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COMPRESSED METAL CONTAINING TERNARY EXPLOSIVE COMPOSITION

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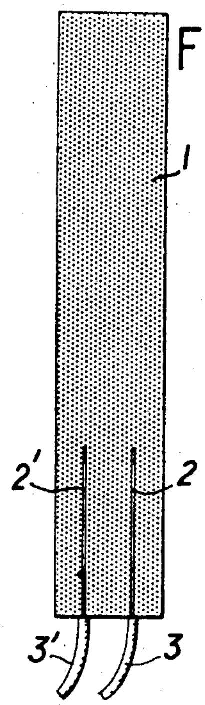
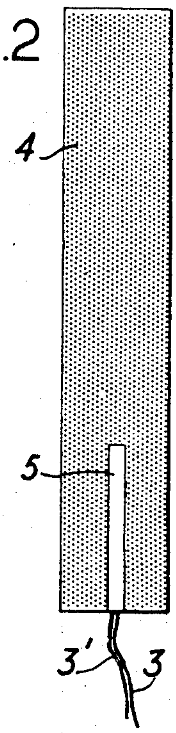


FIG.1

FIG.2



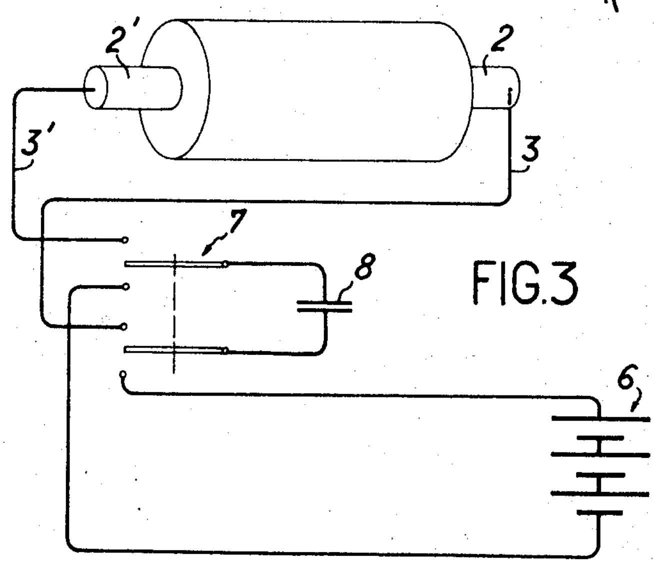


FIG.3

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COMPRESSED METAL CONTAINING TERNARY EXPLOSIVE COMPOSITION

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1 Claim. (Cl. 149—39)

ABSTRACT OF THE DISCLOSURE

This invention consists of an explosive composition consisting of a secondary explosive material, of a substance for lowering the electrical resistivity of the charge, and of an oxidizable material having intense heat release during combustion.

The detonation of an explosive charge is generally brought about by a primer or detonator, which in most cases consists of a small quantity of a very sensitive primary explosive, such as mercury fulminate, lead nitride or the like. The primer is necessarily sensitive to shocks, heat, or weak electric currents and always represents a critical feature of an explosive assembly. For this reason, the statutes in numerous countries (for instance, in France) prohibit the storage of detonators close to explosive charges and vigorously forbid the storage of primed charges. These safety measures constitute a drawback with regard to the automation of the use of explosive cartridges where such would appear to be desirable, notably in seismic prospecting on land or sea. Thus, the problem has arisen in these applications of explosives of finding a way to obtain an integral explosive system, suitable for direct use without requiring the addition thereto of a primer or detonator at the time of use. A corollary to this problem has been the development of an explosive composition which could be easily fired but only by the exertion of sufficiently strong effects, to prevent the occurrence of an accidental explosion in the absence of such effects. These and other problems presented by the prior art compositions have been obviated in a novel manner by the present invention.

It is therefore an outstanding object of the present invention to provide an explosive composition for use in an integral explosive system, making it possible to simplify the structure of explosive charges while increasing their safety.

Another object of the invention is the provision of an explosive composition permitting the construction of a single cartridge, instead of a cartridge and a primer.

A further object of the present invention is the provision of an explosive composition to use in the production of a cartridge which is not sensitive to shocks.

It is another object of the instant invention to provide an explosive composition for use in the production of a cartridge which, instead of detonating under the effects of a weak electrical current of 500 to 2000 volts as is the case with the known electrical detonators, detonates only by use of high voltages, i.e., greater than 2000 volts and frequently exceeding 10,000 volts.

It is a further object of the invention to provide an explosive composition which detonates when subjected to an electrical discharge, without the use of a detonator.

A still further object of this invention is the provision of a cartridge combining the functions of an explosive material and a primer, which cartridge is simple in construction and safe in operation.

With the foregoing and other objects in view, which will appear as the description proceeds, the invention resides in the combination and arrangement of materials and the details of manufacture hereinafter described and claimed, it being understood that changes in the precise embodiment of the invention herein disclosed may be made within the scope of what is claimed without departing from the spirit of the invention.

The character of the invention may be best understood by reference to certain of its structural forms, as illustrated by the accompanying drawings in which:

FIG. 1 is a sectional view of an explosive cartridge embodying the principles of the present invention.

FIG. 2 is a sectional view of a cartridge constructed in accordance with the teachings of the prior art, and

FIG. 3 is an electrical circuit diagram with a sample of the composition being tested,

In general, the invention consists of an explosive composition made up of a known secondary explosive material mixed with a substance for lowering the electrical resistivity of the mixture and with an oxidizable and electrically conductive material having an intense heat release during combustion for initiating detonation by burning within the charge.

According to the invention, a suitable explosive cartridge would be detonated by an electrical discharge acting upon an explosive composition which in the compact state would have an electric resistivity which, although allowing the passage of an electric current, would be sufficiently high to require the application of a voltage greater than 2000 volts to produce a current density between 0.1 and 1000 amp./cm.^{2}. According to a preferred feature of the invention, the voltage to be applied to cause the explosion of the cartridge would be in the order of 5000 to 50,000 volts and preferably 10,000 to 20,000 volts.

The secondary explosive material used in the cartridge may be nitroglycerine, pentaerythritol tetranitrate, cyclotrimethylene-trinitramine ("Hexogen"), trinitrotoluene ("Tolite" or "TNT"), ammonium nitrate, or nitrocotton.

The substances for lowering the resistivity of the explosive composition in the compact state may be one of various solid substances which are compatible with the secondary explosive material and which have a relatively low electric resistivity. Among these substances are graphite, naphthalene, certain metal sulfides, such as iron disulfide. These substances are used in the form of fine powders.

The oxidizable, electrically conductive and strongly exothermic material is selected from strongly electropositive metals in powder form. In particular, the metals of Groups II to VA of the periodic system, alloys formed of these metals or alloys of these metals with metals of other groups give good results. Especially suitable for the purposes of the invention are: magnesium, aluminum, calcium, strontium, barium, zirconium, beryllium, antimony, silicon, ferrosilicon, and various magnesium alloys. These oxidizable materials are preferably employed in the form of very fine powders, with an average particle size in the range from 0.01 to 1 mm.

The proportion of resistivity-lowering substances and of the oxidizable materials incorporated into the explosive may vary in accordance with the electrical and chemical properties of the secondary explosive concerned. The proportion generally lies in the range between 1 and 20%, calculated on the weight of the mixture. In most cases, the proportion of each of these additives is between 3 and 10% by weight.

The mixture of these materials must be as homogeneous as possible. To produce blasting cartridges, the composition is compressed to obtain a compact mass, with a zone for accommodating the firing electrodes. The compression is generally effected with 10 to 100 kg./cm.^{2} and in most cases with 20 to 60 kg./cm.^{2}.

According to a particular form of execution of the invention, only that portion of the cartridge which is intended to accommodate the electrodes is made up with the secondary explosive mixture containing the resistivity-lowering substance and the oxidizable material, the remainder of the cartridge being made up of secondary explosive alone.

The mechanism of action of the oxidizable metal powder appears to be that of a firing relay: when two grains of this metal are traversed by an electric current, they become poles between which a small electric arc is established. These grains then burn by drawing oxygen from the explosive and thus initiate the detonation.

It is seen that the voltage to be employed for detonating the new compositions can be predetermined by the nature and the quantities employed of the above-mentioned materials, so that the required safety margin can be established. It is possible to prepare charges which will explode only at 5000 v., 10,000 v. or 20,000 v. or at any other predetermined voltage. For this purpose, it suffices to confer to the explosive charge the appropriate electrical resistivity. Thus, for example, pure compacted penthrite has a resistivity of the order of 10^8 ohms/cm., while its resistivity falls to 1–1000 ohms./cm. when mixed with 2% flaky graphite and 5% magnesium powder; this resistivity value can be respectively reduced or increased by increasing or diminishing the graphite content. In general, the compressed compositions according to the invention have resistivities below 10^4 ohms./cm., preferably not exceeding 10^3 ohms./cm.

A cartridge made in accordance with the teachings of the invention contains a charge made up of the explosive composition described above. Two diametrically opposite electrodes are fixed in the charge and the extremities project beyond the charge. These external ends of the electrodes are provided with means for connecting them to conductor wires coming from a source of electrical energy. The distance between the electrodes may vary greatly, but in most cases it is between 10 and 80 mm., more especially 30 mm. A circuit for applying the voltage to the cartridge electrodes may consist of a capacitor in series with the conductors connecting the poles of a voltage source to the cartridge electrodes; the capacitor can be alternately connected with the voltage source and with the electrodes by means of a reversing switch.

Referring to FIG. 1, the cylinder **1** represents a cartridge made up of a compact mass of secondary explosive containing about 10% of a resistivity-lowering substance and an oxidizable material, specifically a metal powder. Electrodes **2** and **2'** are inserted into the explosive charge; the latter are simply uncovered metal wires such as copper. Electric leads **3** and **3'** extend away from the cartridge and the electrodes.

In FIG. 2 is shown a cartridge **4** of the old type, containing a secondary explosive. A conventional electrical detonator **5** contains a primer, i.e., a primary explosive, which is not present in the arrangement of FIG. 1, according to the invention. Because of the previously-described danger and by virtue of the existing regulations, when the cartridge **4** is intended for use in high-capacity blasting, as in mines or quarries, the detonator **5** is stored separately from the cartridge **4** and is placed within the latter only at the moment of use.

In FIG. 3, a D.C. voltage source **6** is connected to a switch **7**, whose movable arms are connected to a capacitor **8**. At the same time, the leads **3** and **3'** coming from the electrodes **2** and **2'** are connected to the corresponding terminals of the switch **7**. In this manner, a strong electrical discharge, which is far more powerful than those

hitherto employed, is applied to the electrodes through the capacitor **8**. For example, a D.C. voltage source **6** of 10,000 volts and a capacitor **8** of 2 microfarad may be employed. Electrical energy of the order of 100 joules can be delivered in this manner, at a high voltage, whereas the blasting boxes with magneto and capacitor discharge, used for firing by conventional electrical detonators, can deliver only 1 to 10 joules, at a voltage of the order of 500 volts in general, and a maximum voltage of 2000 volts.

Thus, the device made in accordance with the invention provides a very substantial safety factor, since this new explosive composition cannot explode either under the effects of an industrial A.C. voltage of 220 or 380 volts, nor under the effects of a voltage coming from a battery or a bank of accumulators. The new composition is equally insensitive to induction effects due to a radio transmitter, even if the latter is powerful and located close to the explosive. It is insensitive to natural electrostatic discharges and in some cases also to violent mechanical shocks. In contrast, the electrical detonators or primers now in general use are very sensitive to all these effects.

The invention is illustrated by the following non-limiting examples:

Example 1

72 parts by weight of PETN powder (pentaerythritol tetranitrate) were coated with 20 parts by weight of molten TNT (trinitrotoluene). To this, 3 parts of graphite flakes and 5 parts magnesium powder were added, the mean particle size of the magnesium powder being 0.074 mm. The mixture was well homogenized, after which solid cylindrical cartridges (each weighing about 50 g.) were produced by pressing at 20 kg./cm.^{2}. The cartridges were about 4 cm. high and had a diameter of about 3 cm.

Provided with two copper electrodes, these cartridges exploded under the effects of the discharge of a 2-microfarad capacitor charged to 10,000 volts.

Example 2

A cartridge similar to that of Example 1 was prepared with 82 parts by weight of PETN and 10 parts TNT, the proportions of the additives being the same as in the previous example. The cartridges thus obtained exploded in the same conditions as those in Example 1.

Examples 3–13

Cartridges similar to those in Example 1 were prepared by mixing various secondary explosives with 7% aluminum or magnesium powder, the particle dimensions of which did not exceed 0.074 mm., and with 3% carbon powder. These mixtures were compressed at 50 kg./cm.^{2}. The cartridges were then tested for detonation with the arrangement of FIG. 3, using cylindrical electrodes of 30 mm. diameter, the bases of which were pressed against the base surfaces of the cartridge.

The following table indicates the voltages at which detonation occurred and the capacitances of the capacitor **8** for each of the explosive compositions tested.

Ex. No.	Compositions	Metal Powder	Tension, kv.	Capacitance, mf.
3	Pentrite alone	Al	5.5	5
4	75% Pentrite+25% hexogen.	Al	6	5
5	80% Pentrite+20% nitroglyc.	Al	6	5
6	22% Pentrite+78% hexogen.	Mg	8	5
7	25% Pentrite+75% TNT	Mg	8	5
8	Hexogen alone	Mg	8	5
9	80% Hexogen+20% TNT	Al	8	5
10	Nitroglycerine alone	Al	10	10
11	80% Nitroglycerine+20% nitrocotton.	Al	10	10
12	TNT alone	Al	25	10
13	75% TNT+25% hexogen	Mg	25	10

Examples 14–20

The same method as in Examples 3–13 was employed, but with different proportions of metal powder and carbon-containing materials.

Ex. No.	Composition of Example No.	Powders, Percent Metal	Carbon	Kv.	Mf.
14	3	Al, 2	C, 6	8	10
15	3	FeSi, 5	Naphthalene, 5	7	8
16	3	Mg, 15	Naphthalene, 1	4	5
17	4	Si, 10	Naphthalene, 2	5.5	6
18	4	Sb, 3	C, 1	16	12
19	5	Zn, 4	FeS_2, 10	6	5
20	5	Mg, 2	C, 12	6	6

While it will be apparent that the illustrated embodiments of the invention herein disclosed are well calculated adequately to fulfill the objects and advantages primarily stated, it is to be understood that the invention is susceptible to variation, modification, and change within the spirit and scope of the subjoined claim.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. An explosive composition consisting essentially of a compressed mixture of from 1 to 20% of a substance for lowering the electrical resistivity of the mixture, from 1 to 20% an oxidizable substance, and the rest a secondary explosive material, said secondary explosive material being selected from the group consisting of pentaerythritoltetranitrate, cyclotrimethylene-trinitramine, trinitrotoluene, ammonium nitrate, and nitrocotton, said substance for lowering the electric resistivity being selected from the group consisting of graphite, naphthalene and metal sulphides, and said oxidizable substance being selected from the class consisting of finely powdered magnesium, aluminum, calcium, strontium, barium, zirconium, beryllium, antimony, silicon, and ferrosilicon.

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