

Aug. 10, 1954

G. A. NODDIN ET AL
BLASTING INITIATOR

2,685,835

Filed July 29, 1952

2 Sheets-Sheet 1

Fig. 1.

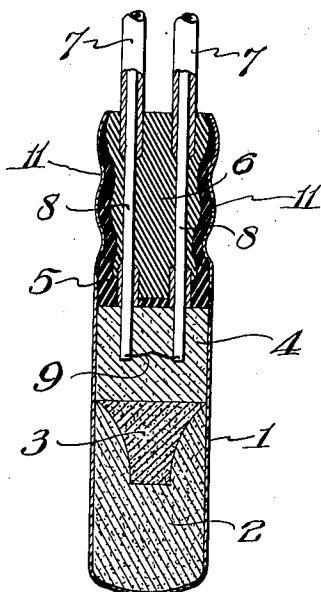


Fig. 2.

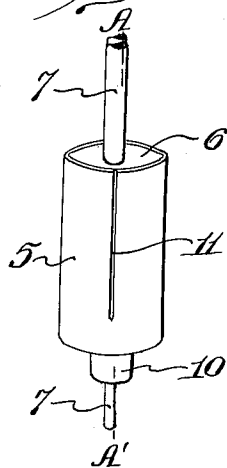


Fig. 3.

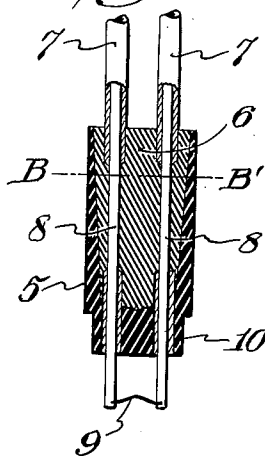
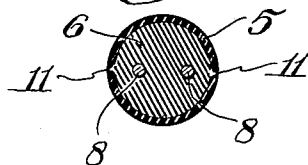


Fig. 4.



INVENTORS:
GEORGE A. NODDIN
PAUL A. RAMSDELL
BY *Thos. A. Wilson*
Joseph J. Heimbach
ATTORNEYS

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Fig. 5.

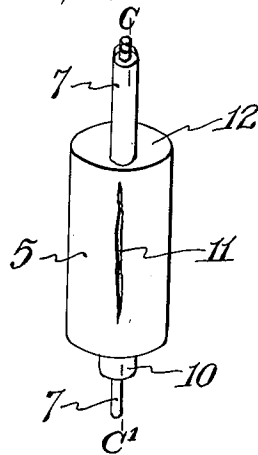


Fig. 6.

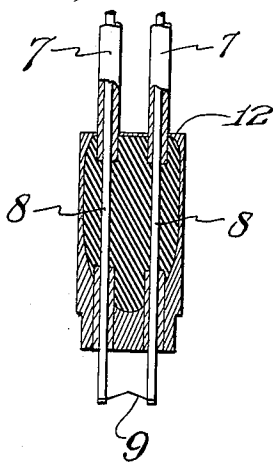
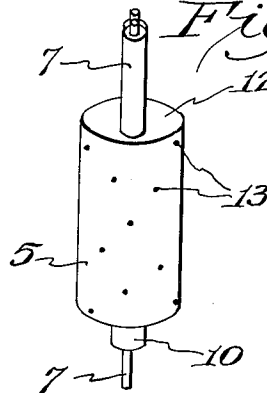


Fig. 7.



INVENTORS
GEORGE A. NODDIN
PAUL A. RAMSDELL

BY

Thos. A. Wilson
Joseph J. Weinbach
ATTORNEYS

UNITED STATES PATENT OFFICE

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BLASTING INITIATOR

George Adelbert Noddin, Paulsboro, and Paul Allen Ramsdell, Pitman, N. J., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del., a corporation of Delaware

Application July 29, 1952, Serial No. 301,464

13 Claims. (Cl. 102-28)

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This invention relates to electric blasting initiators and more particularly to electric blasting initiators of a novel construction such as will assure greater safety in their practical use.

The two types of electric blasting initiators commonly used are the commercial electric blasting cap and the electric squib. The first of these is employed for the detonation of high explosives by means of a pressed detonating charge at the base of the cap shell, whereas the second type is used to initiate deflagrating explosives by a flame. Both forms of initiators are fired by the passage of an electric current through a pair of leg wires which are connected inside the shell by means of a small-diameter bridge wire of high electrical resistance. The bridge wire becomes heated to incandescence on the passage of the current, thereupon igniting a heat-sensitive charge in contact with said bridge wire.

Electric blasting initiators of the usual types function very effectively and without undue hazard when they are used in locations free from sources of electricity extraneous to that intentionally provided in the blasting circuit. When, however, extraneous sources of electricity are present, there is the danger that the usual blasting initiators may fire prematurely. Various types of extraneous electricity are frequently unavoidably present in locations where blasting caps are intended for use. Such sources may be mentioned as lightning, atmospheric static electricity such as is generated by dust storms, snow storms, escaping steam, moving belts, revolving automobile tires, or such as is likely to be present at high altitudes and especially in regions of low humidity. Another source of unwanted electricity exists in stray currents, that is, differences in potential that exist in highly metallic rock formations, as in ore mines, for example, or in the vicinity of electric cables, rails, pipelines, and ventilating ducts, and the like, long conductors of some or all of these types being customary in mines. There is also the possibility that instances of galvanic action may occur in the vicinity of electric blasting initiators which may cause a sufficient difference in potential to fire said initiators.

Various means have been proposed for preventing the premature detonation of electric blasting initiators by extraneous sources of electricity. These methods have depended on the provision of discharge paths within the detonator to permit a charge of high voltage to pass from the leg wire or wires to the detonator shell wall or to the ground without passing near the

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ignition charge. For example, materials having high resistance to low voltages and low resistance to high voltages, such as galena and Carborundum, have been placed between the leg wires and the shell wall, or a layer of a suitable resistance compound, for example, graphite, has been provided between the bridge plug and a water-proofing plug. Furthermore, provision of a coherer mass in contact with the leg wires and the shell wall, for example a plug containing a flaked metal such as aluminum in a plastic mass of an oil, a liquefied paraffin wax, or a rubber-like or other plastic material, has been proposed, the coherer mass offering substantially complete resistance to ordinary firing currents but becoming conductive through coherer action when subjected to high voltages. The use of a plug of a highly conductive rubber-like material, for example a rubber-like material containing a high percentage of carbon black, as the closing plug of an electric blasting initiator has also been proposed.

Means such as those cited have been useful in the prevention of the ignition of electric blasting caps by high-voltage currents, that is, by such currents as are produced by lightning and by static atmospheric electricity, these high-voltage currents causing spark discharges of high voltage and of short duration, and have usually been adequate to prevent ignition by extraneous electricity of lower voltages, as in the majority of stray currents, galvanic currents, and the like, when such low-voltage electricity has not been applied to the caps continuously for a sufficient length of time to cause initiation.

When, however, electric blasting initiators provided with protective means of the prior art have been used for multiple blasting in series in wet, conductive earth, particularly in shale, which is slightly acidic, or, for example, in tunneling and roadbuilding work, the path of low resistance which has been provided by these protective means has been of great disadvantage. When the resistance of the ground is high, as in ordinary nonconductive earth, the current applied for the firing of the detonators in series has followed the path of least resistance, which, in this case, is the path provided from the source of current through the lead wires and the bridge wires of the blasting caps. When, however, the ground itself is highly conductive, a different situation obtains; the path of least resistance is no longer entirely the blasting circuit alone, but also the path from the leg wires of the blasting initiator through the protective means to the shell wall and through the conductive earth.

Consequently, when firing current, the amount of which is limited by the blasting circuit involved, is applied to electric blasting initiators connected in series in conductive earth, some of the current drains away, thereby leaving an inadequate amount in the circuit. Thus, some of the detonators in the series fail to fire, resulting in failure of a portion of the blast and in the great hazard of presence in the material around the blast of unexploded explosive charges and detonators.

An object of the present invention is an electric blasting initiator which is substantially free from susceptibility to initiation by extraneous sources of electricity. A further object is such an initiator which at the same time is substantially free from susceptibility to initiation by extraneous sources of electricity and yet can be used for multiple blasting in series in wet, conductive media. A still further object is an electric blasting initiator which, when connected in series in wet, conductive media, is substantially free from susceptibility to initiation by extraneous electricity and retains the applied firing current within the blasting circuit. A still further object is an electric blasting initiator which is protected against initiation by extraneous sources of electricity and against current leakage when used in multiple blasting in series in wet, conductive media. Additional objects will be disclosed as the invention is described more fully hereinafter.

We have found that the foregoing objects are accomplished when an electric blasting initiator comprising a loaded metal shell is closed at the mouth of the shell by a resilient plug of novel construction. The leg wires pass through said plug in the usual manner, being held at a spaced distance apart thereby. The leg wires extend beyond the surface of the plug within the shell, where their bared ends are connected by a small-diameter bridge wire, which is surrounded by a deflagrating composition adapted to become ignited when current passes through said bridge wire. The leg wires are insulated by a suitable dielectric material except for the ends attached to the bridge wire and a portion of their length within the lug. The novel resilient plug which closes the mouth of the shell of the initiator comprises an essentially cylindrical core of a resilient material of high conductivity covered over at least its base and cylindrical portion and, if desired, over the top with a layer of insulating material in the cylindrical surface of which is provided at least one small opening permitting electrical contact therethrough of the material of high conductivity with the shell wall, the portion of the insulating material over the base and cylindrical portion being of resilient material. With such a design of electric blasting initiator elements, the initiator will fire when the usual current is applied by means of a blasting machine or commercial electric circuit. When, however, a high-voltage charge of extraneous electricity, such as a static charge accumulated by a human operator, is applied, the charge leaks harmlessly to the shell wall instead of causing a spark to jump across from one or both of the terminals, with probable ignition of the static-sensitive charge. When, on the other hand, current is applied to a series of blasting initiators each provided with a novel resilient plug of the type described, which are arranged in a blasting circuit in a wet, conductive medium such as moist earth, current does not leak out through the shell wall to the wet, conductive medium such as the

surrounding ground, but is kept within the proper path of the blasting circuit. Sufficient current is thus received by each initiator in the series to cause its bridge wire to reach a sufficiently high temperature to initiate the deflagrating composition surrounding the bridge wire, and all the initiators in the series are fired.

The invention will be clearly illustrated by reference to the accompanying drawings.

Figure 1 shows a sectional view of an electric blasting cap containing a resilient plug of the type described, said section being made along one edge of the pair of leading wires. Figure 2 represents a side elevation of such a plug. Figure 3 is a longitudinal section made along line A—A' of the plug illustrated in Figure 2. Figure 4 shows a cross-section of a plug of the type described taken along line B—B' of Figure 3. Figure 5 shows a modification of the plug of Figure 2. Figure 6 is a longitudinal section made along line C—C' of the plug illustrated in Figure 5. Figure 7 is a further modification of the plugs of Figure 2 and Figure 5.

In Figure 1, 1 designates a substantially cylindrical metal cap shell containing a base charge 2 of tetryl compressed to high density. A primer charge 3 of pressed lead azide is contained within a cavity in the base charge, the latter substantially surrounding the primer charge. A loose charge of an ignition mixture 4 is superposed on the primer charge, this ignition mixture consisting of a mixture of boron and red lead. The previously open end of the shell is closed by a composite resilient plug consisting of two parts, a cup-shaped portion 5, and an insert 6 therefor, the plug being molded about the leg wires 7, thereby holding the wires in place and at a predetermined distance apart. These wires 7 are connected to a source of electric current at the desired firing time and are coated with a suitable insulating covering outside the cap shell. The wires are free from insulation for at least a portion of their lengths 8 within the insert portion of the plug so that the wire metal is in electrical contact with the material of the insert, and the bared ends of the wires extend beyond the surface of the plug within the shell, where they are connected by means of a small-diameter, electrically resistant bridge wire 9. This bridge wire is surrounded by and in contact with the loose ignition charge 4.

In Figure 2, which is a side elevation of a composite resilient plug such as is shown closing the mouth of the detonator shell 1 in Figure 1, the cup-shaped portion 5 is seen to contain insert, or core 6. Wires 7 enter the core 6 and emerge from the cup-shaped covering portion 5 through a wedge-shaped extension 10 of the cup-shaped portion 5. In the open end of the covering portion 5 is seen one vertical slit 11. Another such slit, not seen, is provided on the opposite side of covering portion 5.

Figure 3 shows a longitudinal section of the plug illustrated by Figure 2, the section being made along line A—A' of Figure 2, that is, close to slit 11, in order that wires 7 may be shown. The plug of Figure 3 is similar to that which closes the mouth of the detonator shell 1 in Figure 1 except that it has not been crimped into a shell and is formed with a wedge-shaped extension 10 of cup-shaped portion 5, as illustrated in Figure 2.

Figure 4 shows a cross-section of the composite resilient plug of Figure 3 made at a point designated by the line B—B' in Figure 3. The por-

tions 8 free from insulation of wires 7 are embedded in the core portion 6 of the plug, which is surrounded by the covering portion 5 except for the slits 11.

Figure 5 shows a plug similar to that of Figure 2, except that the top surface of the plug is provided with a covering 12 of a dielectric material, in this case, the same material as that of the cup-shaped covering portion of the plug.

Figure 6 shows a longitudinal section of the plug illustrated by Figure 5, the section being made along lines C—C' of Figure 5. The plug of Figure 6 is similar to that of Figure 3, except for the top covering 12.

Figure 7 shows a plug similar to that of Figure 5, except that the openings in the cylindrical surface are a multiplicity of perforations 13 instead of a pair of slits.

In the plugs illustrated in Figures 1-7, the core portion 5 comprises a synthetic rubber composition. Natural rubber and synthetic rubber compositions are almost completely non-conductive of electricity under all circumstances. Thus, when, in a detonator plug formed wholly of an ordinary rubber composition, the resistance between the leg wires within the plug is measured in the absence of a bridge wire connecting the two wires, it is found to be in excess of 100,000 ohms. The core portion 6 of the plugs illustrated in Figures 1-4 and 6, on the other hand, comprises a polymerized chloroprene composition of the neoprene type containing 75 parts by weight of carbon black per 100 parts of neoprene. Such a composition has greatly increased electrical conductivity; in fact, the resistance amounts to only about 1.4 ohms per cubic centimeter.

When the usual firing current is applied to detonators provided with composite plugs made in accordance with the foregoing description, it passes through the bridge wire and effects ignition. When, however, static charges of the order of 10,000 volts at 0.0003 microfarad capacity are applied, the conductivity of the resilient composition of the core portion of the plug is sufficient to ground the circuit to the shell by way of the openings 11 or 13, and no detonation occurs. Furthermore, when detonators containing the composite plugs described are connected in series in wet, conductive earth, leakage of current into the earth is prevented by the non-conductive covering of the plug which almost completely surrounds the more highly conductive core.

A comparison of the performance of resilient, rubber-like plugs of the present invention with resilient plugs of the prior art is given in the following. In these comparisons, the various types of resilient plugs tested are given the designations listed below. In these descriptions, where the term rubber is used, either natural rubber or a synthetic rubber, for example of the neoprene type, is meant.

A=the ordinary nonconductive rubber plug

B=a plug made of conductive rubber, i. e. a polymerized chloroprene composition of the neoprene type containing 75 parts by weight of carbon black per 100 parts of neoprene.

C=a laminated rubber plug consisting of a cylindrical core of conductive rubber (composition as in B) surrounded by a cylindrical sheath of nonconductive rubber except for two longitudinal slits in the cylindrical sheath.

D=a plug composed of a cylindrical core of con-

ductive rubber (composition as in B) and a covering of nonconductive rubber over base and cylindrical portion, the covering over the cylindrical portion being provided with longitudinal slits.

D₁=a composite plug like the preceding, provided, in addition, with a top covering of non-conductive rubber.

E=a "coherer" plug made from a composition of flaked aluminum and machine oil.

In a test for sensitivity to static, detonators containing base charges of the same kind and weight were provided with identical loose ignition mixtures comprising boron and red lead around the bridge wire between the leg wires held in the mouth of the detonator shell by means of the various plugs tested. A spark current from a charged condenser was passed simultaneously through both the leg wires to the grounded metal shell of the detonators with the bridge wire in place. The minimum electrical energy in joules required to fire any one of ten detonators provided with plugs of the same type was as follows:

TABLE I

Type of Plug.....	A	B	C	D	D ₁	E
Minimum electrical energy in joules required to fire detonator.....	0.002	0.06	0.002	0.12	0.12	0.16

It may be seen from the foregoing table that detonators containing the ordinary non-conductive rubber plug A and the laminated plug C may be fired by a minimum of only 0.002 joules of electrical energy, i. e. they are sensitive rather than resistant to high-voltage static discharges, whereas plugs of types B, D, D₁ and E require many times that amount of energy to cause them to fire.

Those detonators that were not fired by the minimum amount of electrical energy in the above test, were subjected to increasing amounts of electrical energy until they were either fired or the maximum of the condenser used, 0.8 joules, had been reached. At this point, all of the detonators provided with plugs of types A, B, and C had fired, whereas two of those provided with plugs of type D, six of those provided with plugs of type D₁, and four of those provided with plugs of type E had still not fired. In accordance with this extremely severe test, that of the application of 0.8 joules of electrical energy, it may be seen that detonators provided with plugs of types D, D₁, and E are appreciably more static-resistant than those provided with plugs of types A, B, and C.

As a further measurement of the safety of detonators in the presence of high static potentials and in order to subject the detonators to conditions more severe than those to be expected as a result of ground currents during a lightning discharge, a potential of 28,000 volts was applied by means of a Tesla coil to the twisted bared ends of leg wires of grounded detonators (loaded as in the preceding tests) for one minute. In this test, all of the five detonators closed by non-conductive rubber plugs (type A) under test fired, but none of the detonators closed by the plugs of the other types fired when groups of five each were tested. Thus, plugs of type A are unsafe in the presence of high static potentials in contrast to plugs of the other types.

In order to test the various plugs for resistance

to stray currents, an electric charge of 24 volts direct current was applied between the two twisted leg wires and the shell of detonators provided similarly with a base charge and with an ignition bead surrounding the bridge wire, the detonators being closed by the plugs of the various types. The time required for the ignition of the detonators was measured. Detonators closed by the conductive rubber plug B were ignited in only 40 seconds, whereas the detonators containing the plugs of all the other types withstood ignition by a charge of 24 volts for more than 2 minutes. The conductive plug of type B was thus inadequate to protect the detonator against low-voltage stray currents for an appreciable length of time.

Detonators of like construction except for the different plugs were tested in series under conditions simulating those obtaining in wet, conductive earth by firing them in series of ten in salt water having a resistance of 100 ohms per foot, the detonators being at least one foot apart. The minimum direct current applied for 0.2 second that would fire three separate series of ten detonators having the same type of plug was measured. The results of this test are tabulated below:

TABLE II

Type of Plug.....	A	B	C	D	D ₁	E
Minimum current, in amperes, required to fire 3 separate series of 10 detonators each.....	1.1	1.4	1.1	1.3	1.2	>1.6

From the foregoing table, it may be seen that the laminated plug C was like the ordinary non-conductive rubber plug A in its performance, each of the sets of series containing these requiring a minimum current of 1.1 amperes. The series containing the conductive rubber plug B, on the other hand, required a minimum current of 1.4 amperes, thus indicating loss of current by leakage through the conductive rubber. The "coherer" plug E series required over 1.6 amperes, indicating even greater current leakage. The series containing the composite plug D, requiring a current of 1.3 amperes, and the series containing the composite plug covered by a top insulating coating D₁, requiring a current of 1.2 amperes, showed greater leakage than the series containing the ordinary nonconductive plug A, but this leakage was less than that of the series containing the conductive B and "coherer" E plugs. Actual performance tests, which are tabulated below, demonstrate the critical difference between current leakage which can be tolerated and that which cannot in accordance with the preceding test. In these performance tests, series of 36 detonators each of the same type were fired in water by means of a condenser-discharge blasting machine.

TABLE III

Type of Plug	A	B	C	D	D ₁	E
No. of detonations, = D, and failures, = F, obtained when 36 detonators were fired in series in water by means of a condenser-discharge blasting machine.	36D 0F 36D 0F 36D 0F	32D 4F ----- -----	36D 0F 36D 0F 36D 0F	36D 0F 36D 0F 36D 0F	36D 0F 36D 0F 36D 0F	34D 2F ----- -----

It may be seen from the foregoing table that detonators closed by plugs of types A, C, D, and D₁ perform satisfactorily when fired in series in water, whereas the performance of detonators closed by plugs of types B and E is unacceptable because failures occur.

The tests described in the foregoing are recapitulated in Table IV which follows.

TABLE IV

Results of comparative tests of electric blasting caps sealed with resilient plugs of various types

Type of Plug.....	Nonconductive Rubber Plug A	Conductive Rubber Plug B	Laminated Plug ¹ C	Composite Plug ² D	Composite Plug Having Top Covering of Insulation D ₁	"Coherer" Plug (Flaked Al in Machine Oil) E
Static Tests: (A) Condenser-discharge test (Bridge wire surrounded by a loose B/PbO ₂ ignition mixture)— Minimum energy required to fire detonator, joules.....	0.002.....	0.06.....	0.002.....	0.12.....	0.12.....	0.16.....
No. of detonators that could not be fired at the capacity of the condenser (0.8 joules).	0 out of 10...	0 out of 10...	0 out of 10...	2 out of 10...	6 out of 10...	4 out of 10.
(B) Tesla coil test— No. of detonators fired within 60 sec. at 28,000v.....	5 out of 5....	0 out of 5....	0 out of 5....	0 out of 5....	0 out of 5....	0 out of 5.
Stray Current Test: Time required for ignition upon application of 24 v. D. C. from leg wire to shell in air, bead ignition.	>2 min.....	40 sec.....	>2 min.....	>2 min.....	>2 min.....	>2 min.
Series-Firing Tests: (A) Minimum D. C. amperage for a current application of 0.2 sec. to fire 3 separate series of 10 detonators in series in salt water (resistance 100 ohms/ft.) at least 1 ft. apart.	1.1.....	1.4.....	1.1.....	1.3.....	1.2.....	>1.6.
(B) No. of detonations (D) and failures (F) obtained when 36 detonators were fired in series in water by means of a condenser-discharge blasting machine.	36D 0F 36D 0F 36D 0F	32D 4F ----- -----	36D 0F 36D 0F 36D 0F	36D 0F 36D 0F 36D 0F	36D 0F 36D 0F 36D 0F	34D 2F. ----- -----

¹ Cylindrical, doubly slit sheath of nonconductive rubber around a plug of conductive rubber.

² Doubly slit cup of nonconductive rubber filled with conductive rubber.

It may be seen from Table IV that the plugs of type D and type D₁, those made in accordance with the present invention, are the only ones which satisfactorily meet the requirements of all the tests described. Detonators containing them are resistant to static and to stray currents and at the same time are capable of being fired in series in wet, conductive media without causing failure due to current leakage. Plugs of the other types used heretofore cause failures in one or more of these respects.

The present invention may be used advantageously with all types of electric blasting caps, whatever their design, whether of the "match head," "concave plug," or "bridge plug" type. Although it is particularly suitable where fast caps, free from firing lag, are desired, it is not limited to such types, but is adaptable for use in electric squibs, delay electric caps, etc.

One field in which fast caps are particularly in demand is in that of seismic prospecting, where the success of the work in locating strata is largely dependent on accurate time recording for the measurement of distances. It is important that there be little or no measurable time interval between the breaking of the bridge wire and the detonation of the cap. This requires that a very fast ignition agent be used, and it has been demonstrated that ignition compounds having a negligible induction period are relatively susceptible to static electricity. The present invention, therefore, meets the foregoing need very satisfactorily in that it provides an arrangement whereby fast-burning charges can be used without the hazards that might otherwise be present because of the static sensitivity of these charges. Such compounds as lead styphnate, copper acetylide, basic lead picrate, and the like are materials that may be so characterized. The composite rubber plugs of the present invention may be applied also in delay electric blasting caps and be beneficial in providing a high-resistance shunt whereby arcing may be reduced.

The rubber-like compositions employed in carrying out the invention may be of various types. Natural rubber is, of course, well adapted for use, as are various types of synthetic rubbers, butyl rubbers, polymerized chloroprene, particularly neoprene compositions, etc. It will be seen, therefore, that all materials that have the properties of resiliency to a degree approaching that of rubber are applicable.

Such compositions as are to be used for the core portion of the composite plug of the invention will be so formulated that they are characterized by conductivities considerably greater than that of ordinary rubber, though still of a relatively low order. This conductivity will result from the inclusion in the rubber composition of a content of carbon black in excess of 30 parts by weight to 100 parts of the rubber-like compound. A desirable content of carbon black will be between 30 and 100 parts, though we do not wish to be limited to this range. Various types of carbon blacks are applicable, and we find acetylene black particularly suitable.

The following data are illustrative of the decreased resistivity of rubber-like compositions with increasing contents of carbon black, expressed as parts per 100 parts rubber-like material. The values are for a polymerized chloroprene composition.

Carbon Black Content	Resistivity, ohms/cc.
0.....	10 ¹²
10.....	2×10 ⁸
20.....	9×10 ⁷
30.....	3×10 ⁴
40.....	6.4×10 ³
50.....	1.4×10 ³
75.....	1.4×10 ³

It will be noted that, at a content of 30 parts of carbon black per 100 parts of the rubber-like material, the conductivity, that is, the reciprocal of the resistivity, is greatly increased. We intend, therefore, to use a plug-insert material having a resistivity not greater than 3×10^4 ohms per cubic centimeter, that is, having a carbon black content of at least 30 parts by weight per 100 parts of the polymerized chloroprene. Desirably such content will be between 30 and 100 parts of carbon black.

A plurality of openings is provided in the cylindrical portion of the covering of nonconductive material in order to permit some slight contact of the core of conductive material with the shell wall. These openings may be in the form of slits or perforations or of any other desired form, so long as the exposed area is at least about 2% of the total cylindrical area of the plug surface. Preferably, the openings should not provide an exposed area exceeding 20% of the total cylindrical area of the plug surface. Greater contact than this of the conductive portion with the shell wall may allow current leakage to occur as in the wholly conductive plug of type B. It is preferable that the openings be distributed evenly over the surface of the plug in order to permit several paths of small area from the bare leg wires to shell wall. For example, if slits are used, they are desirably placed on opposite sides of the plug, and if perforations are used, they are scattered around the plug and at several different levels on the plug surface.

The base of the plug is entirely covered with nonconductive material in order to protect the ignition composition, to which the base is in close proximity and which composition may be particularly sensitive to static, from static discharges. The utility of the dielectric covering over the base of the plug may be better understood by reference to Table IV, where it may be seen that the laminated plug of type C, which plug lacks a covering of nonconductive material over the base of the plug, failed in the condenser-discharge test.

Table IV also shows that the performance of the composite plug comprising a cylindrical core covered at the base and on the cylindrical surface except for the openings may be further improved by being provided with a top covering of an insulating material. The static resistance upon the application of 0.8 joules of electrical energy is significantly superior for the plug of type D₁, and the current leakage is even less than when no top covering is provided. Such a top insulating covering may be formed by a thin layer of the nonconductive rubber as shown in Figures 5 and 6. Other coverings may also be used, such as a coating of a nonconductive plastic material, for instance, a glyptal resin. Furthermore, the top covering may be applied after the plug has been crimped in the shell, for example by dipping the loaded shell in a liquid dielectric material such as a solution of

shellac or lacquer which will dry as a thin coating over the exposed end of the resilient plug. Other types of insulation may also be used for covering the top surface of the composite plug. If desired, a partial covering over the top of the plug may also be used, for example a rim of dielectric material. Whereas the covering over base and cylindrical surface is of resilient material to allow sealing of the plug in the open end of the initiator shell by crimping, the top covering, when used, need not be of a resilient material.

The invention has been described adequately in the foregoing. It will be understood, however, that many variations may be introduced in details of design, compositions, types of charges, and the like without departure from the scope of the invention.

We intend to be limited only by the following claims.

We claim:

1. An electric blasting initiator comprising a loaded metal shell and a plug closing the mouth of said shell and holding the leg wires at a spaced distance apart, said plug comprising an essentially cylindrical core of a resilient material of high conductivity, said core being provided with a covering of a resilient material of low conductivity over at least the base and cylindrical surface of said core except for at least one opening in said covering over said cylindrical surface, the area of said uncovered portion of said cylindrical surface amounting to from 2 to 20% of the area of said cylindrical surface, the leg wires being free from insulation in at least a portion of their length through said core.

2. An electric blasting initiator comprising a loaded metal shell and a resilient plug closing the mouth of said shell and holding the leg wires at a spaced distance apart, said resilient plug comprising an essentially cylindrical core of a resilient material of high conductivity, said core being provided with a covering of an insulating material over its base, cylindrical surface, and top except for at least two slits in said covering over said cylindrical surface, said covering of insulating material over the base and the cylindrical portion of said cylindrical core being of resilient nonconductive material, said leg wires being free from insulation in at least a portion of their length through said core of resilient material of high conductivity.

3. The electric blasting initiator of claim 2 wherein the resilient material of low conductivity is natural rubber.

4. The electric blasting initiator of claim 2 wherein the resilient material of low conductivity is synthetic rubber.

5. The electric blasting initiator of claim 2

wherein the resilient material of low conductivity is a polymerized chloroprene composition.

6. The electric blasting initiator of claim 2 wherein the cylindrical core of material of high conductivity is a composition of resilient material having a content of at least 30 parts of carbon black per 100 parts of said material and an electric resistivity not greater than 3×10^4 ohms per cubic centimeter.

7. The electric blasting initiator of claim 2 wherein the top covering of insulating material is a coating of shellac.

8. The electric blasting initiator of claim 2 wherein the top covering of insulating material is a glyptal resin.

9. An electric blasting initiator comprising a loaded metal shell and a resilient plug closing the mouth of said shell and holding the leg wires at a spaced distance apart, said resilient plug comprising an essentially cylindrical core of a resilient material of high conductivity, said core being provided with a covering of resilient material of low conductivity over the base and the cylindrical surface thereof with the exception of at least two essentially diametrically opposed slits in said covering over said cylindrical surface, said leg wires being free from insulation in at least a portion of their length through said core of resilient material of high conductivity.

10. The electric blasting initiator of claim 9 wherein the resilient material of low conductivity is natural rubber.

11. The electric blasting initiator of claim 9 wherein the resilient material of low conductivity is synthetic rubber.

12. The electric blasting initiator of claim 9 wherein the resilient material of low conductivity is a polymerized chloroprene composition.

13. The electric blasting initiator of claim 9 wherein the cylindrical core of material of high conductivity is a composition of a resilient material having a content of at least 30 parts of carbon black per 100 parts of said material and an electrical resistivity not greater than 3×10^4 ohms per cubic centimeter.

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