GENERATION OF GASEOUS MIXTURES FOR INFLATABLE DEVICES

Original Filed Nov. 3, 1961

Fig. 1

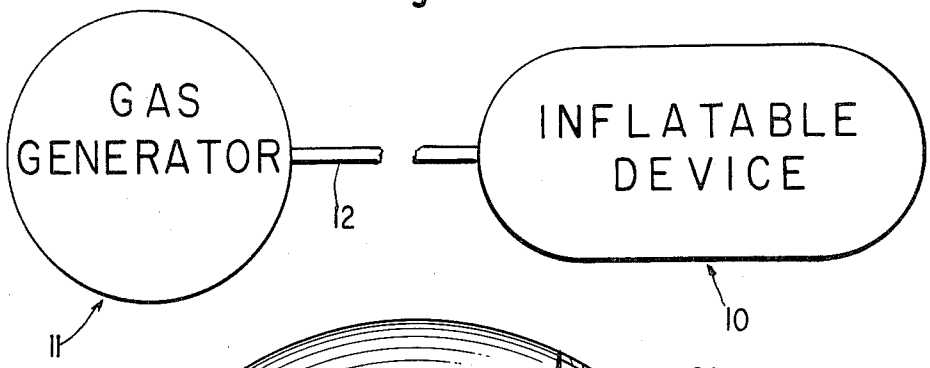
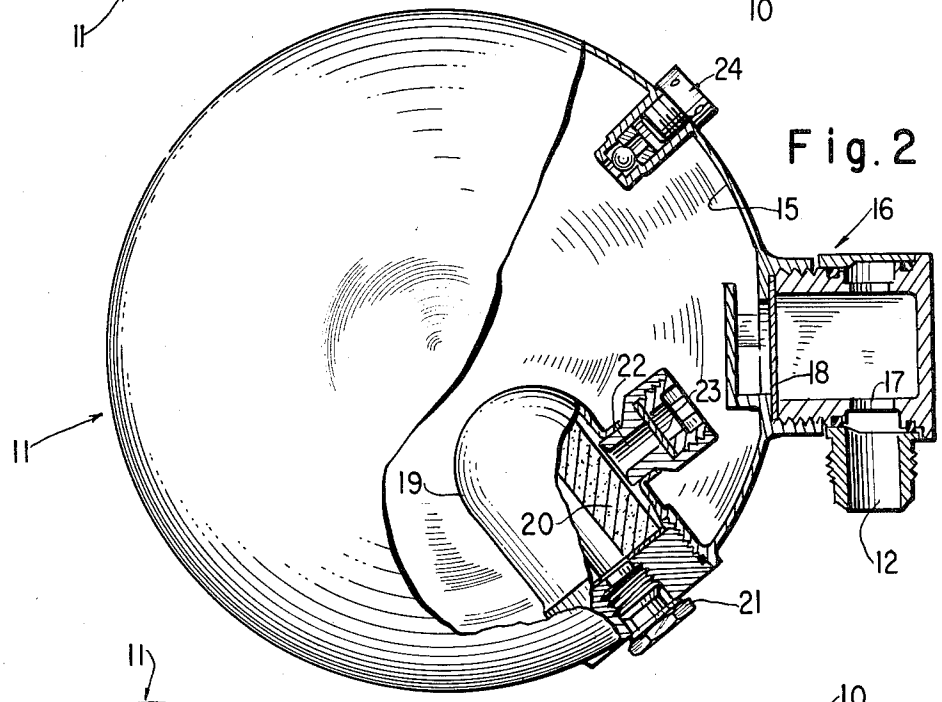


Fig. 2



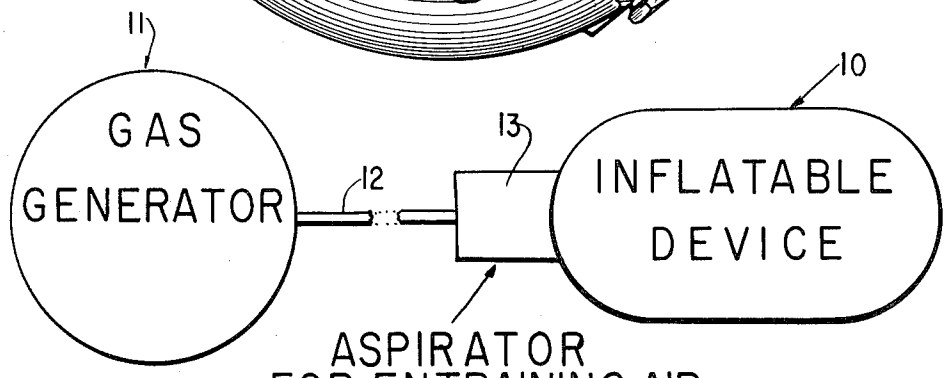


Fig. 3

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GENERATION OF GASEOUS MIXTURES FOR INFLATABLE DEVICES

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Original application Nov. 3, 1961, Ser. No. 149,895, now Patent No. 3,122,181, dated Feb. 25, 1964. Divided and this application Oct. 24, 1963, Ser. No. 318,718

4 Claims. (Cl. 149—1)

This application is a division of application Serial No. 149,895, filed November 3, 1961, now Patent 3,122,181, dated February 25, 1964, and relates to inflating inflatable devices, and, more particularly, to a charge for generating gaseous mixtures of carbon dioxide and combustion products of propellants suitable for inflating such devices.

Heretofore, various types of inflatable devices have been used extensively by the armed forces including landing pads for helicopters and flotation equipment such as rafts, boats, escape ladders and the like. For many years, liquefied carbon dioxide has been considered one of the best sources of pressure media for inflating such devices because of its high storage density, relatively low storage pressure, non-flammability and low toxicity, and because of its ability to be discharged at temperatures as low as —65° F. when confined in a container having a gas such as nitrogen added thereto.

However, when carbon dioxide, after being stored at a low temperature, is rapidly introduced into and is expanded in a relatively large inflatable bag or envelope, it produces carbon dioxide snow and cold carbon dioxide gas with the result that full inflation cannot be attained within the short period of time required in an emergency.

Accordingly, an object of the present invention is to provide a charge for rapidly inflating equipment with carbon dioxide which has been stored at low temperatures.

Another object is to provide such a charge which is suitable for a closed system or a system wherein ambient air is entrained.

Another object is to accomplish the foregoing in a simple, practical, reliable and economical manner.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

In accordance with the present invention, it has been discovered that the foregoing objects can be generally accomplished by mixing the hot gaseous combustion products of propellants such as burning powders with liquefied carbon dioxide, whereby the hot gases heat and gasify the carbon dioxide to attain a desired pressure and the subsequent expansion of the carbon dioxide produces a cooling effect which reduces the temperature of the hot gases so that the mixture is at a temperature which the inflatable equipment can withstand.

It is contemplated that the amount of heat to be produced for each pound of carbon dioxide at a given temperature can be predetermined for summertime or high ambient temperature operation (e.g. 20° F. to 125° F.) and for wintertime or low temperature operation (e.g. —20° F. to 80° F.), as will be explained hereinafter with reference to the specific examples of the present invention.

A preferred embodiment of apparatus for carrying out

the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawing, forming a part of the specification, wherein:

FIG. 1 is a schematic view of a closed system utilizing apparatus provided with a charge in accordance with the present invention for producing a gaseous mixture for inflating an inflatable device.

FIG. 2 is an enlarged longitudinal sectional view, partly in elevation, of the apparatus for producing the gaseous mixture.

FIG. 3 is a schematic view of a system utilizing the apparatus as shown in FIG. 2 wherein ambient air is entrained with the gaseous mixture.

Referring now to FIGS. 1 and 2 of the drawing in detail, a closed system is shown in FIG. 1 which comprises an inflatable device **10**, a gas generator **11**, and a conduit **12** for directly conducting a mixture of gases from the gas generator to the inflatable device. Such a closed system can operate in the air or under water.

The inflatable device **10** may be a bag of any desired shape and size used in connection with boats, rafts, rescue devices or helicopter landing pads.

The interior of the gas generator **11** for producing the mixture of gases is shown in FIG. 2. The gas generator comprises a container **15** for confining carbon dioxide; an outlet assembly **16** having a conduit **12** connected to its outlet **17**; a pressure rupturable disc **18** for normally sealing the container to prevent discharge through the outlet; a hot gas generating chamber **19** including a charge **20** of propellant adjacent the outlet, an electrically actuated squib **21** for igniting the charge, and passageway means **22** for conducting the hot gases from the chamber to the interior of the container **15** for admixture with the carbon dioxide; and a safety disc assembly **24** adapted to burst in the event an unsafe pressure is created within the container.

In operation, the squib **21** is actuated to ignite the charge **20**, and the propellant generates hot gases which are admixed with the carbon dioxide to increase the pressure within the container **15** and burst the disc **18**. This mixture is discharged through the outlet **17** and is conducted by the conduit **12** to the inflatable device **10** or other point of use. As this occurs, the hot gases increase the pressure of the carbon dioxide and the carbon dioxide upon expansion cools the hot gases by the Joule-Thompson effect which takes place when it is suddenly expanded from a high pressure to a much lower pressure, whereby the temperature of the mixture which enters the inflatable device is neither too high to harm the bag nor too low to allow the formation of carbon dioxide snow particles to take place within the bag.

Numerous tests have indicated that, at ambient temperatures between —20° and 125° F., the temperature of the gaseous mixture in the bag can be controlled by varying the ratio of the number of B.t.u. produced for each pound of carbon dioxide. This ratio is higher at the lower ambient temperatures than at the higher ambient temperatures. For example, at —20° F. about 154 B.t.u. may be generated by the propellant for each pound of carbon dioxide, and at 125° F. about 144 B.t.u. may be generated by the propellant for each pound of carbon dioxide.

A propellant charge which has been found suitable is a potassium perchlorate type powder capable of producing about 1740 B.t.u. a pound. Thus, by varying the weight of the charge, the desired number of B.t.u. to be produced can be predetermined within accurate limits.

As specific examples of the present invention, a 56 cubic foot bag for a helicopter pad was inflated to a pressure of about three p.s.i.g. in less than four seconds by a hot gas generator container **11** having a volume of about 329 cubic inches and containing the following amounts of material:

Example I

Working temperature range ____° F__	−20 to 80
Carbon dioxide ____pounds__	7.33
Pyrotechnic substance ____do____	0.65
Total weight of charge ____do____	7.98
B.t.u. generated ____	1121
Carbon dioxide per pound substance _do____	11.3
Bag temperature after inflation:	
Maximum ____° F__	300
Minimum ____° F__	−20

Example II

Working temperature range ____° F__	20 to 125
Carbon dioxide ____pounds__	6.78
Pyrotechnic substance ____do____	0.56
Total weight of charge ____do____	7.34
B.t.u. generated ____	974.4
Carbon dioxide per pound substance _do____	12
Bag temperature after inflation:	
Maximum ____° F__	305
Minimum ____° F__	20

Since the bag during or immediately after inflation rests on a body of water and is partially submerged therein, there is a rapid heat exchange between the gases and the water to immediately lower the higher temperature of the gaseous mixture being generated and to raise the lower temperatures of the gaseous medium introduced into the inflatable device whereby damage to the bag is averted.

Other tests indicated that the mixture in accordance with the foregoing examples are also suitable for inflating flotation equipment, particularly such equipment having a relatively large bag volume.

In FIG. 3, a system is shown which comprises an inflatable device **10**, a gas generator **11** such as described with reference to FIG. 2, a conduit **12** for conducting the gaseous mixture from the generator to the device, and a device **13** connected in the conduit for entraining ambient air and introducing the air into the inflatable device.

Such a system further reduces the temperature of a hot gaseous mixture during inflation and increases the amount of gaseous media introduced into the inflatable device. Such a system is suitable for use where underwater operation is not required.

The air entraining device **13** may be of a conventional design such as shown in United States Patent No. 2,975,958.

From the foregoing description, it will be seen that the present invention provides a simple, practical and economical charge for inflating inflatable devices throughout a wide range of temperatures.

It will be understood that the details and examples hereinbefore set forth are illustrative only and that the invention as broadly described and claimed is in no way limited thereby.

We claim:

1. A charge for producing a mixture of cool gases under low pressure consisting essentially of about 0.56 to about 0.65 pound of a hot gas generating pyrotechnic substance, said pyrotechnic substance being one which produces about 974 to about 1121 B.t.u. when said 0.56 to 0.65 pound of substance is ignited, an expandable fluid coolant isolated from and surrounding said substance, said coolant consisting essentially of about 6.78 to about 7.33 pounds of carbon dioxide, said charge being a total weight of about 7.34 to about 7.98 pounds, said pyrotechnic substance and said isolated coolant being of an arrangement to cause said isolated coolant to admix with hot gases to be generated by said pyrotechnic substance when said pyrotechnic substance is ignited.

2. A charge according to claim **1**, consisting essentially of about 0.65 pound of said pyrotechnic substance which produces about 1121 B.t.u. when ignited, about 7.33 pounds of said coolant, said charge being a total weight of about 7.98 pounds.

3. A charge according to claim **1**, consisting essentially of about 0.56 pound of said pyrotechnic substance which produces about 974 B.t.u. when ignited, about 6.78 pounds of said coolant, said charging being a total weight of about 7.34 pounds.

4. A charge for producing a mixture of cool gases under low pressure consisting essentially of a hot gas-generating pyrotechnic substance, said pyrotechnic substance being one which produces about 1740 B.t.u. when one pound of substance is ignited, an expandable fluid coolant isolated from and surrounding said substance, said coolant consisting essentially of about 11.3 to about 12 pounds of carbon dioxide for each pound of pyrotechnic substance, said pyrotechnic substance and said isolated coolant being of an arrangement to cause said isolated coolant to admix with hot gases to be generated by said pyrotechnic substance when said pyrotechnic substance is ignited.

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