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Graber

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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 3/04	(2006.01)
F42B 12/36	(2006.01)

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

CPC . ***F41A 33/04*** (2013.01); ***F42B 3/04*** (2013.01); ***F42B 12/36*** (2013.01); ***F42B 27/00*** (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, 117, 118, 119; 446/188, 220, 446/221, 222, 223, 224, 225, 226

See application file for complete search history.

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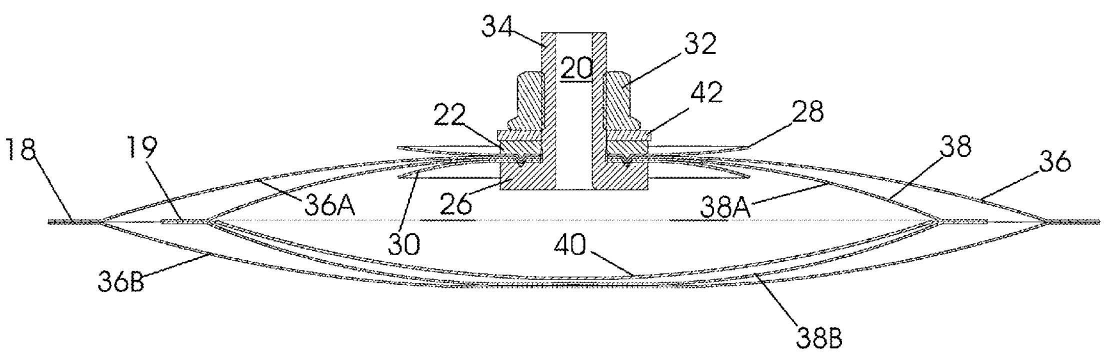
(57) **ABSTRACT**

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.

5 Claims, 9 Drawing Sheets



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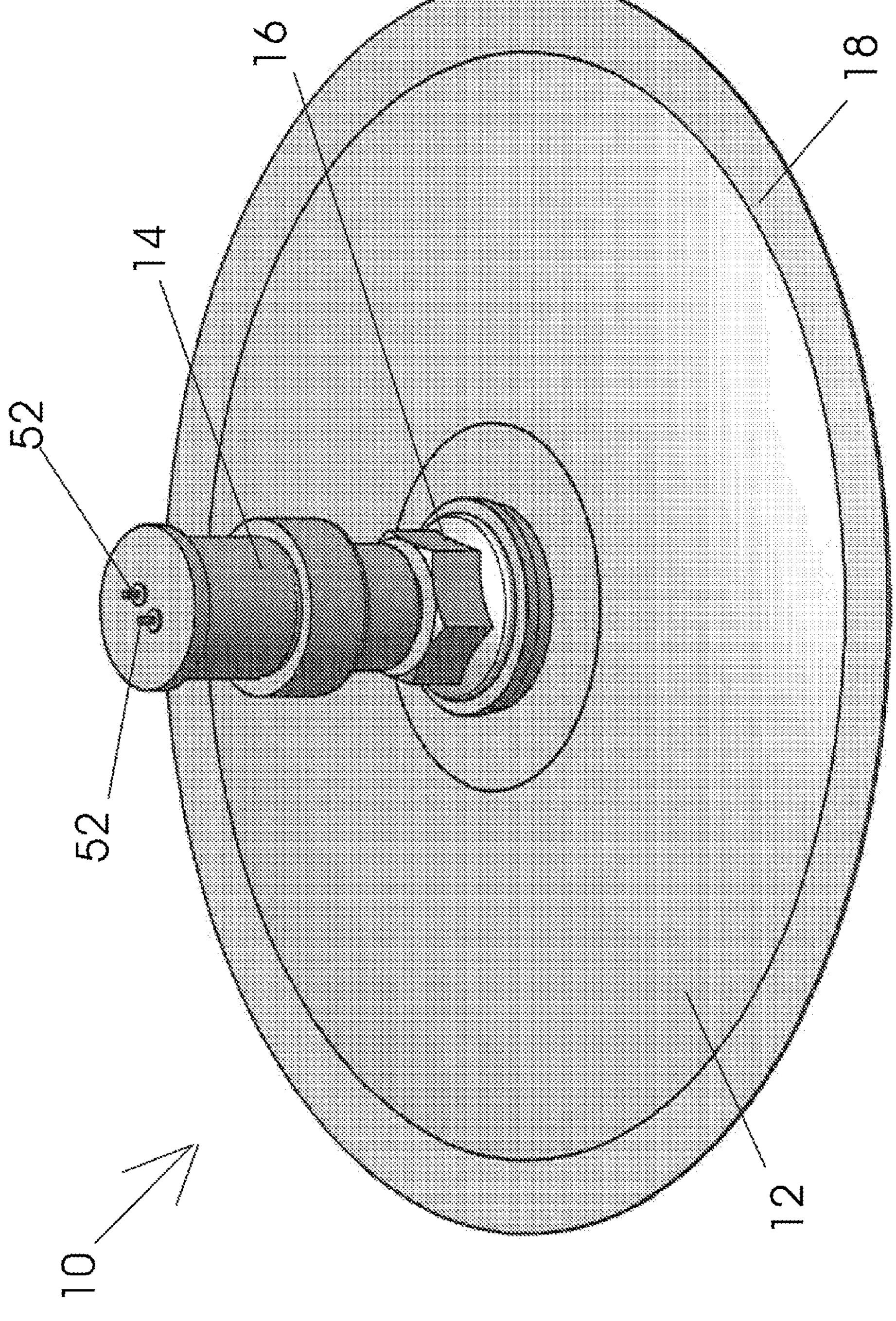


FIG. 1

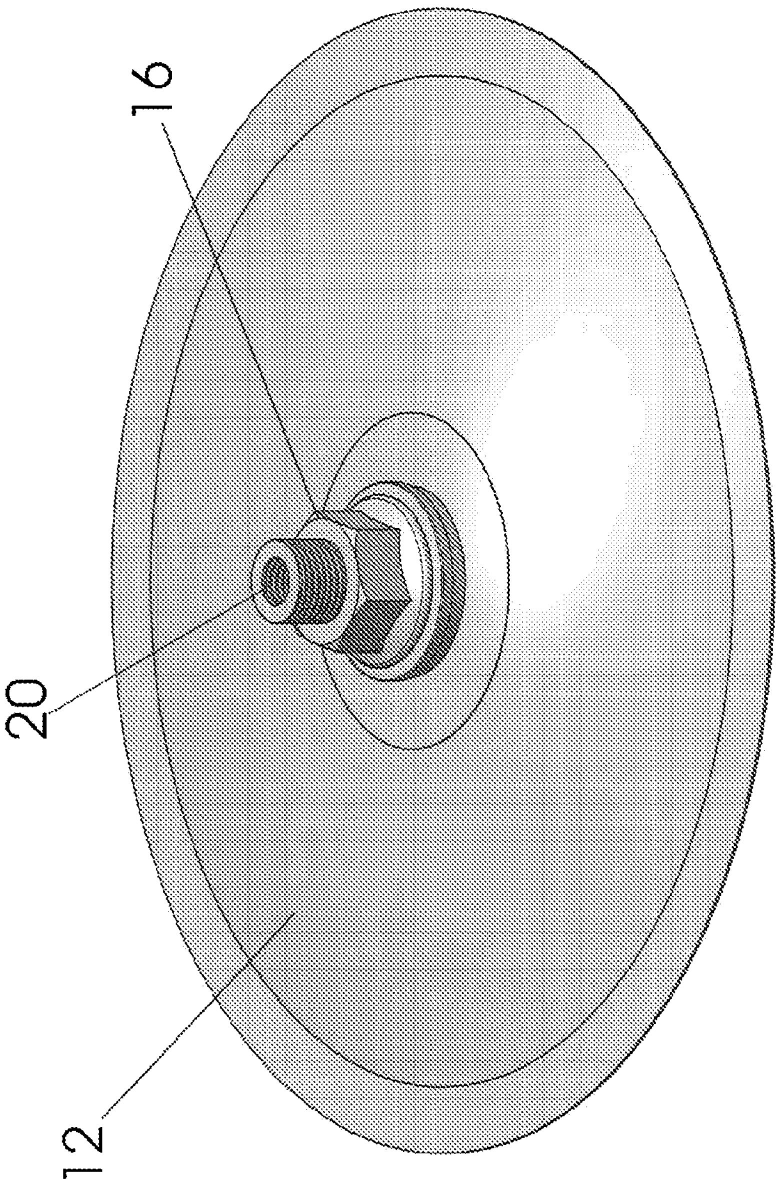


FIG. 2

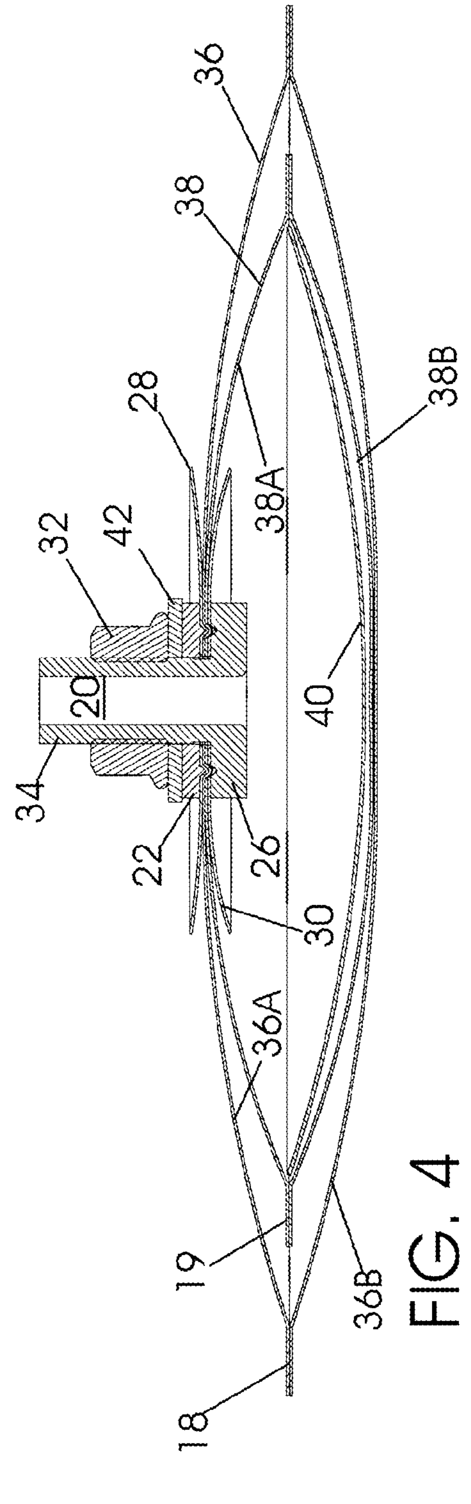


FIG. 4

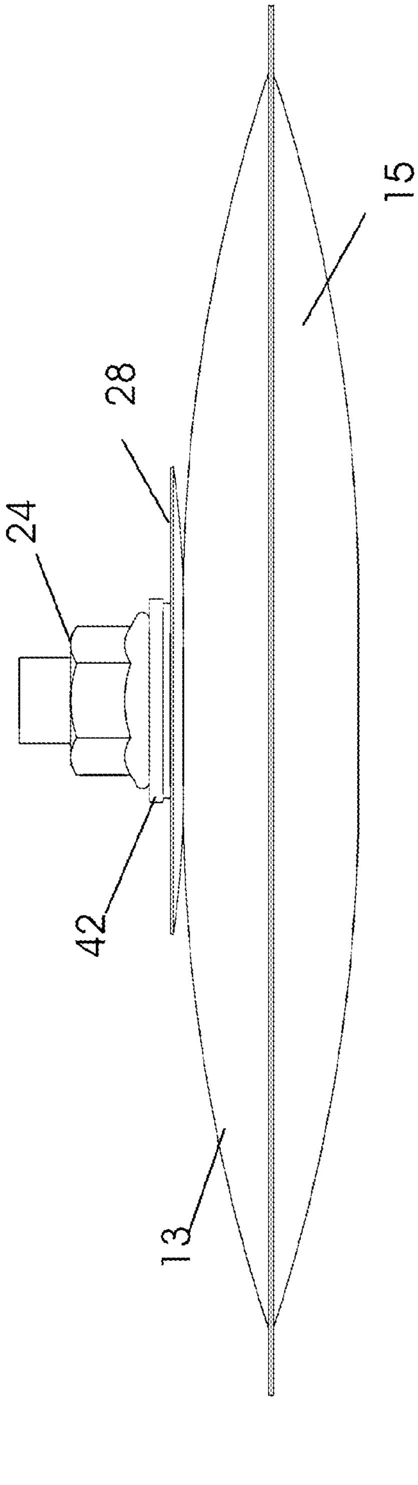


FIG. 3

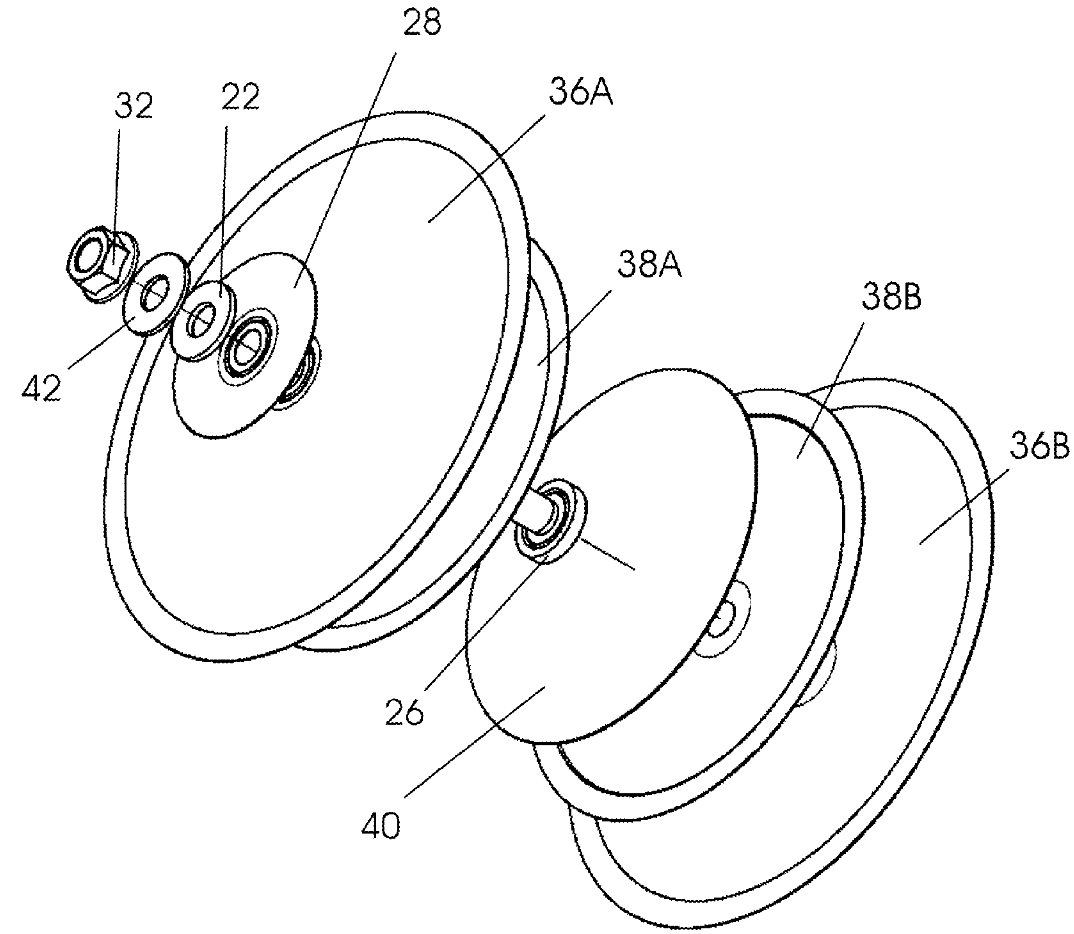


FIG. 5

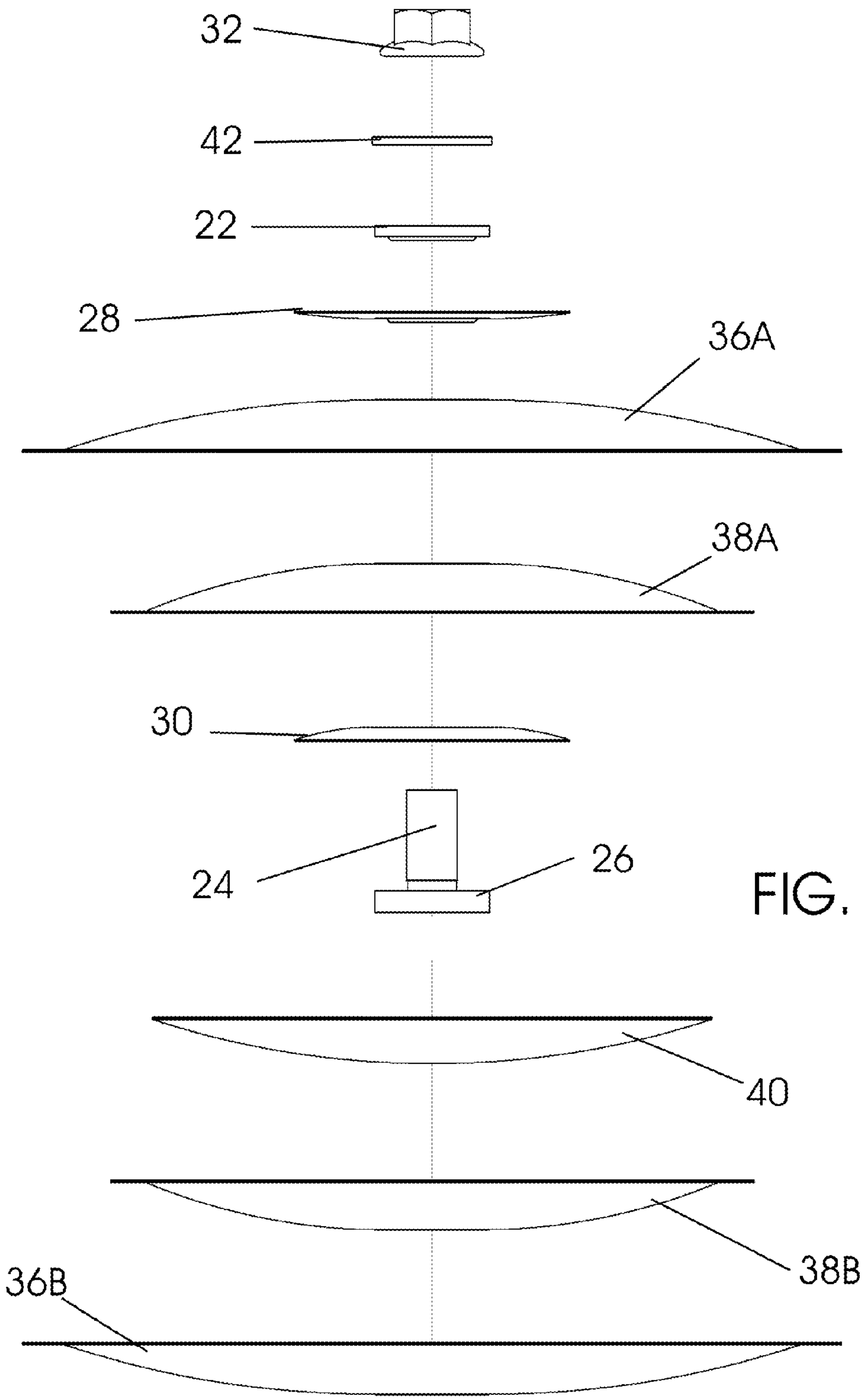


FIG. 6

FIG. 7A

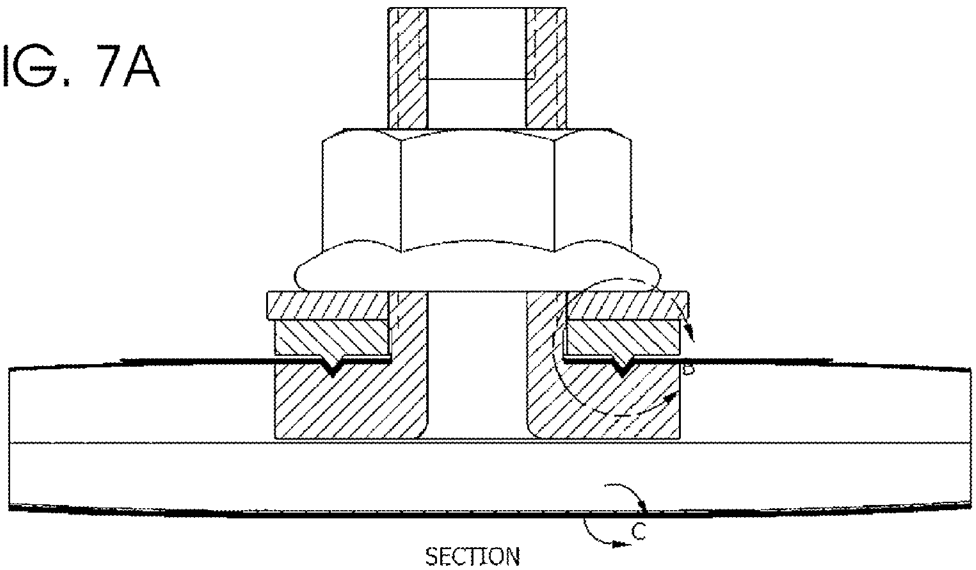
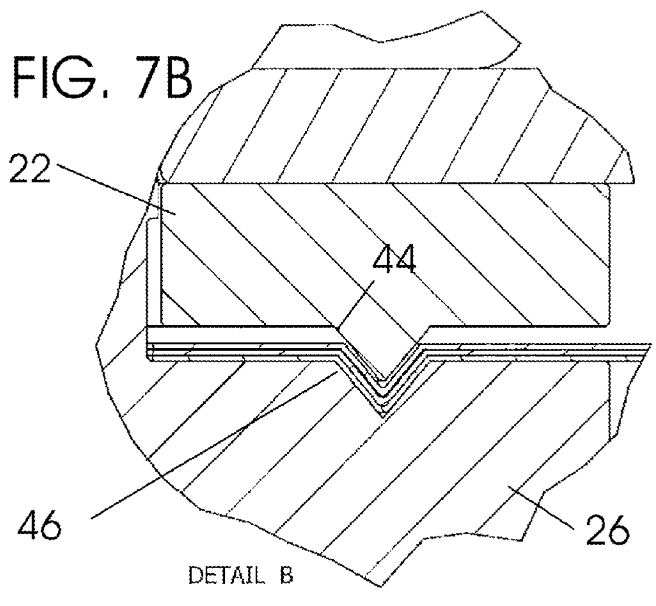


FIG. 7B



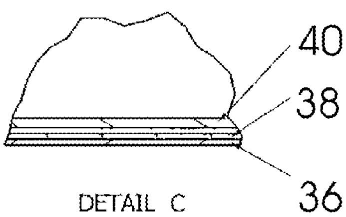
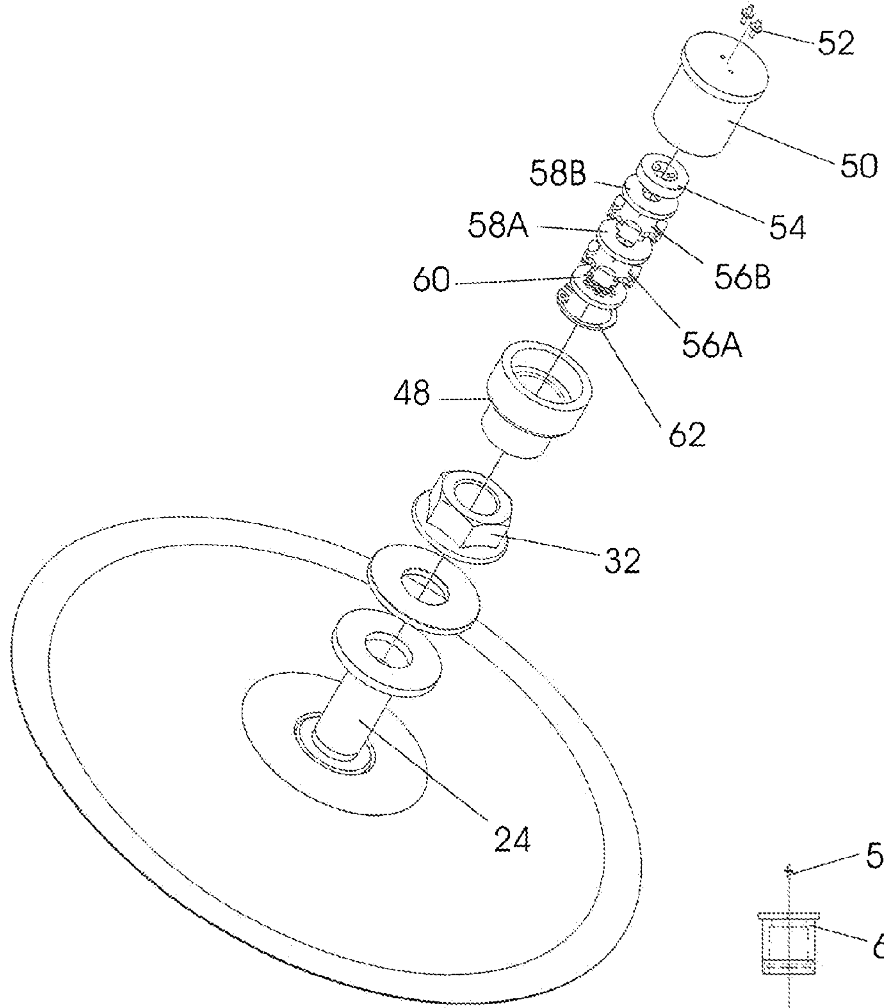


FIG. 7C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50
58B
54
58A
56B
60
56A
48
62
32
24

FIG. 8A

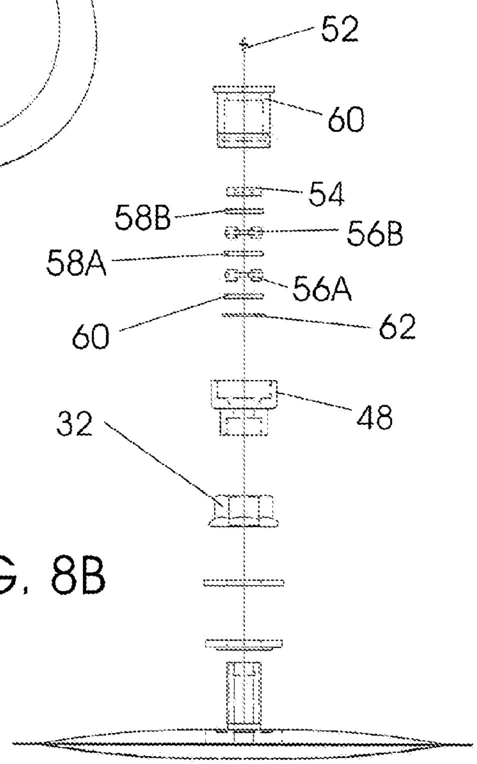
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FIG. 8B

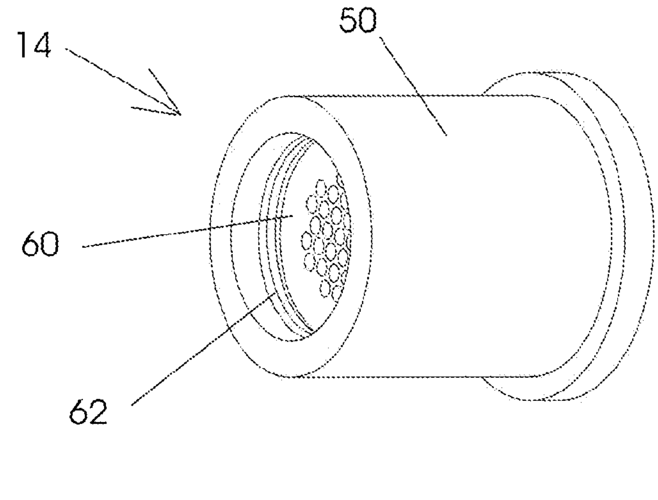

FIG. 9

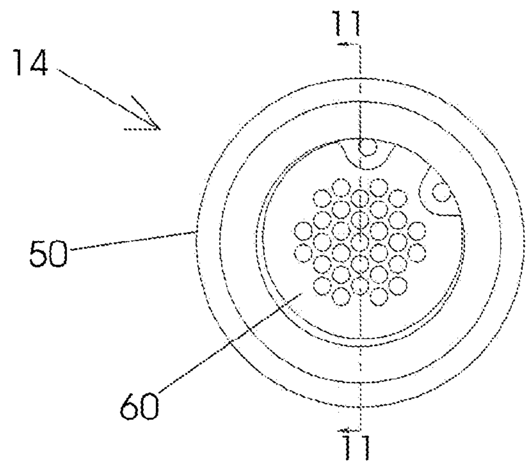

FIG. 10

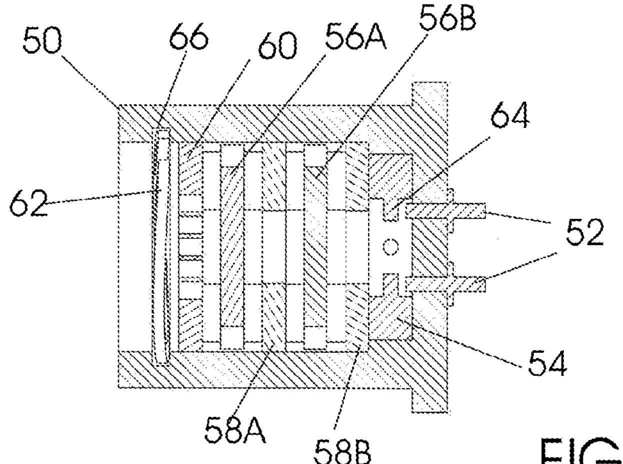

FIG. 11

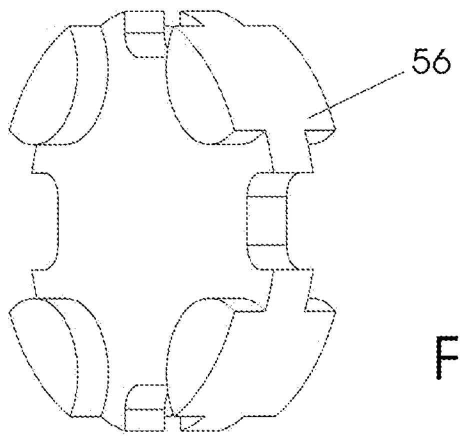

FIG. 12A

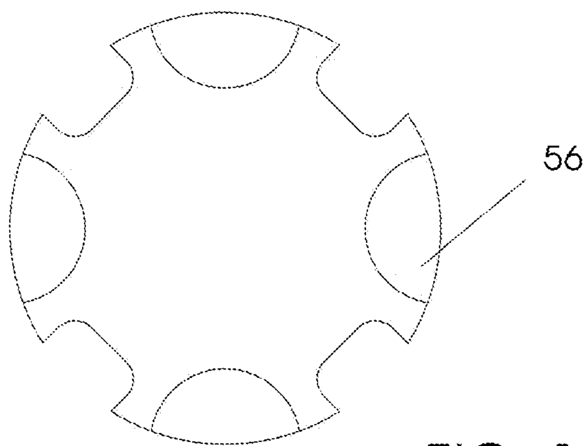

FIG. 12B

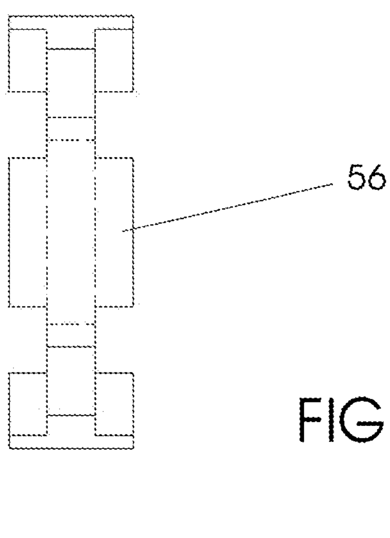

FIG. 12C

INFLATABLE BAG WITH BURST CONTROL ENVELOPE AND GAS GENERATOR

CROSS REFERENCE TO RELATED APPLICATIONS

This 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, which is incorporated herein by reference.

BACKGROUND

1. Technical Field

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 Technical Field

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 silacate and sodium silicate (K_2O_3Si an Na_2O_3Si). 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

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.

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

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

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

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

FIGS. **8**A and **8**B 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. **12**A, B and C are detail views of a assembly washer for the gas arrester.

DETAILED DESCRIPTION

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 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 envelop **36** are constructed from first and second layers, in the case of the inner elastic balloon, first and second layers **38**A and **38**B, and in the case of the outer reinforced envelope **36**, first and second layers **36**A and **36**B. 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 envelop **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 **38**B 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. **7**A-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 an 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**. Connecter **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 an 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 **58**B is located having a central annular opening through which gas is ejected. Next in line is a lower spacing washer **56**B which defines openings between its perimeter edge and the inner wall of the housing **58**B. Spacing elements are constructed into the lower spacing washer **56**B so that gas can pass from the central annular opening of washer **58**B to the perimeter openings. This cycle is repeated once with an upper washer **58**A and an upper spacing washer **56**A. The lower and upper spacing washers **56**B and **56**A are illustrated in detail in FIGS. **12**A-C generally at reference numeral **56**. Washers **58**A, **58**B, **56**A and **56**B, 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.

What is claimed is:

1. A rupturable bag assembly for producing an acoustic shockwave 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 to produce an acoustic shockwave having a minimum target noise level at a prescribed distance;

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; and

the outer wall being constructed of a relatively inelastic material in comparison to the material used to construct the balloon.

2. The rupturable bag assembly of claim **1**, further comprising:

an inflation assembly including a triggerable chemical gas source coupled to the inlet port.

3. The rupturable bag assembly of claim **2**, further comprising:

a configurable flame arrester located between the triggerable chemical gas source and the inlet port.

4. The rupturable bag assembly of claim **3**, wherein the triggerable chemical gas source is a pyrotechnic.

5. The rupturable bag assembly of claim **3**, wherein the triggerable chemical gas source includes sodium azide, potassium nitrate and silicon dioxide.

* * * * *