Sept. 13, 1949. F. R. SEAVEY 2,481,696

ELECTRIC FIRING DEVICE

Filed Sept. 11, 1946

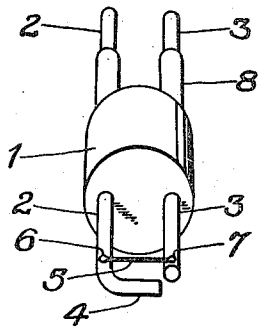

Fig. 1

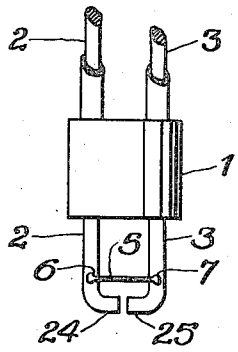

Fig. 2

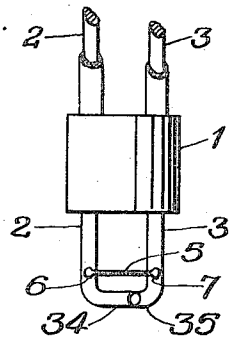

Fig. 3

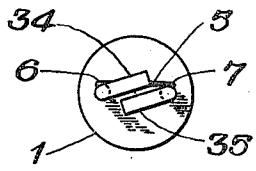

Fig. 4

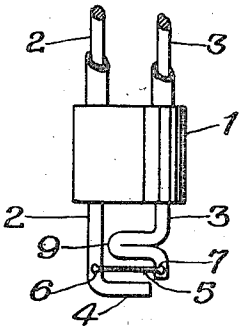

Fig. 5

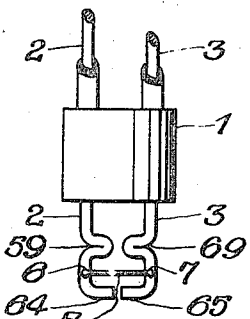

Fig. 6

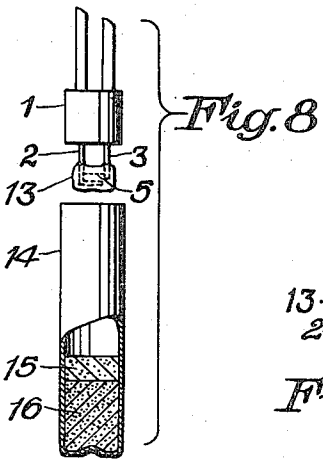

Fig. 8

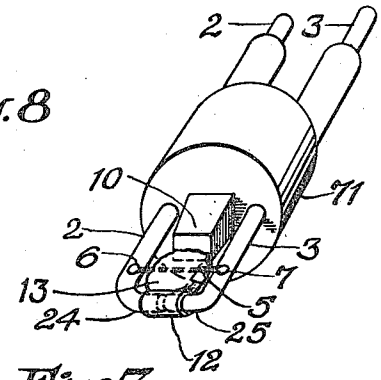

Fig. 7

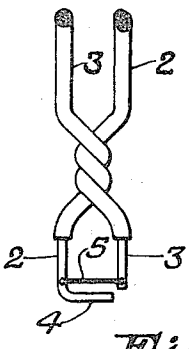

Fig. 9

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Patented Sept. 13, 1949

2,481,696

UNITED STATES PATENT OFFICE

2,481,696

ELECTRIC FIRING DEVICE

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Application September 11, 1946, Serial No. 696,154

11 Claims. (Cl. 102—28)

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This invention relates to electric firing devices and more particularly to devices of the detonator or blasting cap type wherein an explosive is initiated by an electric current.

Electric blasting caps of the bridge plug type usually consist of a deep cylindrical shell or cup, in which is confined a base charge of tetryl, trinitrotoluene, or other explosive; an initiating charge such as lead azide; and the electrical firing device. The firing device generally consists of a plug suitable for closing the shell, a pair of lead wires passing through the plug and extending somewhat beyond the base of the plug, a high resistance wire electrically bridging the lead wires and embedded in a thermally sensitive ignition composition. When sufficient electric current traverses the bridge wire, it is heated to the extent necessary to actuate the ignition composition, the functioning of which in turn initiates the explosive charges within the shell.

When the ignition composition in which the bridge wire is embedded is in the form of a bead, the mechanical deficiencies of such igniter structures are frequently responsible for the total failure and unsatisfactory operation of electric blasting caps. The fine bridge wire supporting the comparatively heavy and bulky igniter bead is highly susceptible to breakage. The bead of ignition composition applied to the bridge wire is very fragile and may crack during shipment or handling, after which all or part of it may either fall from or cling more or less loosely to the bridge wire, but such condition cannot be ascertained without disassembling the detonator, which is not feasible in the field. In practice the fault is seldom discovered until the device has been implanted in a charge of high explosive, and a misfire occurs. Misfired caps from an ore mine, rock quarry, coal mine, or the like are a definite hazard to equipment and life.

Moreover, due to their inherent frailty, numerous bridge wires are broken in that stage of manufacture whereas the bead or other coherent mass of ignition composition is applied about the bridge wire. When discovered, such a device is discarded, but the breakage may not be visible and hence go undiscovered until shown by electrical test, when the whole assembly is scrapped. Consequently, the application of the bead or other coherent mass of ignition composition is recognized in the art as a highly tedious one involving no inconsiderable amount of scrap, and therefore of substantial economic importance.

Accordingly the object of the present invention is to provide a firing device of the kind referred

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to wherein breakage of the bridge wire is minimized.

Another object is to provide on the bridge wire in electric igniters a bead of ignition composition having reduced susceptibility to breakage or movement with respect to the bridge wire.

Still another object is to provide a structure which may be economically and rapidly manufactured.

A still further object of the invention is to provide electric blasting initiators of the beaded bridge wire type having improved firing characteristics and a greatly decreased tendency to misfire when connected in a series firing circuit.

Other objects of the invention will be apparent from the following detail description taken in connection with the accompanying drawings, in which:

Figure 1 is a perspective view of a bridge-plug assembly illustrating one embodiment of this invention;

Figure 2 is a side view of such an assembly according to another embodiment of the invention;

Figure 3 is a side view of a further embodiment and Figure 4 is a bottom view of the embodiment shown in Figure 3;

Figures 5 and 6 are side views respectively illustrating two additional embodiments of the invention;

Figure 7 is a perspective view of still another embodiment of the invention;

Figure 8 is a side view of the firing device in accordance with this invention and the blasting cap shell, shown in partial cross-section, prior to assembly; and

Figure 9 is a side view illustrating another embodiment of the invention.

The above objects and advantages are accomplished in accordance with this invention by the provision of a novel firing device having a relatively rigid and rugged support adjacent the midsection of the bridge wire filament. Such a support not only protects the filament from mechanical injury during insertion into loose ignition composition and during the application of beads of ignition composition, but also, in the latter instance, relieves the filament of the load of the bead. Such support may be conveniently formed by positioning a part of one or more of the lead wires in protective relation with the bridge wire filament.

Although the support may be formed in any suitable manner, it is preferred that it be produced by bending or swagging a portion of at

least one of the spaced lead wires to form a lateral appendage or protrusion adjacent the bridge wire extending in a general direction toward the other lead wire. In order to provide optimum disposition of and support for the igniter bead and mechanical protection for the bridge wire, the diameter of which is usually of the order of 0.001 inch, such appendage or projection is disposed below the bridge wire. In some igniters embodying the present invention, it is desirable that another such appendage may be disposed above the bridge wire to provide additional support and reinforcement for and positioning of the bead with respect to the bridge wire. The projection above the bridge wire may, in some instances, be formed by providing the base of the plug with a boss or protrusion projecting down between the spaced lead wires. When the surface of the bead of ignition composition adheres to the boss, it functions as an upper support member.

In the embodiment illustrated in Figure 1, a plug 1 carries the lead wires 2 and 3 embedded therein and projecting therethrough in the usual manner. At the inner (near) end of plug 1, lead 2 is bent laterally to form the above mentioned lateral projection or appendage 4. A filament 5 bridges the lead wires 2 and 3 and is mechanically and electrically connected thereto as by soldering at 6 and 7, respectively. The appendage 4 thus extends at substantially a 90° angle to the lead 2 in the plane of said lead wires toward the short lead 3, but terminating short thereof so as to leave a small gap, for instance, 0.025 inch, to prevent short circuiting of the lead wires. The end appendage 4 and the bridge wire 5 are substantially parallel and are spaced to prevent contact with and short circuiting of the bridge wire. The lead wires 2 and 3, together with the appendage 4, thus form a relatively rigid, substantially closed frame for receiving, supporting, and reinforcing an igniter bead, and for protecting the bridge wire A portion of the lead wires 2 and 3 extending above the top of the plug 1 is shown with part of the lead wire insulation 8 removed.

In the embodiment shown in Figure 2, the plug 1, lead wires 2 and 3, and filament 5 are arranged as before save that the inner projections of the leads are of equal length and the extremity of each is provided with an appendage shorter than in the previous embodiment. In this case, the extremity of each lead wire is bent to form appendages 24 and 25 in the plane of said lead wires and extending toward each other but leaving a gap therebetween. A 90° bend is shown, but it is to be understood that the appendages 24 and 25 may be bent at any other suitable angle or arc. In this and the succeeding embodiments, corresponding reference characters designate parts similar to those previously described.

In the embodiment illustrated in Figures 3 and 4, the extremities of both spaced lead wires 2 and 3 are bent, substantially as the lead 2 was bent in Figure 1, to provide spaced, substantially parallel appendages 34 and 35 extending obliquely to the plane of the lead wires.

In the embodiment illustrated in Figure 5, lead wire 2 is bent, as in Figure 1. Lead wire 3 is bent above bridge wire 5 toward the lead 2 to form a lateral projection 9 substantially parallel to and in a plane with the bridge wire 5 and projection 4. Thus in this embodiment, the bead-supporting frame consists of the upper appendage 9, the lower appendage 4, and the adjacent portions of the lead wires 2 and 3.

In the embodiment illustrated in Figure 6, the lead wires 2 and 3 are bent inwardly both above and below the bridge wire 5 to form lateral projections 59 and 69 above, and 64 and 65 below, the bridge wire 5. The several projections lie in the plane containing the bridge wire 5 with the oppositely disposed projections spaced sufficiently to prevent short circuiting of the leads, but approaching each other close enough to constitute a substantially closed frame.

In the embodiment of Figure 7, a plug 71 having a protuberance 10 extending adjacent the mid-section of filament 5 is shown in lieu of the plug form of the previous embodiments. While any of the appendage forms above described may be utilized with plugs of the form shown in Figure 7, the appendage form of Figure 2 is adopted by way of example. The gap between appendages 24 and 25 is in this case occupied by an insulator 12 of any suitable solid dielectric material, such as sulfur, rubber, plastic, or ceramic. Alternatively, a dielectric member equivalent to the insulator 12 may be formed by dipping the appendages 24 and 25 into clay or thermoplastic resin compositions. This insulator serves to maintain the gap during manufacture and prevents subsequent short circuiting of the lead wires. While in the embodiment shown, the protuberance 10 is integral with the body of the plug and hence is of dielectric material, it will be understood that such may be a metal insert molded into the body of the plug if care be taken in positioning the same so that it does not short circuit leads 2 and 3. In either event, the protuberance 10 extends sufficiently proximate the bridge wire 5 to constitute the upper reach of a supporting frame about the bead 13 of ignition composition to be applied.

In each of the several alternative bridge-plug assemblies just described, a rugged substantially closed protecting frame consisting of lead wires with or without dielectric members is provided about the bridge wire 5 for the reception of a body of ignition mixture. Having thus provided the supporting frame, the bead of ignition mixture is applied about the bridge wire 5. This may be accomplished by simply dipping any of the assemblies above disclosed into a batch of ignition composition of a consistency such as to cohere together and to adhere to the supporting frame of the assembly. Alternatively, a droplet of ignition composition may be deposited about the bridge wire, as shown in Figure 8. In any event, a sufficient charge of the mixture is applied so that it not only envelops the bridge wire, but also embeds one or more of the lateral appendages or projections.

In Figure 8, the firing device is shown complete with the igniter bead 13 just before insertion into the open end of a blasting cap shell 14 having a base charge 16 and an initiating charge 15.

While in the drawings the lead wires are indicated as extending through the plugs in parallel relation, it will be understood that the wires may be twisted within the plug provided they are insulated one from the other. In fact, in some cases, the plug may be eliminated, as, for example, in Figure 9 wherein a firing device embodying this invention is illustrated in which the insulated portions of the leads 2 and 3 are twisted in order to suitably space the uninsulated end portions of the leads. The bridge wire 5 is attached to the leads, as in Figure 1, with lead 2 bent in-

wardly to form protecting member 4, as previously described.

Electric firing devices suitable for use in electric detonators may be produced in accordance with this invention by first forming the lead wire-plug assembly by any of the well known methods, for instance, by molding the plug about the lead wires. The plug itself may be formed of any suitable material, although sulfur, rubber, thermoplastics, or the like, are usually employed. The lead wires for this purpose are usually of copper about 0.025 inch in diameter and are insulated from each other within the plug. For uses in which no plug is needed, the plug may be omitted and the uninsulated ends of the leads suitably spaced by twisting the insulated portion of the leads, as in Figure 9.

The support or frame for the bead of igniter composition is then formed by suitably bending or otherwise deforming one or both of the lead wires to provide a lateral projection as described above and illustrated in the drawings.

The bridge wire is next secured to the lead wires at 6 and 7, for instance, by welding. The bridge wire is a resistance wire usually substantially less than one-tenth the diameter of the lead wires.

The method is particularly adaptable to mass production of firing devices by automatic machinery, and such devices have many advantages, as indicated hereinafter.

During the formation of the bead of igniter material, the lateral projections function to protect the bridge wire from accidental breakage.

The inclusion of the rigid support members or lead wire appendages within or about the bead of ignition composition produces a reinforced bead having increased strength, durability, and dependability. These support members, which may have a thickness as great as 0.025 inch or greater, provide a much stronger and more rigid support for the bead than is provided in prior devices by the bridge wire, the diameter of which seldom exceeds 0.002 inch. The extremely thin bridge wire is not utilized in accordance with this invention as the bead supporting member and consequently is not subjected to the weight of, and stresses occasioned by, the igniter bead in the formation and use of the firing device.

Igniter beads formed by means of the aforementioned frame are characterized by a uniformity of size and function. Furthermore, the supporting members facilitate control of the disposition of the mass of the ignition composition with respect to the bridge wire.

It is to be understood that many variations may be made in the specific embodiments herein set forth without departing from the spirit and scope of the invention and that the invention is not to be limited thereby except insofar as set forth in the appended claims.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In a firing device for an electric detonator, the combination comprising a pair of lead wires electrically connected by an electric filament, at least one of said lead wires extending beyond the connection with said filament and bent at an angle toward the other lead wire to provide protection for said filament.

2. In a firing device for electric blasting caps, the combination comprising a plug, lead wires passing through said plug and extended in spaced relationship from the base of said plug, a bridge wire electrically connecting said lead wires below the base of said plug, a bead of igniter composition in contact with said bridge wire, and a lateral projection on one of said lead wires for supporting said bead, said lateral projection extending in substantially parallel spaced relation to said bridge wire.

3. In a firing device for electric blasting caps, the combination comprising a plug, lead wires passing through said plug and extended in spaced relationship from the base of said plug, a bridge wire electrically connecting said lead wires below the base of said plug, and a bead of igniter composition in contact with said bridge wire, at least one of said lead wires having at least one lateral projection for supporting said bead, said lateral projection extending in substantially parallel spaced relation to said bridge wire.

4. In a firing device for electric blasting caps, the combination comprising a plug, lead wires passing through said plug and extended in spaced relationship below the base of said plug, a bridge wire electrically connecting said lead wires below the base of said plug, and a bead of igniter composition in contact with said bridge wire, at least one of said lead wires being bent inwardly below the connection with said bridge wire to provide a supporting frame for said bead.

5. In a firing device for electric blasting caps having a plug, a pair of lead wires passing therethrough, a bridge wire connecting said leads below the base of said plug, a bead of igniter composition in contact with said bridge wire, and a support for said bead comprising a lateral projection of at least one of said lead wires, said lateral projection extending in substantially parallel spaced relation to said bridge wire.

6. In an electric firing device, the combination comprising a pair of lead wires having uninsulated portions, means spacing said portions, an electric filament connecting said portions, a bead of igniter composition in contact with said filament, and a lateral projection of at least one of said lead wires supporting said bead, said projection being separated from the other lead by an electrical non-conductor.

7. In a firing device for electric blasting caps, the combination comprising a plug, a pair of lead wires passing therethrough and extending beyond the base of said plug, a bridge wire connecting said leads below the base of said plug, and a bead of igniter composition in contact with said bead, said lead wires having appendages forming a frame supporting said bead at the side thereof remote from the plug.

8. A method of forming a firing device for a blasting cap comprising deforming the end portion of at least one of a pair of lead wires to form a lateral projection, attaching a bridge wire across said lead wires in substantially parallel spaced relation to said projection, and forming a bead of igniter composition in contact with said bridge wire and supported by said lateral projection.

9. In an electric firing device, the combination comprising a plug, a pair of lead wires passing through said plug and having uninsulated end portions extending in spaced relationship from the base of said plug, a bridge wire electrically connecting said lead wires below the base of said plug, at least one of said lead wires having below the connection with said bridge wire a lateral projection, a bead of igniter composition in contact with said bridge wire, and an appendage extending from the base of said plug to provide together with said lateral projection substantial support for said bead.

10. In an electrically actuated firing device, the combination comprising a plug, a pair of lead wires passing through said plug and having uninsulated end portions extending in spaced relationship from the base of said plug, a bridge wire electrically connecting said lead wires below the base of said plug, a bead of igniter composition in contact with said bridge wire, and an appendage extending adjacent the section of the bead midway between the lead wires to support the same.

11. In the art of making electrical firing devices, the process comprising, providing a plug having spaced lead wires extending therethrough, a resistance filament bridging the wires and a protective appendage extending adjacent the bridge wire in substantially parallel spaced relation, and dipping the bridge wire and appendage into a mass of adherent ignition composition.

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