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[54] **EXPLOSIVE BOOSTER FOR RELATIVELY
 INSENSITIVE EXPLOSIVES**
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ABSTRACT: An explosive booster for detonating relatively insensitive blasting charges, such as oiled ammonium nitrate and aluminized ammonium nitrate, the booster including a core of detonating cord-sensitive material, such as detonating cord, pentolite and pentaerythritol tetranitrate (PETN), and a sheath of less sensitive explosive material. The sheath contains on a weight basis:

- (a) 45% to 75% RDX;
- (b) 0.6% to 3.1% Wax;
- (c) 8.6% to 70% TNT; and
- (d) 0.9% to 10% Aluminum.

EXPLOSIVE BOOSTER FOR RELATIVELY INSENSITIVE EXPLOSIVES

This invention generally relates to explosives and more particularly to booster cartridges for detonating relatively insensitive blasting charges.

In recent years, relatively insensitive explosives, e.g., those containing a high percentage of ammonium nitrate, especially ammonium nitrate-fuel mixtures such as nitrocarbonitrates (oiled ammonium nitrate, ammonium nitrate-coal, etc.) and ammonium nitrate-aluminum have found widespread application by military and commercial consumers as blasting explosives. Such insensitive explosive compositions generally are characterized by their inability to be detonated by commercially used blasting caps, such as the widely used No. 8 blasting caps, so as to require a booster to initiate detonation. Boosters, sometimes called primers, are explosive compositions of greater sensitivity, as compared to the ammonium nitrate-fuel mixtures, which can be detonated with a fuse, detonating cord, or blasting cap, and which will produce a sufficient shock wave to detonate the main body of relatively insensitive explosive.

Explosive charges which are useful as boosters are well known in the art, and include, for example, pentolite, Composition B, and RDX (cyclonite). Dynamite and fine grained TNT have also been used as booster charges.

Boosters, their compositions, designs and uses are well known and are described in M. A. Cook et al. U.S. Pat. Nos. 3,037,452 and 3,037,453 issued June 5, 1962; M. A. Cook et al. U.S. Pat. No. 3,185,017 issued May 25, 1965; J. J. Minnick et al. U.S. Pat. No. 3,359,902 issued Dec. 26, 1967; and M. A. Cook et al. U.S. Pat. No. 3,371,606 issued Mar. 5, 1968.

Boosters normally are packaged in metal, plastic or cardboard containers, as are most explosives. Also, boosters generally include a core of detonating cord-sensitive explosive material and a sheath of less sensitive explosive material. In most boosters the cores is imbedded in a sheath of explosive material and the sheath substantially or completely surrounds the core. The present invention is specifically directed to the composition of the explosive explosive sheath.

It is an object of the present invention to provide a booster for detonating relatively insensitive blasting charges.

It is a further object of the present invention to provide an improved booster for detonating insensitive blasting charges including a core of detonating cord-sensitive explosive material and a sheath of less sensitive explosive material.

It is another object of the present invention to provide a novel explosive material useful as a sheath explosive in boosters and possessing high brisance properties.

It is an additional object of the present invention to provide a booster which is reliably detonated by a commercially used blasting cap or commercially used detonating cord and which booster will in turn reliably detonate commercially used ammonium nitrate explosives.

These and other objects and advantages of the invention will be understood from the description of the invention.

The present invention is an improvement in explosive sheath material in a booster for detonating insensitive blasting charges, which booster includes a core of detonating cord-sensitive explosive material and a sheath of less sensitive material. The improved explosive sheath material contains, on a weight basis:

- a. from about 45 percent to about 75 percent RDX;
- b. from about 0.6 percent to about 3.1 percent Wax;
- c. from about 8.6 percent to about 70 percent TNT; and
- d. from about 0.9 percent to about 10 percent Aluminum.

In a preferred embodiment the improved explosive sheath material contains, on a weight basis:

- a. from about 45 percent to about 55 percent RDX;
- b. from about 1.6 percent to about 2.2 percent Wax;
- c. from about 35 percent to about 45 percent TNT; and
- d. from about 7.2 percent to about 9.5 percent Aluminum.

In a specific embodiment the improved explosive sheath material contains, on a weight basis:

- a. about 50 percent RDX;
- b. about 2 percent Wax;
- c. about 39 percent TNT; and
- d. about 9 percent Aluminum.

In accordance with the present invention, a booster is provided for detonating highly insensitive blasting charges, which booster comprises a compacted and relatively small core of cap-sensitive or detonating cord (e.g. Primacord, E-cord) sensitive explosive material substantially or completely surrounded by a compacted sheath, usually of a somewhat larger mass of less sensitive (as compared to the core) explosive material, the latter having high detonation pressure characteristics. The sheath material is less sensitive to detonation than the core and, in general, the sheath explosive is not reliably detonated by a No. 8 blasting cap. The present invention is specifically directed to providing a novel sheath explosive composition. The core of detonating-cord (e.g. Primacord, E-cord, etc.) sensitive material may be cast or pressed explosive material or may be detonating cord itself, wound in a suitable configuration such as represented in the Cook et al. U.S. Pat. Nos. 3,037,453 and 3,185,018 and preferably as represented in the Minnick et al. U.S. Pat. No. 3,359,902. The core may, of course, also be of a shape that is readily moldable, or castable, and easily removed from the mold. Cast or pressed cores of PETN (pentaerythritol tetranitrate), pentolite (50/50, 60/40, or higher ratios), tetryl and other cap-sensitive material may be used. As used herein, the term cap-sensitive is equivalent to detonating cord sensitive.

Any suitable physical configuration of the booster including the core and sheath may be used. A preferred and very reliable booster is described in the J. J. Minnick et al. U.S. Pat. No. 3,359,902. Other boosters are described in the heretofore mentioned U.S. patents. It will be noted that the boosters generally include a blasting cap well extending into the core and one or two perforations extending through the compacted sheath and into, adjacent, or otherwise in direct contact with the core. The core is thus adapted to receive a detonating fuse. It is often desirable to have two perforations, at least one of them extending entirely through the booster.

The core is generally small in mass compared to the mass of the much larger outer sheath. In general, the inner core may be from 5 to 30 percent of the mass of the entire booster, however it may be smaller or larger if desired for some purposes and, of course, depending upon the specific explosive material used for the core. The core, however, must be of sufficient mass so that when the core is detonated it will reliably detonate the sheath explosive material.

The sheath material may be cast or pressed about the core and in accordance with the present invention, the sheath material contains four ingredients in certain specific amounts so as to provide the necessary reliability of detonation while still not being overly sensitive. The four necessary ingredients for the sheath and their amounts are as follows:

- a. about 45 percent to about 75 percent RDX (cyclonite);
- b. about 0.6 percent to about 3.1 percent Wax;
- c. about 8.6 percent to about 70 percent TNT (trinitrotoluene); and
- d. about 0.9 percent to about 10 percent Aluminum.

The weight percentages are based on the total weight of the sheath material.

With sheath material containing these four (*a*, *b*, *c* and *d*) ingredients in the percentages set forth, safe, reliable, economical and effective boosters are provided. Reliability means that the booster must be reliably detonated by detonating cord (50 grain Primacord) or a No. 8 electric blasting cap. The quality of not being overly sensitive means that the booster must not be detonatable by shocks or heat which would be encountered in ordinary handling and shipping.

The boosters may be made by any suitable method, such as the methods described in the aforementioned Cook et al. and preferably as described in the Minnick et al. U.S. patents. The method of manufacture generally includes supporting a core of detonating cord-sensitive explosive material in a suitable container and pouring molten explosive material into the con-

tainer so as to substantially or completely surround the core. Upon cooling the molten material solidifies and forms the sheath of explosive material to which the present invention is specifically directed.

The booster may be manufactured by first making the core by casting or pressing in a suitable mold or forming a suitable wrap of detonating cord, positioning the core in a mold and then casting or pressing the sheath explosive material of this invention around the core.

The booster is of any suitable size and shape but preferably is of cylindrical size and shape as illustrated and described in the Minnick et al. U.S. Pat. No. 3,359,902. In general, the total mass of the booster is from about one-half pound to about 5 pounds. Boosters of about 1-pound mass are widely used to detonate nitrocarbonitrate explosives. Such boosters are generally provided in cylindrical shape of about 3 inches diameter and about 2 inches high.

The sheath material is preferably homogeneous and may be provided by mixing the four ingredients in a molten state (the aluminum is not molten but is maintained in suspension) and then directly pouring the molten mass containing the aluminum in suspension into the booster mold in which the core is already positioned. The four ingredients may be mixed in any desired order. Although each of the four ingredients may be provided as substantially the ingredient itself, the ingredients are also readily available as mixtures. For example, the well-known Composition A-3, usually called Comp. A-3, contains about 91 percent RDX (cyclonite) and 9 percent Wax. Readily available Comp. B contains 60 percent RDX, 40 percent TNT (trinitrotoluene) with 1 percent added wax. Readily available Torpex contains 42 percent RDX, 40 percent TNT and 18 percent Aluminum. Therefore, by proper selection and mixing of Comp. A-3, Comp. B and Torpex, a sheath material in accordance with this invention may be obtained.

The wax may be synthetic or natural wax. The aluminum is preferably in finely divided or explosive grade, more preferably substantially all of smaller than 100-mesh particle size as is generally used in the explosives industry. The aluminum provides added energy to the performance of the boosters.

The following examples further illustrate this invention.

EXAMPLE 1

Six inches of 50 grain reinforced Primacord are wound into three figure eight loops and is snugly positioned between up-standing rods in a cylindrical cardboard mold as illustrated and described in detail in the Minnick et al. U.S. Pat. No. 3,359,902.

A molten mass is provided by mixing 21 percent Comp. A-3, 13 percent TNT, 16 percent Comp. B and 50 percent Torpex. All percentages are on a weight basis. The resultant molten mass contains 50 percent RDX, 39 percent TNT, 9 percent Aluminum and 2 percent Wax. The molten mass is mixed to provide a substantially homogeneous mass and is then poured into the cylindrical cardboard mold containing the Primacord core. The mass is then permitted to cool to solidify the sheath material. The rods are then withdrawn from the booster thus providing a booster with a Primacord sensitive core surrounded by sheath material having a composition in accordance with this invention.

Sixty of these boosters were tested with 25 grain E-cord used to detonate them. All were detonated successfully. These boosters were used to detonate a 94 percent ammonium nitrate-6 percent oil nitrocarbonitrate. This was reliably detonated.

EXAMPLE 2

A quantity of boosters was made in accordance with the procedure set forth in Example 1. The sheath material was

made from a molten mass containing 23 percent Comp. A-3, 14 percent TNT, 9 percent Comp. B, and 54 percent Torpex. This molten mass contains 49 percent RDX, 39.2 percent TNT, 9.7 percent Aluminum and 2.1 percent Wax.

Forty of these boosters were tested with 25 grain E-cord used to detonate them. All fired successfully.

EXAMPLES 3-9

Various other sheathing compositions, as set forth in the following table, are tested and it is concluded that compositions within the broad ranges described in this specification are reliable but not overly sensitive. The sheathing explosive material produces reliable boosters of high brisance.

TABLE

Booster Sheath Compositions

Example	(a) Wt.%, RDX	(b) Wt.%, Wax	(c) Wt.%, TNT	(d) Wt.%, Aluminum
3	45	0.6	53.4	1.0
4	50	1.0	39.0	10.0
5	55	1.5	38.5	5.0
6	60	2.5	30.0	7.5
7	65	2.0	24.0	9.0
8	70	2.5	22.5	5.0
9	75	3.0	19.0	3.0

All of the boosters having sheaths of compositions as set forth above exhibit reliable detonations with standard 50 grain Primacord and No. 8 electric blasting caps.

It is claimed:

1. In a booster for detonating insensitive blasting charges including a core of detonating cord-sensitive explosive material and a sheath of explosive material, the improvement comprising said sheath containing, on a weight basis:

- from about 45 percent to about 75 percent RDX;
- from about 0.6 percent to about 3.1 percent Wax;
- from about 8.6 percent to about 70 percent TNT; and
- from about 0.9 percent to about 10 percent Aluminum.

2. In a booster for detonating insensitive blasting charges including a core of detonating cord-sensitive explosive material and a sheath of explosive material, the improvement comprising said sheath containing, on a weight basis:

- from about 45 percent to about 55 percent RDX;
- from about 1.6 percent to about 2.2 percent Wax;
- from about 35 percent to about 45 percent TNT; and
- from about 7.2 percent to about 9.5 percent Aluminum.

3. In a booster for detonating insensitive blasting charges including a core of detonating cord-sensitive explosive material and a sheath of explosive material, the improvement comprising said sheath containing, on a weight basis:

- about 50 percent RDX;
- about 2 percent Wax;
- about 39 percent TNT; and
- about 9 percent Aluminum.

4. In a booster for detonating insensitive blasting charges having a core of detonating cord-sensitive explosive material encased with a sheath of relatively insensitive explosive material of high brisance, said booster having at least one perforation adapted to receive a detonating fuse and extending through said sheath, the improvement comprising said sheath containing, on a weight basis:

- from about 45 percent to about 75 percent RDX;
- from about 0.6 percent to about 3.1 percent Wax;
- from about 8.6 percent to about 70 percent TNT; and
- from about 0.9 percent to about 10 percent Aluminum.