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METHOD FOR THROUGH-BULKHEAD SHOCK INITIATION

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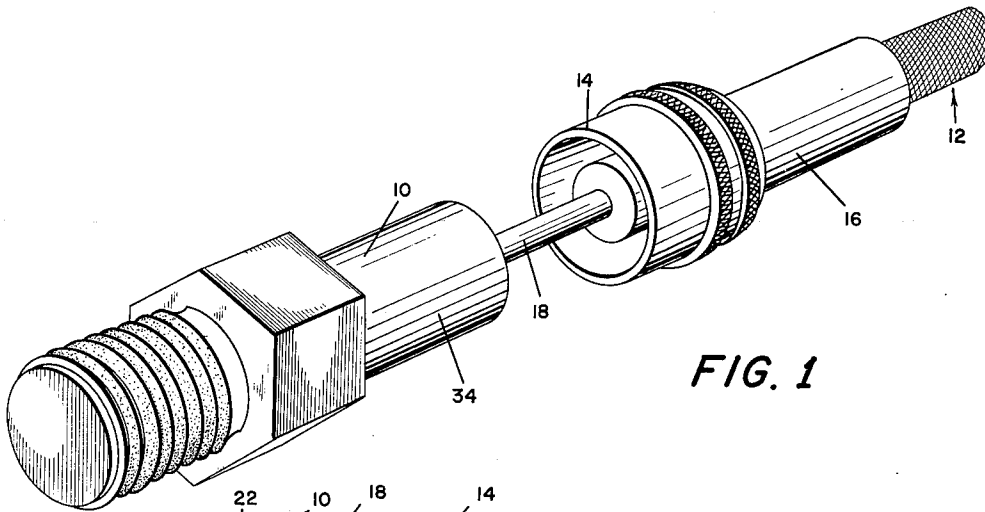


FIG. 1

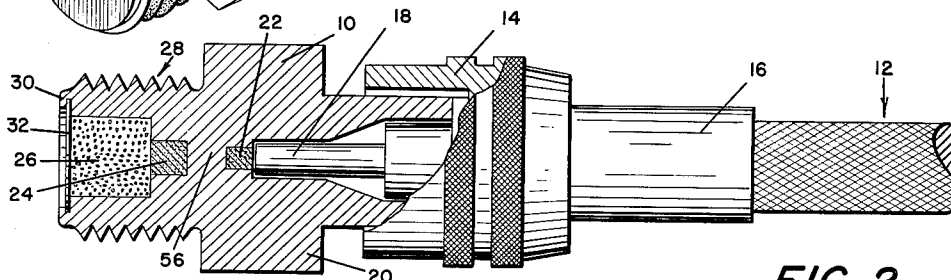


FIG. 2

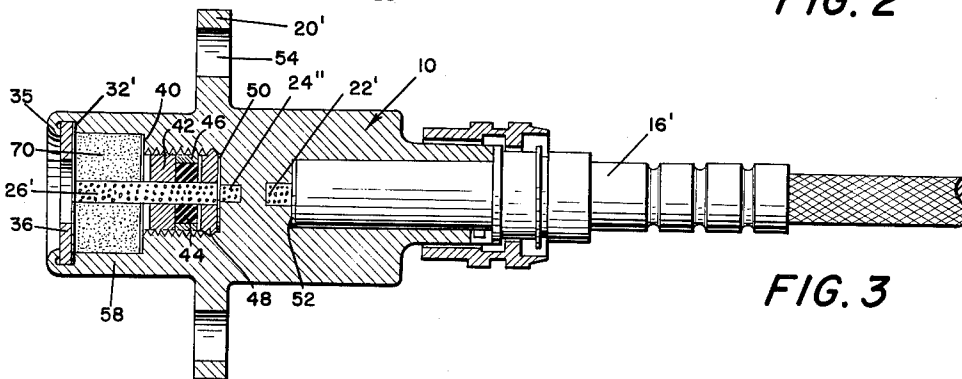


FIG. 3

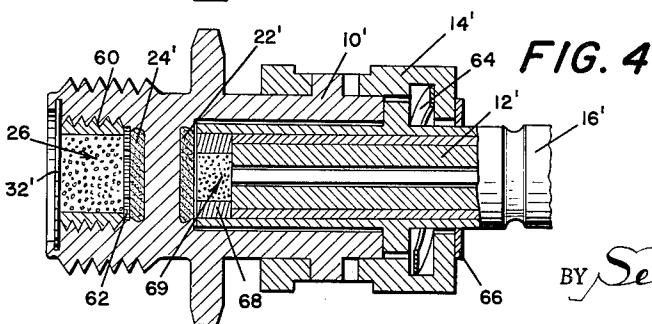


FIG. 4

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**METHOD FOR THROUGH-BULKHEAD SHOCK INITIATION****Robert C. Allen, Hollister, Calif., assignor to McCormick Selph Associates, Inc., Hollister, Calif., a corporation of California**

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5 Claims. (Cl. 102—70)

The present application relates to a method for the exterior application of a high velocity explosively generated shock wave to initiate a deflagration or detonation on the interior of an intervening barrier without perforation thereof.

A contemporary problem in the aerospace industry is the initiation of a high velocity, explosively generated shock wave from the outside of an incompressible bulkhead to initiate a deflagration or detonation on the inside of the bulkhead while maintaining the integrity of the bulkhead. Numerous previous inventors have considered the problem of through-bulkhead shock initiation. Several have discarded attempts to initiate the required shock without perforation of the barrier. At least one, Cushing, Patent No. 1,159,653, has relied on heat conduction through an intervening bulkhead to initiate an internal tracer charge. The present invention depends entirely on shock wave transmission to initiate a pick-up charge within the interior of a bulkhead. The present invention consists in aligning donor and pick-up explosive charges respectively on the outside and the inside of the bulkhead being attacked, positioning a detonating fuse adjacent the donor charge on the outside of the bulkhead; sealing an ignition charge within the bulkhead adjacent the pick-up charge and detonating the detonating fuse and donor charge so as to generate a high-velocity explosive shock wave which initiates the aligned pick-up and ignition charges without perforating the intervening bulkhead. In turn the pick-up charge creates the desired detonation or deflagration. In the ensuing description the term "detonation" is used generically to comprehend also a deflagration reaction.

Accordingly, it is an object of invention to provide a method for through-bulkhead shock initiation while maintaining the integrity of the bulkhead.

Another object of invention is to provide a through-bulkhead shock initiation device which is simply designed and safely operable.

Yet additional objects of invention will become apparent from the ensuing specification and attached drawings wherein

FIG. 1 is a perspective view of a suggested through-bulkhead shock initiation device comprising a housing 10 threaded for engagement with a bulkhead (not illustrated) and a detonating fuse coupling 14 insertable within the housing.

FIG. 2 is a longitudinal section of the housing with detonating fuse coupled thereto;

FIG. 3 is a longitudinal section of a modified housing, having radial flanges for bolting to a bulkhead; and

FIG. 4 is a longitudinal section of another modification of invention.

In FIGS. 1 and 2, a suggested through-bulkhead shock initiation device is represented as comprising a housing 10 connected to a confined detonating fuse 12 by quick disconnect coupling 14, the confined detonating fuse 12 being supported in a quick-disconnect relationship by means of an environmentally sealed end closure 16. Quick-disconnect coupling 14 may be of the Bendix "Pigmy" Type No. PT-06-8. End closure 16 in turn is integrated with environmentally sealed end booster charge 18 of narrow diameter for fitting in a complementary recess in exterior body 34. The sealed end 18 is coaxially aligned with donor charge 22 which may be any

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crystalline high explosive, such as pentaerythrite, tetrinitrate (PETN) or cyclonite (RDX), which reacts with a velocity of reaction in excess of 3,000 feet per second.

The purpose of donor explosive charge 22 is to generate a shock wave and by proper application to efficiently transmit the shock wave into the intervening bulkhead material 56 between donor charge 22 and pick-up charge or slug of inert material 24 without rupturing bulkhead material 56.

It is suggested that the intervening material be relatively incompressible, for example stainless steel, commercially manufactured as Type 321 CRES. It is mandatory, of course, under the present invention, that the intervening material whether aluminum, steel, plastic, or other relatively incompressible material, be integral with the main body of the housing 10.

Turning again to FIG. 2, housing 10 is illustrated as having threads 28 provided to engage complementary threads within the bulkhead of an ignition or like chamber.

Ignition charge 26 may be of a loose-grained type and may be sealed with respect to the inside of the bulkhead by a stainless steel or like sealing 32 supported against the ignition charge by means of an annular rim 30.

In the FIG. 3 modification, annular rim 35 supports propellant trap 36 which abuts stainless steel coined closure 32'. Grain propellant 70 is supported within inside end 58 and in turn at its forward end is supported by an inhibiting stainless steel washer 40.

The loose ignition charge 26' is axially elongated and extends from thrust pick-up charge 24' being sealed at one end by coined closure 32' and at the other end by stainless steel closure 50.

Ignition charge 26' is contained within a stainless steel spacer 48, fiber glass spacer 46, rubber-silicon ring 44, and retainer 42 the assembly of which attenuates the detonation output generated by the pick-up charge. Housing 10 may be provided with radially extending flange 20' having longitudinal apertures 54 for bolting the entire assembly to a bulkhead. As in the modification suggested in FIG. 3, the detonating fuse end closure 16' has a stainless steel closure 52 adjacent the donor charge 22'.

In the FIG. 4 modification interior threaded sleeve 60 is provided for securement of ignition charge 26 and a foraminous trap 62 is positioned intermediate ignition charge 26 and pick-up charge 24'. Wave spring 64 may be fitted into quick-disconnect coupling 14' for a secure fitting of coupling 14' to housing 10'. Confined detonating fuse transfer line 12' may also include a soldered fitting 66 for retaining quick-disconnect 14'. Confinement sleeve 68 may be supported at the end of detonating fuse 12', and contains booster charge 69 to enhance and orient the reactive shock of fuse 12' towards donor charge 22'.

Manifestly, the invention is not restricted to the amount, type or method of application of the pick-up charge, except that the pick-up charge shall be a meta-stable chemical composition capable of being initiated by the energy of an explosively generated shock wave. Recent tests have proven that the suggested method of initiation can be accomplished through 1.60 inches of solid steel without jeopardizing performance reliability. Also, tests have proven that a .110 inch solid steel bulkhead following through-bulkhead shock initiation according to the present method will retain in excess of 50,000 p.s.i. differential pressure without breaking.

The principal advantages of the present method over conventional methods of shock initiation reside in the elimination of the need for drilling, tapping or otherwise disturbing the hermetic seal of containers, pressure vessels and pressure bulkheads, such as rocket engine cases

to accomplish ignition, detonation, or stimulus transfer. Also, the invention eliminates the need for moving parts or electric wiring normally utilized in conventional explosive detonators. The invention eliminates, also, the need for primary explosive compositions normally utilized in conventional explosive initiators thus removing the device from the restricting shipping, storage and handling regulations applicable to primary high explosives.

Since the suggested initiator is non-electric and incorporates continuous conductive shielding around all explosive charges, the initiator is completely insensitive to all R.F., stray currents, or other induced or even deliberately applied electrical energies. The initiator design simplicity renders the unit amendable to economic mass production techniques. The initiator can be easily modified so that either a deflagration for ignition, detonation, or mechanical motion can be generated on the output or pick-up side by simply selecting a properly designed adapter.

The utilization, within the initiator of the rapid and extremely reproducible detonation shock wave phenomenon provides initiation reproducibility and, when properly interconnected, simultaneity that cannot be approached by conventional electric or mechanical initiators. The method of initiating the donor charge, on the input side of the barrier, is not important to the invention and may utilize any of the means, well known to the art including a blasting cap, mild detonating fuse, "Primacord" type detonating fuse, exploding bridgewire and the like.

The type and quantity of the donor charge is not essential, of course, to the invention except that it is restricted to only those chemical compositions that react at a rate sufficient to generate a detonating shock wave when properly initiated such as PETN, TNT and RDX.

Also, the type and thickness of the intervening barrier is not critical for the purposes of the present invention. Metal barriers have been the subject of all previous tests, but it is believed that certain plastic and/or ceramic materials may accomplish the required action essentially as well as metal. Maintaining the integrity of the hermetic seal, formed by the barrier between the donor and pickup charges, before, during, and following the detonating is the most critical aspect of the invention.

The type and quantity of pick-up charge is not intended to be essential to the invention except that it must be of a material and form to accomplish a useful function on receipt of the shock wave generated by the donor charge at the barrier pick-up charge interface. Although only high explosive and a few deflagrating type pick-up charges have been evaluated, it is visualized that any shock sensitive chemical composition may be used as a pick-up charge. In fact, an inert movable piece, such as a metal piston, can be impulsively loaded by the shock wave as it emerges from the barrier, and by moving and accomplishing a useful function, the inert piston, in such a case, can act as a pick-up charge.

As indicated previously, the pick-up charge can be used to generate a detonation, deflagration, slow-burning, or simply mechanical movement. The essential characteristic of the donor and pick-up charges is that their combined explosive charge may be confined, positioned, or contained in a manner that will not cause the hermetic barrier seal to be broken or otherwise perforated.

Manifestly, various types of charges may be substituted and the suggested housing may be differently configured without departing from the spirit and scope of the invention, as defined in the subjoined claims.

I claim:

1. A through-bulkhead detonation device comprising:
  - (a) a housing integrally supported within said bulk-

head and having coaxially aligned donor and pick-up ports opening on either side of said bulkhead, together with an intervening substantially non-compressible portion interposed between said ports;

- (b) a crystalline high-explosive donor charge from a group of secondary high explosives consisting of pentaerythrite tetranitrate (PETN) and cyclonite (RDX) which react with a velocity in excess of 3,000 feet per second positioned at the base of said donor port adjacent said non-compressible intervening portion;

- (c) a secondary high-explosive pick-up charge capable of being initiated by the energy of an explosively generated shock wave positioned at the base of said pick-up port adjacent said intervening non-compressible portion; and

- (d) an ignition charge supported adjacent said pick-up charge inside of said bulkhead.

2. A through-bulkhead detonation device as in claim 1, said pick-up and donor charges being sealed against said housing and said intervening bulkhead portion by stainless steel closure means.

3. A through-bulkhead detonation device as in claim 1, said housing including a radially extending medial flange with longitudinal apertures for securement of said flange to a bulkhead of a chamber into which the shock is being conveyed.

4. Method for through bulkhead initiation of detonation comprising:

- (a) confining a donor explosive charge adjacent the outside of a bulkhead being attached;

- (b) confining a pick-up explosive charge adjacent the inside of said bulkhead and in axial alignment with said donor charge so that an intervening portion of said bulkhead remains between said donor charge and said pick-up charge;

- (c) limiting the combined explosive of said donor and pickup charges so as to avoid perforating and deforming said bulkhead;

- (d) sealing an ignition charge within the inside of said bulkhead adjacent said pick-up charge; and

- (e) detonating said donor charge so as to generate a high velocity shock wave which initiates said aligned pick-up charge and ignition charge without perforating and deforming said bulkhead.

5. Method as in claim 4, wherein said donor explosive charge is a crystalline high explosive from a group consisting of pentaerythrite tetranitrate (PETN) and cyclonite (RDX) which reacts with velocity in excess of 3,000 feet per second.

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