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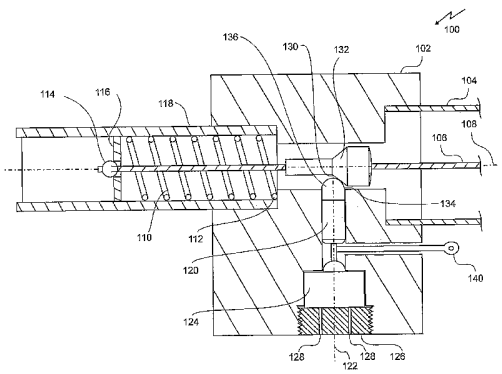
(54) Title: WATER ACTIVATED INFLATOR FOR INFLATABLE DEVICE AND METHOD OF AIR DEPLOYMENT



(57) Abstract: The present invention relates to a water activated inflator and a method of air deployment of a water activated inflatable device. A gas cylinder opening device for opening a sealing mechanism of the gas cylinder is disposed in the housing movable along a first axis having a first orientation between a cocked position and a fired position. A tension mechanism provides tension acting along the first axis for moving the gas cylinder opening device from the cocked position to the fired position. A plunger is holding the gas cylinder opening mechanism in the cocked position. The plunger is movable along a second axis having a different second orientation between a first position and a second position. A water soluble element is holding the plunger in the first position. A first interacting surface of the gas cylinder opening device is disposed at a predetermined angle to the first axis. A second interacting surface of the plunger is in contact with the first interacting surface at the predetermined angle. The angle is determined such that a component along the second axis of a component of the tension acting onto the second interacting surface is within a predetermined range for ensuring structural integrity of the water soluble element in the cocked position and for ensuring movement of the plunger when at least a portion of the water soluble element is dissolved. Using the water activated inflator in a rescue kit is highly beneficial for air rescue operations over a body of water by providing proper timing of the inflation shortly after impact.

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Water Activated Inflator for Inflatable Device and Method of Air Deployment

Field of the Invention

[001] This invention relates to air deployment of an inflatable device and in particular to a water activated inflator for use in an air deployable device and a method of air deployment using the same.

Background of the Invention

[002] There is a continuing need for development of methods of accurately dropping inflatable devices from an airplane, for example, life rafts to survivors in a body of water. The most advanced method, presently in use, is dropping an inflatable device in a deployment container using a parachute and timer as disclosed, for example, in US Patent 4,639,229. Use of the parachute substantially ensures correct orientation of the container on impact with the body of water and a predetermined range of speed at impact through aerodynamically braking the descent of the container. After impact the container is partially or completely submerged in the water, bobbing in the water and then floating on the surface until the device is inflated. Using a timer, the inflation is initiated after a preset time interval elapses, predetermined at time of manufacturing the inflatable device based on an expected altitude of an airplane flying above the water surface such that the inflation starts shortly after impact of the container on the body of water. However, the exact timing for initiating the inflation is a major problem of this method of air deployment using a timer. If the inflation is initiated too early, the device is inflated while still in the air resulting in the inflated device being blown away from a target zone in the presence of wind - even at a relatively small wind speed. On the other hand, if the inflation is initiated too late the container is floating on the surface for a considerable amount of time reducing the likelihood of the device being inflated in its proper orientation. In most rescue operations survivors have to be rescued from rough seas. Under such conditions it is likely for a container to be toppled by the rough sea while floating on the surface resulting in the device being inflated upside down rendering it problematic for rescuing survivors. One solution to this problem is the use of a reversible life raft as taught in US Patent 6,375,529. However, use of a reversible life raft requires physical action from survivors – people in distress - in order to set up a

canopy for protecting them from the elements. In particular, for rescue operations in cold climates it is essential to provide life rafts with a canopy in order to protect survivors from hypothermia.

[003] Auto-inflation of life vests and other personal floatation devices using water activated inflators is well known in the art. Water activated inflators using a water soluble element for holding a membrane piercing mechanism in a cocked position are disclosed, for example, in US Patents 6,589,087; 5,852,986; 5,694,986; 5,370,567; and 5,333,656.

[004] In order to quickly inflate a large floatation device such as a life raft, a large gas flow is needed. Therefore, the inflator has to rapidly open a sealing mechanism of a gas cylinder containing a large volume of gas under high pressure. In order to instantly and reliably create a large opening, it is preferred to provide a significant stroke to a valve - defining the opening – of the sealing mechanism, rather than piercing a sealing membrane. However, for providing a significant stroke a relatively strong force acting along a relatively long distance has to be applied. Timed actuators, explosive actuators, and electronic actuators are typically used to provide the force and distance required in inflating a large inflatable device. As is evident to those of skill in the art, such devices cause serious storage and maintenance problems as well as safety problems during transport in an airplane and, therefore, are not considered useful for air rescue missions. Conversely, none of the passive water activated devices provide for the force and distance of operation required for quickly and reliably inflating a life raft.

[005] It would be advantageous to provide a passive water activated device for supporting inflation of a life raft.

Summary of the Invention

[006] It is, therefore, an object of the invention to provide a water activated inflator capable of providing sufficient force acting along a sufficient distance for opening a sealing mechanism of a gas cylinder in order to quickly and reliably inflate a large inflatable device.

[007] It is further an object of the invention to provide a water activated inflator for inflating a large inflatable device that is safe for use in air deployment.

[008] It is yet further an object of the invention to provide a method of air deployment of a large inflatable device using a water activated inflator.

[009] In accordance with the present invention there is provided a water activated inflator comprising:
a housing having a connecting mechanism for mating with a neck of a gas cylinder;
a gas cylinder opening device for opening a sealing mechanism of the gas cylinder, the gas cylinder opening device being disposed in the housing movable along a first axis having a first orientation between a cocked position and a fired position;
a tension mechanism in mechanical communication with the housing and the gas cylinder opening device for providing tension acting along the first axis for moving the gas cylinder opening device from the cocked position to the fired position;
a plunger for holding the gas cylinder opening mechanism in the cocked position, the plunger being disposed in the housing movable along a second axis having a different second orientation between a first position and a second position;
a water soluble element for holding the plunger in the first position through mechanical communication along the second axis with the plunger and the housing;
a conduit for providing water to the water soluble element;
a first interacting element in mechanical communication with the gas cylinder opening device having a first interacting surface, wherein at least a portion of the interacting surface is disposed at a predetermined angle to the first axis; and,
a second interacting element in mechanical communication with the plunger having a second interacting surface for interacting with the first interacting surface at the predetermined angle when the plunger is in the first position for holding the gas cylinder opening mechanism in the cocked position, wherein the predetermined angle is determined such that a component along the second axis of a component of the tension acting onto the second interacting surface is within a predetermined range for ensuring structural integrity of the water soluble element in the cocked position and for ensuring movement of the plunger when at least a portion of the water soluble element is dissolved.

[0010] In accordance with the present invention there is further provided a water activated inflatable device comprising:

an inflatable device body;

a gas cylinder in fluid communication with the inflatable device body; and,

a water activated inflator comprising:

a housing having a connecting mechanism mated with a neck of the gas cylinder;

a gas cylinder opening device for opening a sealing mechanism of the gas cylinder, the gas cylinder opening device being disposed in the housing movable along a first axis having a first orientation between a cocked position and a fired position;

a tension mechanism in mechanical communication with the housing and the gas cylinder opening device for providing tension acting along the first axis for moving the gas cylinder opening device from the cocked position to the fired position;

a plunger for holding the gas cylinder opening mechanism in the cocked position, the plunger being disposed in the housing movable along a second axis having a different second orientation between a first position and a second position;

a water soluble element for holding the plunger in the first position through mechanical communication along the second axis with the plunger and the housing;

a conduit for providing water to the water soluble element;

a first interacting element in mechanical communication with the gas cylinder opening device having a first interacting surface, wherein at least a portion of the interacting surface is disposed at a predetermined angle to the first axis; and,

a second interacting element in mechanical communication with the plunger having a second interacting surface for interacting with the first interacting surface at the predetermined angle when the plunger is in the first position for holding the gas cylinder opening mechanism in the cocked position, wherein the predetermined angle is determined such that a component along the second axis of a component of the tension acting onto the second interacting surface is within a predetermined range for ensuring structural integrity of the water soluble element in the cocked position and for ensuring movement of the plunger when at least a portion of the water soluble element is dissolved.

[0011] In accordance with an aspect of the present invention there is provided a method of air deployment of a water activated inflatable device comprising:

dropping from an airplane over a body of water a deployment container comprising an inflatable device body, a gas cylinder in fluid communication with the inflatable device body and a water activated inflator mated to a neck of the gas cylinder;
deploying a parachute attached to the deployment container for aerodynamically braking the descent of the container and for ensuring a predetermined orientation of the deployment container at impact on the body of water;
activating the water activated inflator through contact with water after impact of the deployment container on the body of water;
using the water activated inflator opening a sealing mechanism of the gas cylinder; and,
inflating the inflatable device.

[0012] In accordance with the aspect of the present invention there is further provided a water activated inflatable device for air deployment over a body of water comprising:
an inflatable device body;
a gas cylinder in fluid communication with the inflatable device body;
a water activated inflator mated to a neck of the gas cylinder;
a deployment container containing the inflatable device body, the gas cylinder and the water activated inflator, the deployment container comprising a conduit for enabling provision of water to the water activated inflator after impact of the deployment container on the body of water; and,
a parachute attached to the deployment container for aerodynamically braking the descent of the deployment container and for ensuring a predetermined orientation of the deployment container at impact on the body of water.

[0013] Using a water activated inflatable device according to the invention is highly beneficial for air rescue operations over a body of water. The water activated inflator provides proper timing of the inflation shortly after impact independent of the height of the air plane at the time instant the inflatable device is dropped substantially increasing the likelihood of proper placement of the inflatable device in a target zone as well as substantially increasing safety of the rescue personnel in the airplane.

Brief Description of the Figures

[0014] Exemplary embodiments of the invention will now be described in conjunction with the following drawings, in which:

[0015] Figures 1a to 1c are simplified block diagrams schematically illustrating a water activated inflator according to the invention;

[0016] Figures 2a to 2c are simplified block diagrams schematically illustrating various embodiments of interacting elements of the water activated inflator according to the invention;

[0017] Figure 3 is a simplified block diagram illustrating a water activated rescue kit according to the invention; and,

[0018] Figure 4 is a simplified block diagram illustrating a water activated rescue kit for air deployment according to the invention.

Detailed Description of the Invention

[0019] Referring to Figs. 1a and 1b, a preferred embodiment of a water activated inflator 100 according to the invention is shown in a cocked position and a fired position, respectively. The inflator 100 comprises a housing 102 having a connecting mechanism 104 for mating with a neck of a gas cylinder, not shown, attached thereto. A gas cylinder opening device 106 for opening a sealing mechanism of the gas cylinder is disposed in a bore of the housing 102 along a first axis 108. For example, for inflating large floatation devices such as a life raft the gas cylinder opening device 106 is preferably designed using a steel cable, but not limited thereto, for being attached to the sealing mechanism of the gas cylinder. The gas cylinder opening device 106 is movable along the first axis 108 between the cocked position, shown in Fig. 1a, and the fired position, shown in Fig. 1b. Movement of the gas cylinder opening device 106 is realized using a tension mechanism 110 such as a compression spring in mechanical communication with the housing at point 112 and with the gas cylinder opening mechanism 106 through, for example, a ball 114 attached to the steel cable and a washer 116. The tension mechanism 110 is designed to provide sufficient force F acting

along a sufficiently long distance for instantly and reliably providing a significant stroke to the sealing mechanism of the gas cylinder. The tension mechanism is partly accommodated in a tube 118 affixed to the housing 102 or, alternatively, the housing 102 is designed large enough to accommodate the complete tension mechanism 110. The gas cylinder opening device 106 is held in the cocked position using a plunger 120. The plunger 120 is disposed in a bore of the housing 102 and movable along a second axis 122 between a first position, shown in Fig. 1a, and a second position, shown in Fig. 1b. The second axis 122 is oriented substantially perpendicular to the first axis 108. Optionally, it is possible to dispose the second axis at a different angle than 90° to the first axis as long as some conditions, which will be explained below, are fulfilled. The plunger 120 is held in the first position through a water soluble element 124 - made of, for example, a sugar - disposed between the plunger 120 and a plug 126. The plug 126 is, for example, screwed into a threaded bore of the housing 102 along the second axis 122. The plug 126 comprises conduits 128 for enabling provision of water to the water soluble element 124. Alternatively, the conduits are disposed in the housing 102. The gas cylinder opening device 106 is held in the cocked position through interaction of surface 130 of a first interacting element 132 in mechanical communication with the gas cylinder opening device 106 with surface 134 of a second interacting element 136 in mechanical communication with the plunger 120. As shown in Fig. 1c, the interacting surface 130 is disposed at a predetermined angle α other than 0 or 90 degrees to the first axis 108. The angle α is determined such that component F_1 – acting along the second axis 122 - of force F_N – component of the force F oriented normal to the surface 130 in contact point A and transmitted to the surface 134 – is sufficiently small to ensure structural integrity of the water soluble element in the cocked position but also sufficiently large to ensure movement of the plunger 120 when at least a portion of the water soluble element 124 is dissolved. In a preferred embodiment, shown in Figs. 1a – 1c, the first interacting element 132 comprises a frustocone in interaction with a half sphere forming the second interacting element 136.

[0020] Figs. 2a to 2b illustrate some alternative embodiments comprising various combinations of spherical and conical surfaces. However, the embodiment shown in Figs. 1a to 1c is preferred due to its simplicity to manufacture, provision of a predetermined angle at the contact point A and in comparison to the embodiment

shown in Fig. 2c contact in one point instead of a line minimizing static friction at the instant of firing.

[0021] The connecting mechanism 104 comprises a tube affixed to the housing as shown in Figs. 1a and 1b. In a preferred embodiment, the tube is made of a flexible material such as a steel wire mesh and used in combination with a steel cable for the gas cylinder opening mechanism 106, substantially facilitating installation of the inflator 100 in the usually confined space of a deployment container.

[0022] In operation the inflator 100 is connected via connecting mechanism 104 to the neck of a gas cylinder with the gas cylinder opening device being connected to the sealing mechanism of the gas cylinder. During storage and transport of an inflatable life raft the inflator 100 is in the cocked position with the tension mechanism 110 under compression and held in this position by the plunger 120, as shown in Fig. 1a. Additionally, the plunger 120 is locked in the first position through safety pin 140 such that a portion of the component F_1 is still acting on the water soluble element 124 in order to avoid impact of the plunger 120 on the water soluble element 124 during removal of the safety pin 140. During deployment the safety pin 140 is removed. Preferably, a pull cord, not shown, attached to the safety pin 140 and a vessel or airplane carrying the inflatable device is used allowing removal of the safety pin 140 after dropping the inflatable device. After contact with water the water soluble element 124 starts to dissolve loosing its structural integrity and allowing force F_1 to push the plunger 120, thus, enabling the tension mechanism 110 to instantly pull the gas cylinder opening mechanism 106 into the fired position shown in Fig. 1b.

[0023] The water activated inflator 100 according to the invention is highly beneficial for air deployment of a life raft by providing a safe, reliable, compact, light weight and simple apparatus which is very cost effective to manufacture. It allows use of a very simple water soluble element as trigger in a device providing strong force acting along a large distance. Furthermore, the device is easily adaptable to a different stroke by only adjusting the angle α of the interacting surface allowing use of same parts of the inflator for different applications.

[0024] Referring to Fig. 3, a water activated inflatable device 200 according to the invention is shown. A deployment container 202 contains a folded inflatable device body 204 in fluid communication with a gas cylinder 206 comprising a compressed gas such as, for example, CO_2, N_2, or air. A water activated inflator 100 according to the invention is connected to the neck of the gas cylinder 206. The bottom of the deployment container 202 comprises a conduit 208 in order to provide water to the inflator 100 after impact of the container 202 on a body of water. Pull cord 210 is attached to the safety pin of the water activated inflator 100. In use, the pull cord is preferably attached to a vessel or airplane carrying the water activated inflatable device 200, allowing automatic removal of the safety pin when the kit is dropped overboard. In a preferred embodiment the gas cylinder 206 and the water activated inflator 100 are placed in the bottom portion of the deployment container 202 resulting in the center of gravity of the deployment container and its contents being located below a center of buoyancy of a portion or the complete container 202 immersed in water. This results in a more stable orientation of the container 202 when immersed or floating and, furthermore, the inflator is more quickly in contact with water after impact. These measures together with the quick inflation using the inflator 100 instantly enabling a large gas flow substantially reduces the risk of the inflatable device being inflated upside down in rough seas.

[0025] Referring to Fig. 4, a water activated inflatable device 300 for air deployment according to the invention is shown. Here, as in Fig. 3 above, a deployment container 302 contains a folded inflatable device body 304 in fluid communication with a gas cylinder 306 comprising a compressed gas. A water activated inflator 312 – preferably of the design shown in Figs. 1a to 1c - is connected to the neck and the sealing mechanism of the gas cylinder306. The bottom of the container 306 comprises a conduit 308 to enable provision of water to the inflator 312 after impact of the container 302 on a body of water. A top portion of the container 302 comprises a folded parachute 314 for aerodynamically braking the descent of the container 302 and for ensuring a predetermined orientation of the deployment container 302 at impact on a body of water. Affixed to the folded parachute 314 is a pull cord 316 for being attached to the airplane. Also for being attached to the airplane is a pull cord 310 for removing a safety pin of the inflator 312 affixed thereto. Optionally, pull cords 310 and 316 are

combined. Optionally, the water activated inflatable device 300 comprises a release mechanism operated by the inflator 312 for opening the deployment container 302. Alternatively, the deployment container 302 is pushed open by the impact on the water or by the inflating life raft. Further optionally, the deployment container 302 has cords affixed thereto for attachment to deployment containers of other water activated inflatable devices in order to connect a plurality of water activated inflatable devices for deployment.

[0026] In the following, a method of air deployment of a water activated inflatable device over a body of water according to the invention will be described. Preferably, a water activated water activated inflatable device 300 as described above is employed for executing the method. The water activated water activated inflatable device 300 is dropped from an airplane over a body of water in a target zone where survivors are suspected. After dropping the water activated inflatable device 300 from the airplane pulling action on pull cord 316 pulls the folded parachute 314 from the deployment container 302 for deployment through interaction with the airflow around the falling deployment container 302. Pulling action on pull cord 310 removes the safety pin from the inflator 312. Alternatively, a same pull cord is used for deploying the parachute as well as for removing the safety pin. The water activated inflatable device 300 is deployed in various different ways, for example, by release from a loading bay of a transport plane or helicopter, or from a release mechanism mounted to the outside of an airplane at the fuselage or under a wing. Deployment of the parachute provides aerodynamically braking of the descent of the water activated inflatable device 300 and ensures a predetermined orientation of the deployment container 302 at impact on the body of water. After impact, the deployment container 302 is first immersed in the body of water, then bopping in the water and finally floating on the water surface. After impact water is provided through the conduit 308 to the inflator dissolving a water soluble element of the inflator. After a portion of the water soluble element is dissolved the tension mechanism of the inflator is capable of pushing the plunger and, thus, moving the gas cylinder opening device for providing a sufficient stroke to the sealing mechanism of the gas cylinder. Using the water activated inflator 100 a large opening of the gas cylinder is provided instantly after dissolving a portion of the water soluble element enabling quick inflation of the inflatable device body 304. Preferably, the

inflator 312 and conduit 308 are placed such that the water soluble element is exposed to water within a short time interval after impact. The deployment container 302 is opened prior inflation of the inflatable device 304 through the force acting at impact or using an opening mechanism activated by the inflator. Alternatively, the deployment container 302 is opened through expansion of the inflating device 304.

[0027] Using a water activated inflatable device according to the invention is highly beneficial for air rescue operations over a body of water. The water activated inflator provides proper timing of the inflation shortly after impact independent of the height of the air plane at the time instant the water activated inflatable device is dropped substantially increasing the likelihood of proper placement of the inflatable device in a target zone as well as substantially increasing safety of the rescue personnel in the airplane. Since most rescue operations have to be executed under severe weather conditions, employment of prior art rescue kits using, for example, timing devices, either puts the lives of the rescue personnel in the airplane at risk by requiring the pilot to fly the airplane at dangerous heights – below or within a cloud cover for example – for dropping the rescue kit at a given height or substantially reducing the likelihood of proper deployment of the rescue kit by dropping it from a height considered safe by the pilot. Employment of the method of air deployment according to the invention overcomes this dilemma by enabling dropping of the rescue kit from an arbitrary safe height for the airplane and still providing proper deployment and inflation of the life raft.

[0028] Executing numerous drop tests, it has been found that the method for air deployment according to the invention ensures a nearly 100% success rate for proper deployment and inflation of the inflatable device. The likelihood of inflation of the life raft upside down has been substantially reduced despite the fact that after impact the rescue kit is immersed in water and then bopping prior inflation.

[0029] Numerous other embodiments of the invention will be apparent to persons skilled in the art without departing from the spirit and scope of the invention as defined in the appended claims.

Claims

What is claimed is:

1. A water activated inflator comprising:
a housing (102) having a connecting mechanism (104) for mating with a neck of a gas cylinder;
a gas cylinder opening device (106) for opening a sealing mechanism of the gas cylinder, the gas cylinder opening device (106) being disposed in the housing (102) movable along a first axis (108) having a first orientation between a cocked position and a fired position;
a tension mechanism (110) in mechanical communication with the housing (102) and the gas cylinder opening device (106) for providing tension acting along the first axis (108) for moving the gas cylinder opening device (106) from the cocked position to the fired position;
a plunger (120) for holding the gas cylinder opening device (106) in the cocked position, the plunger (120) being disposed in the housing (102) movable along a second axis (122) having a different second orientation between a first position and a second position;
a water soluble element (124) for holding the plunger (120) in the first position through mechanical communication along the second axis (122) with the plunger (120) and the housing (102);
a conduit (128) for providing water to the water soluble element (124);
a first interacting element (132) in mechanical communication with the gas cylinder opening device (106) having a first interacting surface (130), wherein at least a portion of the first interacting surface (130) is disposed at a predetermined angle other than 90 or 180 degrees to the first axis; and,
a second interacting element (136) in mechanical communication with the plunger (120) having a second interacting surface (134) for interacting with the first interacting surface (130) at the predetermined angle when the plunger (120) is in the first position for holding the gas cylinder opening device (106) in the cocked position, wherein the predetermined angle is determined such that a component along the second axis (122) of a component of the tension acting onto the second interacting surface (134) is within

a predetermined range for ensuring structural integrity of the water soluble element (124) in the cocked position and for ensuring movement of the plunger (120) when at least a portion of the water soluble element (124) is dissolved.

2. A water activated inflator as defined in claim 1 characterized in that the second axis (122) is oriented substantially perpendicular to the first axis (108).

3. A water activated inflator as defined in any of claims 1 and 2 characterized in that the first interacting element (132) comprises a frusto cone.

4. A water activated inflator as defined in any of claims 1 to 3 characterized in that the second interacting element (136) comprises a half sphere.

5. A water activated inflator as defined in any of claims 1 to 4 characterized in that the tension mechanism (110) comprises a compression spring.

6. A water activated inflator as defined in any of claims 1 to 5 characterized in that the gas cylinder opening device (106) comprises a cable for being attached to the sealing mechanism of the gas cylinder.

7. A water activated inflator as defined in any of claims 5 and 6 comprising a tube (118) affixed to the housing (102) along the first axis (108) for accommodating the compression spring.

8. A water activated inflator as defined in any of claims 1 to 7 comprising a plug (126) for holding the plunger (120) and the water soluble element (124) in the first position.

9. A water activated inflator as defined in claim 8 characterized in that the plug (126) is screwed into a threaded bore of the housing (102) along the second axis (122).

10. A water activated inflator as defined in any of claims 8 and 9 characterized in that the plug (126) comprises the conduit (128).

11. A water activated inflator as defined in any of claims 1 to 10 comprising a safety pin (140) in mechanical communication with the plunger (120) and the housing (102) for locking the plunger (120) in the first position.

12. A water activated inflatable device comprising:
an inflatable device body (204, 304);
a gas cylinder (206, 306) in fluid communication with the inflatable device body (204, 304); and,
a water activated inflator (100) comprising:
a housing (102) having a connecting mechanism (104) mated with a neck of the gas cylinder (206, 306);
a gas cylinder opening device (106) for opening a sealing mechanism of the gas cylinder (206, 306), the gas cylinder opening device (106) being disposed in the housing (102) movable along a first axis (108) having a first orientation between a cocked position and a fired position;
a tension mechanism (110) in mechanical communication with the housing (102) and the gas cylinder opening device (106) for providing tension acting along the first axis (108) for moving the gas cylinder opening device (106) from the cocked position to the fired position;
a plunger (120) for holding the gas cylinder opening device (106) in the cocked position, the plunger (120) being disposed in the housing (102) movable along a second axis (122) having a different second orientation between a first position and a second position;
a water soluble element (124) for holding the plunger (120) in the first position through mechanical communication along the second axis (122) with the plunger (120) and the housing (102);
a conduit (128) for providing water to the water soluble element (124);
a first interacting element (132) in mechanical communication with the gas cylinder opening device (106) having a first interacting surface (130), wherein at least a portion of the first interacting surface (130) is disposed at a predetermined angle other than 0 or 90 degrees to the first axis (108); and,

a second interacting element (136) in mechanical communication with the plunger (120) having a second interacting surface (134) for interacting with the first interacting surface (130) at the predetermined angle when the plunger (120) is in the first position for holding the gas cylinder opening device (106) in the cocked position, wherein the predetermined angle is determined such that a component along the second axis (122) of a component of the tension acting onto the second interacting surface (134) is within a predetermined range for ensuring structural integrity of the water soluble element (124) in the cocked position and for ensuring movement of the plunger (120) when at least a portion of the water soluble element (124) is dissolved.

13. A water activated inflatable device as defined in claim 12 comprising a safety pin (140) in mechanical communication with the plunger (120) and the housing (102) for locking the plunger (120) in the first position.

14. A water activated inflatable device as defined in claim 13 comprising a pull cord (210, 310) affixed to the safety pin (140) at a first end and for being affixed to a vessel carrying the inflatable device at a second end, the pull cord (210, 310) for removing the safety pin (140) after dropping of the inflatable device from the vessel.

15. A method of air deployment of a water activated inflatable device comprising:
dropping from an airplane over a body of water a deployment container (302) comprising an inflatable device body (304), a gas cylinder (306) in fluid communication with the inflatable device body (304) and a water activated inflator (312) mated to a neck of the gas cylinder (306);
deploying a parachute (314) attached to the deployment container (302) for aerodynamically braking the descent of the deployment container (302) and for ensuring a predetermined orientation of the deployment container (302) at impact on the body of water;
activating the water activated inflator (312) through contact with water after impact of the deployment container (302) on the body of water;
using the water activated inflator (312) opening a sealing mechanism of the gas cylinder (306); and,

inflating the inflatable device body (304).

16. A method of air deployment of a water activated inflatable device as defined in claim 15 characterized in that the parachute (314) is deployed through pull cord action using a pull cord (316) affixed to the airplane after dropping the deployment container (302) from the airplane.

17. A method of air deployment of a water activated inflatable device as defined in claim 16 comprising:
removing after dropping the deployment container (302) from the airplane through pull cord action using a pull cord (310) affixed to the airplane a safety pin locking the inflator in a cocked position.

18. A method of air deployment of a water activated inflatable device as defined in any of claims 15 to 17 comprising:
using the water activated inflator (312) releasing an opening mechanism of the deployment container (302).

19. A water activated inflatable device for air deployment over a body of water comprising:
an inflatable device body (304);
a gas cylinder (306) in fluid communication with the inflatable device body (304);
a water activated inflator (312) mated to a neck of the gas cylinder (306);
a deployment container (302) containing the inflatable device body (304), the gas cylinder (306) and the water activated inflator (312), the deployment container (302) comprising a conduit (308) for enabling provision of water to the water activated inflator (312) after impact of the deployment container (302) on the body of water; and,
a parachute (314) attached to the deployment container (302) for aerodynamically braking the descent of the deployment container (302) and for ensuring a predetermined orientation of the deployment container (302) at impact on the body of water.

20. A water activated inflatable device for air deployment over a body of water as defined in claim 19 comprising a safety pin for locking the inflator (312) in a cocked position.

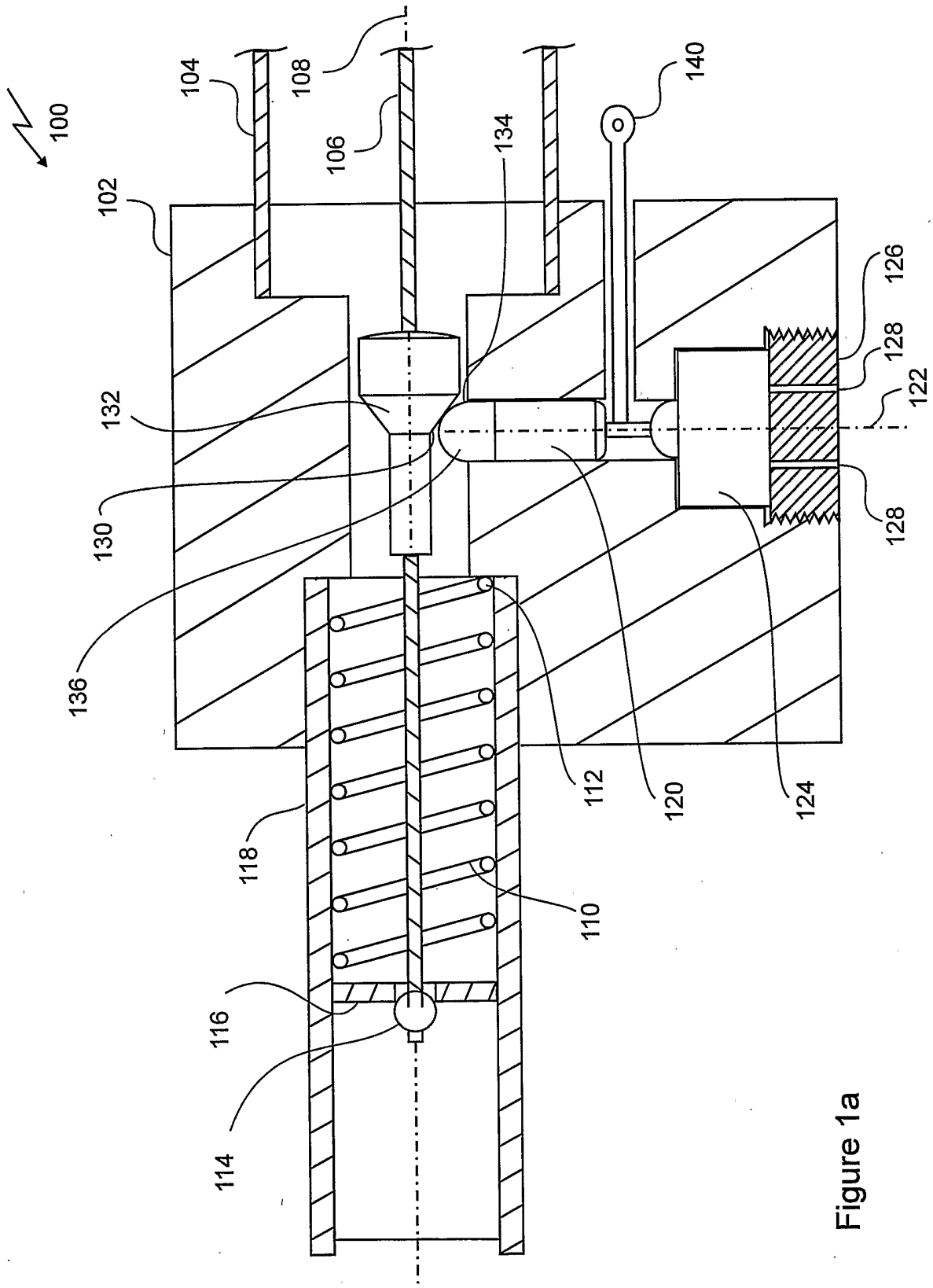
21. A water activated inflatable device for air deployment over a body of water as defined in claim 20 comprising a pull cord (310) affixed to the safety pin at a first end and for being affixed at a second end to an airplane carrying the inflatable device, the pull cord (310) for removing the safety pin after dropping of the inflatable device from the airplane.

22. A water activated inflatable device for air deployment over a body of water as defined in any of claims 19 to 21 comprising a pull cord (316) affixed to the parachute (314) at a first end and for being affixed at a second end to an airplane carrying the inflatable device, the pull cord for deploying the parachute (314) after dropping of the inflatable device from the airplane.

23. A water activated inflatable device for air deployment over a body of water as defined in any of claims 19 to 22 characterized in that the inflator (312) comprises a cable attached to a sealing mechanism of the gas cylinder (306).

24. A water activated inflatable device for air deployment over a body of water as defined in any of claims 19 to 23 comprising a release mechanism operated by the inflator (312) for opening the deployment container (302).

25. A water activated inflatable device for air deployment over a body of water as defined in any of claims 19 to 24 characterized in that components within the deployment container (302) are distributed such that after impact of the deployment container (302) on the body of water a center of gravity of the deployment container (302) and the components is located below a center of buoyancy of a portion of the deployment container immersed in the body of water.


100
102
104
106
108
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112
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116
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120
122
124
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130
132
134
136
140

Figure 1a

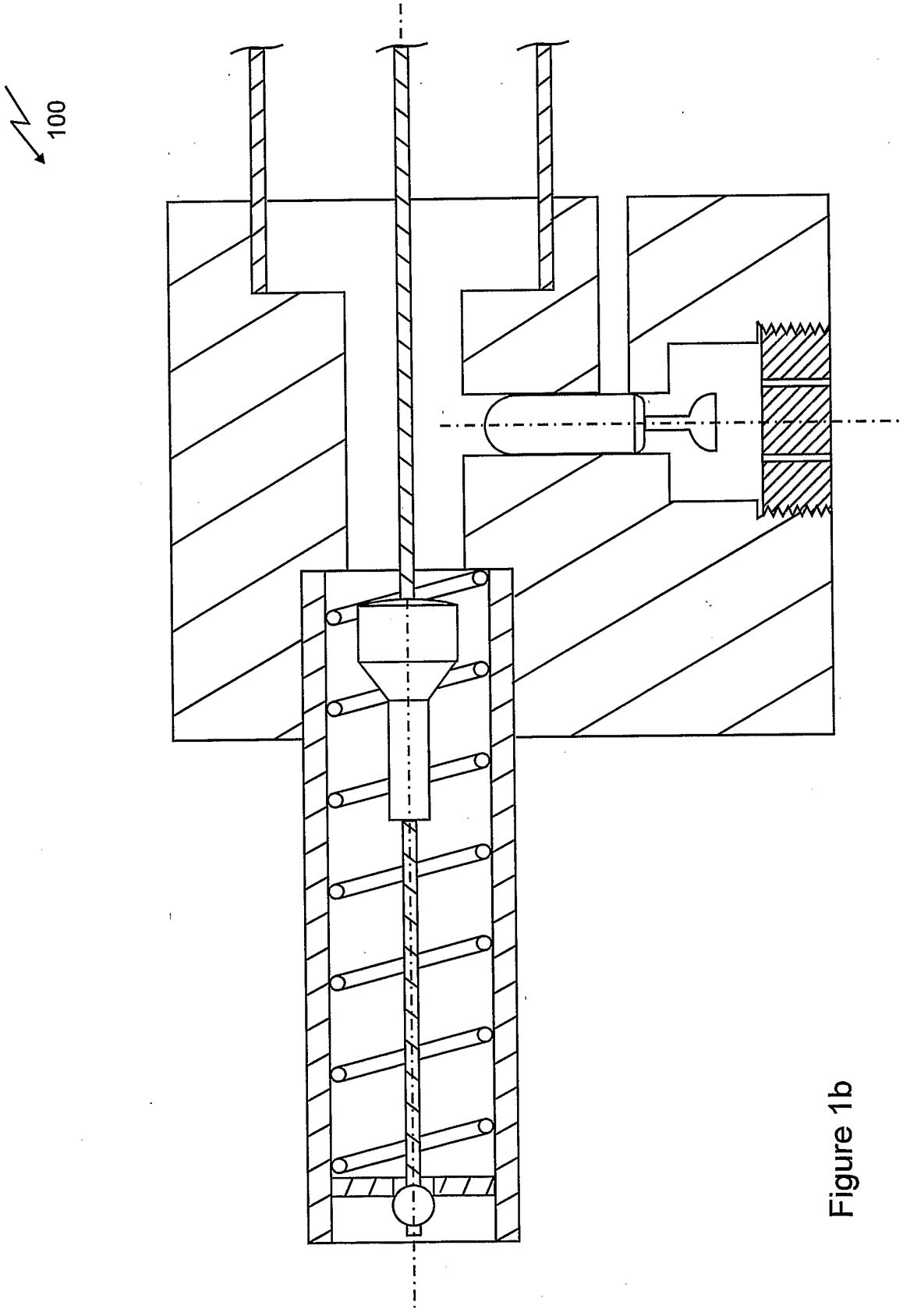

Figure 1b

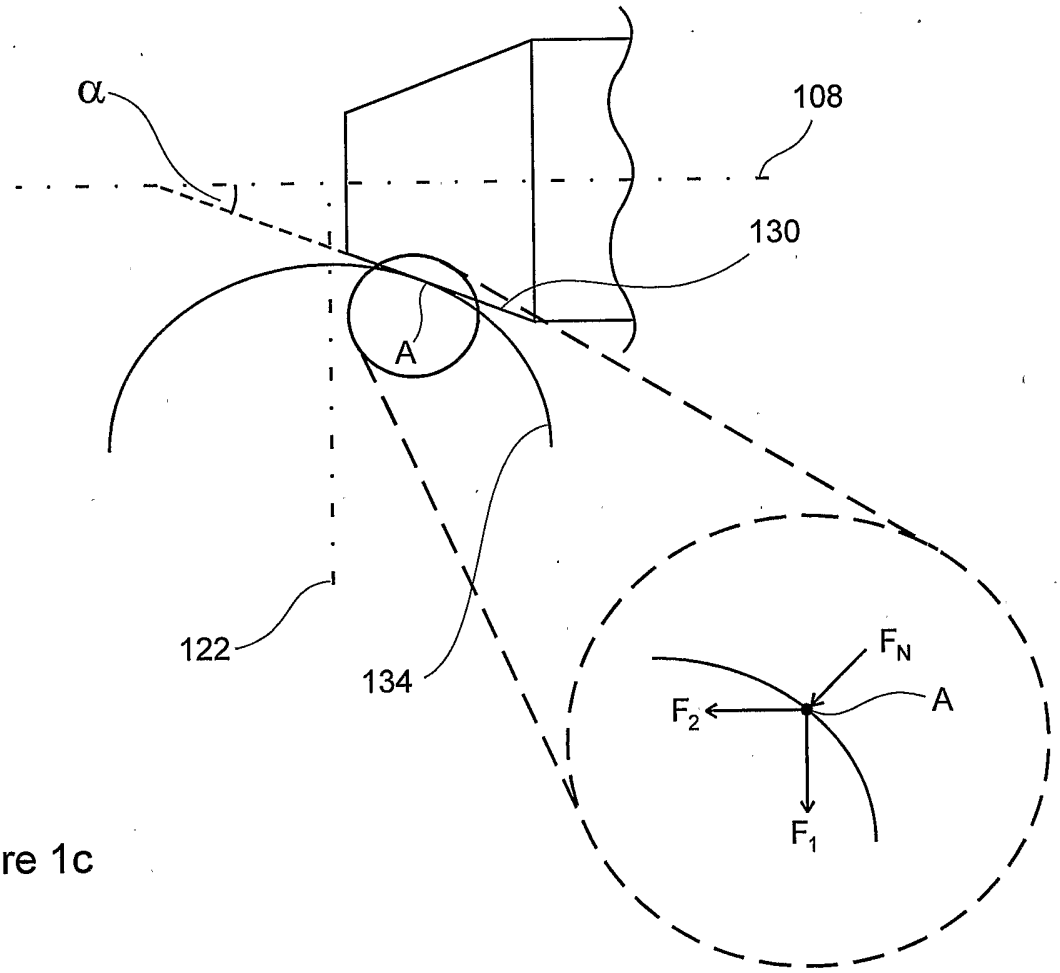

Figure 1c

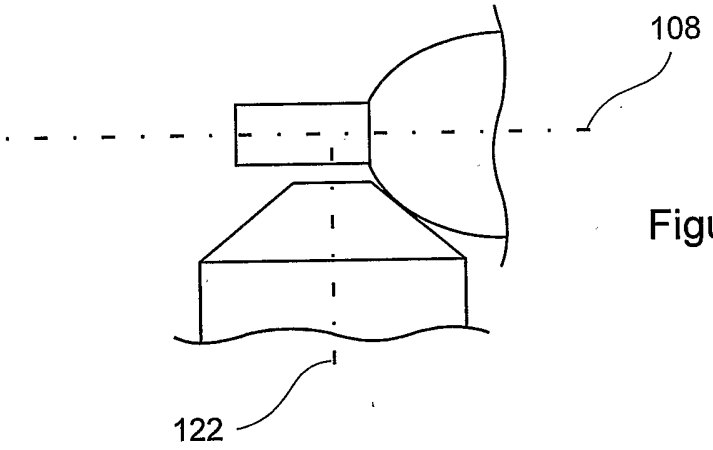

Figure 2a

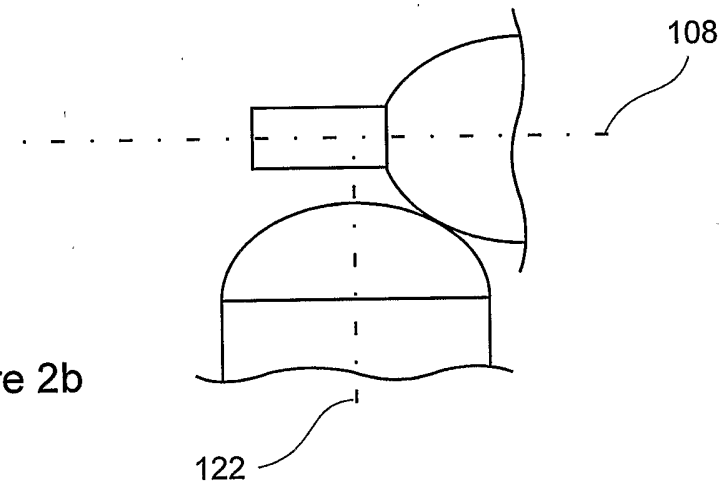

Figure 2b

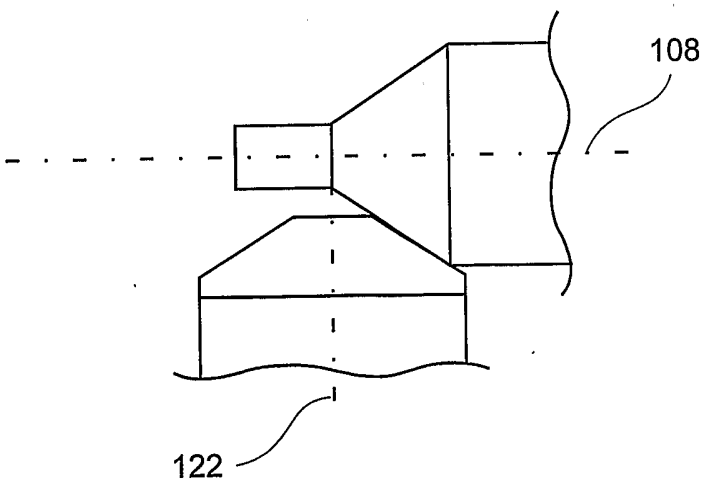

Figure 2c

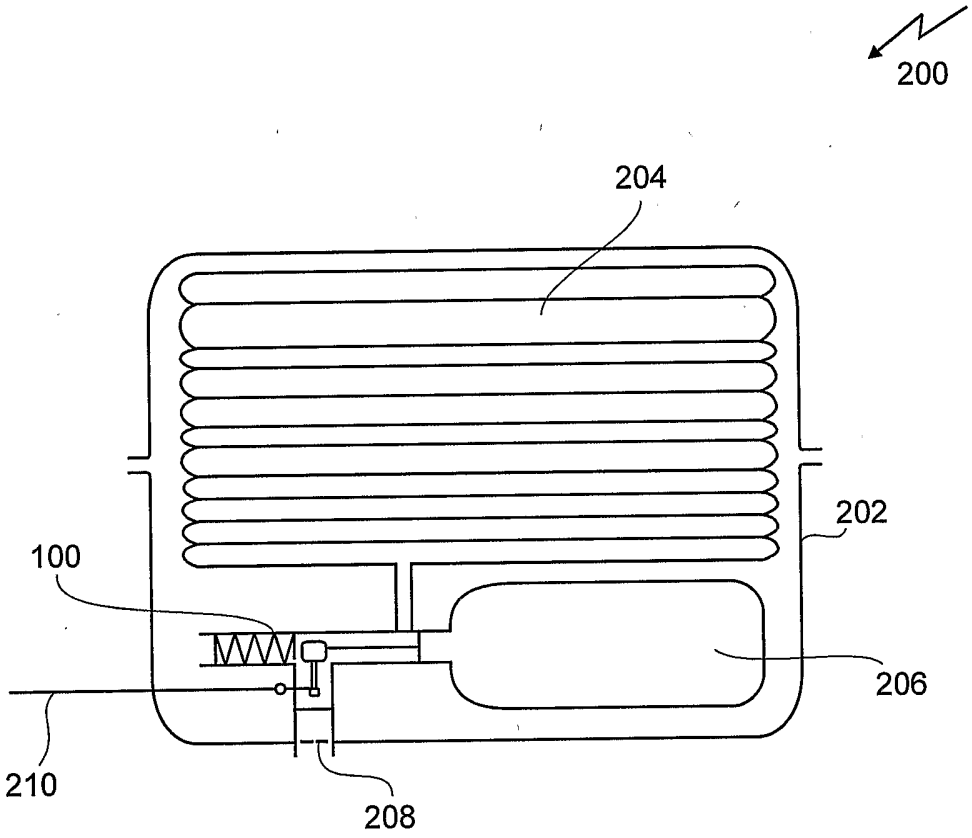

Figure 3

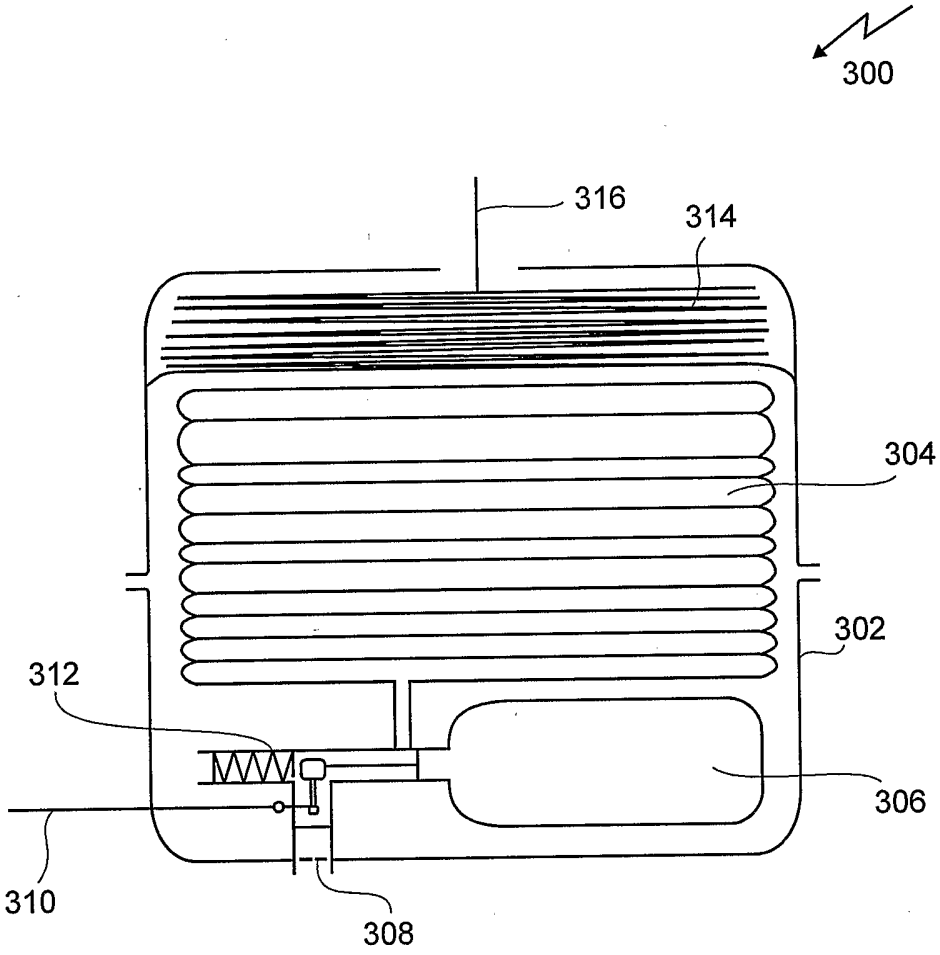

Figure 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2005/000638

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7): B63C 9/01, B63B 7/08, B63B 22/22, B64D 25/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC7: B63C 9/01, B63B 7/08, B63B 22/22, B64D 25/00 USPC: 441/*
CPC: 114/15, 114/58.9, 244/89, 244/110, 244/112, 254/1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Delphion, USPTO, Canadian Patent Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 223 805 A (MACKAL) 23 September 1980 (23-09-1980) *entire document*	15, 16, 19, 22, 24
A		1, 4, 8-10, 12
Y	US 3 997 079 A (NIEMANN) 14 December 1976 (14-12-1976) *entire document*	15, 16, 19, 22, 24
A		1, 5, 7, 12
Y	US 4 267 944 A (MACKAL) 19 May 1981 (19-05-1981) *entire document*	15, 16, 19, 22, 24
A		1, 5, 7, 12
Y	US 5 370 567 A (GLASA) 6 December 1994 (06-12-1984) *entire document*	15, 16, 19, 22, 24
A		1, 5, 7, 8, 12

[x] Further documents are listed in the continuation of Box C. [x] See patent family annex.

* Special categories of cited documents :
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 June 2005 (30-06-2005)	09 August 2005 (09-08-2005)

Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
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50 Victoria Street
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Authorized officer
Hillary Morrow (819) 953-0576

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2005/000638

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons :

1. [ ] Claim Nos. :
because they relate to subject matter not required to be searched by this Authority, namely :

2. [ ] Claim Nos. :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically :

3. [ ] Claim Nos. :
because they are dependant claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows :

Group A: Claims 1-11 are directed to a water activated inflator
Group B: Claims 12-14 are directed to a water activated inflatable device including a water activated inflator
Group C: Claims 15-25 are directed to a method of air deployment of a water activated inflatable device

Groups A and B may be included in the same application.

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [x] As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claim Nos. :

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim Nos. :

Remark on Protest
[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 627 823 A (MACKAL) 9 December 1986 (09-12-1986) *entire document*	15, 16, 19, 22, 24
A		1, 5, 7, 12
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A		1, 12
Y	US 4 639 229 A (WRIGHT et al.) 27 January 1987 (27-01-1987) *entire document*	15, 16, 19, 22, 24
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/CA2005/000638

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