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1 Attorney Docket No. 83901

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3 LOW-POWER GAS CARTRIDGE ACTUATION SYSTEM
4

5 STATEMENT OF GOVERNMENT INTEREST

6 The invention described herein may be manufactured and used
7 by or for the Government of the United States of America for
8 governmental purposes without the payment of any royalties thereon
9 or therefor.
10

11 BACKGROUND OF THE INVENTION

12 (1) Field of the Invention

13 The present invention relates generally to systems for
14 actuating gas cartridges, and more particularly to a gas cartridge
15 actuation system that requires very little electrical power.

16 (2) Description of the Prior Art

17 Currently, torpedoes and other vehicles launched from a
18 surface vessel utilize the vessel's high pressure air for the
19 launching energy source and for disabling the weapon securing
20 mechanism just prior to launch. More recently, development
21 efforts have focused on eliminating the use of the vessel's high
22 pressure air for these functions. Specifically, automotive airbag
23 inflator systems have been selected to provide the launch energy
24 source while gas cartridges have been selected to provide the
25 energy to disable the weapon securing mechanism just prior to
26 launch.

1 With respect to the use of gas cartridges, for safety reasons
2 it is desirable to open such a gas cartridge remotely, i.e.,
3 puncture a sealed end of the gas cartridge as is known in the art.
4 To do this, development efforts have focused on using a solenoid-
5 driven puncturing device that can be remotely actuated to puncture
6 a gas cartridge's sealed end. Unfortunately, the amount of force
7 required to puncture a standard gas cartridge is fairly
8 substantial (e.g., generally in excess of 50 pounds of force).
9 Commercially-available solenoid-driven puncture systems capable of
10 delivering the requisite amount of force also require a
11 substantial amount of electrical power (i.e., on the order of
12 several thousand watts). However, many surface vessels have power
13 availability that is only on the order of 100-200 watts.

14

15 SUMMARY OF THE INVENTION

16 Accordingly, it is an object of the present invention to
17 provide a low-power gas cartridge actuator system.

18 Other objects and advantages of the present invention will
19 become more obvious hereinafter in the specification and drawings.

20 In accordance with the present invention, a low-power gas
21 cartridge actuation system includes a housing adapted to hold a
22 gas cartridge with a sealed end thereof being in fluid
23 communication with a chamber within the housing. The housing
24 further defines a cylinder aligned with the sealed end of the gas
25 cartridge with the cylinder also being in fluid communication with
26 the chamber. A piston, disposed in the cylinder, has a puncture
27 pin coupled to a first end thereof opposing the sealed end of the

1 gas cartridge. A spring assembly, coupled to a second end of the
2 piston that is in axial opposition to its first end, supplies an
3 axial spring force to the piston such that the first end is biased
4 to move towards the sealed end of the gas cartridge. A solenoid
5 assembly including a retractable pin has (i) a non-actuated state
6 defined as the retractable pin being in engagement with the spring
7 assembly to keep the puncture pin spaced apart from the sealed end
8 of the gas cartridge, and (ii) an actuated state defined as the
9 retractable pin being withdrawn from engagement with the spring
10 assembly so that the piston experiences a sliding movement in the
11 cylinder as driven by the axial spring force. The puncture pin
12 punctures the sealed end of the gas cartridge to release gas
13 stored therein into the chamber. The piston's sliding movement is
14 arrested when the puncture pin has punctured a sealed end.

16 BRIEF DESCRIPTION OF THE DRAWINGS

17 Other objects, features and advantages of the present
18 invention will become apparent upon reference to the following
19 description of the preferred embodiments and to the drawings,
20 wherein corresponding reference characters indicate corresponding
21 parts throughout the several views of the drawings and wherein:

22 FIG. 1 is a part schematic, part cross-sectional view of a
23 low-power gas cartridge actuation system prior to the activation
24 thereof according to an embodiment of the present invention;

25 FIG. 2 is an enlarged view of a portion of the system
26 illustrated in FIG. 1;

1 FIG. 3 is a part schematic, part cross-sectional view of the
2 gas cartridge actuation system of FIG. 1 subsequent to activation
3 thereof; and

4 FIG. 4 is a top cross-sectional view of a low-power multiple
5 gas cartridge actuation system prior to the activation thereof.

6
7 DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

8 Referring now to the drawings, simultaneous reference will be
9 made to FIGs. 1-3 where an embodiment of a low-power gas cartridge
10 actuation system is shown and is referenced generally by numeral
11 10. FIG. 1 illustrates system 10 prior to gas cartridge
12 actuation, FIG. 2 is an enlarged view of a portion of the system
13 illustrated in FIG. 1, and FIG. 3 illustrates system 10 after gas
14 cartridge actuation. System 10 is designed to work with a
15 conventional gas cartridge 100. By way of illustrative example,
16 system 10 will be explained for use with a single gas cartridge
17 100. However, the present invention is not so limited as the
18 present invention can be used to actuate multiple gas cartridges
19 as will be explained further below.

20 Gas cartridge actuation system 10 has a housing 12 designed
21 to receive and support gas cartridge 100 such that the penetrable
22 sealed end 100A of gas cartridge 100 is in communication with a
23 chamber 12A defined by housing 12. Housing 12 should form an
24 airtight seal with gas cartridge 100. In this way, when sealed
25 end 100A is punctured, gas from cartridge 100 enters chamber 12A.

26 A piston cylinder 14 formed by housing 12 is contiguous with
27 chamber 12A or can be used, in part, to define chamber 12A.

1 Piston cylinder 14 has a longitudinal axis 16 aligned with sealed
2 end 100A of gas cartridge 100. In the illustrated embodiment,
3 piston cylinder 14 is defined by a (i) first cylinder portion 14A
4 adjacent or contiguous with chamber 12A, and (ii) a second
5 cylinder portion 14B adjacent first cylinder portion 14A. The
6 diameter of second cylinder portion 14B is greater than that of
7 first cylinder portion 14A so that an annular shoulder 14C is
8 formed by the interface between portions 14A and 14B.

9 A piston 18 is disposed in piston cylinder 14 and is
10 configured for axial sliding movement therein. More specifically,
11 piston 18 has (i) a first piston portion 18A disposed partially in
12 first cylinder portion 14A and partially in second cylinder
13 portion 14B, and (ii) a second piston portion 18B slidably
14 disposed and fit in second cylinder portion 14B. As a result,
15 second piston portion 18B has a larger diameter than first piston
16 portion 18A so that second piston portion 18B essentially defines
17 an annular flange 18C that opposes annular shoulder 14C. An o-
18 ring 20 would typically be disposed about first piston portion
19 18A.

20 A puncture pin 22 is coupled to the outboard end of first
21 piston portion 18A and extends axially therefrom. As best seen in
22 FIG. 2, puncture pin 22 is defined by an outboard tip 22A and a
23 shaft 22B coupled to first piston portion 18A. For reasons that
24 will become clearer below, tip 22A and shaft 22B will differ in
25 axial cross-sectional shape and/or area.

26 Coupled to second piston portion 18B is a spring assembly 24
27 for applying a spring force to piston 18 along longitudinal axis

1 16 so that piston 18 is biased towards sealed end 100A of gas
2 cartridge 100. It is to be understood that the particular
3 construction of spring assembly 24 is not a limitation of the
4 present invention. Accordingly, the illustrated construction of
5 spring assembly is provided by way of example only. Spring
6 assembly 24 includes a housing 24A coupled to housing 12 and a
7 spring 24B seated in and against housing 24A and against piston
8 18. Spring 24B is selected such that it can provide a spring
9 force to piston 18 that is sufficient to drive piston 18/puncture
10 pin 22 so that pin 22 punctures sealed end 100A at the time of
11 actuation as will be explained further below.

12 Prior to actuation (FIGs. 1 and 2), piston 18 is positioned
13 such that annular shoulder 14C and annular flange 18C are spaced
14 apart from one another by an axial distance L. By doing so, an
15 annular notch 26 is defined between piston 18 and housing 12.
16 Axial distance L should be such that tip 22A of puncture pin 22 is
17 spaced apart from sealed end 100A by an axial distance D that is
18 less than axial distance L. In addition, puncture pin 22 should
19 be configured such that axial distance L also defines a distance
20 from the outboard end of tip 22A to a position along shaft 22B.

21 To retain piston 18 in its pre-actuation state, a retaining
22 block or pin 30 extends through housing 12 and transverse to
23 piston 18 to engage a portion of notch 26, as shown. A solenoid
24 actuator 32 coupled to pin 30 is capable of retracting pin 30 from
25 its engaged position shown in FIGs. 1 and 2. The disengagement
26 force required to be applied to pin 30 is, in general,
27 substantially less than the force being supplied by spring 24B.

1 Therefore, a low-power solenoid actuator 32 can be used while the
2 stronger cartridge puncturing force is supplied by non-powered
3 spring 24B.

4 When gas cartridge 100 is to be punctured/actuated, solenoid
5 actuator 32 is activated so that pin 30 is retracted/disengaged
6 from notch 26 as illustrated in FIG. 3. Once pin 30 has been
7 disengaged from notch 26, spring 24B is free to act on piston 18
8 to drive piston 18 towards sealed end 100A. Under the force of
9 spring 24B, piston 18 along with tip 22A travels axial distance L
10 at which point contact between annular shoulder 14C and annular
11 flange 18C arrests movement of piston 18 and tip 22A. Since tip
12 22A was separated from sealed end 100A by axial distance D that is
13 less than axial distance L, movement of tip 22A by axial distance
14 L causes tip 22A to puncture sealed end 100A. Further, because of
15 the configuration of puncture pin 22, shaft 22B extends through
16 and resides in the now-punctured sealed end 100A when annular
17 shoulder 14C and annular flange 18C abut as illustrated in FIG. 3.

18 As mentioned above, tip 22A and shaft 22B differ in axial
19 cross-section. In general, these differing axial cross-sections
20 provide gaps around shaft 22B so that the pressurized gas content
21 of gas cartridge 100 is released around shaft 22B and into chamber
22 12A. For example, tip 22A could be triangular in cross-section
23 while shaft 22B could be circular in cross-section and sized to
24 fit within the triangular cross-section of tip 22A. The gas
25 escaping from cartridge 100 can be ported from chamber 12A via a
26 gas relief port 12B as indicated by arrow 40.

27 While piston 18 and piston cylinder 14 have been described as

1 being cylindrical, these could have cross-sections of any
2 complementary shape that allows piston 18 to slide within housing
3 12.

4 Although the present invention has been explained for use in
5 actuating a single gas cartridge, it is not so limited. That is,
6 multiple gas cartridges could be actuated using a single solenoid
7 actuator. For example, FIG. 4 illustrates a system for
8 simultaneously actuating two gas cartridges 100 where two of the
9 above-described systems 10 are incorporated into a single housing
10 12. In this example, a single bar or pin 30 is configured to
11 simultaneously engage a portion of corresponding annular notches
12 26 associated with each gas cartridge 100. When pin 30 is
13 disengaged by a solenoid actuator (identical to actuator 32 but
14 not visible in the FIG. 4 view), pin 30 is simultaneously
15 withdrawn from notches 26 so that springs 24B act on corresponding
16 pistons 18 as previously described.

17 The advantages of the present invention are numerous. A non-
18 powered, mechanical spring provides the necessary puncturing force
19 for actuating a gas cartridge while only a low-power solenoid is
20 required to release the spring. The solenoid allows the mechanism
21 to be operated remotely for purposes of safety.

22 It will be understood that many additional changes in the
23 details, materials, steps and arrangement of parts, which have
24 been herein described and illustrated in order to explain the
25 nature of the invention, may be made by those skilled in the art
26 within the principle and scope of the invention as expressed in
27 the appended claims.

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5 ABSTRACT OF THE DISCLOSURE

6 A low-power gas cartridge actuation system uses a mechanical
7 spring assembly to drive a piston disposed in a piston cylinder.
8 A puncture pin is coupled to one end of the piston opposing the
9 sealed end of a gas cartridge. A spring assembly, coupled to the
10 other end of the piston, supplies an axial spring force to the
11 piston such that it is biased to move towards the sealed end of
12 the gas cartridge. A low-power solenoid assembly including a
13 retractable pin has (i) a non-actuated state defined as the
14 retractable pin being in engagement with the spring assembly to
15 keep the puncture pin spaced apart from the sealed end of the gas
16 cartridge, and (ii) an actuated state defined as the retractable
17 pin being withdrawn from engagement with the spring assembly so
18 that the piston experiences a sliding movement in the cylinder as
19 driven by the axial spring force.

FIG. 1

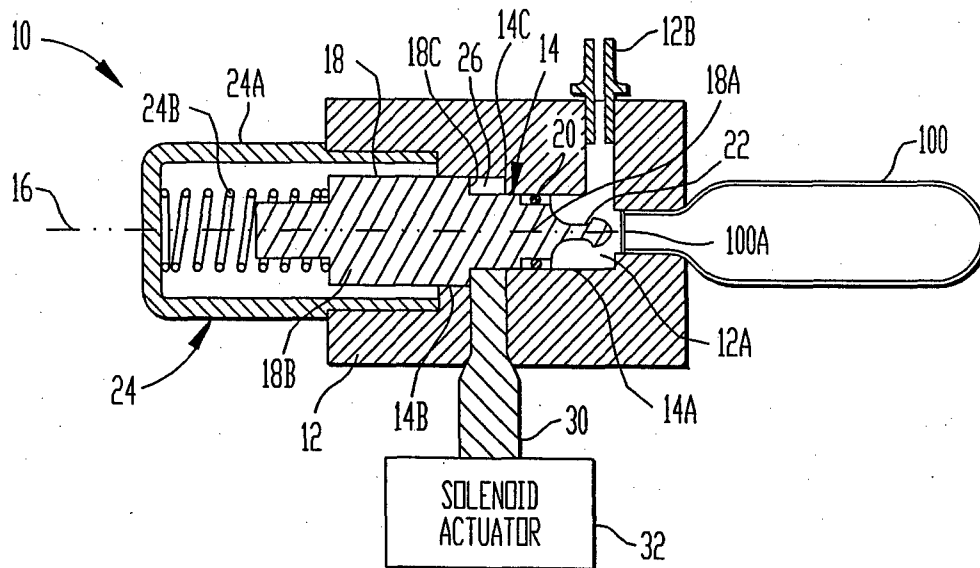


FIG. 2

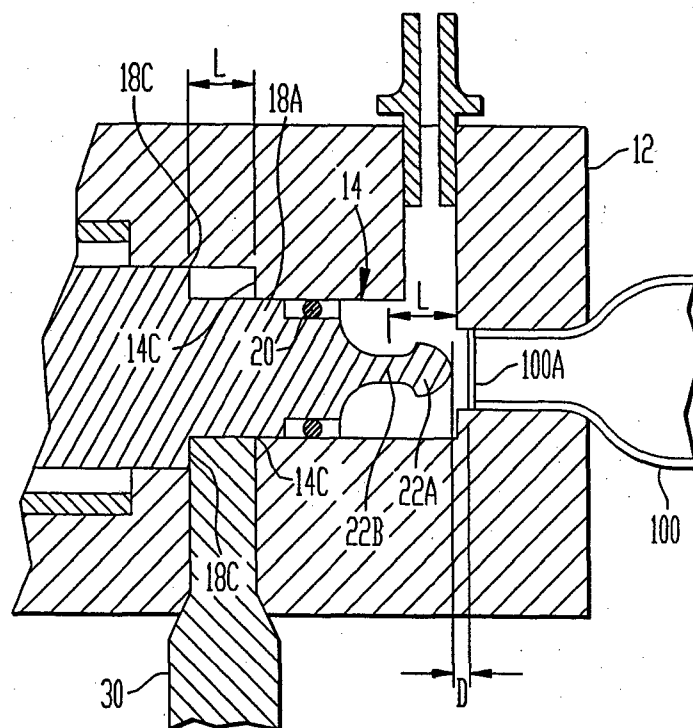


FIG. 3

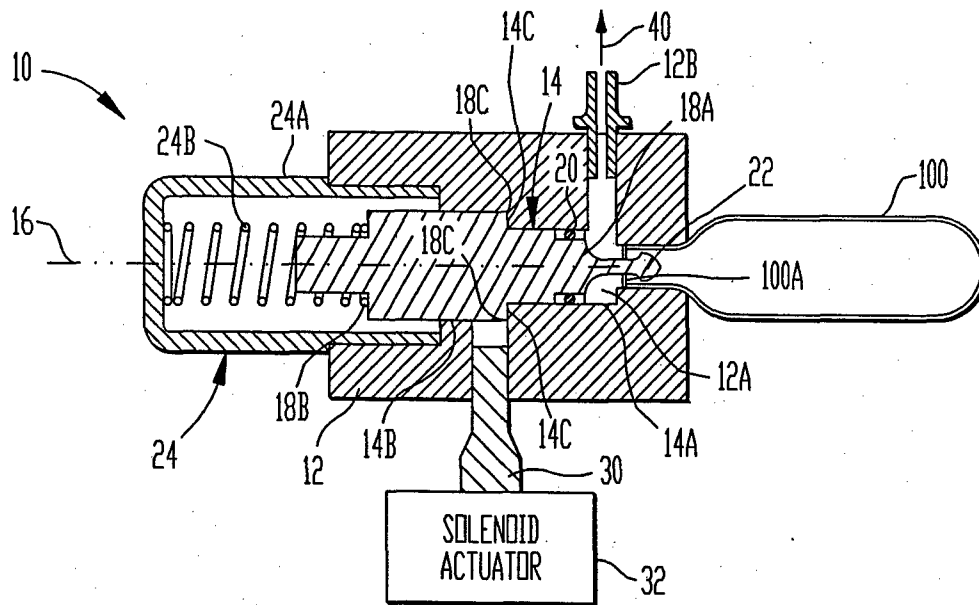


FIG. 4

