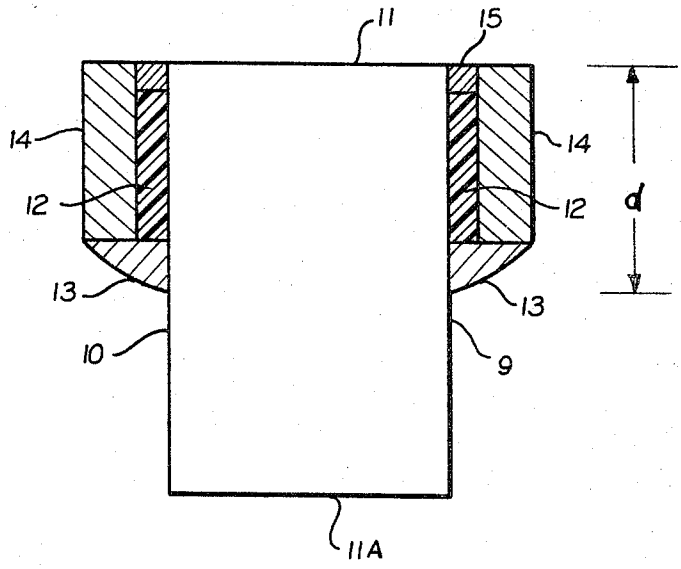
Feb. 25, 1969 S. A. CORREN 3,429,260

MINIATURE INITIATOR FOR ELECTROEXPLODING DEVICE

Filed Feb. 13, 1967



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United States Patent Office

3,429,260

Patented Feb. 25, 1969

3,429,260

MINIATURE INITIATOR FOR ELECTRO-EXPLODING DEVICE

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Filed Feb. 13, 1967, Ser. No. 615,671
U.S. Cl. 102—28 2 Claims
Int. Cl. F42b 3/10

ABSTRACT OF THE DISCLOSURE

An electroexplosive device, comprising an insulated body portion with an electroconductive shaft member mounted within an electrically conductive sleeve positioned about the insulated shaft member and with an electrically conductive plastic resistor member electrically connecting the shaft member and the electrically conductive sleeve member across the face of the insulator.

This invention relates to electroexplosive devices and, in particular, to electrical initiators employed in such devices, especially those of relative small size and capable of mass production.

It is an object of this invention to provide small precision initiators for controlled explosive charges.

It is another object of the invention to produce by mass production relatively small electrical fuses.

An object is to provide electrical fuses which avoid welding and handling of fine wires.

A further object is to utilize the techniques of plastic molding to mass produce miniature fuses.

Another object is to utilize conductive plastic materials to produce relatively small electroexplosive devices.

Another object is to produce initiators having low energy requirements.

Other and further objects will become apparent from the more detailed description given therefore hereinbelow.

The basic problem is to produce a small size initiator or exploding fuse in large numbers and at relatively small expense at the same time achieving a high degree of reliability for the devices. It is also of importantce to produce these items at relatively low cost.

These devices find use as initiators in all kinds of electrochemical and electromechanical devices where a minimum energy is required and at the same time ease and convenience of manufacture is a factor. These initiators find various uses in today's technology and more especially as components in weapons. In general, these devices are used only once, i.e., they are destroyed by use, thus making testing of a particular unit impossible.

The problem is especially important for miniature devices, espectially for those which must be mass produced. In such instances the time and labor required for the welding and assembling of the minute parts are prohibitively expensive. Furthermore, it is necessary that the devices have a high level of reliability.

The usual electroexplosive initiator device consists of a plug adapted to mate with a receptacle in a mechanism to be explosively activated. The plug is provided with electrical terminals to be connected to an electrical energizing circuit. Within the plug there is an electrical initiator such as a resistance element which, upon energizing with sufficient power, is heated, igniting a sensitive explosive charge packed against the resistance element.

The initiators made by the practice of this invention, have been found to be reproducible and reliable and when subjected to standard testing procedures, they have been found to meet the critical requirements of voltage and energy levels. It is an additional advantage that their construction and design is such that they can be mass produced by automated means.

The fuse or initiator device consists of a casing made of a metal such as steel, aluminum, silver and precious metals, and mounted therein, a metal shaft member made of the same or a different metal. Stainless steel can be used, if desired. The metal shaft is surrounded by an insulating material. In one face of the device there is positioned an electrically conductive plastic resistor member which is electrically connected to the metal shaft and to the metal casing or sleeve. Various embodiments of the device may be produced which contain one or more additional features.

It has thus been found that explosive devices can be manufactured utilizing conductive plastics as the electrically conductive material. The parts of the device are conveniently made by comolding them together. It is also possible to make at least some of the components or layers by silk-screening, spraying, dipping, painting and the like. It is also necessary to carry out one or more curing steps, as by baking at elevated temperatures.

The conductive plastic may be any of these materials which are well known in the trade. For instance, moldable plastic materials containing powdered or comminuted conductive metals or carbon black can be used. Descriptions of such materials and methods for their manufacture are to be found for instance, in U.S. Patents 2,683,-669; 2,761,849; and 2,761,854. Typical product which can be satisfactorily used comprises about 60% acetylene black, about 17% flake silver metal and about 23% of a thermo-setting moldable prepolymer on a solids basis. In actual practice the plastic composition as deposited, contains a volatile solvent-dispersant, and a catalyst for polymer formation. The foregoing description of polymer is intended to be illustrative only and it is in no way intended to limit the invention thereto.

The insulating material used for surrounding the shaft member may be any one of the well known electrically insulating materials which are known to the art. For example it can be at heat or pressure curable and moldable epoxy diallyl phthalate or other such resin or plastic having incorporated therein and as a substantial portion thereof, asbestos and titanium dioxide as the insulator. Other materials which can be used include polyesters, polyimides and the material known commercially as Formvar, a polyvinyl acetate resin with a major portion of the acetate groups replaced with alcohol and formal. Broadly, there can be used any of the general class of materials used insulating magnet wire.

Also of great advantage, is the technique untilized for producing the miniature devices. All the parts or members can be dipped, molded, or otherwise formed and assembled by mass production techniques with a minimum of individual handling. No soldering and similar time consuming steps are involved. A further advantage, is that each unit can be tested, if desired, without destruction.

The figure is a longitudinal cross-section of the preferred embodiment of the electrical initiator plug of the invention.

The electrical initiator plug shown in the figure has an electrically conductive shaft member **10** with a body portion **9** and faces **11** and **11A**. The shaft is for example about 0.5 inch long. This shaft, to make the miniature initiator devices for which this invention is especially adapted should be about 0.055 inch in diameter. About the body portion **9** of the shaft member there is positioned or formed a layer, multiple layers or a sleeve **12** of an electrically non-conducting or insulating material. This sleeve preferably has a thickness of about .0025 to .0005 inch. This sleeve may extend the full length (0.5 inch) of the shaft **10** or a distance, only partial length

of the shaft. At location **13** there is preferably placed after enclosure in the casing, some resin or moldable material such as an epoxy resin to form a seal and to function as a support to prevent slipping of the various members located about the shaft. The insulating layer surrounding at least a part of shaft **9** is layer **12**. The entire assembly is then inserted into metal container or casing **14**. This assembly should have a close fitting inside the casing sleeve **14**. The overall diameter of the fuse is now about 0.077 inch. The face **11** is then wet sand blasted or otherwise treated to roughen the metal and to give a depression in the insulator layer **12**. A suitable electrically conductive plastic is sprayed, coated, dipped or otherwise applied to face **11**. The face is then preferably cleaned or wiped to give a ring of the conductive plastic, which will be about 0.001 to .004 inch wide indicated as member **15**. This plug constitutes an initiator device which is now ready for application of primer and insertion into its intended unit for use.

If desired the entire head face **11**, and at least a part of the outer surface of the sleeve unit can be gold plated. This gives an intiator plug having somewhat lower resistance of about 0.9 to 0.1 ohm.

As a typical method for making the above described device, a steel shaft or wire about 0.5 inch in length and about 0.055 inch in diameter is repeatedly dipped into a moldable, curable, insulator mixture. The mixture is preferably applied in layers to a depth on the shaft of about 0.070 inch and a thickness of less than .058 inch. The insulator mixture can, for example consist of:

	Parts
Asbestos fibers	1
TiO_2	2
Diallyl isophthalate	10
Catalyst for polymerization	1
Methyl isobutyl ketone	14

After each dipping step, the insulator mixture was dried for 20 minutes at 100° C. and subjected to a final cure at 170° C. for two hours. If desired, the coated end of the shaft can be sand blasted. In any event, the shaft is dipped into the insulator mixture for a final coating, and while it is still wet, the coated shaft is enclosed in the metal casing or sleeve. This assembly is cured at 170° C. for two hours. The face of the assembly is then cleared and the assembly sealed with an epoxy cement at the end opposite the face. A liquid honing (wet sand blasting) step is then carried out on the active face of the plug. This is done to roughen the steel metal and also to cut away a small amount of the insulator material to form a groove or channel for the conductive plastic member. This "undercut" area should be about .001 to .003 inch deep. The mixture of liquid conductive plastic has the following composition:

	Percent by weight
Acetylene black	14.4
Flake silver	4.0
Diallyl isophthalate prepolymer	5.5
Polymerization catalyst	0.5
Methyl isobutyl ketone	75.6

To adjust the conductivity of the bridge, it may be necessary to add more silver or to change the percentage of black present. This mixture is sprayed or otherwise coated onto the end of the shaft member. Rather than use the insulator member above described, it is also possible to use a Mylar tube or sleeve and shrink it into place. The assembly is cured at 170° C. for about 15 hours. The face of the assembly is wiped to remove excess conductive plastic and to complete the assembly. Gold plating may be applied to give initiators having lower resistance.

It is a further advantage that there is no reason to avoid using copper because the gold plating effectively insulates the copper from contact with the explosive.

Therefore, as another embodiment, commercial insulated copper or aluminum magnet wire can be employed as the insulated shaft with a steel sleeve or casing. The conductive plastic bridge is formed as described above.

It is of significance that these miniature devices can be exploded at very low voltage and low energy. For instance, these units effectively initiated explosives when the discharge of a 100 μfd. condenser, charged at 2.0 volts, was applied at higher voltages even less energy is required. Initiation was achieved with a condenser discharge of 1000 ergs. with voltages in the 7 volt range.

What is claimed is:

1. An electrical iniator plug for electro-explosive devices, said initiator plug comprising:

(a) an electrical conductive shaft member having a body portion and a face portion;

(b) an electrically non-conductive insulator member surrounding the body portion of said shaft member;

(c) an electrically conductive sleeve member surrounding said insulator member;

(d) an inherently non-explosive, non-magnetic, electrically conductive plastic bridge member extending between the electrically conductive shaft member and the electrically conductive sleeve member; and

(e) a gold plating covering the first face of said shaft member and the upper surfaces of said electrically conductive sleeve member and said electrically conductive bridge member.

2. The electrical initiator plug of claim **1** in which the electrically conductive shaft member and the electrically conductive sleeve member are steel.

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