Nov. 29, 1966 G. H. TOUSLEY, JR 3,288,065

BOOSTER AND METHOD OF DETONATING EXPLOSIVE

Filed Nov. 10, 1964

FIG. 1

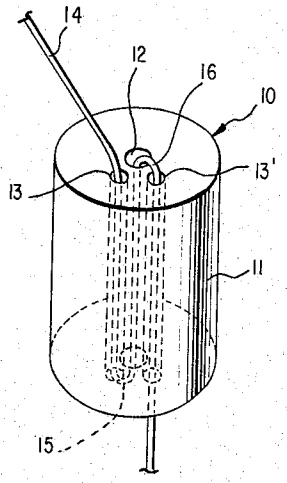


FIG. 2

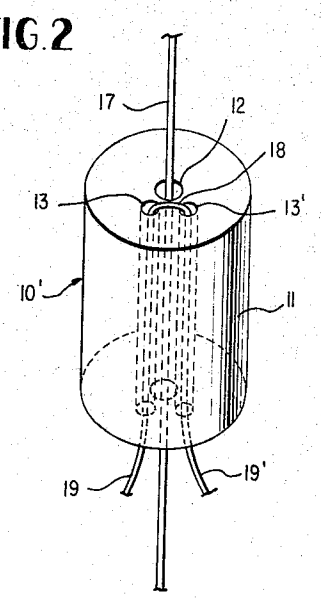
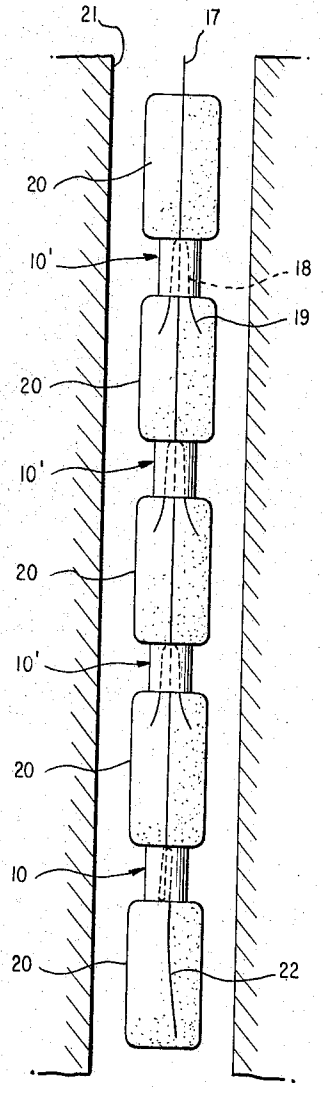


FIG. 3



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BOOSTER AND METHOD OF DETONATING EXPLOSIVE

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This invention relates to detonating means for explosives and more particularly to boosters for relatively insensitive explosive compositions.

Insensitive explosives, containing a high percentage of ammonium nitrate and containing nonexplosive sensitizers, have found wide application as blasting explosives. Prilled ammonium nitrate containing 94% ammonium nitrate (AN) and 6% fuel oil and aqueous slurries of coarse TNT-AN are examples of such insensitive explosives. Such compositions are not reliably detonatable by blasting caps or detonating fuse and prior art methods for detonating them include the use of dynamite or relatively large quantities of fine-grained TNT primers, for example, which are themselves detonated by blasting caps or detonating fuse. These methods suffer, however, from the disadvantage of being expensive. Furthermore, dynamites and fine TNT are very sensitive to heat and shock.

In modern large diameter borehole blasting operations using ammonium nitrate explosives, detonating fuse is the most commonly used detonating method. The ammonium nitrate explosives are not dependably detonatable by detonating fuse, however, and require a booster, as is known in the prior art. Unfortunately, these known boosters have serious drawbacks since they either require relatively large quantities of expensive boostering compositions or require the use of a specially cast or pressed arrangement wherein the booster has within its body a sensitizing element which consists of a material reliably sensitive to detonating fuse or a coil of detonating fute held in place as the cast material is solidified. The job of making, placing, twisting, coiling and holding in place such sensitizing elements adds appreciably to the cost of the boosters. Accordingly, the known booster units do not provide a simple and inexpensive booster as is desired in the explosives industry.

It is an object of the preesnt invention to provide a booster for insensitive explosives which is consistently detonatable by detonating fuse as well as blasting caps. It is another object of the invention to provide such a booster which consistently detonates high percentage ammonium nitrate explosives in either the wet or dry state. A further object of the invention is to provide such a booster which is inexpensive and utilizes a minimum of expensive sensitizing materials. Among the other objects of the invention, one is to provide a booster in which detonating fuse is readily and simply threaded to provide the sole initiator for the booster.

In accordance with the invention, it has been found that a booster of reliable firing characteristics for detonating insensitive blasting charges may be formed without the sensitizing elements required for previous boosters.

In general, the boosters of the invention comprise a compacted core of an explosive material, i.e. a material normally insensitive to detonating fuse, e.g. Primacord, such as composition B (approximately 60% RDX, 40% TNT, 1% wax) for instance, having at least two bores which are adapted to receive detonating fuse extending through the core and arranged close together. In use, a detonating fuse is laced through these bores and when ignited, propagates sympathetically to detonate the core material. Other generally Primacord insensitive explosives which may be used to form the booster of the preesnt invention include pentolite (PETN-TNT), cyclotol (RDX-TNT), tetrytol (tetryl-TNT), torpex (RDX-TNT-aluminum), TNT, ednatol (EDNA-TNT), HBX (RDX-TNT-aluminum-wax), etc.

While the core for the booster of the instant invention may assume substantially any desired shape, it is preferred to use a cylindrical shape for economy of material and ease of manufacture. The core may be either cast or pressed. The bores extending through the core may be drilled through a preformed core or formed, for example, by utilizing pins corresponding to the bores to position the core in a mold during formation thereof, and then removing the pins to form the bores. A preferred embodiment is one where the core is a cylindrical shape about 2½ inches high and about 3 inches in diameter with a center bore of about 5/16 inch in diameter and two additional bores about ¼ inch in diameter. A detonating fuse down line may be strung through the center hole and another length of detonating fuse laced through the two other holes or the detonating fuse may be laced through all three holes, as desired, to detonate the core material.

The spacing and arrangement of the bores in the core is critical for proper and reliable firing of the booster. There must be several, at least two, bores placed in close proximity so that the strands of detonating fuse laced through the bores propagate sympathetically when detonated. If the web thickness between the bores, i.e. that portion of the core which separates the bores, is greater than about 3/16 inch, the booster unit will not fire reliably. Furthermore, if the web thicknes is less than about 1/16 inch, the molten materials will not flow readily into the spacing between the bores to form a continuous homogeneous web. Failure to obtain such a web also contributes to a lack of firing reliability. The web thickness is preferably about 3/32 inch with a tolerance of about ±1/64 inch.

The diameter of the bores is not critical as is the web thickness, but is preferably between about ¼ and about 5/16 of an inch. This diameter is chosen so that the bores easily receive a detonating fuse, e.g. Primacord, or alternately, a blasting cap which normally has an outside diameter of more than ¼ inch but less than 5/16 inch. The number of bores in the core may vary considerably; however, it has been found that at least two bores for lacing the detonating fuse are required for reliable firing. The bores are preferably arranged parallel to the axis of the core since it is the simplest manufacturing method and best fits the pattern of normal usage. Bores that are located diagonally or radially will, however, initiate the booster effectively provided the bore diameters and web thickness between bores are maintained within the limits discussed above.

The overall dimensions of the booster of the instant invention may vary considerably; however, for advantageous overall strength, the diameter of the core should not be less than about 1 inch and the length or height of the core should not be less than about 1½ inches. Generally,

the length, or height, of the core and the diameter are each from about 2 to 4 inches. Other dimensions may, however, be used as desired. Units made to these bore and core dimensions fire with a greater reliability than earlier designs of booster units containing a sensitizing element inside the primer itself. In addition, the production cost of the new booster unit is appreciably lower than the production cost of the earlier designs.

In use, a detonating fuse, such as 50 grain PETN/ft., is threaded through two bores, or more if desired, in the booster core and knotted to prevent the removal of the booster from the fuse. The booster may then be inserted in a priming cartridge of ammonium nitrate explosive, or preferably lowered by itself into a bore hole in the ground by suspending it at the appropriate position in the hole on a detonating fuse down-line passed through a third bore in the core, for example. The main charge is then introduced into the bore hole by simply pouring loose or slurry explosive into the bore hole or by adding packaged explosive. The detonating fuse may be initiated by a blasting cap (electric or fuse) or by a trunkline of detonating fuse as is well known in the art.

There are in general two major classes of insensitive explosives which may be reliably detonated by the booster of the present invention. One such class of explosives comprise those blasting agents generally designated as nitro-carbo-nitrates. This class includes all of the various fuel and oxidizing mixtures such as AN-coal dust, AN-fuel oil, AN-sugar, AN-molasses, AN with any fuel source and AN with various metallic mixtures including aluminum and magnesium, ferrophosphorous and ferrosilicon. It also includes the use of other oxidizing materials such as potassium chlorate and potassium perchlorate. All of the above mixtures may contain a portion of sodium nitrate or potassium nitrate. A second class of insensitive explosives which may be reliably detonated by boosters in accordance with the present invention are the slurry blasting agents. Slurry explosives generally contain AN-water and a sensitizer. This sensitizer may be, or could be, TNT, RDX, PETN, tetryl, smokeless powder, composition B, tetrytol, cyclotol, ednatol, pentolite, torpex, HBX, aluminum, magnesium, ferrophosphorous, ferrosilicon, etc., used individually or in combination. In addition, sodium nitrate may be used to replace part of the AN.

The present invention is further described by reference to the accompanying drawing wherein:

FIGURE 1 illustrates a booster made in accordance with the invention having the detonating fuse laced in a preferred arrangement;

FIGURE 2 illustrates booster having a modified lacing of the detonating fuse and a detonating fuse down line passed therethrough; and,

FIGURE 3 illustrates the use of the boosters of FIGURES 1 and 2 in combination with an insensitive explosive.

FIGURE 1 illustrates detonating fuse **14** threaded through center bore **12** and bores **13** and **13'**. As illustrated, detonating fuse **14** is inserted into bore **13** and bent at **15** through centerb ore **12** and at **16** back through bore **13'**. The arrangement of FIGURE 1 is especially desirable when a single booster **10** is to be used or for use as the end booster when a series of boosters **10** are to be used.

FIGURE 2 illustrates the preferred arrangement of detonating fuse in the booster when there are a series of boosters strung along a down line. In this arrangement a down line **17** is passed through the center bore **12** and an additional length of detonating fuse **18** is threaded through bores **13** and **13'** so as to leave two pigtails **19** and **19'** at the bottom. These pigtails should advantageously be about six inches long to minimize effects of water penetration which tend to desensitize detonating fuse.

FIGURE 3 illustrates an arrangement of boosters and explosive for use in a borehole **21**. As illustrated, a booster **10**, such as illustrated in FIGURE 1, is arranged at the bottom of borehole **21** with detonating fuse laced through the bores thereof. A pigtail **22** which is about six inches long is knotted to keep the booster **10** in place. As loading progresses, boosters **10'**, such as illustrated in FIGURE 2, for example, are alternately arranged with burlap sacks **20** containing an ammonium nitrate-fuel oil explosive, for example. A down line **17** is passed beside the sacks **20** and through the boosters **10'** which have detonating fuse pieces **18** arranged therein with pigtails **19** and **19'**.

The following examples serve to further illustrate the invention.

Example I

As an example of the superior initiating action of the booster of the invention, boosters as illustrated in FIGURES 1 and 2 were prepared utilizing a core cast of composition B. The center hole in the core was $\frac{5}{16}$ inch in diameter for receiving either blasting cap or a detonating fuse and the two additional bores for receiving detonating fuse were ¼ inch in diameter. The overall diameter of the core was 3⅜ inches and the length was about 2⅛ inches. Such boosters have been found consistently to detonate ammonium nitrate-fuel oil, i.e. 94/6 ammonium nitrate-fuel oil, and ammonium nitrate-coarse TNT-water mixtures when initiated by 50 grain detonating fuse threaded through at least two bores. 25 grain detonating fuse has also proved successful.

Such boosters can also be used to reliably detonate blasting agents (nitro-carbo-nitrates) including AN-coal dust, AN-sugar, AN-molasses, and AN with aluminum and magnesium, and the like. Such boosters can also be used to reliably detonate AN-water mixtures which utilize as the sensitizer, in place of the coarse TNT above, RDX, tetryl, PETN, smokeless powder, tetrytol, cyclotol, ednatol, pentolite, torpex, aluminum and magnesium.

Examples II to VIII

Boosters as described in Example 1 are prepared using cores of, respectively, pentolite, cyclotol, tetrytol, torpex, TNT, ednatol, and HBX instead of composition B. Such boosters can be used to reliably detonate ammonium nitrate-fuel oil and ammonium nitrate-coarse TNT-water mixtures when initiated, for instance, by 25 and 50 grain detonating fuses.

I have thus described novel boosters which are consistently operative for priming insensitive explosives, which employ a minimum of expensive materials and which are consistently detonatable, for instance, by 25 grain or 50 grain per foot detonating fuse. While the invention has been described in terms of certain embodiments, these are to be considered illustrative rather than limiting and it is intended to cover all further embodiments that fall within the spirit and scope of the appended claims.

It is claimed:

1. In an explosive arrangement for a large diameter borehole blasting operation comprising a blasting explosive unreliably sensitive to blasting caps and detonating fuse and selected from the group consisting of nitro-carbo-nitrate blasting agents and slurry blasting agents containing ammonium nitrate, water and a sensitizer, the improvement of a booster for reliably detonating said blasting explosive consisting of a compacted core of explosive material generally insensitive to detonating fuse, said core having three bores extending therethrough, each two of said bores being spaced by a web having a thickness of about $\frac{1}{16}$ to $\frac{3}{16}$ inch, a detonating fuse threaded through two of said bores and an initiator for said detonating fuse in the third of said bores.

2. The arrangement of claim **1** wherein said core consists essentially of an explosive material selected from

the group consisting of composition B, pentolite, cyclotol, tetrytol, torpex, ednatol, HBX and TNT.

3. The arrangement of claim 2 wherein said initiator is detonating fuse.

4. The arrangement of claim 2 wherein said initiator is a blasting cap.

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