

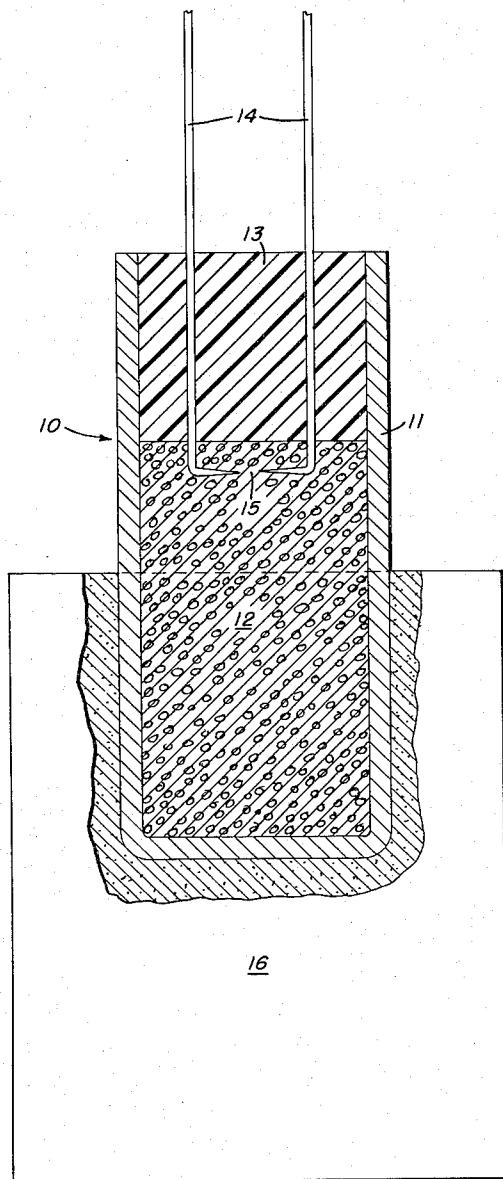
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EXPLOSIVE TRAIN

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EXPLOSIVE TRAIN

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1 Claim. (Cl. 102-22)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

Explosive trains used in ordnance missiles or projectiles ordinarily consist of some type of initiating means, a booster-type explosive adapted to be detonated by the initiating means, and a main explosive which is detonated by the booster-type explosive. The main disadvantage of this type of explosive train is that the initiating means is very sensitive to conditions of heat, shock or friction. Accordingly, in fuze applications, the initiating means is usually retained in an out-of-line position with respect to the booster and main explosive in order to prevent premature explosion of the booster and the main explosive by accidental initiation of the initiating means. Some type of arming system therefore has to be included in the explosive train in order to move the initiating means from an initial out-of-line position to an in-line position relative to the booster explosive prior to initiation of detonation of the initiating means.

If the booster could be detonated directly without the use of the highly sensitive initiating means, the overall sensitivity of the explosive train with respect to heat, shock or friction would then be that of the low sensitive booster explosive. For fuze applications, the sensitivity of the ordinary booster-type explosive is low enough to safely permit the booster to remain in-line with the main explosive. The need for out-of-line arming systems could therefore be eliminated.

Attempts have been made to eliminate the initiating means and initiate detonation of the explosive train directly by embedding electrodes in the booster explosive and thereafter applying electrical energy to the electrodes so as to create an electrical spark between the electrodes.

However, it was discovered that low sensitive booster explosives such as PETN (pentaerythrite tetranitrate), cyclonite (cyclotetramethylenetrinitramine) and tetryl (2,4,6-trinitrophenylmethylnitramine) required extremely high electrical spark energies before they would detonate at high order. For example, in one experiment straight PETN, that is, PETN without any other additive, was tightly confined in a thick-walled steel container and compressed with a pressure of 4,000 p.s.i. Steel electrodes were used to form a spark gap. Detonation of the PETN occurred only after nine thousand volts were applied across the spark gap. The energy required to detonate the straight PETN was in excess of five million ergs.

Because of the extremely high electrical spark energy which is required to obtain high order detonation of the straight booster-type explosive, it has been hitherto considered unfeasible by those in the art to directly initiate detonation of the straight booster explosive by electrical spark producing means.

It is an object of this invention to provide an explosive train which eliminates the need for an out-of-line initiating means and which can be detonated at high order by a low energy electrical spark applied to the booster explosive.

According to this invention, a small quantity of powdered zirconium metal is mixed with a common booster-

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type explosive. The resulting mixture is tightly packed within a thick-walled container and when a relatively low energy spark is applied to the packed mixture, high order detonation of the booster occurs. The addition of the powdered metal does not appreciably increase the explosion sensitivity of the booster and the booster can therefore remain inline with the main explosive.

The specific nature of the invention, as well as other objects, uses and advantages thereof, will clearly appear from the following description and from the accompanying drawing, in which:

The drawing shows the novel in-line explosive train. As shown in the drawing, the improved explosive train of this invention comprises only a booster explosive 10 and a main explosive 16. Booster explosive 10 comprises a substantially thick steel container 11 encasing explosive mixture 12. Booster explosive 10 is placed in or near the main explosive 16 so that explosion of booster 10 causes detonation of main explosive 16. Main explosive 16 is composed of any common low-sensitivity high-order explosive such as TNT.

Mixture 12 is preferably composed of straight PETN and from five to ten percent by weight of zirconium metal powder in mixture. Other low-sensitivity straight explosives such as cyclonite and tetryl may also be used in mixture with zirconium. Mixtures of metal powder and straight explosive are known per se in the art, but have hitherto been used as the main explosive in the explosive train. The open end of container 11 is tightly sealed by plug 13, which is composed of sulphur or any suitable synthetic resin. Steel or copper electrodes 14 embedded in plug 13 taper to a sharp point and form an electrical spark gap 15 as shown. Electrical energy supplied by a capacitor or battery source (not shown) produces an electrical spark across gap 15.

Container 11 is provided with thick walls because confinement of the mixture 12 is necessary for obtaining high order detonation of the mixture. As discussed above, attempts to obtain high order detonation of straight PETN as well as straight cyclonite and tetryl, directly by electrical spark discharges of low electrical energy were not successful. However, the combination of a small quantity of evenly distributed powdered zirconium metal and straight PETN, cyclonite or tetryl, and an electrical spark, substantially reduces the electrical energy required for high order detonation of the booster without substantially increasing the sensitivity of the mixture to heat shock, or friction.

As an illustration, a booster explosive composed of .7 g. of PETN zirconium powder mixture containing 10% zirconium, was sealed in a thick-walled steel container after being compressed at 4,000 p.s.i. The electrical energy required to detonate the booster at high order was 800 ergs with 1,000 volts across two sharply pointed steel electrodes. When the booster was composed entirely of straight PETN under the same conditions, the spark energy required to detonate the straight PETN was in excess of 5,000,000 ergs with 9,000 volts across the two embedded steel electrodes. The spark gap length between the two sharply pointed steel electrodes was 0.005 inch.

While zirconium powder has been used most successfully, titanium powder can also be used with straight PETN, cyclonite or tetryl, in mixtures containing from five to ten percent titanium.

Since the sensitivity of the booster explosive mixture does not increase appreciably by the addition of zirconium, the explosive train comprising the booster explosive and the main explosive may be safely kept in an in-line position. This arrangement eliminates the need for out-of-line safety and arming systems.

It will be apparent that the embodiments shown are

only exemplary and that various modifications can be made in construction and arrangement within the scope of the invention as defined in the appended claim.

I claim as my invention:

A complete explosive train consisting solely of two stages, said train comprising: first and second containers, the first container having thick walls and being positioned in the second container, a high-order booster explosive composed of a mixture of powdered pentaerythrite tetra-nitrate and approximately 10% of zirconium metal, said high-order booster explosive being sealed in said first container and constituting the first of said two stages, a pair of electrodes disposed in said first container and extending into said booster, the ends of said electrodes in said booster being spaced apart a distance sufficient to permit discharge of a low energy spark therebetween, a main high-order explosive charge in said second container constituting the second of said two stages, and means connected to said pair of electrodes for discharging a low energy electrical spark into said booster explosive and causing high-order detonation thereof, deto-

nation of said booster explosive causing detonation of said main explosive.

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