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The present invention relates to a pyrotechnic delay element for delay fuses, at least composed of a transmission fuse composition which is made up of fuel* and an oxidising agent, a delay fuse composition which is made up of fuel, an oxidising agent, a binding agent, a sensitizer and an inert additive, and a fuse composition which is for the main charge, the fuse compositions being arranged one behind the other in a case. Furthermore, preferred applications of the delay element are claimed.

Delay fuses and what are known as delay-action compositions are known (Rudolf Meyer, "Explosivstoffe" [Explosives], page 329, 1979, Verlag Chemie). From US-PS 3,981,222 there is known a method of manufacturing a delay fuse composition, with which method there can be obtained delay times of up to 18 seconds per inch of the power mixture used. Here corruscatives known per se are placed into a capsule which is constructed of paper reinforced with glass fibre and has baffle plates in its interior in order to lengthen the burning course. The size of a capsule of this type given as an example is 1 7/16 inches in diameter and 0.2 of an inch thick, it brings about a delay time of 8 seconds. The ratio of delay time to size permits such capsules to be used solely with large-calibre weapons and systems. The use of paper reinforced with glass fibre is frowned upon in pyrotechnics for reasons of safety (friction ignition; damage). Likewise there is the risk that the safety and/or the reproducibility of the delay time is/are

* The German literally reads 'a fuel carrier and an oxidising agent' - the dash after Brennstoff is presumably a mistake and has been treated as such.

disturbed by discontinuous burning due to heat accumulations in the heat-insulating glass-fibre paper and by the inserted baffle plates.

The problem of the present invention is therefore to develop a pyrotechnic delay element which due to its size can also be used in medium-calibre weapons (above 20 mm in diameter), which has a high level of safety and which, even in series production, achieves delay times which can be reproduced exactly. Moreover, the design should be such that no expensive and difficult to manufacture baffle plates are necessary.

This problem is solved in that the case is composed of a metallic material with a high resistance to heat and chemicals and in that the delay fuse composition is composed of a mixture made up of a metallic fuel, a halogen-containing polymerized oxidizer and a metallocene as a sensitizer.

The solution in accordance with the invention enables the manufacture of delay elements with dimensions which correspond to modern detonator caps functioning on a silver azide basis. The actual main charges are composed of high-power explosives of a known type, such as nitropenta, tetryl, hexogen (RDX), octogen (HMX), octastite etc.

The delay element described in Claim 2 is mainly used in weapon systems with which no electric energy for the ignition device is provided.

The delay element is advantageously produced with the case in accordance with Claim 3, since in addition to excellent heat conductance this case also has a high degree of resistance to chemicals.

The metallocenes listed in Claim 4 have particularly proved their worth in the delay fuse composition as

sensitizers.

As an oxidizer the polytetrafluoroethylenes (Teflon, Hostaflon; trade marks) or polymonochlorotrifluoroethylenes standard in trade, in accordance with Claim 5, have proven to be advantageous out of a number of halogen-containing substances of high molecular weight.

A targeted additional temporal delay in the consumption of the delay fuse composition can be achieved by the mixing therewith of inert additives, in accordance with Claim 6.

The oxidising agent lead chromate in the proportion stated in Claim 7 has proved very favourable in the delay fuse composition.

The applications of the invention subject-matter in accordance with Claims 8 and 9 have become possible through the advantages discussed in the preceding Claims.

The initiation of physical processes can be effected in a simple manner by a pyrotechnic delay element, Claim 10. This is particularly favourable when mechanical and/or electronic delay elements are out of the question due to high accelerative forces or other disturbance variables or when no appropriate energies are available.

Embodiments of the subject matter of the invention are described below with the aid of drawings.

Fig. 1: shows a pyrotechnic delay element, suitable in connection with an electrically initiated miniature detonator cap and

Fig. 2: shows a delay element with a priming fuse composition to be initiated by means of a striking pin.

The pyrotechnic delay element in Fig. 1 is composed of a metallic case 1 of light metal into which there are inserted one behind the other: a transmission fuse composition 3, a delay fuse composition 4 and a fuse composition 5 which is for a main charge 6. This light-metal case 1 is manufactured in a manner known per se from a copper-free light metal (material DIN 1' 725 No.: 3.0615) and is 17 mm in length and 5 mm in diameter. The wall thickness of the case 1 is 0.75 mm; at the priming-side the case has a bore 1a into which there is mounted a detonator cap ZK standard in the trade. At the main-charge side, a covering disc 7 of 0.3 mm [thickness of] copper-free aluminium is inserted over a bore 1b. When the delay time has expired, the covering disc 7 is staved in by the arising blast wave and ignites the charge (explosive or explosive charge) - not shown - in a known manner.

The transmission fuse composition 3 is composed of a mixture of silicon, lead chromate, red lead and nitrocellulose. The silicon, acting as a fuel and having a grain size of 25 μm , is present with a proportion by weight of 30% in the transmission fuse composition. Lead chromate with 30 weight-%, red lead with 37 weight-%; both the latter assume the function of an oxidising agent. Nitrocellulose acts as a binding agent with a proportion by weight of 3%.

This fuse composition, in the form of a powder, is manufactured using constituents of grain size standard in the trade. These constituents are wet-mixed in an acetone solution. This mixture is homogenized by ultrasound and is then air-dried and granulated in a known manner. A granule size of 0.5 to 0.7 mm with a subsequent further drying at 60°C has particularly proved its worth.

The transmission fuse composition is inserted into the

case 1 by being poured into the latter and subsequently pressed.

This transmission fuse composition ensures a reliable ignition of the subsequent delay fuse composition. In spite of a high temperature of reaction, this transmission fuse composition only liberates gas to a small degree, this keeping the remaining components from igniting prematurely.

A pyrotechnic delay element of the type described above achieves reproducible delay times of 20 secs.; the fluctuation within a production run of 100 delay elements is at maximum plus/minus 0.9 secs.

The manufacture of the delay fuse composition 4 takes place in an analogous manner to the below-described manufacture of the priming fuse composition 2. The result is a delay fuse composition which burns away very slowly and has relatively high temperatures of reaction from 350 - 650°C and only a very low gas output. The preferred embodiment has as a fuel tungsten with 10 weight-% and as an oxidising agent lead chromate with 77 weight-%. Nitrocellulose serves as a binding agent with a proportion of 2 weight-% and furthermore there are also present ferrocene as a sensitizer with 1 weight-% and polytetrafluoroethylene in its role as an oxidizer with 10 weight-%.

The delay element in Fig. 2 has a similar construction to that in Fig. 1. Here only a priming fuse composition 2 which is closed off by a covering disc 8 is added. Here instead of a jet of flame, a pin, a striking pin or the like is driven into the priming composition 2 to initiate the ignition. The covering disc 8 is again

made from copper-free aluminium and is 0.1 mm thick.

It is consequently the object of the priming fuse composition 2 to ensure the communication of the pyrotechnic reaction in the ignition chain in the presence of a small amount of energy necessary for its introduction. A powder mixture composed of antimony trisulphide with a proportion of 40 weight-% and lead thiocyanate with 6 weight-%, friction agents and calcium silicide with 8 weight-% has proved to be optimum; it serves as a fuel. Furthermore there are present potassium chlorate as an oxidising agent with a proportion of 40 weight-% and tetracene as a sensitizer with 6 weight-%. The mixture of these composition constituents, which are in the form of powder, in their standard-in-trade grain sizes of approximately 10 - 200 μm according to the constituent are mixed with one another in a process known per se using a tumbling mixing drum (what is known as the TURBULA-Process) and then the mixture is measured out and pressed into the appropriate dimensions. In order to receive the striking pin or the pin, the case 1' has in its end face an opening which is smaller than the opening in case 1 in Fig. 1.

Priming fuse compositions in the following mixture ratios have proved their worth:

Antimony trisulphide	30 to 50 weight-%
lead thiocyanate	5 to 15 weight-%
calcium silicide	5 to 10 weight-%
potassium chlorate	30 to 50 weight-%
tetracene	2 to 7 weight-%

With both delay elements Fig. 1 and Fig. 2, transmission

fuse compositions with the following mixtures can be used:

silicon	10 to 40 weight-%
lead chromate	20 to 40 weight-%
red lead	20 to 50 weight-%
nitrocellulose	1 to 5 weight-%

Delay fuse compositions with a long delay time can have the following mixture ratios:

tungsten	5 to 30 weight-%
lead chromate	50 to 80 weight-%
nitrocellulose	1 to 4 weight-%
ferrocene	1 to 4 weight-%
polytetrafluoroethylene	5 to 20 weight-%

The burning away speed of a delay fuse composition can furthermore be predetermined by inert additives such as glass powder, micro balloons (small gas balls which are evacuated or filled with air or an inert gas), barium sulphate, metallic salicylates such as copper salicylates and/or sandwich molecules.

During burning away of the delay fuse composition, in the same way as as in the priming fuse composition initiated by a striking pin, the metallocene acting as a sensitizer is — in spite of its low proportion in the mixture — attributed great importance with regard to increasing the operational safety. In addition to or instead of ferrocene, the following metallocenes can be used successfully: nickelocene, cobaltocene and ruthenocene.

In experiments, delay times from 1 to approximately 30 seconds can be fixed in a reproducible manner.

Claims

1. A pyrotechnic delay element at least composed of a transmission fuse composition (3) which is made up of fuel and an oxidising agent, a delay fuse composition (4) which is made up of fuel, an oxidising agent, a binding agent, a sensitizer and an inert additive, and a fuse composition which is for the main charge (5), the fuse compositions being arranged one behind the other in a case (1), characterized in that the case (1) is composed of a metallic material with a high resistance to heat and chemicals and in that the delay fuse composition (4) is composed of a mixture made up of a metallic fuel, a halogen-containing polymerized oxidizer and a metallocene as a sensitizer. (Fig. 1)
2. A pyrotechnic delay element in accordance with Claim 1, having a priming fuse composition (2) which is initiated by a striking pin and is arranged in the metallic case (1'), characterized in that the priming fuse composition (2) is composed of a mixture made up of an initiating explosive, a fuel and a metallocene as a sensitizer. (Fig. 2)
3. A pyrotechnic delay element in accordance with Claim 1 or Claim 2, characterized in that the metallic case (1, 1') is composed of a copper-free light metal (Fig. 1; Fig. 2)
4. A pyrotechnic delay element in accordance with Claim 1 or 2, characterized in that the sensitizer is composed of ferrocene and/or nickelocene and/or



cobaltocene and/or ruthenocene.

5. A pyrotechnic delay element in accordance with Claim 1, characterized in that the oxidizer is a polytetrafluoroethylene or a polymonochlorotrifluoroethylene.
6. A pyrotechnic delay element in accordance with Claim 1, characterized in that inert additives such as glass powder, glass balls or barium sulphate are added to the delay fuse composition (4).
7. A pyrotechnic delay element in accordance with Claim 1, characterized in that lead chromate with a proportion by weight of 50 to 80 % is added to the delay fuse composition as an oxidising agent.
8. An application of a pyrotechnic delay element for the temporal control of the self-disintegration of a projectile and/or a secondary projectile.
9. An application of a pyrotechnic delay element for starting the ignition of an explosive charge of a projectile at the end of the latter's flight time and after the latter has penetrated into a target.
10. An application of a pyrotechnic delay element for initiating a physical process with a predetermined delay time.



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