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SUNAO HIGASHISHIMA ETAL

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DETONATOR HAVING A PRIMING SPONGE

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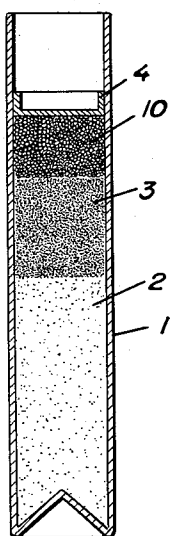


FIG 1

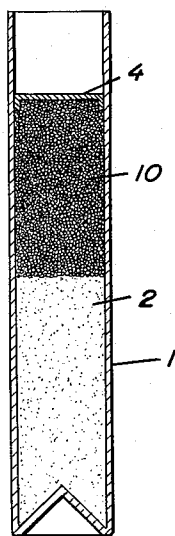


FIG 2

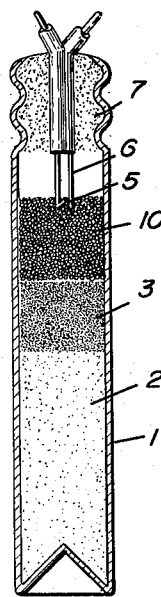


FIG 3

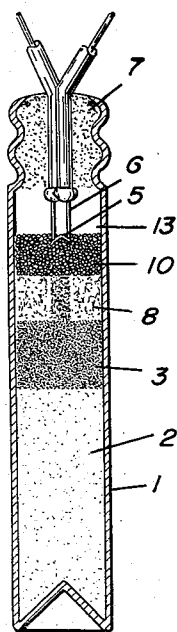


FIG 4

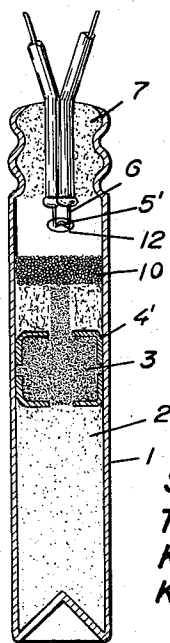


FIG 5

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DETONATOR HAVING A PRIMING SPONGE
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4 Claims. (Cl. 102-28)

This invention relates to improvement in a primer charge in a detonator and an igniter of an electric detonator.

Heretofore, detonators have been manufactured by charging a base charge into a metallic cylindrical shell, and a primer charge in a capsule was pressed into the shell against the base charge.

As the primer charges, mercury fulminate, lead azid, and diazo dinitro phenol are widely used, but they are very sensitive to friction or shock. In a process of manufacturing detonators, especially during pressing, when the primer charge is rubbed between the interior side of the shell and a compressor or an interior capsule, the primer charge is initiated whereby manufacturing efficiency decreases and also there will be a danger of unexpected disaster.

A low tension electric detonator whose igniter is of the match head type or of the bead type is widely used. An instantaneous electric detonator having an igniter in which the bridge wire is inserted into the primer charge, is also available. A conventional regular delay or short period delay electric detonator wherein an igniter is of the match head type or the bead type has a space to control the pressure of the gas generated in the detonator by the ignition of the primer charge. It has heretofore been thought almost impossible to manufacture a delay electric detonator having a bridge wire inserted in a primer charge.

It is an object of the present invention to manufacture these detonators efficiently and safely to be able to handle them without danger. It is another object of the present invention to use in a detonator, a high polymer sponge having elasticity and low specific gravity.

A primer charge prepared by impregnating the primer composition into a high polymer sponge (we call it hereinafter priming sponge) is not sensitive to friction and shock, but it is initiated by the sensitive primer charge by the spit of sparks from the safety fuse or the flash of the igniter. Accordingly, when this priming sponge is pressed on the priming charge, there is no friction between the primer charge and the surface of the metal, and also said sponge acts as a cushion against shocks with the result that detonators can be manufactured very safely.

Alternatively, the priming sponge made by impregnating a large amount of primer composition into a high polymer sponge, can be used as a primer charge pressing it directly against the base charge.

In order to show the safety of such priming sponges, the results of a drop hammer test are set forth in Table 1, using a piece of polyurethane sponge as a high polymer sponge, impregnated with primer composition in an amount by weight which is the same as that of the sponge.

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TABLE 1

Results of Drop Hammer Test of Priming Sponge

Name of explosives	Critical height	
	Powder	Priming sponge
DDNP-----	Cm. 9	Cm. 16
Tetracene-----	8	25

NOTE.—The weight of hammer used was 2 kg.

As is clear from the table, by the use of this priming sponge, the detonator is produced safely and at the same time it is not dangerous even when friction accidentally occurs on the primer charge while setting the igniter or safety fuse against the detonator.

Various modifications of this invention will now be explained with reference to the accompanying drawings.

FIG. 1 is a sectional view of a detonator according to the invention;

FIG. 2 is a sectional view of a modified form of a detonator according to the present invention;

FIG. 3 is a sectional view of an electric detonator according to the present invention; and

FIGS. 4 and 5 are sectional views of modified forms of electrical detonators according to the invention and having a delay element therein.

In FIG. 1, said priming sponge is directly against the primer composition. 1 is a cylindrical shell, 2 is a base charge, 3 is a primer composition, 10 is a priming sponge, and 4 is an interior capsule which is used to fix the priming sponge on the primer composition. The priming sponge 10 and primer composition 3 together make up the primer charge.

In FIG. 2, 1 is a cylindrical shell, 2 is a base charge, 10 is a high polymer sponge impregnated with a large amount of primer composition, which is pressed against the base charge and held in place by an interior capsule. It thus acts as the primer charge for the base charge.

Such a priming sponge, when initiated in the open, just ignites, and only when press-charged into a tube, does it detonate. Table 2 shows the difference of detonation velocity, when said priming sponge is initiated in the open and in a tube, press-charged.

TABLE 2

Detonation Velocity When the Priming Sponge is Initiated in the Open and in a Tube Press-Charged

Priming sponges	Initiated in open	Press-charged into cylindrical tube by 50-200 kg./cm. ²
DDNP impregnated to synthetic resin sponge 3-6 times by weight.	200-400 m/sec....	1,200-3,000 m/sec.
DDNP impregnated to synthetic resin sponge 10-16 times by weight.	700-1,000 m/sec...	3,000-6,000 m/sec.

As it is seen from this table, the priming sponge, when in the open, only ignites, but when press-charged, it has a sufficient detonation velocity to detonate a base charge; accordingly, this kind of detonator is not only safe in manufacturing and handling but also decreases the danger of miss fire caused by overpressing of the primer charge.

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Detonators of FIGS. 1 and 2, can be used as plain detonators by setting them off directly with safety fuse, and also as electric detonators by setting them off with an electric igniter as in FIG. 3.

FIG. 3 shows an instantaneous electric detonator in which a priming sponge is used as a portion of the primer charge. The sponge portion of the primer charge is composed of primer composition in a priming sponge 10 and a bridge wire 5 is placed in the sponge.

In FIG. 3, 1 is a cylindrical shell, 2 is a base charge, 3 is a primer composition. The bridge wire 5 is connected to leg wires 6 extending through a plug 7.

In the detonator of FIG. 3, instead of compacting a primer composition 3 with an interior capsule 4, the priming sponge 10 is used to compact it lightly, so that the said primer composition does not move, and this method can be used in manufacturing detonators while using only slight pressing on a primer composition.

FIG. 4 shows a regular delay and short period delay detonator with a delay element 8 inserted against the primer composition 3. A priming sponge 10 is compacted on the delay element and the bridge wire 5 is inserted in said sponge. FIG. 5 is a delay electric detonator, manufactured by compacting the primer composition 3 by means of interior capsule 4' and using the priming sponge 10 on the delay element 8 in order to make sure of the firing of the delay element. A bead or match head type of igniter 12 is positioned in space 13 to throw a spark against sponge 10.

Thus, a so-called priming sponge manufactured by impregnating a primer composition into a high polymer sponge is not only used as a part or all of the primer charge from the viewpoint of safety, but is also utilized as an igniter in an electric detonator.

The high polymer sponges used in detonators of our invention are synthetic resin sponge, viscose sponge or cellulose acetate sponge such as polyurethane, polyethylene, polystyrol, polyvinylchloride, phenol and polyether etc., and any substance is available having elasticity, low specific gravity and interconnected foam pores.

Priming compositions which can be impregnated in such sponges are substances such as lead styphnate, tetra-cene, DDNP or mercury fulminate etc. or mixtures thereof. These substances may also have added thereto nitrate such as potassium nitrate, chlorate such as potassium chlorate, perchlorate such as potassium perchlorate or peroxide such as BaO_2 . Base charges and delay elements may be any of the conventionally used materials. For example red lead-lead chromate may be used as a delay element.

A method of impregnating a priming composition into a high polymer sponge, when the priming composition is soluble in a proper solvent, is to dissolve the priming composition in this solvent and immerse the high polymer sponge in it, and after sufficient absorption of the solution has taken place, said sponge is taken out of the solution and dried, thus leaving the priming composition in the sponge. The amount of the priming composition impregnated into the sponge is controlled by adjusting the concentration of the solution. In order to impregnate a large amount of the priming composition into the sponge or in case the priming composition is insoluble into the solvent, said composition is dispersed in the solvent, while the high polymer sponge is immersed in the solution and after the sponge is impregnated with the priming composition by mixing or agitating, the solvent is evaporated and dried until a so-called priming sponge is made. We may use the high polymer sponge in the manufacture of a detonator either by cutting it into pieces of fixed size beforehand and then impregnating the pieces with the priming composition or after impregnating a sponge which is in the shape of a string or a plate, cutting the sponge into pieces of fixed size. There are set forth hereinafter examples of the priming sponge and examples of manufacturing the detonators using a priming sponge.

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After immersion in a solution of 3-7% DDNP dissolved in acetone, a polyurethane sponge piece cut in a column or a cube shape, having a volume of 0.1-0.3 cm^3 , is removed from the solution and the acetone is evaporated leaving the DDNP in the sponge. The weight of DDNP contained in the sponge thus prepared, is 50-150% of the sponge weight and it is preferable to use a part of the priming charge in a detonator or an igniter of electric detonator, shown in FIGS. 1, 3, 4 and 5.

EXAMPLE 1

DDNP was added to acetone in an amount of 20-60%. Polyurethane sponge was immersed in the solution and agitated until it contained about 10-20 times the amount of DDNP as the weight of the sponge. About 0.20 gr. of such priming sponge was placed on a base charge of 0.40 gr. of PETN, thus composing a primer charge which was press-charged into a detonator of the type of FIG. 2 by means of an interior capsule with a pressure of 50-100 kg./cm^2 to manufacture the detonator.

EXAMPLE 2

40-50% of a mixture of lead styphnate and potassium chlorate in equal parts by volume was dispersed in ethanol. Viscose sponge was impregnated by the same process as in Example 1, to prepare the priming sponge. 0.35 gr. of said sponge used as the primer charge of the detonators of FIG. 2 type was press-charged into a cylindrical shell of copper to manufacture the detonator charging 0.40 gr. of RDX as a base charge, with a pressure of 250-300 kg./cm^2 .

EXAMPLE 3

According to the process as described in Example 2, a priming sponge was prepared by impregnating a polyethylene sponge with equal volume of tetrasen. This sponge was used in an electric detonator as an igniter.

At this time, 0.45 gr. of tetryl was used as a base charge, 0.20 gr. of mercury fulminate was charged thereon, and a priming sponge prepared by the said process was compacted on the mercury fulminate to manufacture an instantaneous electric detonator as shown in FIG. 3.

We show in the following table, the results of the various tests of detonators formed according to Examples 1 to 3.

TABLE 3

Detonators	Numbers of complete detonation/numbers of testing sample			Drop hammer test (height of fall of non-explosion)
	Firing test	Lead plate test	Haid-test (talc 32 percent)	
Example 1.....	100/100	50/50	10/10	Cm. 80 80 50
Example 2.....	100/100	50/50	10/10	
Example 3.....	100/100	50/50	10/10	

NOTE.—Detonators of Examples 1 and 2 were initiated by safety fuse and the detonator of Example 3 was fired by 0.6 a. of direct current.

The drop hammer test was performed by dropping a 5 kg. steel hammer on a detonator and measuring the greatest height of fall from which no explosion resulted.

As above stated, using a high polymer sponge in a part of the detonator enables safe manufacturing and not only can said sponge be used to control the spacing of an igniter and a detonator, but also is extremely convenient to use as a primer charge by impregnating it with a primer composition for use with an igniter of an electric detonator.

What we claim is:

1. In a detonator having a base charge, and a primer charge against the base charge, that improvement comprising a priming sponge forming at least a part of said primer charge, said priming sponge consisting essentially of an elastic sponge having interconnected pores and being of a low specific gravity material selected from

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the group consisting of polyethylene, polyurethane, polystyrol, polyvinyl chloride, polyether, viscoses and cellulose acetate, and a primer composition impregnated in said elastic sponge.

2. The improvement as claimed in claim 1 in which the priming sponge is the entire primer charge.

3. In an electric detonator having a base charge and a primer charge against the base charge, that improvement comprising a priming sponge forming part of said primer charge, said priming sponge consisting essentially of an elastic sponge having interconnected pores and being of a low specific gravity material selected from the group consisting of polyethylene, polyurethane, polystyrol, polyvinyl chloride, polyether, viscoses and cellulose acetate, and a primer composition impregnated in said elastic sponge, and an electric igniter element contacting said priming sponge.

4. In an electric detonator having a base charge and a primer charge against the base charge, that improvement comprising a priming sponge forming part of said primer charge, a delay element between said priming sponge and the remainder of said primer charge, said priming sponge consisting essentially of an elastic sponge having inter-

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connected pores and being of a low specific gravity material selected from the group consisting of polyethylene, polyurethane, polystyrol, polyvinyl chloride, polyether, viscoses and cellulose acetate, and a primer composition impregnated in said elastic sponge, and an electric igniter element contacting said priming sponge.

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