United States Patent [19]

Patterson, Jr. et al.

[11] **3,799,092**

[45] **Mar. 26, 1974**

[54] **EMERGENCY BUOYANCY SYSTEM**

[75] Inventors: **Arthur E. Patterson, Jr.,** Cupertino; **Edward J. Barakauskas,** Saratoga, both of Calif.

[73] Assignee: **Westinghouse Electric Corporation,** Pittsburgh, Pa.

[22] Filed: **Oct. 14, 1971**

[21] Appl. No.: **189,383**

[52] **U.S. Cl.** ..... **114/0.5 D**

[51] **Int. Cl.** **B63b 35/44**

[58] **Field of Search** ..... 114/.5 R, .5 D, 16.4, 16.5, 114/16.6, 16.7, 16.8; 9/8 R, 8.3 E, 9

[56] **References Cited**

UNITED STATES PATENTS

3,210,785 10/1965 Ward 9/9

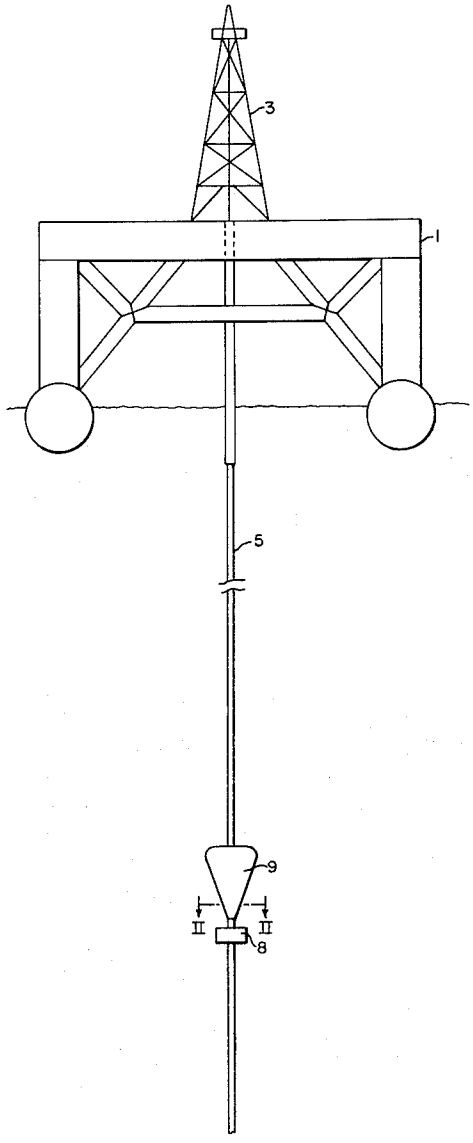
3,566,426 3/1971 Davidson et al. 9/9

Primary Examiner—Duane A. Reger
Assistant Examiner—Jesus D. Sotelo
Attorney, Agent, or Firm—F. J. Baehr, Jr.

[57] **ABSTRACT**

Gases from a solid propellent rocket fuel unit are mixed with carbon dioxide from a pressure vessel to inflate an inflatable buoy, which is connected to a riser pipe utilized in drilling a hole in the bottom of the ocean. The structure buoy is fastened to the riser pipe, about 300 feet below the water, at a level unaffected by wave action, but accessible to divers and is adapted to be rapidly inflated to support the riser pipe, if there is a severe storm and it becomes necessary to cut the drilling platform loose from the riser pipe.

3 Claims, 4 Drawing Figures



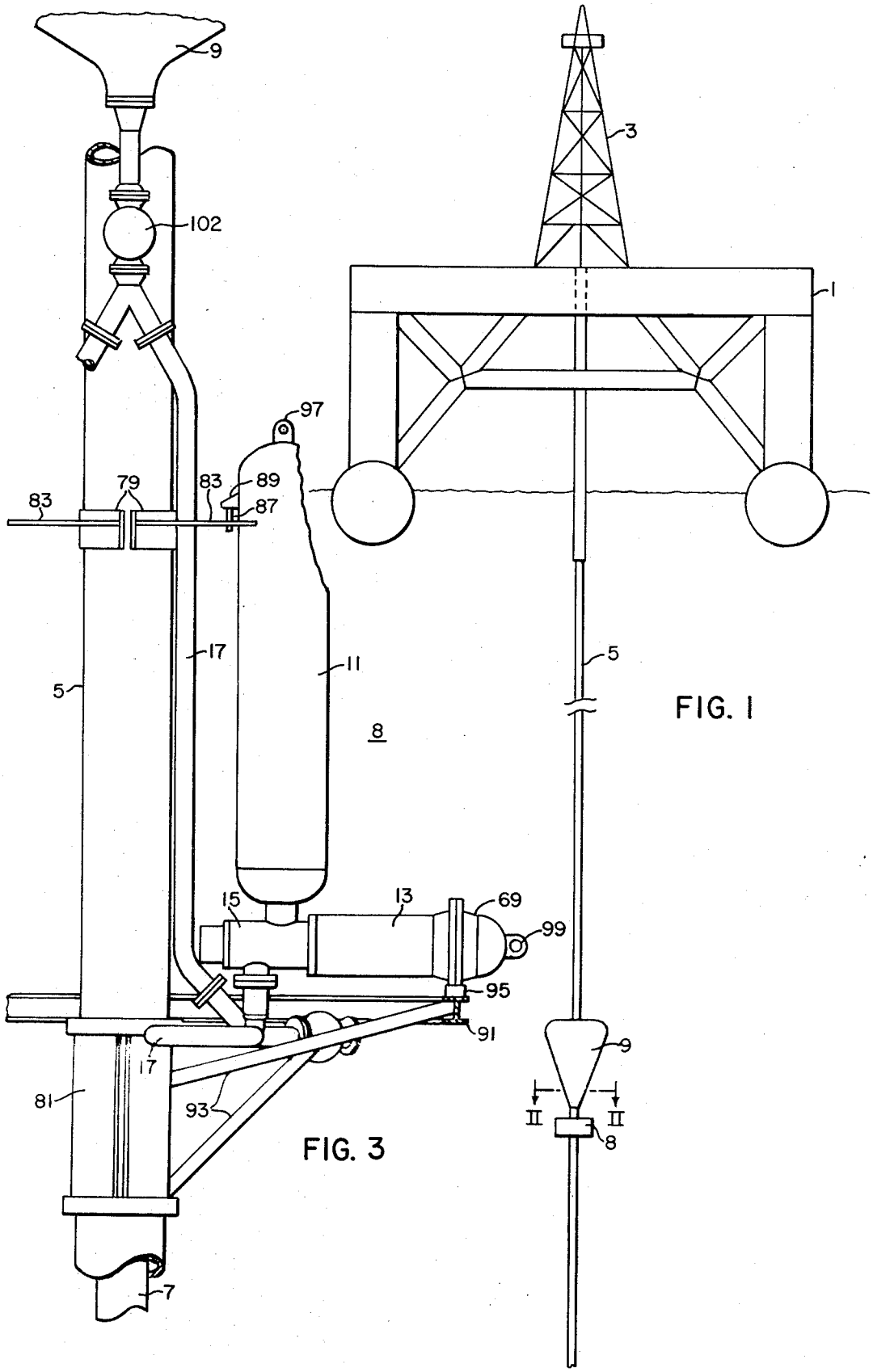

9
102
97
79
83
89
87
83
17
11
5
8
15
13
69
99
95
91
17
81
93
7
3
1
5
9
II
II
8

FIG. 1

FIG. 3

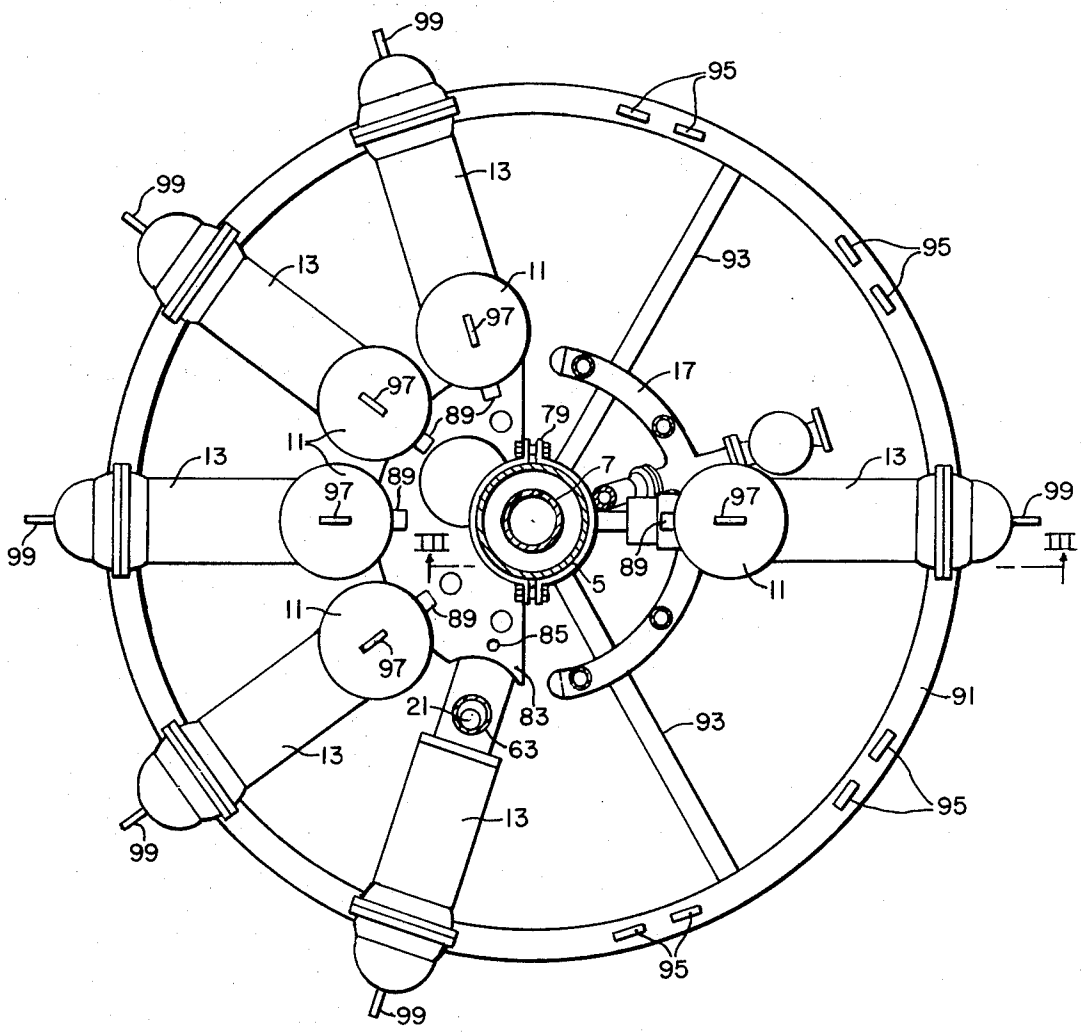

99
95
13
99
93
95
13
11
97
97
17
89
79
11
13
7
13
99
97
97
99
89
III
III
89
5
11
11
89
85
97
91
21
83
93
63
13
13
95
99
95
99

FIG. 2

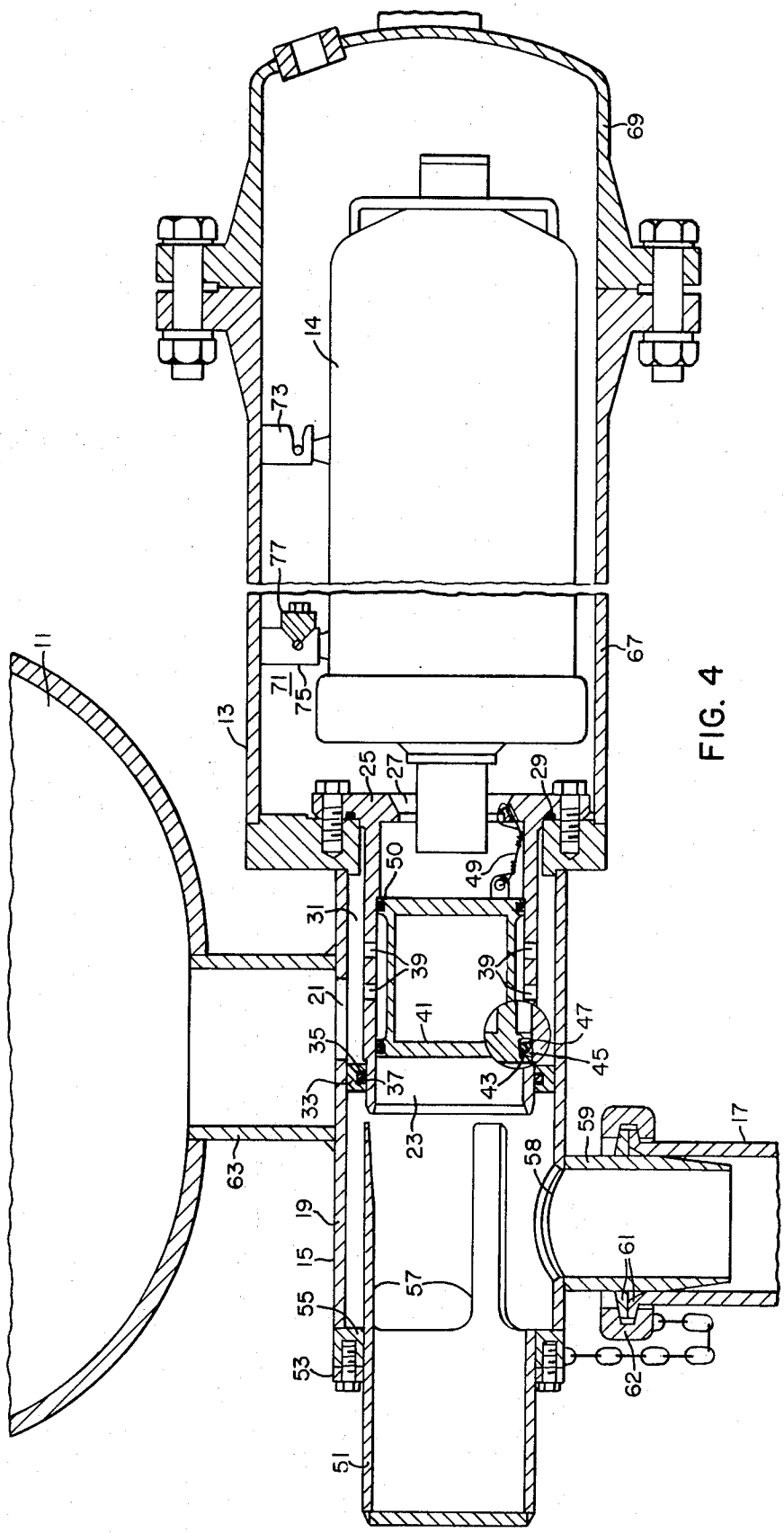

69
14
73
77
11
71
75
67
13
25
27
29
50
49
31
39
39
21
41
47
35
45
37
43
33
23
59
17
63
58
19
61
15
57
55
53
62
51

FIG. 4

EMERGENCY BUOYANCY SYSTEM

The invention hereinafter described was made in the course of, or under a contract for, the National Science Foundation, an agency of the U.S. Government.

BACKGROUND OF THE INVENTION

This invention relates to deep water drilling and more particularly to an emergency buoyancy system for supporting the riser casing if the drilling platform must be cut loose from the hole.

Development of offshore drilling began in the 1930's and developed simultaneously in California and Louisiana, however the early drilling platforms, which support the familiar oil derricks, were either on artificial islands or supported by legs extended to the bottom of the sea. By the mid 1950's floating platforms with legs that were jacked to the bottom to raise the platform above the water came into use along with floating platforms, which were held in place by mooring lines fastened to buoys anchored to the floor of the sea. The latter arrangement could be utilized to drill holes under water several hundred feet deep. In 1961 the first deep sea holes were drilled in water over 10,000 feet deep, demonstrating the feasibility of dynamically positioning a drilling platform in the ocean. For additional information on the development of deep sea drilling, reference may be made to *A Hole In The Bottom Of The Sea* by Willard Bascom, published in 1961, which relates to the story of the Mohole Project.

SUMMARY OF THE INVENTION

In general, an emergency buoyancy system made in accordance with this invention comprises a tank for containing pressurized fluid, an exothermic gas generator, a mixing chamber for mixing fluid from the tank with gas produced by the gas generator to form a gaseous mixture and an inflatable buoy adapted to contain the gaseous mixture and provide a predetermined amount of buoyancy.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and advantages of this invention will become more apparent from reading the following detailed description in connection with the accompanying drawings, in which:

FIG. 1 is a partial elevational view of a floating drilling platform and an emergency buoyancy system made in accordance with this invention;

FIG. 2 is an enlarged sectional view taken on line II—II of FIG. 1;

FIG. 3 is an enlarged sectional view taken on line III—III of FIG. 2; and

FIG. 4 is an enlarged sectional view of a quick opening valve and mixing chamber made in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in detail, FIG. 1 shows a floating drilling platform 1 having a derrick 3 disposed thereon and a riser pipe or casing 5 depending from the drilling platform 1. A drill pipe or drill string 7 having a boring bit at the lower end thereof extends downwardly through the casing to bore a hole beneath the floor of the ocean in several thousand feet of water. In the event of a severe storm it may be necessary to detach the drilling platform 1 from the riser pipe 5. With the drilling platform removed, additional buoyancy may be required to support the riser pipe. The amount of buoyancy would vary depending on the length of the riser pipe, its size, the desired tension, and many other factors. The additional buoyancy is preferably added at a level not appreciably affected by wave action and yet accessible to divers.

As shown in FIG. 1, an emergency buoyancy system 8 adapted to provide gases to an inflatable buoy 9 is disposed approximately 300 feet below the water level. Utilizing compressed gases to inflate the buoy would produce undesirably low temperatures, which could cause freezing and malfunction of the system 8, while utilizing a gas generator, such as a solid propellent fuel unit, would produce a large quantity of compressed gases at elevated temperatures, which are difficult to handle and would cool over a period of time, reducing the buoyancy. Therefore a workable system must produce gases at the ambient pressure and temperature at a depth of 300 feet below the surface of water.

As shown in FIGS. 2 and 3, such an emergency buoyancy system comprises a CO_2 tank or pressure vessel 11, an exothermic gas generator 13 having a solid fuel rocket propellent unit 14, commercially known as a Jato unit (jet assist take-off unit as manufactured by Hercules Powder Corporation, Radford, Va.), disposed therein and a combination quick opening valve and mixing chamber 15 adapted to mix the CO_2 fluid with the gaseous products of combustion from the gas generator 13 tempering both fluids so that the gaseous mixture has a temperature of approximately 70°F as it enters the inflatable buoy 9, which is fastened to the riser pipe 5 at a depth of approximately 300 feet below the surface of the water.

Each CO_2 tank 11 and gas generator 13 will produce a predetermined amount of buoyancy so that by providing the proper size inflatable buoys 9 and a plurality of CO_2 tanks 11 and gas generators 13, the amount of buoyancy can be varied in increments providing a flexible system capable of responding to various buoyancy needs.

An ignition control system which monitors the amount of CO_2 in each tank 11 and provides an ignition system for each gas generator 13 is operable from the drilling platform 1 above the water, and contains monitors which inform the operator that the system has functioned.

As shown in FIGS. 2 and 3, each CO_2 tank 11 and gas generator 13 is cooperatively associated with a mixing chamber 15, which is connected to the inflatable buoy 9 by a manifold 17. As will be hereinafter described in detail, the tank 11, gas generator 13 and mixing chamber 15 are removably fastened to the manifold 17 and riser pipe 5 so that after they have functioned, they can be easily removed and recharged, and subsequently reinstalled to provide buoyancy in future emergencies.

As shown in FIG. 4, the combination quick opening valve and mixing chamber 15 comprises an outer cylindrical shell or tubular housing 19 disposed generally horizontally, an inlet port 21 in communication with the CO_2 tank 11 and a cylindrical or tubular sleeve member 23 disposed within the outer cylindrical shell 19. The sleeve member 23 is axially aligned with the outer shell 19 and is flange mounted to one end thereof. The flanged end 25 of the sleeve member 23 has an orifice 27 disposed therein for receiving the dis-

charge end of the Jato unit **14** and a seal **29** disposed to seal one end of the annular chamber **31** formed between the shell **19** and sleeve **23.** An annular seal ring **33** is seal welded to the shell **19** and has a circumferential groove **35** adapted to receive an O-ring type seal **37,** which engages the outer peripheral surface of the sleeve **23** to seal the other end of the chamber **31.** A plurality of openings or ports **39** are circumferentially spaced adjacent the central portion of the sleeve placing the annular chamber **31** into communication with the bore or inner surface of the sleeve **23.**

A spool shaped valve member **41** is slidably disposed within the sleeve **23.** The spool member **41** has end flanges **43,** which slidably engage the inner surface of the sleeve **23** and each flange **43** has a groove **45** shaped to receive an O-ring **47,** which forms a seal at the end flanges **43.** The spool member **41** is so disposed with respect to the ports **39** as to form a seal on opposite sides thereof closing or plugging off the ports **39.** A small diameter lock wire **49** is fastened to the spool member **41** and to the sleeve member **23** limiting relative movement therebetween. The lock wire **49** is sufficiently strong to hold the spool member **41** in plugging relation with the ports **39** under severe operating conditions, however, the lock wire **49** is designed to break when subjected to the pressure produced by the gas generator **13** when it is ignited. A counter-bore forms a step **50** in the inner surface of the sleeve forming a unidirectional valve, which only responds to a pressure build-up on one side thereof.

The other end of the shell **19** is closed by a cup-shaped cap **51** having an outer flange **53,** which is fastened to an inwardly directed flange **55** at the end of the shell forming a seal therebetween. The cap **51** is of the proper diameter and depth of receive the spool member **41** and has a plurality of fingers **57** extending outwardly to the sleeve **23.** The fingers **57** have tip ends, which taper outwardly to provide a guideway for receiving the spool member **41** as it leaves the sleeve **23,** to assist in directing the spool member **41** towards the cup-shaped cap **51,** when the gas generator **13** is ignited.

A discharge port **58** is disposed in the shell **19** adjacent the fingers **57.** A short nozzle **59** connects the discharge port **57** to the manifold **17.** Quick disconnecting mating flanges **61** are provided and are held in sealing relation by a quick disconnect clamp **62.** A portion of the discharge nozzle **59** extends downwardly into the manifold, the lower end of the discharge nozzle **59** is tapered inwardly to assist in aligning the flanges **61** so that they can be assembled under water.

As shown in FIG. **4,** the inlet port **21** is placed in communication with the CO_2 tank **11** by a short nozzle **63** welded to the tank **11** and to the shell **19.** FIG. **4** also shows the Jato unit **14** mounted in the gas generator **13,** which comprises a tubular shell portion **67** having a flanged end closure **69.** The Jato unit **14** is suspended from mounting brackets **71** and **73** fastened to the shell portion **67.** The mounting brackets locate the Jato unit **14** within the shell so that the discharge nozzle extends through the orifice **27** and withstand the thrust of the Jato unit **14** after it is ignited. The mounting bracket **71** is formed from interconnecting portions **75** and **77** which are bolted together to fix the position of the Jato unit **14** within the shell **67** and allow it to be easily replaced.

The CO_2 tank **11,** gas generator **13,** and mixing chamber **15** are fastened together to form a unitized structure or assembly, which is supported from a pair of collars **79** and **81** fastened to the riser pipe **5.** The upper collar **79** has a pair of semicircular plates **83** extending radially therefrom. The plates **83** have arcuate scalloped peripheral edges for receiving the CO_2 tanks **11** and a plurality of holes **85** adapted to receive a tapered pin **87,** which is fastened to the upper end of the CO_2 tank **11** by a bracket **89.** The lower collar **81** is encircled by an I-beam **91,** which is fastened thereto by a plurality of struts **93** extending radially outwardly from the lower collar **81.** The I-beam **91** is disposed under the flanges of the end closures **69** and has a pair of wedge-shaped blocks **95** fastened thereto to form a cradle for each gas generator. The CO_2 tanks **11** and gas generators **13** have lifting lugs **97** and **99,** respectively, properly disposed so that when the quick disconnect flange clamp **62** is removed the assembly can be removed from the manifold **17.** An isolation valve **102** is disposed in the manifold upstream of the inflatable buoy so that portions thereof may be shut off.

Each CO_2 tank **11** and gas generator **13** will produce a predetermined amount of buoyancy so that by varying the number of units activated incremental buoyancies can be obtained. To activate a portion of the system a Jato unit **14** is ignited by operating a switch at the surface to commence burning of the solid fuel propellent. The products of combustion are gases so that the pressure in the shell **67** of the gas generator **13** builds up rapidly causing the lock wire **49** holding the spool valve **41** in place to break, allowing the valve member **41** to slide into the cup-shaped cap **51,** and liquid CO_2 to begin to flow through the ports **39** and into the mixing chamber **15,** wherein it vaporizes and mixes with the products of combustion from the Jato unit **14** to reduce the temperature of the products of combustion and raise the temperature of the CO_2 so that the temperature of the mixture leaving the discharge port **57** is approximately 70°F, which is generally equal to the temperature of the water at a depth of 300 feet. Once the Jato unit **14** is ignited it burns without external oxygen until it is burned out. The CO_2 tank is sized to provide sufficient cooling for the Jato unit. The CO_2 begins to flow into the mixing chamber shortly after combustion of the Jato unit **14** is initiated and continues to flow during combustion and for a short period after combustion is completed to insure that no hot gases flow through the manifold and into the inflatable buoy **9.** As noted hereinbefore, the spool valve **41** is unidirectional so that no other valving is required in the manifold and activation of one unit will not cause spool valves of other units to operate. Thus, the apparatus hereinbefore described advantageously produce incremental quantities of noncondensable gaseous mixtures at the ambient temperature and pressure expected to exist approximately 300 feet below the surface of the water to provide incremental amounts of emergency buoyancy.

What is claimed is:

1. An emergency buoyancy system comprising a pressure vessel for pressurized fluid; an exothermic gas generator; a mixing chamber fluidly connected to said pressure vessel and said gas generator for producing a gaseous mixture of pressurized fluid from said pressure vessel and gas from said gas generator; said mixing chamber comprising an outer tubular shell, a sleeve disposed within the outer shell, the sleeve being fastened

to one end of said shell, a circumferential seal between the shell and the sleeve, the gas generator being disposed to discharge into said sleeve, a second circumferential seal between said sleeve and said shell cooperating with said first mentioned circumferential seal to form an annular chamber between said sleeve and said shell, said shell having an opening placing the pressure vessel in communication with said annular chamber, said sleeve member having at least one port placing said annular chamber in communication with the inner side of said sleeve, means for plugging said port, means for holding said plugging means in plugging relation under normal conditions and operable to allow said plugging means to move out of plugging relationship with said port, when said gas generator is activated, and an opening in said shell for discharging the gaseous mixture from said shell at ambient temperature; and means for containing said gaseous mixture under water to provide a predetermined amount of buoyancy.

2. An emergency buoyancy system as set forth in claim **1**, wherein the plugging means is slidably disposed within the sleeve.

3. An emergency buoyancy system as set forth in claim **1**, wherein the gas generator comprises a solid propellent rocket fuel and the fluid is liquid carbon dioxide.

* * * * *