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Sutliff et al.

[11] **3,910,457**

[45] **Oct. 7, 1975**

[54] **ELECTRONIC WATER-ACTIVATED PARACHUTE RELEASE AND LIFE VEST INFLATOR**

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[73] Assignee: **H. Koch & Sons, Inc.,** Anaheim, Calif.

[22] Filed: **May 6, 1974**

[21] Appl. No.: **467,298**

[52] **U.S. Cl.** **222/5;** 222/76; 9/316; 9/325; 307/246

[51] **Int. Cl.²** **B67B 7/24**

[58] **Field of Search** ..... 222/5, 76, 504; 9/8.3 E, 9/319, 316, 320, 321, 323, 324, 325, 313, 336, 337, 338, 339; 244/149, 152; 307/246

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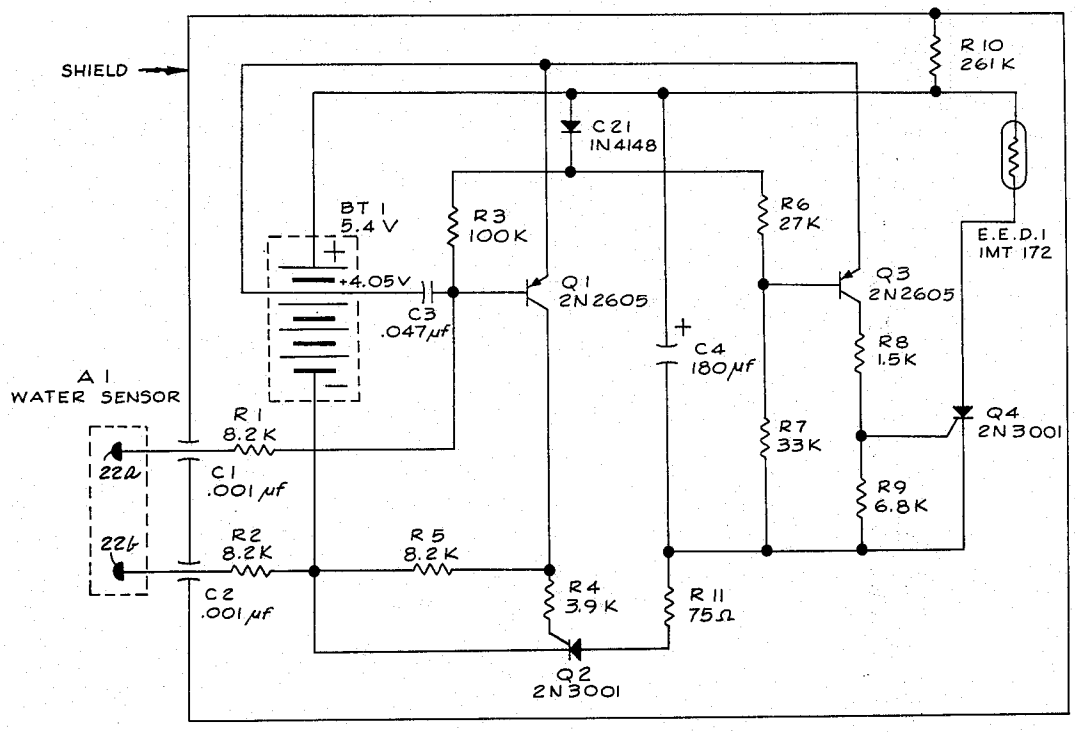
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Primary Examiner—Robert B. Reeves
Assistant Examiner—Joseph J. Rolla
Attorney, Agent, or Firm—George B. White

[57] **ABSTRACT**

An electronic water-activated package is described for automatically releasing a parachute canopy and inflating a life vest upon immersion in water. Separate electronic water-activated packages are incorporated into frames of break away webbing releases securing the parachute canopy to the parachute harness, and into inflating assemblies located at the bottom of each lapel of a life vest. The electronic water-activated package includes an explosive squib and water sensing circuitry which both detonates the explosive squib and minimizes current leakage from a power supply also contained in the electronics package.

22 Claims, 11 Drawing Figures



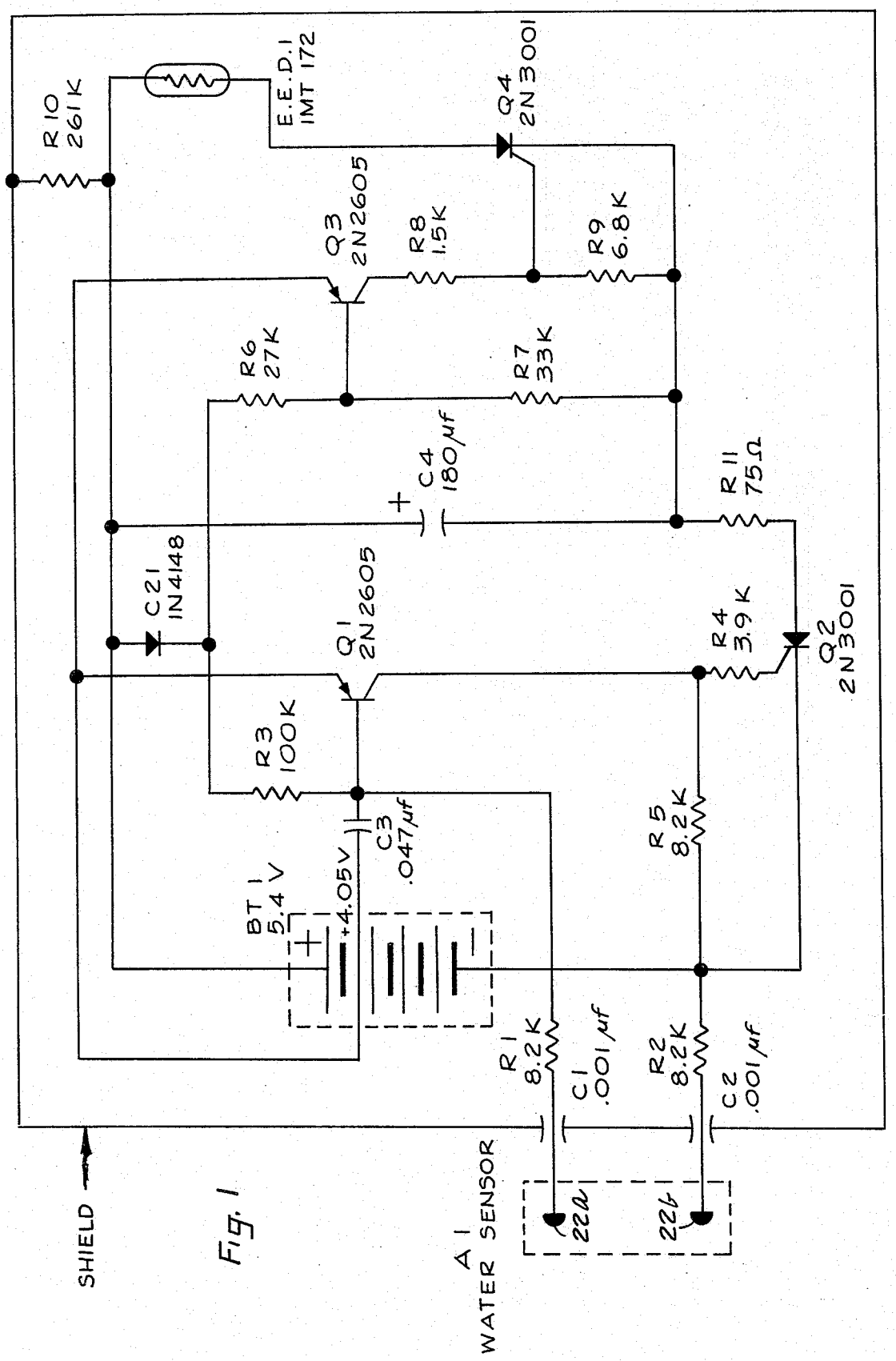

R10
261K
E.E.D.I
IMT 172
Q4
2N3001
Q3
2N2605
R8
1.5K
R9
6.8K
R6
27K
R7
33K
C4
180μf
R11
75Ω
C21
IN4148
Q1
2N2605
R4
3.9K
Q2
2N3001
R3
100K
C3
.047μf
BT1
5.4V
+4.05V
R5
8.2K
R1
8.2K
C1
.001μf
R2
8.2K
C2
.001μf
SHIELD
A1
WATER SENSOR
22a
22b

Fig. 1

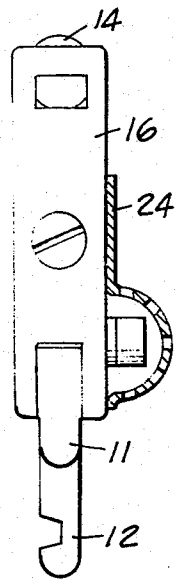


Fig 4.

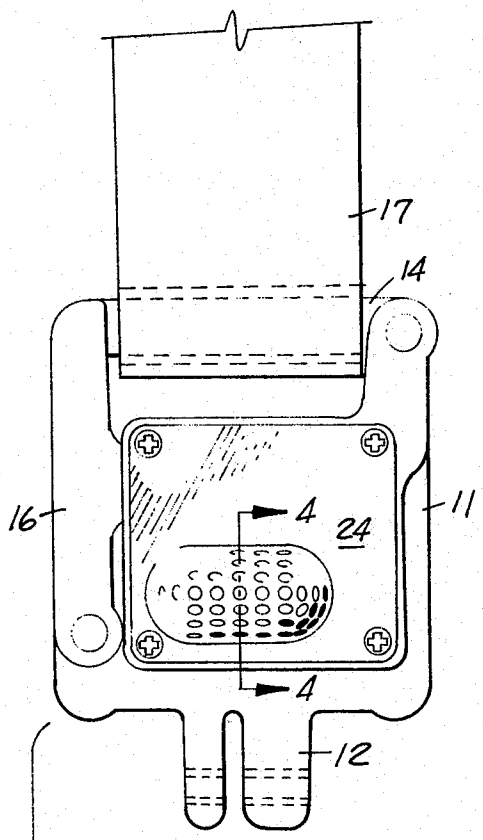


Fig. 2.

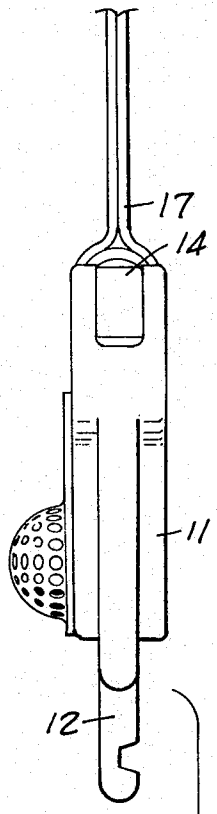
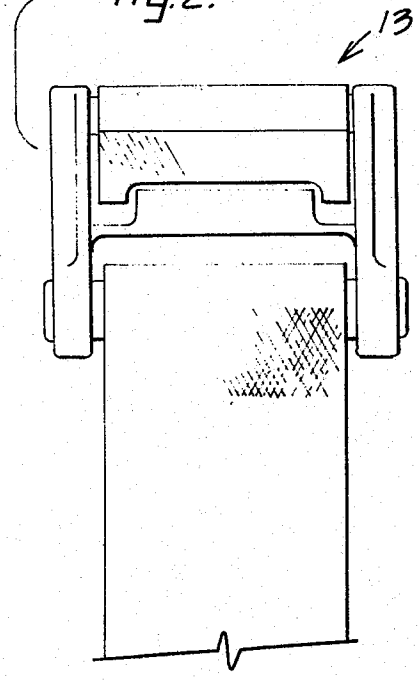


Fig 3.



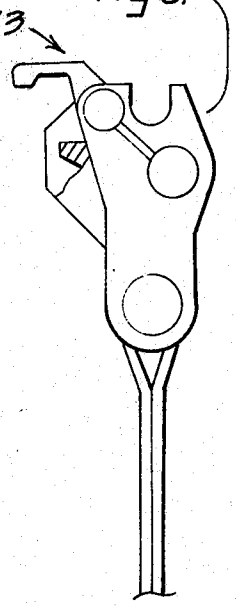


Fig 5.

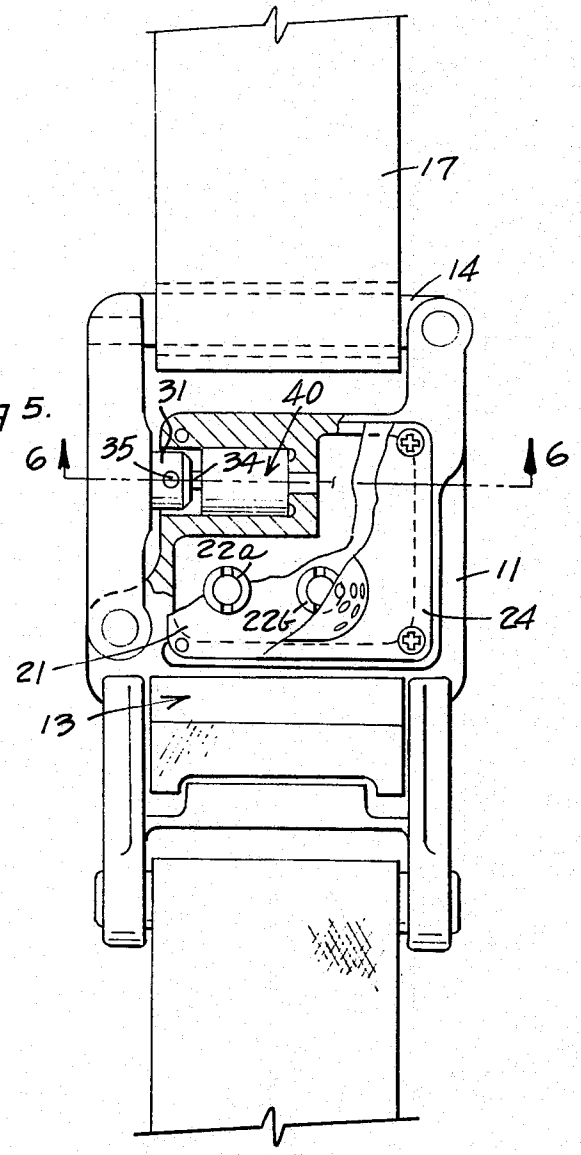
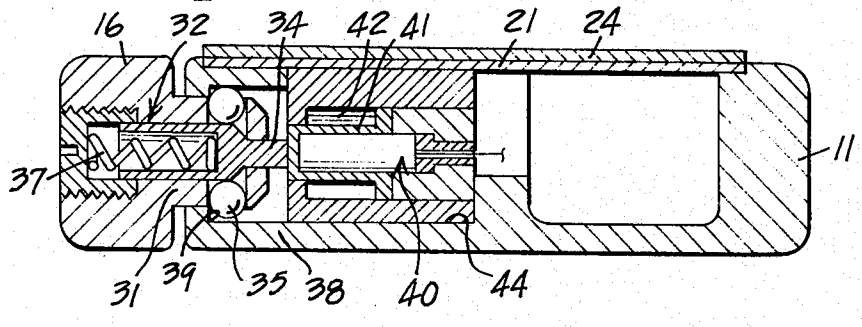

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22a
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22b
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Fig.6.


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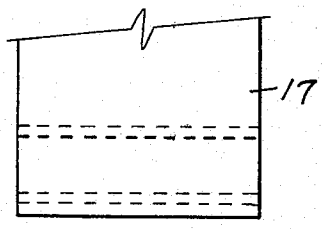

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Fig. 7.

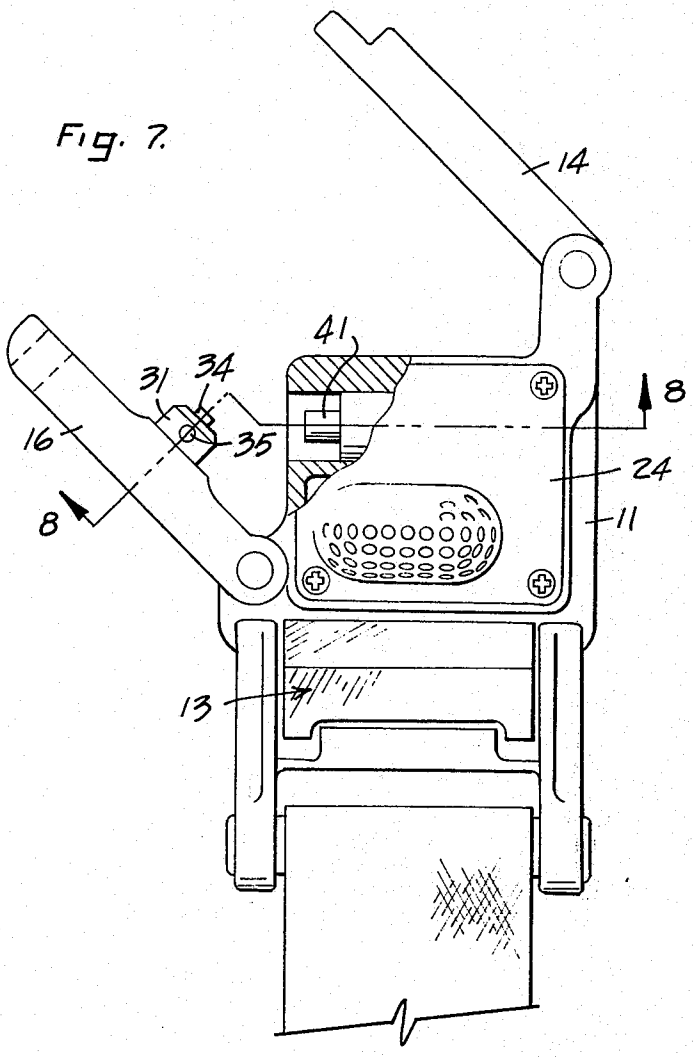
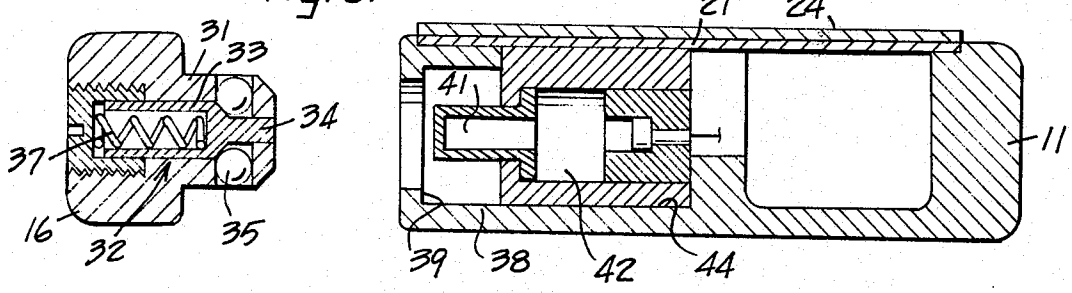

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Fig. 8.


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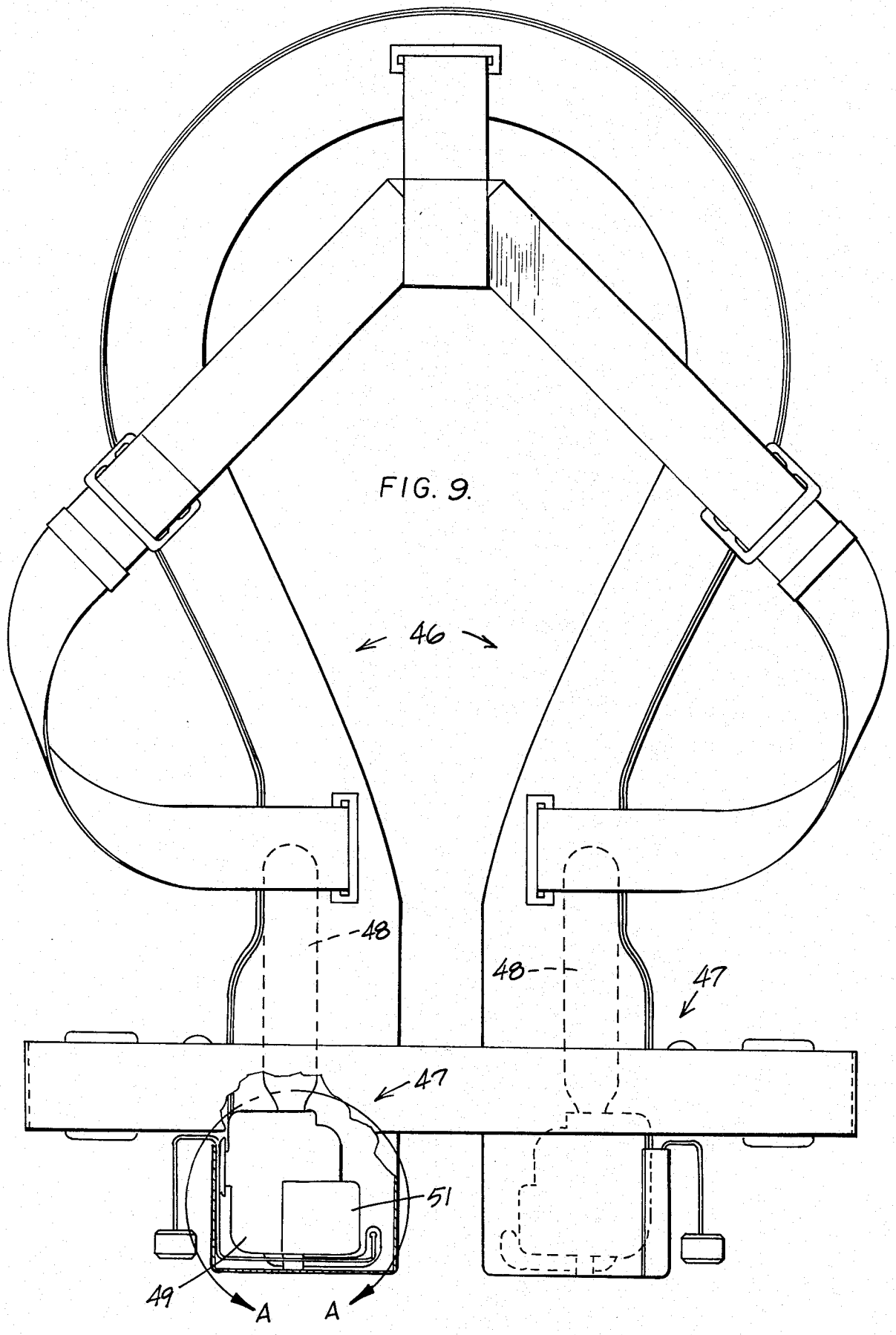


FIG. 9.

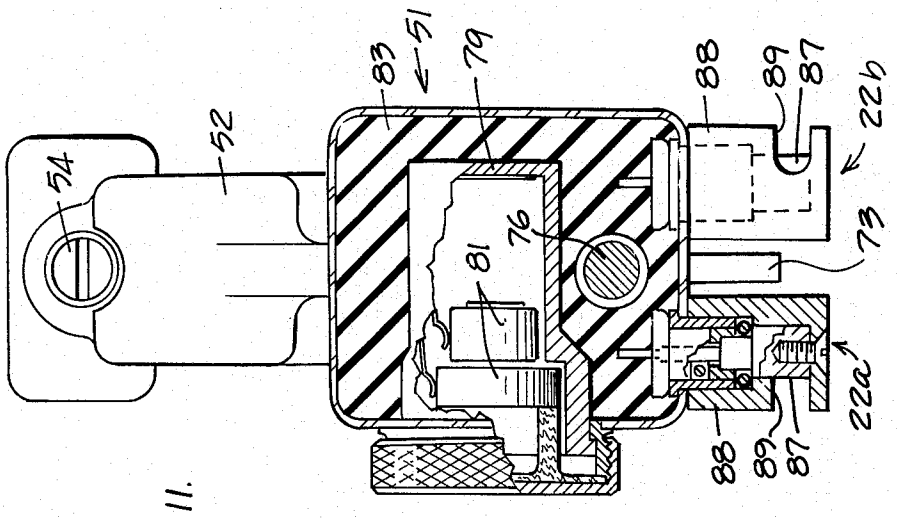

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22b
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FIG. 11.

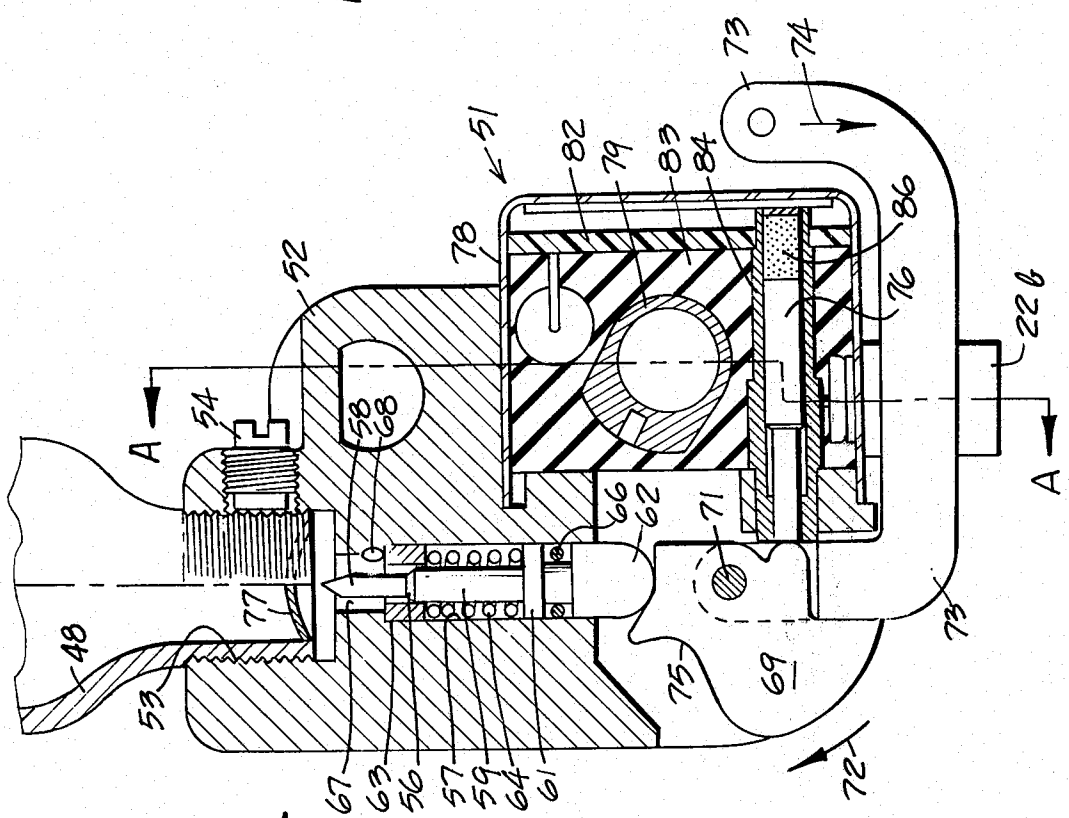

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22b
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FIG. 10.

ELECTRONIC WATER-ACTIVATED PARACHUTE RELEASE AND LIFE VEST INFLATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to an electronic water-activated package for energizing a parachute canopy release mechanism and an inflating assembly in a life vest upon immersion in water. More particularly, the invention relates to an electronics package with a self-contained power source adapted to be integrally incorporated into a break away webbing frame and into a gas cannister piercing mechanism which, upon immersion in water, triggers an electrical explosive device for energizing the break away release of the webbing frame and for driving the cannister piercing mechanism and which, prior to immersion in water, minimizes current leakage from the power source to give the package a long shelf life.

2. Description of the Prior Art

Airmen are sometimes required to eject from a disabled aircraft over water and parachute to safety. To enhance his survival, the airman must, in addition to executing other survival maneuvers, release himself from the parachute canopy as his feet contact the water. Otherwise, the parachute canopy may settle around him and he may become entangled in the straps and canopy and drown. Also, the parachute canopy can drag the airman through the water where there are strong surface winds and/or air currents.

The airman must also, soon after contacting the water, inflate his life vest to preserve his buoyancy. Such life vests typically include a cannister of compressed gas with a mechanism for piercing the cannister to release the gas into the inflatable portion of the life vest. Typically, such piercing mechanisms require manual manipulation by the pilot.

Frequently, the airmen ejecting from the disabled aircraft are injured or unconscious when they enter the water and cannot carry out the proper manual maneuvers to ensure their survival.

In U.S. Pat. No. 3,426,942, issued on Feb. 11, 1969, to B. D. McMains, et al., a water-sensitive energizing apparatus is described wherein a silicon-controlled rectifier used as a thyristor switch interrupts a circuit loop having a battery and an explosive squib. The McMain apparatus further includes two substantially parallel conductor plates of dissimilar metals to provide a galvanic element. The conductor plates are connected to the battery such that the electrical potential of the galvanic unit opposes that of the battery. Immersion of the plates in water completes the galvanic cell allowing current conduction which switches the thyristor to close the circuit loop between the battery and the explosive squib for detonating the squib.

However, in the McMain circuit, the battery must have a sufficient current capacity to cause the squib to detonate. The galvanic unit saps that current source. In addition, the current conduction characteristics of the galvanic unit are temperature-dependent, thus making the entire circuit temperature-dependent. Another defect of the McMain circuit is that droplets of water, due to condensation and other debris, can accumulate between the conductor plates to cause a slow current leak which again saps the current capacity of the battery. Moreover, in the McMain circuit, there is a distinct possibility that sufficient water and debris can collect between the plates to cause the thyristor to fire prematurely.

The primary disadvantage of the McMain circuit is that the power source has a relatively short shelf life because of current leakage and, for that reason, must be frequently checked. Such checks are easily forgotten or omitted by human personnel.

SUMMARY OF THE INVENTION

An electronic water-activated package is described which automatically energizes a webbing strap release mechanism and a cannister piercing mechanism upon immersion in water. Specifically, separate water-sensitive electronic packages are integrally incorporated into break away webbing frames securing a parachute canopy to a parachute harness and into an inflation assembly at the bottom of each lapel of a life vest.

The water-activated electronics package includes a self-contained power source, an electrical explosive device, a capacitor discharge circuit for detonating the electrical explosive device, and a water-sensing circuit which, in addition to triggering the capacitor discharge circuit, also minimizes current leakage from the power source. The invented electronic water-activated package, when incorporated into the break away webbing frame and into the inflation assembly, are completely self-contained and do not require external connections and/or circuitry.

In addition, the elements of the circuit which minimize current leakage from the power source give the invented electronics package a shelf life on the order of five to ten years. Moreover, by utilizing a capacitor discharge circuit to detonate the explosive device, the power source need only charge the capacitor and is not required to have sufficient current capacity to detonate the explosive device. Finally, the invented release includes electronic elements which render it relatively insensitive to environmental temperature changes.

DESCRIPTION OF THE FIGURES

FIG. **1** is a schematic of the electronics package which is integrally mounted within a break away webbing frame.

FIG. **2** is a top view of a break away webbing frame showing the electronics package mounted therein. The webbing frame illustrated also includes male prongs for insertion into a conventional manual release mechanism, also shown.

FIG. **3** is a right-side profile of the break away frame and manual release shown in FIG. **1.**

FIG. **4** is a left-side profile of the break away webbing frame shown in FIG. **1** with the cover shield partially cut away.

FIG. **5** is a partial cutaway, top view, of the release in a locked position.

FIG. **6** is a partial sectional view taken along lines **6—6** of FIG. **5.**

FIG. **7** is a partial cutaway, top view, of the release in its break away configuration.

FIG. **8** is a cutaway sectional view taken along lines **8—8** of FIG. **7.**

FIG. **9** is a frontal view of the life preserver showing the location of the automatic inflating assemblies incorporated into each lower lapel of the preserver.

FIG. **10** is an enlarged cross sectional view of the automatic inflating assembly (detail A of FIG. **9**).

FIG. 11 is a cutaway sectional view taken along lines A—A of FIG. 10.

DETAILED DESCRIPTION

Description of the Structure of the Break Away Release

The invented release mechanism includes a break away webbing frame 11 having male latching prongs 12 adapted for insertion into a conventional manual release mechanism 13. A webbing pin 14 is pivotably mounted on one corner of the webbing frame, and a side bar 16 is pivotably mounted to the opposite corner of the webbing frame 11. A webbing strap 17 is secured around the webbing pin 14. The side bar 16 captures the free end of the webbing pin and is locked to the webbing frame 11 by a releasable ball lock detent mechanism 20.

Referring to FIGS. 6 and 8, the ball lock detent mechanism 20 includes a hollow cylindrical protrusion 31 extending perpendicularly inward into the webbing frame 11 from the side bar 16. Coaxially mounted within the protrusion 31 is a spring-loaded cylindrical release plunger 32, having a large diameter section 33, conically tapering to a small diameter section 34. A plurality of steel balls 35 are disposed in an equal number of holes through the sidewall of the cylindrical protrusion 31 near its end. When the mechanism is in a locked position, as shown in FIG. 6, the balls rest against the larger diameter section 33 of the release plunger 32. The diameter of the balls 35 are chosen such that they extend beyond the sidewall of this cylindrical protrusion 31 when resting on the larger diameter section 33 of the release plunger 32. A spring 37 holds the release plunger 32 in a "normally locked" position.

A cylindrical receptable 38 in the webbing frame 11 receives the locking protrusion 31 of the side bar 16. The receptacle 38 includes an annular shoulder 39 at its entrant end of a slightly smaller diameter than the receptacle for engaging the steel balls 35 of the cylindrical protrusion 31 when the protrusion is in a locking posture. (See FIG. 6).

To release the ball lock detent mechanism 20, the release plunger 32 is depressed against the spring 37 allowing the balls 35 to drop down in their respective holes 36 against the smaller diameter section 34 of the release plunger 32 where they cannot engage the annular shoulder 39 of the receptacle 38.

As shown in FIG. 6, the release plunger is depressed by a piston actuator 41 of an electrical explosive cartride unit 40. The cartridge unit 40 includes a cylindrical chamber 42 for receiving the piston actuator 41. An explosive charge 43 is disposed behind the piston actuator 41 and the chamber 42. The unit 40 is secured to a mounting plate 21 and fits within a rectangular receptacle 44 within the webbing frame 11.

In operation, the explosive charge is detonated by an electrical current pulse whereupon hot combustion gases drive the piston actuator 41 outward in its cylindrical chamber 42. The extending piston actuator 41 first depresses the release plunger 32 sufficiently to allow the balls 35 to drop down into their respective holes 36, releasing the lock. The extending piston 41 then engages the end of the cylindrical protrusion 31 to drive the side bar 16 outward to thereby free the end of the webbing pin 14. The tensile force extant on the webbing strap 17 causes the webbing pin 14 to pivot outward, whereupon the strap 17 pulls free as shown in FIG. 7.

Description of the Electronics

Referring to FIG. 1, the water-sensing circuitry includes a battery BT-1 with a positive and negative terminal and an intermediate positive voltage tap. A PNP transistor Q-1 switches a silicon-controlled switch Q-2 responsive to current conduction between the two electrodes, 22*a* and 22*b*, of the water sensor A-1. The electrodes 22*a* and 22*b* are connected to the positive and negative terminals of the battery BT-1 respectively. The switch Q-2 serially interrupts the current pulse-generating circuit between the negative terminal of the battery and a capacitor C-4. When the silicon-controlled switch Q-2 is switched to a conducting status, the capacitor C-4 is allowed to charge.

The current pulse-generating loop includes a silicon-controlled switch Q-4 connected in series between the capacitor C-4 and a bridgewire of an electrical explosive device designated as EED-1. The switch Q-4 is switched to a conducting state by a PNP transistor Q-3 which becomes conducting between the emitter and collector responsive to the potential difference across the capacitor C-4. Upon switching, the switch Q-4 discharges the charge buildup across the capacitor through the bridgewire EED-1 to detonate the electrical explosive device.

The emitters of the transistors Q-1 and Q-3 are connected directly to the positive voltage tap of the battery BT-1. A temperature-compensating diode CR-1 is connected between the positive terminal of the battery BT-1 and the base of the transistors Q-1 and Q-3 through resistances R-3 and R-6 respectively. The diode CR-1 is also connected serially between the electrode 22*a* and the positive terminal of the battery BT-1.

The diode CR-1 renders the described circuit relatively insensitive to environmental temperature changes. Specifically, environmental temperature changes affect the base voltage potential at which the transistors Q-1 and Q-3 become conducting through their collectors and emitters respectively. In particular, as temperature increases, a smaller potential difference is required between the bases and emitters of the transistors Q-1 and Q-3 to "turn on," i.e., become conducting between the emitter-collector connections. The effect of temperature on the transistors Q-1 and Q-3 is compensated by the diode CR-1 in that, as the temperature of the package increases, the forward drop voltage of the diode CR-1 decreases, raising the positive potential on its cathode. The increase of the positive potential on the cathode also increases the positive potential at the base of the PNP transistors Q-1 and Q-3. The transistors Q-1 and Q-3 and the temperature-compensating diode CR-1 are chosen such that the increased positive potential supplied by CR-1 offsets the decreased "turn on" potential between the bases and emitters of the transistors Q-1 and Q-3 as temperature increases.

From the above, it should be obvious to those skilled in the art that the diode CR-1 not only holds the sensitivity of the water-sensing circuitry loop approximately constant, it also insures that the capacitor C-4 is completely charged before it is discharged through the electrical explosive device EED-1. The resistances R-1 through R-9 insure proper ratios of potential differences between the described circuitry components to

optimize the function of the circuit. The resistance R-11 between the silicon-controlled switch Q-2 and the capacitor C-4 is optional. Specifically, it is designed to limit the amount of current flowing in the current loop defined by the battery and the electrical explosive device.

All of the circuitry elements, including the battery BT-1, are packaged in a unitized metal shield connected to the circuitry with a single high-point resistance R-10 to prevent electrostatic charge buildup in the capacitor C-4 and to isolate the described circuit from strong electromagnetic fields. The conductors to the electrodes 22*a* and 22*b* pass through the shield via ceramic low-pass filter feeds C-2. In addition, a monolithic by-pass capacitor C-3 is connected directly to the base of the transistor Q-1 and through resistances R-3 and R-6 to the base of the transistor Q-3.

The described circuit functions as follows: As the water-sensor A-1 is immersed in water, the base of the transistor becomes negative due to conduction from the base of Q-1 through the resistance of R-1, the water-sensor A-1 and the resistance R-2 to the negative terminal of the battery BT-1. When the potential difference between the base and emitter of Q-1 reaches its "turn on" threshold, a conduction path is provided through its emitter and collector from the positive voltage tap of the battery BT-1 through the resistance R-2 to the negative terminal of the battery BT-1. The potential drop across the resistance R-5 causes the gate of the silicon-controlled switch Q-2 to become positive through the resistance of R-4. As the gate of the switch Q-2 becomes positive, it switches to a conducting state allowing the capacitor C-4 to charge through the current-limiting resistance R-11. when the capacitor C-4 is fully charged, the "turn on" potential difference between the base and emitter of the transistor Q-3 is reached, thereby allowing conduction through its emitter and collector from the positive voltage tap to the silicon-controlled switch Q-4. The potential drop across R-8 causes the gate of the switch Q-4 to become positive, switching it to a conducting state. Upon switching to a conducting state, the switch Q-4 allows the positive charge built up across the capacitor C-4 to discharge through the electrical explosive device EED-1 to detonate the explosive charge.

The described water-sensing circuit not only switches the capacitor-discharge circuit to generate an electrical current pulse, but also minimizes current leakage from the battery BT-1. Specifically, absent a conduction path between the electrodes 22*a* and 22*b* of the water-sensor A-1, current leakage from the battery BT-1 occurs through three circuit elements: (1) The monolithic capacitor C-3 connected between the positive voltage tap of the battery BT-1 and the base of the transistor Q-1; (2) The transistor Q-1; and, (3) The silicon-controlled switch Q-2.

The monolithic capacitor C-3 is chosen to have a minimum insulation resistance greater than 5,000 megohms, such that current leakage through it is reduced to an insignificant value. Evaluation of leakage currents through the transistor Q-1 and the silicon-controlled switch Q-2 should be considered at the full-rated voltage of each device at 50°. For example, if Q-1 is chosen to have a rated leakage of 35 nanoamps at 45 volts and the switch Q-2 rated to have a leakage of 90 nanoamps at 30 volts, the total maximum leakage is approximately 125 nanoamps at 50°C. If the battery BT-1 has an available life of 180 M.A.H., the 125 nanoamp leakage represents only about 5.5 M.A.H. of the available battery life. This amount is approximately equal to 3% of the battery life lost in 5 years of storage.

Referring now to FIGS. 4 and 5, the electrical circuitry components are mounted in a unitized metal-covered package and mounted within an L-shaped cavity 19 within the webbing frame 11. The electrical components are sealed from the outside environment by a mounting plate 21 secured to the webbing frame 11. Two water-sensing electrodes 22*a* and 22*b* are mounted on the exterior of the mounting plate 21 and are insulated therefrom by the low-pass ceramic feed-through filters 23. The perforated shield 24 covers the two electrodes 22*a* and 22*b* to prevent inadvertent shorting therebetween. The perforations in the shield 24 allow air bubbles to escape from the shiled when the release is immersed in water.

As shown in FIG. 4, electrodes 22*a* and 22*b* extend perpendicularly through the mounting plate 21. The post-like configuration of the electrodes 22*a* and 22*b* prevent and minimize inadvertent shorting and leakage therebetween due to water condensation or debris. The electrodes are gold-plated to enhance their sensitivity to moisture and water vapor and to maximize their corrosion resistance.

Description of Structure of Life Preserver Inflating Assembly

Referring now to FIG. 9, the airman is provided with an inflatable life preserver 46 in which the automatic inflating assembly 47 is incorporated into the bottom section of each lapel of the preserver 46. The automatic inflating assembly 47 includes a cannister 48 containing compressed gas at high pressure, a cannister piercing mechanism 49, and a water-sensing electronics actuator package 51.

In more detail, referring to FIG. 10 showing the cross-sectional view of the automatic inflating assembly 47, the cannister piercing mechanism 49 comprises a cast structure 52 having a port 53 appropriately threaded for receiving the neck of a high pressure gas cannister 48. A set screw 54 prevents the gas cannister 48 threaded into the port 53 from vibrating free. A piercing pin 56 is located in a passageway 57 through the cast structure 52 in axial alignment with the gas cannister port 53. The piercing pin 56 includes a piercing point 58, a shank 59, an annular shoulder 61, and a rounded head 62. A bushing 63, disposed in the passageway 57, holds the piercing pin 56 in axial alignment with the cannister port 53. A spring 64 is disposed between the bushing 63 and the annular shoulder 61 of the piercing pin 56. An O-ring seal 66 is disposed around the piercing pin 56 between the annular shoulder 61 and the rounded head 62 of the pin. The end of the passageway 57 proximate the gas cannister port 53 defines a gas plenum 67 having a vent 68 which ultimately communicates to the inflatable portion of the life preserver 46 (not shown).

The rounded head 62 of the piercing pin 56 extends out of the passageway 57 and engages a rotatable cam 69. As shown in FIG. 10, the cam 69 is adapted to rotate clockwise about a pivot pin 71, as indicated by the arrow 72. A manual lever 73 also pivots on the pin 71 and is adapted to rotate the cam 69 when pulled in the direction of the arrow 74. The cam 69 is also adapted

to be rotatably driven by a transfer plunger **76** from the water-sensing electronic actuator package **51.**

The cannister piercing mechanism **49** operates as follows: With reference to FIG. **10,** as the cam **69** rotates clockwise, the piercing pin **56** is driven upward until the piercing point **58** of the pin breaks the closure membrane **77** of the gas cannister **48.** The cam **69** continues to rotate until the recessed section **75** is in alignment with the piercing pin **56,** whereupon the combined effect of gas pressure in the cannister and the compressive force of the spring **64** force the pin back out, whereupon the rounded head **62** of the pin is received in the recessed section **75** of the cam **69.** Gas vents from the cannister **48** into the plenum **67,** then through the vent **68** into the inflatable section of the life preserver.

Referring now to both FIGS. **10** and **11,** the water-sensing electronic actuator package **51** includes an enclosure **78** adapted to be mounted on the cannister piercing mechanism **49,** above the manual actuator lever **73.** The package **51** includes a watertight container **79** for receiving batteries **81.** The water-sensing circuitry is mounted on a printed circuit board **82.** The enclosure is then filled with a conventional potting compound **83,** isolating the circuit from water and moisture. The transfer plunger **76** of the actuator package **51** is disposed in a retainer sleeve **84.** An electrical explosive device **86** is disposed in the retainer sleeve **84** behind the transfer plunger **76.** The free end of the transfer plunger **76** engages the cam **69** of the piercing mechanism **49.** Water-sensing electrodes **22***a* and **22***b* are mounted on the actuator package enclosure **78** on either side of the manual actuator plunger **73** of the piercing mechanism **49.**

In more detail, referring to FIG. **11,** the water-sensing electrodes **22***a* and **22***b* of the water-sensing circuit hereinbefore described each include a central conductive pin **87** extending through the enclosure wall **78** of the actuator package. The extending pins are surrounded by an insulative sleeve **88** having a relief **89** to expose a portion of the pin **87** to the environment. The reliefs **89** in the insulative sleeves face or open in opposite directions to preclude shorting of the electrodes by a small amount of water.

Referring back to FIG. **9,** the entire automatic inflating assembly **47** is received in an enclosure integral with the life preserver **46.** The bottom of the enclosure containing the automatic inflating assembly is sealed from the environment by a stretched nylon fabric **50.** Accordingly, the sensing electrodes **22***a* and **22***b* of the water-sensing electronic acutator package **51** are isolated from dust and dirt. However, upon the immersion of the vest in water, water quickly percolates through the stretched nylon fabric **50,** establishing electrical conduction between the sensing electrodes **22***a* and **22***b*, whereupon the circuit detonates the electrical explosion device **86** for energizing the transfer plunger **76** and rotating the cam **69.**

FIG. **1** gives a complete specification of an exemplary circuit designed according to the teachings of this invention. The battery BT-**1** can be four 1.35-volt mercury cells connected in series to provide a 5.4-volt battery rated at 180 M.A.H., when the sensing electrodes are immersed in a liquid medium having a conductance of 100 MHO or greater.

While the invented water-activated parachute canopy release mechanism is described with respect to exemplary, representative and schematic embodiments, it should be apparent to those skilled in the art that numerous variations and modifications can be effected within the scope and spirit of the invention as described hereinabove and as defined and set forth in the appended claims.

We claim:

1. A water-sensitive energizing electrical circuit for detonating electrical explosive devices upon immersion in water comprising, in combination,

a source of electrical current,

a first means of generating an electrical current pulse at an output,

a switching means for minimizing current leakage from said current source prior to immersion of said circuit in water and for switching said first means to generate a current pulse responsive to immersion in water, said switching means being connected between said current source and said first means,

and a temperature compensation means for minimizing temperature dependence of said first means and said switching means respectively, said temperature compensation means being connected between said current source and each of said means respectively.

2. The circuit of claim **1** further defined in that said electrical current source comprises a battery having a positive terminal, a negative terminal and an intermediate positive voltage tap.

3. The circuit of claim **2** further defined in that first means for generating an electrical current pulse comprises

a capacitor connected between the positive and negative terminals of the battery in parallel with the electrical explosive device,

sensing means for sensing electrical potential across said capacitor, said sensing means being connected to said temperature compensating means,

a first controlled switching means having a conducting and a non-conducting state connected in series in a circuit loop defined by said capacitor and said electrical explosive device and having a gate connected to said sensing means whereby said first controlled switching means changes from a non-conducting to a conducting state responsive to a signal from said sensing means allowing electrical charge buildup across said capacitor to discharge through said electrical explosive device.

4. The circuit of claim **3** further defined in that said first controlled switching means comprises a silicon-controlled switch having a gate connection; a first resistance connected serially between the gate connection and the sensing means and a second resistance connected serially between said gate connection and the negative terminal of the battery, said silicon-controlled switch having a non-conducting state when a negative potential is impressed on said gate connection and having a conducting state when a positive potential is impressed upon said gate.

5. The circuit of claim **4** further defined in that said sensing means comprises a PNP transistor having an emitter connected to said intermediate positive voltage tap of the battery, a base connected between said capacitor and said negative terminal of said battery and a collector connected to said first resistance; said PNP transistor having a "turn on" potential difference be-

tween the base and emitter at which electrical conduction occurs through the emitter and collector; said temperature-compensating means being connected serially with a resistance between said base of said transistor and said positive terminal of said battery for compensating a decreasing "turn on" potential difference between said base and said emitter of said transistor as temperature increases, whereby, upon said capacitor becoming fully charged, the potential difference between the base and emitter of the transistor reaches the "turn on" potential difference and allows conduction of a positive potential from said positive voltage tap through the emitter and collector of the transistor to be impressed upon said gate of said silicon-controlled switch.

6. The circuit of claim **2** further defined in that said switching means for minimizing current leakage from said current source prior to immersion of said circuit in water and for switching said first means to generate a current pulse comprises, in combination,

a first water-sensing electrode electrically connected to the positive terminal of said battery,

a second water-sensing electrode electrically connected to the negative terminal of said battery,

means for sensing electrical conduction between said first and second electrodes,

a second controlled switching means for allowing current flow to said first means, said second controlled switching means being serially connected between the negative terminal of said battery and said first means and having a gate connection, said second controlled switching means having a non-conducting state when a negative potential is impressed upon said gate connection and a conducting state when a positive potential is impressed upon said gate connection, said gate connection being connected to said means for sensing current conduction between said first and second electrodes, whereby said means for sensing conduction between said electrodes impresses a positive potential on said gate of said second controlled switch causing it to become conducting, allowing current flow into first means.

7. The circuit of claim **6** further defined in that said second controlled switching means comprises a silicon-controlled switch connected serially between said first means and said negative terminal of said battery having a gate connection; a fourth resistance connected serially between said gate connection and said means for sensing current flow between said electrodes and a fifth resistance connected serially between fourth resistance and said negative terminal of said battery.

8. The circuit of claim **7** further defined in that said means for sensing current conduction between said electrodes comprises, in combination, a second PNP transistor having a base connected between said first electrode and said positive terminal of said battery, an emitter connected to said positive voltage tap of said battery and a collector connected to said fourth resistance; said second transistor having a "turn on" potential difference between said base and emitter at which electrical current conduction occurs through said emitter and collector; said temperature-compensation means being connected serially between the base of said second transistor and the positive voltage terminal of said battery for compensating a decreasing "turn on" potential difference between the base and emitter of said second transistor as temperature increases, whereby current conduction between said first and second electrodes causes a "turn on" potential difference between said base and emitter of said second transistor allowing a positive potential from said voltage tap to be impressed through the emitter and collector of said second transistor on said gate of said second silicon-controlled switch to thereby allow current conduction to said first means.

9. The circuit of claim **8** further defined in that said temperature-compensating means comprises a silicon diode and in that said PNP transistor is a silicon PNP transistor.

10. The invention specified in claim **1**, and an inflating assembly for an inflatable life vest including a cannister containing high pressure gas, having a piercable closure membrane disposed across a necked section of said cannister, and a structure adapted to hermetically receive said necked section of said cannister for conveying gas from said cannister to said inflatable life vest, the structure comprising

a piercing mechanism incorporated into said structure adapted to pierce said closure membrane and

actuator means for operating said piercing mechanism, responsive to an electrical current pulse from said first means; said first means, said switching means and said actuator means being encapsulated in a unitary package adapted to be mounted on said structure.

11. The device of claim **10** wherein said piercing mechanism comprises

a piercing pin disposed in a passageway defined through said structure, said passageway communicating with the necked section of said cannister received in said structure, said pin having a point proximate said closure membrane across said necked section of said cannister and having a rounded head extending out of said passageway,

a rotatable cam pivotably mounted in said structure, adapted to drive the rounded head of said pin into said passageway upon rotation, to thereby pierce said closure membrane, said rotatable cam being adapted for rotation responsive to said actuator means.

12. The device of claim **11** further defined in that said actuator means comprises, in combination,

a retainer sleeve having an open end and a closed end,

a plunger disposed in said retainer sleeve adapted to extend out said open end of said sleeve responsive to gas pressure and engage and rotate said rotatable cam,

an explosive charge for generating gas pressure upon detonation disposed within said sleeve between said plunger and said closed end of said sleeve,

and means for electrically detonating said charge whereby said plunger moves outward from said sleeve responsive to gas pressure generated by said exploding charge to rotate said cam and drive said piercing pin through said closure membrane of said cannister.

13. The device of claim **12** further defined in that said means for electrically detonating said explosive charge comprises a bridgewire which vaporizes upon conduction of an electrical current pulse therethrough, said bridgewire being imbedded in said said explosive

charge, and in that said first means includes a self-contained current source.

14. The device of claim **13** further defined in that said switching means for switching said first means to generate a current pulse in response to immersion in water further includes a means for minimizing current leakage from said current source prior to immersion of said assembly in water.

15. The device of claim **14** wherein said piercing mechanism further includes a lever pivotably mounted on said structure for rotating said rotatable cam, whereby said piercing mechanism can be operated manually by said lever.

16. The device of claim **15** further comprising a temperature-compensating means for minimizing the temperature dependence of said first means and said switching means which means includes a silicon diode and a silicon PNP transistor.

17. The device of claim **16** further defined in that said life vest includes an enclosure for receiving said inflating assembly, said enclosure having a stretched fabric membrane for allowing passage of water and for preventing passage of particulate debris.

18. The device of claim **14** here further defined in that said current source comprises a battery.

19. In a parachute strap release mechanism, including a webbing frame, a webbing pin pivotably connected at one end to said frame, a side bar for releasably securing the free end of said webbing pin for holding a strap, and a latching means for securing said side bar to said frame, the combination comprising,

a first means for generating an electrical current pulse at an output,

switching means for switching said first means to generate a current pulse responsive to immersion in water,

actuator means for disengaging said latching means and for forcing said side bar outward to release said webbing pin responsive to an electrical current pulse from said first means,

and temperature-compensating means for minimizing the temperature dependence of said first means and said switching means; said first means, said switching means, said actuator means and said temperature-compensating means being encapsulated in a unitary package mounted integrally within said webbing frame.

20. The device of claim **19** further defined in that said actuator means comprises, in combination,

a chamber having an open end and a closed end,

a piston disposed in said chamber adapted to extend out said open end of said chamber responsive to gas pressure,

an explosive charge for generating gas pressure upon detonation disposed within said chamber between said piston and said closed end of said chamber,

and means for electrically detonating said charge whereby said piston moves outward from said chamber responsive to gas pressure generated by said charge to disengage said latching means and to force said side bar outward to thereby release said webbing pin.

21. The device described in claim **20** further defined in that said means for electrically detonating said explosive charge comprise a bridgewire which vaporizes upon conduction of an electrical current pulse therethrough, and in that said first means includes a self contained current source.

22. The device described in claim **21** further defined in that said switching means for switching said first means to generate a current pulse responsive to immersion in water further includes a means for minimizing current leakage from said current source prior to immersion of said release in water.

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