

March 14, 1961

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ELECTRIC FUSES FOR DETONATORS AND THE LIKE

Filed April 4, 1958

2 Sheets-Sheet 1

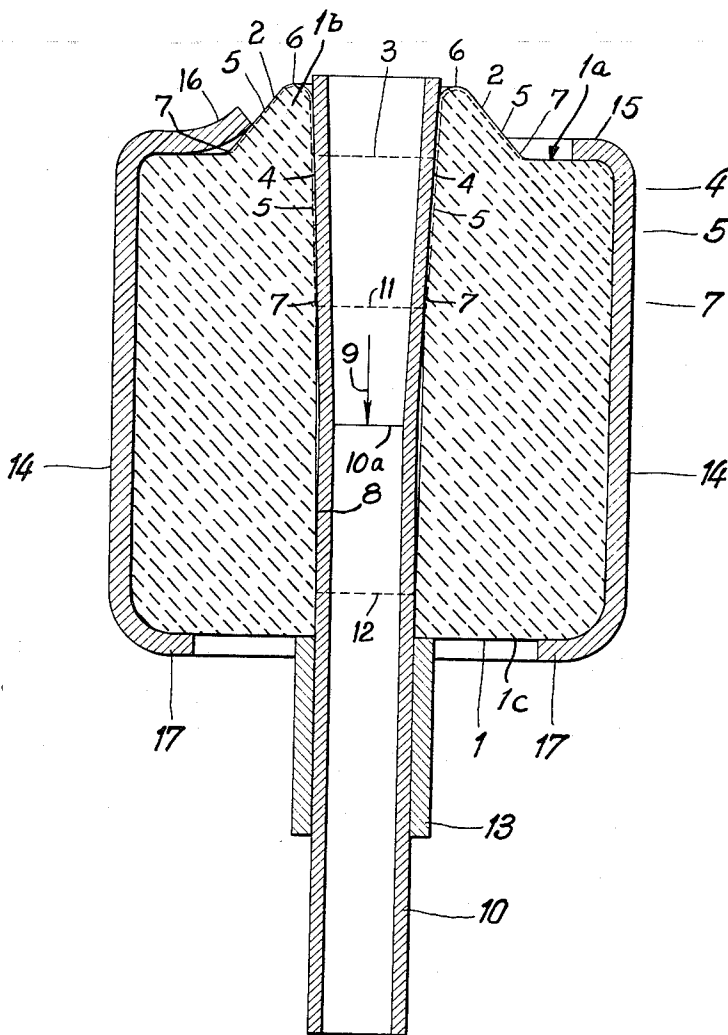


Fig. 1

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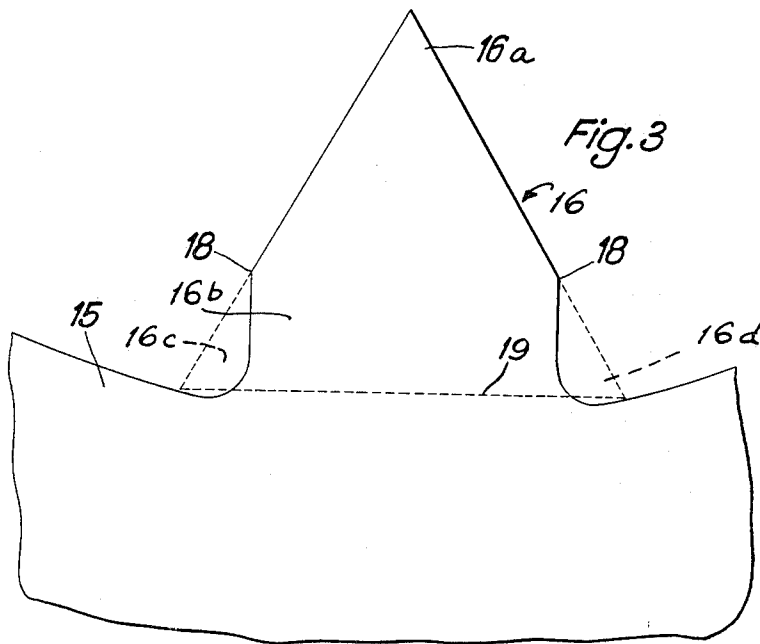
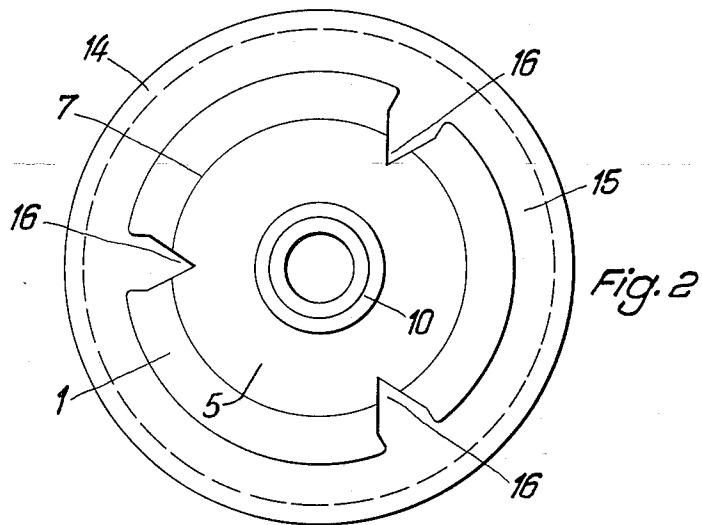
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Filed April 4, 1958

2 Sheets-Sheet 2



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ELECTRIC FUSES FOR DETONATORS AND THE LIKE

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Filed Apr. 4, 1958, Ser. No. 726,501

Claims priority, application Germany Apr. 4, 1957

8 Claims. (Cl. 102—28)

The present invention relates to electric fuses, and more particularly to a detonator fuse in which the insulator is partially covered with a film of metallic material serving as conductor between its electrodes. This metallic film evaporates when the electrodes are connected to a source of electric current and brings about a jump spark between the electrodes to initiate detonation by igniting the primer charge.

Proposals have been made to provide the insulators in certain types of detonator fuses with a metallic coating which covers all but that end face of the insulator's body which is not in contact with the detonator. Such known fuses generally comprise a rivet-shaped metallic center electrode received in the generally cylindrical insulator, and a sleeve-like output electrode which latter simultaneously serves as a housing for the ignition charge.

According to another proposal, the igniter comprises two spaced metallic wire electrodes enclosed in a spherical glass insulator. The outer surface of the spherical insulator is provided with a strongly adherent metallic coating having a predetermined electrical resistance and in conductive contact with the wire electrodes.

Proposals were also made to apply a coating to the insulator of an igniter fuse in such a way that the metallic film provides one or more paths for high-density current when the electrodes are connected with a current source. One or more contactors, e.g. suitably profiled metallic wires connected with one of the electrodes, are in conductive contact with a coated surface of plane or other specific configuration. The fuse constructed in accordance with this invention is somewhat similar to this last-mentioned class of devices but constitutes a considerable improvement thereover in that it satisfies certain requirements which are not or only partially met by the known devices of this general character.

An important object of the invention is to provide an improved igniter fuse for use in detonators and the like which is of very simple construction and particularly suitable for mass production.

Another object of the invention is to provide a fuse of the above described character which consists of a small number of component parts.

A further object of the invention is to provide a fuse so constructed that the spark produced upon connection of its electrodes to a current source is at a predetermined location so disposed as to be in immediate proximity of the detonator's primer charge.

An additional object of the present invention is to provide a detonator fuse comprising an insulating element of such configuration as to facilitate convenient and fully controllable application of a metallic film to selected areas thereof.

A still further object of the invention is to provide a detonator fuse comprising an insulator so constructed as to facilitate application thereto of a metallic film having a uniform ohmic resistance.

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A yet further object of the invention is to provide a fuse constructed with such tolerance as to permit its insertion into a detonator with practically constant and uniform forces.

The invention is based on the recognition that if one contacts the surface of a thin homogeneous metallic film connected to one pole of a current source, with the pointed end of a conductor connected to the other pole of the current source, the metallic film melts due to high current density at the point of contact and the melting occurs with such velocity that an observer's eye registers it as a spark. It has been further observed that the spark develops at that side of the contact point between the end of a conductor and the surface of a metallic film which is opposite to the point of connection between the metallic film and the pole of a current source connected thereto.

Based on this recognition, the aforementioned and many other important objects are attained by the provision of an electric fuse comprising an insulator disposed between a pair of current supplying electrodes and a metallic film applied to a selected surface area of the insulator in such a way as to provide a conductive connection and at least one path for high-density current between the electrodes. The selected surface which is coated by the metallic film is disposed on a projecting portion of the insulator, the projecting portion being of such shape as to have a continuous or, if desired, several contiguous surfaces.

According to another feature of my invention, the preferably cylindrical insulating body is formed with a central channel or bore, at least a portion of the bore having a slight taper to receive one of the electrodes. A part or the entire peripheral zone of the center electrode received in the insulator's bore is conically shaped, the conical zone being received in the tapering portion of the bore, preferably in self-locking relationship. The other electrode is shaped as a cylinder surrounding the peripheral zone of cylindrical insulator and has at least one pointed contactor extending along the coated surface of the insulator's projection toward but short of the center electrode. The projection or protuberance of the insulator extends from an end surface of the latter and the metallic coat covers not only said projection but also at least a portion of the insulator in its bore. Thus, the center electrode is in contact with the metallic film in the insulator's bore while the surrounding or output electrode contacts only selected portion or portions of the film by its contactor or contactors extending along the latter toward but short of the center electrode.

By forming at least a portion of the central bore in the insulating element with a predetermined taper adjacent to that end face from which the protuberance extends, the thickness of the metallic film in the bore may be increased as compared with the thickness of the film covering the outer surface of the protuberance. In addition, selected zones of the metallic film may be made of uniform thickness which is particularly important in the insulator's bore since the latter must snugly receive and preferably lockingly engage the aforesaid conical portion of the center electrode.

The angle of inclination of the insulator's bore preferably should not exceed 4.5 degrees since, by increasing the angle beyond this value, the self-locking engagement of the tubular center electrode would be impaired.

An additional advantage of such conical center electrode and self-lockingly receiving tapered bore in the insulator is in that the electrode remains in conductive contact with the metallic film despite eventual slight longitudinal displacements in the insulator as long as the stresses resulting from snug insertion of and pressures

existing between these elements are held within Hooke's law.

Moreover, the above-described construction takes into full consideration the requirement that sparks between the metallic film and the output electrode should develop at that side of the contactor which is opposed to the pole connection of the metallic layer. Accordingly, the direction in which the spark develops is fully controlled by the improved construction. Full control of the spark is essential for proper operation of an igniter, and the novel device thus represents a considerable improvement. The primer should be closely adjacent to the point at which the spark develops as only such positioning insures safe and satisfactory ignition. Since, as above mentioned, the improved fuse provides for full control of the point where the spark develops, the placing of a primer may be selected accordingly and its ignition insured at all times. All this, as above stated, is attained by the provision of an insulator having a bore and a protuberance projecting beyond one of its end faces, a metallic film applied to the outer surface of the insulator's protuberance and also coating at least a portion of the insulator in its bore, a preferably conical center electrode fitting into the bore and contacting the metallic film therein, and an output electrode which defines at least one pointed contactor extending toward and along the protuberance to provide a path for high-density current when the electrodes are connected to a current source. The protuberance extending from an end face of the generally cylindrical insulator is preferably of conical or pyramidal contour and the pointed contactor or contactors of the output electrode extend from an annular flange forming an integral part of the latter and located adjacent to the outer edge of the insulator's end face from which the protuberance extends.

The pressure with which the contactor or contactors bear against the metallic layer covering the insulator's protuberance may be controlled by flanging the other end of cylindrical output electrode along the other end face of the insulator.

When the improved fuse is inserted into a detonator, the primer charge not only penetrates into the interior of tubular center electrode and thus increases the pressure between said electrode and the metallic film in insulator's bore, but the primer charge also slides along outer surfaces of the protuberance and bears against the contactor or contactors of the output electrode.

Proper adherence of my improved fuse to, and satisfactory retention thereof in, a detonator is attained in that both the fuse and the detonator's bore are machined with a certain tolerance. In this manner, a generally uniform pressure of the fuse against a primer charge in the detonator is insured.

The insulator of my improved fuse is preferably manufactured of a suitable ceramic. However, it may also be made of a synthetic material, for example, a resin or the like. Pressures between the insulator and center electrode should be held below the maximum pressure allowable for the material of which the insulator is made to avoid any damages or eventual destruction of the latter. Moreover, the specific pressure acting against a unit area of the peripheral zone of conical center electrode should not exceed the allowable maximum specific pressure allowable when a ceramic insulator is used.

The output electrode which, as above mentioned, preferably comprises a cylindrical body surrounding the peripheral zone of a generally cylindrical insulator, a flange extending a short distance along that end face of the insulator from which the protuberance extends, this flange being extended into at least one pointed contactor in contact with the metallic film coating applied to the outer surface of the protuberance, and a flanged portion adjacent to the other end face of the insulator, may be made of silver as silver does not react with the material of primer charge. It is advisable to form the contactors of output electrode in such a way as to uniformly dis-

tribute bending stresses over the entire cross-sectional area of each contactor. The contactors are of basically triangular shape, that side which is common with the flange of the output electrode being equal to the height of the triangular members. It is preferred, however, to so form the contactors that they comprise a triangular and a generally rectangular portion with one side of the rectangular portion integral with the flange of the output electrode. Such shape of the contactor may be attained by cutting off from the originally triangular element a pair of relatively small triangular portions adjacent to the flange to thus slightly reduce the length of connection between a contactor and said flange, whereby the former may be bent with greater facility and may conform to preferably conical or pyramidal configuration of protuberance on the insulator's end face. In this manner, the tip of each contactor is in firm point contact with the metallic film coating applied to the outer surface of the insulator's protuberance.

The height of rectangular section of each contactor in radial direction of the output electrode may be somewhere between one-third and one-fourth of the overall height of the contactor.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, whoever, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of a specific embodiment when read in connection with the accompanying drawings, in which:

Fig. 1 illustrates the improved fuse in axial section;

Fig. 2 is an end view of the fuse; and

Fig. 3 is an enlarged detail view of a contactor forming part of the output electrode.

Referring now in greater detail to Fig. 1, the improved fuse therein shown comprises a cylindrical body 1 of insulating material, preferably a ceramic of good shaping characteristics. One (in Fig. 1 the upper) end face 1a of insulator 1 is formed with a concentric protuberance 1b having its outer surface 2 inclined with respect to the general plane of said end face. Thus, by cutting off protuberance 1b along broken line 3 in the general plane of end face 1a, one would obtain a hollow pyramidal of preferably conical body, the latter form being shown in Fig. 1. Surface 2, rounded annular ridge 6, and surface 4 of the wall surrounding the bore 8 which latter is coaxial with cone 1b of the insulator 1 are coated with a metallic layer 5 indicated in Fig. 1 in somewhat heavier broken lines. Surface 4 surrounds not only that portion of the bore 8 which traverses conical member 1b but extends further to terminate at a point indicated by reference numerals 7. By shaping the insulator 1 and its conical extension 1b in the above described manner, it is possible to increase the thickness of metallic layer 5 on the surfaces 6 and 4 as compared with the thickness of said layer along the surface 2 of conical protuberance 1b.

The diameter of bore 8 in insulating member 1 decreases gradually from ridge 6 in the direction of arrow 9. This bore receives a tubular center electrode 10 whose portion received in the tapering portion of bore 8 between ridge 6 and broken line 11 is of conical contour, its conicity corresponding to the taper of bore 8. As can be observed upon a more careful inspection of Fig. 1, the taper of bore 8 is not uniform, i.e. it is more pronounced between ridge 6 and line 11, less pronounced between lines 11 and 12, and the bore becomes cylindrical beyond line 12. Greater taper at the coated end of bore 8 allows for more convenient application of metallic layer 5 and for self-locking of center electrode 10 therein. The cone angle of electrode 10 depends upon the nature of metallic layer 5 as well as upon the material of electrode 10 itself. In the illustrated embodiment, the angle is 4.5 degrees, it being assumed that the

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metallic layer 5 is a palladium-silver alloy and that the electrode 10 is made of silver or another metal. The taper of bore 8 between broken lines 11 and 12 is considerably smaller, mainly due to manufacturing requirements. Center electrode 10 is cylindrical beyond line 10a.

Even though the electrode is self-lockingly inserted into the metallic coat 5, it is advisable to provide additional locking means to prevent its displacements in the direction opposed to that indicated by arrow 9. In the embodiment of Fig. 1, a cylindrical sleeve 13 partially surrounds that portion of electrode 10 which extends beyond the end face 1c of the insulating member. Member 13 is secured to electrode 10 by soldering, by a glue, or in any other suitable way. By abutting against the end face 1c of insulator 1, sleeve 13 positively prevents any displacements of the electrode. Element 13 may be omitted altogether and the peripheral zone of electrode 10 which projects beyond and is adjacent to end face 1c may be coated with a layer of glue, e.g. a synthetic resin; or a tensioning ring may be drawn tight about electrode 10 in abutting relationship with end face 1c of the insulator.

Output or collector electrode 14 is of cylindrical contour and surrounds the peripheral zone of insulator 1. One end thereof defines an inwardly extending flange 15 adjacent to the end face 1a of the insulator, the flange having at least one pointed contactor 16 which extends toward and along the surface 2 and is thus in conductive contact with metallic coating 5. It is desirable to so install the output electrode that the contactor or contactors 16 exert a predetermined pressure against the metallic coating. In the illustrated embodiment, the pressure between members 15, 16 on the one hand, and insulator 1 with its projecting portion 1b on the other hand is created by flanging the other end of output electrode 14; the so formed concentric flange 17 extends along end face 1c of the insulator and positively holds the flange 15 and contactor or contactors 16 in contact with the end face 1a and conical surface 2, respectively.

As shown in Fig. 2, the flange 15 of output electrode 14 is provided with three pointed contactors 16.

Fig. 3 is drawn to greatly enlarged scale and illustrates the preferred shape of a contactor 16. The latter consists of a pointed portion 16a having the shape of an isosceles triangle whose base is integral with a longer side of rectangular portion 16b. The other longer side of portion 16b is joined with flange 15 as is indicated by the broken line 19. Contactor 16 is formed by cutting off a pair of smaller triangular portions 16c, 16d from the originally triangular member 16 along a pair of parallel lines extending between points 18 and the imaginary base 19 of the contactor. By cutting off said triangular portions 16c, 16d, contactor 16 may be bent with greater ease along broken line 19 and may thus conform to the configuration of conical portion 1b of the insulating member.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In an electrical detonator fuse, in combination, a substantially cylindrical body of insulating material having a transverse end face; an axial protuberance on said end face, said protuberance having an inclined side portion defining a predetermined acute angle of inclination with said transverse end face, said body being formed with an axial bore terminating in an opening in said pro-

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tuberance; an inner tubular electrode extending through and fitted to said bore; a film of metallic material on said protuberance and extending on said body of insulating material at least partly into said bore for contact with said tubular electrode; and an outer electrode member secured to said body adjacent the circumference of said transverse end face and extending therefrom in a radially inward and axially outward direction toward said inclined side portion of said protuberance, said outer electrode member ending in pointed contactors contacting said film of metallic material on said protuberance.

2. In an electrical detonator fuse, in combination, a substantially cylindrical body of insulating material having a transverse end face; an axial protuberance on said end face, said protuberance having a conical side portion defining a predetermined acute angle of inclination with said transverse end face, said body being formed with an axial bore terminating in an opening in said protuberance; an inner tubular electrode extending through and fitted to said bore, said electrode having a portion outwardly flaring toward said opening in said protuberance and projecting therefrom; a film of metallic material on said protuberance and extending on said body of insulating material at least partly into said bore for contact with said tubular electrode; and an outer electrode member secured to said body adjacent the circumference of said transverse end face and extending therefrom in a radially inward and axially outward direction toward said conical side portion of said protuberance, said outer electrode member ending in pointed contactors contacting said film of metallic material on said protuberance.

3. In an electrical detonator fuse, in combination, a substantially cylindrical body of insulating material having a transverse end face; an axial protuberance on said end face, said protuberance having an inclined side portion defining a predetermined acute angle of inclination with said transverse end face, said body being formed with an axial bore terminating in an opening in said protuberance; an inner tubular electrode extending through and fitted to said bore, said electrode having a portion outwardly flaring toward said opening in said protuberance and projecting therefrom; a film of metallic material on said protuberance and extending on said body of insulating material at least partly into said bore for contact with said tubular electrode, the thickness of said metallic film on said protuberance increasing in a direction radially inward to said bore; and an outer electrode member secured to said body adjacent the circumference of said transverse end face and extending therefrom in a radially inward and axially outward direction toward said inclined side portion of said protuberance, said outer electrode member ending in pointed contactors contacting said film of metallic material on said protuberance.

4. In an electrical detonator fuse, in combination, a substantially cylindrical body of insulating material having a transverse end face; an axial protuberance on said end face, said protuberance having an inclined side portion defining a predetermined acute angle of inclination with said transverse end face, said body being formed with an axial bore terminating in an opening in said protuberance and having an outwardly flaring portion adjacent said opening; an inner tubular electrode extending through and fitted to said bore, said electrode having a portion outwardly flaring toward said opening in said protuberance and projecting therefrom; a film of metallic material on said protuberance and extending on said body of insulating material at least partly into said bore for contact with said tubular electrode; and an outer electrode member secured to said body adjacent the circumference of said transverse end face and extending therefrom in a radially inward and axially outward direction toward said inclined side portion of said protuberance, said electrode member ending in pointed contactors contacting said film of metallic material on said protuberance.

5. In an electrical detonator fuse, in combination, a

substantially cylindrical body of insulating material having two opposite transverse end faces; an axial protuberance of substantially frustoconical configuration on one of said end faces, said body being formed with an axial bore therethrough terminating in one opening in said protuberance and another opening in the other one of said end faces; an inner tubular electrode extending through and fitted to said bore, said electrode having a portion outwardly flaring toward said one opening and projecting therefrom and another portion projecting from said other opening, said other portion of said tubular electrode being secured to said body of insulating material; a film of metallic material on said protuberance and extending on said body of insulating material at least partly into said bore for contact with said tubular electrode; and an outer electrode member secured to said body adjacent the circumference of said one transverse end face and extending therefrom in a radially inward and axially outward direction toward said inclined side portion of said protuberance, said outer electrode member ending in pointed contactors contacting said film of metallic material on said protuberance.

6. In an electrical detonator fuse, in combination, a substantially cylindrical body of insulating material having a transverse end face; an axial protuberance on said end face, said protuberance having an inclined side portion defining a predetermined acute angle of inclination with said transverse end face, said body being formed with an axial bore terminating in an opening in said protuberance; an inner tubular electrode extending through and fitted to said bore, said electrode having a portion outwardly flaring toward said opening in said protuberance and projecting therefrom; a film of metallic material on said protuberance and extending on said body of insulating material at least partly into said bore for contact with said tubular electrode; a cylindrical outer electrode on the cylindrical surface of said body of insulating material; a flange portion integral with said cylindrical electrode and extending radially inward over the circumference of said transverse end face; and a plurality of pointed contactors integral with said flange portion and projecting therefrom in a radially inward and axially outward direction and contacting said film of metallic material on said protuberance.

7. In an electrical detonator fuse, in combination, a substantially cylindrical body of insulating material having a transverse end face; an axial protuberance on said end face, said protuberance having an inclined side por-

tion defining a predetermined acute angle of inclination with said transverse end face, said body being formed with an axial bore terminating in an opening in said protuberance; an inner tubular electrode extending through and fitted to said bore, said electrode having a portion outwardly flaring toward said opening in said protuberance and projecting therefrom; a film of metallic material on said protuberance and extending on said body of insulating material at least partly into said bore for contact with said tubular electrode; and an outer electrode member having a base portion secured to said body adjacent the circumference of said transverse end face and at least one pointed portion extending from said base portion in a radially inward and axially outward direction toward said inclined side portion of said protuberance for contact of said pointed portion with said film of metallic material on said protuberance.

8. In an electrical detonator fuse, in combination, a substantially cylindrical body of insulating material having a transverse end face; an axial protuberance on said end face, said protuberance having an inclined side portion defining a predetermined acute angle of inclination with said transverse end face, said body being formed with an axial bore terminating in an opening in said protuberance; an inner tubular electrode extending through and fitted to said bore, said electrode having a portion outwardly flaring toward said opening in said protuberance and projecting therefrom; a film of metallic material on said protuberance and extending on said body of insulating material at least partly into said bore for contact with said tubular electrode; and an outer electrode member having a substantially rectangular base portion secured to said body adjacent the circumference of said transverse end face and at least one substantially triangular pointed portion extending from said base portion in a radially inward and axially outward direction toward said inclined side portion of said protuberance for contact of said substantially triangular portion thereof with said film of metallic material on said protuberance.

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