

age is applied from a potentiometer 117 and also by way of an attenuating pad 162 and a resistor 163 to terminal 131. Terminal 131 is connected to ground by way of a resistor 164. With no unbalance signal present in the system, the voltage from potentiometer 117 is applied to terminal 131 in an amount exactly equal to the DC bias applied to an input terminal 165 of amplifier 132.

In the pulse generator 98, the 400 cycle voltage is applied by way of resistor 170 to a Zener diode 171 which clips the peaks of the voltage wave and maintains a relatively constant reference voltage. The positive going waves are passed by way of diode 172 to the base electrode of a transistor 173. The transistor 173 generates a spacer pulse which is applied to transistor 174 by way of diode 175. The time delay is such that a positive going pulse of 0.0002 seconds is generated at the collector of transistor 174 and applied by way of a line 176 and diode 177 to the input terminal 131 of the amplifier 132 of fixed high gain. The positive going pulse is also applied to the base of a transistor 178 whose output is a negative going pulse of 0.0002 seconds duration. The latter pulse is applied by way of a line 179 from the cathode electrode of the transistor 178 and by way of diode 180 to the input terminal 165.

The positive and negative going pulses applied to amplifier 132 serve to actuate the amplifier 132 for relatively short intervals during each cycle. For example, the period of the 400 cycle input signal is 2.5 milliseconds whereas the gating pulses centered at the positive and negative half cycles are 0.0002 seconds. The unbalance signal which may be applied to terminal 131 from either the gyro 20, the potentiometer 114, or the feedback transducer 50 will thus be amplified in amplifier 132. Amplifier 132 comprises three stages 191, 192 and 193. The emitter electrode of the output stage 193 is connected by way of channel 194 to the center tap of an input transformer 195 of a bilateral gate 196. Gate 196 is in all essential characteristics the same as gate 136 including a sample and hold capacitor 197. The voltage across the capacitor 197 is applied to the input of a Darlington connected pair of transistors 199 and 200. The collector electrode of the output transistor 200 is connected by way of resistor 201 to one terminal of the torque motor winding 112. The other terminal of the torque motor winding 112 is connected by way of a resistor 202 to the emitter electrode of transistor 193 and by way of resistor 203 to ground. Negative gating pulses are applied to the gate 196 by way of conductor 204. The circuit operates such that during the period of the negative going pulses on channel 204 a voltage is stored on capacitor 197. This voltage is then compared with the voltage appearing at the emitter of transistor 193 during the remainder of each cycle. The difference in voltage is representative of the current which flows through the torque motor winding 112. This voltage may be either positive or negative and thus may be employed to control a flapper in a conventional hydraulic actuator. When no current flows through the torque motor winding 112, the flapper in the first stage of a hydraulic actuator, such as actuator 16, is in a balanced position. Positive or negative current flowing in the winding 112 will change the position of the flapper in the hydraulic actuator to cause the actuator to make a suitable change in the control system.

It will now be seen that the compensating networks 24 and 38 of FIG. 1 have been consolidated in FIG. 10. That is, the command signal from tap 114 and the error signal from the gyro 20 pass through the same lag network wherein the lag is controlled by condenser 151. They pass through a first gating amplifier stage 152 and thence through the washout circuit which includes condenser 154 and resistor 155. Terminal 131 represents the summation point for signals from the washout circuit and from the feedback actuator transducer 16, the signal from the latter transducer being applied to terminal 116.

The use of one lag circuit and one washout circuit for both the command signal and the error signal assures identical phase and amplitude responses and permits introduction of a

command from lever 10 without compromise or alteration of the gain of amplifier 132.

Where desired, separate lag and washout circuits may be employed.

Further, only one channel has been shown, it being understood that such a channel will be provided for each of the yaw, roll and pitch axes in a complete stability control augmentation system.

While a preferred embodiment of the invention, together with modifications thereof, has been described in detail herein and shown in the accompanying drawing, it will be evident that various further modifications are possible in the arrangement and construction of its components without departing from the scope of the invention.

I claim:

1. An aircraft control system for selectively establishing and maintaining an attitude rate in the presence of disturbing forces from wind gusts, weapon recoil, and the like, which comprises:

- a. a control loop including said aircraft, a reference element coupled to said aircraft, first signal coupling means connected to said reference element, a fixed high gain amplifier for amplifying error signals from said coupling means and an actuator responsive to signals from said amplifier for continuous control of said attitude rate;
- b. a manual input element for introducing a command for a desired change in attitude rate including transducer means to produce a command signal, and
- c. second coupling means for applying said command signal with said error signal for amplification in said amplifier to produce a specific aircraft attitude rate response independent of the response of said control loop to said disturbing forces.

2. The combination set forth in claim 1 wherein said coupling means apply said command signal and said error signal to the input to said amplifier with time delays and frequency responses which bear predetermined relationships to each other.

3. The combination set forth in claim 2 wherein said coupling means have the same time delays and the same frequency responses.

4. The combination set forth in claim 2 in which said coupling means are common to the signal paths for both said error signal and said command signal.

5. In a control and stabilization system for a vehicle, the combination comprising:

- a feedback system having an outer feedback loop which includes said vehicle and responsive to external forces applied to thereto to provide stabilization relative to an established course, said feedback system also including an inner control feedback loop responsive to the amount of stabilization provided by said first feedback loop, and
- a feedforward control loop including a command element and means responsive to commands applied to the vehicle and having a fixed high gain amplifier means common to said inner loop for controlling the course of travel of the vehicle, and

a compensating network having a lag and washout circuit in said outer feedback loop which also forms a lag and washout circuit in said feedforward control loop.

6. A control and stabilization system for a vehicle, the combination comprising:

pilot control means for controlling the direction of travel of said vehicle,

actuating means having a mechanical input proportional to a desired rate of change in direction of travel of said vehicle coupled to said control means for establishing the position of said actuating means,

first transducer means for detecting the rate of divergence of said vehicle from an established direction of travel,

a fixed high gain amplifier completing a feedback loop between said transducer means and said actuating means for applying a signal to said actuating means proportional

FIG. 1

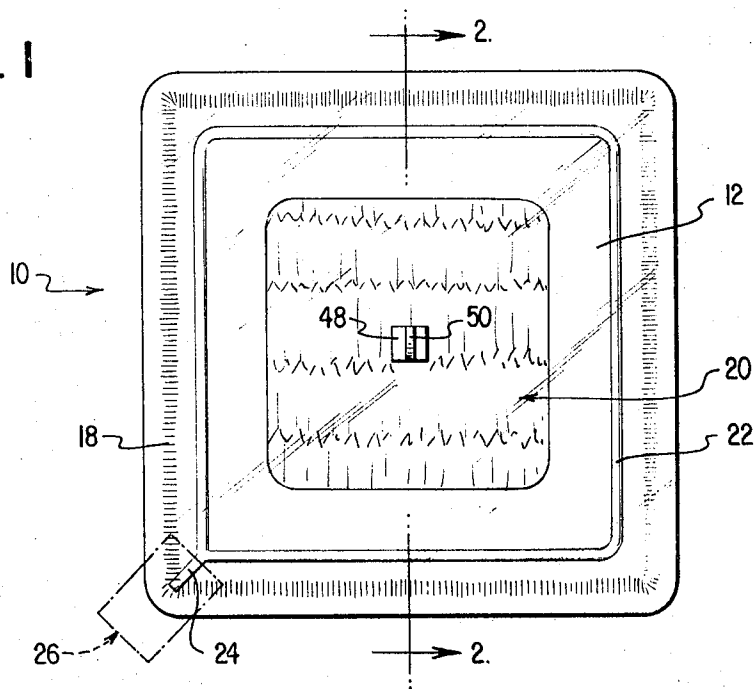


FIG. 2

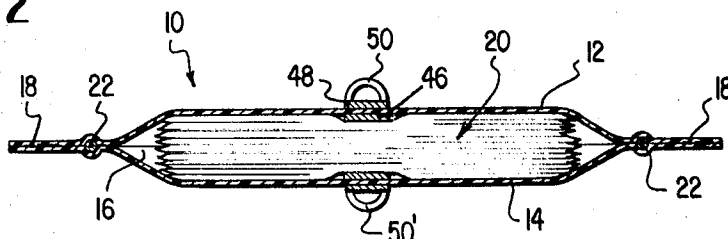
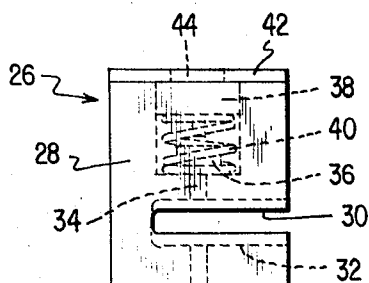
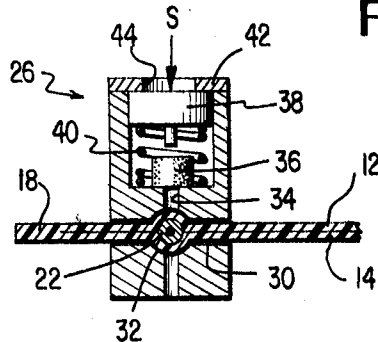


FIG. 3

FIG. 4

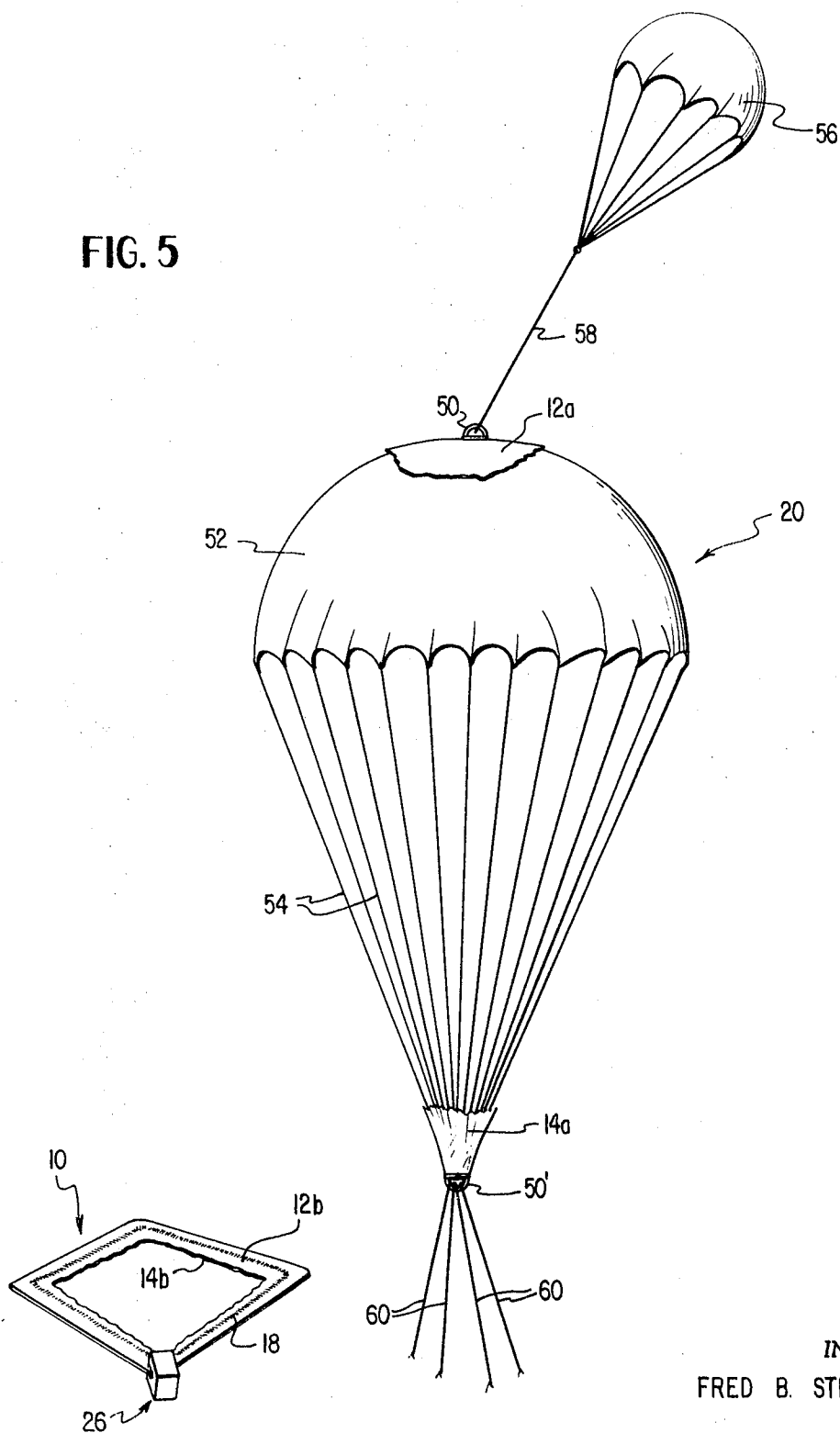


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FIG. 5



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METHOD AND MEANS FOR OPENING VACUUMIZED PARACHUTE PACKAGE

This invention relates to parachutes and more particularly it relates to vacuum packed parachutes and a method and means for opening the vacuumized package to enable the parachute to be deployed.

It is well known that parachutes are prefolded and prepacked before use, and subsequently are inserted into a parachute pack which can be attached by a harness to the load which is to be lowered by the parachute. The most common form of parachute pack is, of course, the canvass bag or container, but it is also a known expedient to package such parachutes in a vacuumized or evacuated container.

It is felt that packing a parachute in a vacuum packed container possesses certain benefits and advantages not realizable with conventional parachute packs, such as canvass bags. That is, the vacuum packaging of the parachute creates a higher density of the parachute itself, thereby enabling the size of the parachute pack to be smaller. Also, vacuum packaging protects the parachute since the same is hermetically sealed, and it thereby extends the useable life of the parachute, as well as eliminating the need for frequent repacking. Moreover, such vacuumized parachute packs are protected from the deleterious effects of weather, moisture and liquids or chemicals to which the package might ordinarily be exposed. For all of these reasons, it is believed that a vacuum packed parachute offers significant advantages and benefits. The difficulty, however, with such vacuumized parachute packages resides in finding a means for quickly and efficiently opening the package. It must be realized, of course, that the occupant of an aircraft might find himself in need of the parachute under extreme emergency conditions and the package in which the parachute is contained must therefore be of the type which can be opened very quickly and without the need for undue manual manipulation. In the case of an aircraft where the occupant is seated within an ejection seat, such occupant, in the event of an emergency, will immediately initiate ejection procedures which will cause the ejection seat to be propelled upwardly out of the aircraft, and will subsequently separate the occupant from the seat at some point in space. Once the occupant and the ejection seat have been propelled out of the aircraft, it is of vital importance that the parachute be deployed quickly and properly, and it is unrealistic to expect the occupant to go through any unusual amount of manual manipulations at such time in an endeavor to get the parachute package open and the canopy deployed.

It can thus be seen that while vacuum packed parachutes do have certain advantages and benefits, they will not be fully useful and widely acceptable until some suitable means is provided for quickly and efficiently opening the package, and it is an object of the present invention to provide such means.

Another object of the present invention is to provide a method and means for quickly and efficiently opening a vacuumized parachute package with a minimum amount of manual manipulation.

Another object of the present invention is to provide a new and improved parachute package which incorporates a highly efficient opening means therein.

Another object of the present invention is to provide a package wherein a parachute is vacuum packed, and wherein the package is compact, safe, efficient, and easily opened.

Other objects, advantages and salient features of the present invention will become apparent from the following detailed description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment thereof.

Referring now to the drawings, which form a part of the original disclosure:

FIG. 1 is a plan view of a parachute package in accordance with the principles of the present invention;

FIG. 2 is a sectional view thereof taken along the line 2-2 of FIG. 1;

FIGS. 3 and 4 are respectively side elevational and sectional views of one suitable form of detonating means useable with the parachute package of the present invention; and

FIG. 5 is a diagrammatic view showing the parachute deployed after the package has been opened.

Referring now to the drawings in greater detail, the package of the present invention is generally designated 10 in FIG. 1 and it includes a pair of superposed plastic sheets, the uppermost of which is designated 12 and the lowermost of which is designated 14. These plastic sheets are advantageously formed of a thin, flexible synthetic resinous material such as polyethylene, polyvinylidene chloride, high impact polystyrene, or other similar plastic sheet or film materials.

The plastic sheets 12, 14 are joined together about their peripheral margins to form a sealed interior chamber 16. If two separate plastic sheets 12, 14 are used, then these sheets are superposed to one another and joined along their peripheral margins at 18 as by heat sealing the sheets together. A suitable alternative arrangement would be to use a single plastic sheet and to fold the same in half, thereby creating a top layer 12 and a bottom layer 14, whereupon only three of the peripheral margins would have to be heat sealed, the other one being sealed by the fold line.

A parachute generally designated 20 is prefolded and placed centrally within the interior chamber 16 and the chamber itself is then evacuated or vacuumized to create therewithin a vacuum in which the parachute 20 is maintained.

Prior to evacuation of the chamber 16, and during formation of the package 10, an elongated pyrotechnic fuze 22 is disposed within the chamber 16 adjacent to the peripheral margins of the plastic sheet where the heat sealing 18 is located. As shown clearly in FIG. 1, the fuze 22 completely surrounds the parachute 20 and is provided with a small projecting tail portion 24 near one corner of the package 10. The fuze itself can be fabricated of any suitable well-known pyrotechnic material, such as, for example, Primacord, or any other explosive powder packaged within a surrounding tubular sheath. When the chamber 16 is evacuated or vacuumized, the sheets 12 and 14 are, of course, pulled tightly toward one another thus causing the sheets to closely surround the fuze 22 throughout its entire path within the container 10.

The package 10 thus far described represents the item as manufactured, and due to the hermetically sealed conditions within the chamber 16, the parachute 20 and the fuze 22 will be protected and will have a long useful life. Packages 10 of this type can thus be stored on shelves, and otherwise maintained in storage until it is desired to use the same. When it is desired to install the package 10 as part of an escape system, however, suitable detonating means generally designated 26 must be provided for opening the package, and this detonating means 26 can advantageously work in conjunction with the tail portion 24 of the fuze 22, in the manner shown in FIG. 1. While various suitable forms of detonating means can be used, one such means is shown in FIGS. 3 and 4 in the form of a casing 28 having a slot 30 formed therein to enable the casing to be slipped over and attached to one end of the package 10. The slot 30 is provided with a central cylindrical bore 32 which is sized and shaped to receive the tail portion 24 of the fuze 22, with the plastic sheets surrounding the same, in the manner shown in FIG. 4. A port 34 extends transversely of the bore 32 and communicates with a recess in the housing 28 within which an explosive charge or primer charge 36 is located. The recess also contains a striker pin or firing pin 38 positioned above the primer charge 36 and a biasing spring 40 normally urging the pin 38 away from the charge 36. The movement urged by the spring 40 is resisted by means of a top cover 42 having a port 44 therein for receiving an initiating signal designated S. This initiating signal S can be supplied by any mechanical, pneumatic or electrical means, including an electrically fired squib. Once the signal is received, it forces the striker pin into contact with the charge 36 to explode the same, thereby causing a blast whose forces are directed

through the port 34 to burn through at least one of the plastic sheets, which, in FIG. 4 would be the uppermost sheet 12, and which subsequently ignites the fuze 22.

Once the fuze 22 is ignited by the detonating means 26, it will very rapidly burn around its entire length, thereby burning through at least one of the plastic sheets forming the package and hence causing the package to open so that the parachute 20 can be deployed out of the chamber 16. The rate of opening of the package depends directly upon the burning rate of the fuze 22, and this rate can be varied, as desired, to provide a preselected opening rate for the package 10. A typical opening rate would be in the neighborhood of 0.1 seconds although this rate could be increased or decreased, as desired.

In order to attach the parachute 20 to whatever load it is intended to lower, and also to attach such parachute to a drogue chute, if the same is to be used, suitable coupling means must be provided on the package 10. As shown most clearly in FIG. 2, such coupling means includes an inner disc 48 positioned within the package and connected with the parachute, an outer disc 46 located outside the package 10 and aligned with the inner disc 46, with the plastic sheet extending through and between the inner and outer discs 46 and 48. Such discs, however, are connected with one another by any suitable connecting means such as rivets or the like, but in no event does the interconnection of the discs 46 and 48 impair the integrity of the vacuumized chamber 16. An eye or open link 50 connects to the disc 48 for the purpose of connecting the parachute to a suitable remote member. For convenience, the uppermost eye or link can be designated 50 while the lowermost link will be designated 50'.

Referring now to FIG. 5 which shows the package after it has been opened, it will be seen that the parachute 20 consists of a main canopy 52 to which the uppermost link 50 is connected at the apex, and a series of suspension lines 54 connecting the skirt of the canopy 52 to the lowermost link 50'. A drogue parachute 56 is connected by a towline to the uppermost link 50 for the purpose of deploying the main canopy 52 out of the package 10, after the same has been opened. The central portion of the uppermost plastic sheet is designated 12a and it can be seen that the same is still connected to the apex of the canopy, while the lowermost plastic sheet central portion 14a is connected at the converging point for the suspension lines 54 of the parachute 20. Riser lines 60 connect from the lowermost link 50' to the man or load which is to be suspended and lowered by the parachute 20. FIG. 5 also shows the package 10 after the fuze 22 has been burnt to open the

same and it will be seen that the central portions 12a and 14a have been removed, thus leaving peripheral portions 12b and 14b.

Assuming that the parachute package 10 of the present invention is to be used in connection with an ejection seat, the package can remain closed until the automatic ejection sequencing operates the man-seat separation, which separation can be used to send the signal S to the detonating means for firing the fuze. Thus, the seat occupant's lap belt will open at man-seat separation and the occupant will move out of the seat at the same time that the detonating means fires the fuze 22 to thus cause the parachute 20 to deploy out of the package. As the parachute deploys into the airstream and opens, the occupant can then be lowered to safety.

After reading the foregoing detailed description, it will be apparent that the objects set forth at the outset of the specification have been successfully achieved by the present invention. Accordingly,

What I claim is:

1. A parachute package comprising a pair of superposed plastic sheets joined together about their peripheral margins to define a sealed interior chamber; a folded parachute disposed within said interior chamber; an elongated pyrotechnic fuze positioned within said chamber in surrounding relationship to said parachute; and means for detonating said fuze whereupon said fuze will burn through at least one of said plastic sheets to thereby open said chamber and permit said parachute to be deployed from said package.

2. A parachute package as defined in claim 1 wherein said chamber is evacuated thereby causing said sheets to closely surround said fuze.

3. A parachute package as defined in claim 2 wherein said plastic sheets are formed of thin, flexible synthetic resinous material and wherein at least a portion of said peripheral margins is joined by heat sealing said sheets together.

4. A parachute package as defined in claim 2 further including coupling means connected through said package to the parachute therein to enable said parachute to be connected to a remote member even while said chamber remains sealed.

5. A parachute package as defined in claim 2 wherein said detonating means includes a device having an explosive charge, a striker pin for firing the explosive charge and a port directing the blast from the explosive charge to one of said plastic sheets at a location overlying said fuze whereby said blast can burn through said one plastic sheet to ignite said fuze.

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