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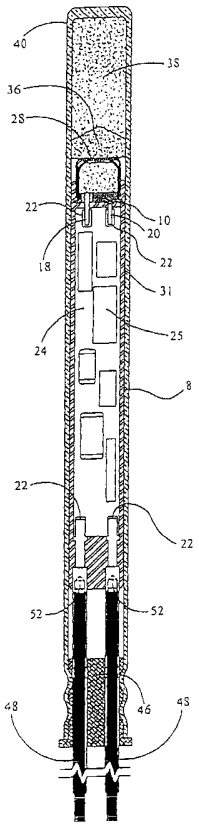
(54) Title: DETONATOR WITH AN IGNITION ELEMENT HAVING A TRANSISTOR-TYPE SEALED FEEDTHROUGH

(57) Abstract: A detonator with an ignition element (28) that includes a transistor-style sealed header feedthrough.



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SPECIFICATION

DETONATOR WITH AN IGNITION ELEMENT HAVING A TRANSISTOR-TYPE SEALED FEEDTHROUGH

BACKGROUND OF THE INVENTION

[0001] The present invention relates to pyrotechnic detonators, and more particularly, to a detonator with an ignition element that includes a transistor-style sealed header feedthrough.

[0002] The efficient use of explosives in mining operations and the demolition of structures often requires that many charges be placed in a predetermined pattern and detonated in a timed sequence. In general, timed detonation can be accomplished by detonators that use pyrotechnic delays, sequential-type blasting machines, and electronically programmable detonators. Some examples of time-delayed detonators are described in U.S. Patent Nos. 6,173,651, 6,085,659, 6,079,332, 5,602,360, 5,460,093, 5,435,248, 4,869,170, 4,819,560, 4,730,558, and 4,712,477, the disclosures of which are hereby incorporated by reference herein.

[0003] Such detonators are subject to one or more drawbacks, however, such as the following: (1) the use of an ignition element that is difficult to manufacture to precise dimensions so as to ensure predictable performance, (2) the use of an ignition element that requires careful handling during

manufacturing and thus impedes the beneficial incorporation of automated steps in the detonator assembly process, (3) the use of an ignition charge that contains lead, which presents an environmental and health hazard, (4) the use of a non-low energy ignition element, which inhibits compact design, (5) lack of reliability, and (6) costly manufacturing.

[0004] On the other hand, such problems are overcome or at least ameliorated in well-known glass-to-metal sealed initiators such as those currently manufactured and sold by the assignee of this patent application. Various patents also disclose other examples of glass-to-metal sealed initiators having features that address one or more of such problems, including U.S. Patent Nos. 6,274,252, 5,709,724, 5,639,986, 5,602,359, 5,596,163, 5,404,263, 5,140,906, and 3,971,320, the disclosures of which are hereby incorporated by reference herein.

[0005] Despite the aforementioned problems and the widespread existence of such initiators, it is believed that hitherto it has not been conceived or attempted to utilize an ignition element that includes a transistor-type glass-to-metal sealed header, in a detonator for use in mining, blasting, and demolition.

SUMMARY OF THE INVENTION

[0006] One object of the present invention is to provide a detonator that incorporates a transistor-type glass-to-metal sealed header so as to overcome or ameliorate one or more of the problems enumerated above.

[0007] Another objective of the present invention is to provide a detonator utilizing an ignition element having a transistor-type glass-to-metal sealed header, resulting in a reliable and economical detonator.

[0008] Another separate and alternative objective of the present invention is to provide a detonator utilizing an ignition element that is relatively easy to manufacture to precise dimensions with known and proven manufacturing processes, resulting in a detonator having predictable performance.

[0009] It is another separate and alternative objective of the present invention to provide a detonator utilizing an ignition element that is sufficiently durable to permit the incorporation of useful automation steps in the detonator assembly process.

[0010] It is a further separate and alternative objective of the present invention to provide a detonator utilizing an ignition charge that does not contain any lead, so as to reduce hazards to the environmental and health resulting from the use of the detonator.

[0011] It is yet another separate and alternative objective of the present invention to provide a detonator utilizing a low energy ignition element, resulting in a detonator that may be made more compact.

BRIEF DESCRIPTION OF THE FIGURES

[0012] Fig. 1 is a top sectional view of an embodiment of the present invention.

[0013] Fig. 2 is a partial top sectional view of the ignition element portion of the embodiment shown in Fig. 1.

[0014] Fig. 3 is a partial top sectional view of the ignition element portion of an alternate embodiment to that shown in Figs. 1 and 2.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT[1]

[0015] Referring to Figs. 1 and 2, an embodiment of a detonator according to the present invention is shown. The detonator

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[1] The present description incorporates by reference in full the disclosures of the following copending applications filed herewith: "DETONATOR UTILIZING FEATURES OF AUTOMOTIVE AIRBAG INITIATORS," by John J. Walsh, David M. Forman, Abrar A. Tirmizi, and Gloria Vawter (Express Mail No. EU124494952US), "STANDALONE IGNITION SUBASSEMBLY FOR DETONATORS," by John J. Walsh, David M. Forman, Abrar A. Tirmizi, and Gloria Vawter, (Express Mail No. EU124495286US), and "DETONATOR WITH ONBOARD ELECTRONICS MECHANICALLY CONNECTED TO IGNITION ELEMENT" (Express Mail No. EU124495683US), each of which applications is assigned to the assignee of the present application.

includes a shell 40 loaded with a primary charge 36 and a base charge 38, and an ignition subassembly 8. (A detonator shell is typically a metal cylinder 6 to 8 mm. in diameter and from 60-100 mm. in length). Subassembly 8 is then secured in place in the shell 40 preferably by placing an elastomeric plug 46 or the like in the open end of the shell and crimping the shell 40 to the plug, or subassembly 8 can be secured using any other suitable method. Subassembly 8 may have a body portion formed of an encapsulation 31 and may be formed to snugly hold subassembly 8 within the shell 40 and dampen vibrations to which the detonator may be subjected, generally in accordance with the teachings of U.S. Patent No. 6,079,332.

[0016] Alternately, an ignition subassembly similar to that of Fig. 1 (but preferably lacking encapsulation 31) can be directly incorporated into a shell, such as by molding it directly in the shell. Various other methods of incorporating a transistor-type header ignition element into a detonator in accordance with the present invention will be readily apparent, and the present invention does not require the use of a "standalone" ignition subassembly although one is shown in Fig. 1.

[0017] Turning to the specifics of the depicted transistor-type glass-to-metal sealed header ignition element 28, it can be seen that ignition element 28 includes a header assembly with a sealed electrical feedthrough, comprising an eyelet 10

(preferably Kovar®), insulator glass 14 (preferably a glass such as a sodasilicate, e.g., 9010, that is chosen to form a matched seal with the eyelet and center pin), a center pin 18 (preferably a nickel/chromium alloy), a ground pin 20, and an igniter wire 12 (preferably a low energy igniter wire with a diameter of 10 to 20 microns). Due to its thin profile, eyelet 10 can be stamped or cold-formed, resulting in cost savings as compared to a machining operation. Ground pin 20 and center pin 18 are preferably selected of the same material. The ignition element 28 further preferably includes a charge can 26 that is preferably metallic and hermetically sealed to the eyelet at circumferential through-weld 16, with an ignition charge 30 contained between the can 26 and upper surface of the header, in tight contact with igniter wire 12. An insulator cup 27 may preferably be attached around the can 26 so that, except for female connectors 52 that protrude from the input end of the subassembly, the entire outer surface of ignition subassembly 8 consists of insulating material, thus electrically isolating and providing vibration and environmental protection to the components within. Fig. 3 depicts an alternate header including a dogleg eyelet 10' with an integral ground pin 19 that may be formed by stamping if the eyelet is stamped.

[0018] In the depicted embodiment, a circuit board 24 and electronic components 25 may be provided within the ignition

subassembly 8, to provide a means of triggering ignition of the ignition element based on the processing of an electrical ignition signal received by connectors 52, which are electrically connected to a blasting machine or the like that powers the detonator. Such electronic components are well-known and preferably include means for imparting a programmable period of delay to the ignition, means for ESD and RF protection, et cetera. Circuit board 24 and electronic components 25 are preferably encapsulated together in encapsulation 31, and connected to pins 18 and 20 at contacts 22 through soldering or other suitable connection. Referring to Figs. 2 and 3, retention of the ignition element 28 to the encapsulation 31 may be enhanced by providing a lip 17 (or 17') at the bottom of the eyelet 10 or (10'). The insulator cup 27 may also be held within the encapsulation 31 to facilitate its retention as well.

[0019] By way of example, in an embodiment like that shown in the Figures, it has been found that a nickel/chromium alloy, 13 micron diameter, 0.7 mm long igniter wire, and a 50 mg ignition charge of zirconium potassium perchlorate with a height of 1.0mm and a diameter of 4.8mm is suitable. Preferably, a minimum suitable charge is approximately 30 mg for a configuration of this size, as a smaller charge may result in an insufficient charge thickness. A preferred all-fire voltage may be 6 volts, and may be delivered with a 100 microfarad capacitor

included in the electronic components 25 in an embodiment like that depicted.

[0020] It should be noted that although the Figures depict embodiments including electronic components that receive, process, and deliver an ignition signal, such an ignition signal may alternately be received, processed, and delivered by a number of other well-known non-electronic or partly-electronic means, such as through the use of a shock tube to deliver an ignition signal to a piezoelectric device, column fuse delays, et cetera. It is noted that this detailed description of certain embodiments does not imply that such alternate embodiments are not within the scope of the invention.

[0021] A preferred embodiment of a detonator with an ignition element that includes a transistor-style sealed header feedthrough, and many of its attendant advantages, has thus been disclosed. It will be apparent, however, that various changes may be made in the form, construction, and arrangement of the parts without departing from the spirit and scope of the invention, the form hereinbefore described being merely a preferred or exemplary embodiment thereof. Therefore, the invention is not to be restricted or limited except in accordance with the following claims.

What is claimed is:

1. A detonator comprising:

a) a cylindrical shell having a detonator end and an input end, said detonator end being closed and packed with a charge;

b) an ignition element within said shell and located adjacent to said charge, said ignition element including a transistor-style sealed header having a feedthrough; and,

c) a trigger means extending from said input end of said shell to said ignition element, for causing said ignition element to ignite in response to the receipt of a selected signal by said trigger means.

2. The detonator of claim 1, wherein said ignition element includes a charge enclosure and an ignition charge, said ignition charge being hermetically sealed within said enclosure

3. The detonator of claim 2, wherein said ignition element includes a can surrounding said ignition charge and connected to said header, and an insulating cup surrounding said can.

4. The detonator of claim 1, wherein said ignition element includes an ignition charge that includes zirconium potassium perchlorate.

5. The detonator of claim 1, wherein said ignition element includes a low-energy igniter wire having two ends that are electrically connected to said feedthrough.

6. The detonator of claim 5, wherein the diameter of said igniter wire is less than 20 microns.

7. The detonator of claim 1, wherein said shell has a thickness of 0.5mm, and an outer diameter of between 6mm and 8mm.

8. The detonator of claim 1, wherein said trigger means includes two electrical input leads at said input end of said shell.

9. The detonator of claim 1, wherein said trigger means includes a delay means for delaying the ignition of said ignition means for a predetermined period of time after receipt of said selected signal by said trigger means.

10. The detonator of claim 9, wherein said delay means is an electronic delay means.

11. An ignition element for use in a detonator, comprising:

a) a transistor-style sealed header having a top surface, a bottom, and an outer surface, and a feedthrough extending through said header from said top surface to said bottom;

b) an igniter wire having two ends, said wire being on the top surface of said header, and the ends of said wire being electrically connected to said feedthrough; and,

c) an ignition charge on the top surface of said header.

12. The ignition element of claim 11, wherein said ignition charge includes zirconium potassium perchlorate.

13. The ignition element of claim 11, wherein the diameter of said igniter wire is less than 20 microns.

14. The ignition element of claim 11, further comprising a can hermetically attached to the outer surface of said header and extending above the top surface of said header, with said ignition charge contained between said can and the top surface of said header.

15. The ignition element of claim 11, further including an insulating cup surrounding said can.

16. The ignition element of claim 11, wherein said header includes a stamped eyelet.

17. A method of making a detonator comprising the following steps:

a) providing a cylindrical shell having a detonator end and an input end, said detonator end being closed;

b) packing said detonator end of said shell with a suitable charge;

c) providing an ignition element including a transistor-style sealed header within said shell and adjacent to said charge;

d) providing a trigger means extending from said input end of said shell to said ignition element, said trigger means for causing said ignition element to ignite in response to the receipt of a selected signal by said trigger means; and,

e) securing said ignition element and trigger means within said shell.

18. The method of claim 12, further comprising the step of loading an ignition charge of zirconium potassium perchlorate within said ignition element.

19. The method of claim 12, further comprising the steps of: providing a metallic can and loading it with an ignition charge, securing said can to said header, and securing an insulating cup around said can.

20. The method of claim 12, wherein said trigger means includes a delay means for delaying the ignition of said ignition means for a predetermined period of time after receipt of said selected signal by said trigger means.

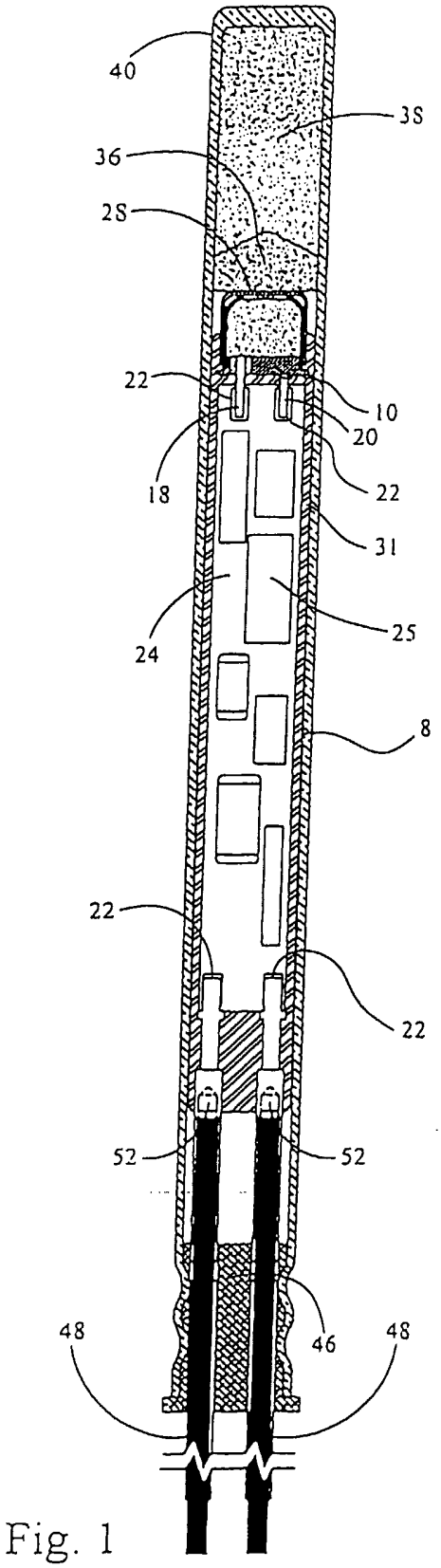

Fig. 1

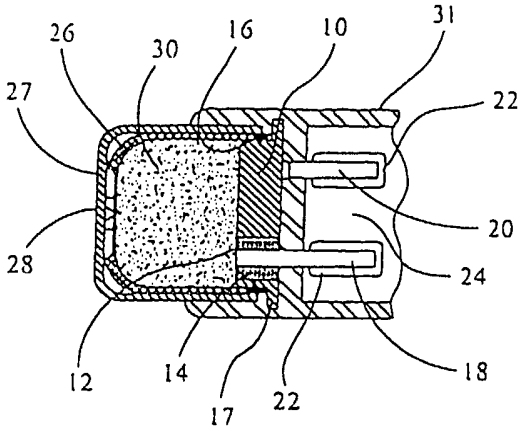

Fig. 2

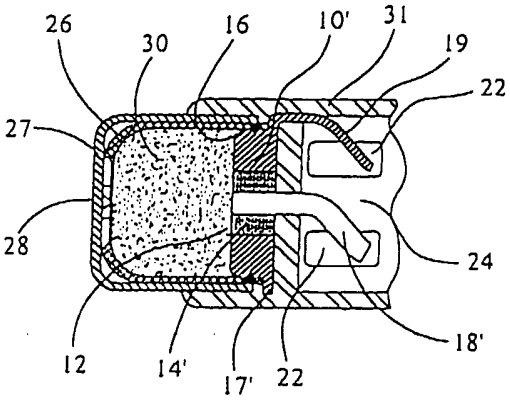

Fig. 3

INTERNATIONAL SEARCH REPORT

Internat Application No
PCT/IB 03/02001

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F42C11/06 F42D1/045

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F42B F42C F42D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the International search	Date of mailing of the international search report
5 September 2003	12/09/2003

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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