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ELECTRIC INITIATOR WITH EXPLODING BRIDGE WIRE

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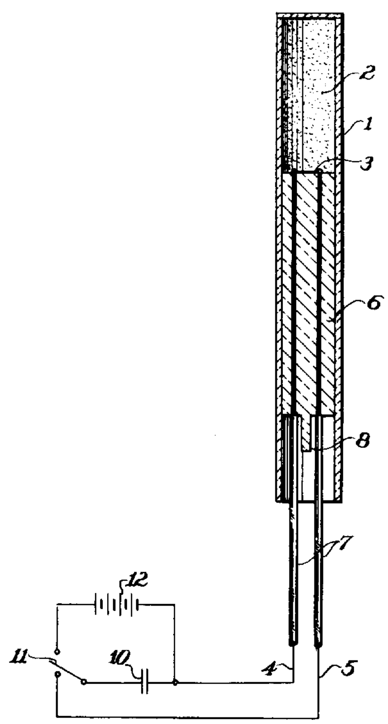

Fig.1

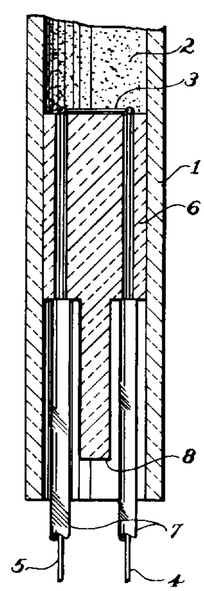

Fig.2

WITNESSES.

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ELECTRIC INITIATOR WITH EXPLODING BRIDGE WIRE

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1 Claim. (Cl. 102—28)

This invention relates to detonators and more particularly to blasting initiators of the electric ignition type.

Electric detonators of the prior art generally employ a fuse wire which melts with the application of a relatively low voltage and current. The fuse wire is imbedded in a quantity of primer material, such as mercury fulminate, lead azide, or the like. Adjacent the primer material is the base charge which may be a high explosive substance, such as pentaerythritol tetranitrate (PETN) or trimethylenetrinitramine (RDX), etc. The melting of the fuse wire by application of an electric current sets off the sensitive primer which detonates the high explosive in the shell. This explosive in turn transfers the detonation wave to the high explosive material to be set off. While these initiators, generally called squibs, are quite satisfactory, they possess certain disadvantages. In view of the fact that a sensitive primer material is needed they are sensitive to mechanical shocks and must be handled very carefully. Moreover, they are very sensitive to electric currents in view of the fact that only a low current is necessary to melt the wire. As a precautionary measure, the lead-in wires must be twisted and thereby shortcircuited for shipment or when the fuses are stored. This precaution is necessary to prevent chance detonation with the inadvertent application of an electric current, or a static electric charge.

Another disadvantage in certain cases is the time delay involved between application of current and detonation. This time interval is approximately a millisecond or greater, which in special industrial applications is an undesirable time factor. In such applications, it is also desirable to have a uniform time factor for one type of detonator, whereby several may be synchronized to detonate at exactly the same time, preferably within microseconds of time difference.

The object of this invention is to improve the operation of electric blasting initiators to obtain a more uniform time constant and a shorter time interval for effecting detonation.

Another object of the invention is to improve the electrically operated squib with respect to safety in handling by making it insensitive to shocks.

A further object of the invention is to reduce the hazard concomitant with the use of sensitive primer material together with low current and low voltage operation.

A particular advantage of the detonator in accordance with this invention is that no primer material is required, which increases stability to shocks as well as reduces the ignition time delay.

Another advantage of the invention is that a uniform ignition time interval can be obtained for all fuses whereby a number of detonators may be operated simultaneously at synchronized uniform time interval.

Other objects and advantages will be apparent from the following description of the invention, pointed out in particularity in the appended claims and taken in connection with the accompanying drawing, in which:

FIGURE 1 illustrates the novel construction of an electric detonator in accordance with the invention, and

FIGURE 2 is an enlarged cross sectional view of a portion thereof.

The detonator comprises a shell, or housing 1 which

may be of tubular form closed up at one end. The material for the housing may be metal or plastic composition or any suitable material which is easy to handle and can be stored without being affected by moisture. The housing is filled at one end with a high explosive substance 2, such as pentaerythritol tetranitrate or trimethylenetrinitramine, etc. loosely packed. In contact with the explosive material is the fuse wire 3 bridged across a pair of lead-in wires 4 and 5. The lead-in wires are firmly held by the insulating support 6 which seals off the open end of the housing 1. The insulating support 6 may be a molded composition or the same plastic material as the housing. Other materials having suitable insulating properties may be used as long as they form a solid support for the lead-in wires, and at the same time prevent the falling out of the loose charge from the shell. The lead-in wires 4 and 5 are brought out for electrical connection and may be insulated by cambrick tubing 7 extending to the support 6. The latter has a dividing portion 8 for additional separation and insulation of the lead-in wires.

It is to be noted that in the construction of the fuse the customary primer material is omitted and the high explosive charge is in direct contact with the current reactive element; that is, the fuse wire 3. The high explosive material is insensitive to shocks normally encountered in handling and the hazard of explosion due to inadvertent use is practically eliminated.

Another and far more important advantage results from the use of a detonating, e.g. high explosive material in place of a deflagrating primer material. This advantage is the reduction in the time delay from milliseconds to microseconds. The sensitivity of the primer has always been a potential hazard and introduced also a time delay in the operation. In view of the fact that the initiation of the explosion depends upon the comparatively slow burning or deflagrating material of the primer charge to transfer the detonation wave to the high explosive, a considerable delay is unavoidable. Aside from this time delay which in certain materials may amount to several thousandths of a second, there is also a considerable variation of time factor between a number of squibs of the same type and construction. In certain industrial applications it is extremely important that the detonation of a number of squibs should be effected at exactly the same time in order to obtain exact synchronization.

Employing a high explosive substance free from deflagrating material necessitates certain changes in the electric fuse. The detonation is not to be achieved by the slow melting of a fuse wire, instead a sudden and large thermal impact must be produced by the applied current. In accordance with the invention the fuse wire is so proportioned that for a given predetermined current at a considerably high voltage the fuse material disintegrates completely, in other words, practically explodes and thereby transmits a detonation wave of sufficient magnitude to cause sudden detonation of the high explosive charge. The fuse wire may be made of various metals. Platinum, tungsten, or nickel-chromium alloy are particularly well suited with different types of high explosive charges. In practice it was found that a tungsten wire about .001 in. in diameter and ⅛ of an inch long produces very good results. The electric energy necessary for its disintegration was approximately ½ joule. This can be accomplished for example, by a high voltage discharge of a condenser. A condenser of 2 microfarads charged to about 1500 volts produced sufficient energy to explode the tungsten wire. Equal results can be obtained with a #34 Nichrome wire of the same length at a 500 volt discharge of a large condenser, about

50 microfarads. The number 34 Nichrome wire used was a Brown and Sharpe gauge and had a diameter of .006 inch.

For the purpose of illustrating the preferred method of electrical ignition, the schematic circuit in connection with FIGURE 1 shows a condenser **10** connected to the lead-in wires **4** and **5** through a switch **11**, which in one position connects the condenser **10** to a source of voltage, shown here by way of example, by the battery **12**, and in the other position discharges the condenser **10** across the terminals of the lead-in wires. The condenser discharge type of ignition is merely a preferred way insofar as it is well suited for exact timing. The high voltage source may be connected directly across the fuse terminals and the voltage supply may be any suitable source as long as it has the necessary voltage and current capacity.

Referring to FIGURE 2 the enlarged cross sectional view of the squib construction shows the placement of the fuse wire **3** against the surface of the insulating support **6**. The lead-in wires **4** and **5** terminate very close to the end surface of the support **6**, and the wire **3** is attached to the terminals, for example by soldering, in such manner that it will rest on the flat end surface of the support **6**. The purpose of placing the fuse wire **3** against the surface results in a definite improvement when the current discharge explodes the wire. The surface on which the wire rests forms a baffle or deflecting plate confining the scattering of the wire particles in the direction of the high explosive charge. The detonating efficiency of the wire **3** is thereby increased, and less current can be applied to produce the required detonating effect.

Blasting initiators constructed as described can be used with all types of detonation charges intended to be set off. The time factor of the squib is not greater than a few microseconds and the uniformity of this factor in squibs of identical construction makes practical the synchronous operation of several detonators to within ½ microsecond.

What is claimed is:

An apparatus for detonation of a high explosive in a uniform short time interval which comprises loosely packed pentaerythritol tetranitrate, a bridge wire of 80 percent nickel and 20 percent chromium one-eighth inch long and .006 inch in diameter and means for introducing electric current of an energy in excess of one-half joule at about 500 volts to said bridge wire, whereby it is explosively distintegrated upon the application of said current with the formation of a detonation wave of sufficient magnitude to detonate the pentaerythritol tetranitrate.

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