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3,228,045

BUOYANT SAFETY DEVICES

Filed May 26, 1964

2 Sheets-Sheet 1

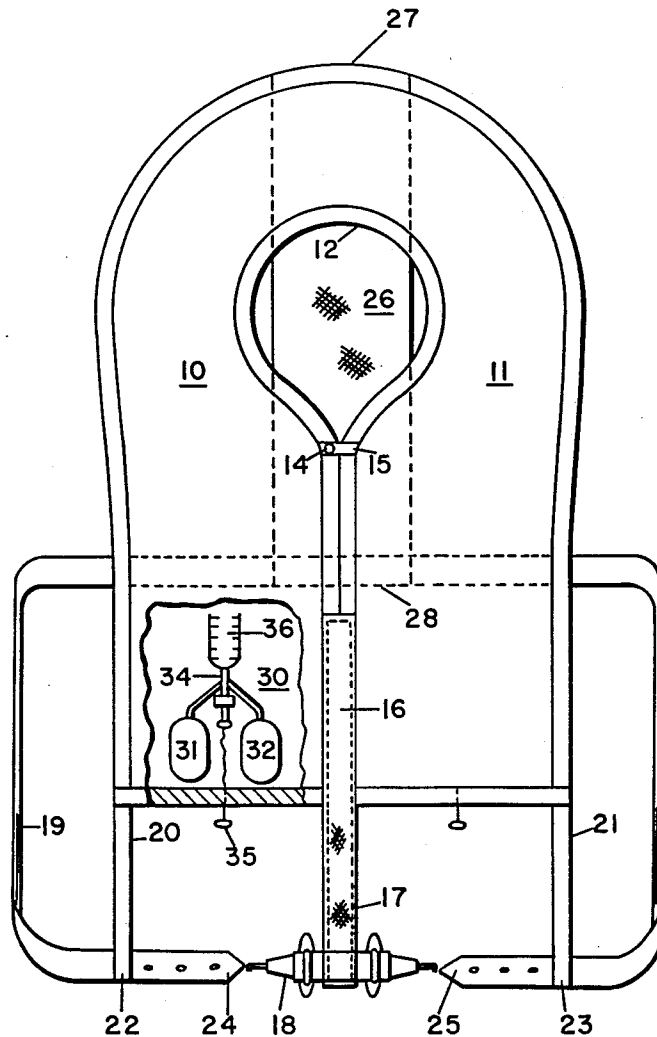


FIGURE 1

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2 Sheets-Sheet 2

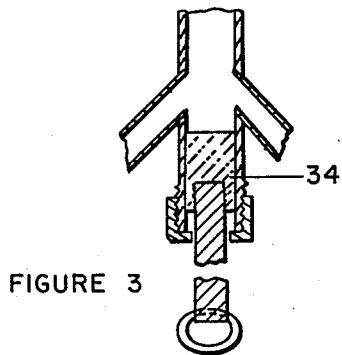


FIGURE 3

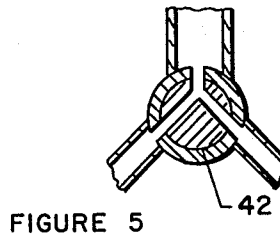


FIGURE 5

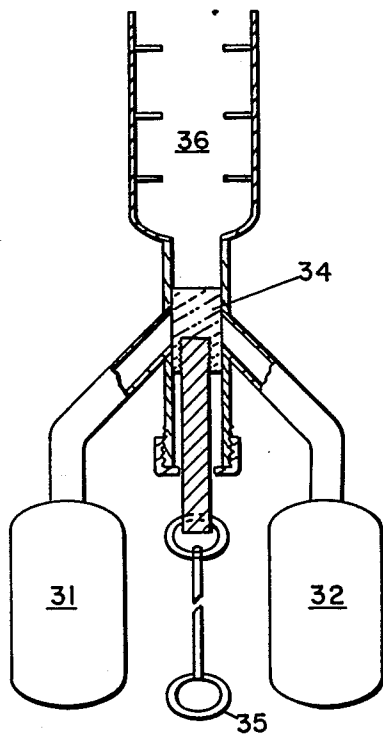


FIGURE 2

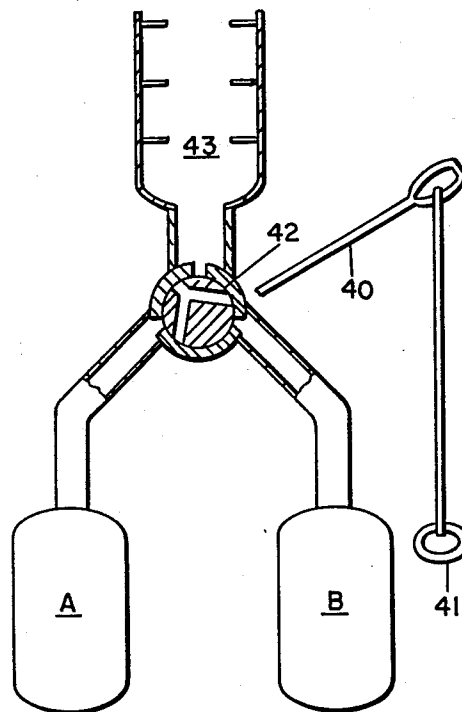


FIGURE 4

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BUOYANT SAFETY DEVICES

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3 Claims. (Cl. 9—314)

This application is a continuation-in-part of our co-pending application, Serial No. 286,561, filed June 10, 1963, now abandoned.

This invention relates to novel self-inflating buoyant safety devices such as life preservers, life vests and inflatable life rafts and to a novel method for inflating the same.

In man's activities involving water, whether aboard ship or in recreational swimming, buoyant safety devices have saved innumerable lives. These safety devices have been provided with two types of buoyancy elements. In one type the buoyancy chamber of the safety device is pre-filled with a low density material such as cork, kapok, etc. Although these devices can adequately fulfill their designed for function, they do possess distinct disadvantages. Due to their volume they are inconvenient to store when not in use. Also the bulky pre-filled life vests interfere with freedom of action when worn on board ship under emergency conditions. Further, these materials tend to become waterlogged in use with a hazardous loss of buoyancy. The second type is stored in the uninflated condition and is designed for inflation only in emergency situations by release of pressurized carbon dioxide or other gaseous material. However, this involves another hazard resulting from the leakage of inflating gas through imperfections or punctures in the safety device.

The safety devices of our invention are inflated immediately prior to use by the polymerizing expansion of a self-contained foamable resinous material to a cured foam within the buoyancy chamber. The advantages of prior safety devices have been retained and the disadvantages and hazards eliminated by our invention. Thus our safety devices may be conveniently stored in the deflated condition and life vests may be worn for long periods during emergency conditions on shipboard in the deflated state without materially interfering with the user's movements. Yet in an emergency situation the safety devices may be completely inflated in minutes or less with a non-leakable, non-absorbent buoyant material.

These and other objects of our invention will become apparent from the following description.

FIGURE 1 is a front elevation of an uninflated safety vest embodying our invention.

FIGURE 2 is a partial cross sectional view of one modification of the inflating unit showing the valve in the closed position.

FIGURE 3 is the same unit showing the valve open.

FIGURE 4 is a partial cross sectional view of another modification of the inflating unit showing the valve in the closed position.

FIGURE 5 is the same unit showing the valve open.

Our invention relates to any inflatable life saving device for use on water, including life savers, life vests and jackets, and inflatable life boats or rafts. The invention is described for convenience as applied to a specific life vest. Referring to FIGURE 1 a conventional yoke-shaped life vest is illustrated having a right and left chest

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portion, 10 and 11 respectively, and neck opening 12. This vest may be conveniently formed from two substantially flat resilient pieces of material cut in the yoke shape and securely joined together along their edges. Any suitable material may be used for the body of the safety device, such as a close knit fabric, coated fabric, or a plastic film.

The wearer's head fits through neck section 12. Fastener button 14 and fastener strap 15 are provided to permit access of the wearer's head. The lower part of the breast portions are joined together by strap 16 with a downward extension 17 joining to the center section 18 of belt 19. The lower outer corners of the breast portions are joined to the belt by straps 20 and 21 in slip connections 22 and 23. The ends 24 and 25 of belt 19 are joined to the center section 18 by hook and eye or other suitable fastener. A web strap 26 connects the upper part 27 of the neck portion of the vest to the rear of the belt at 28. The belt fits snugly around the waist of the wearer and straps 17, 20 and 21 provide for the expansion of the vest in inflation. Groin straps (not shown) may also be attached to belt 16 to insure against the belt riding up on the wearer during use.

Within the lower part of each chamber forming the two breast portions are inflating units. In FIGURE 1 only the right inflating unit 30 is illustrated, shown in greater detail in FIGURES 2 and 3. This inflating unit includes two separated compartments 31 and 32 which may either be physically separate, as illustrated, or may be part of an integral unit. One compartment contains a suitable resinous material under slight pressure and the other contains a curing agent also under slight pressure preferably by use of a suitable fluorocarbon propellant. Upon downward movement of the plunger 34 manually operated by pull cord 35 the resinous material and curing agent will be pressure ejected and physically combined and a foaming polymerizing reaction will take place. Baffled compartment 36 insures a better mixing of the resinous material with the curing agent and a more uniform foam. The expanding foam produced by this reaction pours out of the baffled chamber into the chamber formed within the life vest inflating the vest chamber to its maximum limit. The reactant compartments 31 and 32 and the baffled compartment 36 are preferably flattened in order to avoid an inconvenient bulge while the life vest is being worn in the uninflated condition.

Suitable foams for specific requirements may be obtained having a density of from about 1 to 10 pounds per cubic foot and may vary from rigid to resilient in their physical characteristics. The density, rigidity and other properties may be altered according to the knowledge in the art by the proper choice of resins, curing agents, wetting agents, plasticizers and propellants. Suitable formulations for foams for a life vest of the yoke-type having an expanded volume of about one half cubic foot are provided for purposes of exemplification.

Example I.—Epoxy resin

Component A:	G.
Epoxy resin	300
Epoxidized linseed oil	75
Dichlorodifluoromethane	36
Wetting agent	2.5
Component B:	
Trimethoxyboroxine	30
Dichlorodifluoromethane	4

The epoxy resin used in component A is 3,4-epoxy-6-methylcyclohexylmethyl-3,4-epoxy - 6 - methylcyclohexane carboxylate having one gram equivalent weight of oxirane oxygen in 155 g. The epoxidized linseed oil contains about 9% oxirane oxygen. The wetting agent is a conventional silicone-glycol copolymer which functions as a cell-control additive. Many other wetting agents are well known for this use. When components A and B are intermixed the resulting foam will expand to a volume of about one half cubic foot within about one minute and will harden to a slightly flexible solid foam within two minutes of the intermixing. Half of component A is placed in compartment 31 and half of component B is placed in compartment 32. The remaining material is placed in the left inflating unit. Upon activation of plunger 34 and the corresponding left hand plunger full inflation to a rigid foam will result within two minutes.

Example II.—Urethane resin

Component A:	G.
Propoxylated sucrose -----	160
Propoxylated pentaerythritol -----	40
Wetting agent -----	2
Triethylenediamine catalyst -----	1
Dichlorodifluoromethane -----	32
Component B:	
Polymethylene polyphenylisocyanate -----	210
Dichlorodifluoromethane -----	32

The propoxylated sucrose contains one gram equivalent weight of hydroxyl per 160 g. The propoxylated pentaerythritol has one gram equivalent weight of hydroxyl per 100 g. The wetting agent is a silicon-glycol copolymer, functioning to control the cell size. Many wetting agents are well known for this use. The diisocyanate in component B contains about 31 weight percent of isocyanate groups. In both examples the dichlorodifluoromethane serves as the propellant causing the controlled ejection of the ingredients.

These formulations of foam producing chemicals are specified by way of example. Both formulations produce a foam having a specific gravity of about 2 pounds/ft.³. Any formulation which will fulfill the intended function will suffice. Variations in formulations are within the skill of the art for varying the density of the resulting foam, for controlling cell size and closed cell structure, for controlling the rigidity-flexibility characteristics and so forth. Additionally, it is very important that the unreacted formulations have good storage stability, this characteristic being measured in months or even years depending on the users' specific requirements. It is also obviously critical that a formulation be selected in which the foaming action is self-initiating at ambient conditions and has sufficient strength to inflate the safety device. Further, the heat from the foaming reaction must be compatible with the material from which the safety device is constructed and in the case of life vests, it must not be so high as to cause physical discomfort.

A sufficient amount of each component is initially provided in a completely deflated safety device to fully expand the compartment after the foaming reaction takes place. If an excess of foam is desired to insure complete expansion of the compartment, it may be advisable to provide an outlet valve for excess foam which will also permit escape of residual air in the compartment. In the case of safety devices in which the foam compartments are made from a porous fabric, the fabric itself serves as an outlet for any air in the foam compartment without permitting escape of the foam.

It is desirable that the foam be water resistant and have a substantial closed-cell structure. By water resistant is meant the ability of the foam to resist degradation or

destruction when in actual contact with water at least for the length of time that the safety device is in actual life saving usage. By substantial closed-cell structure is meant that a sufficient percentage of the cells are completely enclosed by the resin so that the foam substantially retains its buoyancy in direct contact with water over an extended period of time. It is desirable if at least 50% of the cells are closed and it is preferred that a least 75% of the cells are closed with about 90% being the optimum. Although a substantially open-celled structure will prevent collapse of the safety device in case of a tear or puncture, only a safety device with a substantial closed-cell structure will ensure buoyancy after a rip or tear. Although many foaming formulations are theoretically possible, only a relatively small number, including the two specified above, will meet all of these requirements.

The precise method of causing the foams to mix is of no criticality as long as the two foam producing materials are separated from one another until released by a suitable release means. FIGURE 4 illustrates an alternative valve mechanism for permitting release of the two components simultaneously. When the operator depresses lever 40 by pulling on the ring 41 the valve 42 is rotated from the closed position of FIGURE 4 to the open position of FIGURE 5 permitting the simultaneous exit of component A and component B into a foaming intermixture in baffle chamber 43 and emission of the fluid foam into the buoyancy chamber with which the inflating unit is being used. The resulting foam fills the buoyancy chamber due to the expansion of the resulting foam. A single two chambered container for the foam producing reactants is, in certain usages, more convenient. It is noted by reference to Examples I and II that the volume of components A and B may have a considerable difference in relative volume. Thus it is necessary to size each container of the inflating unit for each specific formulation.

According to the provisions of the patent statutes, we have explained the principal and mode of practicing our invention and have described what we now consider to be its best embodiments. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

We claim:

1. An inflatable buoyant safety device having a flexible chamber and inflating means associated with said chamber, said inflating means comprising two separately contained components for producing a predominantly closed cell solid foam upon intermixture, the first of said components consisting essentially of 300 parts of 3,4-epoxy-6 - methylcyclohexylmethyl - 3,4 - epoxy - 6 - methylcyclohexane carboxylate, 75 parts epoxidized linseed oil, 36 parts dichlorodifluoromethane and 2.5 parts wetting agent, the second of said components consisting essentially of 30 parts trimethoxyboroxine and 4 parts of dichlorodifluoromethane, and means for mixing said components to produce foam and inflate said chamber.

2. An inflatable buoyant safety device having a flexible chamber and inflating means associated with said chamber, said inflating means comprising two separately contained components for producing a predominantly closed cell solid foam upon intermixture, the first of said components consisting essentially of 160 parts of propoxylated sucrose, 40 parts propoxylated pentaerythritol, 2 parts wetting agent, 1 part triethylenediamine and 32 parts of dichlorodifluoromethane, the second of said components consisting essentially of 210 parts polymethylene polyphenylisocyanate and 32 parts dichlorodifluoromethane, and means for mixing said components to produce foam and inflate said chamber.

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3. An inflatable buoyant safety device having a flexible chamber and inflating means associated with said chamber, said inflating means comprising two separately contained components for producing a predominantly closed cell solid foam upon intermixture, the amount of said components being in excess of that required to fully inflate said chamber, said chamber being formed at least in part of a porous fabric, and means for mixing said components to produce foam and inflate said chamber. 5

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