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(54) **INFLATABLE BAG WITH BURST CONTROL ENVELOPE AND GAS GENERATOR**

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(51) **Int. Cl.**

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F41A 33/04 (2006.01)

F42B 12/50 (2006.01)

(52) **U.S. Cl.**

CPC **F42B 27/00** (2013.01); **F41A 33/04** (2013.01); **F42B 3/04** (2013.01); **F42B 12/36** (2013.01); **F42B 12/50** (2013.01)

(58) **Field of Classification Search**

CPC F41A 33/04; F42B 12/36; F42B 12/46; F42B 12/50; F42B 27/00
USPC 102/355, 482, 498, 529, 367, 368; 181/116, 181/117, 118, 119; 446/188, 220, 221, 446/222, 223, 224, 225, 226

See application file for complete search history.

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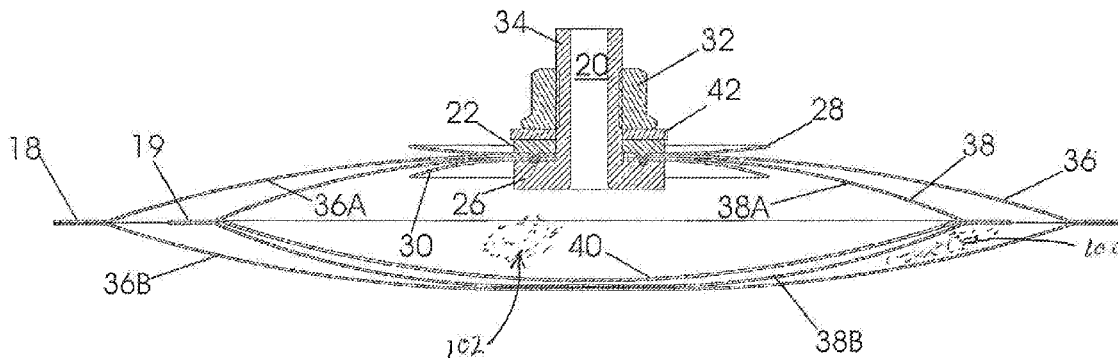
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(57) **ABSTRACT**

A rupturable bag assembly including a balloon, an outer wall, an inlet port, and a heat resistant shield. The balloon is fabricated from an elastic material. The outer wall is disposed around the balloon, the outer wall having a perimeter seam which parts abruptly at a predetermined tension. The inlet port passes through the outer wall into the balloon for inflating the balloon to produce the predetermined tension. The heat resistant shield is disposed within the balloon opposite the inlet port. The outer wall is constructed of a relatively inelastic material in comparison to the material used to construct the balloon. There is a dispersible medium disposed within the outer wall and/or the balloon.

20 Claims, 9 Drawing Sheets



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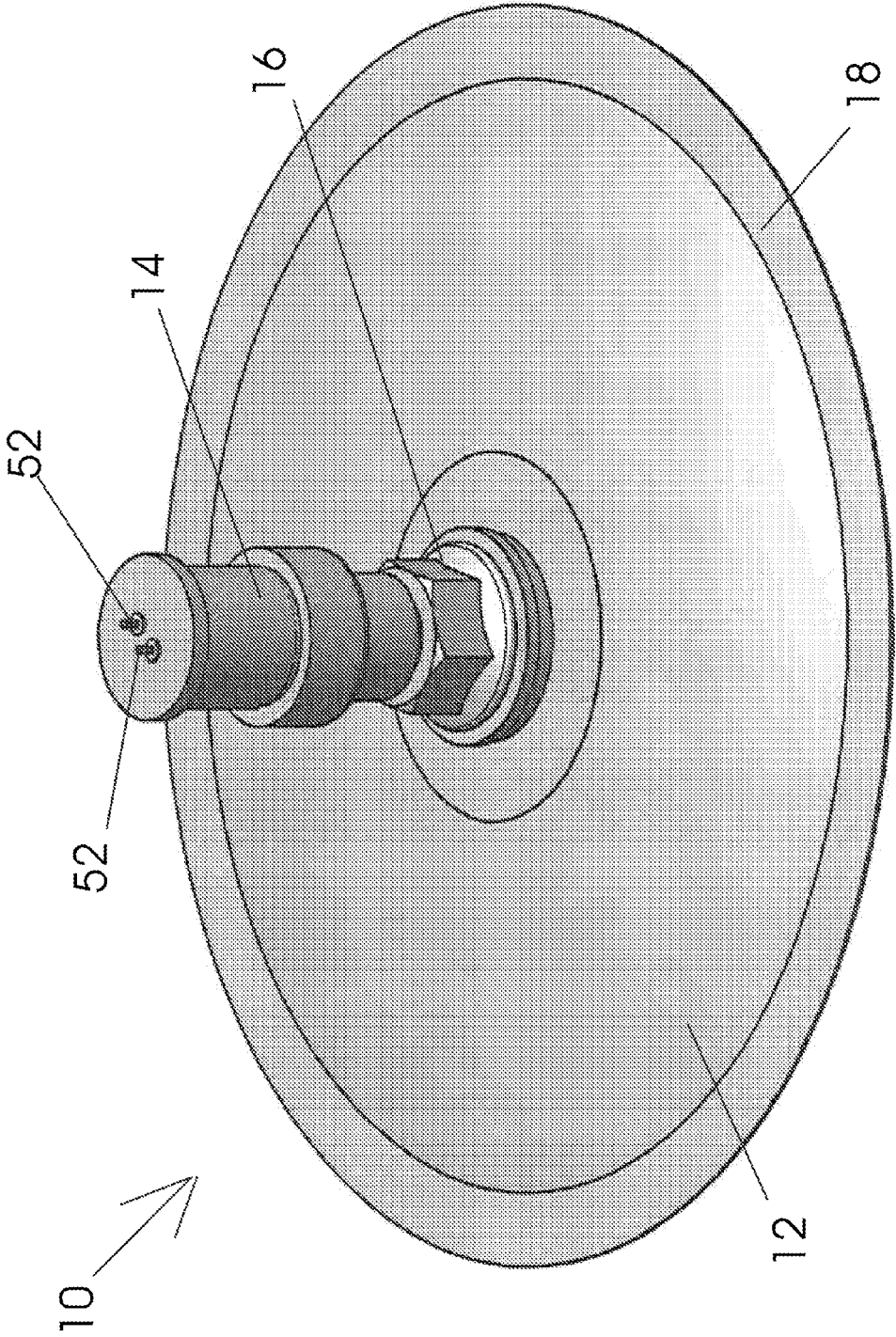


FIG. 1

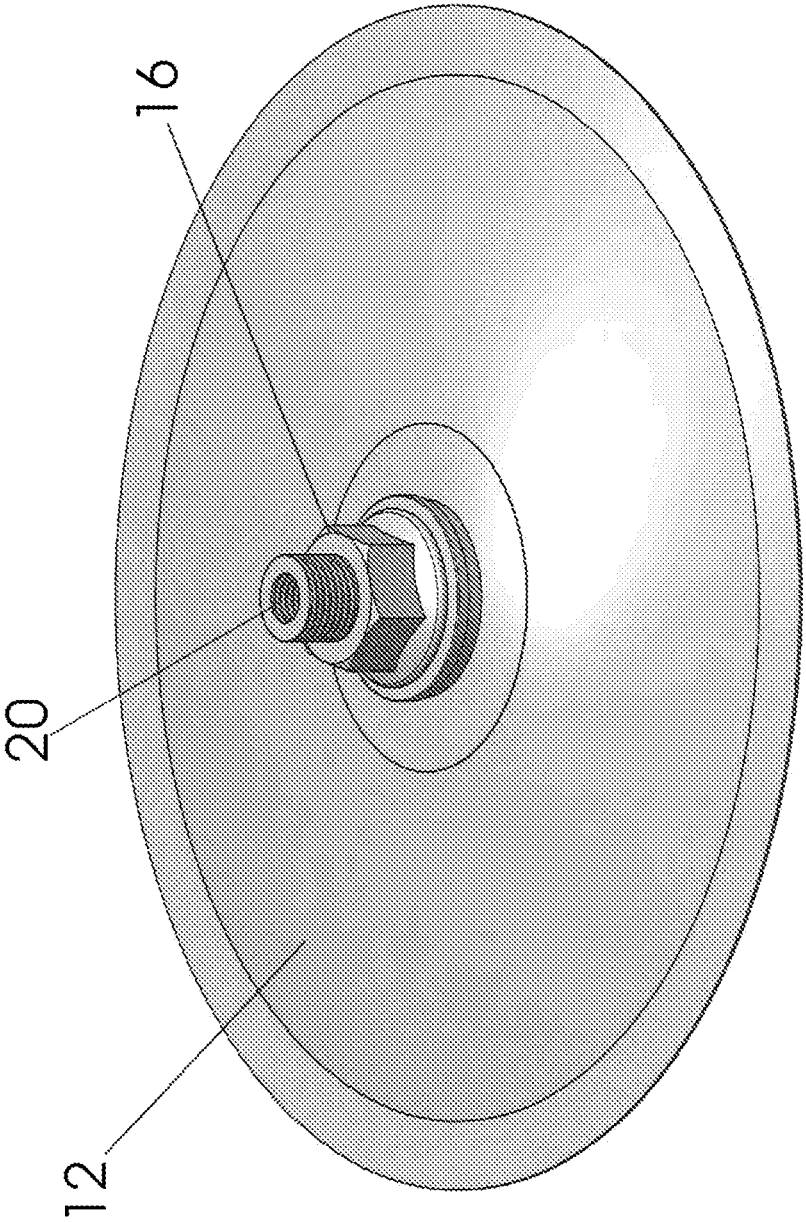
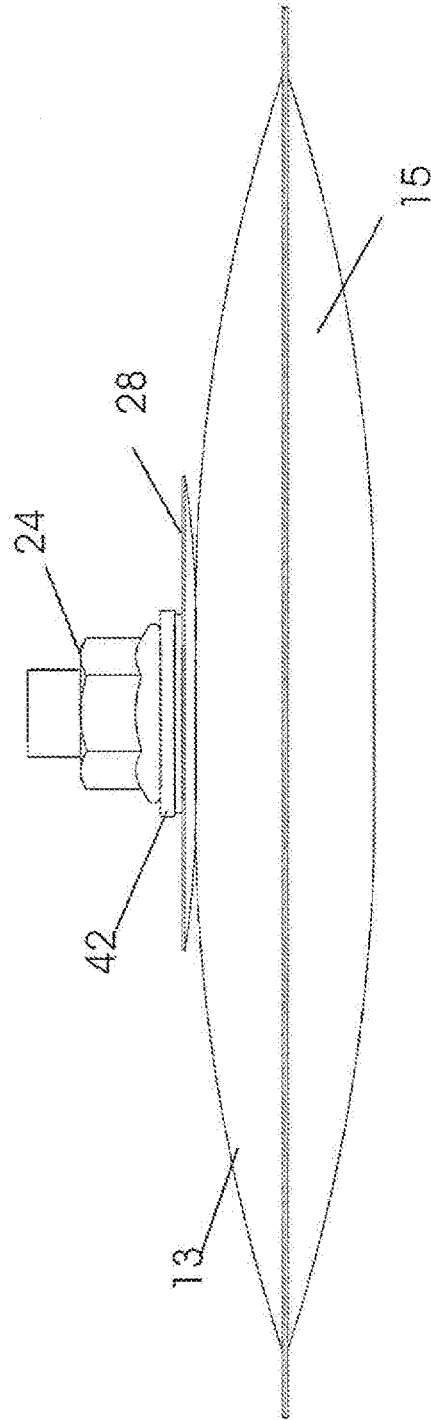
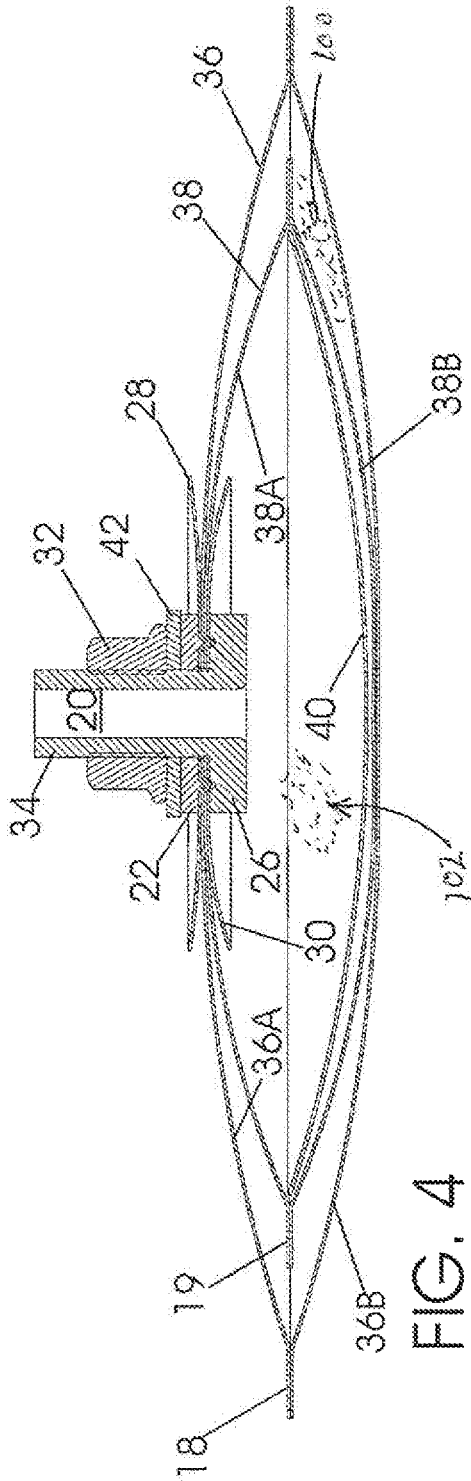


FIG. 2



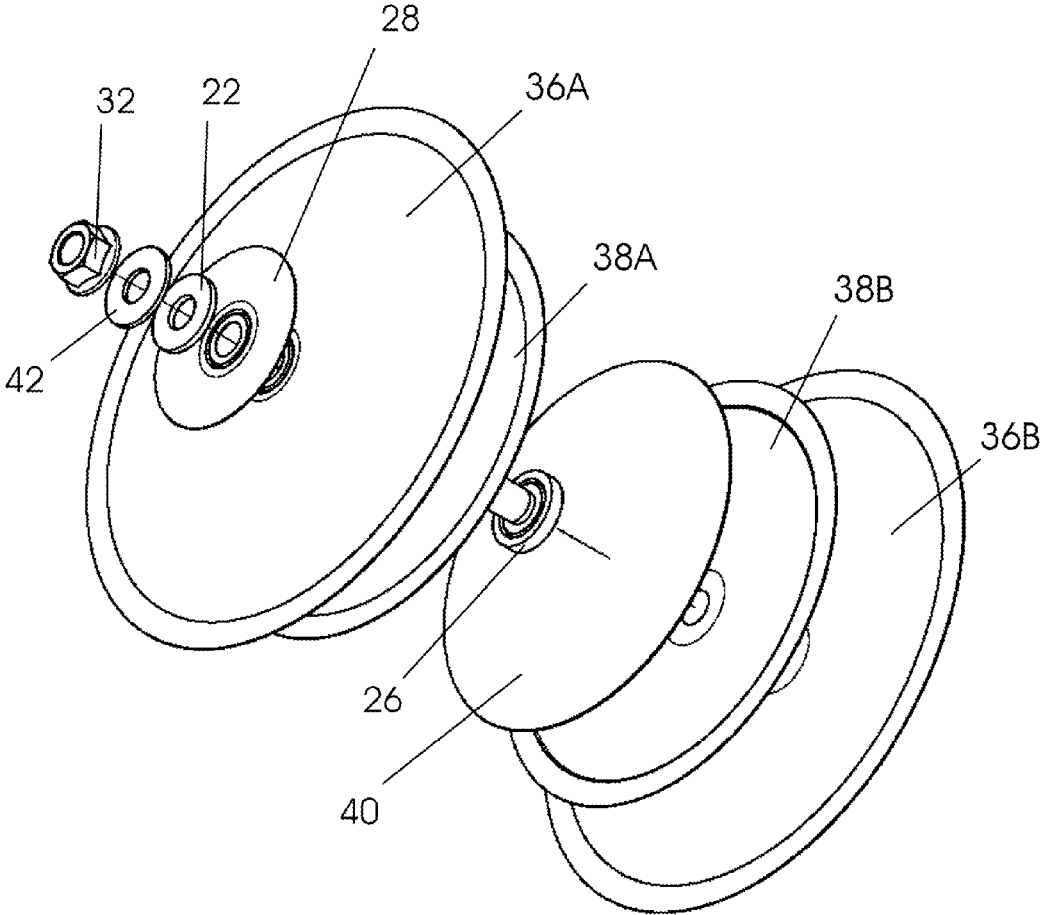


FIG. 5

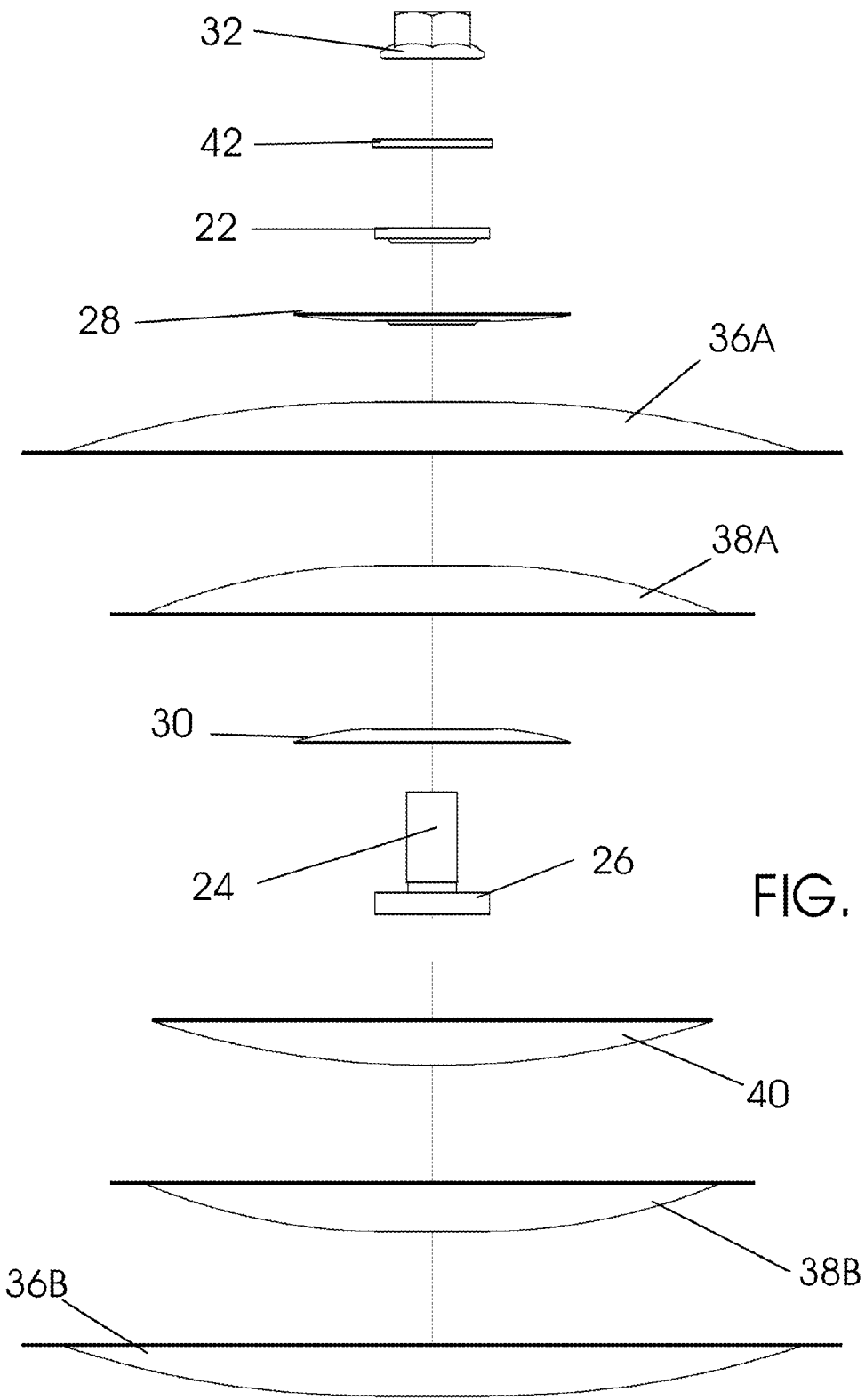


FIG. 6

FIG. 7A

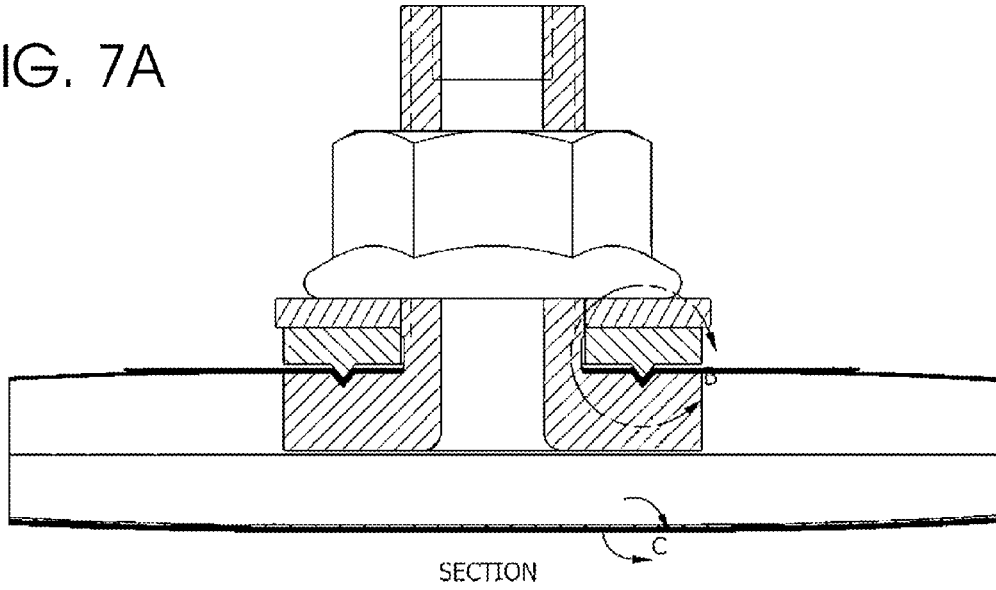


FIG. 7B

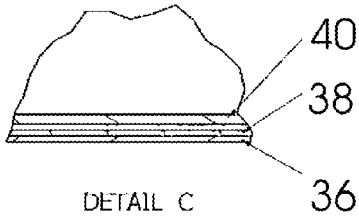
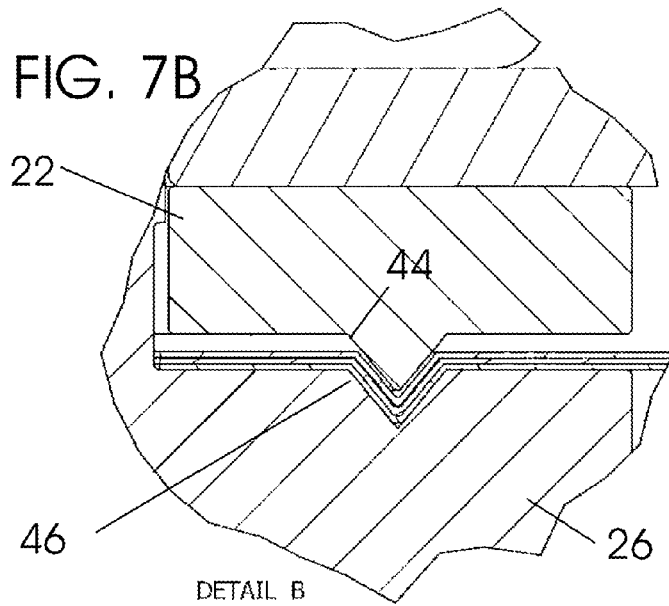


FIG. 7C

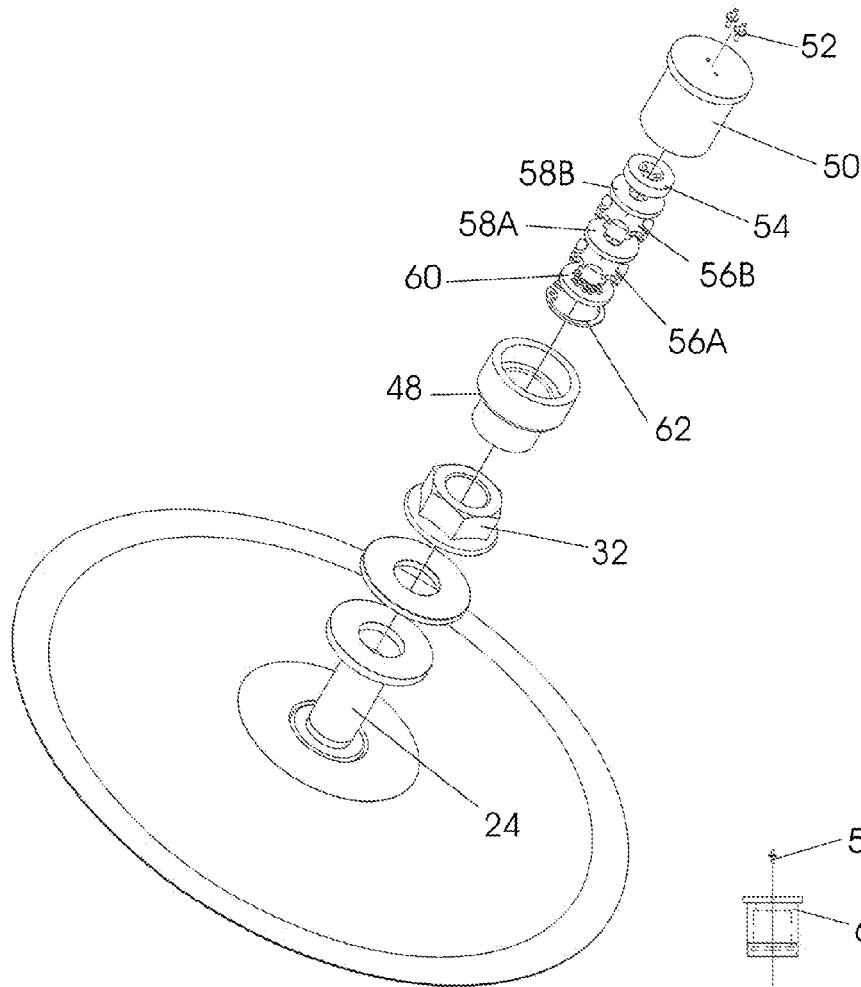


FIG. 8A

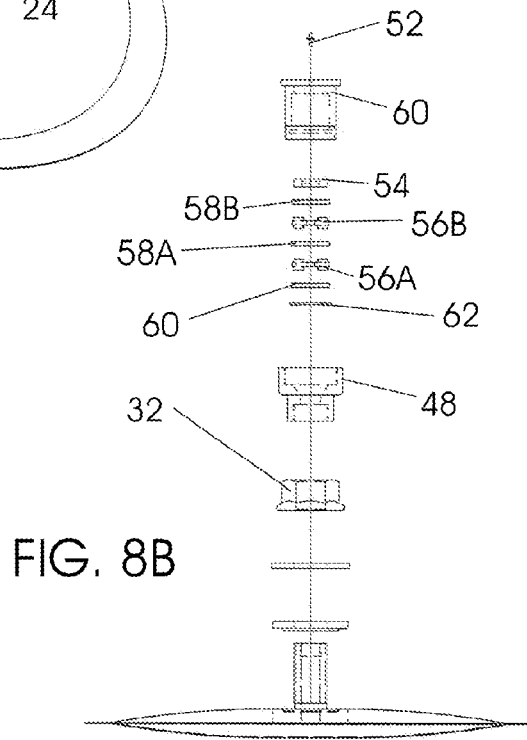
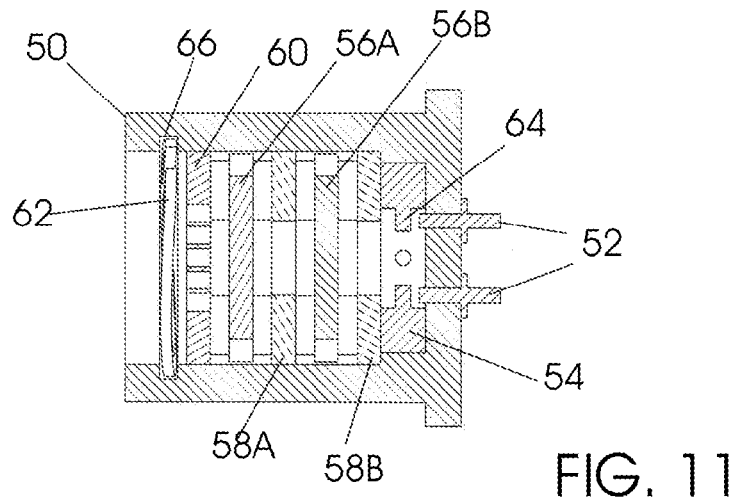
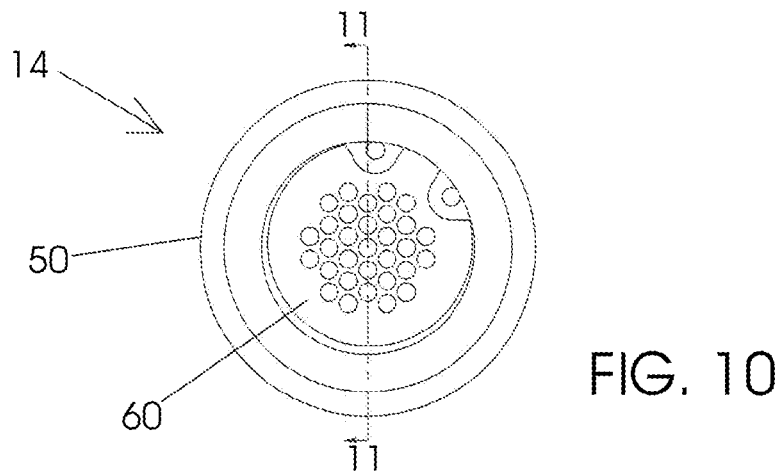
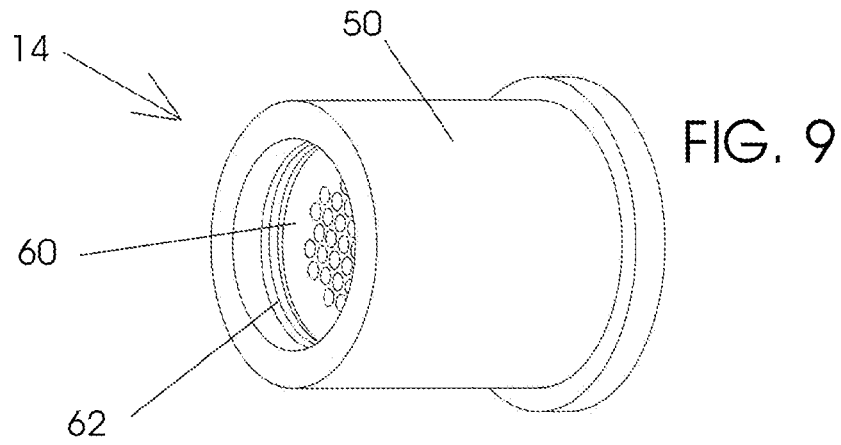


FIG. 8B



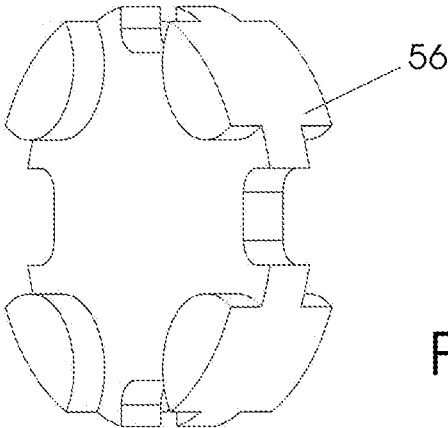


FIG. 12A

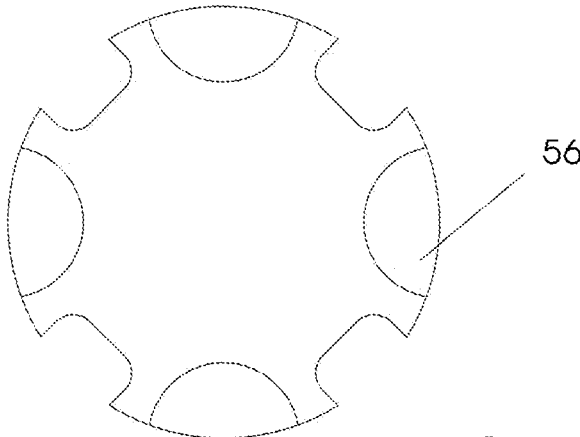


FIG. 12B

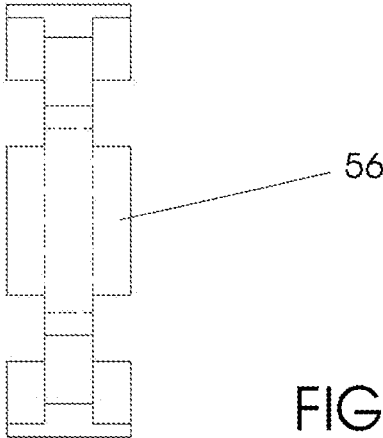


FIG. 12C

INFLATABLE BAG WITH BURST CONTROL ENVELOPE AND GAS GENERATOR

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of U.S. patent application Ser. No. 14/543,490, entitled "INFLATABLE BAG WITH BURST CONTROL ENVELOPE AND GAS GENERATOR", filed Nov. 17, 2014, which is incorporated herein by reference, which is a divisional of U.S. patent application Ser. No. 13/529,489, entitled "INFLATABLE BAG WITH BURST CONTROL ENVELOPE AND GAS GENERATOR", filed Jun. 21, 2012, now issued as U.S. Pat. No. 8,887,639.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field relates to inflatable devices such as air bags and more particularly to an air bag having a burst point control envelope with particular application to stun grenades.

2. Description of the Related Art

U.S. Pat. No. 8,117,966 taught a non-pyrotechnic stun grenade for generating loud, explosive sound by inflation to rupture of an inflatable bag. To make the point of rupture consistent from bag to bag and to achieve target noise levels within a limited time period the '966 patent proposed to construct a single layer inflatable bag with a rupture seam. Upon inflation the rupture seam parted abruptly at a particular and predetermined degree of tension on the seam. The rupture seam parted at a design volume of the bag and pressure within the bag to produce an N-wave. The explosive sound produced consistently met a minimum target volume level. Although the '966 patent provided for a non-pyrotechnic, compressed air, inflation source the patent suggests that pyrotechnic gas generation more readily produced high gas flow rates than compressed gas sources.

The use of chemical reactions to generate gas generators for inflation of automotive air bags is known. One issue addressed during the development of such air bags was the type of gas generator to use. Among the concerns was the byproducts produced by the chemical reactions or combustion of the fuel source used to generate the gas.

A popular contemporary gas generator for automotive applications is a mixture of sodium azide (NaN_3), potassium nitrate (KNO_3) and silicon dioxide (SiO_2). An exothermic (heat producing) decomposition of sodium azide into nitrogen gas and sodium can be initiated by exposure of the compound to 300°C . The free nitrogen gas inflates the bag while the potassium nitrate reacts with the sodium in a second reaction to produce potassium oxide (K_2O), sodium oxide (Na_2O) and more free nitrogen (N_2). A final reaction translates the reactive potassium oxide and sodium oxide compounds into more stable byproducts by a reaction with the silicon dioxide to produce potassium silicate and sodium silicate ($\text{K}_2\text{O}_3\text{Si}$ and $\text{Na}_2\text{O}_3\text{Si}$). These are chemically stable compounds which pose no known environmental and health threat. See Gas Laws Save Lives: The Chemistry Behind Airbags, Casiday, R. and Frey, R. (2000). In addition, the initiating materials are not hygroscopic as water absorption can slow or stop gas generating reactions limiting the shelf life of units. Alternative pyrotechnic formulations for a gas generator may make use of potassium nitrite (KNO_2). Such fuel sources result in reactions which are highly exothermic and can produce higher temperatures than the reaction based on sodium azide.

Construction of an inflatable bag which ruptures at a consistent degree of inflation to produce predictable noise levels using an exothermic chemical reaction to produce the inflation gas poses issues not present when a compressed air source is used. In contrast, where a compressed gas source is used for inflation the temperature of compressed gas falls upon expansion.

SUMMARY OF THE INVENTION

A rupturable bag assembly including a balloon, an outer wall, an inlet port, and a heat resistant shield. The balloon is fabricated from an elastic material. The outer wall is disposed around the balloon, the outer wall having a perimeter seam which parts abruptly at a predetermined tension. The inlet port passes through the outer wall into the balloon for inflating the balloon to produce the predetermined tension. The heat resistant shield is disposed within the balloon opposite the inlet port. The outer wall is constructed of a relatively inelastic material in comparison to the material used to construct the balloon. There is a dispersible medium disposed within the outer wall and/or the balloon.

An inflation port is provided from outside into the rupturable bag through the first sections of the outer and inner walls to deliver gas into the rupturable bag and against the heat resistant shield.

An inflation gas generator and flow arrester assembly is fitted to the inflation port outside of the rupturable bag.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of a rupturable bag assembly for a stun grenade.

FIG. 2 is a perspective view of a rupturable bag.

FIG. 3 is a side elevation of the rupturable bag of FIG. 2.

FIG. 4 is a cross section view of the rupturable bag of FIGS. 2 and 3.

FIG. 5 is an exploded perspective view of the rupturable bag.

FIG. 6 is an exploded side view of the rupturable bag.

FIG. 7A is a cross sectional view of mating of an air inlet with the rupturable bag.

FIG. 7B is a detail view of clamping the bag with the air inlet.

FIG. 7C is detail of the rupturable bag upper wall.

FIGS. 8A and 8B are exploded perspective and side views of the rupturable bag assembly.

FIG. 9 is a perspective view of the pressurization gas arrester for the rupturable bag assembly.

FIG. 10 is a top view of the gas arrester.

FIG. 11 is a cross-sectional view of the gas arrester taken along section lines 11-11 of FIG. 10.

FIGS. 12A, B and C are detail views of a assembly washer for the gas arrester.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplification set out herein illustrate embodiments of the invention and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE
INVENTION

In the following detailed description, like reference numerals and characters may be used to designate identical, corresponding, or similar components in differing drawing figures. Furthermore, example sizes/models/values/ranges may be given with respect to specific embodiments but are not to be considered generally limiting.

Referring now to the figures and in particular to FIG. 1, a self-inflating rupturable bag assembly **10** is shown. Rupturable bag assembly **10** may conceptually be divided into two sections, a rupturable bag **12** and an inflation gas generator assembly **14** which is mounted to bag inflation port **16**. Rupturable bag **12** parts along a perimeter seam **18** upon inflation to a minimum pressure and tension on the seam. The rupturable bag assembly **10** may be used with a variety of stun grenades to generate an explosive sound. A pair of electrical studs **52** allow connection to an electrical circuit which may be used to ignite a fuel source located in the inflation gas generator assembly **14**.

In FIG. 2 the rupturable bag **12** is shown with inflation gas generator assembly **14** detached to better show inflation port **16**. The upper portion of inflation port **16** is threaded for attachment to the inflation gas generator assembly **14** and provides an inlet **20** disposed through its center. Inflation gas is introduced to rupturable bag **12** via inlet **20**.

The details of construction of rupturable bag **12** are shown in FIGS. 3-6. Inflation port **16** is a multiple element assembly extending through an upper wall of rupturable bag **12**. The inflation port **16** incorporates a conduit **34** which is flattened and thickened at one end to form an inner bulkhead **26**. Conduit **34** extends through a first of two walls **13**, **15** of rupturable bag **12** which places inner bulkhead between the two walls, inside an assembled rupturable bag **12**.

Located between the inner bulkhead **26** and the first wall **13** is an inner collar **30**. Outside of first wall **13** is an outer collar **28**. Adjacent the outer collar **28** moving along conduit **34** is a washer **42**. The collars **30**, **28**, clamp washer **22** and washer **42** are held in place by a nut **32** which is threaded onto the conduit **34**.

The rupturable bag **12** comprises first and second walls **13**, **15**. The rupturable bag **12** also comprises an inner elastic balloon **38** and an outer reinforced envelope **36**. The material of the outer envelope **36** is less elastic than the material used to construct the inner balloon **38**. A nylon weave fabric would be suitable. Both the inner elastic balloon **38** and the outer reinforced envelope **36** are constructed from first and second layers, in the case of the inner elastic balloon, first and second layers **38A** and **38B**, and in the case of the outer reinforced envelope **36**, first and second layers **36A** and **36B**. The halves of inner elastic balloon **38** are closed along seam **19**. The halves of outer reinforced envelope **36** are closed along seam **18**. Seam **18** is constructed to part upon application of pressure from within. Failure of seam **18** results in a cascade failure of inner elastic balloon **38**. Seam **18** may be constructed in a number of ways. Where closed mesh, rip stop (a type of weave) nylon is used as a fabric from which outer reinforced envelope **36** is constructed. The seam **18** may be formed using braided nylon or polyester with a typical strength range of 20 to 50 lbs. tensile strength stitching the two halves together. A zig-zag stitch allows the use of lower tensile strength materials for the burst envelope and the seam than a straight stitch allows. The inner elastic balloon may be made with vinyl with the halves welded together. Welding may be done a number of ways, for example,

sonically, chemically or radio frequency welded. Adhesives and heat bonding are also possible. In this way a volumetrically small envelope can be constructed which can be inflated to a target burst pressure of 375 psi. A bag having a diameter of 5 inches on inflation producing a 180 dB peak over pressure shock wave on rupture can be built. Such a bag can be inflated to rupture in 20 to 30 milliseconds using a sodium azide or similar gas source.

Applied to the inner face of second layer **38B** of inner elastic balloon **38** is a heat shield layer **40**, which may be constructed of aluminum foil of mylar. Heat shield layer **40** is used to prevent premature failure of rupturable bag **12** due to ejection of hot gas from inlet **20**.

FIGS. 7A-C illustrate of the juncture between inlet port assembly **16** and the first wall **13** of rupturable bag **12** and of the second wall **15** of the rupturable bag. The clamp washer **22** carries an annular dimple **44** on one face displaced outwardly from the conduit **24**. Annular dimple **44** aligns on and is shaped to conform to an annular depression **46** on the adjacent face of inner bulkhead **26**. The first wall **13** of the rupturable bag **12** is pinched between the inner bulkhead **26** and the clamp washer **22**. Adhesive layers may be used between wall elements in the area of the clamp washer **22** to improve sealing.

FIGS. 8-12 illustrate construction of the inflation gas generator assembly **14**. Gas arrester assembly **14** includes a housing/body **50** which is essentially a tube which is open on one end, closed at the other. The open end of the body **50** is mated with a connector **48** fitted between the inflation gas generator assembly **14** and the inflation port **16**. Connector **48** is fitted to conduit **24** outside nut **32** on the exposed end of the conduit relative to the rupture bag **12**. The remaining elements of the inflation gas generator assembly **14**, excluding a pair of electrical studs **52**, are located in the housing **50**. The electrical studs **52** pass through the housing to allow application of an electrical trigger signal from outside the housing to a fuel source **54** located in the housing **50**.

Combustion of fuel source **54**, which may be a dry, packed blend of sodium azide, silicon dioxide and potassium nitrate, results in a jet of high temperature gas being ejected from the open end of the inflation gas generator assembly **14** into a connector **48** between the assembly **14** and the inlet **20** of the inflation port **16**. Fuel source **54** is shaped a ring with a plurality of radial connecting rods **64** aimed inwardly on the ring for connection to the electrical studs **52** by wires (not shown). As an alternative to a fuel source including sodium azide, more conventional pyrotechnic fuel sources may be used, typically incorporating potassium nitrite. To protect the elastomeric and fabric layers of the rupturable bag **12** from the full force and heat of gas ejected from the gas generator assembly **14** the path from fuel source **54** to connector **48**, while axial, is not direct. A variety of trigger mechanisms may be used, particularly where an electronic trigger signal is provided.

Upon assembly of inflation gas generator assembly **14** the fuel source **54** is located deepest in the housing **50**, proximate to the closed end of the housing and distal to its open end. Moving toward the open end of housing **50** a lower washer **58B** is located having a central annular opening through which gas is ejected. Next in line is a lower spacing washer **56B** which defines openings between its perimeter edge and the inner wall of the housing **58B**. Spacing elements are constructed into the lower spacing washer **56B** so that gas can pass from the central annular opening of washer **58B** to the perimeter openings. This cycle is repeated once with an upper washer **58A** and an upper spacing washer **56A**. The lower and upper spacing washers **56B** and **56A** are

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illustrated in detail in FIGS. 12A-C generally at reference numeral 56. Washers 58A, 58B, 56A and 56B, along with top cap 60, provide a flame arresting function the fuel source 54 and the inlet port 20. A more extensive flame arresting system incorporating additional washers of alternating types may be employed for pyrotechnic devices as the target temperature range in the rupture envelope is below 100 to 125 degrees Celsius.

Gas is ejected from housing 50 through a perforated top cap 60. Top cap 60 is retained in housing 50 using a spring spacing ring 62 which fits in an annular slot 66 in the inner wall of the housing proximate to the open end of the housing.

The rupturable bag assembly 10 includes balloon 38 fabricated from an elastic material. There is an outer wall of envelope 36 that is disposed around balloon 38, the outer wall 36 having a perimeter seam 18 which parts abruptly at a predetermined tension. The inlet port 20 through the outer wall 36 into the balloon 38 inflates the balloon 38 to produce the predetermined tension. The heat resistant shield 40 is disposed within the balloon 38 opposite the inlet port 20. The outer wall 36 is constructed of a relatively inelastic material in comparison to the material used to construct the balloon 38. As seen in FIG. 4 a dispersible medium 100 is disposed within the outer wall 36 and between the outer wall 36 and the balloon 38. The invention also contemplates that a dispersible medium 102 is located inside of balloon 38. The dispersible medium 100 and/or 102 may be singularly present in either location or in both. Also dispersible medium 100 and 102 may be the same or different mediums.

Dispersible mediums 100 and 102 may interact to cause a secondary reaction after the rupture of balloon 38 and envelope 36. For example, the mediums 100 and 102 may chemically react with each other to result in another event, or to cause the two mediums 100 and 102 to combine to have an effect on the surrounding area or organisms proximate to rupturable bag assembly 10.

The mediums 100 and 102 can be a powder or an aerosol liquid, or some other medium. Once rupturable bag assembly 10 ruptures an acoustic shockwave is produced, as the perimeter seam 18 parts abruptly, the acoustic shockwave being primarily responsible for a dispersment of the dispersible medium 100 and/or 102. Once the dispersible medium 100 and/or 102 has dispersed or is dispersing it may provide a visual effect, an olfactory effect, a secondary acoustic effect, and/or a biological effect to an organism. For example, the medium 100 and/or 102 can include a paint that is distributed in the vicinity thereby being a visual effect. The medium 100 and/or 102 can cause a smell to be distributed in the area. Additionally, a secondary acoustic effect may take place if the medium 100 and/or 102 is ignited, or self ignites causing an explosion, which can also include visual and olfactory results as well. The dispersal of medium 100 and/or 102 can also result in a reaction of organisms in the area, such as an irritant that will cause the organisms to leave the area. Also, the medium 100 and/or 102 may be a cleansing agent to attack chemicals or germs in the area.

The triggerable chemical gas source can be configured to cause a dispersment of the dispersible medium 100 and/or 102 within the rupturable bag assembly before the balloon 38 ruptures.

While this invention has been described with respect to at least one embodiment, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general

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principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

What is claimed is:

1. A rupturable bag assembly comprising:
 - a balloon fabricated from an elastic material;
 - an outer wall disposed around the balloon, the outer wall having a perimeter seam which parts abruptly at a predetermined tension;
 - an inlet port through the outer wall into the balloon for inflating the balloon to produce the predetermined tension;
 - a heat resistant shield disposed within the balloon opposite the inlet port;
 - the outer wall being constructed of a relatively inelastic material in comparison to the material used to construct the balloon; and
 - a dispersible medium disposed within at least one of the outer wall and the balloon.
2. The rupturable bag assembly of claim 1, wherein the dispersible medium is a powder.
3. The rupturable bag assembly of claim 1, wherein the dispersible medium is an aerosol liquid.
4. The rupturable bag assembly of claim 1, wherein an acoustic shockwave is produced when the perimeter seam parts abruptly, the acoustic shockwave being primarily responsible for a dispersment of the dispersible medium.
5. The rupturable bag assembly of claim 4, wherein the dispersible medium once dispersed provides at least one of a visual effect, an olfactory effect, a secondary acoustic effect, and a biological effect to an organism.
6. The rupturable bag assembly of claim 1, further comprising an inflation assembly including a triggerable chemical gas source coupled to the inlet port.
7. The rupturable bag assembly of claim 6, further comprising a configurable flame arrester located between the triggerable chemical gas source and the inlet port.
8. The rupturable bag assembly of claim 6, wherein the triggerable chemical gas source is a pyrotechnic.
9. The rupturable bag assembly of claim 6, wherein the triggerable chemical gas source includes sodium azide, potassium nitrate and silicon dioxide.
10. The rupturable bag assembly of claim 6, wherein the triggerable chemical gas source is configured to cause a dispersment of the dispersible medium within the rupturable bag assembly before the balloon ruptures.
11. A grenade assembly, comprising:
 - a gas source; and
 - a rupturable bag assembly coupled to the gas source, the rupturable bag assembly including:
 - a balloon fabricated from an elastic material;
 - an outer wall disposed around the balloon, the outer wall having a perimeter seam which parts abruptly at a predetermined tension;
 - an inlet port through the outer wall into the balloon for inflating the balloon to produce the predetermined tension;
 - a heat resistant shield disposed within the balloon opposite the inlet port;
 - the outer wall being constructed of a relatively inelastic material in comparison to the material used to construct the balloon; and
 - a dispersible medium disposed within at least one of the outer wall and the balloon.

12. The grenade assembly of claim 11, wherein the dispersible medium is a powder.

13. The grenade assembly of claim 11, wherein the dispersible medium is an aerosol liquid.

14. The grenade assembly of claim 11, wherein an acoustic shockwave is produced when the perimeter seam parts abruptly, the acoustic shockwave being primarily responsible for a dispersment of the dispersible medium. 5

15. The grenade assembly of claim 14, wherein the dispersible medium once dispersed provides at least one of a visual effect, an olfactory effect, a secondary acoustic effect, and a biological effect to an organism. 10

16. The grenade assembly of claim 11, wherein the gas source is a triggerable chemical gas source coupled to the inlet port. 15

17. The grenade assembly of claim 16, further comprising a configurable flame arrester located between the triggerable chemical gas source and the inlet port.

18. The grenade assembly of claim 16, wherein the triggerable chemical gas source is a pyrotechnic. 20

19. The grenade assembly of claim 16, wherein the triggerable chemical gas source includes sodium azide, potassium nitrate and silicon dioxide.

20. The grenade assembly of claim 16, wherein the triggerable chemical gas source is configured to cause a dispersment of the dispersible medium within the rupturable bag assembly before the balloon ruptures. 25

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