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ELECTRICAL PELLET PRIMER

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FIG. 1

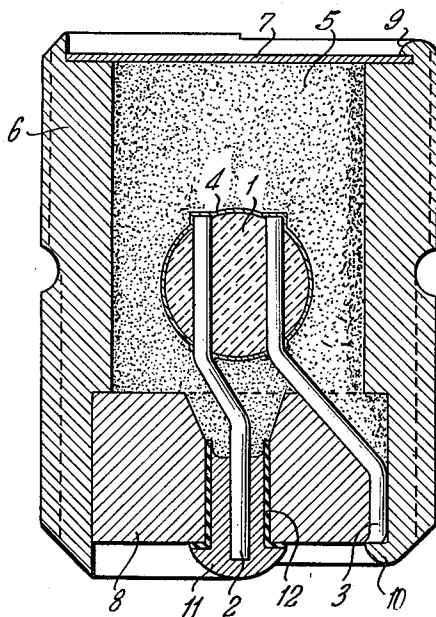
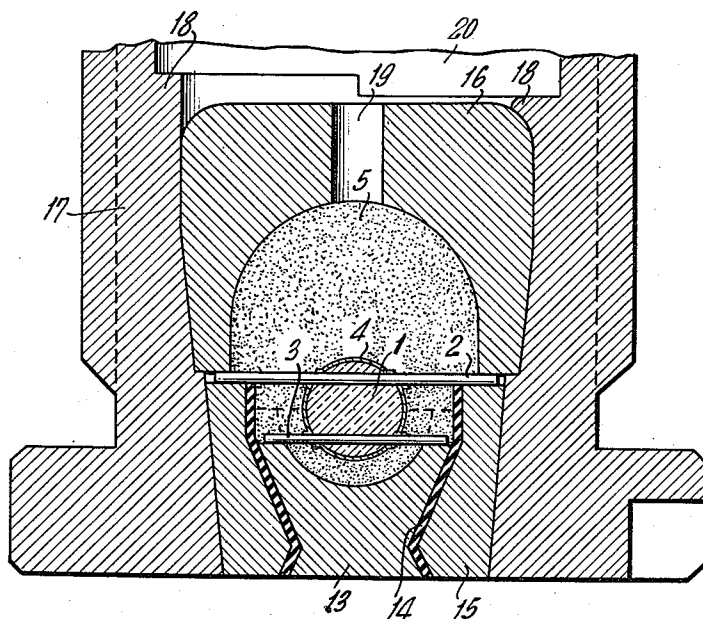


FIG. 2



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ELECTRICAL PELLET PRIMER

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4 Claims. (Cl. 102—70.2)

This invention relates generally to detonators or firing devices for explosive and similar blasting charges.

Electrical pellet primers are used for priming explosive charges for mining and military purposes and propellant charges in cartridges and rockets. These primers after assembly are inserted in suitable holders or mounts which are called fuses, and the latter are divided into two classes: bridge fuses and split or gap fuses. The bridge fuses between two terminals comprise a bridge to be fused which has an electrical resistance of one to three ohms. Said bridge may be formed by a wire or a thin metallic coat on an insulating carrier. Since in mines leakage currents are always present, a safety regulation requires that five series-connected bridge fuses have to withstand a continuous current of 0.18 ampere for five minutes without fusing of the bridge and without igniting the ignition material surrounding the bridge. In the case of gap fuses, an electrically conducting admixture in form of metal or graphite powder is added to the ignition material in order to afford an electrical connection between two electrodes. According to the conditions present, the electrical resistance between the electrodes is different, but amounts always to several thousand ohms. Owing to the uncontrollable distribution and disposition of the metal and graphite particles, the path followed by the current on ignition is uncertain and may run in any of the three space directions. A safety regulation for mining fuses requires that each gap fuse withstand, without fusing, a continuous voltage of 15 volts for the time of five minutes. A further requirement is that five series-connected fuses are simultaneously ignited when applying a direct voltage of 220 volts.

With reference to the last-mentioned requirement, bridge fuses are less favorable than gap fuses. When the fuse bridge of one of the series-connected fuses does not melt at the same time as the other bridges, the circuit for this one fuse is permanently interrupted and subsequently cannot be operated any more. In the case of gap fuses, the pilot spark generally develops into an arc in which the current is increased on account of the so-called negative characteristic of the resistance. Thereby the current is increased also in the non-ignited fuses of the series connection, which increase favors the ignition of the latter.

Our present invention relates to an electrical pellet primer which combines the advantages of bridge fuses and gap fuses while eliminating the disadvantages of these known fuses.

In accordance with our invention, the electrical pellet primer employs two spaced electrodes, which are surrounded by a bead which preferably consists of a glass-like insulating material and to which is bonded a metallic coat which is conductively connected to the electrodes and serves as primer.

The spherical shape of the insulating bead ensures a high mechanical strength permitting the insulation carrier to be pressed thereon, together with the electrodes and

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the conducting metallic coat, and into the ignition material under comparatively high pressure.

The metallic coat on the beads advantageously may be produced by immersing the beads, after mounting same on the wires, into a solution from which on subsequent heating metal is precipitated, and then heating the beads so as to precipitate the metal. Such process steps of immersion and subsequent heating may be repeated several times until the metallic bridge disposed between the electrode wires has the desired electrical conductivity on the bead surface.

Further features and advantages of our present invention may be derived from the claims, the specification and the accompanying drawing in which, by way of example, two different fuse units are shown, of which each comprises an embodiment of our present pellet primer.

In the drawing:

Fig. 1 shows a longitudinal section through a detonator which comprises a pellet primer of which the wires, which serve as electrodes and leads, are secured at one end only, and

Fig. 2 illustrates a longitudinal section through a portion of a firing relay which comprises a pellet primer of which the wires are secured at both ends.

The pellet primer 1 to 4 of the detonator shown in Fig. 1 comprises a glass bead 1 in which are sealed two metal wires 2 and 3. The latter are made, for example, of a chrome-nickel alloy and pass through the entire bead 1 so that their two ends project beyond the bead surface. While those ends of the wires 2 and 3 which in Fig. 1 are situated on top, lie in the immediate vicinity of the bead surface, the other wire ends are disposed at a substantial distance from the bead in order that they may be used as leads and for securing the pellet primer.

On the bead surface and also on the portions of the wires 2 and 3 adjacent thereto, is provided a thin electrically conducting coat preferably made of platinum or another metal which is chemically non-attackable by the appurtenant ignition substance. The thickness of said coat is so chosen that the metal bridges provided between the bead-entering wire portions and between the bead-leaving wire portions, have an electrical resistance such as is required for the production of the Joule's heat upon passage of the current, which resistance may amount, for example, to 40 to 100 ohms. To said metal coat is bonded a thin layer of ignition substance such as cuprous carbide C_2Cu_2 and, further, a thin layer of thermally insulating, ignitable material such as nitrocellulose. The totality of said layers in Fig. 1 is represented by a dash line and designated by 4.

The layer of ignition substance applied to the metal coat serves to intensify the electrically produced spark with the aid of chemical energy, so that this spark suffices to ignite the detonator charge 5. The insulating layer surrounding the ignition substance, solely serves to avoid an increase in the heat capacity (which is low per se) of the pellet primer (which is of comparatively small dimensions) by thermal contact with the surroundings, i.e. with the detonator charge 5.

The pellet primer described is disposed inside of said detonator charge 5 which, for example, may consist of lead azide and which on all sides is in intimate contact with the pellet primer. Said charge 5 is disposed in a cylindrical casing 6 which on its upper side is closed by a membrane 7 which is readily destructible under the detonation action, and said casing on its underside is closed by a comparatively sturdy bottom plate 8. The latter and membrane 7 are located by a bead edge 9 and 10 respectively, which edges in the left-hand portion of Fig. 1 are illustrated prior to being beaded.

In the center of bottom plate 8 is secured a connecting contact member 11 through the intermediary of an in-

insulating sleeve 12. Said member 11 is connected to wire 2 of the pellet primer, while the other wire 3 is clampedly engaged in a groove between bottom plate 8 and casing 6.

It is to be noted that the entire ignition unit shown in Fig. 1 may have comparatively small dimensions and, for example, a total height of $\frac{3}{8}$ inch and a diameter of $\frac{1}{16}$ inch. The glass bead 1 may have a diameter of 2 millimetres or less.

In the pellet primer shown in Fig. 2, the ends of the wires 2 and 3 project so far beyond the surface of bead 1 that both wires may be used for connecting and securing the bead. The ends of the shorter wire 3 are clampedly engaged in grooves of a contact member 13 which is recessed in the manner of a trough and through the intermediary of an insulating envelope 14, is riveted in a metal ring 15 which is conically tapered both inside and outside. The ends of the other wire 2 are engaged in slits of said ring 15 and are located by means of a cap 16. Ring 15 as well as cap 16 are inserted from the inside, into the casing of the ignition relay 17 and secured in their position by beading an edge 18 which in the left-hand portion of Fig. 2 is shown prior to such beading operation. An ignition substance 5 is introduced into the free spaces of member 13 and cap 16 and surrounds bead 1 with the layers 4 applied to its surface. The ignition spark may strike through a central opening 19 in cap 16 into an adjoining chamber 20 of the ignition relay.

In both examples of the pellet primer, the wires 2 and 3 serve as electrodes as well as leads and pellet holders.

The pellet primers of the kind described may be used, for example, for pyrotechnical purposes, for igniting purposes in projectile fuses and other fuses and for releasing photographic flash-lights.

The mode of operation of the pellet primers 1 to 4 of both ignition devices described, is similar. When applying a source of current to the electrode wires 2 and 3, the metal coat of the bead fuses when the current intensity is sufficiently high, and an ignition substance. When, for any reason, the detonator charge 5 is not ignited, the evaporated metal of the platinum coat through condensation is precipitated again on the surface of bead 1, the bridge strip between the electrode wires 2 and 3 being regenerated. The same pellet primer then may be re-used for ignition by again applying it to the current source. If required, such procedure may be repeated several times until the detonator charge 5 is finally ignited. Said ability of regeneration also is particularly great for the reason that the pellet primer comprises two points of ignition, namely between the points of entrance of the wires 2 and 3 into bead 1, and between the points of exit of the wires from the bead. One of said points of ignition may be used at least for a second ignition in the case that the detonator charge 5 has not been set off in the first ignition.

Since the platinum layer on bead 1 has a compact structure, the resistance of the leading bridge between the electrode wires 2 and 3 is constant and fixed. In this respect, the pellet primer resembles the bridge fuses known so far. The electrical resistance between the electrode wires 2 and 3, however, may be made comparatively high so that the pellet primer in its behaviour resembles the known gap fuses.

In contrast to the gap fuses known so far, the resistance here between the electrodes 2 and 3, is constant, and the current path at the moment of firing is better defined since it may take place only in two directions on the surface of bead 1, and not in three dimensions within the entire ignition substance. When the resistance is sufficiently high, the metal layer on bead 1 does not fuse when applying a certain voltage of, for example, 15 volts, since the produced current is too small and the heat generated is carried off without causing damage. The pellet primer then satisfies the safety regulation

which has been set up for the gap fuses. Each pellet fuse is so formed that it will ignite at a voltage of, for example, 20 volts. Within the stated range of resistance of the pellet primer there is a somewhat narrower range in which the regulation valid for bridge fuses is substantially fulfilled, namely that ignition shall not take place yet under a current of, for example, 0.05 ampere. For a certain range of resistance of the metal layer between the electrode wires, the same pellet primer according to our invention entirely satisfies the respective safety regulations for gap fuses, but partly only for bridge fuses.

When a plurality of pellet primers of the kind described are series-connected, the probability that all of them are ignited at one and the same time is much greater than in the case of gap fuses or even of the bridge fuses of known design. When, according to the firing conditions, five fuses are laid out in series connection under 220 volts, then each fuse is subjected to 44 volts. The arcing voltage across a fired pellet, however, only amounts to approximately 16 volts so that for the other non-fired pellets a voltage of $220 - 16 = 204$ volts is available, i.e. 51 volts for each, which voltage favors ignition. For the pellet fired last, the voltage rises to $220 - 4 \times 16 = 156$ volts. When igniting each of the series-connected pellet primers, the current passing through the pellets thus rises so as to initiate the ignition of all the pellet primers.

A further advantage of the new pellet primers is founded in their rugged construction. Owing to the preferred spherical shape of the insulating bead 1, the detonator charge 5 which has to surround the pellet primer, may be pressed-in under the comparatively high pressure of, for example, 30,000 pounds per square inch without any risk of damaging the metallic conducting layer on bead 1. The pellet primers and the fuse unit provided therewith thus also are suited for cartridges, grenades, rockets and the like which are exposed to high accelerating and delaying forces partly when loading in automatic weapons and partly when being fired. The manufacturing method, described below, ensures a perfectly rigid connection between the electrode wires 2 and 3 and insulating bead 1 and between the metallic layer and the bead surface.

In a melting or fusing machine of a construction known per se, two continuous metal wires which over a certain distance are run parallel to each other, are surrounded with glass beads 1, being fused thereto with the aid of a source of heat such as a gas flame, and said beads being arranged at equal spacing from each other. The chain so formed is cleaned, dried and run through a metal salt solution, e.g. a luster platinum solution, in a continuous operation. From such solution there is produced on the surfaces of the beads 1 a coat which first is dried and then treated in a protective-gas atmosphere, at a rising heat supply, for the purpose of reducing the metallic salt to metal. Thereby is produced on the beads a thin metallic coat which may be increased to any desired thickness by repeating the operation described of immersing and heating. The bead chain then is calcined at a temperature at which the glass of the beads starts to turn plastic. The individual metal particles of the coat through sintering are bonded to the glass. The desired electrical resistance of the bead metal layer can be maintained by a corresponding number of immersions in the metal salt solution, by a corresponding choice of the latter's concentration and by the extent of sintering.

In the reduction process described of the metal from a solution of the respective salt, the metal is precipitated in the form of molecular structures or aggregates. Therefore the metal layer varies, from high to low resistances, so that in the first case it comprises relatively few metal particles which in statistical distribution contact each other more or less. In the second case, the layer assumes more and more the structure of a solid metal layer. At the points of contact of the individual par-

ticles which, as known, in their totality form the total resistance of the priming path, Joule's heat is released in very small ranges when the power load is on during ignition, and such heat leads to formation of an arc.

The subsequent operation of coating the beads with a thin layer of ignition substance of high sensitivity, and also that of applying a thin layer of an ignitable and thermally insulating lacquer, may be effected by immersion into a corresponding solution. The ignition substance, however, also may be applied to the beads by pressing.

After the pellet primers have been completed, they are cut off the chain according to usage. In the case of a detonator shown in Fig. 1, the pellet primers, while still on the chain, are inserted into the bottom plate 8, and after having been secured, the wires 2 and 3 are cut off immediately at the surface of the beads. When manufacturing fuses shown in Fig. 2, small sections of the wire 3 may be cut out intermediate of two beads for the purpose of an intermediate check of the electrical resistance, and so that the remaining wire just fits into the grooves of member 13. The pellet primers thus remain on the chain until assembly has been completed, and do not require any complicated straightening and clamping devices.

The ruggedness of the pellet primers also affords the advantage that now all of the mechanical and electrical assembly operations for fuses, detonators and the like may be carried out prior to the application of the primary ignition substance, which so far has not been possible in the case of bridge fuses. Thereby are eliminated substantial restrictions for the continuous fabrication, which restrictions would become effective according to the prevailing safety regulations as soon as an explosive charge is present. The ignition substance thus may be filled, flooded or pressed in at the end of the fabrication process, without risk of damaging the ignition train.

The beads 1 of the pellet primers described do not necessarily have to be made of glass, but may be made of some other glass-like, ceramic or plastic material, provided that the metal precipitation in a thermal reduction process of the kind described may be produced. It is not necessary that the beads be of spherical shape, although such shape has been found best for structural strength.

What we claim as new and desire to secure by Letters patent is:

1. An electrical pellet primer comprising a spherical bead of electrically insulating material, two leads serving as electrodes, said leads being extended in spaced relation to each other through said bead, an electrically conductive metal coat provided on substantially the entire surface of said bead and bonded thereto, and a layer of thermally insulating ignitable material superimposed on

said metal coat, said coat being in contact with said electrodes, said coat and said layer serving to initiate the ignition spark, said leads passing through the entire bead so that their two ends are situated outside of the bead surface in order to afford two ignition points of which one is situated between the entrance locations of said leads into the bead and the other between the locations of exit of said leads from within said bead.

2. An electrical pellet primer comprising a cylindrical casing, a substantially spherical bead of electrically insulating material centrally disposed in said casing and spaced from said casing, an electrically conductive metal coat provided on substantially the entire surface of said bead, a detonator charge compacted in said casing surrounding said bead, a first electrode embedded in said bead and extending beyond said bead at opposite ends thereof, a second electrode bonded to said bead and extending therebeyond, and a layer of ignition material covering substantially all of the surface of said coat and in contact with said first electrode and said second electrode to serve to initiate an ignition spark.

3. An electric pellet primer according to claim 2, wherein said layer of ignition material includes a relatively thin layer of thermally insulating ignitable material superpositioned on said metal coat.

4. An electrical pellet primer comprising a cylindrical casing, a spherical bead of electrically insulating material centrally disposed in said casing and spaced from said casing, a detonator charge compacted in said casing surrounding said bead, two leads serving as electrodes, said leads being extended in spaced relation to each other through said bead, an electrically conductive metal coat provided on substantially the entire surface of said bead and bonded thereto, and a layer of ignition material covering substantially all of the surface of said bead and in contact with said first electrode and said second electrode to serve to initiate an ignition spark.

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