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LEAD WIRE FOR INITIATING DEVICES

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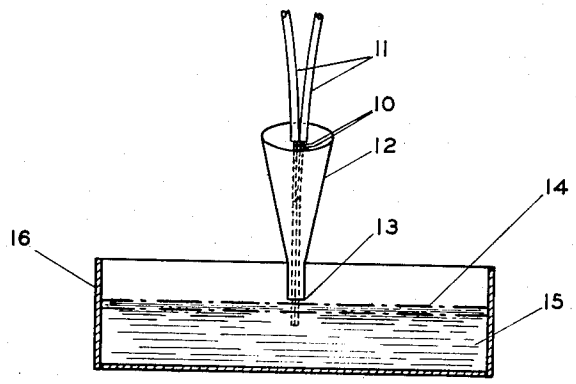


FIG. 1

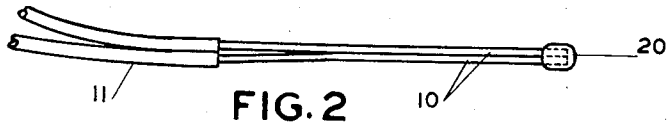


FIG. 2

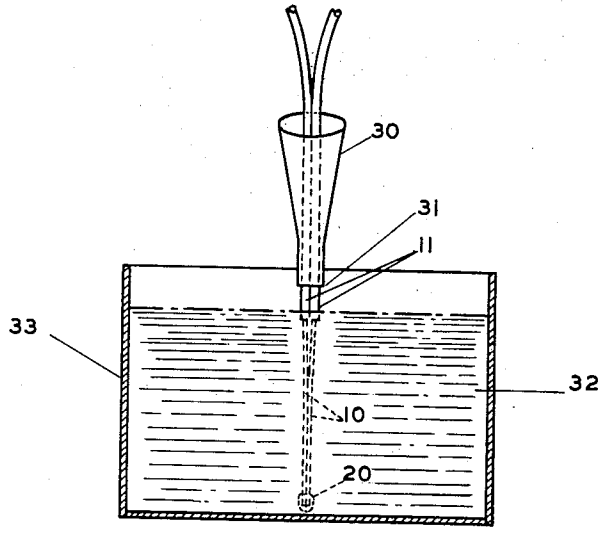


FIG. 3

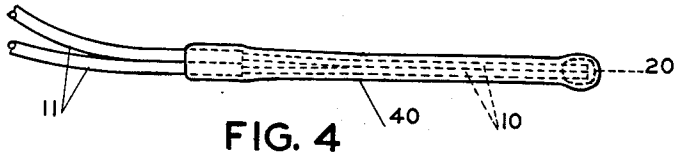


FIG. 4

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LEAD WIRE FOR INITIATING DEVICES

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8 Claims. (Cl. 102—28)

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This invention relates to an improvement in electrical initiating devices for explosives and more particularly to a protected lead wire assembly for an electrically-fired initiating device.

Generally, electrical initiating devices and more particularly electric blasting caps comprise a shell containing explosive material and an initiating assembly comprising a plug having lead wires extending therethrough to which a resistance element or bridge wire is affixed. The bridge wire is embedded or otherwise encompassed in a suitable initiating explosive which in turn initiates other explosive material disposed within the shell. This initiation is accomplished by connecting the lead wires to a source of electrical energy whereby the resistance element or bridge wire is heated sufficiently to cause ignition of the explosive.

The lead or "leg" wires extending from the initiating device are insulated and are of such length that they may be connected to a source of electric current for the purpose of firing the cap. In order to facilitate connection to a source of electric current, it has been the normal practice to furnish about two or three inches of bare wire at the ends of these insulated lead wires. It has been long recognized by the art that this uninsulated portion constitutes a definite hazard since accidental firing of the initiating device may result from contact with a live circuit or a stray current such as a trolley line or charged rail. This hazard is especially prevalent in mining operations.

As a consequence, many means of preventing an accidental firing have been suggested but none have proved completely satisfactory from the combined viewpoints of safety, utility and economy. The usual approach has been to shunt the uninsulated portion or bare ends of the lead wires in some way. Many such shunting methods are now in use, such as tightly twisting the wires together or bridging them with various types of metal shunts. Wires so twisted or bridged are hard to separate without considerable distortion of the bare ends with the result that tight electrical connections are harder to obtain. Since bare copper or iron wire corrodes to an extent which also prevents good electrical contact, it is necessary to coat a bare copper wire with tin or to galvanize a bare iron wire if the initiating device or blasting cap is to be stored for any appreciable length of time. An additional difficulty arises if the lead wire has a plastic insulation in that the temperature of the melt used for tinning or galvanizing the bare wires causes the insulation to fuse. Consequently, if a plastic insulation is desired, the wire must be completely tinned or galvanized prior to being insulated.

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Another means which has been suggested is to leave the insulation in place and to cut or weaken it at the required distance from the ends of the wire so that a sufficient portion may be removed to allow connection to a firing circuit. If the insulation is actually cut through, the wire is exposed and the possibility of accidental firing is still present. If the insulation is weakened to a point where a portion may be removed, the possibility exists that the weakened portion will be worn through during trailing or other such procedures and that the bare wire will again be exposed. Furthermore, unless special means are used, the ends of the insulated wires are still exposed and even though the insulation is cut or weakened, it is still quite difficult to remove. In addition to these disadvantages, the covered wires are not shunted in any way to eliminate the possibility of accidental discharge.

It has also been suggested to coat the bare ends of lead wires with a frangible substance which will cut through when twisted together with the wire from the firing circuit. Not only is a satisfactory electrical connection difficult to obtain through the frangible substance, but such a coating is also unsatisfactory where the coated ends of the lead wires must be subjected to dragging or other frictional abuse. Furthermore, the coated wires are not shunted to eliminate the possibility of accidental discharge.

It is therefore the object of this invention to provide a means whereby the bare ends of the lead wires of initiating devices may be simultaneously and completely protected from static discharge, live or stray electrical currents and corrosion without distortion of the wires which makes good electrical connection to the firing circuit difficult to obtain.

Generally described, the present invention comprises a protected lead wire assembly for an electrically-fired initiating device and the method for its manufacture. This lead wire assembly comprises a pair of lead wires having insulation extending from the initiating device substantially to their terminal ends, and a shunt forming an electrical connection between the wires, the remaining uninsulated portions and the shunt being completely covered with a nonadhering, nonfrangible, insulating coating of a plastic material. The shunt may be formed by soldering or welding the terminal ends of the wires together or else by twisting the bare portions together to an extent where the plastic coating will securely hold the bare wires in electrical contact but not to an extent where disengagement results in distor-

tion of the bare portions. Once the bare portions have been thus shunted, the ends of the lead wires are immersed in a hot melt of a suitable plastic composition to completely cover the shunt and uninsulated portions of the lead wires. The wires are quickly withdrawn and the plastic retained is allowed to cool and solidify. The plastic melt is of such composition that on cooling to room temperature, it forms a tough but flexible, nonadhering, nonfrangible, insulating coating. When the initiating device is used, the lead wires may be readily pulled apart and the plastic coating removed by the thumbnail to leave a clean, uncorroded surface.

Having now indicated in a general way the nature and purpose of this invention, there follows a description of one embodiment thereof as shown by the accompanying drawing in which:

Fig. 1 is a diagrammatic view of an apparatus employed to shunt the bare ends of lead wires in accordance with this invention.

Fig. 2 is a view of the bare ends of a pair of lead wires which have been shunted in the apparatus of Fig. 1.

Fig. 3 is a diagrammatic view of an apparatus employed to dip the bare ends of the shunted lead wires depicted in Fig. 2 in a plastic melt in accordance with this invention.

Fig. 4 is a view of the ends of a pair of lead wires produced in accordance with this invention which has been shunted in the apparatus of Fig. 1 and dipped in a plastic melt in the apparatus of Fig. 3.

Referring now to the drawing and specifically to Fig. 1, the bare ends 10 of a pair of conventional, insulated copper lead wires 11 is passed through a guide funnel 12, the lower opening 13 or vertex of which is slightly larger than the combined diameters of the two bare wires, thus bringing their terminal ends into close proximity. The wires are lowered through a film of liquid flux 14 floating on the surface of a solder bath 15 maintained in a vessel 16 immediately below the vertex 13 of the guide funnel 12. The tips are submerged momentarily in the solder bath 15 and then withdrawn through the guide funnel 12. The withdrawal of the bare ends 10 of the wires, now connected at their tips by a small spot of solder, through the opening 13 of the guide funnel serves to remove any excess solder and leaves a smoothly soldered joint. The appearance of the lead wires after withdrawal is illustrated in Fig. 2 which shows portions of the insulated wires 11 and the extremities of the bare portions 10 held closely together and effectively shunted at their terminal ends by a solder joint 20.

Referring to Fig. 3, the solder shunted lead wires are now passed through a guide funnel 30, the lower opening 31 or vertex of which is slightly larger than the combined diameters of the insulated lead wires 11. The shunted lead wires are lowered into a plastic melt 32, positioned immediately below the vertex 31 of the guide funnel 30 in a vessel 33, until the bare ends 10 of the wires and a short length of the insulated portion are covered. The wires are then withdrawn. Immersion and withdrawal are carried out as rapidly as possible and any excess plastic is allowed to drain off. The plastic is then allowed to set and cool to room temperature. The resulting product is illustrated in Fig. 4 where the solder joint 20, all of the bare ends 10, and a short length of the insulated wires 11 are covered by a plastic coating 40.

Having fully described the present invention, the following examples are given to illustrate additional embodiments and operable plastic compositions. All parts are by weight unless otherwise specified.

Example 1

Insulated copper lead wires with the bare ends two inches long were shunted and coated as described with reference to Fig. 1 through Fig. 4. The solder employed was 60% lead and 40% tin and was maintained at a temperature of 285° C. A calcium silicate metallurgical flux was floated on the surface of the solder bath. The following plastic composition was employed:

	Parts
Ethyl cellulose (22 centipoises viscosity, 47.5% ethoxyl)	25
Mineral oil—naphthenic type	62
Blown castor oil	10
Paraffin wax	3
Menthyl phenol (stabilizer)	1

The satisfactory dipping viscosity of this composition occurred between temperatures of 190° C. and 200° C. After immersion in the plastic melt, all excess plastic dripped off after ten seconds and was fully set and ready for packaging when it had cooled to room temperature. The coatings were uniform, continuous and flexible and exhibited no tendency to cut through. When the two wires were held just above the plastic coating and pulled one away from the other, the plastic tore lengthwise and the solder shunt was ruptured. The coating did not adhere tightly to the wire and was easily removed with the thumbnail.

Example 2

Insulated iron lead wires with bare ends two inches in length were employed. The bare portions were held tightly in a parallel position and their terminal ends were welded together with a percussion welder. The bare ends were then dipped in a plastic melt of the following composition:

	Parts
Cellulose acetate (viscosity of 4 sec. by Hercules Ball method, and having a combined acetic content of 54%)	35
Substantially petroleum hydrocarbon-insoluble pine wood resin	30
Methyl phthalyl ethyl glycolate	35

The above melt had a satisfactory dipping viscosity at temperatures of about 185°–190° C. The plastic coatings were completely set when cooled to room temperature, were uniform and continuous and showed no tendency to cut through. When the two wires were held just above the plastic coating and pulled one away from the other, the plastic tore lengthwise and the weld was ruptured. The coating did not adhere tightly to the wire and was easily removed with the thumbnail.

Example 3

Insulated copper lead wires with bare ends two inches long were shunted with solder as in Example 1 and the bare ends were dipped in the following composition:

	Parts
Polyvinyl butyral	25
Dioctyl phthalate	30
Substantially petroleum hydrocarbon-insoluble pine wood resin	45

A satisfactory dipping viscosity of this composition was obtained at temperatures of between 195° C. and 200° C. The plastic was fully set on cooling to room temperature and the coatings were uniform, continuous and flexible and showed no tendency to cut through. When the two wires were held just above the plastic coating and pulled one away from the other, the plastic tore lengthwise and the solder shunt was ruptured. The coating did not adhere tightly to the wire and was easily removed with the thumbnail.

Although the plastic composition set forth in Example 1 is the preferred ethyl cellulose base melt, the compositions given in the following table give satisfactory results. All parts are by weight.

Example	4	5	6
Ethyl Cellulose (50 centipoises, 45.5 to 50% ethoxyl)	25	25	25
Glycerol Ester of Hydrogenated Rosin	25	------	------
Styrene Base Resin	25	------	------
White Mineral Oil	25	------	------
Paraffin Wax	3	32.5	25
Menthyl Phenol (or Octyl Phenol)	1	1	1
Hydrogenated Castor Oil	------	32.5	25
Paracoumarone-Indene Resin	------	10	10
Stearic Acid	------	------	15

Operable ethyl cellulose base melts have been compounded using ethyl cellulose having a viscosity of from 7 to 100 centipoises. Satisfactory dipping viscosities are obtained at lower temperatures with melts comprising ethyl cellulose of low viscosity while tougher and more easily removed coatings are obtained with more viscous ethyl cellulose. This ease of removal is due to the greater film strength of the melt containing the more viscous material. The difficulties encountered with the more viscous melts are that the coatings are much thicker than necessary and that the higher temperatures at which satisfactory dipping viscosities are obtained tend to decompose the melt itself. It is possible to get satisfactory dipping viscosities at lower temperatures with the more viscous ethyl cellulose by incorporating greater amounts of modifiers, especially the higher fatty acids. It is also possible to operate at higher temperatures without decomposition of the melt by maintaining the molten composition under an inert atmosphere of nitrogen or carbon dioxide to prevent oxidation. It has furthermore been found that best results are obtained when the ethoxyl content of the ethyl cellulose is maintained between 45.5 and 50%.

Cellulose acetate base compositions such as that employed in Example 2 have proved highly satisfactory. Best results are obtained when the cellulose acetate has a viscosity of from 2 to 25 seconds by the Hercules Ball Method and a combined acetic content of from about 52% to about 56%. The amount of adhesion to the wires is readily controlled by varying the amount of pine wood resin. The desired flexibility can be obtained by varying the amount of plasticizer.

Plastic melts with a vinyl polymer as their base have also given satisfactory results. The composition used in Example 3 is typical of these. Such compounds as polyvinyl chloride or the copolymer of vinyl chloride and vinyl acetate may be readily substituted for the polyvinyl butyral. As in the case of the cellulose acetate base melts, adhesion and flexibility may be controlled by the amount of pine wood resin and plasticizer used.

Although the invention has been specifically

illustrated with respect to preferred plastic compositions having ethyl cellulose, cellulose acetate, and vinyl compounds as their base, it is to be understood that any plastic melt giving a durable insulating coating which may be easily removed from the lead wires is operable.

The solder used for formation of the shunt may be of varied composition. A 60% lead-40% tin solder has been found very satisfactory. The preferred temperature for the solder bath shown in Fig. 1 is about 10° C. higher than the melting point of the particular solder used. The above 60% lead-40% tin solder was therefore maintained at a temperature of about 285° C. While it is preferred to form the solder shunt by dipping, the tips of the lead wires may be soldered together in any conventional manner.

If it is necessary to employ a flux to make the solder shunt stick, a flux that will not deteriorate at the temperature of the solder bath may be floated on the solder as shown in Fig. 1. Operable fluxes are silica and silicates, lime and limestone, fluorite, and various boron compounds. The boron compounds are especially desirable for iron wire. Flux may of course be applied in any conventional way if it is not desired to float the flux on the solder bath and numerous fluxes are available for this purpose.

The terminal ends of the lead wires may be welded in any conventional way. Percussion welding has proved very satisfactory as long as the force used is not great enough to distort the extremities of the wires to an appreciable degree.

When the shunt is formed by twisting the uninsulated portions of the lead wires together, it is only necessary and desirable to twist one wire around the other far enough that they will maintain their position and the resulting electrical contact during the dipping operation. Once the plastic has solidified the wires are held in position and the contact maintained.

An additional advantage incident to the use of the plastic coatings of this invention lies in the fact that various fillers or pigments may be added to the plastic composition to produce identifying colors for the different types of initiating devices. For instance, titanium oxide in the amount of 1 to 2 parts per 100 will produce a white coating. Five-tenths to 1 part of titanium oxide per 100 in combination with 0.2 part per 100 of yellow pigment produces a yellow coating while 0.5 to 1 part per 100 of titanium oxide and 0.6 part per 100 of red pigment produces a red coating.

It is evident that in the mass production of the shunted, plastic-coated lead wires of this invention, modifications of the basic method herein set forth may be made without departing from the spirit and scope of the invention.

Thus, in accordance with this invention, the bare ends of lead wires of initiating devices may be insulated, shunted and protected from corrosion and stray currents. Both the shunt and plastic coating may be easily removed without distortion of the bare lead wires when the initiating device is ready for use. Initiating devices equipped with the coated and shunted lead wires of this invention are extremely safe to use because the possibility of accidental firing due to static discharge or accidental contact with live or stray currents is completely eliminated. Furthermore, it is an added safety factor to have the shunt and bare leg wires completely encased in insulating material until actual connection to an electrical circuit at which time the shunt is

broken and the insulation removed substantially in one manipulation.

What I claim and desire to protect by Letters Patent is:

1. In the manufacture of a protected lead wire assembly for an electrically-fired initiating device, the method which comprises passing the bare ends of the otherwise completely insulated lead wires through a guide funnel, the lower vertex of which has a diameter only slightly larger than the combined diameters of the bare wires, into a molten solder bath to form a bead of solder between and about their terminal ends, withdrawing the wires through the funnel, and passing the wires now joined at their terminal ends through a guide funnel, the lower vertex of which has a diameter only slightly larger than the combined diameters of the insulated portions of the lead wires, into a molten plastic composition to completely cover the soldered joint and the uninsulated portions of the lead wires.

2. An electric blasting initiator assembly comprising an electric blasting initiator; a pair of lead wires extending therefrom; an electrical shunt disposed adjacent the terminal ends of the lead wires, said lead wires having initially applied insulation extending from the initiator to a point short of the terminal ends; and a substantially nonadhering coating of tough, dielectric, plastic hot-melt composition disposed intimately about the initially uninsulated portions of the shunted lead wires and extending a short distance over the insulation in substantially airtight and watertight relationship therewith, said plastic hot-melt composition having been applied by dipping the shunted terminal ends and the lead wire adjacent thereto into a bath of the molten composition.

3. A lead wire assembly according to claim 2 in which the hot-melt composition comprises ethyl cellulose.

4. A lead wire assembly according to claim 2 in which the hot-melt composition comprises cellulose acetate.

5. A lead wire assembly according to claim 2 in which the hot-melt composition comprises a vinyl polymer.

6. A lead wire assembly according to claim 2 in which the terminal ends of the lead wire are soldered together to form a joint.

7. A lead wire assembly according to claim 2 in which the terminal ends of the lead wire are welded together to form a joint.

8. A lead wire assembly according to claim 2 in which the terminal ends of the lead wire are twisted together to form a joint.

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