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METHOD OF INTERNALLY VENTING GASLESS DELAYS

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to time delay fuze and more particularly to a time delay fuze that may be hermetically sealed or potted either singularly or in a detonating device and be stored for long periods of time in an adverse environment without losing its dependability.

In the field of time delay fuzes it has been the general practice to vent the fuze either to the outside atmosphere or to large chambers provided within the detonating element. The time delay fuze used in an antiaircraft projectile which is vented to the outside burned at various rates depending on the atmospheric pressure. As the external pressure is reduced, the gases are vented at a more rapid rate, thereby reducing the heat and internal pressure in the fuze and allowing the powder of the time delay train to burn less rapidly than a fuze at normal atmospheric pressure. On account of the variations in atmospheric pressure and the irregularity of the combustion of the powder time train, it follows that a fuze which is designed and set to explode a projectile after the lapse of a predetermined interval of time can at best be merely an approximation of the time before the explosion occurs. Other units utilized at a large cavity in the detonating device to confine all the gases generated by the burning of the powder train. This causes the internal pressure and temperature within the device to rise and consequently cause faster combustion of the powder train than a vented fuze at atmospheric pressure. The increase of the burning rate can be as much as 2:1 over the non-obturated design. This rate of increase in burning is not always predictable or reproducible. In addition these fuzes could never be stored for long periods of time in adverse environments and thereafter be considered dependable.

Applicants' device overcomes the disadvantages of the prior art and provides a new and improved dependable uniform time delay train.

An object of the present invention is to provide a new and improved fuze time delay train.

Another object is to provide a time delay train fuze switch device designed to confine within itself all the gases generated by the burning powder train thereby creating a uniform time delay regardless of atmospheric pressure.

A further object is to provide a new and improved self contained fuze time delay capable of long term storage in an adverse environment without loss of dependability.

Still another object is to provide a new and improved self contained time delay fuze train capable of being potted and having a time delay substantially identical to that of a fuze operating under standard atmospheric conditions.

Yet another object is to provide a hermetically sealed self contained time delay fuze having a time delay similar to a vented fuze at standard pressures and capable of long term storage in adverse environments.

Further objects and the entire scope of the invention will become further apparent in the following detailed description and in the appended claims. The accompanying

drawings display the general construction and operational principles of an embodiment of the invention. It is to be understood, however, that the drawings are furnished by way of illustration and not in limitation of the invention in which:

FIG. 1 is an elevational view of a device utilizing the invention and showing the general construction thereof;

FIG. 2 is an enlarged sectional view of the invention;

FIG. 3 is a curve on which is shown the variations in outside diameter of the delay body vs. the time delay;

FIG. 4 is a curve illustrating the effect on the burning rate of the delay composition when the internal volume is increased and the delay body is decreased; and

FIG. 5 is a curve illustrating the effect of external expansion chamber volume on burning rate of delay powder after compensation for change in surrounding mass.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 the pyrotechnic delay actuator 11 which is employed to operate switch 12. Switch 12 is designed to close one circuit and open another circuit upon being actuated. The details of the switch will not be described herein except for its relationship to the delay actuator.

The pyrotechnic delay actuator 11 is shown in detail in FIG. 2. The delay time of the pyrotechnic actuator may be varied within wide limits such, for example, as one tenth of a second to two minutes depending upon the length of the delay train 23.

The pyrotechnic actuator assembly consists of an initiator plug 14 which has a pair of electrical contacts 15 insulated in the plug by a plastic material such, for example, as phenolic, or Kovar glass. The contacts 15 are connected by a high resistance wire 16. The end of the plug having the high resistance wire 16 mounted thereon is of such size and shape as to be insertable in charge holder 17 having a charge 18 located in the central portion thereof. The charge holder 17 is of the chimney type and designed in this fashion to direct the hot gases past the vent holes 21 onto a pellet composed of an igniting powder 20 which ignites readily, quickly and reliably initiates burning of the delay column 23. The chimney 19 directs the hot gas blast from the initiator plug assembly past the vent holes 21 to the next pellet of igniting powder 20 before leaving by vent holes 21. The charge holder 17 generally has a charge 18 containing lead styphnate around the bridge wire followed by an ignitor mix 22. The initiator assembly is either soldered or crimped into place in the initiator plug substantially as shown. When sufficient electrical energy is passed through the wire bridge the temperature is raised high enough to initiate the normal lead styphnate. This in turn initiates the ignitor mix causing hot particles and gases to travel down the chimney 19 striking the next explosive column 23 and then out the vent holes 21. The explosive column 23 being a so-called gasless delay composition consisting, for example, of barium chromate, lead chromate, and manganese mixture. The delay column is held in place at the top by a retaining ring member 24 and at the bottom by a slotted baffle member 25. The easily ignited powder 20 is placed on both sides of the baffle member 25 to insure that the delay column continues to burn past the partial barrier. A cylinder 26 made of brass, for example, is soldered on the actuator container 27. An external expansion chamber 28 is located between the actuator container 27 and the cylinder 26 and which will contain the hot gases as they leave the vent holes.

The time delay powder will continue to burn when ignited for a predetermined amount of time until it reaches the operating charge 29. The operating charge 29 drives

switch plunger 30 downward with respect to FIG. 1 of the drawing closing normally open contacts 31 and opening the normally closed contacts 32.

Since the system is to be hermetically sealed, it will be necessary to keep the internal pressures at a minimum by providing a maximum free volume. Of the explosive materials used in the actuator, normal lead styphnate and the ignitor mix give off the most gas, the delay composition gives off relatively little gas. The free volume necessary for venting, therefore, will depend largely on the initiator assembly rather than upon the amount of delay composition being used. The initiator assembly will be the same regardless of the desired delay time. It is considered obvious that the external expansion chamber for this type delay actuator is independent of delay time, this volume will suffice for other delay times of the same order of magnitude.

One of the important parameters affecting the delay time of a fuze is the metal in container 27 surrounding the delay column. As the mass of metal about the delay column is increased, the delay time for a delay train is also decreased for the reason that a greater portion of the heat generated by the delay powder is dissipated in the large mass and less is available for heating the delay powder. As the mass about the delay column is decreased, more heat remains in the powder delay train, resulting in a speed-up of the burning time. In FIG. 3 is shown a curve which illustrates the result of varying the outside diameter of the container 27 from 0.280 inch to 0.500 inch. The inside diameter of the pyrotechnic column was held constant at 0.203 inch. The graph of FIG. 3 indicates that an infinite heat sink is approached when the outside diameter is 0.500 inch.

FIG. 4 discloses the burning rate of the delay powder when the size of the chamber is increased from 0.010 to 0.259 cubic inch by machining the outside diameter of the delay body from 0.494 inch to 0.312 inch respectively. The inside diameter of the pyrotechnic column is maintained at 0.203 inch.

In order to determine the dimensions of a potted delay fuze having characteristics of a delay fuze operating under standard atmospheric conditions, it is necessary for the expansion volume area and the support of the delay column to be at certain optimum values. In FIG. 5 the delay fuzes with a pyrotechnic column of 0.203 inch in diameter and having different size expansion chambers and supports of the delay column were fired and compared with a standard fuze which was vented to the atmosphere. The graphic results show that an optimum condition is achieved when the free volume of 0.066 cubic inch is used. Any increase in available volume past 0.066 cubic inch to slow the burning rate is more than counteracted by the decreasing mass of the delay body as shown in FIG. 4.

As a result of applicants' invention a self contained delay fuze has been developed having delay characteristics of a vented fuze. The fuze is impervious to moisture and therefore is capable of being stored for long periods of time under adverse conditions and still be dependable when needed. These characteristics are very desirable in fuzes for mines and other demolition devices which are stored for long periods of time.

It should be understood that the foregoing disclosure relates to only a preferred embodiment of a delay fuze and that numerous modifications or alterations may be made therein without departing from the spirit and scope of the invention, as hereinafter defined by the appended claims, as only a preferred embodiment thereof has been described.

What is claimed is:

1. An internally vented time delay fuze switch device comprising a fuze container of a predetermined size, an initiator plug located at one end of said container having an electrical initiator circuit for receiving an electrical pulse, a cylindrical chimney type charge holder having two open ends, a large outer diameter portion and a smaller outer diameter portion, said charge holder located in said container and having one end encasing said initiator plug and having a charge therein responsive to said electrical pulse for initiating the delay fuze, a cylindrical time delay fuze column of predetermined diameter located in said fuze container in near proximity of said charge holder and having a predetermined time delay characteristic when ignited by said charge, said container having a plurality of apertures intermediate said charge holder and said delay fuze column and located immediately opposite said smaller diameter portion of said charge holder for allowing the gases generated therein to escape, an airtight external cylinder of a predetermined size surrounding and enclosing said container and having a predetermined inside diameter sufficiently greater than a predetermined outside diameter of the container so as to form an external expansion chamber of predetermined volume for the escaped gases of the expended powder such that the internally vented time delay fuze provides the burning characteristics of an externally vented fuze, said cylindrical chimney type charge holder extending past the apertures in said container in such a manner that the hot gases of the charge when ignited are directed toward the time delay fuze along a first path before being vented through said apertures to said external expansion chamber along a second path, switching means including an operating charge and a switch located on the other end of said container for operating said switch when the delay fuze powder ignites the operating charge.

2. An air tight internally vented time delay fuze comprising a fuze container of predetermined size having a plurality of apertures located in one end portion, an electrical initiator means located in said one end portion of said container for igniting the fuze when energized, wherein the electrical initiator means comprises an insulated plug with a pair of electrical contacts therethrough, an electrically responsive bridge wire connecting said pair of contacts at one end of said plug, a cylindrical chimney type charge holder having two open ends, a large outer diameter portion and a smaller outer diameter portion, one end of said charge holder encasing said one end of the plug and bridge wire, a powder charge located in said charge holder and positioned in close proximity of said initiator wire, a time delay fuze powder of predetermined size and cylindrical configuration compressed in said container and held in place by a retaining ring on one end and a slotted baffle on the other end thereof, said plurality of apertures in said container being disposed intermediate said electrical initiator and said delay fuze powder for allowing the gases from the expended powder to escape, an airtight external cylinder encasing said container and having a predetermined internal diameter sufficiently greater than a predetermined outside diameter of the container to provide an expansion chamber of predetermined volume for the expended gases leaving said container such that the internally vented time delay fuze provides the burning characteristics of an externally vented fuze, said cylindrical chimney type charge holder extending past the apertures in said container in such a manner that the hot gases of the charge when ignited are directed toward the time delay fuze along a first path before being vented to said external expansion chamber by a second path.

3. An airtight internally vented time delay fuze comprising a metallic container of predetermined size having a plurality of apertures near one end, an electrical initiator means located in said one end of the container for generating a quantity of hot gases and for directing the flow of the hot gases therein, a cylindrical time delay pyrotechnic column of predetermined diameter compressed in said container and ignitible by said directed hot gases, a retaining ring located on one end of the pyrotechnic column adjacent said initiator means, a slotted baffle lo-

cated on the other end of said pyrotechnic column, the apertures in said container being intermediate said electrical initiator means and said retaining ring providing an escape path for gases generated in said container, and an airtight external cylinder of predetermined size encasing said container and forming an airtight expansion chamber of predetermined volume for the hot gases escaping from said container whereby the internally vented time delay fuze is provided with the burning characteristics of an externally vented time delay fuze, the electrical initiator means comprising an insulated plug, a pair of electrical contacts extending through said plug, an electrically responsive bridge wire connecting said pair of contacts, a charge located in close proximity of said bridge wire, a cylindrical chimney type charge holder having two open ends, a large outer diameter portion and a smaller inner diameter portion, one end of said charge

holder encasing said charge, bridge wire and one end of said plug, the other end of said charge holder forming a chimney for directing the hot gases past the apertures toward the pyrotechnic column along a first path before being vented to said external expansion chamber through the apertures by a second path.

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