

INITIATED PYROTECHNIC BLOCKS AND METHOD FOR PRODUCING SAME

5 The present invention relates to initiated pyrotechnic blocks, their manufacturing method and their use. The pyrotechnic blocks of this invention comprise an initiating composition integrated directly into said blocks, and are produced advantageously by compression, casting or extrusion. They are used advantageously as infrared decoys, typically in the classic field and the spectral field.

10 TECHNOLOGICAL BACKGROUND OF THE INVENTION

A pyrotechnic block is a solid block, optionally composed of several sub-parts or layers, whereof the composition, geometry and volume can differ, and comprising at least one layer of a pyrotechnic composition.

15 Pyrotechnic blocks can be characterized by radial combustion (from the exterior to the interior), or by axial combustion (also known as “cigarette-type combustion”). The aim of the present invention is preferably pyrotechnic blocks having radial combustion.

Such pyrotechnic blocks are intended for various civil or military applications, such as missile decoying by infrared emission.

20 Combustion of a pyrotechnic block of infrared type is characterized by its luminance, its duration and its rising front (speed and intensity on ignition). The luminance is directly linked to the nature of the pyrotechnic composition itself. The duration of combustion is not only a function of the nature of the composition, but also of the geometry of the block. Finally, the rising front is generally ensured by concomitant use of an initiating composition.

25 The prior art in particular describes pyrotechnic blocks so-called “initiated”, i.e., these pyrotechnic blocks are made and generally grooved so they can receive the initiating composition in their free grooves in paste form. An example of pyrotechnic blocks is described in patent FR 2 729 749, comprising pyrotechnic composition in the form of a grooved block, in the grooves of which an initiating composition has been deposited.

30 But the method for initiating pyrotechnic blocks is generally long and costly, especially in terms of:

- infrastructure: to date, work boxes must be specifically dedicated to initiating and equipped with a specific mixer for making the initiating composition in the form of paste.
- 5 • labour: after manufacturing, the initiating composition is deposited in the free grooves of the pyrotechnic block, generally manually or automatically (for examples of automatic methods see especially EP 0 665 415, US 6,427,599, EP 0 309 097).
- 10 • logistics: once made, the initiating composition is in paste form and in solvent. It therefore has a limited shelf life, which limits its use. This limited shelf life also means restrictive planning of the different manufacturing steps of the initiated pyrotechnic block.

Also, to ensure cohesion of the two compositions (initiating and main), the initiating composition most often comprises a thermosensitive, thermosetting or thermoplastic crosslinking agent.

- 15 Also, depositing the initiating composition in the form of paste in the grooves of the pyrotechnic block generally causes weak cohesion between the initiating paste and the pyrotechnic block, which influences the physical and mechanical properties of the initiated pyrotechnic block. This weak cohesion causes poor transmission of (combustion) fire between the different layers, engendering a non-optimal combustion and therefore infrared emission profile.
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The prior art further describes initiated pyrotechnic blocks not suited for applications of infrared decoying, having axial combustion. Particular examples are US 2001/013384, US 8,465,606, US 3,744,418, US 5,466,314, US 2,868,129, DE 876 822 and US 2013/0036932, none of which mentions adding grooves to the pyrotechnic block.

- 25 There is therefore a need for a new method for manufacturing, depositing and shaping an initiated pyrotechnic block having radial combustion which significantly improves adhesion of the initiating on the block and cohesion between the main and initiating compositions so as to improve the combustion profile, less costly, simplifying the execution infrastructures. This concept not only no longer limits the service life of initiating compositions, but also varies the initiating compositions. This concept has the advantage of optimizing IR performances by improving the luminescence of the blocks,
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especially via better fire transmission between the initiating and the infrared composition of the block.

SUMMARY OF THE INVENTION

5 Surprisingly, the applicant has developed a method for manufacturing an initiated pyrotechnic block, typically with radial combustion, which overcomes the problems of the prior art. Also, this novel manufacturing method accesses initiated pyrotechnic blocks in few operations, offering many advantages in terms of mechanical strength, integration (for example in the DSMF, Safe and Initiation Device), decrease in
10 vulnerability especially to mechanical attack (for example MURAT classification), cohesion between block and initiating, performance, time gain, and significantly decreases manufacturing and deposit costs.

The present invention thus relates to a method for manufacturing an initiated pyrotechnic block in the form of a preferably grooved multilayer block, said method comprising the
15 following successive steps:

1) successive arrangement, in a shaping tool, of at least:

a) a layer (a) of initiating composition, and

b) a layer (b) of main composition,

2) shaping, preferably by compression.

20 In this way, the method according to the invention is simplified relative to methods of the prior art, as the initiating composition is shaped at the same time as the main composition.

The present invention also relates to a particular texture of the initiating composition, resulting in an initiated IR block in a single compression operation, retaining its geometry and these dimensions. The initiating composition is no longer in the form of
25 paste, but in the same form as the main pyrotechnic composition, dispensing with problems of segregation or density.

The present invention also relates to a pyrotechnic block, comprising at least:

a) a layer (a) of initiating composition,

b) a layer (b) of main composition,

30 obtainable by the method according to the invention.

The present invention also relates to a pyrotechnic device comprising a pyrotechnic block according to the invention.

The present invention also relates to use of a pyrotechnic block or a device according to the invention as infrared decoy.

DEFINITIONS

- 5 According to the present invention, “pyrotechnic block” means a solid block, optionally comprising several sub-parts or layers, whereof the composition, geometry and volume can differ. A pyrotechnic block comprises at least one main composition. Preferably, the pyrotechnic block according to the invention has civil or military applications such as missile decoying by infrared emission, in particular in the classic and spectral field.
- 10 In terms of the present invention, a “main composition” comprises a mix of at least one oxidant and at least one reducer, combustion of which generates chemical species radiating in the infrared. In this way, due to combustion the main compositions produce strong emission in the infrared, according to a specific profile, and optionally gas and/or fumes, or a combination thereof. In the present invention the term “infrared
- 15 composition” will be used as a synonym for “main composition”.
Main compositions can be either of “classic” type or of “spectral” type.
Main classic compositions are defined as compositions with strong reducers (magnesium, for example) having strong combustion temperature with IR emission of black body type.
- 20 Main spectral composition means in terms of the present invention compositions having specific infrared radiation in particular IR bands (band I and band II) with a Band II/Band I ratio greater than compositions known as classic.
According to the present invention, “initiating composition” or “ignition composition” means a composition for initiating the main pyrotechnic block, on a defined surface,
- 25 over a defined time.
“Initiated pyrotechnic block” in terms of the present invention means a pyrotechnic block comprising at least one layer of main composition and a layer of initiating composition. Preferably, the initiated multilayer block is in the form of a multilayer block.
- 30 In the present invention, “radial combustion” means combustion which takes place from the exterior of the material being consumed to the center of the pyrotechnic block (from the exterior to the interior, see figure 5a). So in terms of a cylindrical pyrotechnic block,

radial combustion takes place according to a radius of the cylinder, from the exterior to the interior. By analogy, in the case of a parallelepipedic block, radial combustion also means combustion which takes place from the exterior of the parallelepiped to its center, according to the transverse direction for example. Radial combustion is opposed to axial combustion which in turn takes place from an external layer to an external layer opposite the material according to an axis of the latter (see figure 5b). In this way, in the case of a cylinder, an axial combustion takes place from one circular base to the other circular base for example.

“Composition in the form of dry grains” in terms of the present invention means that the composition (main or initiating) is in the form of a granular solid (optionally powder) of determined granulometry, the composition comprising at most 5% by weight, for example between 3 and 4% by weight, of solvent relative to the total weight of the composition. “Solvent” means any organic and/or aqueous solvent compatible with the (main or initiating) composition, i.e., especially any inert organic and/or aqueous solvent with regard to the composition and producing even slightly humid grains.

DETAILED DESCRIPTION

Method

The present invention relates to a method for manufacturing an initiated pyrotechnic block in the form of a multilayer block, said method comprising the following successive steps:

- 1) successive arrangement, in a shaping tool, of at least:
 - a) a layer (a) of initiating composition, and
 - b) a layer (b) of main composition,
- 2) shaping.

Preferably, the initiated pyrotechnic block obtained according to this method presents radial combustion.

Advantageously, the main layer is the majority layer of the block, i.e., it represents the greater proportion by weight of the initiated pyrotechnic block. In particular the layer of main composition represents between 60 and 95% by weight, especially between 80 and 92% by weight relative to the total weight of the initiated pyrotechnic block.

Shaping

In terms of the present invention, “shaping” means an operation aimed at fixing the final form of the pyrotechnic block. Preferably, the shaping is done via compression, casting or extrusion, even more preferably by compression.

- 5 In a particularly advantageous way the method according to the present invention comprises few operations relative to methods of the prior art. The method according to the present invention comprises essentially a first step of arranging the main and initiating compositions typically in the form of grains, then a shaping step, typically by compression, to produce an initiated pyrotechnic block. Advantageously, the method according to the invention comprises a single shaping step, step (2). The method according to the invention in fact produces initiated blocks directly following shaping step (2). It therefore generally needs no extra initiating or shaping step. The initiated block obtained directly on completion of the shaping step (2) can be used such as in a pyrotechnic device the initiating composition being already deposited on the main infrared composition in the block (by single compression).

The shaping is done in a compression tool capable of receiving the appropriate quantities of initiating composition and of main composition, and able to support strong pressure. It is clear that the tool used is not specific to the method, but is identical to what is classically used in the technique. By way of example of tool, there is a compression mold with a main body having a volume capable of receiving the compositions, a compression piston equipped with adapted punches (especially grooved) and a demolding piston; the whole being capable of resisting strong pressures.

When shaping is done by compression, the method according to the invention comprises advantageously a step 3) for demolding of the pyrotechnic block.

- 25 Advantageously, the initiating composition and the main composition are in the form of solid powder or dry grains, having a calibrated granulometry preferably between 0.5 and 5 mm, even more preferably between 0.5 mm and 2 mm, even more preferably between 0.8 and 1.2 mm. Advantageously, compression is uniaxial, taking place typically at pressure between 5 kPa and 50 kPa (5 tonnes and 50 tonnes) according to the composition(s) employed. Compression is advantageously performed at room temperature or hot between 30°C and 120°C, preferably between 30°C and 80°C.

When shaping is done by casting, the method according to the invention comprises advantageously a step 3') for drying of the pyrotechnic block. Drying is preferably conducted in an autoclave. Also, the initiating and main compositions exhibit a texture and viscosity compatible with a casting step.

5 *Grooving*

Preferably, the resulting pyrotechnic block is grooved typically in the longitudinal direction. The presence of grooves best circulates hot gases and accordingly imparts a more effective combustion regime to the initiating composition, with even and rapid ignition of all initiated surfaces. In fact, the grooves enlarge the contact surface between
10 the hot air and the grooved block, ensuring better homogeneity of radial combustion.

The grooving is particularly advantageous when radial combustion is preferred.

The grooving is obtained by way of the shaping step by use of a tool fitted with punches having an adapted form (especially grooving). So in a compression tool, the compartment into which the initiating and main compositions are poured is such that the form obtained
15 after compression corresponds to that of a grooved block.

Advantageously, in an extrusion tool the section of the nozzle has a grooved profile. For a method by casting, the compositions are advantageously cast in molds having grooved imprints.

As the method according to the invention needs no shaping step other than step (2), the
20 geometry of the block on completion of this step (2), especially as to what relates to the number and geometry of the grooves, corresponds generally to that of the finished product (pyrotechnic block directly utilizable in a pyrotechnic device).

So, the method according to the invention produces pyrotechnic blocks with "free" grooves of any composition, the initiating composition being already integrated into the
25 block (see figures 1 to 4).

The skilled person will adapt the number and geometry of grooves to the speed and preferred combustion profile, especially given the fact that combustion will typically occur in dynamic conditions, i.e. the initiated pyrotechnic block will be in movement during combustion.

Geometry of the initiated pyrotechnic block

In a particular embodiment, the pyrotechnic block is formed so as to obtain a multilayer parallelepipedic or cylindrical block, preferably grooved, typically in the longitudinal direction. Advantageously, the grooved layer comprises or consists of the initiating
 5 composition. An example of pyrotechnic parallelepipedic grooved block is given in figures 1 and 2. An example of grooved cylindrical pyrotechnic block is given in figures 3 and 4.

The initiated bi- and tri-layer pyrotechnic block

The multilayer block according to the invention comprises a minimum of two layers, the layer of initiating composition and the layer of main composition.

10 In a preferred embodiment the resulting block is tri-layer. In this embodiment the pyrotechnic block preferably comprises a central layer of a main composition, “sandwiched” or coated on two opposite sides (two opposite faces in the case of a parallelepiped, or two layers radially opposite in the case of a cylinder) or on either side with a layer of initiating composition. The method according to the invention comprises
 15 the following successive steps:

1) successive arrangement in this order, in a shaping tool, of:

- a) a first layer (a) of initiating composition,
- b) a layer (b) of main composition,
- c) a second layer (c) of initiating composition;

20 2) shaping.

In other words, in this embodiment step 1) further comprises arrangement of a layer (c) of an initiating composition such that the layer (b) of main composition is coated on two sides of an initiating composition (a) and (c).

According to a variant of this embodiment, the initiating compositions are identical in the
 25 layers (a) and (c). Typically, the layers (a) and (c) contain the same quantity by weight of initiating composition.

Preferably, the resulting tri-layer pyrotechnic block has grooves on at least two opposite faces, preferably on the faces of initiating composition.

Double initiating

As indicated above, the method according to the invention produces initiated blocks directly up on completion of the shaping step (2). It therefore needs no extra initiating step in general. The initiated block obtained directly up on completion of the shaping step (2) can be used as such in a pyrotechnic device.

- 5 In particular, in the case of grooved pyrotechnic blocks, the method according to the invention produces pyrotechnic blocks with grooves “free” of any composition, the initiating composition being already integrated into the block (see figures 1 to 4).

According to a variant, the method according to the invention makes pyrotechnic blocks “doubly initiated”. In fact, in an embodiment of the invention, the method comprises an
10 extra step of depositing an additional initiating composition (a’), preferably in the form of paste, in the grooves of the initiated and grooved pyrotechnic block according to the invention. The additional initiating composition (a’) is identical or different to the initiating composition(s) used in the initiating layer(s). The additional initiating composition (a’) is for example deposited manually in the grooves of the initiated and grooved pyrotechnic
15 block according to the invention. The pyrotechnic block doubly initiated has the advantage of supplying more power on initiation of the block (strong power on ignition) and therefore achieving a more effective rising front.

This particular embodiment (double initiating) combines the advantages of methods used previously and the method according to the invention, the latter producing an initiated
20 pyrotechnic block with free grooves, which was not the case of some methods of the prior art, which are filled with initiating composition in turn is in the form of viscous paste, on the first initiating layer obtained by compression – hence the name “double initiating”.

It is clear that the methods of the prior art with manual deposit of the initiating layer in the grooves of the pyrotechnic block, constituted solely by the main composition, failed to
25 produce “doubly initiated” blocks.

Advantageous embodiment

According to a preferred variant of the invention, it relates to a method for manufacturing an initiated pyrotechnic block in the form of a grooved multilayer block typically in the longitudinal direction, said method comprising the following successive
30 steps:

- 1) successive arrangement, in a shaping tool, of at least:

- a) a layer (a) of initiating composition, and
 - b) a layer (b) of main composition, typically classic or spectral,
- 2) shaping by compression, especially by means of grooved punches.

The skilled person will adapt the number and geometry of grooves to the preferred speed
 5 and combustion profile, especially given the fact that combustion will typically occur in dynamic conditions, i.e. the initiated pyrotechnic block will be in movement during combustion.

The initiated pyrotechnic block obtained according to this variant advantageously retains radial combustion.

10 Advantageously, the main layer is the majority layer of the block, i.e., it represents the greater proportion by weight of the initiated pyrotechnic block. In particular the layer of main composition represents between 60 and 95% by weight, especially between 80 and 92% by weight relative to the total weight of the initiated pyrotechnic block.

Shaping is performed in a compression tool capable of receiving the appropriate quantities
 15 of initiating composition and of main composition, and able to support strong pressure. By way of example of tool, there is a compression mold with a main body having a volume capable of receiving the compositions, a compression piston equipped with adapted punches (typically grooved punches) and a demolding piston; the whole being capable of resisting strong pressures.

20 In this preferred embodiment, the method advantageously comprises a single shaping step by compression.

In this preferred embodiment, the method advantageously comprises a demolding step 3) of the pyrotechnic block.

Advantageously, the main composition and the initiating composition are in the form of
 25 solid powder or dry grains, having a calibrated granulometry preferably between 0.5 and 5 mm, even more preferably between 0.5 mm and 2 mm, even more preferably between 0.8 and 1.2 mm. Advantageously, compression is uniaxial, taking place typically at pressure between 5 kPa and 50 kPa (5 tonnes and 50 tonnes) according to the composition(s) employed. Compression is advantageously performed at room temperature or hot between
 30 30°C and 120°C, preferably between 30°C and 80°C.

In this particular embodiment, the pyrotechnic block can be formed so as to produce a parallelepipedic, or cylindrical multilayer block.

The method can also comprise an extra step for depositing an additional initiating composition (a'), preferably in the form of paste, in the grooves of the initiated pyrotechnic block according to this preferred embodiment. The additional initiating composition (a') is identical or different to the initiating composition(s) used in the initiating layer(s). The additional initiating composition (a') is for example deposited manually in the grooves of the initiated pyrotechnic block.

Preferably, the obtained block is tri-layer. According to this variant, the pyrotechnic block comprises preferably a central layer of a main composition, "sandwiched" or coated on two opposite sides (two opposite faces in the case of a parallelepiped, or two layers radially opposite in the case of a cylinder) or on either side of a layer of initiating composition. The method comprises the following successive steps:

1) successive arrangement in this order, in a shaping tool, of:

- a) a first layer (a) of initiating composition,
- b) a layer (b) of main composition,
- c) a second layer (c) of initiating composition;

2) shaping by compression, especially by means of grooved punches.

The initiating compositions in the layers (a) and (c) can be identical or different. Typically, the layers (a) and (c) contain the same quantity by weight of initiating composition.

Preferably, the resulting tri-layer pyrotechnic block has grooves on at least two opposite faces, preferably on the faces of initiating composition.

Advantages of the method according to the invention

In this way, the method according to the invention noticeably reduces production cost and time of the initiated pyrotechnic blocks especially by reducing the number of operations carried out in the production method. In particular, a single compression step is sufficient to obtain an initiated pyrotechnic block, which may be used directly in a pyrotechnic device.

Also, a single compression step is sufficient to obtain cohesion of all the layers of the pyrotechnic block.

Also, the method according to the invention reduces the quantity of solvents used, as it is no longer necessary to work with a mixture at controlled viscosity (mixture in the form of paste for example). Also, the method according to the invention decreases, or even eliminates, some steps such as drying, especially in the case of shaping by compression, when the compositions are thermoplastic (classic decoy).

The method according to the invention also makes pyrotechnic blocks of unrivalled structure, and improves cohesion between the layers of initiating composition and of main composition. Since the interface between the initiating and main layers is linked more closely, combustion (generally radial) is more regular and a drop or even an overpressure of transitory combustion regimes is noted.

The present invention also relates to a method such as described previously, further comprising a crosslinking step by heating, when the initiating or main compositions are thermosetting (spectral decoy). In this case, the method according to the invention during crosslinking creates chemical bonds between the block and the initiating, on condition of having the same type of binder (of resin type) between the block and the initiating, consequently boosting the mechanical strength and transmission of fire between the block and the initiating.

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Initiated pyrotechnic block

The invention also proposes providing initiated pyrotechnic blocks, in the form of a preferably grooved multilayer block, obtainable by the method according to the invention, comprising at least one layer of initiating composition and a layer of main composition.

25 The initiated pyrotechnic blocks according to the invention have a particular arrangement. In fact, the initiating step of the blocks is no longer conducted after the shaping and steaming step, but during the shaping step, preferably during the compression step. The composition of the pyrotechnic block is “sandwiched” between the initiating compositions, typically in the form of dry grains in the compression tool.

30 The initiated pyrotechnic block advantageously has radial combustion.

Advantageously, the main layer is the majority layer of the block, i.e., it represents the greater proportion by weight of the initiated pyrotechnic block. In particular the layer of main composition represents between 60 and 95% by weight, especially between 80 and 92% by weight relative to the total weight of the initiated pyrotechnic block.

5 *Main classic composition*

According to a particular embodiment of the invention, the main composition of the block constitutes a classic decoy.

In this case, such a composition is preferably intended to emit in the infrared.

Advantageously, such a main composition comprises an MTV mixture: (Magnesium,

10 Teflon, Viton), comprising typically:

- between 30 and 60% of a reducer, preferably magnesium, zirconium, boron or mixtures thereof, and

- between 30 and 40% of a mixture of at least two fluoropolymers, the first fluoropolymer being selected from polytetrafluoroethylene, and the second fluoropolymer
15 being a fluoroelastomer advantageously selected from copolymers of vinylidene fluoride, hexafluoropropylene, perfluoromethylvinylether and/or tetrafluoroethylene or PMF (polymonofluoride) .

- optionally, between 2 and 20% of carbonaceous polymers or their co-polymers such as polypropylene, polybutadiene, polycarbonate, polyethylene or polystyrene.

20 Typically, the initiating composition used in combination with a classic main composition is thermoplastic, preferably comprising a MTV mixture: (Magnesium, Teflon, Viton), comprising typically:

- between 30 and 50% of a reducer, preferably magnesium, zirconium, boron or mixtures thereof, and

- between 30 and 40% of a mixture of at least two fluoropolymers, the first fluoropolymer being selected from polytetrafluoroethylene, and the second fluoropolymer
25 being a fluoroelastomere advantageously selected from copolymers of vinylidene fluoride, hexafluoropropylene, perfluoromethylvinylether and/or tetrafluoroethylene or PMF (polymonofluoride),

- optionally, between 2 and 8% of carbonaceous polymers or their co-polymers
30 such as polypropylene, polycarbonate, polyethylene or polystyrene.

In this case, the block now initiated during compression can be directly integrated into the DSMF (Safe and Initiation Device).

Main spectral composition

5 According to another embodiment of the invention, the main composition of the block constitutes a spectral decoy.

In this case, such a composition is intended to emit in the infrared field.

Advantageously, such a main composition is a mixture comprising:

- between 5 and 15% of a resin selected from a polyester, epoxy, polybutadiene
10 resin or its co-polymers;
- between 1 and 4% of an isocyanate-functional crosslinking agent such as: IPDI (isophorone diisocyanate),
- between 20 and 30% of oxidant such as ammonium perchlorate, ammonium nitrate, potassium nitrate, potassium chlorate or potassium perchlorate,
- 15 - between 2 and 5% of energetic molecules such as RDX (1,3,5-trinitroperhydro-1,3,5-triazine), HMX (cyclotetramethylenetetranitramine), and
- between 10 and 30% of reducer such as aluminium, zirconium, or mixtures thereof.

Typically, the initiating composition used in combination with a main spectral composition
20 is a thermosetting resin, preferably constituted by a mixture comprising:

- between 5 and 15% of a resin selected from a polyester, epoxy, polybutadiene resin or its co-polymers;
- between 1 and 4% of an isocyanate-functional crosslinking agent such as: IPDI (isophorone diisocyanate),
- 25 - between 20 and 30% of oxidant such as ammonium perchlorate, ammonium nitrate, potassium nitrate, potassium chlorate or potassium perchlorate,
- between 2 and 5% of energetic molecules such as RDX (1,3,5-trinitroperhydro-1,3,5-triazine), HMX (cyclotetramethylenetetranitramine), and
- between 10 and 30%, of reducer such as aluminium, zirconium or mixtures
30 thereof.

In this case, the initiated spectral block is autoclaved after compression to create chemical bonds between the block and the initiating. The consequence is a clear improvement in

cohesion between initiating composition and main composition, which further improves the infrared emission profile during combustion (and overall decoying performance), especially by cancelling the transitory regimes during passage of the combustion of the initiating layer to the main layer.

5 *Grooves*

Preferably, the initiated pyrotechnic block according to the invention is grooved, such as described hereinabove.

Double initiating

10 In a particular embodiment, the pyrotechnic block is “doubly initiated”. In this embodiment it comprises an additional initiating composition (a’) in the grooves of the initiated and grooved pyrotechnic block according to the invention. The additional initiating composition (a’) is identical or different to the initiating composition(s) used in the initiating layer(s).

Tri-layer block

15 In a preferred embodiment, the resulting block is tri-layer. In this embodiment the pyrotechnic block preferably comprises a central layer of a main composition (b), “sandwiched” or coated on two opposite sides (two opposite faces in the case of a parallelepiped, or two layers radially opposite in the case of a cylinder) or on either side with a layer of initiating composition, layers (a) and (c). Advantageously the initiating
20 composition is identical in the layers (a) and (c). Typically, the layers (a) and (c) contain the same quantity by weight of initiating composition.

Preferably, the resulting tri-layer pyrotechnic block has grooves on at least two opposite faces, preferably on the faces of initiating composition.

25 In a particular embodiment, the pyrotechnic block can also consist of several different main compositions sandwiched with the initiating composition.

In terms of the present invention it is understood that a main composition is the main composition of the block. This composition will provide the required effect during combustion. The main composition is the majority composition of the pyrotechnic block. The initiating composition is the initiation composition of this main composition.

Particular embodiments

In a particular embodiment, the pyrotechnic block can be partially sandwiched between the initiating composition and the main composition(s) of the block. Part of the block can be initiated in this way.

- 5 In a particular embodiment, the pyrotechnic block can be partially grooved (the groove advantageously circulates the ignition gas during initiation of the block) and initiated. Part of the block can be “sandwiched” between the initiating composition and the main composition of the block.

- 10 In a particular embodiment, the pyrotechnic block can be initiated and not grooved. The whole block is initiated where the main composition is “sandwiched” by the initiating composition over the full length.

- 15 In a particular embodiment, the pyrotechnic block can be entirely initiated with several initiating compositions and grooved. In fact, the main composition is sandwiched with an initiating composition or several initiating compositions. In this embodiment, the first initiating composition can be shaped at the same time as the main composition and the other initiating compositions formed in a second instance. In this way, it is possible to have an initiating composition A1 on a preferred part of the block, then have an initiating composition A2 on the rest of the block. So, several different formulations can be used, on all or part of the block as a function of performance requirement.

20 *Preferred embodiment*

According to a preferred variant, the invention relates to an initiated pyrotechnic block in the form of a grooved multilayer block comprising at least one layer of initiating composition and a layer of main composition, likely to be obtained by the method according to the invention, in which the shaping step is performed by compression.

- 25 Preferably, the initiated pyrotechnic block is of “sandwich” type, i.e., it comprises three layers: a layer of main composition typically classic or spectral, “sandwiched” or between two layers of initiating composition.

The composition of the pyrotechnic block is “sandwiched” between the two layers of initiating composition which is typically in the form of dry grains in the compression tool.

Advantageously, the main layer is the majority layer of the block, i.e., it represents the greater proportion by weight of the initiated pyrotechnic block. In particular the layer of main composition represents between 60 and 95% by weight, especially between 80 and 92% by weight relative to the total weight of the initiated pyrotechnic block.

5 *Advantages of initiated pyrotechnic blocks according to the invention*

The initiated pyrotechnic blocks according to the invention have several advantages relative to initiated blocks of the prior art:

- improvement in fire transmission between the block and the initiating, resulting especially in overpressure of transitory combustion regimes,
- 10 - clearly improved physical properties of the initiating,
- improvement of mechanical resistance to external attacks of the pyrotechnic block.
- improvement of the thermal efficiency of combustion,
- increase in shelf life of initiating compositions prior to shaping,
- 15 - reduction in manufacturing phases of the initiating composition.

In particular, the pyrotechnic blocks according to the invention have excellent resistance to vibrations, especially relative to pyrotechnic blocks made according to methods of the prior art, in particular methods comprising manual or automatic deposit of the initiating composition.

20

Devices and Use

The present invention also relates to a pyrotechnic device comprising a pyrotechnic block according to the invention.

Preferably, the initiated block according to the invention is inserted into a pyrotechnic device. This pyrotechnic device is advantageously a cartridge, to which an initiation system is typically added. In an embodiment of the invention, the cartridge is mounted in a magazine to be used from an aircraft.

25 The present invention also relates to use of the pyrotechnic block according to the invention or the device according to the invention as infrared decoy.

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DESCRIPTION OF THE FIGURES

Figure 1: Drawing of an initiated pyrotechnic block in the form of a parallelepipedic tri-layer block comprising a central layer of a main composition (b), “sandwiched” or coated on two opposite sides of a layer of initiating composition, layers (a) and (c). The block is grooved on the faces of a layer of initiating composition, and the grooves (d) are longitudinal.

Figure 2: Photograph of an initiated pyrotechnic block on exiting the production line in the form of a tri-layer block comprising a central layer of a main composition (b), “sandwiched” or coated on two opposite sides of a layer of initiating composition, layers (a) and (c), obtained as per example 1, in parallelepipedic form.

Figure 3: Drawing of an initiated pyrotechnic block in the form of a cylindrical tri-layer block comprising a central layer of a main composition (b), “sandwiched” or coated on two opposite sides of a layer of initiating composition, layers (a) and (c). The block is grooved on the faces of layer of initiating composition, and the grooves (d) are longitudinal.

Figure 4: Photograph of an initiated pyrotechnic block on exiting the production line in the form of a tri-layer block comprising a central layer of a main composition (b), “sandwiched” or coated on two opposite sides of a layer of initiating composition, layers (a) and (c), obtained as per example 1, in cylindrical form.

Figure 5: Drawing showing a profile of radial (a) or axial (b) combustion. The arrows indicate the direction of combustion.

Figure 6: Radiometric measurement of infrared decoys of spectral type in dynamic configuration. Curve in solid lines: tri-layer block of sandwich type according to the invention. Curve in dots: block made according to the prior art. Significant improvement in performance at the start of combustion is noted, with excellent fire transition between the block and the initiating. The axis of abscissae represents time. The axis of ordinates represents luminance (in watt per steradian).

Figure 7: Radiometric measurement of infrared decoys of classic type in static configuration. Curve in solid lines: tri-layer block of sandwich type according to the invention. Curve in dots: block made according to the prior art. Significant improvement in performance at the start of combustion is noted, with excellent fire

transition between the block and the initiating. The axis of abscissae represents time. The axis of ordinates represents luminance (in watt per steradian).

EXAMPLES

5 **Example 1: IR Spectral Decoy**

Manufacture in planetary mixer, in solvent, the same day, of compositions of the block then of the initiating. The compositions are granulated to produce a calibrated size of grain of around 1.2 mm. Next the resulting grains are dried at 50°C for 2h to evaporate the solvent. The result therefore is compositions in the form of non-crosslinked dry grains.

10 The initiating composition is a mixture comprising:

- between 5 and 15% of a resin selected from a polyester, epoxy, polybutadiene resin or its co-polymers;

- between 1 and 4% of an isocyanate-functional crosslinking agent such as: IPDI (isophorone diisocyanate),

15 - between 20 and 30% of oxidant such as ammonium perchlorate, ammonium nitrate, potassium nitrate, potassium chlorate or potassium perchlorate,

- between 2 and 5% of energetic molecules such as RDX (1,3,5-trinitroperhydro-1,3,5-triazine), HMX (cyclotetramethylenetetranitramine), and

20 - between 10 and 30% of reducer such as aluminium, zirconium or mixtures thereof.

In the compression tool, fitted with grooved punches on at least 2 opposite faces, the layers following are arranged successively:

- a) a first layer (a) of initiating composition, on the grooved punches side,
 - 25 b) a layer (b) of main composition,
 - c) a second layer (c) of initiating composition, on the grooved punch side
- (see figure 2).

Around 4 grams of initiating composition are placed uniformly over the entire surface to form the layer a). The initiating composition of the layer a) is on the side of the grooved punches. To form the layer b), around 90g of main composition is placed uniformly above
30 the layer a). Finally, the second initiating layer c) is placed uniformly over the entire

surface above the layer b). The initiating composition of the layer c) is on the side of the grooved punches.

Metering the compositions and their deposit in the compression tool can be done automatically and the masses can be adjusted as a function of the calibers.

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The piston is then brought down onto this succession of layers to apply a compression rate of 10 kPa (10 tonnes) for 10 seconds. The compression rate is adapted to the manufactured caliber.

The whole is then demolded, by automatic cycle of the press, by reverse thrust.

10 The initiated IR block is obtained directly in a single compression step.

The initiated block is then autoclaved at 70°C for 5 days to undergo crosslinking for binding the layer of main composition to the layers of initiating composition. Chemical bonds are therefore created between the layer of main composition and the layers of initiating composition.

15 A photograph of the thus obtained block by the method according to the invention is given in figure 6a or 6b (as a function of the form of the compression tool).

It is no longer necessary to give it to the next workshop for it to be initiated by manual or automatic deposit by means of a cannula.

Next, the Safe and Initiation Device (DSMF) is added to realize integration into the

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Example 2: Performance of the blocks according to the invention

The performance of the blocks according to the invention were compared to those obtained with a block of the prior art (i.e. initiated by manual deposit) during dynamic

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firing for the “spectral” block pyrotechnic of example 1 and during static dynamic firing for the “classic” pyrotechnic block of example 1.

Experimental device:

After assembly of the DSMF in the initiated block, the whole is placed in a cartridge.

For dynamic firing: the cartridge is positioned on a chariot which will be launched at a certain speed on a rail, then the decoy in a cartridge will be launched to simulate ejection by aircraft.

Measuring means such as radiometers and thermographs are arranged to measure the
5 infrared performance of the blocks, in dynamic firing.

For static firing: the sub-assembly is wedged on a fixed support, and the decoy is initiated. The infrared performance is measured by means of radiometers

Results

10 Figure 6 demonstrates on the one hand that the rising front obtained with a block according to the invention is faster and higher than with a block according to the prior art and on the other hand that the block/initiating transition is no longer marked by a hollow at the performance level (block according to the prior art) corresponding to a
15 transitory combustion regime, but continuous measuring of the infrared signal (block according to the invention).

The remarks are the same in figure 7.

So, figures 6 and 7 illustrate the disappearance of the transitory regime obtained with the initiated pyrotechnic blocks according to the invention, also in dynamic or static firing conditions.

20 In conclusion, the blocks according to the invention increase throughput, simplify the method which needs far fewer means and personnel, show significant improvement in transition of combustion between initiating composition and main composition (with overpressure of transitory combustion regimes), which especially increases the rising front, but also confers on the initiating composition better mechanical resistance
25 (passage of vibrations and shock tests and strong cohesion with the block).

Claims

1. A method for manufacturing an initiated pyrotechnic block in the form of a grooved multilayer block, said method comprising the following successive steps:

1) successive arrangement, in a shaping tool, of at least:

a) a layer (a) of initiating composition, and

b) a layer (b) of main composition,

2) shaping by compression.

2. The method of claim 1, characterized in that it comprises a single shaping step by compression.

3. The method of claim 1 or 2, characterized in that the initiating composition and the main composition are in the form of dry grains.

4. The method of any one of claims 1 to 3, characterized in that step 1) further comprises arrangement of a layer (c) of an initiating composition, such that the layer (b) of main composition is coated on two opposite sides with an initiating composition (a) and (c).

5. The method of any one of claims 1 to 4, characterized in that the main layer represents between 60 and 95% by weight, especially between 80 and 92% by weight relative to the total weight of the initiated pyrotechnic block.

6. The method of any one of claims 1 to 5, characterized in that it comprises an extra step of depositing an additional initiating composition in the grooves of the initiated pyrotechnic block, the additional initiating composition preferably being in the form of a paste.

7. The method of any one of claims 1 to 6, characterized in that the obtained initiated pyrotechnic block has radial combustion.

8. The initiated pyrotechnic block in the form of a grooved multilayer block, obtainable by the method according to any one of claims 1 to 7 comprising at least one layer of initiating composition and a layer of main composition.
9. The initiated pyrotechnic block of claim 8, characterized in that it comprises a central layer of a main composition (b), coated on two opposite sides with a layer of initiating composition, layers (a) and (c).
10. The initiated pyrotechnic block of any one of claims 8 or 9, characterized in that the main layer represents between 60 and 95% by weight, especially between 80 and 92% by weight relative to the total weight of the initiated pyrotechnic block.
11. The initiated pyrotechnic block of any one of claims 8 to 10, characterized in that it comprises an additional initiating composition in the grooves of the initiated pyrotechnic block.
12. The initiated pyrotechnic block of any one of claims 8 to 11, characterized in that it has radial combustion.
13. A cartridge comprising an initiated pyrotechnic block according to any one of claims 8 to 12.
14. Use of the initiated pyrotechnic block according to any one of claims 8 to 12 or of the cartridge according to claim 13 as infrared decoy.