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(54) **Igniting substance mainly for industrial detonators with the explosion delay time up to 9000 ms after ignition, methods of its production, and industrial electric detonator and industrial non-electric detonator**

(57) An igniting substance mainly for detonators made of a metallic salt of 4,6-diaziido-N-nitro-1,3,5-triazine-2-amine selected from a group of salts containing silver salt, copper(I) salt and copper(II) salt, with the following skeletal formula



where M is a metal selected from a group comprising silver and copper:

M = Ag, m = 1, n = 1, x = 1 for silver salt,

M = Cu, m = 1, n = 2, x = 2 for copper(I) salt,

M = Cu, m = 2, n = 2, x = 1 for copper(II) salt.

Production method of silver salt of 4,6-diaziido-N-nitro-1,3,5-triazine-2-amine, when the heated aqueous solution of 4,6-diaziido-N-nitro-1,3,5-triazine-2-amine is mixed with the aqueous solution of silver nitrate AgNO₃ and, while stirring vigorously, the silver salt of 4,6-diaziido-N-nitro-1,3,5-triazine-2-amine is precipitated and then filtered off and dried at laboratory temperature.

Production method of silver salt of 4,6-diaziido-N-nitro-1,3,5-triazine-2-amine, when the heated aqueous solution of 4,6-diaziido-N-nitro-1,3,5-triazine-2-amine is mixed with the aqueous solution of silver nitrate AgNO₃ and, while stirring vigorously, the silver salt of 4,6-diaziido-N-nitro-1,3,5-triazine-2-amine is precipitated and

then filtered off and dried at laboratory temperature.

A non-electric industrial detonator which has a casing in the form of a cup (1) with an inserted detonation tube (19) and a space (11) for the secondary explosive at the bottom of the cup (1) closed with a lid (15), where the space is closed at the top with a time-delay device (12) with a cylindrical case containing delay-action composition (14) and with the primary explosive (13) below it, above the space (11) for the secondary explosive as the igniting substance which is metallic salt of 4,6-diaziido-N-nitro-1,3,5-triazine-2-amine selected from a group of salts containing silver salt, copper(I) salt and copper (II) salt.

An electric industrial detonator which has a casing in the form of a cup (2) with an inserted electric fuse head (25) provided with supply cables (26) where in the casing there is space (21) at least for the secondary explosive and for the time-delay device (14) with a cylindrical case containing delay-action composition (14) and with the primary explosive (13) below it, above the space (11) for the secondary explosive where the primary explosive (13) as the igniting substance is metallic salt of 4,6-diaziido-N-nitro-1,3,5-triazine-2-amine selected from a group of salts containing silver salt, copper(I) salt and copper (II) salt.

DescriptionField of the Invention

[0001] This invention relates to an igniting substance for electric and non-electric detonators for industrial purposes, where a primary explosive with explosion delay time from 0 to 9000 ms after ignition is used. The igniting substance will be compacted in a casing of a delay-action device, fuse or sleeve, for detonators ignited by an electric fuse head by an impulse generated by an exploder, as well as for detonators ignited by a non-electric detonation tube by means of a shock wave or a spark generated by an exploder.

[0002] This invention also relates to two independent methods of the igniting substance manufacture.

[0003] Apart from that, this invention relates to electric detonators in series or series-parallel connection.

[0004] As an independent invention it also relates to a non-electric detonator with a firing circuit consisting of connected detonation tubes of non-electric detonators, particularly for surface destruction of rocks, mining in quarries, underground mining of rocks and tunnel excavation. The detonators according to the invention are to be used together with the igniting substance.

Prior State of the Art

[0005] Explosives are a group of chemical compounds that are ignited easily and start burning or explode quickly by means of external mechanical impulses (friction, impact, spearing) or by virtue of fire, heat, light, an electric spark or sound (generally by means of a uniform initial impulse). The output is then a shock wave or flame, depending on the explosive properties and design of the ignition device. The type of the output impulse is always selected according to the actual ignition system. In case of detonators, for instance, the desirable type of the output is a shock wave, while in case of caps, igniter and fuse head it is flame.

[0006] The explosives using an igniting substance in detonators must meet a number of stringent requirements so that the substance can be used to the given purpose. These requirements include, in particular, high ignition strength, i.e. the explosive should explode at the lowest weight by means of a uniform initial impulse and in the given design. The detonation of the explosive generates a shock wave that must have sufficient intensity to initiate the other members of the ignition chain, in case of detonators, it is less sensitive secondary filling of penthrite $C_5H_8N_4O_{12}$, hexogene $C_3H_6N_6O_6$ or hexanitrostilbene (HNS). The higher the ignition strength, the lower the charge required for the given system, which brings financial savings and reduced risk of accidental explosion in production, as smaller quantity of the explosive is processed for the given quantity of the products.

[0007] Currently, lead(II) azide $Pb(N_3)_2$ is used as the explosive for detonators. This explosive has high ignition strength and proven technology of its production. Lead(II) azide, however, contains lead in its molecule, which is released by detonation in metallic form as vapour. Lead is a heavy metal, which deposits in human body with highly toxic effects on human organism. Therefore, the research in the field of explosives is today focussed on compounds that have no toxic effects on humans and are environmentally acceptable.

[0008] A natural substitute of lead(II) azide is silver azoimide AgN_3 . Silver azoimide is characterised by high ignition strength surpassing that of lead(II) azide. Silver azoimide can be prepared using the same process equipment in a manner similar to that of lead(II) azide - by simple precipitation of silver azoimide in reaction of aqueous solutions of sodium azoimide and silver nitrate. Unfortunately, silver azoimide produced in this way has an unsuitable, highly sensitive and very fine form preventing its industrial use. Therefore, in the 1950s, a new method of its production based on slow crystallisation of ammoniac solution was developed. The process equipment, however, differs from the process equipment used for the production of lead(II) azide (Taylor G. W. C.: The manufacture of silver azide RD 1336; 2/R/50 accession No. ADA 474242; ERDE, Waltham Abbey; 1950; GB 781 440 from 1957; GB 887 141 from 1962).

[0009] Recently, several compounds that should meet the stated requirements have been published. Fronabarger et al. in patents *WO 2010/085583* and *US 2009/0069566* published the preparation and use of copper(I) salt of 5-nitro-1H-tetrazole. This compound is characterised by high brisance (plate dent test) and temperature stability (DSC decomposition 335°C), surpassing lead(II) azide in both these characteristics.

[0010] Patent US 7 375 221 from 2008 describes the preparation of alkali salts of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine. Rubidium and caesium salts of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine were tested as potential substitutes of lead explosives (Hirlinger J. M., Bichay M.: New primary explosives development for medium caliber stab detonators, report SERDP PP-1364, US Army ARDEC, 2004). Nevertheless, both salts showed low brisance in the plate dent test (0.5 mm pro for caesium salt and 0.8 mm for rubidium salt, vs. 37.3 for lead(II) azide).

[0011] Millar (Millar R. W.: Lead-free initiator materials for small electro-explosive devices for medium caliber munitions, report PP-1306, QinetiQ/FST/CR032702/1.1; 2003) tested silver azoimide, silver salt of 5-nitro-1H-tetrazole, potassium salt of dinitroacetone nitrile and copper(II) salt of ethylendinitramine. The first two compounds were assessed as prospective for further research, while the other two were excluded for their low brisance.

[0012] Cyanuric triazide, a compound which has been known for more than one hundred years, has also been tested recently as a substitute of lead(II) azide (Mehta N., Cheng G., Cordaro E., Naik N., Lateer B., Hu C., Stec D., Yang K.: Performance testing of lead-free stab detonator, proceeding of NDIA fuze conference, 2006). Cyanuric triazide is characterised by high ignition strength. What is more, it could be produced using the same process equipment as that for lead(II) azide. The substance has low physical stability though. The melting temperature is only 94°C and the substance sublimates at mere 30°C (Danilov J. N., Ilyusin M. A., Tselinsky I. V.: Promyshlennye vzryvchatye veshchestva; Part I. Iniciruyushchie vzryvshchatye veshchestva, Sankt-Peterburgskii gosudarstvennyi tekhnologicheskii institut, Sankt-Peterburg 2001).

[0013] The present invention aims at providing a substitute for lead(II) azide currently used as an igniting substance in detonators which is environmentally objectionable. Another aim is to develop a simple production method for the new substance. The invention also aims at developing an electric detonator and a non-electric detonator that would be suitable for use with the new igniting substance according to this invention.

Figures in Drawings

[0014] The invention is described using the drawings attached, where Fig. 1 shows a skeletal formula of the metallic salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine, where M is a metal selected from a group comprising silver and copper:

M = Ag, m = 1, n = 1, x = 1 for silver salt,

M = Cu, m = 1, n = 2, x = 2 for copper(I) salt,

M = Cu, m = 2, n = 2, x = 1 for copper(II) salt.

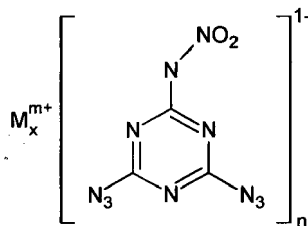
[0015] Fig. 2 is a schematic representation of the production reaction for the preparation of silver salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine from 4,6-diazido-N-nitro-1,3,5-triazine-2-amine.

Fig. 3 is a schematic representation of the production reaction for the preparation of silver salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine from sodium salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine.

Fig. 4 shows an industrial electric delay-action detonator while Fig. 5 shows an industrial non-electric delay-action detonator

Nature of the Inventions

[0016] The subject of the first independent invention is an igniting substance to be used mainly in industrial detonators. It is based on the principle that the igniting substance is made of a metallic salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine selected from a group of salts containing silver salt, copper(I) salt and copper(II) salt, with the following skeletal formula



where M is a metal selected from a group comprising silver and copper:

M = Ag, m = 1, n = 1, x = 1 for silver salt,

M = Cu, m = 1, n = 2, x = 2 for copper(I) salt,

M = Cu, m = 2, n = 2, x = 1 for copper(II) salt.

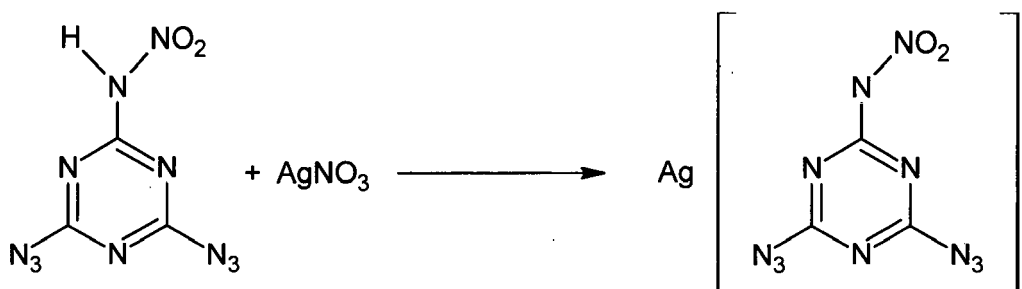
[0017] The igniting substance may be a combination of silver salt and/or copper(I) salt and/or copper(II) salt and it may be complemented with other substances.

[0018] The major advantage of the igniting substance according to this invention is that it substitutes lead(II) azide currently produced and used as an igniting substance in detonators. It reduces the environmental load of the use of explosives as no lead is released into the natural environment. The detonation products contain no toxic heavy metals. The detonation of the aforementioned salts of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine generates silver and copper in their elemental states which, contrary to lead, are not toxic.

Comparison of the amount of lead generated by the detonation of 60 mg of the explosive (average detonator charge):

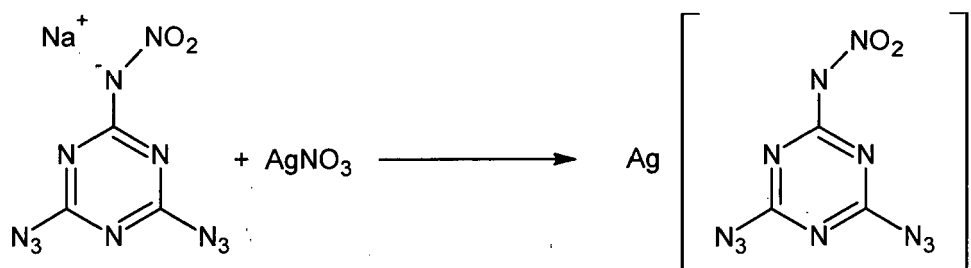
Substance	Lead content in detonation products (mg)
Silver salt of 4,6-diazo- <i>N</i> -nitro-1,3,5-triazine-2-amine	0
Copper(I) salt of 4,6-diazo- <i>N</i> -nitro-1,3,5-triazine-2-amine	0
Copper(II) salt of 4,6-diazo- <i>N</i> -nitro-1,3,5-triazine-2-amine	0
Lead(II) azide	42.7

[0019] The essence of the second independent invention, which is the production method of silver salt of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine, lies in that the heated aqueous solution of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine is mixed with the aqueous solution of silver nitrate AgNO_3 and, while stirring vigorously, the silver salt of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine is precipitated and then filtered off and dried at laboratory temperature



[0020] In a specific advantageous embodiment the solution of 0.5 g of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine in 20 ml of water (2.24 mmol) is heated at the temperature of $45^\circ\text{C} \pm 3^\circ\text{C}$, then the solution of 0.44 g of silver nitrate AgNO_3 in 20 ml of water (2.59 mmol) is added and the produced precipitate of silver salt of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine is left in the solution for 35-55 minutes while stirring it vigorously and then filtered off and let dry.

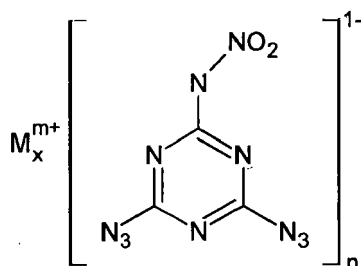
[0021] The essence of another independent invention, which relates to the production method of the silver salt of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine, lies in that the heated aqueous solution of the sodium salt of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine is mixed with the aqueous solution of silver nitrate AgNO_3 and, while stirring vigorously, the silver salt of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine is precipitated and then filtered off and dried at laboratory temperature



[0022] In a specific advantageous embodiment of the production method of the silver salt of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine the solution of 0.55 g of the sodium salt of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine in 20 ml of water (2.24 mmol) is mixed with the aqueous solution of silver nitrate AgNO_3 (2.59 mmol) is added and the produced precipitate of silver salt of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine is left in the solution for 35-55 minutes while stirring it vigorously and then filtered off and let dry.

[0023] The advantages of both production methods are the possible use of the existing production equipment as well as low demands on production technology and investments.

[0024] An independent invention is also a non-electric industrial detonator which is designed only for use with the igniting substances according to the invention. It has a casing in the form of a cup with an inserted detonation tube and a space for secondary explosive at the bottom of the cup closed with a lid. The space is closed at the top with a time-delay device with a cylindrical case containing delay-action composition and with the primary explosive below it, above the space for the secondary explosive. Essentially, the primary explosive as the igniting substance is made of a metallic salt of 4,6-diazo-*N*-nitro-1,3,5-triazine-2-amine selected from a group of salts containing silver salt, copper(I) salt and copper(II) salt, with the following skeletal formula



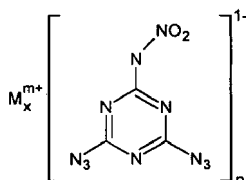
where M is a metal selected from a group comprising silver and copper:

M = Ag, m = 1, n = 1, x = 1 for silver salt,

M = Cu, m = 1, n = 2, x = 2 for copper(I) salt,

M = Cu, m = 2, n = 2, x = 1 for copper(II) salt.

[0025] Another independent invention is an electric industrial detonator which has a casing in the form of a cup with an inserted electric fuse head and supply cables. In the casing is space for at least the secondary explosive and a time-delay device with a cylindrical case containing delay-action composition and with the primary explosive below it, above the space for the secondary explosive. Essentially, the primary explosive as the igniting substance is made of a metallic salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine selected from a group of salts containing silver salt, copper(I) salt and copper(II) salt, with the following skeletal formula



where M is a metal selected from a group comprising silver and copper:

M = Ag, m = 1, n = 1, x = 1 for silver salt, ,

M = Cu, m = 1, n = 2, x = 2 for copper(I) salt,

M = Cu, m = 2, n = 2, x = 1 for copper(II) salt.

[0026] An advantage of both inventions relating to industrial detonators is that they use a modified design of the existing detonators and no new equipment for their manufacture has to be developed.

Examples of the Invention

Example 1

[0027] In this example of the invention the igniting substance, silver salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine was used as the primary explosive in the electric instantaneous detonator. The igniting substance was filled in the fuse in the amount of 0.045 to 0.060 g together with penthrite $C_5H_8N_4O_{12}$ in the amount of 0.030 to 0.35 g. Both substances were compressed with the force of 56 to 69 MPa. The secondary explosive of the instantaneous electric detonator was penthrite $C_5H_8N_4O_{12}$ in the amount of 2x 0.360 to 0.380 g compressed with the force of 64 to 70 MPa in an aluminium or copper cup.

The secondary explosive can also be hexogen $C_3H_6N_6O_6$ in the amount of 2x 0.380 to 0.400 g compressed with the force of 64 to 70 MPa in an aluminium or copper cup.

The instantaneous electric detonator was fitted with an electric igniter.

[0028] Comparison of the ignition strength of lead(II) azide and silver salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine:

Substance	Ignition strength (mg) for penthrite	Pressing force (MPa)
Lead(II) azide	10	67
Silver salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine	40	67

Example 2

[0029] In this example of the invention the igniting substance, silver salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine, was used as the primary explosive in the delay-action electric detonator. The igniting substance was filled in the case of the delay-action device in the amount of 0.045 to 0.060 g together with penthrite $C_5H_8N_4O_{12}$ in the amount of 0.030 to 0.035 g. Both substances were compressed with the force of 56 to 69 MPa. Along with that, an appropriate quantity of the delay-action composition was compressed in the case of the delay-action device which, together with the type of the delay-action composition determines the appropriate delay. The secondary explosive of the delay-action electric detonator was penthrite $C_5H_8N_4O_{12}$ in the amount of 2x 0.360 to 0.380 g compressed with the force of 1800 to 2000 N/pc in an aluminium or copper cup or hexogen $C_3H_6N_6O_6$ in the amount of 2x 0.380 to 0.400 g compressed with the force of 1800 to 2000 N/pc in an aluminium or copper cup. The delay-action electric detonator was fitted with an electric igniter. The diagram of the delay-action electric detonator is shown in Fig. 4 and Example 9.

Example 3

[0030] In this example of the invention the igniting substance, salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine, was used as the primary explosive in the instantaneous non-electric detonator. The igniting substance was filled in the fuse in the amount of 0.045 to 0.060 g together with penthrite $C_5H_8N_4O_{12}$ in the amount of 0.030 to 0.035 g. Both substances were compressed with the force of 56 to 69 MPa. The secondary explosive of the instantaneous non-electric detonator was penthrite $C_5H_8N_4O_{12}$ in the amount of 2x 0.360 to 0.380 g compressed with the force of 64 to 70 MPa in an aluminium or copper cup or hexogen $C_3H_6N_6O_6$ in the amount of 2x 0.380 to 0.400 g compressed with the force of 64 to 70 MPa in an aluminium or copper cup. The instantaneous non-electric detonator was fitted with a detonation tube according to Fig.5 and Example 8.

Example 4

[0031] In this example of the invention the igniting substance, copper(I) salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine, was used as the primary explosive in the delay-action non-electric detonator. The igniting substance was filled in the case of the delay-action device in the amount of 0.045 to 0.060 g together with penthrite $C_5H_8N_4O_{12}$ in the amount of 0.030 to 0.035 g. Both substances were compressed with the force of 56 to 69 MPa. Along with that, an appropriate quantity of the delay-action composition was compressed in the case of the delay-action device which, together with the type of the delay-action composition determines the appropriate delay. The secondary explosive of the delay-action non-electric detonator was penthrite $C_5H_8N_4O_{12}$ in the amount of 2x 0.360 to 0.380 g compressed with the force of 64 to 70 MPa in an aluminium or copper cup or hexogen $C_3H_6N_6O_6$ in the amount of 2x 0.380 to 0.400 g compressed with the force of 64 to 70 MPa in an aluminium or copper cup. The delay-action non-electric detonator was fitted with a detonation tube. The diagram of the delay-action non-electric detonator is shown in Fig. 5 and Example 8.

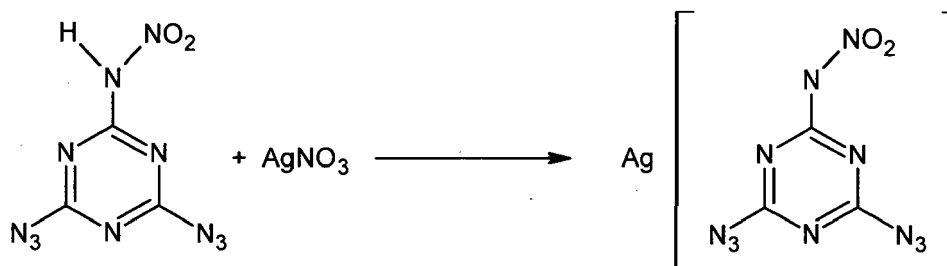
Example 5

[0032] In this example the igniting substance, copper(II) salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine, was used as the primary explosive of the electric detonator for petroleum industry. The ignition substance was filled in the sleeve in the amount of 0.250 g $\pm$ 0.01 g together with hexanitrostilbene (HNS) in the amount of 0.100 g $\pm$ 0.005 g. Both substances were compressed with the force of 1400 $\pm$ 100 N/ks. The secondary explosive of the electric detonator for petroleum industry was hexanitrostilbene (HNS) in the amount of 0.315 $\pm$ 0.010 g compressed with the force of 59 to 64 MPa in an aluminium cup. The electric detonator for petroleum industry was fitted with and electric igniter.

Example 6

Method of production of silver salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine from 4,6-diazido-N-nitro-1,3,5-triazine-2-amine:

[0033] Solution of 0.5 g of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine in 20 ml of water (2.24 mmol) is heated up to the temperature of 45°C. Solution of 0.44 g of silver nitrate $AgNO_3$ in 20 ml of water (2.59 mmol) is added to this solution at this temperature. Immediately after the start of dosing, white precipitate of silver salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine generates in the reaction mixture, which is left in the solution for 45 minutes after the dosing of silver nitrate while stirring it vigorously. After that the product is filtered off and let dry out at laboratory temperature. 0.48 g of silver salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine (97% theory) was produced by drying.



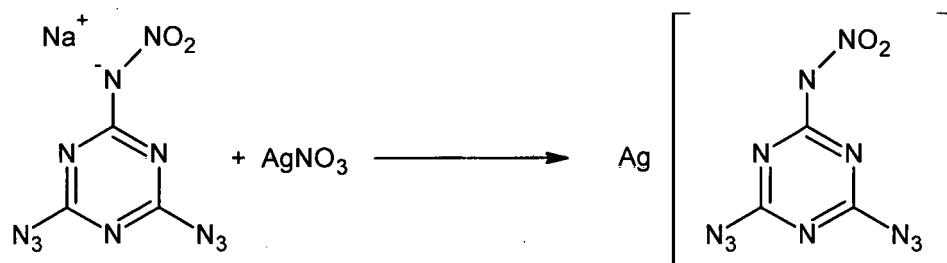
[0034] Atomic absorption spectrometry of $\text{C}_3\text{N}_{11}\text{O}_2\text{Ag}$: Calculated: Ag 32.68; found: Ag 30.51. Infrared spectroscopy (device Protégé 460 with ATR adapter, measurement of samples in solid state, OMNIC evaluation software). Values (cm^{-1}): 2205, 2153, 1570, 1527, 1483, 1454, 1384, 1350 (strong), 1252, 1226, 1205 (strong), 1081, 1010, 946, 816, 792 (strong), 744, 719.

Differential thermal analysis (device DTA 550Ex manufactured by OZM Research; 10 mg sample charging; linear temperature rise of $5^\circ\text{C} \cdot \text{min}^{-1}$; (measured in open microtubes in the presence of air). Start of exothermic decomposition at 166°C .

Example 7

Method of production of silver salt of 4,6-diazido-*N*-nitro-1,3,5-triazine-2-amine from sodium salt of 4,6-diazido-*N*-nitro-1,3,5-triazine-2-amine:

[0035] Sodium salt of 4,6-diazido-*N*-nitro-1,3,5-triazine-2-amine in the amount of 0.55 g is mixed by stirring in 20 ml of water and the solution is heated up to the temperature of 45°C . Then, solution of 0.44 g of silver nitrate AgNO_3 in 20 ml of water (2.59 mmol) is added to the solution of sodium salt. During dosing, white precipitate of silver salt of 4,6-diazido-*N*-nitro-1,3,5-triazine-2-amine generates in the reaction mixture, which is left in the reaction mixture for 45 minutes after the dosing of silver nitrate AgNO_3 while stirring it vigorously. The precipitate is then filtered off and dried out at laboratory temperature. 0.45 g of silver salt of 4,6-diazido-*N*-nitro-1,3,5-triazine-2-amine (96% theory) was produced after drying.



[0036] Atomic absorption spectrometry of $\text{C}_3\text{N}_{11}\text{O}_2\text{Ag}$: Calculated: Ag 32.27; found: Ag 30.51. Infrared spectroscopy (device Protégé 460 with ATR adapter, measurement of samples in solid state, OMNIC evaluation software). Values (cm^{-1}): 2205, 2153, 1570, 1527, 1483, 1454, 1384, 1350 (strong), 1252, 1226, 1205 (strong), 1081, 1010, 946, 816, 792 (strong), 744, 719.

Differential thermal analysis (device DTA 550Ex manufactured by OZM Research; 10 mg sample charging; linear temperature rise of $5^\circ\text{C} \cdot \text{min}^{-1}$; (measured in open microtubes in the presence of air). Start of exothermic decomposition at 167°C .

Example 8

[0037] This example according to Fig. 5 describes a non-electric industrial detonator with an igniting substance according to the aforementioned examples. The detonator has a casing in the form of a cup 1 with an inserted detonation tube 19. In the lower part of the casing there is a space 11 for the secondary explosive, which is closed at the top by a time-delay device 12. Its cylindrical case contains delay-action composition 14 and the igniting explosive 13 below it, which is the primary explosive according to the aforementioned examples. A sleeve 15 with strengthening composition 16 closed by a lid 17 is inserted in the cup 1 above the time-delay device 12. A detonation tube 19, fitted with a sealing 18 against the cup casing 1 is inserted in the casing 1 from the top.

Example 9

[0038] This example according to Fig. 4 describes an electric industrial detonator with an igniting substance 23 according to the aforementioned examples. The electric industrial detonator has a casing in the form of a cup 2 with an inserted electric fuse head 25 and supply cables 26. In the lower part of the casing there is a space 21 for the secondary explosive, which is closed at the top by a time-delay device 22. The cylindrical case of the time-delay device 22 contains delay-action composition 24 and the igniting explosive 23 below it, which is the primary explosive. In the cup 2 above the time-delay device 22 is inserted an electric fuse head 25 with supply cables 26. These are provided with sealing 27 against the cup 2.

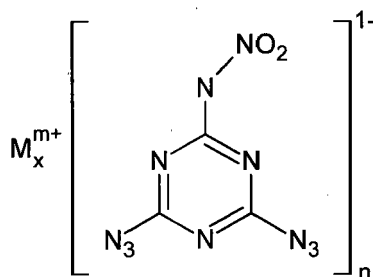
The functioning of both types of detonators is apparent from their design and does not differ from that of normally used detonators. Silver salt, copper(I) salt and copper(II) salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine are used as the igniting substance (explosive, primary explosive) in detonators. The substance can be used in pure condition or in mixtures with other substances. When ignited by flame, hot wire or another initial impulse, the salt is ignited which is followed by its quick detonation. The shock wave which is generated by the salt detonation then ignites the other members of the initiation chain, e.g. the secondary charge of the detonator. The result is the detonation of the entire initiation device which induces the detonation of the booster or the main explosive charge.

Industrial Application

[0039] The igniting substance for industrial detonators as well as the detonators for the aforementioned igniting substance are intended for industrial use. Both the igniting substance for the detonators and the detonators themselves can be used in particular for ground rock disintegration, in petroleum industry and mining in quarries, for underground mining or tunnel excavation, destruction and other similar specialised works.

Claims

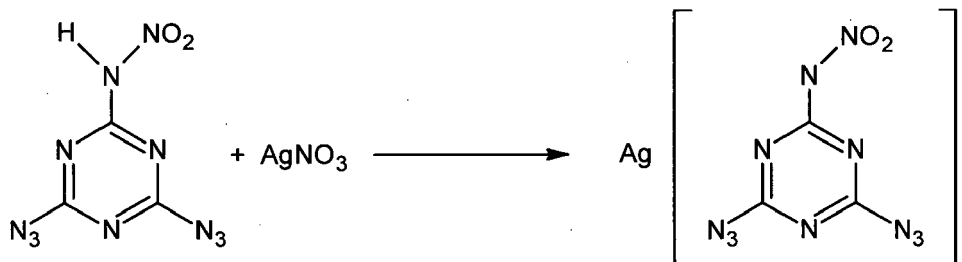
1. An igniting substance mainly for detonators **characterised in that** it is made at least of a metallic salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine selected from a group of salts containing silver salt, copper(I) salt and copper(II) salt, with the following skeletal formula



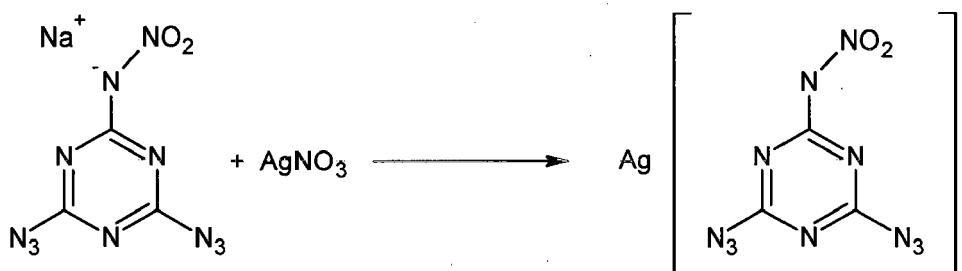
where M is a metal selected from a group comprising silver and copper:

M = Ag, m = 1, n = 1, x = 1 for silver salt,
 M = Cu, m = 1, n = 2, x = 2 for copper(I) salt,
 M = Cu, m = 2, n = 2, x = 1 for copper(II) salt.

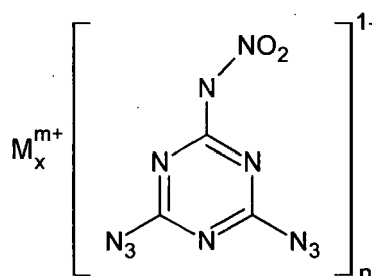
2. An igniting substance according to Claim 1 **characterised in that** it is a combination of silver salt and/or copper(I) salt and/or copper(II) salt.
3. Production method of silver salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine, **characterised in that** heated aqueous solution of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine is mixed with the aqueous solution of silver nitrate AgNO_3 and, while stirring vigorously, the silver salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine is precipitated and then filtered off and dried at laboratory temperature



4. Production method of silver salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine according to Claim 3, **characterised in that** the solution of 0.5 g of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine in 20 ml of water is heated at the temperature of $45^\circ\text{C} \pm 3^\circ\text{C}$, then the solution of 0.44 g of silver nitrate AgNO_3 in 20 ml of water is added and the produced precipitate of silver salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine is left in the solution for 35-55 minutes while stirring it vigorously and then filtered off and let dry.
5. Production method of silver salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine, **characterised in that** heated aqueous solution of sodium salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine is mixed with the aqueous solution of silver nitrate AgNO_3 and, while stirring vigorously, the silver salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine is precipitated and then filtered off and dried at laboratory temperature



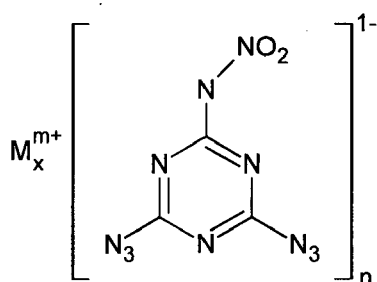
6. Production method of silver salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine according to Claim 5, **characterised in that** the solution of 0.55 g of sodium salt 4,6-diazo-N-nitro-1,3,5-triazine-2-amine in 20 ml of water is heated at the temperature of $45^\circ\text{C} \pm 3^\circ\text{C}$, then the solution of 0.44 g of silver nitrate AgNO_3 in 20 ml of water is added and the produced precipitate of silver salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine is left in the solution for 35-55 minutes while stirring it vigorously and then filtered off and let dry.
7. A non-electric industrial detonator which has a casing in the form of a cup (1) with an inserted detonation tube (19) and a space (11) for the secondary explosive at the bottom of the cup (1) closed with a lid (15), where the space is closed at the top with a time-delay device (12) with a cylindrical case containing delay-action composition (14) and with the primary explosive (13) below it, above the space (11) for the secondary explosive **characterised in that** the primary explosive (13) as the igniting substance is metallic salt of 4,6-diazo-N-nitro-1,3,5-triazine-2-amine selected from a group of salts containing silver salt, copper(I) salt and copper(II) salt, with the following skeletal formula



where M is a metal selected from a group comprising silver and copper:

M = Ag, m = 1, n = 1, x = 1 for silver salt,
 M = Cu, m = 1, n = 2, x = 2 for copper(I) salt,
 M = Cu, m = 2, n = 2, x = 1 for copper(II) salt.

8. An electric industrial detonator which has a casing in the form of a cup (2) with an inserted electric fuse head (25) provided with supply cables (26) where in the casing there is space (21) at least for the secondary explosive and for the time-delay device (14) with a cylindrical case containing delay-action composition (14) and with the primary explosive (13) below it, above the space (11) for the secondary explosive **characterised in that** the primary explosive (13) as the igniting substance is metallic salt of 4,6-diazido-N-nitro-1,3,5-triazine-2-amine selected from a group of salts containing silver salt, copper(I) salt and copper(II) salt, with the following skeletal formula



where M is a metal selected from a group comprising silver and copper:

M = Ag, m = 1, n = 1, x = 1 for silver salt,
 M = Cu, m = 1, n = 2, x = 2 for copper(I) salt,
 M = Cu, m = 2, n = 2, x = 1 for copper(II) salt.

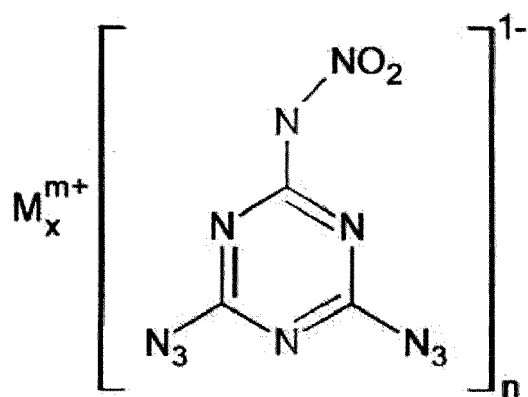


Fig 1.

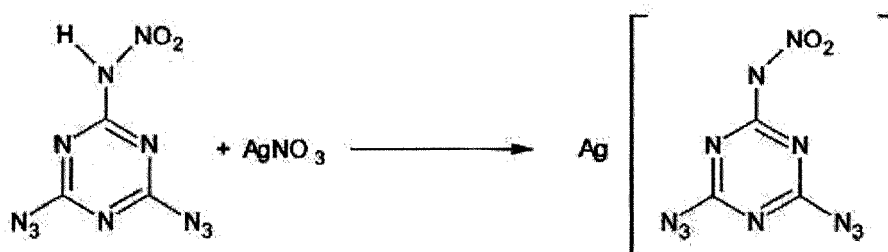


Fig 2.

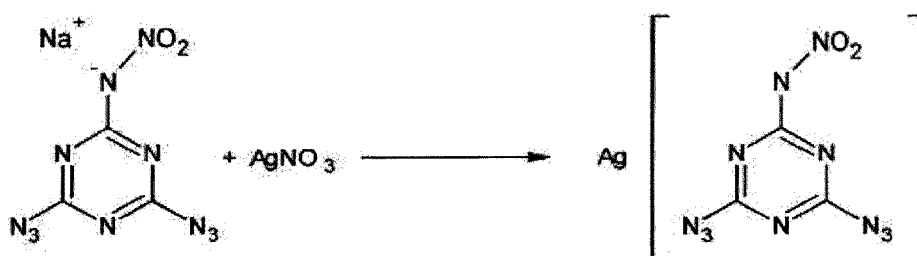


Fig 3.

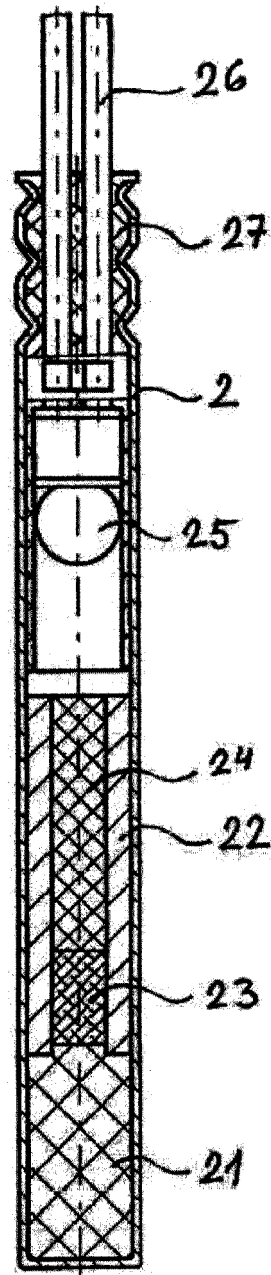


Fig 4

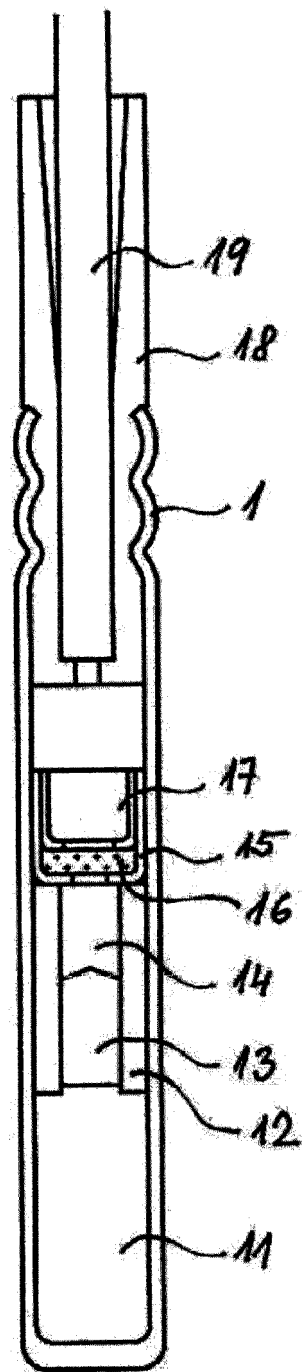


Fig 5

REFERENCES CITED IN THE DESCRIPTION

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