April 4, 1961 C. F. KINKEL ET AL 2,977,878

DETONATOR

Filed Jan. 13, 1954 2 Sheets-Sheet 1

FIG. 1.

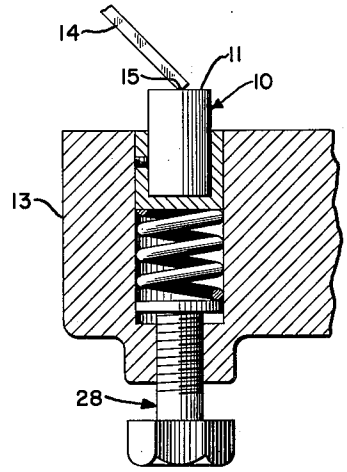


FIG. 2.

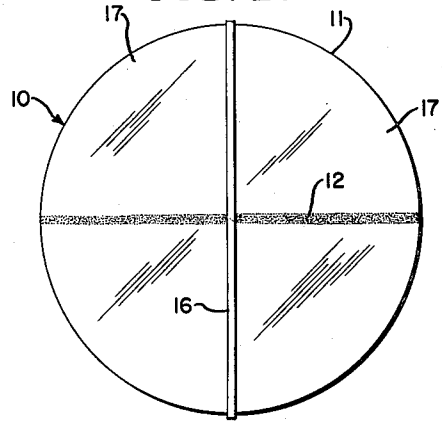


FIG. 3.

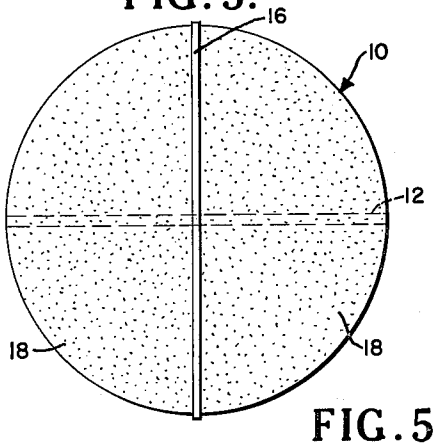


FIG. 4.

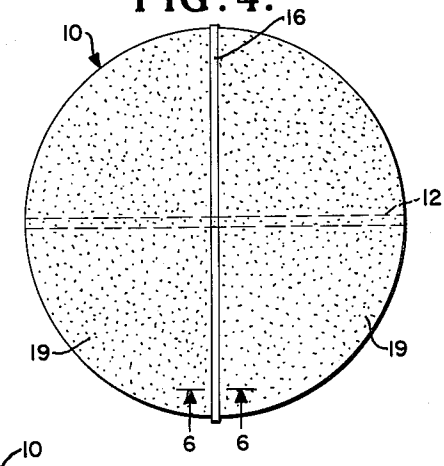
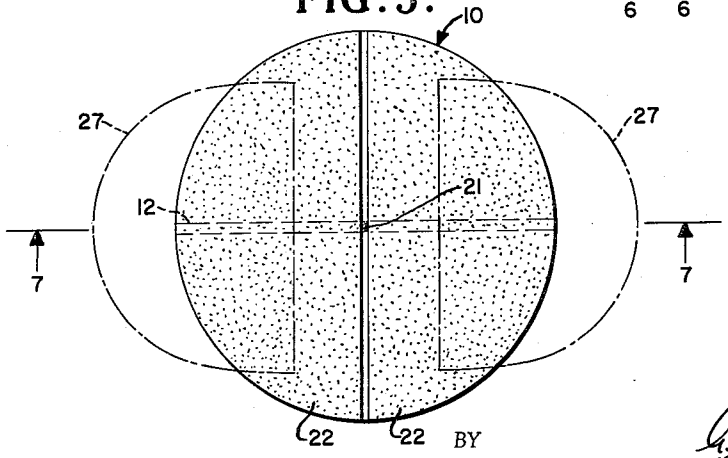


FIG. 5.



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April 4, 1961 C. F. KINKEL ET AL 2,977,878

DETONATOR

Filed Jan. 13, 1954 2 Sheets-Sheet 2

FIG. 7.

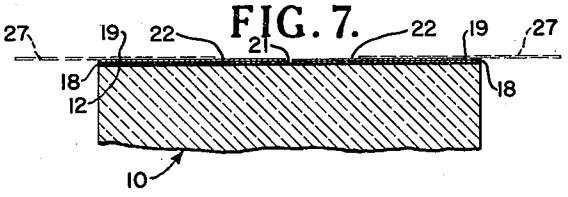


FIG. 8.

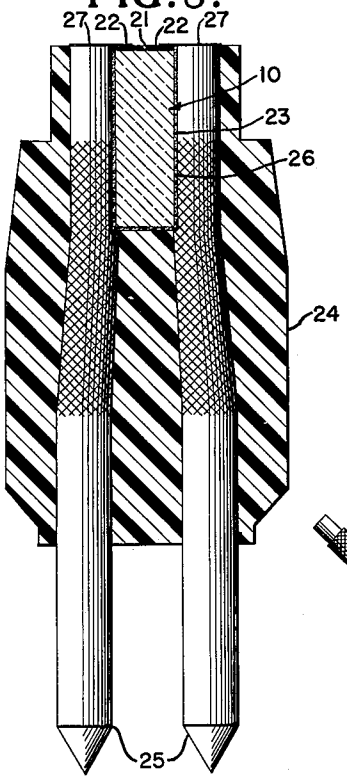


FIG. 9.

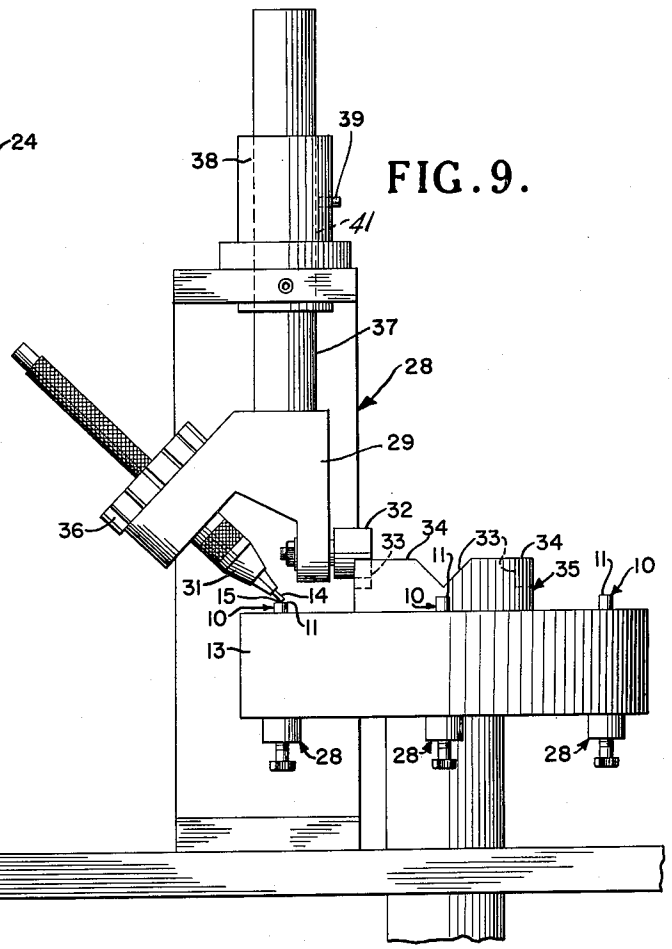
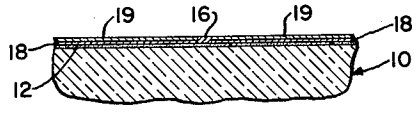


FIG. 6.



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DETONATOR

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4 Claims. (Cl. 102—28)

The present invention relates to a detonator and more particularly to a low energy operated initiator therefor.

Moreover, the invention contemplates the provision of a new and improved electric initiator and method of making the same, the initiator possessing a low impedance, easily reproducible initiating element having the desired characteristics of resistance to sudden and severe mechanical shock during handling, transportation and in service. The initiator comprising a cylindrical base composed preferably of glass having scribed on one end thereof a metallic line, a pair of highly conductive members secured on the aforesaid end of the base in spaced relation with respect to each other and connected by the metallic line, a sensitive bridge element between the conductive members consisting of minute portion of the metallic line, and terminal elements for connecting the conductive member to the external leads of the detonator.

The method of making the initiator comprises several essential steps such, for example, as preparation of one end of the glass base by polishing the surface thereof, scribing the polished end of the base with a metallic line masking off a certain portion of the plug and metallic line, spraying the unmasked portion of the polished end with highly conductive metals, and connecting the conductive metals to the external leads of the detonator. However, a more complete and comprehensive description of the aforesaid steps will appear as the description proceeds.

An object of the present invention is to provide a new and improved electric initiator for a detonator.

Another object of the invention is the provision of a method of applying a metallic line on a base member in such a manner that only a small portion of the line is effective to ignite the explosive of a detonator in response to an electrical impulse of low order received thereby.

Still another object of the invention is the provision of a new and improved method of constructing an electroresponsive detonator and controlling the effective length of the bridge portion of a metallic line initiator.

A further object of the invention is the provision of an electric initiator wherein a scribed metallic line provides means for firing an explosive charge.

A still further object of the invention is the provision of a miniature electric initiator possessing a low impedance, easily reproducible detonator element and possessing superior resistance to suddent and severe shock.

Still another object of the invention is the provision of a new and improved electric initiator and method for making the same.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a fragmentary sectional view of a suitable jig for supporting and scribing a base element with a metallic line in accordance with the present invention;

Figs. 2 through 5 inclusive are plan views of the base element of Fig. 1, illustrating the essential steps during the construction of the electric initiator;

Fig. 6 is an enlarged fragmentary sectional view taken on the line 6—6 of Fig. 4;

Fig. 7 is a fragmentary sectional view taken on the line 7—7 of Fig. 5;

Fig. 8 is an enlarged sectional view illustrating the electric initiator in connection with a detonator plug; and

Fig. 9 illustrates an elevational view of the scribing device for scribing the metallic line on the polished end of the base member.

Referring now to the drawings and more particularly to Fig. 1 thereof, the numeral 10 generally indicates a cylindrical base member or plug composed of any material suitable for the purpose such, for example, as "Pyrex" glass, quartz or the like and having one end thereof polished to provide a suitable scribing surface 11. The surface 11 is scribed with a metallic line 12 as more clearly shown in Fig. 2, the scribing being performed by a scribing machine fragmentarily shown on Fig. 1 and in its entirety on Fig. 9 and includes a turntable 13 and a stylus 14. Furthermore, since the speed at which the base 10 is rotated by the turntable and the pressure of the scriber 14 on the polished surface 11 are critical factors in obtaining consistent reproducible results, it has been found advantageous to employ the aforesaid scribing machine.

In practice the stylus may be composed of any suitable alloy or metal, such as for example, zirconium or titanium or any metal or alloy that can be suitably bonded to the base through chemical reaction. Preferably a length of pure titanium wire .090 of an inch in diameter and surface hardened by being treated for substantially 16 hours in highly purified nitrogen gas at 1650° F. is used. A stylus produced by the aforesaid treatment will produce a thin continuous metallic line on the polished surface 11 of the plug 10 as the plug 10 is rotated by the turntable and the working edge 15 of the stylus engages the surface 11, the aforesaid operation will become more fully apparent as the description proceeds.

After the scribing operation the plug 10 is removed from turntable 13 and the surface 11 thereof cleaned in any suitable manner. The typical cleaning operation consists of a soap and water bath followed by dipping the plug in boiling distilled water and thereafter spraying the plug with freshly distilled acetone.

When this has been done the treated and scribed end of the plug is masked, Fig. 2. In the preferred embodiment the masking operation is accomplished by arranging a steel wire or strip 16 across the aforesaid treated and scribed end of the plug at a right angle to the metallic line 12, the opposite ends of the masking element being secured to the cylindrical wall of the plug in any suitable manner, such, for example, as by wax or the like. Certain photoengraving techniques may advantageously be employed to provide a suitable mask in lieu of the wire masking element 16. It will be seen on Fig. 2 that when the masking element 16 is applied to the end 11 of the plug a predetermined length of the metallic line 12 is masked and a pair of terminal areas 17 are provided thereon and separated by the masking element 16.

When the masking operation has been completed, highly conductive terminal elements are applied to the terminal areas 17 by vapor deposition of suitable metals thereon in any suitable manner. For example, the terminal areas 17 are first coated with a thin film of nickel indicated as at 18, Fig. 3, which has the desired characteristics of adhering to the glass plug 10. Thereafter a film of gold indicated as at 19, Fig. 4 is applied on the nickel film. As shown more clearly in Figs. 6 and

7 the gold film is somewhat thicker than the nickel film and thus provides adequate protection against adverse atmospheric conditions.

After deposition of the aforesaid metals on the end of the plug **10**, the masking element **16** is removed therefrom, thus leaving a bridge element **21** and a pair of mutually spaced highly conductive contacts **22** on the end **11** of the plug **10** as more clearly shown on Fig. 5, the contacts being electrically connected by the metallic scribed line **12** and the bridge element consisting of the exposed minute portion of the aforesaid metallic line. The preferred length of the bridge element **21** is substantially .001 of an inch and the width thereof being between .0006 and .0008 inch.

When the unmasking operation has been completed the electric initiator is now in condition to be attached to the detonator plug. For a better understanding of this operation attention is directed to Fig. 8 which illustrates the detonator in its entirety. It will be noted that the base **10** is disposed within a recess **23** formed in one end of the "Bakelite" plug or detonator casing **24**, the base being pressed therein in any suitable manner with the pair of conductive contacts **22** and the pair of mutually spaced external leads **25** flush with the outer end surface of the detonator plug. If desired, however, the base **10** may be secured within the recess **23** by a suitable adhesive **26** which is applied thereto prior to the insertion of the base within the recess. After the initiator has been secured to the plug in the aforesaid manner, electrical connection between the respective pairs of contacts **22** and leads **25** is established by spraying metal having a low melting point on and between the contacts and leads thereby to provide a conductive bridge therebetween as indicated in full outline as at **27**, Fig. 8 and in dashed outline, Figs. 5 and 7. While the aforesaid spray metal bridging connections have proven satisfactory good results have been obtained by employing a highly conductive silver paint for electrically connecting the contacts and leads or by soldering the leads directly to the metal film **22** with a suitable medium such, for example, as indium bismuth solder. Since the metallic film is easily damaged no flux is used during the aforesaid soldering operation and it is essential to maintain the molten spray metal slightly above its melting point.

Referring now to Fig. 9 it will be noted that a suitable scribing machine is illustrated, the essential elements of the machine being the aforesaid turntable **13** and titanium scribing tool **14**. The turntable is provided with suitable arrangements for clamping and yieldably supporting at least 4 glass base members **10** thereon and indicated generally by the numeral **28**. The scribing head is indicated by the reference character **29** and carries a pin vise or suitable clamping device **31** which clamps the titanium stylus **14** in operative relation with respect to the base members **10** and at an angle of 45° to the plane of the surface **11** thereof, upon which the metallic line is to be scribed. The head **29** oscillates in a vertical direction by the cam follower **32** secured thereto as the follower progressively engages the V-shaped slots **33** and the elevated portions **34** of the cam track **35** as the track and turntable are rotated. By the aforesaid follower and cam track arrangement it will be understood that when the follower drops into the V-shaped slots **33** the stylus engages the polished surface **11** of the base and scribes a metallic line thereon. After traversing the surface **11** of the base **10** the stylus is raised out of engagement therewith as the follower rides out of the V-shaped slot and onto the elevated portion **34** of the cam track and thus the stylus is in position for another scribing operation. After each application of the metallic line on the end **11** of the base the indexing wheel **36** operatively connected to the pin vise is rotated sufficiently to expose a freshly ground working edge of the stylus for engagement with the next base to be scribed.

The head **29** is secured to a tubular member **37** slidably arranged within a bushing **38** for vertical movement therein as the follower rides over the cam track; however, rotative movement of the head and member **37** is prevented by a pin **39** carried by member **37** and disposed within an elongated slot **41** formed in the bushing **38**.

The turntable may be driven in any suitable manner such, for example, as by an electric motor and the indexing device may be geared to the turntable for imparting an intermittent rotative movement to the stylus corresponding to the stylus movement desired for exposure of a new scribing edge. Furthermore, an automatic dressing device for dressing the stylus may be employed whereupon a freshly ground edge is available for each scribing operation as the indexing device is rotated a predetermined amount.

From the foregoing, it will be apparent that a new and improved electrical initiator and method of making the same has been devised wherein a metallic line is scribed to one end of a glass base and thereafter the end is coated with highly conductive material in such a manner as to cover the end of the base and metallic line except for a narrow strip masked by a relatively thin wire or strip whereupon the effective length or bridge portion of the metallic line is controlled and thus the low energy required to cause heating thereof sufficient to fire an explosive charge is concentrated on the minute bridge portion of the metallic line. Furthermore, the aforesaid structure and arrangement provides a miniature electrical initiator possessing a low impedance, easily reproducible detonating element which has the desired characteristics of superior resistance to sudden shock.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An electric initiator for firing a detonator comprising in combination, a casing composed of insulating material, a pair of mutually spaced terminals molded in said casing, a plug arranged within one end of said casing, a pair of highly conductive elements on one end of said plug in proximate spaced relation with respect to each other, a thin titanium line scribed and bonded on said end of the plug in engagement with and bridging said elements for providing a minute longitudinal intermediate bridge portion therebetween, said line having a uniform width and consistency such that the bridge portion is instantaneously heated to incandescence in response to a minute electrical impulse applied to said line, and means on each of said elements in engagement with said pair of terminals respectively for establishing an external electrical connection to said elements thereby to apply said impulse to the line.

2. An electrical initiator for firing a detonator comprising in combination, a casing composed of insulating material and having a recess in one end thereof, a pair of mutually spaced terminals molded in said casing, a glass plug secured within said recess, a pair of highly conductive elements on one end of said plug in proximate spaced relation with respect to each other, a thin titanium line scribed and bonded on and intersecting said end of the plug and bridging said elements for providing a minute longitudinal intermediate bridge portion between said elements, said line having a uniform width and consistency such that the bridge portion is instantaneously heated to incandescence in response to a minute electrical impulse applied to said line, and contact members on each of said elements and said terminal respectively for establishing an external electrical connection to said elements thereby to apply said impulse to said line.

3. An electrical initiator for firing a detonator compris-

ing in combination, a casing composed of insulating material and having a recess in one end thereof, a pair of mutually spaced terminals molded in said casing, a glass plug disposed within and secured to said casing, a thin titanium line scribed and bonded on one end of said plug and including a minute longitudinal intermediate bridge portion, said line having a width and consistency sufficient to cause the bridge portion to be instantaneously heated to incandescence in response to a low order of electrical energy momentarily applied to said line, a pair of mutually spaced conductive elements on said end of the plug in engagement with and bridged by said line for applying said energy thereto, and contact elements applied to each of said elements and said terminals respectively for establishing an external electrical connection to said elements.

4. An electrical initiator for firing a detonator comprising in combination, a casing composed of insulating material and having a recess in one end thereof, a pair of mutually spaced terminals molded in said casing, a plug disposed within and secured to said casing, a thin titanium line scribed and bonded on one end of said plug and including a minute longitudinal intermediate bridge portion, said line having a width and consistency sufficient to cause the bridge portion to be instantaneously heated to incandescence in response to a minute electrical impulse applied to said line, a pair of mutually spaced films of nickel on said end of the plug in engagement with and bridged by said titanium line, a film of gold on each of said films of nickel respectively for providing a pair of highly conductive elements on said end of the plug for applying said electrical impulse to said line, and contact elements applied to each of said highly conductive elements and said terminals respectively for establishing an external electrical connection to said elements.

References Cited in the file of this patent

UNITED STATES PATENTS

2,021,661	Kisfaludy	Nov. 19, 1935
2,240,438	Durant	Apr. 29, 1941
2,597,674	Robbins	May 20, 1952
2,641,672	Parrish	June 9, 1953
2,676,117	Colbert et al.	Apr. 20, 1954

FOREIGN PATENTS

982,837	France	Jan. 31, 1951