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[54] **MOLDED EXPLOSIVE BODIES HAVING VARIABLE DETONATION SPEEDS**

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[51] **Int. Cl.**[2] **F42B 1/00**

[58] **Field of Search** .... 149/2, 18, 19, 20, 21, 149/46, 60, 88, 92, 93, 105, 19.6, 19.91; 264/3 R

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[57] **ABSTRACT**

Process of manufacturing molded explosive bodies so that their detonation speeds can be varied within a defined range by reducing the density of the molded body. The reduction in density can be effected by incorporating into the starting components, porous, voluminous or air containing materials. The solidification of the resulting compositions is thereafter carried out by incorporating into the above starting components a suitable binding agent, varying the working pressure in the forming of the bodies, or suitably regulating the sintering conditions.

The resultant bodies are characterized by their reduced densities and therewith reduced detonation speeds and by their high mechanical strengths.

3 Claims, No Drawings

MOLDED EXPLOSIVE BODIES HAVING VARIABLE DETONATION SPEEDS

RELATED APPLICATION

This application is a divisional application of application Ser. No. 759,501, filed Sept. 12, 1968, now U.S. Pat. No. 3,619,306.

This invention relates to molded explosive bodies having variable detonation speeds within a defined range. More particularly this invention relates to homogeneous explosive bodies molded in any desired shape having detonation speeds with high mechanical strengths which can be adjusted as desired to values of between 1500 m/s and the maximum detonation speed of the specific explosive composition involved.

It is known that the detonation speed of explosives can be decreased by the addition thereto of inert substances. This procedure has only limited application, since the explosive's sensitivity is so greatly diminished by very large additions of inert substances that the same are no longer capable of detonation.

Another possibility proposed for reducing the detonation speed is the reduction of the density of the explosive body by inclusion therein of air spaces. This is accomplished, for example, by compressing the explosives at different pressures. The compression effects a reduction of the density, but at the same time it produces a diminution of the mechanical strength of the resultant body, so that the density can be reduced in this manner only down to a certain limit. This in itself constitutes a considerable disadvantage.

It is an object of the invention to provide molded explosive bodies having reduced densities and therewith reduced detonation speeds.

Another object of the invention is to provide molded explosive bodies having reduced densities and therewith reduced detonation speeds characterized by high mechanical strengths.

A further object of the invention is to provide a process for producing molded homogeneous explosive bodies of the type described.

These and further objects of the invention are accomplished by sintering or binding with known binding agents explosive compositions, consisting of known solid explosives and air-containing, porous or voluminous materials.

In accordance with the invention there are accordingly provided explosive molded bodies having variable detonation speeds within a defined range, which are characterized in that in addition to the explosive agents, they contain porous, voluminous or air-containing materials.

The molded bodies according to the invention having the necessary strength characteristics and which are possessed of the required homogeneity can be prepared without the danger that the components of the mixture will separate out by heating a homogeneous mixture of the explosive and density reducing components too close to the melting point of the explosive component.

In the case of non-sinterable explosives, or if the sintering temperature required is too high, a suitable sintering temperature can be selected by the addition of a sinterable substance that may also be of an explosive nature.

An alternate method for solidifying the molded bodies according to the invention consists in adding a hardenable plastic or adhesive to the mixture of explosive and density reducing components and allowing the resultant compositions to set rather than using the sintering process. In this case the manufacture of the molded bodies is carried out, for example, by uniformly mixing the porous, voluminous, or air-containing materials with a binding agent and the explosive in finely powdered form, it being desirable in this connection for the grain size of the explosive to equal the grain size of the other components, since otherwise the danger that the components will become separated in the mixture exists. The mixture is then put into a mold which is closed with a plunger and pressed. The pressure employed ranges preferably between 0.1 and 1 kg/cm^2, though it may be lower or higher. To achieve bodies of equal volume and hence of equal density, the movement of the plunger can be limited while the same quantity is always charged.

When the sintering process is used, in which case the addition of the binding agent can be omitted, i.e. the explosive itself serves as the binding agent, and then the filled molds are brought to a temperature just under the melting temperature of the explosive. The sintering temperature depends on the purity of the fusible explosive component used, or the melting point of the eutectic mixture if mixtures are used. The sintering temperature can also be raised above the melting point if the percentage of the component or mixture thereof that is to be melted, (i.e. the amount of fusible mixture or explosive) is so low that no separation of the mixture takes place. The most important sintering explosive involved is trinitrotoluene (TNT). However, explosives or explosive mixtures can also be advantageously used which are still sufficiently stable at their melting temperature and which do not tend to undergo separation. The pressure in the sintering process amounts preferably to 0.1 to 1 kp/cm^2, though it may be higher or lower. After the mixture has set or cooled in the sintering process, the bodies, which until then have been kept under pressure, are removed from the mold.

The explosives which can be used according to the invention include, for example:

a. Aromatic nitro substances, such as trinitrobenzene, trinitrotoluene, trinitroanisole, trinitrocresol, trinitrophenol (picric acid), trinitrophenetol, trinitroresorcinol, trinitromethylaniline, trinitrophloroglucine, hexanitrodiphenylamine, (hexyl) hexanitrodiphenyl, hexanitrodiphenylsulfide, hexanitrodiphenylsulfone, hexanitroazobenzene.

b. Nitramines, such as cyclotrimethylenetrinitramine (hexogen), trinitrophenylmethylnitramine (tetryl), cyclotetramethylenetetranitramine (octogen), ethylenedinitramine.

c. Nitrosamines, such as cyclotrimethylenetrinitrosamine.

d. Nitric acid esters, such as pentacrythritol tetranitrate.

e. Ammonium nitrate admixed with a combustible substance.

As air-containing materials there come into consideration the materials which consist of individual gas-filled hollow bodies, such as microbubbles (hollow spheres of phenolic or urea resin), and closed-pore foam plastic.

As porous materials there are intended the substances which are filled with fine air spaces, but whose openings to the surface of the particles are nevertheless so small that viscous liquids (for instance, adhesives) cannot appreciably penetrate therein.

As voluminous materials there are suitable those substances having a large surface area and a low bulk weight, as for example, wood flour and cork flour.

The binding agents which are suitable for use herein include:

a. Adhesives dissolved in water or an organic solvent, whereby the setting takes place by the evaporation of the solvent, including glue, dextrine, polychlorobutadiene, polyvinyl acetate, and other like compounds.

b. Inorganic binding agents to which water is added and which set as a result of the addition of water, for instance, plaster of Paris, Portland cement, magnesium cement, minium-glycerin cement, and other like mixtures.

The explosive molded bodies obtained by the process of the invention have such great strength that they can after their production be subjected to mechanical working.

By combining molded explosive bodies having different detonation speeds, systems can be formed which form a shock wave front of any desired shape when they are detonated.

The invention is illustrated by the following examples. The same are, however, not to be construed in limitation thereof.

The percentage of air-containing materials and/or porous materials and/or volumious materials in the molded explosive bodies is 0.1 to 40 %, preferably 1 to 30 % based on the explosive composition.

The binding agents cited sub (a) are used in an amount of 2 to 40 %, preferably 5 to 25 % based on the explosive composition.

The binding agents cited sub (b) are used in an amount of 4 to 35 %, preferably 10 to 25 % based on the explosive composition.

EXAMPLES 1 – 4

Examples 1 – 4 describe the manufacture of molded explosive bodies using the sintering method which has been set out above, in which the explosive itself serves as the binding agent. Trinitrotoluene was used as the explosive. Microbubbles having a diameter of 0.005 to 0.15 mm and prepared from phenolic resin were used to reduce the density, or alternatively cork flour was used for this purpose.

The quantities of the components which were used in each case, the conditions of manufacture and the detonation speeds, are set out in the following table:

TABLE I

Example	1	2	3	4
TNT, ground(wt-%)	100	89	73	90
Microbubbles (wt-%)	0	11	27	
Cork flour (wt-%)				10
Density, g/cm³	1.1	0.74	0.4	0.3
Sintering pressure (kp/cm²)	0.5	0.2	0.4	0.3
Sintering temp. in °C	79	79	79	80
Sintering time, hours	5	5	5	5
Detonation speed, m/s	5700	3360	1500	2710

EXAMPLES 5 – 7

In Examples 5 – 7 the manufacture of molded explosive bodies is also carried out by the sintering process, but in this instance the binding agent was not the explosive itself, but rather an explosive (TNT) which is used additionally in small amounts for this purpose. Wood flour, cork flour and the microbubbles as used in Examples 1 – 4 were employed to reduce the density. The quantities in which the components were employed in each case, the manufacturing conditions and detonation speeds, are reported in the following table:

TABLE II

Example	5	6	7
Ammonium nitrate (wt-%)	85	77	74
TNT, ground (wt-%)	10	14	13
Microbubbles (wt-%)	5		
Wood flour (wt-%)		9	
Vegetable flour (wt-%)			13
Density, g/cm³	0.8	0.85	1.1
Sintering pressure,(kp/cm²)	0.3	0.3	0.3
Sintering temp. in °C	80	80	80
Sintering time, hours	5	6	6
Dentonation speed, m/s	2350	2290	3670

EXAMPLES 8 – 20

Examples 8 – 10 and 14 – 20 describe the manufacture of the molded explosive bodies using a binding agent which sets without heating. Such agents include adhesives sold under the trade names "Araldit", "Adhesin", "Pattex" and "UHU", as well as plaster of Paris and Portland cement. (The trade names are more precisely defined in the following summary.)

Examples 11 – 13 are specifically concerned with the manufacture of the molded explosive bodies using the sintering process, in which an inert compound without properties of an explosive serves as the binding agent.

The quantities of the components, the manufacturing conditions as used in Examples 8 – 20, and the detonation speeds are reported in the following table. The microbubbles which have been used are the same as those which were used in Examples 1 – 4.

TABLE III

Examples	8	9	10	11	12	13	14	15	16	17
Nitropenta (wt-%)	76	72	56	90	85	75	63.2	56.6	81	81
Microbubbles "	4	8	24	5	10	15	3.4	10	10	10
Centralit I "				5	5	10				
Araldit R "	20	20	20							
Adhesin R							33.4	33.4		
[R = registered trademark]										
Pattex R									9	
UHU R										9
Density g/cm³	0.87	0.78	0.58	0.62	0.51	0.48	0.87	0.57	0.71	0.67
Compression pressure kp/cm²	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Sintering temp. °C				86	86	86				
Sintering time, hours				5	5	5				

TABLE III-continued

Examples	8	9	10	11	12	13	14	15	16	17
Detonation speed, m/s	4710	4280	3220	4185	3370	3215	4730	3220	4226	4300

Centralit I = Diethyldiphenyl urea
Araldit = Synthetic glue made from ethoxylin resins (cold setting two-component plastic)
Adhesin = Polyvinyl acetate
Pattex = Contact cement made from polychlorobutadiene plus resins and organic solvents
UHU = All-purpose cement (polyvinyl resin plus solvent)

Examples	18	19	20
	Percentages by weight		
Nitropenta	60	65	60
Microbubbles	20	15	20
Plaster of Paris	20	20	
Portland cement			20
Water added per 100g of mixture (cm^3)	60	60	60
Density (g/cm^3)	0.36	0.42	0.46
Compression pressure (kp/cm^2)	0.1	0.1	0.1
Detonation speed (m/s)	2110	3440	3610

We claim:

1. A homogeneous high strength molded explosive body comprising a solidified mixture of solid pentaerythrite-tetranitrate explosive, hollow spheres of phenolic resin density reducing material and diethyldiphenyl urea binding agent, said molded explosive body having a detonation velocity within a defined range, said detonation velocity being less than the detonation velocity of the explosive itself, said pentaerythrite-tetranitrate uniformly mixed with said hollow spheres and said binding agent.

2. A homogeneous high strength molded explosive body comprising a solidified mixture of solid pentaerythrite-tetranitrate explosive, hollow spheres of phenolic resin density reducing material and a hardenable cold setting plastic based on ethoxylin resins as binding agent, said molded explosive body having a detonation velocity within a defined range, said detonation velocity being less than the detonation velocity of the explosive itself, said pentaerythrite-tetranitrate uniformly mixed with said hollow spheres and said binding agent.

3. A homogeneous high strength molded explosive body comprising a solidified mixture of solid pentaerythrite-tetranitrate explosive, hollow spheres of phenolic resin density reducing material and a polyvinylacetate adhesive binding agent, said molded explosive body having a detonation velocity within a defined range, said detonation velocity being less than the detonation velocity of the explosive itself, said pentaerythrite-tetranitrate uniformly mixed with said hollow spheres and said binding agent.

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