SOLID DIELECTRIC EXPLODING BRIDGEWIRE
SERIES SAFETY ELEMENT
Filed Jan. 12, 1962

FIG. 1

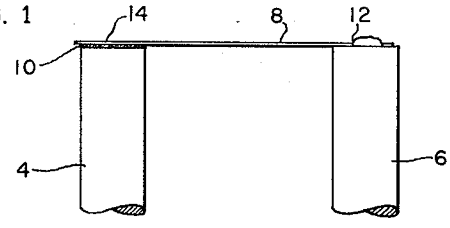


FIG. 2

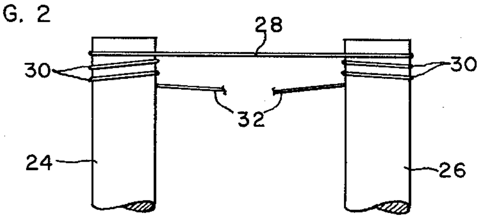
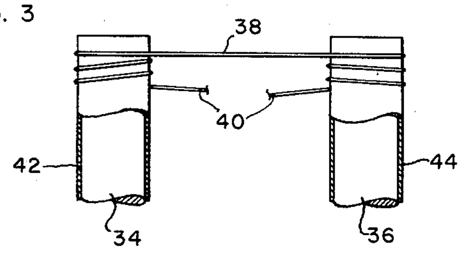


FIG. 3



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SOLID DIELECTRIC EXPLODING BRIDGEWIRE SERIES SAFETY ELEMENT

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1 Claim. (Cl. 102—28)

This invention relates to a novel and improved exploding bridgewire unit and more particularly to a novel solid dielectric exploding bridgewire series safety unit.

As a safety feature in both exploding bridgewire and straight electrical resistance firing devices, it is highly desirable to include as a safety feature, some means to prevent the passage of electrical current at low voltages but at the same time not interfere with the passage of a proper higher voltage and current into the wire. Heretofore, various attempts have been made to solve this problem, and perhaps the commonest and the most successful to date is the system of placing a safety air gap in series with the firing circuit developed for and used extensively with conventional blasting cap electrical firing circuits. There have been attempts to provide the exploding bridgewire with the safety feature of the series air gap but numerous objections to the use of an air gap were found when the rigid requirements for the exploding bridgewire were encountered. For example, in the conventional electrical blasting cap art, a relatively wide range of voltage and current was tolerable and a failure meant no more than that a new blasting cap was required. However, with the advent of the exploding bridgewire for many uses in the missile industry today, failures cannot be tolerated. High altitude temperatures vary over a wide range, extreme variations in atmospheric conditions such as humidity and barometric pressure are encountered and a safety element which is completely insensitive to all of these variables, is necessary.

In the conventional air dielectric series safety spark gap, it has been found that the breakdown of voltage is dependent over an intolerable range of atmospheric pressures. Likewise, the breakdown of voltage of the air dielectric series safety spark gap is equally sensitive to and variable with changes in humidity; again this particular gap is highly sensitive to the composition of particles in the air. A series safety spark gap variable with and sensitive to any or all of these conditions is intolerable for uses which vary from sea level to altitudes of 50,000 to 100,000 ft. or higher with a correspondingly variable barometric pressure. Also, it has been found that for the highly sensitive exploding bridgewire firing circuitry, that temperature changes so vary the distance between the electrodes in the spark gap as to make the firing circuitry either completely useless or even highly dangerous. Attempts have been made to overcome some of the objectionable features by encapsulating the spark gap in a hermetically sealed chamber or by gas filling a closed and sealed chamber. While such a step will overcome some of the objections, particularly as to humidity and barometric pressure these efforts have failed to solve the problem of temperature changes over the wide range encountered. Also, attempts have been made to solve this problem by the inclusion of diodes in the firing circuit, but again, the problem is not adequately solved because it is found that the diode, when "hit" by the high voltages required for preliminary and safety testing, are completely destroyed and their functional operation as a diode ceases under these conditions.

Another disadvantage and objection to series safety air gaps heretofore utilized in bridge or conventional hot wire firings, has been the remote location of gap from the wire and stray currents, such as short wave radio and

high frequency currents, have been known to cause the wire to fire because of the length of the conductor between the firing wire and the safety gap.

One object of this invention is to combine the solid dielectric or insulated gap so intimately with the bridgewire as to eliminate sensitivity to electro magnetic radiation.

Another object of this invention is to provide a novel and improved series safety element in the exploding bridgewire assembly which overcomes objectionable characteristics and features of the gaseous or air dielectric series safety spark gap with a minimum of substitution of unfavorable characteristics therein.

Briefly described, this invention entails the ultilization of a solid matter as opposed to a gaseous dielectric interposed between two electrodes connected electrically in series with the exploding bridgewire and combined integrally with the exploding bridgewire itself.

Other advantages and objects of this invention will become apparent when taken in connection with the accompanying claims and drawings in which:

FIG. 1 shows a cross-sectional view of one embodiment of this invention;

FIG. 2 shows another embodiment of this invention illustrating the principle involved; and

FIG. 3 shows still another form of this invention.

Turning now to a detailed description of this invention. In FIG. 1, illustrating one form of this invention, the numerals 4 and 6 refer to lead posts of a conventional exploding bridgewire system. The numeral 10 designates a solid dielectric material located on lead post 4, and the numeral 8 designates a conventional exploding bridgewire which is electrically connected to lead post 6, as by means of welding, soldering or the like designated by the numeral 12 and which is affixed to the dielectric insulating material 10 at 14 as by glueing or the like. It is to be here noted that the bridgewire 8 is separated from the lead post 4. The amount of separation will vary according to the type of material 10 and the operating voltage selected for firing the bridgewire. As this forms no part of this invention and is deemed to be obvious to those skilled in the art, no specifics are here given.

In FIG. 2 wherein there is illustrated another manner in which the principle embodying this invention is applied, the numerals 24 and 26 refer to the conventional lead post similar to the lead posts 4 and 6 discussed in connection with FIG. 1. The numeral 28 designates an exploding bridgewire but which differs from the wire 8 is discussed in FIG. 1 in that this wire itself is insulated. The ends 30 of wire 28 are each looped around the lead post 24 and 26 as shown, and are affixed to a non-conductive member (not shown) for the purpose of retaining the wires around the lead post 24. It is to be understood that if desired, the insulation can be removed from one end of the wire 28 and an electrical connection can be made to one of the posts, either 24 or 26 in the same manner the wire is connected to post 6 in FIG. 1.

In the form shown embodying this invention in FIG. 3, the numerals 34 and 36 respectively, designate the lead posts comparable in all but one respect to the lead posts 4 and 6, and 24 and 26 of FIGS. 1 and 2. Surrounding each end of the lead posts similar to that shown in FIG. 2, is a bare exploding bridgewire designated by the numeral 38 which, in turn, is anchored to a non-conductive support member at 40 in the same manner as are the ends of the wire 28 anchored to an insulating support illustrated and explained in connection with FIG. 2. Dissimilar from the form shown in FIG. 2, the wire 38 is bare and the lead posts 34 and 36 are insulated by means of a suitable insulation designated by the numerals 42 and 44 respectively.

Turning now to an explanation of the operation and use of this invention, it is first pointed out that the solid dielectric **10** can be of any number of dielectrics and in actual experimental tests, the silicone plastics, ceramics, the polyurethane plastics, the polyesters, the acrylic plastics, the polyvinyl, the polyethylene, the ethyl cellulose, the epoxys, including such plastics as polytetrafluoro ethylene (Teflon) have all been found to be satisfactory for this purpose. The thickness of the dielectric material, of course, varies with the dielectric strength of the material and must be varied accordingly. It will, of course, also be varied in accordance with the amount of electrical energy desired to explode the bridgewire.

It is also pointed out that a certain amount of electrical energy is required to explode the bridgewire.

It is also pointed out that a certain amount of energy is required to break down the dielectric insulation and it must be realized that the currents utilized in breaking down the dielectric must be increased accordingly to offset the loss of the energy so used. For example, it was found that the bruceton 50% threshold voltage for a silicon base plastic coated platinum wire of 2 mils in diameter and with the silicon insulation of approximately 0.2 to 0.4 mil thick was approximately 300 volts higher than an identical non-insulated platinum 2 mil wire. In each case, both wires were fired from a one microfarad capacitor. In each case, the energy from the one microfarad capacitor charged to 2,000 volts which provided a current with an amplitude of 800 amperes with a rise time 0.8 of a microsecond or less was found to be sufficient to break down the silicon base plastic dielectric mentioned above and to explode the wire.

It will be apparent from the foregoing, that the solid dielectric insulation, when it breaks down, does not returnto its original state as does a gaseous dielectric but is completely consumed or destroyed in the breakdown process. Also, should a higher voltage, but with a lower current of sufficiently specific characteristics so as to avoid firing the exploding bridgewire, "hit" the dielectric and while it may rupture or knock holes in the dielectric, it will not necessarily break down and de-

stroy the dielectric. For example, it has been found that some dielectrics can be hit with 9,000 volts but with a .001 microfarad current, the dielectric will be punctured but will not be destroyed and in some cases there has been found to be a phenomenon of self curing of the dielectric takes place.

It is to be understood that various changes in wire, dielectric, etc., can be resorted to without departing from the spirit of this invention as set forth in the accompanying claim.

What is claimed is:

A solid dielectric exploding bridgewire series safety unit comprising:

(A) A pair of lead posts;

(B) An exploding bridgewire mounted upon and in close proximity to but in spaced relation to at least one of said lead posts and being adapted to "explode" upon the passing of an electric current through said wire;

(C) A solid dielectric insulation substantially coating and surrounding said entire bridgewire, said insulation separating said exploding bridgewire from at least one of said lead posts, whereby a series safety gap between said lead post and said bridgewire is formed to "stand off" uncontrolled voltages from firing said bridgewire; and

(D) Said bridgewire being wound around at least one of said lead posts to support said bridgewire thereon.

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