United States Patent [19]

Kilmer

[11] **3,893,395**

[45] **July 8, 1975**

[54] **END COUPLER FOR HEAT RESISTANT MILD DETONATING FUSE**

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[22] Filed: **July 26, 1965**

[21] Appl. No.: **475,035**

[52] **U.S. Cl.** ..... **102/27 R**; 102/70 R

[51] **Int. Cl.** **C06c 5/06**

[58] **Field of Search** 102/27, 70

[56] **References Cited**

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Primary Examiner—Verlin R. Pendegrass

EXEMPLARY CLAIM

1. An end coupler for transmitting a detonation from a heat resistant mild detonating fuse to a base charge having a diameter greater than the diameter of the mild detonating fuse comprising,

an elongated housing,

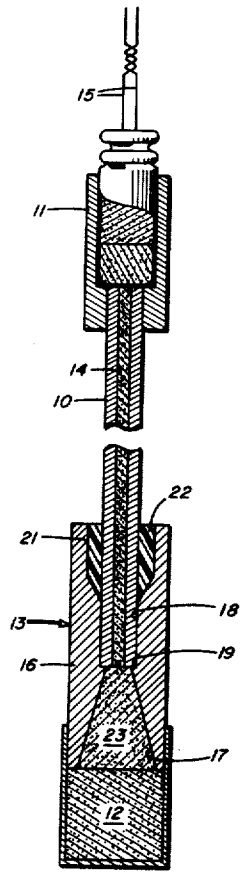
said housing having a tapered recess formed in one end thereof,

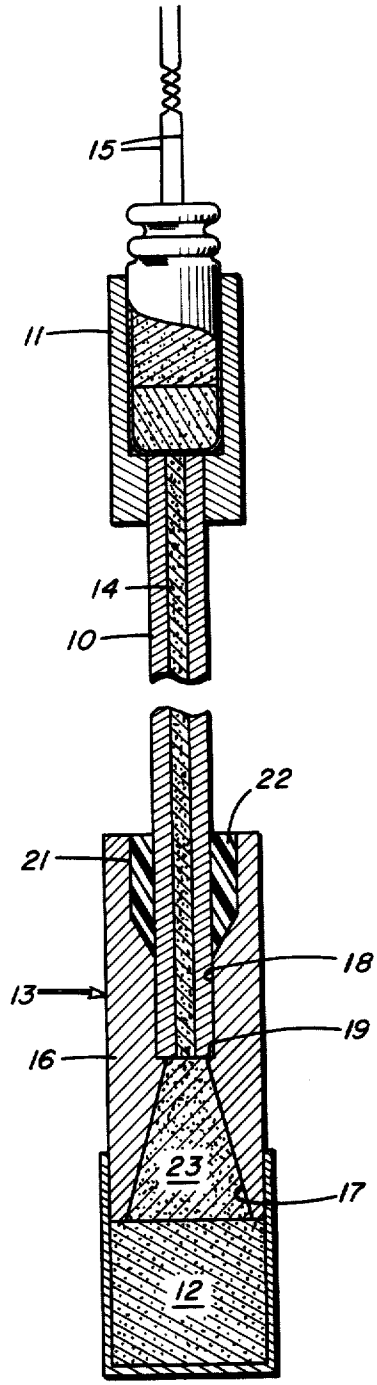
said housing having an axial bore formed in the other end thereof and intersecting said tapered recess,

tapered recess being filled with hexanitrostilbene (Grade 1) explosive,

whereby a heat resistant mild detonating fuse may be inserted into said axial bore and a base charge may be positioned adjacent said one end of said housing so that said end coupler may amplify a shock wave produced by the mild detonating fuse to a magnitude necessary for the detonation of the base charge.

10 Claims, 1 Drawing Figure





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END COUPLER FOR HEAT RESISTANT MILD DETONATING FUSE

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to explosive transmission lines wherein a mild detonating fuse is initiated at one point for transmission of a detonation to a base charge at another point and particularly to a method and apparatus for transmitting a detonation from a mild detonating fuse packed with a heat resistant explosive to a base charge which may be either a conventional explosive or a heat resistant explosive.

A line of mild detonating fuse, hereinafter called MDF, consists essentially of an explosive mixture encased within a metallic sheath which is usually made of lead alloy and may be provided with a fibrous or laminated coating. The core diameter of the explosive mixture is generally about 0.025 inches and the core load of the mixture within the metallic sheath is approximately 1 to 2 grains per foot of length. Initiation of the explosive mixture at one end of the MDF creates a detonation front which travels to the opposite end of the MDF, the explosion being of such a low order of magnitude that the casing of the mild detonating fuse is not ruptured, thus enabling an explosion to be safely conducted along a path adjacent to other explosives or in close proximity to intricate instrumentation. The characteristics of the MDF make it ideally suitable for various applications in missiles, high speed aircraft, space vehicles, and various ordnance items.

In the past, mild detonating fuse has been loaded with PETN explosive or other conventional explosives and has been employed to detonate conventional booster charges but recent advances in technology have created a need for a MDF containing a heat resistant explosive to withstand the thermal conditions encountered by missiles and space vehicles. The term "heat resistant explosives" is used herein to define those explosives which have a melting point above 300°C and have a vacuum thermal stability such that they decompose at a rate less than 2.0 cc/gram/hr at 260°C. A MDF packed with a heat resistant explosive could be used in many applications where a conventional explosive MDF could not be used since the shock intensity of the detonation front developed by the heat resistant explosive is substantially smaller than the shock intensity of the detonation front developed by conventional explosives. The shock intensity developed by a heat resistant MDF is so low that it has heretofore not been possible to detonate base charges of heat resistant explosive. The present invention provides an end coupler device for magnifying and amplifying the shock intensity of the detonation front developed by a heat resistant MDF to enable the heat resistant MDF to initiate a large diameter base charge which may be formed from either a conventional explosive or a heat resistant type explosive.

Accordingly, an object of the present invention is the provision of means for transmitting a detonation from a heat resistant mild detonating fuse to an explosive charge of larger diameter than the mild detonating fuse.

Another object is to provide a means for the transmitting of a detonation from a mild detonating fuse

packed with a heat resistant explosive to heat resistant explosive charge of larger diameter than the mild detonating fuse.

A further object of the invention is the provision of means for amplifying and intensifying a detonation front.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

The FIGURE shows a sectional view of a preferred embodiment of the present invention.

The general arrangement of the present invention may be seen in the drawing wherein the mild detonating fuse **10** is connected at one end to an electroresponsive detonator **11** for initiation thereby and is connected at its other end to a base charge **12** by means of an end coupler **13.** The MDF **10** comprises a cylindrical metallic sheath preferably made of a lead alloy and having an inner diameter of approximately 0.025 inches and is filled with a heat resistant explosive **14.** Heat resistant explosives are those explosives which have: (1) a melting point in excess of 300°C; (2) a vacuum thermal stability such that they decompose at a rate less than 2.0 cc/gm/hr at 260°C; (3) a particle size ranging from 10 to 725 microns; and (4) exhibit substantially no weight loss when subjected to temperatures of 210°C for a period of 48 hours. Examples of heat resistant explosives are DIPAM (dipicramid), HNS (hexanitrostilbene), NONA (nonanitroterphenyl), and the like.

DIPAM may be prepared by means of a synthesis utilizing dipicric acid (3,3'-dihydroxy-2,2',4,4',6,6'-hexanitrobiphenyl) as a starting material, as described in the application of Joseph C. Dacons et al, Ser. No. 334,667, filed Dec. 30, 1963. Briefly, the synthesis involves the conversion of dipicric acid to its dipyridinium salt, the conversion of the salt to dipicryl chloride and finally the conversion of the dipicryl chloride to DIPAM.

The preparation of HNS has been described in the application of Kathryn G. Shipp, Ser. No. 365,572, filed May 5, 1964 and involves a one-step reaction which comprises the addition of a solution of 2,4,6-trinitrotoluene to an aqueous solution of an alkaline metal hypochlorite and then recovering the resulting product.

NONA may be prepared according to the methods disclosed by Joseph C. Dacons, Ser. No. 320,579, filed Oct. 31, 1963 and generally involves a reaction between picryl halides and a halotrinitrobenzene.

The MDF may be initiated by any conventional and commercially available detonator such as the electroresponsive detonator **11** shown in the drawing. Due to the fact that a heat resistant MDF has a lower intensity detonation front than a conventional MDF, it has been found that when the detonation front from the small diameter heat resistant MDF travels into a substantially larger diameter base charge of a heat resistant explosive, degradation of that wave front occurs and the base charge does not detonate. The end coupler of the present invention provides a means for amplifying the detonation front of the heat resistant MDF to a magnitude sufficient to initiate the base charge **12,** whether the base charge be a conventional explosive or a heat resistant explosive.

The end coupler of the present invention comprises a metallic housing **16** having a frusto-conical recess **17** formed in one end thereof and having an axial bore **18** formed in the other end thereof, said axial bore intersecting said frusto-conical recess at the point of intersection thereof to define an annular shoulder **19**. The housing **16** is further provided with a counterbore **21** in said axial bore to provide an enlarged chamber for the reception of an adhesive so that the MDF may be bonded to the housing.

When assembling the end coupler of this invention, the MDF is inserted into the axial bore **18** until the end of the MDF abuts against the annular shoulder **19** and then a suitable adhesive **22** such as epoxy resin or other potting composition is inserted into the annular chamber around the MDF formed by the counterbore **21** to thereby bond the MDF to the housing and fixedly secure the housing and the MDF in their relative positions shown in the drawing. The frusto-conical recess **17** is then filed with a booster charge **23** which is HNS (Grade 1) explosive. HNS (Grade 1) is a superfine grade of hexanitrostilbene prepared in the method disclosed in application Ser. No. 365,572 of Kathryn G. Shipp, filed May 5, 1964 and is obtained directly in the chemical synthesis from the mother liquor and has a particle size less than 10 microns. It has been found that if it is attempted to utilize other explosives for the booster charge rather than the HNS (Grade 1) type booster charge, the shock wave deteriorates rather than amplifies and hence does not detonate the base charge **12**. When the end coupler is assembled and the booster charge **23** is packed into the frusto-conical recess, the packing pressure should preferably be 4,000–64,000 psi to achieve a packing density in the range of 1.1–1.7 g/cc. It is believed that the fine particle size which is characterized of the HNS (Grade 1) explosive is the property which enables the booster charge to sustain and amplify the shock wave received from the small diameter core of the heat resistant MDF.

It is known that when a detonation front travels from a small diameter core such as the MDF to a large diameter explosive such as the base charge **12**, the temperature and pressure of the detonation front decreases and therefore the tapered frusto-conical recess provides a booster charge having a gradually increasing cross-sectional area so that the booster charge may sustain and amplify the detonation front to a magnitude sufficient to detonate of the base charge.

It has been found that the end coupler of this invention functions well when the included angle defined by the tapered walls of the frusto-conical recess is less than 30° and preferably in the range of 20°–30°. Substantial increases in the angle of the frusto-conical recess above 30° produces a change in cross-sectional area which is too abrupt and degradation of the detonation front is likely to occur. It is also noted that the diameter of the frusto-conical recess **17** at the point of intersection with the axial bore **18** is shown as being less than the diameter of the bore **18** to reduce the difference between the cross-sectional area of the explosive core **14** in the MDF and the cross-sectional area of the frusto-conical recess at the point of intersection with the bore **18**, thus preventing the degradation of the shock wave front as it travels from the MDF into the booster charge. The diameter of the frusto-conical recess at the point of the intersection with the bore **18** may be as large as the diameter of bore **18**, but the best reliability of operation is assured when the diameter of the recess **17** at the point of intersection with bore **18** is approximately equal to the diameter of the explosive core **14** in the MDF.

As can be readily understood by those skilled in the art, the end coupler of this invention provides a means for receiving a low intensity detonation wave from a heat resistant MDF and amplifying that detonation wave to a magnitude sufficient to initiate the detonation of a base charge having a diameter substantially greater than the diameter of the MDF, and which will detonate the base charge whether the base charge be formed from conventional explosives or the less sensitive heat resistant explosives.

What is claimed is:

1. An end coupler for transmitting a detonation from a heat resistant mild detonating fuse to a base charge having a diameter greater than the diameter of the mild detonating fuse comprising,

an elongated housing,

said housing having a tapered recess formed in one end thereof,

said housing having an axial bore formed in the other end thereof and intersecting said tapered recess,

tapered recess being filled with hexanitrostilbene (Grade 1) explosive,

whereby a heat resistant mild detonating fuse may be inserted into said axial bore and a base charge may be positioned adjacent said one end of said housing so that said end coupler may amplify a shock wave produced by the mild detonating fuse to a magnitude necessary for the detonation of the base charge.

2. The end coupler of claim **1** wherein said tapered recess is formed to have an included angle less than 30°.

3. The end coupler of claim **1** wherein the diameter of said tapered recess at the point of intersection with said axial bore is less than the diameter of said axial bore.

4. The end coupler of claim **2** wherein the diameter of the tapered recess at the point of intersection with the axial bore is less than the diameter of said axial bore.

5. The coupler of claim **2** wherein said housing has a counterbore formed in said other end of said housing to receive an adhesive for fixedly securing the mild detonating fuse within the end coupler.

6. In an explosive train having a mild detonating fuse, a base charge and an initiator for the mild detonating fuse, the improvement comprising,

an end coupler having an elongated housing,

said housing having a frusto-conical recess formed in one end thereof,

said housing having an axial bore formed in the other end thereof and intersecting said recess for receiving one end of said mild detonating fuse,

said mild detonating fuse being packed with heat resistant explosive and having the initiator operatively connected at the other end thereof,

said recess being filled with hexanitrostilbene (Grade 1) explosive, and

said base charge being mounted upon the end of said housing in the operative engagement with said hexanitrostilbene (Grade 1) explosive.

7. The explosive train of claim 6 wherein the heat resistant explosive in said mild detonating fuse is selected from the group consisting essentially of dipicramid, hexanitrostilbene, and nonanitroterphenyl.

8. The explosive train of claim 6 wherein the explosive in said base charge consists essentially of an explosive selected from the group of dipicramid, hexanitrostilbene, and nonanitroterphenyl.

9. The explosive train of claim 7 wherein the diameter of the frusto-conical recess at the point of intersection with said axial bore is less than the diameter of said axial bore.

10. The explosive train of claim 7 wherein said frusto-conical recess is formed to have an included angle which is less than 30°.

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