

Aug. 13, 1957

C. F. HORNE

2,802,422

STATIC RESISTANT ELECTRIC INITIATOR

Filed Nov. 9, 1953

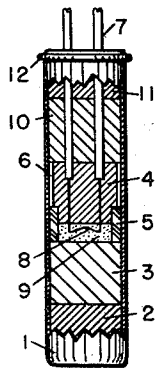


FIG. 1

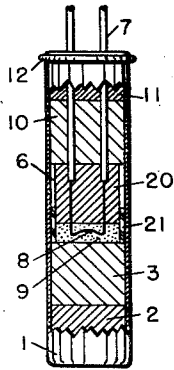


FIG. 2

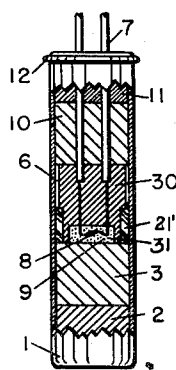


FIG. 3

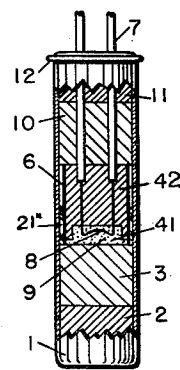


FIG. 4

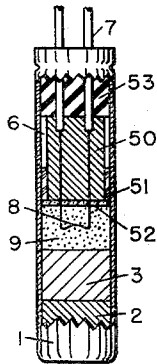


FIG. 5

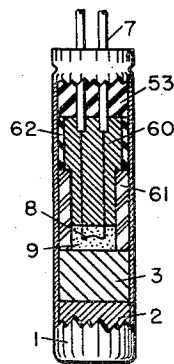


FIG. 6

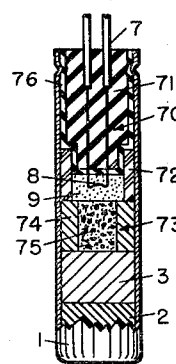


FIG. 7

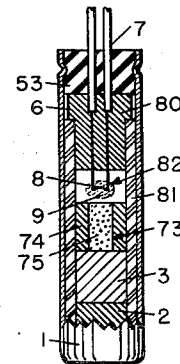


FIG. 8

CHARLES F. HORNE
INVENTOR.

BY *Ernest G. Peterson*

AGENT

1

2,802,422

STATIC RESISTANCE ELECTRIC INITIATOR

Charles F. Horne, Kingston, N. Y., assignor to Hercules Powder Company, Wilmington, Del., a corporation of Delaware

Application November 9, 1953, Serial No. 391,097

18 Claims. (Cl. 102—28)

This invention relates to electric initiators and more particularly to electric initiators which are highly resistant to premature firing by static electricity.

The art has long recognized the dangers inherent in accidental discharge of electric initiators by means of static electricity. Accidents, which at the time of their occurrence have seemed without explanation, have been subsequently traced to the firing of an initiator by a static discharge. Since normally used ignition compositions necessarily are highly heat sensitive, a discharge of relatively high voltage is quite capable of igniting the composition and firing the initiator. The art has generally considered that such accidental firings result from a direct discharge from a lead wire to a metallic initiator shell in the locus of the ignition composition. Obviously, caps can also be fired by direct discharge through the bridge wire via the two lead wires. What is not so well understood, however, is the fact that an initiator can also be fired by the passage of a static voltage through the bridge wire when the discharge is from shunted lead wires to shell at a point other than through the explosives charge.

While the danger of premature firing due to static discharge is present in all types of electric initiators, the procedures employed in seismographic prospecting and the sensitive ignition compositions employed in seismic-type blasting caps have tended to make this type of initiator more susceptible to static than regular electric blasting caps and delay electric blasting caps. Until very recent years, commercial seismograph caps generally required a discharge in the order of 5000 volts to fire the cap by direct discharge through the ignition composition and a discharge in the order of 12,000 volt to fire the caps by heating of the bridge wire when the charge was supplied by a 750 micromicrofarad capacitor and the discharge was from shunted lead wires to shell. It has been established that voltages of this magnitude may be developed by a man under proper conditions and that much higher voltages may be generated in equipment employed by seismic prospectors such as drill rigs and trucks. Actually, conditions favoring high voltage static generation, such as low humidity, high winds, sandstorms, and the like, are common in the localities where most seismic prospecting is done. Consequently, it will be seen that a definite danger of accidental firing of seismic caps is present under such adverse conditions. As a result of this danger, seismographic prospecting organizations and blasting cap manufacturers have been constantly attempting to raise the static resistance of all electric initiators and especially that of the seismic-type blasting cap.

A blasting cap structure has previously been proposed in which a lead wire is disposed in contact or almost in contact with the shell, at a point removed from the ignition composition, in order to provide for a discharge of the static electricity from the lead wire to the shell. However, this type of structure offers good protection from static or firing of the cap only when the charge passes down the one lead wire to the shell. Little or no benefit is obtained when the current passes through both lead

2

wires. Even when both lead wires are so disposed, discharge will occur from only one wire in many instances and protection will be limited as far as heating of bridge is concerned.

5 A structure has also been proposed wherein one or both of the bared lead wires are connected to the shell by means of semiconductive material outside the locus of the ignition composition. This construction affords a considerable improvement in static resistance. However, it is very difficult with such a structure to maintain a proper balance of conductivity that will allow a discharge from both wires to the shell and still have sufficient resistance for protection against the low voltage currents which attend many commercial blasting operations. Additionally, it has been found that in some instances, the static resistance of this type of structure diminishes with storage. Furthermore, such caps have been known to fire when 10-40 volts from a battery are applied between lead wires and shell.

10 In another proposed structure, conductive material is disposed about the bared lead wires and extends to the shell. This conductive material acts as a true resistor in that the resistance is low, normally from 10-100 ohms. The resistance of such a body of material is similar to that of a regular carbon resistor, being fairly constant, but subject to variation due to temperature. The resistance does not change greatly due to passage of current until the current is sufficient to cause heating. This type of cap gives good static protection in most instances. However, it has been found that in some instances discharges occur from only one wire which allow a firing of the cap by the heating of the bridge wire. Even more than in the case of the semiconductive material, this structure has a serious deficiency of insulation from shell to lead wires and can be fired in this manner with a very low voltage. In other words, this structure, while removing a considerable part of the hazard of static electricity, has introduced an equally undesirable hazard in the form of undesirably low resistance between lead wires and shell.

15 In still another structure, it has been proposed to equip the bared lead wires with protrusions which extend toward the shell. This structure is usually employed with a matchhead ignition element which is insulated. However, a discharge usually takes place from only one wire and a firing of the cap by the heating of the bridge wire is thus permitted. In addition, a hotter spark is obtained when the discharge is directed from localized points. Even though the protrusions are outside the locus of the ignition composition, such violent discharges are to be avoided when the same results can be obtained in a less violent manner.

20 While all of these preceding structures give an initiator a measure of static resistance, it will be seen that in each case, the protection from static is not complete and, in most instances, what protection is obtained is brought by a structure which is characterized by low voltage breakdown. Furthermore, these structures are not characterized by a sufficient resistance to heating of the bridge wire by a static discharge through the bridge wire itself.

25 In copending application Serial No. 340,821, filed March 6, 1953 (now U. S. Patent No. 2,658,451, issued November 10, 1953) there is disclosed a structure which gives greatly improved performance in that low static susceptibility and high resistance to firing by stray currents are simultaneously achieved. Protection from static discharge is obtained by disposing a semiconductive body around bared portions of the lead wires and in close proximity to the shell wall. However, the semiconductive body is spaced from the shell wall by a distance substantially less than the distance between either lead wire and the shell wall in the locus of the ignition composition. Thus static electricity is conducted to the edge of the

semiconductive body and jumps to the grounded shell outside the locus of the ignition composition. In accordance with U. S. Patent 2,658,451 above referred to, increased resistance to firing due to heating of the bridge wire by passage of a static charge is obtained by increasing the heat capacity of the wire.

The present application is a continuation-in-part of application Serial No. 340,821, now U. S. Patent No. 2,658,451 and is directed to a static resistant initiator which is of improved design and performance and is easier to manufacture.

Generally described, the present invention is a static resistant electric initiator having in combination a metallic shell, a pair of lead wires, an ignition plug of semiconductive material disposed about bared portions of the lead wires within the shell, a bridge wire joining the terminals of the lead wires below the lower surface of the plug, an ignition composition disposed about the bridge wire, a spacing body of dielectric material disposed about the lower portion of the plug between the plug and shell wall, the portion of the plug above the spacing body approaching the shell wall but being separated therefrom by a distance substantially less than that between either lead wire and the shell in the locus of the ignition composition, and the total resistance between the shell wall and plug being substantially less above the spacing body than at any other point on the plug. As will be hereinafter described, the semiconductive ignition plug may be of uniform diameter or stepped, or may be provided with a cavity to house ignition composition. The dielectric spacing body may take different forms. For example, it may be a sleeve, a ferrule, or a shell liner. If desired, part or all of the plug may be coated with a dielectric layer or film. Other and more specific embodiments will be subsequently described.

Having generally described the initiator of the invention, the novel structure thereof will be more particularly illustrated with reference to the accompanying drawing in which part sectional, part elevational views of various embodiments are shown and in which similar parts are designated by similar identifying symbols.

In Fig. 1, an instantaneous electric blasting cap is shown having a metallic shell 1, a base charge 2, and a priming charge 3. Above the priming charge 3 is disposed an ignition assembly comprising a semiconductive ignition plug 4. The plug 4 is stepped to form a lower portion of lesser diameter. About the lower portion of the plug 4 is disposed a cardboard spacing sleeve 5 which contacts the wall of the shell 1. The spacing sleeve 5 maintains the plug 4 in concentric relationship with the shell 1 and provides a gap 6 between the upper portion of the plug 4 and the shell 1. Bared terminal portions of otherwise insulated lead wires 7 extend through the plug 4 and are joined at their ends beneath the plug 4 by a bridge wire 8. An ignition composition 9 is disposed about the bridge wire 8 in the cavity formed by the portion of the spacing sleeve 5 extending below the plug 4. An asphaltic sealing layer 10 is disposed above the plug 4 and a layer of sulfur 11 is disposed above the asphalt. The sulfur layer 11 is maintained in place by a bead 12.

The initiator shown in Fig. 2 is similar to that of Fig. 1. In Fig. 2, however, the semiconductive ignition plug 20 is cylindrical and the dielectric spacing sleeve 21 has a thickness equal to width of the gap 6 between the plug 20 and the shell 1 above the sleeve 21.

In Fig. 3, is shown a cap similar in all respect to that of Fig. 1, except for the provision of the cavity 31 in the stepped semiconductive ignition plug 30.

The initiator of Fig. 4 is similar to that shown in Fig. 2 except for provision of the cavity 41 in the cylindrical semiconductive ignition plug 42.

In the cap of Fig. 5, a conventional shell 1, base charge 2, priming charge 3, loose ignition composition 9, lead wires 7 and bridge wire 8 are employed. However, the dielectric spacing sleeve 51 does not extend below the

lower surface of the cylindrical semiconductive ignition plug 50. The lower surface of the plug 50 is coated with a dielectric film 52 of nitrocellulose lacquer to prevent static discharge from the base of the plug 50 to the shell 1 at the interface of the ignition composition 9 and the plug. A rubber sealing plug 53 is crimped in the mouth of the shell 1 to complete the device.

The initiator of Fig. 6 is similar to that of Fig. 1, except for provision of a thin film 62 of rubber disposed in the gap between the upper portion of the semiconductive ignition plug 60 above the cardboard spacing sleeve 61. A rubber sealing plug 53 is crimped in the mouth of the shell 1 to complete the cap as in Fig. 5.

In Fig. 7 is shown a static resistant delay electric blasting cap in accordance with the invention. A conventional shell 1, base charge 2, priming charge 3, lead wires 7, and bridge wire 8 are employed. A delay fuse element 73 is disposed above the priming charge 3 and consists of a lead tube 74 filled with a delay train 75 composed of barium peroxide-selenium. A single stepped plug 70 is employed as ignition plug and sealing plug. The plug 70 has a semiconductive core 71 consisting of a rubber-graphite composition and a thin outer sheath 76 of non-conductive rubber. A dielectric spacing sleeve 72 is disposed around the lower portion of plug 70 having the lesser diameter and contacts the shell wall. The outer sheath 76 of plug 70 also contacts the shell wall above the sleeve 72 but the semiconductive core 71 is spaced from the wall by the thickness of the sheath 76. The plug 70 is crimped in place to form a waterproof closure.

The delay electric blasting cap of Fig. 8 again employs a conventional shell 1, base charge 2, priming charge 3, lead wires 7, bridge wire 8, and delay fuse element 73. A matchhead ignition assembly 82 is employed to ignite the fuse and consists of a bead of ignition composition 9 formed around the bridge wire 8. A dielectric shell liner 81 of cardboard is disposed in the shell 1 and extends above the base of a stepped semiconductive ignition plug 80. The shoulder formed by the upper portion of the plug 80 rests on the top of the liner 81 and the lower portion of the plug 80 fits snugly into the liner 81. The upper portion of the plug 80 is thus spaced from the shell wall at a distance less than that between either lead wire and shell. A rubber sealing plug 53 is crimped in the mouth of the shell 1 to complete the cap.

In all of the initiators illustrated in Figs. 1-8, static differential applied between lead wire and shell will discharge to the grounded shell outside the locus of the ignition composition and therefore accidental firing from this type of discharge is prevented. In the caps of Figs. 1, 3, and 8, the distance between the semiconductive body and shell is shortest above the sleeve or liner and discharge will, therefore, occur at this point. In the devices of Figs. 2 and 4, the spacing sleeves are of the same thickness as the gap 6, but the sleeves extend below the semiconductive plugs, making the resistance of the path from the plug to the shell greater below or through the sleeve than above the sleeve. In Fig. 5, the spacing sleeve terminates at the base of the plug. However, the coating of the lower surface of the plug with a dielectric film results again in less resistance to discharge above the sleeve. In Fig. 6, the gap between the upper portion of the sleeve and shell is filled with dielectric material. However, since the distance to shell wall is still less above the sleeve, discharge takes place through the film 62 above the sleeve 61. In Fig. 7, a similar thin film is provided about the entire plug 70. Again, however, total resistance from the core 71 to shell is less above the sleeve 72 and discharge takes place along this path.

The initiators of the invention are initially advantageous since they are easier to manufacture and are structurally stronger than the initiators of U. S. 2,658,451 above referred to in that the semiconductive body and the ignition plug are a single unit, and in the preferred

embodiments shown in Figs. 1-5 and 8, are a single body of uniform composition. Moreover, the increased amount of semiconductor thus economically available for contact with the lead wires has been found to give greater protection against static firing of caps having a broken bridge wire. Even though the possibility of firing can be reduced to practically nil by employing the semiconductive body and high heat capacity bridge wire of the parent application, it has been established in planned tests that where the bridge wire is loosened from the lead wire at one end or is broken and a tiny particle of static sensitive ignition composition is placed in the resulting gap, the cap of the parent application can be fired with static potential less than that which would otherwise fire the cap by heating the bridge. Although such circumstances are remote, the increased protection obtained by the present invention is desirable.

The increased protection readily obtained by employing semiconductive ignition plugs in accordance with the invention was demonstrated by preparing special experimental devices in which the unbridged terminals of the lead wires were brought to within .001 inch of each other. Highly sensitive lead styphnate was placed between the terminals. Semiconductive bodies having the indicated composition were formed about the lead wires. The static charge was applied across the gap by a 750 mmf. condenser.

TABLE 1

Al/Wax Ratio.....	50/50		55/45		
Plug Height.....	1/8	3/8	1/8	1/4	3/8
Test Voltage:					
1,000.....			3S, 2F		
2,000.....	5S	5F	2S, 3F	5F	
4,000.....	5S	3S, 2F	3S, 2F	S, 4F	5F
6,000.....					5F
10,000.....					5F
15,000.....					3S, 2F

In the foregoing table the letter S represents "shot" and the letter F represents "failed." It will be noted that a decreasing amount of shots was obtained in each case as the height of the semiconductive plug was increased.

The static resistance of the caps of the invention to a charge applied between shunted lead wires and shell is illustrated in Table 2. Seismic caps were employed similar to that shown in Fig. 1. The semiconductive ignition plugs were formed from the indicated compositions and were spaced from the shell above the cardboard sleeve by a distance of 0.015 inch and were 0.5 inch in height. The sleeve was .025 inch thick. The ignition composition was a conventional mixture of milled diazodinitrophenol-potassium chlorate employed in commercial seismic caps.

TABLE 2

Volts	35/65— Wax/Aluminum Mix		36/64— Wax/Aluminum Mix	
	Number Tested	Number Fired	Number Tested	Number Fired
16,000.....	15	0	10	0
21,000.....	15	0	5	0
31,000.....	15	0	5	0
40,000.....	15	0	5	0

As indicated, the novel structure of this invention may be employed in any type of electric initiator to give substantially complete protection from the static discharge customarily encountered in blasting operations.

In the structures described in the drawing, it will be noted that the body of semiconductive material is spaced from the inner wall of the shell by a distance which is substantially less than the distance between the lead wires and the shell in the vicinity of the ignition composition.

The semiconductive body acts as a nonconductor for the voltage employed to fire an electric initiator but is a good conductor for a high voltage static discharge. Therefore, while the semiconductive body has no effect on the normal operation of the cap, it does constitute a shunt for high voltage discharges between the lead wires within the shell when the static voltage is applied to both lead wires. This effect is of particular benefit with a cap in which the bridge wire has been accidentally broken during manufacture. As indicated, formation of the ignition plug itself from the semiconductive material allows increased contact with the lead wires without necessitating an increase in cap length. When the static voltage is applied across either of the wires and the shell, the charge is conducted from the lead wire through the semiconductive mass and arcs across the gap between the semiconductive body and the shell wall. Since the breakdown voltage of the semiconductive body must be fairly low in order to give the desirable protection against static discharge, the cap as a whole would have undesirably low voltage breakdown characteristics if the body were to contact the shell wall as is the case in several antistatic designs employed in prior art initiators. Because of the fact that the ignition plug is spaced from the shell wall, the voltage breakdown value of the cap is greatly increased and offers adequate protection against the type of stray current which can reasonably be expected to be found in blasting operations. For best results it is preferred to space the semiconductive plug from the shell wall by a distance of between 0.005 and 0.050 inch.

When the strength of the static charge results in a passage of the current through the bridge wire, despite the shunt formed by the semiconductive body, the use of a high heat capacity wire in accordance with application Serial No. 340,821 impedes the generation of sufficient heat in the bridge to ignite the ignition composition. The heat capacity of a bridge wire can be increased by increasing the length of the diameter. The dimensions of an electric initiator and manufacturing considerations place a limitation on the permissible length of a bridge wire, and it is consequently preferred to increase heat capacity by increasing the diameter. An increase in diameter will give the desired increase in protection against static electricity but for a given material the increase in diameter will also result in a corresponding increase of the minimum firing current of the cap. While this fact has no bearing upon the reduction of static susceptibility of the initiator, it is desired to maintain the minimum firing current of an electric initiator at a low level in the neighborhood of 0.5 to 1 amp. Therefore, if, in accordance with the present invention, the diameter of the wire is to be increased, it is desirable to employ a metal or alloy in the bridge wire which is characterized by a high specific resistance and a high specific heat. It has been found that with most of the ordinary materials used by the art, the minimum firing current of the initiator is undesirably raised if the diameter of the bridge wire exceeds about 0.0015 inch, which is the usual diameter employed by the art. It has been found that greatly increased static resistance is obtained if a diameter of 0.0020 inch is employed. It is preferred to employ a bridge wire diameter of about 0.0025 inch and in order to avoid any substantial increase in minimum firing current, it is preferred to employ a bridge wire made from a nickel-chromium alloy.

Although it is usually preferred to employ a conductive metal powder as the conductive component of the semiconductive ignition plug, especially aluminum powder, other particulate conductive materials, such as conductive carbon may be employed. The nonconductive component which acts as a binder and a carrier for the conductive particles is preferably wax. The wax employed will desirably have a melting point of 120° F. or above in order to prevent substantial cold flow of the wax subsequent to manufacture. The melting point of the

wax, or any other operable carrier, will, of course, depend largely upon practical considerations. For instance, if the waterproofing material employed is an asphaltic composition which is poured into the cap in molten form, a wax will be employed which has a melting point substantially higher than the temperature of the filling composition as it is poured into the shell. On the other hand, if a rubber or resin sealing plug is employed and is placed in position in cold form, the only consideration then is to use a wax which will not cold flow. If a molten resin is employed, the same considerations then pertain as in the case of a molten asphaltic composition. Preferred waxes include such natural waxes as candelilla, montan, and carnauba, and synthetic waxes.

Instead of wax, however, rubber or rubber-like materials, resinous materials, sulfur and equivalent materials may be employed. Since it is desirable that the body of semiconductive material be molded about the lead wires, readily moldable nonconductive materials are preferred.

It is preferred that the annulus between the semiconductive plug and the shell above the dielectric spacing body be substantially unfilled except by air. If the shell is sealed by a molten material which hardens in situ, some of this material may flow into the annulus. It has been found in practice, however, that this seldom occurs, probably due to the fact that the air is not readily displaced. Flow of molten sealing material into the annulus can be promoted, if desired, by preheating the shell. Improved static resistance is still obtained, however, even when the annulus is filled with an insulatory material, since the static will still discharge through the thin layer. In Figs. 6 and 7, a thin dielectric layer of rubber has been employed about the plug where discharge occurs, but other dielectric, insulatory materials may be employed such as sulfur, asphalt, synthetic resins, and the like.

The structures of Figs. 6 and 7 are advantageous in that protection is automatically present against inadvertent contact between core and shell if the plug is not properly centered in the shell. The structures of Figs. 1-4 and 8 can be modified to afford similar protection by employing a narrow dielectric collar or band around the upper portion of the semiconductive ignition plug. Alternatively, small dielectric beads or spacing members may be employed. In a further embodiment, a dielectric spacing disc may be mounted on top of the ignition plug. Further, the dielectric sleeve disposed between the upper portion of the ignition plug and shell in Fig. 6 may be perforated to facilitate discharge while still insuring proper spacing.

The amount of a particular conductive filler employed in the semiconductive body will depend on the conductivity of the particular material and on the degree of static protection desired. The method of forming the semiconductive body about the lead wires will also dictate the optimum quantity of particulate conductive filler employed. In the preferred composition of wax and aluminum, it has been found that best results are obtainable when between 60 and 70% of particulate aluminum is employed. The upper limit of 70% is primarily dictated by the fact that it is desired to employ a pourable mixture for molding. The use of more than 70% of aluminum powder usually results in a mixture which is undesirably viscous. It has been found that adequate protection against static discharge from the lead wire to the shell through the ignition composition can be obtained with about 60% of particulate aluminum. Lesser amounts of aluminum can be employed with very beneficial results.

From all considerations a 35/65 mixture of wax/aluminum has been found to give excellent results and is preferred.

As indicated in the drawing, the dielectric spacing body may have various configurations and may be made of many different solid dielectric materials. Such materials include cardboard, paper, fiberboard, rubber, plastic, and

the like. For most purposes cardboard is preferred due to its ease of fabrication, economy, and excellent dielectric qualities.

If it is desired to employ the structure of Fig. 5, any suitable material may be employed as the dielectric film 52. Lacquer is preferred due to ease of application. Generally, however, it is preferred to employ structure in which the spacing body extends below the base of the semiconductive plug unless the plug is stepped as in Fig. 3.

As will be apparent to those in the initiator art, the conventional components of the initiators may be replaced by equivalents. The shells may be of any conductive metal such as aluminum, brass, copper, ferrous metals and various alloys. The lead wires may be made of any of the conventional materials such as copper and iron, and may be tinned if desired. The lead wires may be insulated with any desired material such as cotton servings, rubber or various plastics.

The base charges may be formed from any secondary detonative explosive such as pentaerythritol tetranitrate, cyclonite, tetryl, trinitrotoluene, and the like, and may be cast or pelleted as well as pressed when the nature of the explosive permits. The priming charge may be omitted if the base charge is capable of initiation by the action of the ignition composition. When a priming charge is employed as is preferred, any primary explosive or mixture may be used such as diazodinitrophenol, diazodinitrophenol-potassium chlorate, lead azide, lead styphnate, and mercury fulminate. Any of the known ignition compositions may also be employed such as finely divided diazodinitrophenol-chlorate mixture, fulminates, lead- or tin-selenium mixtures, etc.

As indicated in the drawing, the ignition assemblies may employ cavity ignition plugs, matchheads or loose ignition charges in accordance with conventional structures employed in the blasting initiator art. The shell may be sealed by more than one sealing layer or, as indicated, a single seal may be employed such as a rubber sealing plug or a cast or molded resin plug, and the shell suitably crimped.

Since, as indicated, the initiators within the scope of the invention can be altered in many respects without changing their mode of operation, it is intended that the invention be limited only by the scope of the appended claims.

What I claim and desire to protect by Letters Patent is:

1. A static resistant electric initiator having in combination a metallic shell, a pair of lead wires, an ignition plug of semiconductive material disposed about bared portions of the lead wires within the shell, a bridge wire joining the terminals of the lead wires below the lower surface of the plug, an ignition composition directly below said plug and disposed about the bridge wire, a spacing body of dielectric material surrounding a lower portion of the plug between the plug and shell wall, the portion of the plug above the spacing body approaching the shell wall but being separated therefrom by a distance substantially less than that between either lead wire and the shell in the locus of the ignition composition, and the total resistance between the shell wall and plug being substantially less above the spacing body than at any other point on the plug.

2. An electric initiator in accordance with claim 1 in which the semiconductive material comprises particulate conductive material in admixture with a nonconductive binder.

3. An electric initiator in accordance with claim 1 in which the semiconductive material comprises particulate conductive metal powder in admixture with a nonconductive binder.

4. An electric initiator in accordance with claim 1 in which the semiconductive material comprises particulate aluminum and wax.

5. An electric initiator in accordance with claim 1 in

which the semiconductive material comprises from 60 to 70% of particulate aluminum and 40 to 30% of wax.

6. A static resistant electric initiator having in combination a metallic shell, a pair of lead wires, an ignition plug of semiconductive material disposed about bared portions of the lead wires within the shell, a bridge wire joining the terminals of the lead wires below the lower surface of the plug, an ignition composition directly below said plug and disposed about the bridge wire, a sleeve of dielectric material surrounding a lower portion of the plug between the plug and shell wall and extending below the plug to form a housing for ignition composition, the portion of the plug above the sleeve approaching the shell wall but being separated therefrom by a distance substantially less than that between either lead wire and the shell in the locus of the ignition composition, and the total resistance between the shell wall and plug being substantially less above the sleeve than at any other point on the plug.

7. An electric initiator in accordance with claim 6 in which the semiconductive material comprises particulate conductive material in admixture with a nonconductive binder.

8. An electric initiator in accordance with claim 6 in which the semiconductive material comprises particulate conductive metal powder in admixture with a nonconductive binder.

9. An electric initiator in accordance with claim 6 in which the semiconductive material comprises particulate aluminum and wax.

10. An electric initiator in accordance with claim 6 in which the semiconductive material comprises from 60 to 70% of particulate aluminum and 40 to 30% of wax.

11. A static resistant electric initiator having in combination, a metallic shell, a pair of lead wires, an ignition plug of semiconductive material disposed about bared portions of the lead wires within the shell, said plug having a lower portion of reduced diameter, a bridge wire joining the terminals of the lead wires below the lower surface of the plug, an ignition composition directly below said plug and disposed about the bridge wire, and a sleeve of dielectric material of uniform wall thickness surrounding the portion of the plug having a reduced diameter and said sleeve having a portion of reduced wall thickness extending over the upper portion of the plug to space said upper portion from the shell wall, said upper portion of the plug being separated from the shell wall by a distance substantially less than that between either lead wire and the shell in the locus of the ignition composition.

12. An electric initiator in accordance with claim 11 in which the semiconductive material comprises particulate conductive material in admixture with a nonconductive binder.

13. An electric initiator in accordance with claim 11 in which the semiconductive material comprises particulate conductive metal powder in admixture with a nonconductive binder.

14. An electric initiator in accordance with claim 11 in which the semiconductive material comprises particulate aluminum and wax.

15. An electric initiator in accordance with claim 11 in which the semiconductive material comprises from 60 to 70% of particulate aluminum and 40 to 30% of wax.

16. A static resistant electric initiator having in combination a metallic shell, a pair of lead wires, an ignition plug of semiconductive material disposed about bared portions of the lead wires within the shell and coated on its undersurface with a layer of dielectric material, a bridge wire joining the terminals of the lead wires below the lower surface of the plug, an ignition composition directly below the said coated plug and disposed about the bridge wire, a spacing body of dielectric material surrounding a lower portion of the plug between the plug and shell wall, the portion of the plug above the spacing body approaching the shell wall but being separated therefrom by a distance substantially less than that between either lead wire and the shell in the locus of the ignition composition, and the total resistance between the shell wall and plug being substantially less above the spacing body than at any other point on the plug.

17. A static resistant electric initiator having in combination a metallic shell, a pair of lead wires, an ignition plug of semiconductive material disposed about bared portions of the lead wires within the shell and coated on its undersurface with a layer of dielectric material, a bridge wire joining the terminals of the lead wires below the lower surface of the plug, an ignition composition directly below the said coated plug and disposed about the bridge wire, a sleeve of dielectric material surrounding a lower portion of the plug between the plug and shell wall and extending below the plug to form a housing for ignition composition, the portion of the plug above the sleeve approaching the shell wall but being separated therefrom by a distance substantially less than that between either lead wire and the shell in the locus of the ignition composition, and the total resistance between the shell wall and plug being substantially less above the sleeve than at any other point on the plug.

18. A static resistant electric initiator having in combination a metallic shell, a pair of lead wires, an ignition plug of semiconductive material disposed about bared portions of the lead wires within the shell and coated on its undersurface with a layer of dielectric material, said plug having a lower portion of reduced diameter, a bridge wire joining the terminals of the lead wires below the lower surface of the plug, an ignition composition directly below the said coated plug and disposed about the bridge wire, and a sleeve of dielectric material of uniform wall thickness surrounding the portion of the plug having a reduced diameter and said sleeve having a portion of reduced wall thickness extending over the upper portion of the plug to space said upper portion from the shell wall, said upper portion of the plug being separated from the shell wall by a distance substantially less than that between either lead wire and the shell in the locus of the ignition composition.

References Cited in the file of this patent

UNITED STATES PATENTS

2,240,438	Durant	Apr. 29, 1941
2,408,125	Rolfes	Sept. 24, 1946
2,658,451	Horne	Nov. 10, 1953
2,685,835	Noddin et al.	Aug. 10, 1954