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Galbraith

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[54] **LIQUEFIED GAS VAPORIZER ATTACHMENT FOR A PRESSURE BOTTLE**

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[52] **U.S. Cl.** **62/50,** 60/39.48, 62/52

[51] **Int. Cl.**.....**F17c 7/02**

[58] **Field of Search**.....9/323-325; 23/281; 137/68; 60/39.48; 62/48, 45, 52, 53; 149/1; 141/4, 10

[56] **References Cited**

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3,143,445	4/1964	Hebenstreit	149/1
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3,180,373	4/1965	Hebenstreit	141/4

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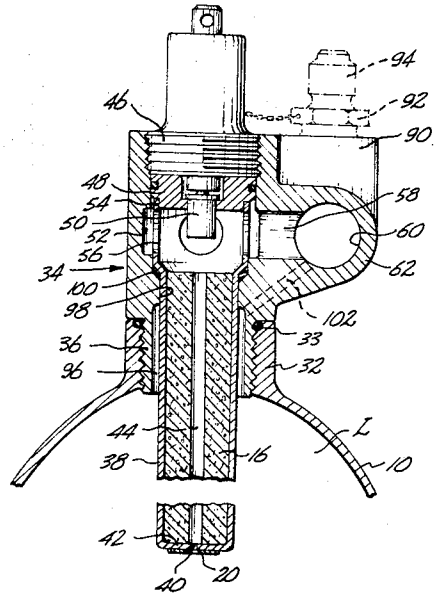
[57] **ABSTRACT**

The attachment is securable to the outlet of a storage bottle for liquefied CO_2 or other pressure liquefied gases. It houses a breech containing a solid fuel grain. Combustion gases flow from the breech through the storage bottle outlet into the liquefied gas. The added heat rapidly vaporizes the liquefied gas. The vapor pressure eventually opens a closure for an outlet passageway leading through the breech. This causes the combustion process to depressurize at a rate sufficient to cause extinguishment of the burning fuel grain and also provides a flow of coolant over the grain burning surface which ensures extinguishment.

25 Claims, 6 Drawing Figures



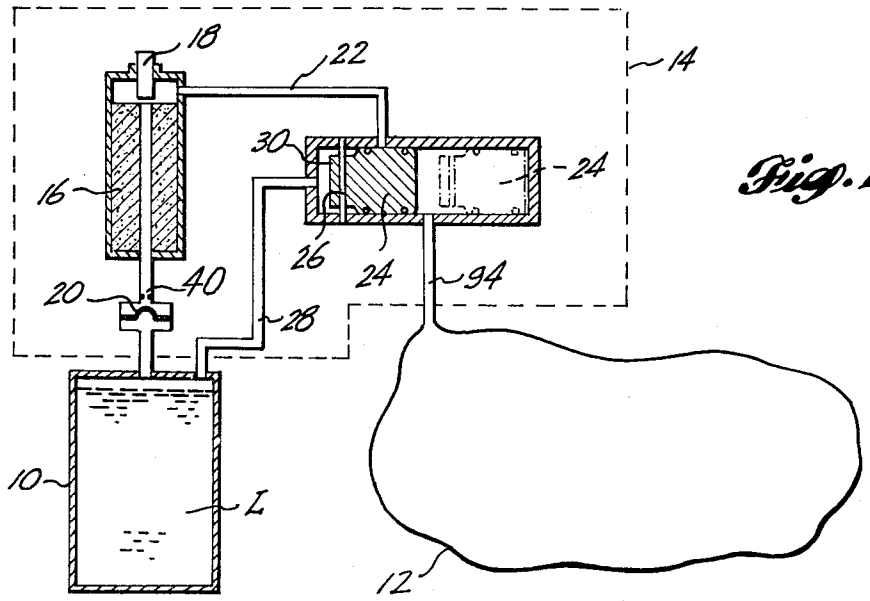


Fig. 1.

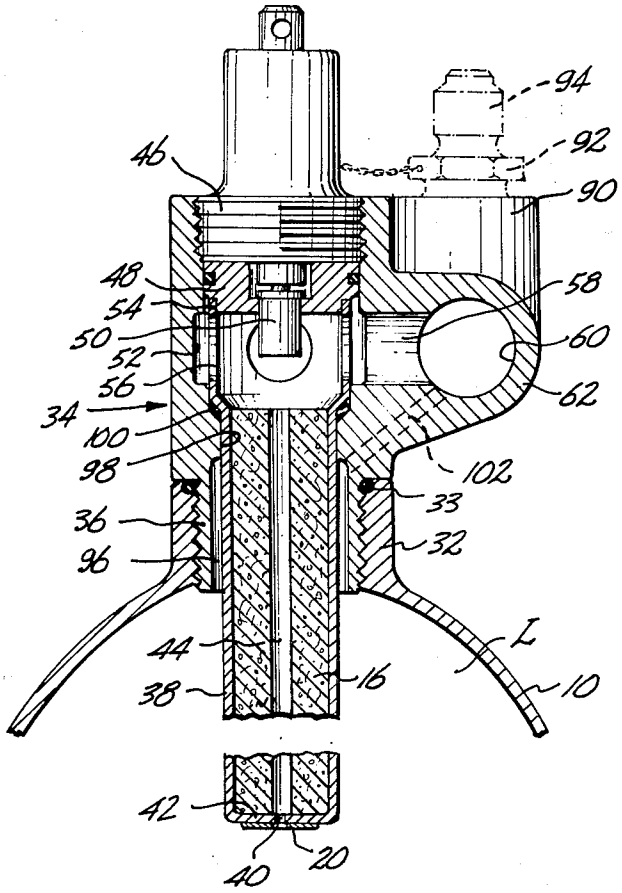


Fig. 2.

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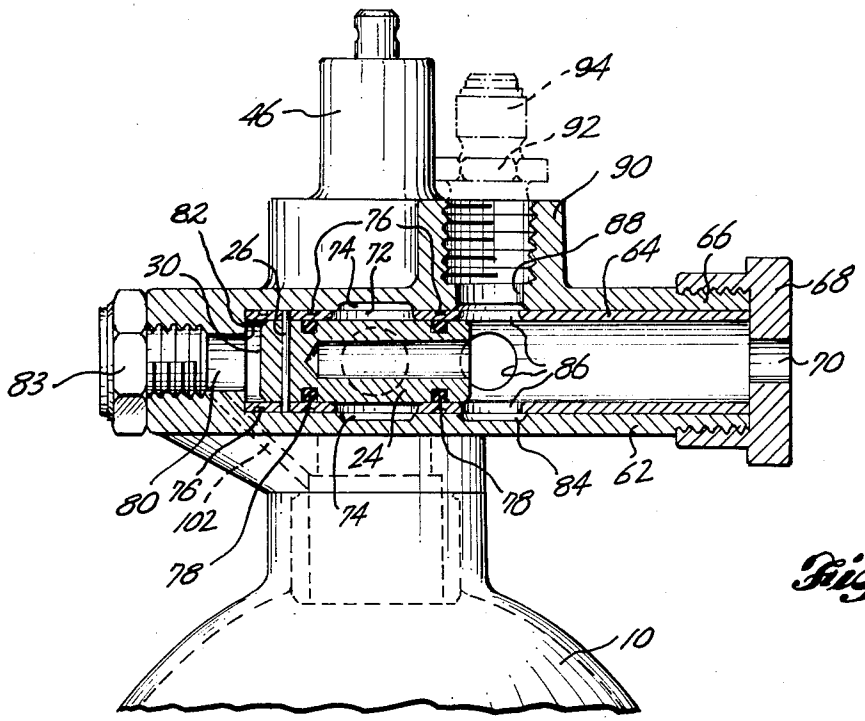

Fig. 3.

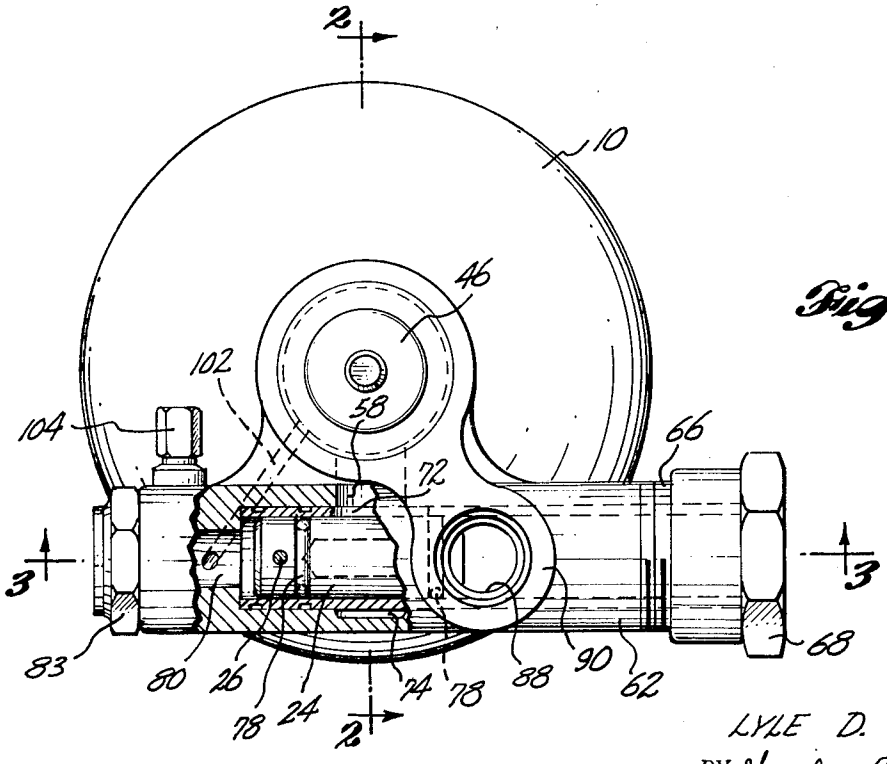

Fig. 4.

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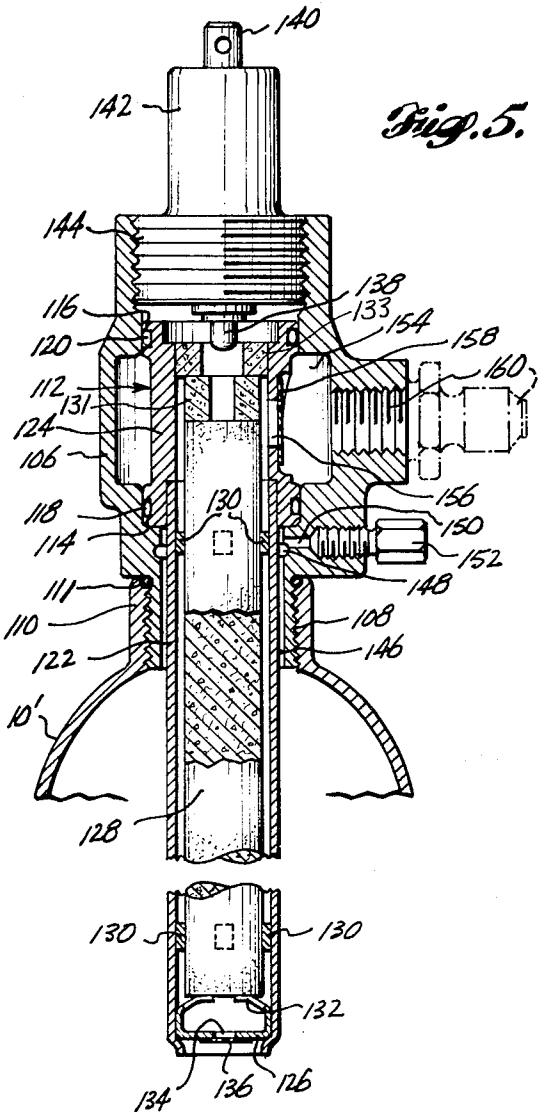

Fig. 5.

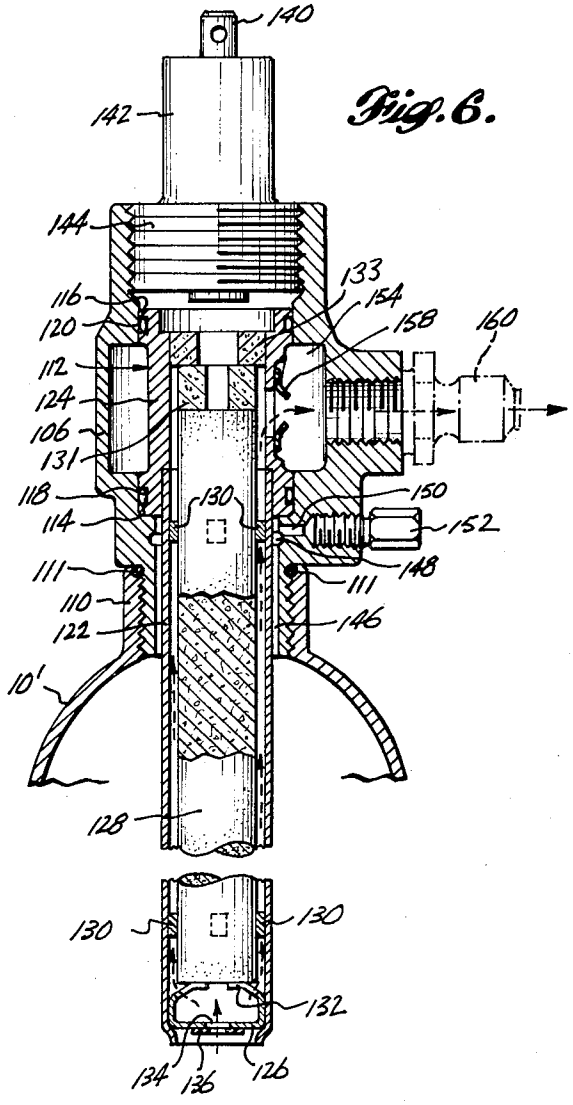

Fig. 6.

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LIQUEFIED GAS VAPORIZER ATTACHMENT FOR A PRESSURE BOTTLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to apparatus for and a method of rapidly vaporizing a pressure liquefied gas within its storage vessel and then rapidly removing it from Such storage vessel, and in particular to an outlet attachment for a high pressure storage bottle, adapted to add heat to the stored liquefied gas by introducing hot gases into same.

2. Description of the Prior Art

Liquefied refrigerant gases (e.g., CO_2, NH_3 or one of the fluorinated hydrocarbons) are good sources of inflation gases, but a means for expelling the liquefied gas from its storage vessel must be provided so that the inflation device will operate at the lower temperatures. As an example, a pressure vessel containing CO_2 has a vapor pressure of approximately 750 psia at 60° F, which is sufficient vapor pressure to expel the fluid from the vessel. However, if this identical system were cold soaked to a temperature of −65° F, the vapor pressure of the refrigerant would be less than 80 psia, and the time required to expel the refrigerant from the storage vessel would be excessively long, which would not be sufficient if the inflation device were intended for emergency use (i.e., rapid inflation times). One other apparent problem associated with such systems is the tendency for "ice" to form in the control nozzle and restrict the flow further.

TO alleviate these shortcomings, it is known to utilize a solid propellant cartridge to supply heat to the refrigerant. Examples of these so-called "cool gas generators" are shown by U.S. Pat. No. 3,122,181, granted Feb. 25, 1964 to Lester V. Hebenstreit and Charles A. Hines; by U.S. Pat. No. 3,143,445, granted Aug. 4, 1964 to Lester V. Hebenstreit; and by U.S. Pat. No. 3,180,373, granted Apr. 27, 1965 to Lester V. Hebenstreit.

Each of these patents discloses a storage container for liquid carbon dioxide or the like provided with a hot gas generator adapted to discharge hot gases into the stored liquid. The outlet from the storage container is initially closed by a burst disc. When the vapor pressure in the liquid storage container exceeds a predetermined value it breaks the disc, permitting the contents of the container to flow out through the outlet and into a conduit leading to a utilization device. At the same time additional hot gases are being supplied to the pressure vessel.

This type of gas generator tends to solve the low temperature problems associated with the system but at the expense of creating new problems at the higher operating temperatures. For example, if an adequate amount of solid propellant were provided to make the system function properly at the low temperatures, there is essentially too much solid propellant (and thus thermal energy) for the higher temperature operating condition. This results in a high output gas temperature, which is directed into the inflatable to accomplish the inflation. Since the inflatables generally have a relief valve, this valve would control pressure within the inflatable at the desired level (e.g., 2.0 psig). At the end of the inflation process the gases in the inflatable would, for example, then be at approximately 2.0 psig and at a temperature higher than the ambient environment. When the gases later cool to ambient temperature, the pressure drops considerably leaving the inflatable in an unusable state. The device proposed herein tends to improve on this type system by alleviating the problem of high output temperatures at the high operating temperatures, but still provide sufficient thermal energy to the vaporized fluid to ensure satisfactory operation at the lower operating temperatures.

SUMMARY OF THE INVENTION

The present invention relates to an outlet attachment for a conventional liquefied gas storage bottle, adapted to convert such bottle to a cool gas generator of the same general type as is disclosed by the aforementioned U.S. Pat., Nos. 3,122,181; 3,143,445 and 3,180,373, but of an improvemented nature.

Briefly, the attachment is adapted to be connected to (e.g., screwed into) the outlet of a conventional pressure bottle. The attachment holds a solid fuel grain breech which is also a section of a fluid passageway leading out from the storage bottle. According to the invention, hot gases are delivered from the breech into the pressurized fluid within the storage bottle, thereby raising the temperature and pressure of the fluid. Once the pressure within the bottle reaches a predetermined value a closure member for the outlet passageway is opened. When the outlet passageway is open the gaseous content of the bottle flows first through the breech and then through other avenues in the attachment to a conduit leading from the attachment to a utilization device. Opening of the outlet passageway depressurizes the combustion process at a rate sufficient to pull the frame front away from the fuel grain and cause extinguishment of combustion. The flow of refrigerant across any unburned solid fuel assures extinguishment. In practice, the solid fuel grain utilized In this system would be sized to provide a slight excess of thermal energy when utilized in a low temperature (e.g., −65° F) environment. Thus at any higher temperature operating condition, only a portion of the Solid fuel grain would be utilized (i.e., the grain would be extinguished prior to complete exhaustion of solid propellant into the refrigerant tank).

The invention also relates to a preferred embodiment Of the outlet attachment, comprising a reusable body and two easily installable and easily removable inserts incorporating certain single use parts. One of the inserts includes the breech, an igniter, and certain control orifices and burst disc. The other insert includes a sliding piston type closure member for the outlet passageway and a shear pin for initially holding such member in a passageway closing position.

The invention also relates to a gas generator having the above described features but not necessarily involving an attachment for a conventional pressure bottle.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic diagram of an inflation system Which includes a cool gas generator embodying the present invention;

FIG. 2 is an axial sectional view taken through the Outlet portion of a pressure vessel and an attachment of the present invention shown connected thereto, taken substantially along line 2—2 of FIG. 4, with parts shown in side elevation;

FIG. 3 is another sectional view taken through the attachment, substantially along line 3—3 of FIG. 4;

FIG. 4 is a top plan view of the bottle and the attachment, with portions of the attachment being broken away to expose internal parts thereof;

FIG. 5 is a view similar to FIG. 2, but of a modified form of the attachment, in a state prior to initiation; and

FIG. 6 is a view like FIG. 5, but showing a state following initiation, and including flow arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 the vessel **10** represents a conventional high pressure storage bottle for a compressed or pressure liquefied gas and element **12** is an inflatable bag, representing a typical utilization device. The functional elements shown Within the area **14** bordered by a broken line are the functional parts of an attachment for the pressure bottle **10**, adapted to convert the bottle **10** to a cool gas generator.

These functional parts include a solid fuel grain **16** arranged to discharge into the interior of the bottle **10**. The grain **16** is ignited by an igniter **18**. Once the combustion gases exceed a predetermined pressure they fracture a burst disc **20** and then flow into the body of liquid (e.g., liquefied carbon dioxide) contained within the bottle **10**.

A passageway **22** extending from the combustion zone towards the inflatable **12** is initially closed by a valve member **24**. By way of typical and therefore nonlimitive example, the valve member **24** may be initially held in a closed position (i.e., the position shown by solid lines in FIG. 1) by a shear pin **26**. A second passageway **28** communicates the interior of the bottle **10** with one end **30** (hereinafter referred to as the "active" end) of the valve member **24**. The hot combustion gases supply heat to, and cause vaporization of, the liquid L contained within the bottle **10**. Once the vapor pressure of this liquid L has reached a predetermined value, such vapor pressure exerts a Sufficient force on the valve member **24** to break shear pin **26**. When this happens the member **24** is moved by the fluid pressure to the open position shown by broken lines in FIG. 1. This permits the gases in bottle **10** to flow back through the combustion zone and from such zone through passageway **22** into the inflatable **12**. As will hereinafter be described in greater detail, a particular advantageous feature of the present invention is that the displacement of valve member **24** exposes the burning solid propellant fuel grain to an exit flow path which is orders of magnitude larger in flow area than the primary control orifice **40**. This rapidly depressurizes the breech, which tends to extinguish the solid propellant grain, and also allows the gases in the storage vessel to flow back through the combustion zone, which reduces the temperature significantly and assures extinction of the solid propellant fuel grain.

Referring now to FIGS. 2–4, the bottle **10** is shown to comprise an internally threaded neck portion **32**. The attachment **34** of the invention is shown to comprise an externally threaded nipple **36** adapted to screw into the neck **32**. An O-ring **33** is shown in FIG. 2 to provide a seal between the parts **32, 36**.

Attachment **34** may contain a replaceable tubular housing or breech **38** in which is located the solid fuel grain **16**. The burst disc **20** may be a "patch" like element which initially overlies and covers a control orifice and outlet **40** located in the wall of the breech **38**. The grain **16** is shown to include a longitudinal center passageway **44**, but may be configured so as to be a solid cylindrical rod, which would combust radially inward.

At its upper end the attachment **34** includes a plug **46** adapted to screw into the attachment **34**. The plug **46** serves to close an opening in the attachment through which the breech **38** is inserted. At its upper end the plug **46** carries a mount **48** for an igniter **50**. Igniter **50** is of conventional form and may be electrically or mechanically operated.

A circumferential groove **52** is formed in the attachment body where it surrounds the upper end portion **54** of the breech **38**. A plurality of openings **56** are provided in breech portion **54** to provide avenues leading from the breech into the groove **52**. A port **58** communicates the grooved region **52** with a longitudinal bore **60** formed in a valve barrel **62**. The grooved region **52**, the openings **56** and the port **58** together constitute the passageway **22** shown in FIG. 1.

As best shown by FIG. 3, the valve barrel **62** is provided with a liner **64** in the nature of an insert. This liner **64** is inserted into the barrel **62** through an end thereof having an externally threaded portion **66**. A cap **68** is screwed onto this portion **66** and serves to hold the liner **64** in place and also to stop the valve member **24** when it is active. A vent opening **70** is provided in the end wall of cap **68**, to provide an avenue of escape for air within the space between the valve member **24** and the cap **68**.

The liner **64** supports the two ends of the shear pin **26**. A plurality of side openings **72** are provided in the liner **64** in positions to communicate with an annular grooved region **74** of the attachment body which is itself in communication with the port **58**. Circumferential grooves are provided in the exterior surface of liner **64** on opposite sides of the grooves **74**, to receive O-ring seals **76**, or the like. The piston **24** also includes girth grooves on opposite sides of the channel **74** in which O-rings **78** or the like are received. The second end of barrel **62** includes a reduced diameter open center portion **80**. The shoulder **82** which exists between open portion **80** and the passageway **60** serves as an end stop for the liner **64**. The outer end portion of passageway **80** is internally threaded to receive the threaded shank of a closure plug **83**. Closure plug **83** may carry pressure gauge for indicating the charge of fluid in the bottle, or a burst disc assembly designed to relieve pressure within bottle **10** in the event of an overpressure.

A second annular groove **84** is formed in the inner surface of barrel **62**. A plurality of side ports **86** are provided in the liner **64** within the region thereof adjacent groove **84**. A port **88** communicates the grooved region **84** with an internally threaded outlet duct **90**. An inlet fitting **92** of a conduit **94** leading to the inflatable object **12**, or some other utilization device, is threadably received within the outlet member **90**.

Referring now to FIG. 2, the attachment **34** is formed to include an annular chamber **96** which surrounds the breech **38** in the region of the threaded nipple **36**. At its upper end the annular chamber **96** narrows down to a

diameter substantially equal to the outside diameter of the casing **98**. This reduced diameter portion **98** of the body, together with a resilient seal ring **100**, effectively seals the upper end of the chamber **96**. As shown in each of FIGS. **2–4**, a diagonal passageway **102** in the attachment body extends from annular chamber **96** up to space **80** adjacent the active face **30** of the valve member **24**.

In operation, the igniter **50** is energized. It delivers burning particles to the interior passageway **44** of the fuel grain **16**, causing ignition of the fuel grain **16**. As burning proceeds a gas pressure builds up within the breech **38** until the resistance pressure of the burst disc **20** is exceeded. At that time the disc **20** breaks and the combustion products flow from breech **38** through control orifice **40** and into the body of liquid L contained within the pressure bottle **10**. The relatively high pressure of the hot combustion gases combined with the relatively small diameter of the opening **40** result in the hot gases entering as a high velocity jet stream into the liquid L. This results in a deep penetration of the hot gases into the liquid L and a relatively fast transfer of heat to the liquid L. The heat supplied by the combustion products causes the liquid L to vaporize, increasing the vapor pressure within the container **10**. This vapor pressure is communicated through annular chamber **96** and passageway **102** into the chamber **80** which is exposed to the active surface **30** of the valve member **24**. Once this vapor pressure is sufficiently high (e.g., 3,500 psig) to indicate that most of the liquid within the bottle **10** has been vaporized, the vapor pressure acting on surface **30** breaks the shear pin **26** and then moves the valve member **24** to a position (shown by broken lines in FIG. **1**) on the opposite side of the ports **86** from its shear pin held position. This unblocks the outlet passageway which leads from bottle **10** back through the casing **98**, then through ports **56**, region **52**, port **58**, openings **86**, annular region **84**, port **88** and outlet **92** into the delivery conduit **94** leading to the utilization device **12**.

A particular advantageous feature of the present invention is that the sudden opening of the extinguishment orifice **58** reduces the pressure on whatever portion of the fuel grain **16** that still remains at a rate sufficient to cause extinguishment of combustion. The rapid pressure reduction "pulls" the flame front away from the fuel grain **16**. If this alone does not cause extinguishment, the flow of refrigerant over the remaining fuel will.

By way of nonlimitive example, the liquid L may be a liquefied carbon dioxide, a liquefied fluorinated hydrocarbon type refrigerant, NH_3 or another material or mixture of materials which will produce gaseous mixtures of a desired composition and properties. A fill opening, normally closed by a conventiOnal fill valve **104**, is provided in the side of barrel **62** leading into zone **80** and from there through passageway **102** into bottle **10**.

A modified embodiment of the invention is shown by FIG. **5**. This embodiment is also in the form of an attachment for a conventional pressurized gas storage bottle **10'**. The attachment comprises a housing **106** having an externally threaded connector portion **108** adapted to mate with the internal threads formed in the neck **110** of the storage bottle **10'**. As in the earlier embodiment, and in accordance with conventional practice, a sealing type O-ring **111** is provided between the housing **106** and the bottle neck **110**.

As in the earlier design, the housing **106** is constructed to receive a breech assembly **112**. The breech assembly **112** is shown to comprise an upper head portion which is circumferentially grooved at **114** and **116** to receive sealing O-rings **118** and **120**. A cylindrical casing **122** depends downwardly from the breech head **124** and is substantially closed at its lower end by an end wall **126**. An elongated solid fuel grain **128** is supported within the tube **122** and the head member **124** by a plurality of side spacers **130**. A $BKNO_3$ igniter grain **131**, or the like, is shown above the grain **128** and a foam rubber or plastic spacer **133** is located above it. During the early stages of combustion both of the members **131**, **133** burn out. The lower end of the fuel grain **128** may be held elevated above the end wall **126** by a plurality of finger like extensions **132** of the end wall **126**. A control orifice **134** is formed in the end wall **126** and is initially closed by a pressure burst disc **136**.

The fuel grain **128** is of an outer surface burning type. The breech includes a percussion type starter **138** which is mechanically or electrically initiated by an igniter mechanism **140** which is carried by the cap **142** for the breech opening **144** in the housing **106**.

The tubular connection portion **108** has an internal diameter which is larger than the external diameter of breech housing **122**, resulting in the formation of an annular passageway **146** around the breech housing **122** immediately below the head portion **124**. The annular zone **146** communicates with an internal girth groove **148** which in turn communicates with a radial port **150** leading to a fill fitting **152**. The liquid contents of the storage chamber **10'** is introduced into the chamber **10'** through the fitting **152**, the port **150**, groove **148** and annular chamber **146** after the attachment housing **106** has been firmly affixed to the bottle **10'**.

The head portion **124** of the breech assembly **112** is surrounded by an annular chamber **154** formed in the housing **106**. A side opening **156** is formed in the head portion **124** of the breech assembly in the region of this chamber **154**. Opening **156** is initially closed by a pressure burst disc **158** which is constructed to open at a much higher pressure than the burst disc **136**. Chamber **154** directly communicates with a side port **160** which forms the outlet for the housing **106** and is secured to a passageway (not shown) which leads to the utilization device.

In operation, the solid fuel grain is ignited by operation of the igniter means **138**, **140**. The starting flame from device **138** spreads over the upper end of the fuel grain **128** and flows downwardly around the fuel grain **128**, initiating combustion on the outer surface of the grain **128**. As combustion progresses the grain burns radially inwardly. The burst disc **136** is designed so that it opens when a relatively low pressure differential (e.g., 100 psi) exists between the breech chamber and the tank **10'**. Upon opening of control orifice **134**, the hot combustion gases flow through the orifice **136** into the liquefied gas. The hot gases mixed with the liquefied gas, adding heat to the latter and raising the vapor pressure of the mixture within the bottle **10'**. The increasing tank pressure causes the combustion pressure of the solid fuel grain to increase. Once the breech

pressure has reached a relatively high level (e.g., 3,800 psi) the upper burst disc **158** ruptures. The disc **158** is insulated by a layer of heat resistant material (not shown) so that the high temperature gases do not affect its burst-rating.

Opening of orifice **156** serves to communicate the breech chamber, and the interior of the storage **10'** via the breech chamber, with a relatively large outlet passageway. As a result, there is a rapid depressurization within the breech, tending to pull the flame front away from the surface of any remaining fuel grain, and in that manner tending to extinguish combustion. Substantially simultaneously, the gas mixture from the tank **10'** flows rapidly through the breech and out of the system, to the utilization device. As such gases flow over the surface of any removing portion of the fuel grain, they cool the grain and in that fashion ensure extinguishment.

What is claimed is:

1. An outlet attachment for a pressure bottle defining a storage chamber containing a stored fluid, said attachment comprising:

wall means forming a fluid passageway which when the attachment is on a pressure bottle is in communication with the storage chamber via the outlet opening in the bottle;

said attachment including means in said fluid passageway for generating hot gases and releasing them into the fluid stored within the storage chamber via the outlet opening in the bottle, for supplying heat into said fluid; and

closure means for closing said fluid passageway until the hot gases have mixed with and heated said fluid within said storage chamber, with the mixture of hot gases and stored fluid flowing out from the storage chamber of the pressure bottle and through the fluid passageway in the attachment upon opening the closure means.

2. A cool gas generator comprising a pressure bottle defining a storage chamber containing a pressurized fluid, said bottle including an outlet including an outlet opening;

an outlet housing at the outlet of said bottle, said housing including a breech having an inner end portion positioned in the region of the outlet opening to discharge into said storage chamber and into the contents of the bottle;

a solid fuel grain in said breech;

an igniter for igniting said solid fuel grain to generate hot gases;

passageway means in said outlet housing, leading from said storage chamber and including a path back through said breech to an outlet opening from said housing; and

closure means for initially closing said passageway until the hot gases mix with the fluid in said storage chamber and the vapor pressure of the mixture storage chamber exceeds a pre-determined value.

3. A method of generating a cool working fluid comprising:

burning a solid fuel within a first confined zone under pressure;

discharging the combustion products from said first confined zone into a second storage zone for a liquid, to add heat to the liquid and cause its vaporization;

then rapidly reducing the pressure on any remaining solid fuel in said first confined zone, and discharging the mixture of combustion products and vaporized liquid from the storage zone back through said first zone, to extinguish combustion; and then

delivering such mixture to a utilization device.

4. The method of claim **3**, further comprising flowing the mixture of combustion products and vaporized liquid directly over the combustion surfaces of the grain.

5. The method of claim **3**, further comprising containing the initial combustion products within said first confined zone until the pressure in said zone exceeds a predetermined value, then discharging such combustion products into the storage zone for the liquid, and containing the fluid mixture of combustion products and stored liquid within said storage zone until the pressure in said first zone exceeds a second and higher predetermined pressure, and then discharging said mixture from said storage zone, through said first zone, to the outlet opening.

6. An outlet attachment for a fluid containing pressure bottle, comprising:

wall means forming a fluid passageway which when the attachment is on a pressure bottle is in communication with the outlet opening in the bottle said wall means forming a fluid passageway including a tubular portion;

said attachment including means for generating hot gases and releasing them into the fluid within the pressure bottle via the outlet opening in the bottle, for supplying heat into said fluid said means for generating hot gases including a solid fuel grain within said tubular portion;

closure means for closing said fluid passageway until the hot gases have mixed with and have heated the said fluid, with the hot gas and stored fluid mixture flowing out from the pressure bottle and through the fluid passageway in the attachment and out through the outlet opening in the bottle upon opening the closure means, and with said fluid passageway being sized to provide an outlet avenue from the combustion zone large enough so that upon opening of the fluid passageway there is a rapid depressurization of the combustion zone followed by a flow of fluid from the storage bottle to which the attachment is secured out through the combustion zone, for extinguishing combustion of the solid propellant fuel grain.

7. An outlet attachment according to claim **6**, wherein said tubular portion is a removable breech and the attachment includes means for receiving and holding the breech generally axially with respect to the outlet opening of a pressure bottle to which the attachment is in use attached.

8. An outlet attachment according to claim **7** wherein said solid fuel grain is smaller in cross-sectional dimension than the breech, leaving a space between the grain and the tubular portion, and combustion occurs on the external surface of the solid fuel grain.

9. An outlet attachment according to claim **7**, wherein said breech includes an inner end wall including an opening therein which in use functions as a control orifice and wherein said solid fuel grain includes a

central passageway extending therethrough which is generally coaxial with said opening.

10. An outlet attachment according to claim 7, wherein the attachment includes an outlet and said fluid passageway leads to the outlet, and wherein said passageway means contains a sliding valve member and means for initially holding said member in a position wherein it blocks flow from said breech to said outlet.

11. An outlet attachment according to claim 10, wherein said attachment includes a shear pin for initially holding the valve member in its passageway closing position.

12. An attachment according to claim 11, wherein said valve member is slidably received with a tubular insert for a portion of the passageway means, and wherein said shear pin includes at least one end portion anchored in said insert.

13. An attachment associated to claim 7, wherein said breech includes an inner end wall including an opening therein which during operation functions as a control orifice, wherein said breech further includes an outer end portion having an outlet orifice therein which is a portion of said fluid passageway, and wherein said closure means is a pressure responsive element designed to release when the breech pressure exceeds a predetermined value.

14. An attachment according to claim 13, wherein said solid fuel grain is smaller in cross sectional dimension than said breech, leaving a space between the outer surface of the grain and the tubular breech, with combustion occurring on the outer surface of the grain.

15. An outlet attachment for a fluid containing pressure bottle, comprising:

a tubular portion securable to the pressure bottle adjacent the outlet opening in said bottle;

wall means forming a fluid passageway which when the attachment is on a pressure bottle is in communication with the outlet opening in the bottle;

means defining a fill passageway, a portion of said fill passageway being radially between said tubular portion and the wall means which forms said fluid passageway;

said attachment including means for generating hot gases and releasing them into the fluid within the pressure bottle via the outlet opening in the bottle, for supplying heat into said fluid; and

closure means for closing said fluid passageway until the hot gases have mixed with and have heated the said fluid, with the hot gas and stored fluid mixture flowing out from the pressure bottle and through the fluid passageway in the attachment and out through the outlet opening in the bottle upon opening the closure means.

16. A cool gas generator comprising a pressure bottle containing a pressurized fluid, said bottle including an outlet including an outlet opening;

an outlet housing at the outlet of said bottle, said housing including a breech having an inner end portion positioned in the region of the outlet opening to discharge into the contents of the bottle;

a solid fuel grain in said breech;

an igniter for igniting said solid fuel grain;

passageway means in said outlet housing leading from and including a path through said breech to an outlet opening from said housing,

said passageway means being sized to provide a relatively large outlet avenue from the combustion zone, whereby upon opening of the passageway means there is a rapid depressurization of the combustion zone followed by a flow of fluid from the storage bottle out through the combustion zone, for extinguishing combustion of the solid propellant fuel grain; and

closure means for initially closing said passageway until the vapor pressure in the bottle exceeds a predetermined value.

17. A cool gas generator according to claim 16, wherein said attachment includes means for receiving and holding the breech generally axially with respect to the outlet opening of the pressure bottle.

18. A cool gas generator according to claim 17, wherein said solid fuel grain is smaller in cross-sectional dimension than the breech, and combustion occurs on the external surface of the solid fuel grain.

19. A cool gas generator according to claim 17, wherein said breech includes an inner end wall including an opening therein which in use functions as a control orifice and wherein said solid fuel grain includes a central passageway extending therethrough which is generally coaxial with said opening.

20. A cool gas generator according to claim 17, wherein said passageway means contains a sliding valve member and means for initially holding said member in a position wherein it blocks flow from said breech to said outlet.

21. A cool gas generator according to claim 20, including a shear pin for initially holding the valve member in its passageway closing position.

22. A cool gas generator according to claim 21, wherein said valve member is slidably received with a tubular insert for a portion of the passageway means, and wherein said shear pin includes at least one end portion anchored in said insert.

23. A cool gas generator associated to claim 17, wherein said breech includes an inner end wall including an opening therein which during operation functions as a control orifice, wherein said breech further includes an outer end portion having an outlet orifice therein which is a portion of said passageway means, and wherein said closure means is a pressure responsive element designed to release when the breech pressure exceeds a predetermined value.

24. A cool gas generator according to claim 23, wherein said solid fuel grain is smaller in cross sectional dimension than said breech, leaving a space between the outer surface of the grain and the tubular breech, with combustion occurring on the outer surface of the grain.

25. A cool gas generator comprising a pressure bottle containing a pressurized fluid, said bottle including an outlet including an outlet including an outlet opening;

an outlet housing at the outlet of said bottle, said housing including a breech having an inner end portion positioned in the region of the outlet opening to discharge into the contents of the bottle said outlet housing including a tubular portion securable to the pressure bottle adjacent the outlet opening in said bottle, and also including a fill passageway, a portion of which is located radially between said tubular portion and the wall means which forms said fluid passageway;

a solid fuel grain in said breech;
an igniter for igniting said solid fuel grain;
passageway means in said outlet housing, leading from and including a path through said breech to an outlet opening from said housing; and
closure means for initially closing said passageway until the vapor pressure in the bottle exceeds a predetermined value.

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