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Bendler et al.

[11] **3,763,782**

[45] **Oct. 9, 1973**

[54] **METAL LAYER INITIATOR**

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[30] **Foreign Application Priority Data**

Apr. 24, 1970 Germany ..... P 20 20 016.2

[52] **U.S. Cl.** ..... **102/28 EB,** 102/70.2 R

[51] **Int. Cl.** **F42b 3/12**

[58] **Field of Search** ..... 102/28 EB, 28 R, 102/42, 27, 70.2 R

[56] **References Cited**

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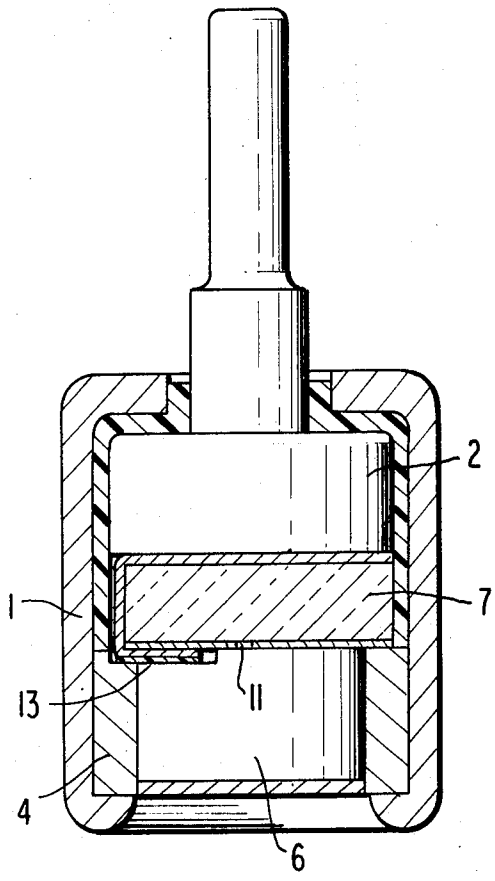
[57] **ABSTRACT**

An electric detonator element in which an ignition bridge, intended to set off a charge, is formed on one side of a non-conductive carrier which is inserted into a conductive housing with one surface contacting a pole piece and the other surface having the bridge formed thereon being pressed against the primer charge which is electrically connected with the housing, and conductive means interconnecting the bridge on one side of the carrier with the surface of the carrier contacting the pole piece either through a bore in the carrier or around the periphery thereof.

16 Claims, 8 Drawing Figures



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SHEET 1 OF 2

FIG.1

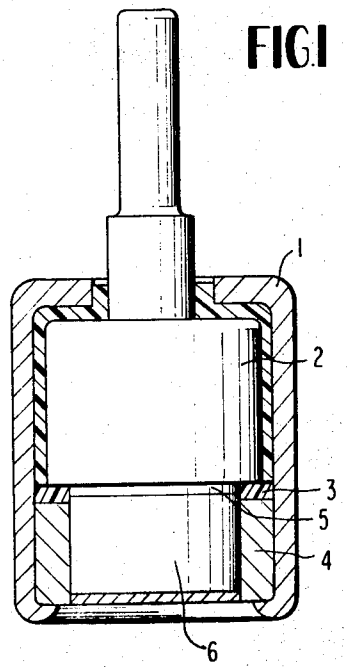
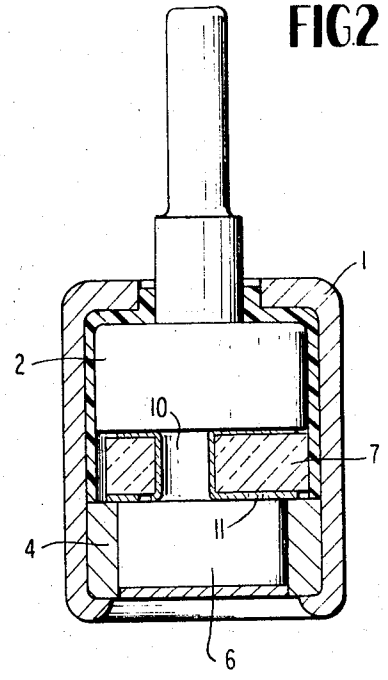


FIG.2



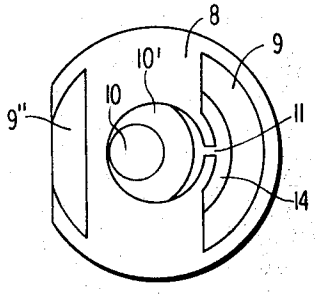


FIG.3a

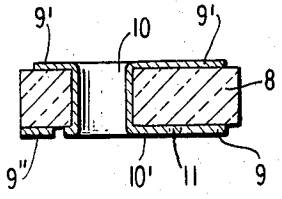


FIG.3b

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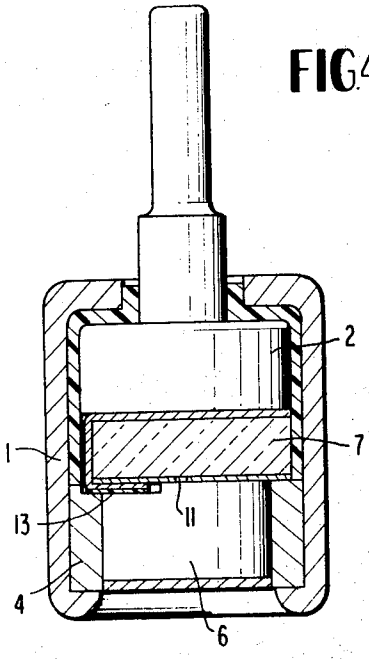
FIG.4



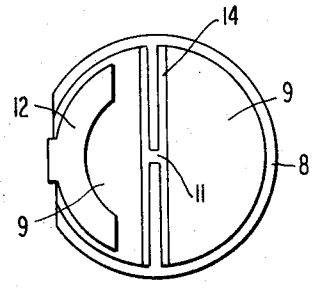


FIG.5a

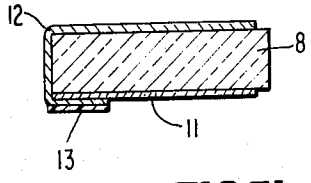


FIG.5b

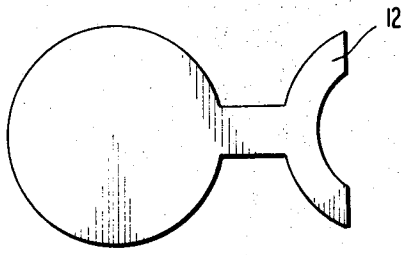


FIG.6

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METAL LAYER INITIATOR

The present invention relates in general to the manufacture of electric detonator elements, such as primer caps, and more particularly to an initiator, having an electrically conductive housing, a pole piece, and an ignitable charge, wherein a carrier of glass or ceramic having metallic layers plated thereon forms an ignition bridge disposed between said pole piece and the ignitable charge, which charge contacts or is in electrically conductive relationship with the conductive housing.

In such primer elements, it is necessary to fashion the electrically conductive connection between the external pole piece and the conductive housing or conductive ignitable charge in such a manner that, on the one hand, the expenses for mass production of the initiator are as low as possible and, on the other hand, the resistance of the electric circuit is extremely stable and the circuit construction is such that as small a current leakage as possible is permitted in the device.

It is conventional to form the ignition bridge as an extremely thin and very short metallic wire jointed to the housing or the pole piece by soldering or welding. However, this procedure exhibits the disadvantage that the manufacturing expenses are relatively high, since the dimensions of the individual parts are very small, and accordingly, a large amount of skill and precision is required to flawlessly execute the welding or soldering operations necessary to effect the connection of the incandescent bridge with the poles.

In copending application Ser. No. 844,823, filed July 25, 1969, in the names of Wolfgang Ludke and Peter Roh, and assigned to the same assignee as the present application, an initiator is described wherein a metallic foil is applied, for example with the aid of an adhesive, to an electrically non-conductive carrier with the use of pressure and heat so as to cover the entire surface thereof. Subsequently thereto, the metallic foil is covered with an etch-proof varnish or lacquer in a pattern corresponding to the intended configuration of the ignition bridge; then, the metallic foil is removed in the zones which are not covered, by means of an etching acid. Finally, the etch-proof lacquer is removed again so that there remains on the carrier material only a metallic foil pattern corresponding to the desired configuration of the ignition bridge. Additionally, the standard photo-resist technique could be used with equal results. In this connection, suitable materials for the non-conductive carrier element are laminated materials consisting of synthetic resin materials such as phenol, epoxy, or of unsaturated polyesters, impregnated cellulose paper, cotton, glass fiber, and synthetic fiber fabrics impregnated with unsaturated polyester, or the like.

The ignition bridge can also be fashioned, for example, as an extremely thin metallic wire which is held on the non-conductive carrier element, for instance, by means of an adhesive.

The thus-produced primer elements possess the disadvantage that the mechanical stability thereof is not sufficiently large to withstand the shock stress arising, for example, by the firing of a projectile, with a sufficient degree of safety. The invention is based on the problem of producing a connection of the conductive ignition bridge with a solid non-conductive carrier material, so that the conductive bridge is provided with an increased mechanical stability. Thereby, it is possible

to produce primer elements withstanding an impact stress of up to 500,000 g's (g = gravitational acceleration), without the necessity of utilizing a welded or soldered incandescent wire, and thus to fashion these elements with a maximum degree of safety.

This invention relates to an electric primer element consisting of an insulating body carrying two lead electrodes and a metallic bridge, which bridge serves to ignite a primer composition upon the passage of current therethrough, which element is characterized in that the insulating body consists of a glass or ceramic carrier material to which the electrodes and the bridge are applied by vaporization, printing, and in a chemical manner.

The mechanical strength of this primer element is determined solely by the carrier material. Due to the high mechanical stability of the carrier material, which is made of glass or ceramic, it is possible to press the primer composition against the conductive bridge with a higher pressure, whereby a substantially better thermal contact is established between the conductive bridge and the primer composition than is possible in the usual dipping or dripping process. Thus, it is possible to place pure explosives, for example lead trinitroresorcinate, lead azide, or lead picrate, into a close thermal bond with the primer element, for example by compression.

These and other objects, features, and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a side elevation partly in section of a conventional electrical detonator element;

FIG. 2 is a side elevation partly in section of an electrical detonator in accordance with the present invention;

FIGS. 3*a* and 3*b* are bottom elevational and side sectional views of the ignition bridge element used in the device of FIG. 2;

FIG. 4 is a side elevation partly in section of a second embodiment of the present invention;

FIGS. 5*a* and 5*b* are bottom elevational and side sectional views of the ignition bridge element used in the device of FIG. 4; and

FIG. 6 is a detailed view of the conductive bridge member used on the ignition bridge element of FIGS. 5*a* and 5*b*.

FIG. 1 shows a conventional electrical primer of the spark gap type. The primer consists of a conductive casing 1 containing, in an insulated manner, a pole piece 2. An insulating ring 3 is disposed on the inner side of the pole piece 2, this ring being pressed against the pole piece 2 by means of a conductive supporting ring 4. The gap 5 is formed between the pole piece 2 and a primer composition 6 which is pressed into the area defined laterally by the conductive supporting ring 4, the latter being retained by the casing 1.

FIG. 2 shows an electrical primer constructed according to FIG. 1, except that the insulating ring 3 is replaced by a metal covered ignition bridge element 7 constructed as seen in FIGS. 3*a* and 3*b*. The structure of the remaining parts of the initiator corresponds to the primer cap illustrated in FIG. 1. The bridge element 7 consists of a carrier 8 in the form of a round disk of glass or a ceramic material, especially sintered aluminum oxide, having a high surface quality and conductive contact members 9 applied to the surfaces of this

carrier material. The insulator **8** is provided with a bore **10** made conductive by means of a metallic layer **10'** on the surface thereof which extends through the bore, so that electrical contact can be established therethrough to conductive layers **9'** on the opposite surface of the carrier. In this connection, the round disk carrier **7** can be provided with indentations, notches, or it can be flattened on one side by sections, so that the primer element can be inserted or fitted in the housing **1** during the assembly of the initiator in an oriented manner. The bore **10,** lined with a conductive material, is connected with one of the contact surfaces **9** by a conductive ignition bridge **11,** overlapping both the conductive layer **10'** and the contact surface **9** at portions **14.** As shown in FIGS. *3a* and *3b* the contact surface **9''** is not electrically connected and serves a support function to ensure proper positioning of the bridge element.

Upon the application of a voltage between the pole piece **2** and the housing **1,** the ignition current flows via the pole piece **2** through the metallized bore **10,** by way of the ignition bridge **11** to the conductive spacer ring **4,** the latter constituting the connection to ground together with the external housing **1.** During this process, the ignition bridge is heated in such a manner that the primer composition **6** is ignited.

FIG. **4** shows another embodiment of the metal layer ignition bridge initiator wherein the current is fed to a bridge electrode constructed according to FIGS. *5a*, *5b* and **6** using a metallic bracket **12** extending around the periphery of the carrier so as to eliminate need for the bore **10.** In order to prevent grounding between the spacer ring **4** and the metallic bracket **12,** an additional layer of insulation **13** is provided therebetween. The current flows, in this embodiment, from the pole piece **2** on the outside via the bracket **12** to the ignition bridge **11,** which interconnects the contact surfaces **9.**

In FIGS. *5a* and *5b*, the details of the further embodiment of a metal layer bridge element are shown. As illustrated, the carrier **8** does not have a bore for electrical conducting purposes, but rather utilizes a rerouting or by-pass element **12** made of a conductive material. One embodiment of this rerouting element **12** is shown in FIG. **6.** In order to orient the layer, a segment has been cut out from the circular surface of the carrier **7,** whereby simultaneously space has been made available for the lateral conductive rerouting element **12.** The ignition bridge **11** is disposed in the center of the carrier.

The contacting surfaces **9** are applied to the carrier material **8** preferably by the silk screen printing process, wherein conventional material is employed, for example palladium, a palladium silver mixture, palladium gold, platinum silver, platinum gold, nickel, or a silver-aluminum alloy. The thus-applied material is sintered at about 1,000°–1,100° C. Any bore, such as the bore **10** of the embodiment illustrated in FIG. **2,** required in certain cases in the bridge element for establishing electrical contact through the carrier is already provided during the production of the blank. Thereafter, a tantalum or tantalum nitride layer of a specific thickness is deposited thereon by vaporization in a high-vacuum process. In this connection, silver can be employed as the contact material. Subsequently, a photosensitive layer is applied by means of a spraying or sputtering process. The desired and predetermined shape of the ignition bridge **11** is applied either by positive or negative contact copying procedures to the pretreated electrodes **9** and transferred to the light-sensitive coating of the electrodes **9** by appropriate developing methods. The electrodes **9** illustrated in FIGS. *3a*, *3b* and *5a*, *5b* are shaped essentially in the form of circular segments, for example of platinum silver. Since the primer element shown in FIG. *3a* is provided with a bore **10,** a layer of platinum silver is likewise arranged around this bore; however, this layer does not have any connection with the electrodes **9.** In the example of FIG. *3a*, the ignition bridge **11** is disposed between the layer around the bore **10** and an electrode **9,** and in the example of FIG. **5,** the bridge is arranged between the two electrodes **9.** Suitably, the ignition bridge **11,** consisting of tantalum or tantalum nitride, is enlarged at the contact surface with the electrodes **9,** so that it covers part of the electrodes **9.** The overlapping portions **14** serve for the purpose of establishing as good a contact as possible with the electrodes.

Thereby, the objective of the present invention is attained in that an ignition bridge **11** is obtained at a predetermined place, the ignition sensitivty of which is determined by the layer thickness, length, and width of the transition between the contact surfaces and can be measured by the electric resistance thereof. The less material that is employed for the ignition bridge **11,** the higher the resistance of the latter, and the higher the temperatures produced in this ignition bridge during the flow of current therethrough. The conductive bridge preferably exhibits a width and a length of 50 – 100 μ, and a thickness of 0.1 – 1.5 μ.

While we have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to a person skilled in the art, and we therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are obvious to one of ordinary skill in the art.

What is claimed is:

1. In an electrical detonator element including a pole piece and a housing means forming a pair of electrical leads, a primer composition and an ignition bridge element disposed with said primer composition between said pole piece and said housing means, said ignition bridge element comprising an insulating body having first electrode means arranged on at least a first surface of said body for electrically contacting said pole piece and second electrode means arranged on a second surface of said body for electrically contacting said housing means, each of said first and second electrode means including an electrode member formed on said second surface of said body, and a bridge member of a size providing a specific electrical resistance interconnecting said first and second electrode means, said bridge member being provided as a plated metal layer on said second surface of said body in overlapping relationship with portions of each of said electrode members.

2. An electrical detonator element according to claim **1,** wherein said insulating body is formed as a round disc having a bore therethrough, and said first electrode means includes a conductive layer provided on the first surface of said body in contact with said pole piece and a metal portion plated on the surface of said bore electrically interconnecting said conductive layer on said first surface with said electrode member

of said first electrode means on said second surface of said body.

3. An electrical detonator element according to claim 1, wherein said insulating body is formed as a round disc, said first electrode means including a conductive layer on said first surface of said body contacting said pole piece and means for connecting said conductive layer to said electrode member of said first electrode means on said second surface of said body.

4. An electrical detonator element according to claim 3, wherein said connecting means is provided as a metallic foil.

5. An electrical detonator element according to claim 4, wherein said connecting means extends around the periphery of said disc.

6. An electrical detonator element according to claim 4, wherein said connecting means extends through a bore in said disc.

7. An electrical detonator element according to claim 3, wherein said insulating body is provided as a round disc having a portion thereof removed to serve as a key to the orientation thereof.

8. An electrical detonator element according to claim 7, wherein said connecting means is a metallic foil extending around the periphery of said disc at said removed portion.

9. An electrical detonator element according to claim 1, wherein said bridge member is arranged for contacting said primer composition.

10. An electrical detonator element according to claim 1, characterized in that said insulating body is formed of sintered aluminum oxide material.

11. An electrical detonator element according to claim 1, wherein said insulating body is provided as a round disc having a portion thereof removed to serve as a key to the orientation thereof.

12. An electrical detonator element according to claim 1, said bridge member having a width and a length of 50 – 100 μ and a thickness of 0.1 – 1.5 μ.

13. An electrical detonator element according to claim 1, wherein said electrode members are formed of a conductive material selected from the group consisting of nickel, palladium, palladium silver alloy, palladium gold, platinum gold, platinum silver, or a silver-aluminum alloy.

14. An electrical detonator element according to claim 13, wherein said electrode members are applied to said insulating body by currentless galvanizing.

15. An electrical detonator element according to claim 14, wherein said bridge member consists of a metal selected from the group consisting of tantalum and tantalum nitride.

16. An electrical detonator element according to claim 1, wherein said bridge member consists of a metal selected from the group consisting of tantalum and tantalum nitride.

* * * * *