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[54] **GAS GENERATOR WITH LIQUID PHASE COOLING**

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[52] **U.S. Cl.** ..... **280/150 AB,** 23/281, 222/3, 222/386.5, 102/39

[51] **Int. Cl.** **B60r 21/08**

[58] **Field of Search** ..... 280/150 AB; 222/3, 386.5; 23/281, 282; 141/4

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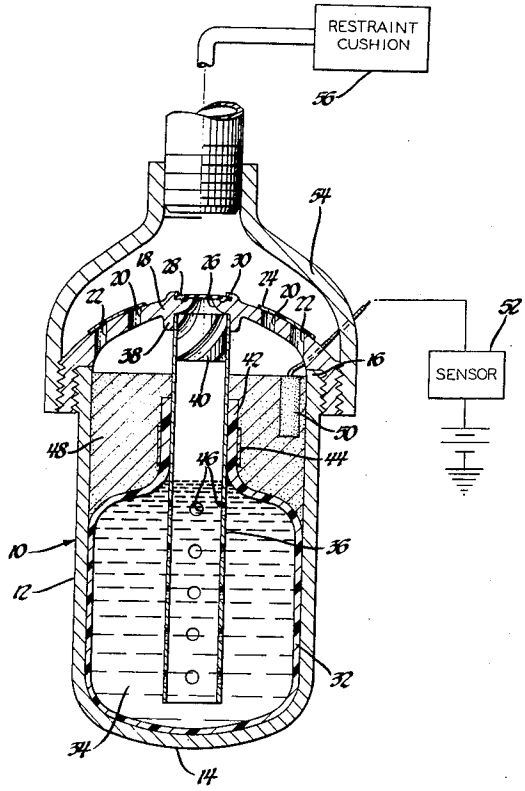
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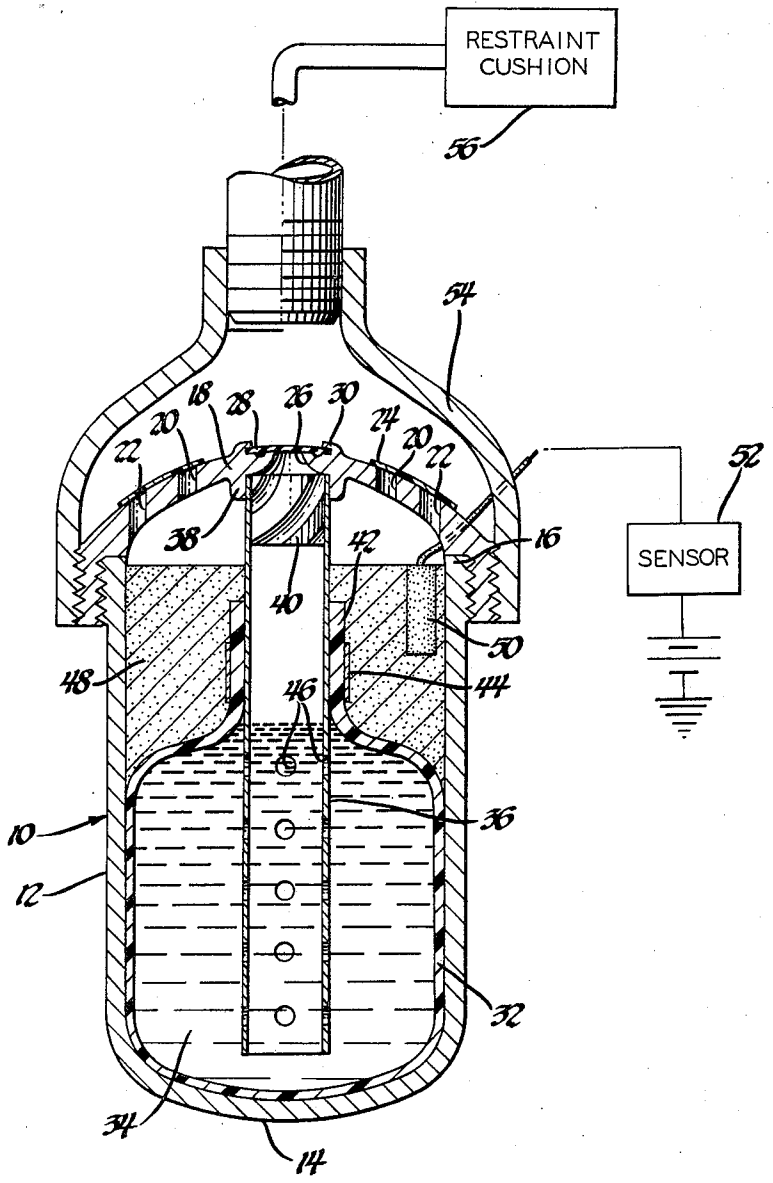
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[57] **ABSTRACT**

A cylindrical housing has one closed end wall and an opposite end wall provided with an atomizing nozzle and a pair of concentric rows of nozzles encircling the atomizing nozzle. A flexible container within the housing contains a mixture of water and ethyl alcohol. A conduit connects the atomizing nozzle and the container. A charge of propellant material is located within the housing. When the charge is ignited, the hot gases compress the container to force the liquid therein through the conduit and the atomizing nozzle to atomize the liquid. The droplets mix with the hot gases flowing through the concentric rows of nozzles to cool the gases as the gases flow to an inflatable occupant restraint cushion.

2 Claims, 1 Drawing Figure




RESTRAINT CUSHION
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SENSOR
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GAS GENERATOR WITH LIQUID PHASE COOLING

This invention relates to gas generators with liquid phase cooling and particularly to such gas generators intended primarily for use with inflatable occupant restraint cushions.

It is well known to use gas generators for inflation of inflatable occupant restraint cushions. Such gas generators contain a charge of propellant material which is ignitable to generate gases for inflating the cushion. Generally the charge of propellant material consists primarily of black powder although it may be admixed with other materials. The ignition of the gas generator is controlled by either inertia type or acceleration type sensors. The sensors are mounted on the vehicle and are actuated when impact of the vehicle with an obstacle generates an acceleration pulse of predetermined amplitude and time or the vehicle experiences a predetermined change of velocity.

The generated gases are of high pressure and high temperature. Since the gases inflate the occupant restraint cushion, it is well known to mix the propellant gases within the gas generator with either liquid materials or endothermic compounds in order to decrease the temperature of the gases so that the temperature of the cushion remains below a certain limit.

The gas generator of this invention uses liquid phase cooling to cool the high pressure, high temperature gases before the gases flow to the occupant restraint cushion. The mixing occurs exteriorly of the gas generator by the intermixing of the generated gas with atomized liquid. Since the droplets of liquid have a large surface-to-volume ratio, the evaporation rate is greatly increased when the droplets are mixed with the generated gases.

The evaporation rate is important since a high rate of heat transfer must occur between the generated gases and the liquid within a very short time period, such as 30 to 40 milliseconds.

One of the features of this invention is that it provides an improved gas generator with liquid phase cooling wherein high temperature, high pressure gases generated by the ignition of a charge of propellant material compress a flexible container containing liquid to force the liquid through an atomizing nozzle and mix the resultant droplets with the gases flowing from the generator to an inflatable occupant restraint cushion to thereby cool the gases. Another feature of this invention is that it provides such a gas generator wherein the atomizing nozzle is encircled by other nozzles through which the hot gases flow to the cushion to ensure a high degree of mixing between the droplets and the hot gases. A further feature of this invention is that the flexible container is axially remote from the atomizing nozzle and communicates with the nozzle through a conduit passing through the charge.

These and other features of the invention will be readily apparent from the following specification and drawing wherein:

The FIGURE is a sectional view of a gas generator according to this invention.

Refęrring now to the drawing, a gas generator designated generally **10** includes a cylindrical vessel or housing **12** having a closed dome type end wall **14.** The axial wall of housing **12** is externally threaded at **16,** and an

internally threaded cap or housing closure **18** is threaded thereto to close the housing.

The closure **18** includes first and second concentric rows of circumferentially spaced nozzles **20** and **22** which are shown as openings through the closure wall. The nozzles **20** and **22** may be arranged in any pattern, such as in radial alignment with each other or staggered with respect to each other. Any type of removable seal **24,** such as tape, normally covers the rows of nozzles. The closure **18** further includes a convergent type opening **26.** A suitable pressure rupturable seal **28,** such as one of rubber, as shown, or thin metal, closes the opening **26.** The seal is staked at **30** to the closure.

A flexible container **32** fits within the housing **12** and conforms to the axial wall thereof and the end wall **14** thereof. The container **32** may be made of any suitable material, such as neoprene type rubber, and is filled with liquid **34,** such as a mixture of ethyl alcohol and water.

A cylindrical tube or conduit **36** has the upper end thereof received within a cylindrical axial flange **38** of the closure **18.** A swirl nozzle **40** is received within the upper end of the conduit and cooperates with the convergent opening **26** to provide an atomizing nozzle. The neck or outlet **42** of the container **32** receives the conduit and is conventionally clamped thereto at **44** to provide a pressure seal between the container and the conduit. The conduit further includes a number of radial openings **46** which communicate the interior of the conduit with the container **32.** The lower end of the conduit opens to the container.

A charge **48** of propellant material, such as conventional black powder with other ingredients, is contained within the housing **12** between the flexible container **32** and the closure **18.** As shown, the charge annularly surrounds the neck **42** of the container and the tube **36.** A conventional igniter **50** is provided for igniting the charge. The igniter is conventionally connected across a sensor **52** and a source of power.

As is well known in the art of vehicle occupant restraint systems, the vehicle includes redundant inertial type sensors or acceleration sensors, or combinations of these, which sense impacts of the vehicle with an obstacle of a magnitude sufficient to generate acceleration pulses of predetermined amplitude and time or predetermined changes in vehicle velocity. When such pulses or changes occur, the sensors actuate the restraint system.

Assuming now that the sensor **52** is actuated due to impact of the vehicle with an obstacle, the charge **48** will be ignited by the igniter **50** to generate volume of high temperature, high pressure gas. The generated gas will flow through the nozzles **20** and **22** and into the schematically indicated manifold **54** which is threaded to closure **18.** The manifold conventionally communicates with the inflatable occupant restraint cushion **56.** The manifold and cushion are conventional and it is believed that the details thereof are known to those skilled in the art.

The generated gas will additionally act upon the flexible container **32** to compress or squeeze this container so that the liquid **34** will be forced through the openings **46** and the lower open end of the tube and upwardly of the tube. As the liquid is forced upwardly of the tube, it will flow through the swirl nozzle **40** and out through the opening and be atomized. The droplets will

mix with the hot gases passing through the nozzles **20** and **22** and be evaporated so as to cool the hot gases so that the temperature of the gases flowing to the cushion **56** through the manifold **54** will be below a preset maximum. The container **32** will be collapsed against the tube when all of the generated gas has flowed to the cushion.

Conventionally, the inflator **10** has a time budget of approximately 30 to 40 milliseconds in which to generate the volume of gas. Thus, heat transfer must take place at an extremely high rate in order for the generated gas to be cooled below a certain temperature before the gas inflates the cushion **56.** By forcing the liquid **34** through an atomizing nozzle to disperse the liquid into fine droplets, a large surface-to-volume ratio is obtained and this, of course, enhances the evaporation rate and likewise increases the temperature drop in the gases flowing through the nozzles **20** and **22.** By dispersing the liquid into fine droplets and by mixing the droplets with the hot gases exteriorly of the gas generator, the gas generator of this invention reduces the temperature of the gas to that desired prior to the time that the gas flows to the cushion **56.**

Thus, this invention provides an improved gas generator with liquid phase cooling.

I claim:

1. A gas generator comprising, in combination, a generally cylindrical housing having end walls, one being provided with an axially located first atomizing nozzle means and an encircling series of radially spaced second nozzle means, a flexible container containing atomizable liquid and located within the housing adjacent the other end wall, conduit means extending axially of the housing from within the container to the first nozzle means, an ignitable charge surrounding the conduit means and located adjacent the one end wall in communication with the second nozzle means, ignition of the charge generating high pressure, high temperature gas within the housing, the gas providing an axial compressing force on the flexible container to force the liquid therein through the conduit means and the first nozzle means and atomize the liquid in droplets, the droplets mixing with the generated gas flowing through the second nozzle means to cool the gas, and means communicating the first and second nozzle means with an inflatable occupant restraint cushion.

2. A gas generator comprising, in combination, a generally cylindrical housing having end walls, one being provided with an axially located atomizing nozzle and an encircling series of radially spaced second nozzles, a flexible container containing atomizable liquid and located within the housing adjacent the other end wall, a conduit extending axially of the housing from within the container to the atomizing nozzle, means sealing the container to the conduit, an annular ignitable charge surrounding the conduit and sealing means and located adjacent the one end wall in communication with the second nozzles, ignition of the charge generating high pressure, high temperature gas within the housing, the gas providing an axial compressing force on the flexible container to force the liquid therein through the conduit and the atomizing the nozzle and atomize the liquid in droplets, the droplets mixing with the generated gas flowing through the second nozzles to cool the gas, and means communicating the atomizing nozzle and second nozzles with an inflatable occupant restraint cushion.

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