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(71) Applicant *(for all designated States except US)*: **ROCK-TEK LTD** [AU/AU]; Lot 33, Harries Way, Pinjarra, Western Australia 6208 (AU).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **GAVRILOVIC, Mihailo** [US/US]; 3272 Leyden Street, Denver, CO 80222 (US). **MICKE, Brian, P** [US/US]; 22910 Pinecrest Road, Golden, CO 80401 (US).

(74) Agent: **MIZZI, Anthony, Paul**; c/- Griffith Hack, Level 6, 256 Adelaide Terrace, Perth, Western Australia 6000 (AU).

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(54) Title: COMPOSITE PROPELLANT AND CARTRIDGE INCORPORATING SAME

(57) Abstract: A solid particulate composite propellant comprising a first proportion of ammonium nitrate in the form of granules or prill where the granules or prill have a diameter in the range of 0.5mm to 4mm and a second proportion of a propellant. An advantageous oxidising agent is ammonium nitrate in the proportion of 45 to 49% by weight of the composite propellant and particularly advantageous propellant is double based propellant (which comprises a mixture of nitroglycerine and nitrocellulose) in the proportion of 55 to 51% by weight of the composite propellant.

Composite Propellant and Cartridge Incorporating Same

Field of the Invention

The present invention relates to a composite propellant, particularly, though not exclusively, for breaking and fracturing hard materials and, to a cartridge incorporating said composite propellant.

Background of the Invention

Many types of energetic substances are currently used in mining and civil construction for the purposes of blasting or fragmenting hard materials such as rock and concrete. The expression "energetic substance" is intended to cover both explosives and propellants.

The difference between an explosive and a propellant is functional rather than fundamental. Explosives are intended to be functioned by detonation following shock initiation. Propellants on the other hand are intended to burn (ie deflagrate) steadily at a rate determined by designed pressure of their environment, e.g. a rocket, or a gun breach, and are ignited by a flame.

What type of energetic material is used in a particular instance is dependent on many factors including: the strength of the material to be fragmented; the location of the material to be fragmented; whether or not production of noxious gases and materials is of importance; the allowable seismic signature; the availability and cost of the energetic substance; and whether fragmentation is to occur in heavily populated, i.e. residential areas, where often governed authorities exclude the use of explosives in favour of propellants. Further, the conditions on the handling and transport of explosives is substantially more stringent than that for propellants. Thus while at times, a particular explosive may be preferred on technical grounds over a propellant for the purposes of fragmentation, regulations relating to the use and handling of explosives may prohibit their use.

It is an object of the present invention to provide an composite propellant having characteristics which enable classification as a propellant, and produce a sufficiently large volumes of gas to facilitate fracturing and breaking of hard materials. A further object of the present invention is to provide an composite propellent that produces minimum volumes of toxic by-products.

Summary of the Invention

According to a first aspect of the present invention there is provided a solid particulate composite propellant including at least:
a first proportion of an oxidising agent in the form of granules or prill, said granules or prill having a diameter in the range of 0.5mm to 4mm; and,
a second proportion of a propellant.

Preferably said granules or prill have a diameter in the range of 1mm to 3mm.

Preferably said oxidising agent has a density in the range of 1.1 to 1.7g/cc.

Preferably said oxidising agent has a density in the range of 1.3 to 1.5g/cc.

Preferably said oxidising agent is an inorganic nitrate.

Preferably said inorganic nitrate is ammonium nitrate.

Preferably said propellant is a double base propellant.

Preferably said double-based propellant includes a first percentage of nitrocellulose and a second percentage of nitroglycerine.

Preferably said first proportion of oxidising agent is between 40 to 60% by weight of said composite propellant and said second proportion of propellant constitutes between 60% to 40% by weight of said composite propellant.

Preferably said first proportion of oxidising agent is between 40 to 50% by weight of said composite propellant and said second proportion of propellant constitutes between 60 to 50% by weight of said composite propellant.

More preferably said first proportion constitutes between 45 to 49% by weight of said composite propellant and said second proportion constitutes between 55 to 51% by weight of said composite propellant.

More preferably, said first proportion constitutes between 45 to 49% by weight of said composite propellant, and said propellant includes 26 to 36% by weight nitrocellulose and 26 to 16% by weight nitroglycerine.

More preferably, said composite propellant includes approximately 48% by weight ammonium nitrate, 31% by weight nitrocellulose and 21% by weight nitroglycerin.

Preferably said first proportion of said oxidising agent is approximately 47% by volume of said composite propellant and said second proportion of said nitro based propellant is approximately 53% by volume of said composite propellant.

According to a further aspect of the present invention there is provided a cartridge for breaking or fracturing a hard material including at least:
a cartridge shell defining a cavity;
a volume of composite propellant in accordance with the first aspect of the present invention contained in said cavity; and,
a hot flame igniting means disposed in said cavity in intimate contact with said composite propellant.

Preferably said hot flame igniting means is a pyrotechnic chemical mixture including boron, calcium chromate, titanium, potassium perchlorate and dextrin.

An embodiment of the present invention will now be described with reference to Figure 1.

Detailed Description of Preferred Embodiment

An embodiment of the composite propellant in accordance with the present invention includes a first proportion of an oxidising agent in the form of granules or prill where the granules or prill have a diameter in the range of 0.5mm to 4mm. Mixed with the oxidising agent is a second proportion of a propellant. The composite propellant is in the physical form of a particulate solid.

In order to control burn rate of the oxidising agent, particularly for breaking or fracturing of hard materials such as rock or concrete it has been found most advantageous if the granules or prill have a diameter in the range of 1mm to 3mm and a density in the range of 1.1 to 1.7g/cc and more preferably, a density in the range of 1.3 to 1.5g/cc.

A particularly well suited oxidising agent for this purpose is an inorganic nitrate such as ammonium nitrate (AN). AN is particularly advantageous due to its abundance of supply, low cost and high gas volume. However, it is envisaged that oxidising agents other than inorganic nitrates can be used. For example inorganic perchlorates, alkali metal perchlorates, heavy metal perchlorates, alkali metal permanganates and ammonium perchlorates.

. It is envisaged that the first proportion of the oxidising agent will constitute between 40 to 60% by weight of the composite propellant while the propellant constitutes between 60 to 40% by weight of the composite propellant. More advantageously, the oxidising agent constitutes between 40 to 50% by weight of the composite propellant while the propellant constitutes between 60 and 50% by weight of the composite propellant.

Specifically for underground application, where the production of toxic by-products is more critical than aboveground application, it is more advantageous for the oxidising agent to be present in a proportion of 45 to 49% by weight of the composite propellant with the propellant constituting between 55 to 51% by weight of the composite propellant.

A particularly advantageous propellant is double based propellant which comprises a combination of nitrocellulose (NC) and nitroglycerine (NG). The nitroglycerine is provided in a proportion of 26 to 36% by weight of the composite propellant with the NG constituting between 26 and 16% by weight of the composite propellant. A specific composite propellant in accordance with the present invention includes approximately 48% by weight oxidising agent (about 47% AN and about 1% potassium nitrate), 31% NC and 21% NG. The NG and NC act as an oxygen balancing fuel. Tests on this specific composite propellant show that the gas evolved comprises mainly N_2, H_20 (as steam) and CO_2 , with very little production of carbon monoxide. Indeed specific test figures indicate the gas evolved to comprise around 24.5% by volume N_2, 49.3% H_20, 26% CO_2 , and 0.4% CO.

Embodiments of the present composite propellant have been found to be surprisingly effective in fracturing and breaking hard materials such as rock and concrete. The propellant portion burns very rapidly providing a very rapid build up in gas pressure which initiates fracture of the hard material. The combustion of the AN is slower and burns at a lower temperature, and during this burning process consumes CO produced by the propellant. The gas produced by the burning of the AN, while produced at a lower rate, is provided in very high volume and assists in propagating the fractures initiated by the rapid build-up in pressure produced by the propellant. This, combined with the oxygen balanced characteristics render the present composite propellant extremely useful for underground application, particularly in continuous mining. Significantly embodiments of the composite propellant the have the essential characteristics of a propellant of deflagrating, as distinct from detonating. As such the composite propellent is not cap sensitive (ie does not require shock wave initiation, and associated detonators and/or boosters).

A cartridge 10 containing the composite propellant 12 is depicted in Figure 1. Here, the cartridge 10 comprises a cylindrical shell 14 made for a plastics materials having a closure disc 16 and 18 at opposite ends thereof. In order to initiate the burning of composite propellant 12, the cartridge 10 is also provided with a hot flame igniter 20 coupled to a

lead 22 passing through the closure disc 18. The lead 22 can be in the form of a shock tube. The hot flame igniter 20 produces a hot flame or shower of metal sparks to commence the burning of the propellant. To this end, a pyrotechnic chemical mixture including boron, calcium chromate, titanium, potassium perchlorate and dextrin (BTCK) is particularly useful.

The end caps 16 and 18 are coupled to the shell 14 in a manner which allows them to relatively easily "pop off" when the cartridge 14 is unconfined. This prevents the rapid build-up of pressure within the cartridge 14 when in an unconfined state, for example during transport for storage. In the event of initiation of the composite propellant 12 when the cartridge 10 is unconfined, the initial build-up of pressure will cause the caps 16 and 18 to pop off thereby creating a sharp decrease in pressure to the extent that the continued burning of the composite propellant 12 can not be sustained and in particular will not produce a rapid build-up of gas requirements.

It is believed that the cartridge 10 in accordance with embodiment of this invention meets the requirements of UN classification code 1.4S with a commensurate packaging and transportation freedom.

All modifications and variations to the invention that would be obvious to a person of ordinary skill in the art are deemed to be within the scope of the present invention the nature of which is to be determined from the above description and the appended claims.

Claims:

1. A solid particulate composite propellant including at least:

a first proportion of an oxidising agent in the form of granules or prill, said granules or prill having a diameter in the range of 0.5mm to 4mm; and,

a second proportion of a propellant.

2. The composite propellant according to claim 1 wherein said granules or prill have a diameter in the range of 1mm to 3mm.

3. The composite propellant according to claim 2 wherein said oxidising agent has a density in the range of 1.1 to 1.7g/cc.

4. The composite propellant according to claim 2 wherein said oxidising agent has a density in the range of 1.3 to 1.5g/cc.

5. The composite propellant according to claim 4 wherein said oxidising agent is an inorganic nitrate.

6. The composite propellant according to claim 5 wherein said inorganic nitrate is ammonium nitrate.

7. The composite propellant according to claim 6 wherein said propellant is a double base propellant.

8. The composite propellant according to claim 7 wherein said first proportion of oxidising agent is between 40 to 60% by weight of said composite propellant and said second proportion of propellant constitutes between 60% to 40% by weight of said composite propellant.

9. The composite propellant according to claim 7 wherein said first proportion of oxidising agent is between 40 to 50% by weight of said composite propellant and said

second proportion of propellant constitutes between 60 to 50% by weight of said composite propellant.

10. The composite propellant according to claim 7 wherein said first proportion constitutes between 45 to 49% by weight of said composite propellant and said second proportion constitutes between 55 to 51% by weight of said composite propellant.

11. The composite propellant according to claim 10 wherein said double-based propellant includes a first percentage of nitrocellulose and a second percentage of nitroglycerine.

12. The composite propellant according to claim 11 wherein said first proportion constitutes between 45 to 49% by weight of said composite propellant, and said propellant includes 26 to 36% by weight nitrocellulose and 26 to 16% by weight nitroglycerine.

13. The composite propellant according to claim 12 wherein said composite propellant includes approximately 48% by weight ammonium nitrate, 31% by weight nitrocellulose and 21% by weight nitroglycerine.

14. A cartridge for breaking or fracturing a hard material including at least:
a cartridge shell defining a cavity;
a volume of composite propellant in accordance with any one of claims 1-13 contained in said cavity; and,
a hot flame igniting means disposed in said cavity in intimate contact with said composite propellant.

15. The cartridge according to claim 14 wherein, said hot flame igniting means is a pyrotechnic chemical mixture including boron, calcium chromate, titanium, potassium perchlorate and dextrin.

16. The cartridge according to claim 14 or 15 wherein, said cartridge shell has

first and second opposite end and one or both of said end are closed by releasable caps.

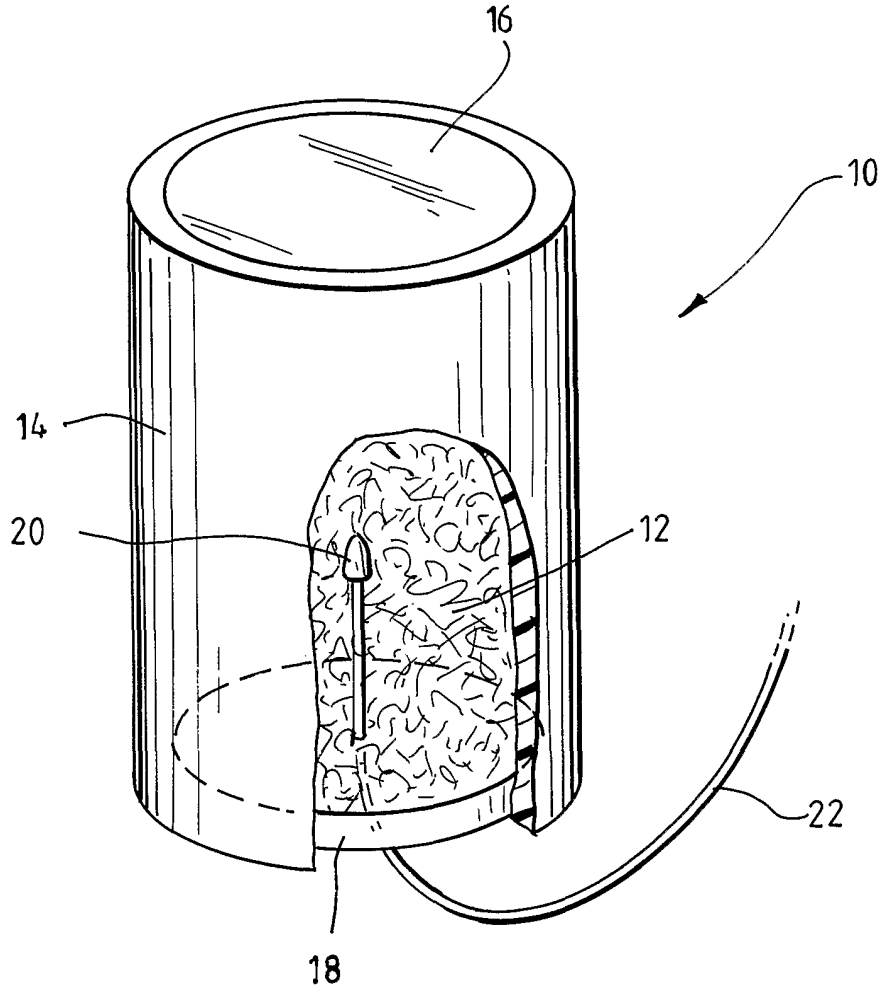

FIG. 1.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/00235

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: C06B 31/00, 31/52, 31/56

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)

AU: IPC C06B 31/00 (Pre-1975). In addition electronic database was searched as mentioned below.

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 practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Derwent Accession No. 2001-244179/25 (ATLANTIC RES. CORP.) 15 February 2001 & WO 01/10677-A	1-7
X	EP 661251 B (DYNO INDUSTRIER A/S) 17 March 1999 see claims 1-2	1-7
X	Derwent Accession No. 96-403931/41 (SPRENGSTOFFWERK GNASCHWITZ) 2 December 1996 & EP 731069 A	1-9

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 May 2002	- 5 JUN 2002
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **J.G. HANSON** Telephone No : (02) 6283 2262

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/00235

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Derwent Accession No. 98-479679/41 (UNIV. KAZAN. TECH.) 27 February 1998 & RU 2105748-C1	1-7
X	AU 7357/27 (NOBEL INDUSTRIES LIMITED) 18 May 1927 see column 6 lines 14-44	1-7
X	AU 9532/47 (139891) (IMPERIAL CHEMICAL INDUSTRIES LIMITED) 27 March 1947 see whole document	1-7
X	AU 54348/59 (465395) (IMPERIAL CHEMICAL INDUSTRIES LIMITED) 25 September 1975 see examples	1-7
X	AU 43045/68 (416157) (IMPERIAL CHEMICAL INDUSTRIES) 25 February 1971 see Table II	1-7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU02/00235

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
EP	661251	FI	945645	NO	934363

END OF ANNEX