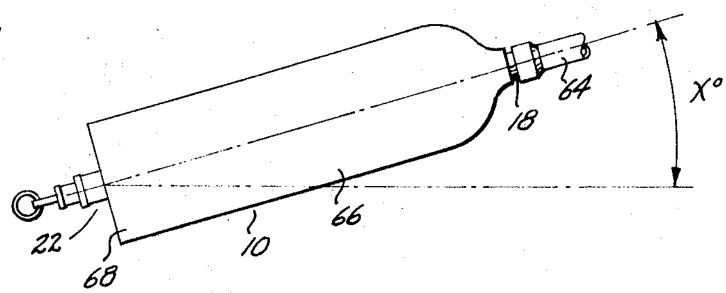


Fig. 2.

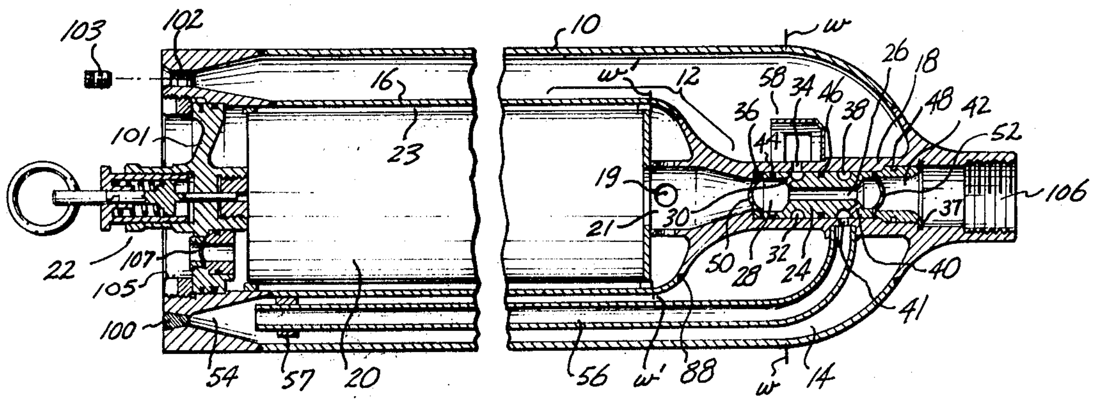
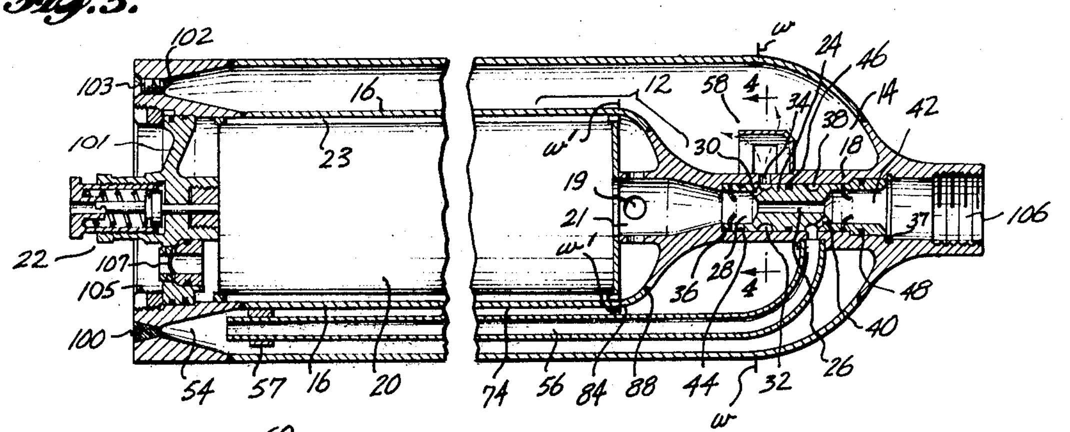


Fig. 3.



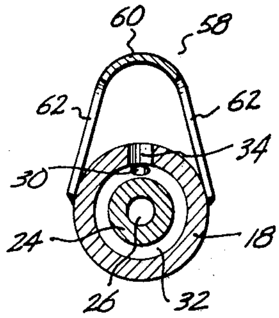


Fig. 4.

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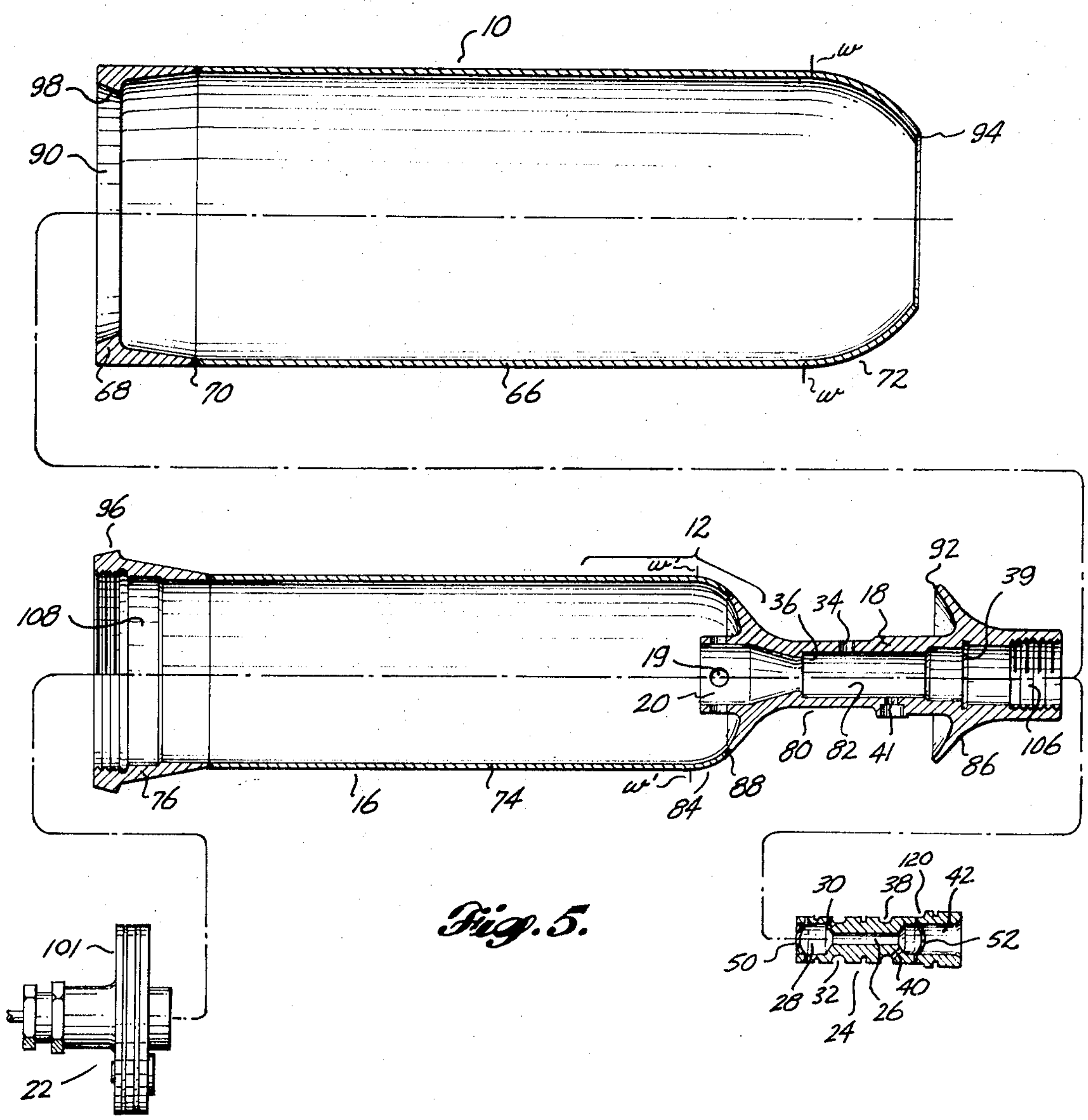

Fig. 5.

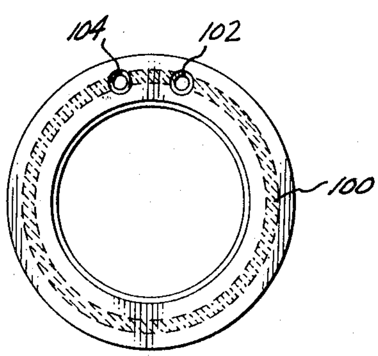

Fig. 6.

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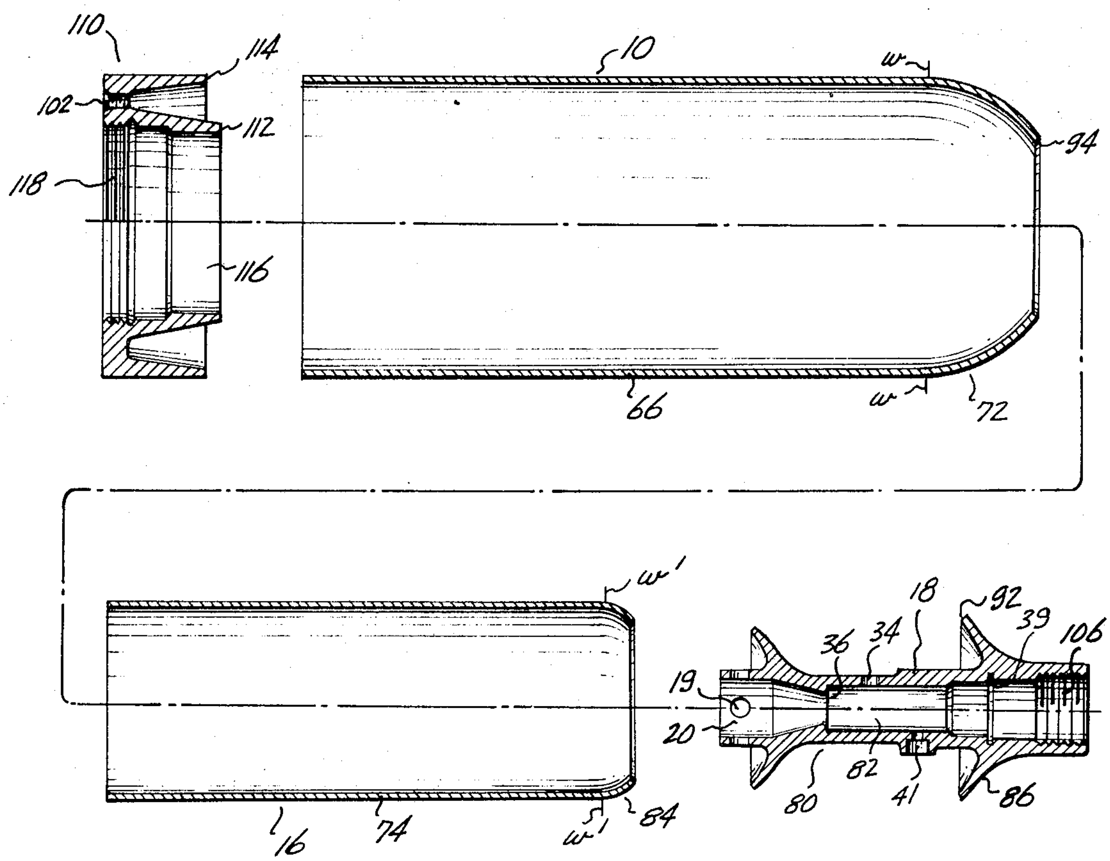

Fig. 7.

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GENERATOR OF COOL WORKING GASES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates primarily to the generation of a relatively low-temperature working fluid, and in particular to a construction of the equipment or hardware for handling and combining the substances which produce the working fluid.

Herein the expressions "relatively low temperature working fluid," "cool working gases" and "cool gas generator" are used to respectively describe gases which are relatively cool when compared to undiluted combustion gases or reaction products, and generators of same.

2. Description of the Prior Art

Known gas or gas-included fluid generators which involve mixing combustion products and a coolant are disclosed by Goddard U.S. Pat. No. 2,522,113; Scholz U.S. Pat. No. 2,530,633; Maurice U.S. Pat. No. 2,779,281; Volk, Jr. U.S. Pat. No. 2,994,194, Barakauskas U.S. Pat. No. 3,182,554; and Barakauskas U.S. Pat. No. 3,298,278, and also by Hebenstreit U.S. Pat. No. 3,117,424; Hebenstreit et al. U.S. Pat. No. 3,122,181; Hebenstreit U.S. Pat. No. 3,143,445; Wismar U.S. Pat. No. 3,163,014; Hebenstriet U.S. Pat. No. 3,180,373; Hebenstreit U.S. Pat. No. 3,232,481 and Wismar U.S. Pat. No. 3,269,310.

Each of the latter seven patents involves a system wherein combustion products and a liquefied gas are mixed together in the storage chamber for the liquefied gas, and the resulting mixture, which is gaseous, is then released or withdrawn from such storage chamber.

Wismar U.S. Pat. No. 3,163,014 discloses a process comprising: generating hot combustion gases and initially directing all of such gases into a chamber containing liquefied carbon dioxide. Such chamber is initially closed by a blowout element. When the pressure in such chamber exceeds the burst pressure of the blowout element, such element is ruptured, and the outlet is opened. The remaining combustion gases then serve to aspirate the mixture of gases from the carbon dioxide storage chamber.

Hebenstreit et al. U.S. Pat. No. 3,122,181 discloses entraining ambient air in a working fluid constituting a mixture of combustion gases and carbon dioxide, and then introducing the mixture into an inflatable device.

Barakauskas U.S. Pat. Nos. 3,182,554 3,298,278 disclose adding water to combustion gases and then directing the resulting gas-water-steam mixture into a space below a missile for exerting a launching force on the missile.

The present invention relates to a particular gas generator capable of performing the methods disclosed in the Charles J. Green U.S. Pat. Nos. 3,431,742 and 3,431,743, both granted on Mar. 11, 1969, and both entitled Generation of Cool Working Fluids.

SUMMARY OF THE INVENTION

Briefly, the gas generators of this invention each comprises a housing of welded composite form, including concentrically related inner and outer housing parts. The outer housing part includes a cylindrical body. The inner housing part includes a flanged tubular outlet member and a tubular body member. In one form of the invention a one-piece inlet ring member is welded to the inlet ends of the two body members. In another form one piece of a two-piece inlet ring is welded to the inlet end of the outer body member and the other piece is welded to the inlet end of the inner body member. In both forms during fabrication of the housing the inner housing part is inserted into the outer housing part and the two housing parts are welded together at the two ends of the generator.

The inlet ring member is internally threaded to receive the threads of a retainer ring restraining an end closure which carries a firing assembly for the fuel grain. The fuel grain is inserted into the gas generator through an inlet opening in the inlet ring member and then the end closure member and retainer ring are installed. A control orifice and burst disc insert is inserted into, and after use is removed from, the assembly via an outlet passageway provided in the outlet member of the inner housing part.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a cool gas generator embodying features of the present invention, shown in a leaning attitude typical of one it might occupy in some aircraft escape slide inflation systems;

FIG. 2 is a longitudinal sectional view of the cool gas generator of FIG. 1, prior to activation, with a closure plug thereof shown spaced outwardly from its installed position;

FIG. 3 is a view like FIG. 2, but showing the generator in an active condition;

FIG. 4 is a cross-sectional view taken substantially along line 4—4 of FIG. 3;

FIG. 5 is an exploded view of various casing parts which make up the gas generator of FIGS. 1–4, with the liquid pickup tube, its connector, the gas deflector, and the retainer ring omitted;

FIG. 6 is an end elevational view at the inlet end of the assembled casing members, with the inlet and closure member removed and the outlet end details omitted; and

FIG. 7 is an exploded view of the housing parts only of a modified form of gas generator.

DETAILED DESCRIPTION

Referring more specifically to the figures of the drawing, the cool gas generator of FIGS. 1–6 is shown to comprise an outer enclosure or casing **10** of elongated tubular form. Located inside of enclosure **10** is a smaller inner tubular enclosure **12**. An annular space **14** exists between the respective annular sidewall means of the two enclosures **10**, **12**. This space **14** constitutes a storage space for the vaporizable liquid L.

The inner enclosure **12** is axially divided into a breech or hot gas generator chamber **16** and an outlet passageway **18**. Chamber **16** is shown to contain a solid fuel grain **20**. A percussion-type firing mechanism **22** is illustrated by way of typical example only. Also by way of typical and therefore nonlimiting example, the fuel grain **20** may be constructed according to any of the designs of fuel grains disclosed by the aforementioned U.S. Pat. No. 3,431,742.

The upstream end portion of the outlet passageway **18** includes a grain support **21** formed to include a plurality of gas openings **19**. Some of the hot gases flow through these openings **19** into the annular space **23** which surrounds grain **20**, for substantially equalizing the pressure on the grain casing. This makes it possible to use a thin casing material around the grain **20**.

A control orifice insert **24** is supported within the outlet passageway **18**. Insert **24** is shown to include an axial passageway **26** through which most of the hot gases flow. Insert **24** also includes an enlarged inlet cavity **28**. A second hot gas passageway extends from the inlet cavity **28** into the liquid storage space **14**. This passageway comprises one or more generally radial ports **30** formed in the insert **24**, a girth channel or groove **32** formed in the insert in the vicinity of where the port(s) **30** breaks the periphery of the insert **24**, and one or more radial ports **34** formed in the wall of the outlet passageway **18**.

A shoulder **36** (FIGS. **2**, **3** and **5**) serves as a spacing stop for the insert **24**. When the forward end of the insert **24** is against shoulder **36**, and the snapring **37** (FIGS. **2** and **3**) is placed within girth groove **39** (FIG. **5**), groove **32** is properly aligned with the port(s) **34**. The use of a girth groove **32** makes it possible for the port(s) **30** to always be in communication with the port(s) **34** (via groove **32**) regardless of the angular position of the insert **24** in its receiving chamber.

A second girth groove or channel **38** is formed in the insert **24**, downstream of groove **32**. When the front end of the insert **24** is against the stop **36** this channel **38** is in communication with one or more radial ports **41** formed in the sidewall of outlet passageway **18**. One or more ports **40** in insert **24** communicate the channel **38** with an enlarged outlet cavity **42** in the insert **24**.

The insert **24** includes a plurality of axially spaced girth grooves for receiving sealing O-rings. The first O-ring **44** (FIGS. **2** and **3**) is provided in insert **24** upstream of groove **32**. The second O-ring **46** is located between grooves **32** and **38**. The third O-ring **48** is located downstream of groove **38** and may be at larger diameter than O-rings **44, 46**.

The insert **24** is constructed for receiving and retaining a pair of burst discs **50, 52**. The upstream burst disc **50** is located upstream of the inlets for port(s) **30** and passageway **26**. The second burst disc **52** is located downstream of the outlets from port(s) **40** and passageway **26**.

In a typical escape slide inflation installation such as shown by FIG. **1** the gas generator may occupy an inclining attitude of X degrees (shown by way of example to be about fifteen degrees (15°) to horizontal). The gas generator may occupy such an attitude within a compartment prepared for it within the door for the opening in the aircraft with which the escape slide to be inflated is associated. Of course, it is to be understood that the gas generator has general utility and in other aircraft or nonaircraft installations may occupy an entirely different attitude.

When the gas generator is in the sloping attitude pictured, the lowest portion **54** of the liquid storage space **14** is near the inlet end of the gas generator. A liquid pickup tube **56** extends from this region **54** up to a point of connection with the wall means for passageway **18**, at a location enveloping the port(s) **41**. Of course, in other installations involving a different attitude of the gas generator the inlet for the pickup tube **56** is located in the region of the low point for such installation.

Preferably, a gas deflector is mounted on outlet passageway **18** radially outwardly from the port(s) **34**. In FIGS. **2–4** this deflector is shown in the form of a sheet material hood **58** having an end wall **60** aligned with the port **34** and having sidewall openings **62**.

In operation, the fuel grain **20** is initiated by a pulling-on or other (e.g., electrical control) release of the firing pin, to activate the firing mechanism **22**. Burst discs **50, 52** break (almost simultaneously) when the pressure on them exceeds a predetermined value. A first portion of hot gases flows through the ports **30, 34** and into the liquid storage chamber **14**. The hot gases entering the storage chamber **14** pressurize the liquid L therein and force feed it through the pickup tube **56** towards the annular manifold **38**. The pressurized liquid L flows from manifold **38** through the ports **40** and into mixing contact with the hot gases issuing from passageway **26**. The hot gases and liquid meet and mix together in outlet cavity **42**. The outlet cavity **42** is at least the start of a mixing chamber or zone. In some installations some mixing may continue in the passageway downstream of cavity **42**. The hot gases supply the latent heat of vaporization for the liquid, causing its vaporization, attended by a significant cooling of the hot gases. The relatively cool gaseous working fluid that is formed then flows from the outlet passageway **18** through a conduit **64** to a utilization device, e.g., the inlet of a gas confining type inflatable.

By way of nonlimitive example, the liquid may be a liquefied fluorinated hydrocarbon type refrigerant, liquefied carbon dioxide, liquefied air, liquefied ammonia, a mixture of liquefied ammonia and water, i.e., aqueous ammonia, water alone, or a mixture of these or other such materials blended to produce gaseous mixtures of various desired compositions and properties.

Referring now to FIGS. **5** and **6**, relating to a preferred construction of the gas generator housing and fluid control parts. The outer housing **10** is shown to comprise a cylindrical shell **66** and a specially formed (e.g., forged or cast) end piece **68**. The piece **68** is welded to one end of cylinder **66** at weld line **70**. The opposite end of cylinder **66** is either drawn into the shape shown, or the generally hemispherical section **72** is separately formed and is then welded to the cylinder **66** (at location *w*). The inner housing assembly **16** comprises a cylindrical intermediate portion **74**, a specially constructed (e.g., forged or cast) inlet end member **76** and a specially fabricated (e.g., forged, machined or cast) opposite end member **80** which defines the outlet passageway, including the cavity **82** for the insert **24**. The generally ellipsoidal portion **84** of cylinder **74** may be a draw-formed part of cylinder **74**, or may be a separately constructed member which is later welded to the cylinder **74** (at location *w*), or may be included as a part of member **80**.

Member **80** includes a generally radial-contoured flange **86**. In the illustrated embodiment member **80** is welded at **88** to the section **84** of cylinder **74**.

In assembly, the downstream end of the inner housing **16** is inserted through the inlet opening **90** of outer housing **10**. The inner housing **16** is then moved completely into the outer housing **10** until the edge surface **92** of flange **86** is adjacent the edge surface **94** of section **72**, and the edge surface **96** of member **76** is adjacent the edge surface **98** of member **68**. Then the two housings are welded together where the surfaces **92, 94** meet and where the surfaces **96, 98** meet. The gap between surfaces **96, 98** is completely filled by weld **100**. Then, fill and liquid level indicator openings **102, 104** (FIG. **6**) are drilled through the welded area and are tapped for receiving a threaded closure fitting or plug therein. The closure plug **103** for opening **102** is shown in FIGS. **2** and **3**. The firing mechanism **22** is carried by a cap **101** insertable in through opening **108**, and retained in place by retainer ring means **105**, as shown in FIGS. **2** and **3**. The cap **101** also includes a threaded opening for receiving a safety burst disc fitting **107**.

FIG. **7** shows a slightly modified form of the generator. In this embodiment of the invention a one-piece end ring **110** is used. During assembly the ring **110** is welded at **112** to the inlet end of member **74**. With member **80** attached (by welding) the inner assembly is inserted into member **66**. Then ring **110** is welded at **114** to the inlet end of member **66** and member **66** is welded at **94** to the flange **86** at **92**, but not necessarily in this order.

Ring member **110** is threaded at **118** to receive the retainer ring means **105**, as shown in FIGS. **2** and **3**.

In both embodiments the inner and outer housing assemblies **10, 16** are permanently joined so that the resulting housing structure is of one-piece composite form.

Liquid pickup tube **56** is secured at its outlet end to the member **80**. A connector **57** is used to secure the opposite end of tube **56** to a portion of wall **16**. This connector **57** has a generally U-shaped central portion which partially surrounds tube **56** and straplike end portions which are secured to the wall **16**.

Following a use of a generator its insert **24** is removed from the generator via the outlet opening **106**, and is replaced by a new insert through the same opening **106**. Similarly, the spent solid fuel cartridge **20** is removed from the breech chamber **16** via the opening **108** (FIG. **5**) in member **76**, or opening **116** (FIG. **7**) in member **110**, and a new cartridge **20** is replaced through the same opening.

Another important advantage of the construction of this gas generator is that a family of several sizes of gas generators can be easily built without having to fabricate an entirely new set of gas generator parts. According to the invention, for a given family of sizes it is only necessary to vary the lengths of the cylinders **66, 74** and the length of the fuel grain **20**. The other parts of the gas generator are standard and may be used with any size generator of the family. In some installations it may be desirable to vary the size of the ports in insert **24** from one size to the next, but this is an easy and inexpensive modification. Additional ranges of sizes may be similarly provided in a larger or smaller diameter generator by similar length variations.

As a safety feature, the insert **24** is provided with an enlarged diameter outer end portion. If the insert **24** is not seated tight against surface **36** and the snapring **37** is not properly within groove **39**, the vapor pressure of the stored liquid will exert a force on surface **120**, causing ejection of insert **24**. Thus, the gas generator will not let the person loading it forget to install, or to improperly install, snapring **37**.

The restricted nature of passageway **26** is a very important feature of the invention. It causes a pressure drop which makes flow of the liquid possible. Owing to the presence of this restriction **26** the pressure in region **42** is less than in chamber **14**. Thus, the gas pressure on the liquid in chamber **14** force feed the liquid into the zone **42**.

As heretofore stated, the gas generator has general utility. Examples of uses in addition to escape slide inflation include: for turbine operation, for undersea flotation bag inflation, for flotation systems generally, and for controlled temperature hot gas supply systems.

These and other variations, modifications, adaptations, features and characteristics of cool gas generators according to the present invention will be apparent to those skilled in the art to which such invention is addressed, within the scope of the following claims.

What is claimed is:

1. A cool gas generator, comprising:

outer housing means;

smaller diameter inner housing means inside said outer housing means;

with a storage space for a liquid existing about the inner housing means, between it and the outer housing means, and a vaporizable liquid in said space;

said inner housing means comprising tubular wall means defining a hot gas generation chamber and a communicating tubular outlet section extending from said chamber to an outlet opening in said outer housing means; generation means in said hot gas generator chamber for generating hot gases therein, for release therefrom into said outlet section;

said inner housing means also including a hot gas passageway leading from the interior thereof into said storage space, for delivering a first portion of the hot gases into said space, and a liquid passageway downstream of said hot gas passageway, leading from said space into said outlet section, and conduit means leading from said outlet section to a utilization station; and

the improvement comprising:

the tubular wall means defining the outlet section has first and second ports therein, one of which constitutes a portion of said hot gas passageway and the other of which constitutes a portion of said liquid passageway; and

an elongated, replaceable control insert snugly received inside said outlet section, said insert having inlet and outlet portions, and elongated, generally axial, small diameter passageway therein, extending from said inlet portion to said outlet portion, through which a second portion of the hot gases flow, a first side port extending from said inlet portion to the hot gas passageway port in said tubular wall means, in parallel flow relationship to said generally axial passageway, a second side port extending from said outlet portion to the liquid passageway port in said tubular wall means, a first pressure-releaseable closure member spanning across and initially closing the inlet end portion at a location upstream of the entrances of both said first side port and said generally axial passageway, and a second pressure-releaseable closure member spanning across and initially closing the outlet portion, at a location downstream of the outlets of both said second side port and said generally axial passageway.

2. A cool gas generator according to claim **1**, wherein said insert is accessible from the outlet opening in the outer housing, so that it can be removed and replaced by a new insert through said outlet opening.

3. A cool gas generator according to claim **1**, wherein said insert includes a peripheral groove on each side of each side port and an O-ring in each groove, for sealing between the insert and the tubular wall means of the outlet section.

4. A cool gas generator according to claim **1**, further including deflector means secured to the tubular wall means of the outlet section, for turning the hot gases issuing from said first port and directing them substantially axially.

5. A cool gas generator according to claim **1**, wherein said insert includes a girth channel surrounding its periphery where each said side port meets the periphery, so that the side ports of the insert are always in communication with the ports in the tubular wall of the outlet section regardless of the angular relationship of the insert ports to the ports in the sidewall means.

6. A cool gas generator according to claim **1**, wherein the inlet and outlet portions of said insert are larger in diameter than said generally axial passageway through the insert, said first side port has its entrance in said inlet portion, upstream of the entrance to said generally axial passageway, and the second side port discharges into said outlet portion, downstream of the discharge end of said generally axial passageway.

7. A cool gas generator, comprising:

an elongated, generally cylindrical, outer sidewall member having first and second ends;

an elongated, generally cylindrical, inner sidewall member having first and second ends, said member being both shorter and smaller in diameter than said outer member and being located inside said outer member;

ringwall means connecting together the first ends of said sidewall members and forming a radial wall between said first ends, said ringwall means including an open center for receiving a gas generator grain cartridge assembly insertable through said center into the inner sidewall member;

an outlet member having a first end connected to the second end of said inner sidewall member, said outlet member extending from said second end of the inner sidewall member through an opening in the second end of the outer side member, and having an outlet opening at its second end, with said outer sidewall member meeting said outlet member in the vicinity of said outer wall opening to form an end closure for the annular space which surrounds said inner sidewall member and the portion of the outlet member which is housed therein, said outlet member including sidewall means forming an axial chamber therein, first and second sidewall openings in said sidewall means extending between said chamber and said annular space; and

an elongated, replaceable control insert snugly received inside said chamber, said insert having inlet and outlet portions, an elongated, generally axial, small diameter passageway therein, extending from said inlet portion to said outlet portion, a first side port extending from said inlet portion to the first sidewall opening and a second side port extending from said outlet portion to said second sidewall port.

8. A cool gas generator according to claim **7**, wherein said insert is accessible from the outlet opening in said outlet member, so that it can be removed and replaced by a new insert through said outlet opening.

9. A cool gas generator according to claim **7**, wherein the opening at the second end of the outer sidewall member is larger in diameter than the control insert containing portion of said outlet member and said outlet member includes a radial flange which projects outwardly to the rim of said opening, and is connected thereto.

10. A cool gas generator according to claim **7**, wherein said insert includes a peripheral groove on each side of each side port and an O-ring in each groove, for sealing between the insert and the tubular wall means of the outlet section.

11. A cool gas generator according to claim **7**, further including deflector means secured to the tubular wall means of the outlet section, for turning the hot gases issuing from said first port and directing them substantially axially.

12. A cool gas generator according to claim **7**, wherein said insert includes a girth channel surrounding its periphery where each said side port meets the periphery, so that the side ports of the insert are always in communication with the ports in the tubular wall of the outlet section regardless of the angular relationship of the insert ports to the ports in the sidewall means.

13. A cool gas generator according to claim **7**, wherein the inlet and outlet portions of said insert are larger in diameter than said generally axial passageway through the insert, said first side port including its entrance in said inlet portion, upstream of the entrance to said generally axial passageway, and the second side port discharges into said outlet portion, downstream of the discharge end of said generally axial passageway.

14. A cool gas generator comprising:

generally concentric inner and outer housing means defining an annular storage space between them which is closed at both of its ends, said inner housing means including a combustion chamber, a control insert chamber, a mixing zone, and an outlet in series, said inner casing also including an access opening at the combustion chamber end therein, through which a solid fuel grain may be inserted into the combustion chamber, and a removable closure for said opening, said closure carrying initiator means for said grain, and a control insert insertable into and removable from its chamber through the outlet of said inner housing means, said control insert comprising a first metering passageway for combustion gases leading to the mixing zone, a second combustion gases passageway leading into the storage space, for supplying pressurizing gases into said space, and an outlet passageway leading from said storage space into the mixing zone.

15. A cool gas generator according to claim **14**, wherein said insert includes a peripheral groove on each side of each side port and an O-ring in each groove, for sealing between the insert and the tubular wall means of the outlet section.

16. A cool gas generator according to claim **14**, further including deflector means secured to the tubular wall means of the outlet section, for turning the hot gases issuing from said first port and directing them substantially axially.

17. A cool gas generator according to claim **14**, wherein said insert includes a girth channel surrounding its periphery where each said side port meets the periphery, so that the side ports of the insert are always in communication with the ports in the tubular wall of the outlet section regardless of the angular relationship of the insert ports to the ports in the sidewall means

18. A cool gas generator according to claim **14**, wherein the inlet and outlet portions of said insert are larger in diameter than said generally axial passageway through the insert, said first side port has its entrance in said inlet portion, upstream of the entrance to said generally axial passageway, and the second side port discharges into said outlet portion, downstream of the discharge end of said generally axial passageway.

19. A cool gas generator, comprising:

a one-piece housing formed from integrally joined inner and outer tubular wall means defining a liquid storage space between them;

said inner wall means defining communicating breech, control insert and mixing chambers;

said housing being open at one end of the inner wall means for insertion of a fuel cartridge through such end into the breech chamber;

said housing being open in the vicinity of the mixing chamber for insertion of a control insert through such opening and the mixing chamber into the control insert chamber;

said inner wall means having openings therein in the vicinity of the control insert chamber, for communicating the interior of the control insert chamber with the liquid storage space; and

a control insert sized to snugly fit inside said control insert chamber and including a first metering orifice leading through it, for communicating the breech chamber with the mixing chamber, a second metering orifice for communicating the breech chamber with the interior of the liquid storage space, via a said opening in the control insert chamber portion of the inner wall means, and a third metering orifice for communicating the interior of the liquid storage space with the mixing chamber, via a said opening in the control insert chamber portion of the inner wall means.

20. A cool gas generator according to claim **19**, wherein said insert includes a peripheral groove on each side of each side port and an O-ring in each groove, for sealing between the insert and the tubular wall means of the outlet section.

21. A cool gas generator according to claim **19**, further including deflector means secured to the tubular wall means of the outlet section, for turning the hot gases issuing from said first port and directing them substantially axially.

22. A cool gas generator according to claim **19**, wherein said insert includes a girth channel surrounding its periphery where each said side port meets the periphery so that the side ports of the insert are always in communication with the ports in the tubular wall of the outlet section regardless of the angular relationship of the insert parts to the ports in the sidewall means.

23. A cool gas generator according to claim **19**, wherein the inlet and outlet portions of said insert are larger in diameter than said generally axial passageway through the insert, said first side port has its entrance in said inlet portion, upstream of the entrance to said generally axial passageway, and the second side port discharges into said outlet portion, downstream of the discharge end of said generally axial passageway.

24. A cool gas generator according to claim **1**, wherein said second and third metering orifices are side ports in said insert, and said insert includes a girth channel surrounding its periphery where each said side port meets the periphery, so that the side ports of the insert are always in communication with the ports in the tubular wall of the outlet section regardless of the angular relationship of the insert ports to the ports in the sidewall means.

25. A cool gas generator according to claim **1**, wherein the insert includes relatively enlarged inlet and outlet portions which are interconnected by the first orifice through the insert which orifice functions as a pressure-reducing restriction, said second orifice side port has its entrance in said inlet portion, upstream of the entrance to the first orifice, and the third orifice side port discharges into said outlet portion, downstream of the discharge end of said first orifice.

26. A cool gas generator according to claim **19**, wherein said control insert has an enlarged-diameter outlet end portion including surfaces in communication with the stored liquid pressure, and retainer means for holding the insert in place, with the stored liquid pressure acting on said surface of said enlarged diameter outlet end serving to force the insert out of the outlet section if it is not properly retained by said retainer means.

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