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A. R. ELY ET AL
EXPLOSIVE DEVICE

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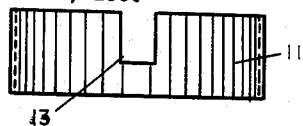


FIG. 1

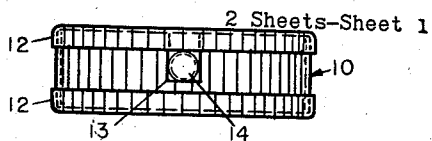


FIG. 2

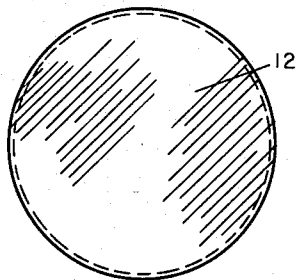


FIG. 3

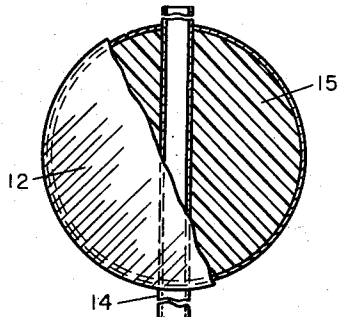


FIG. 4

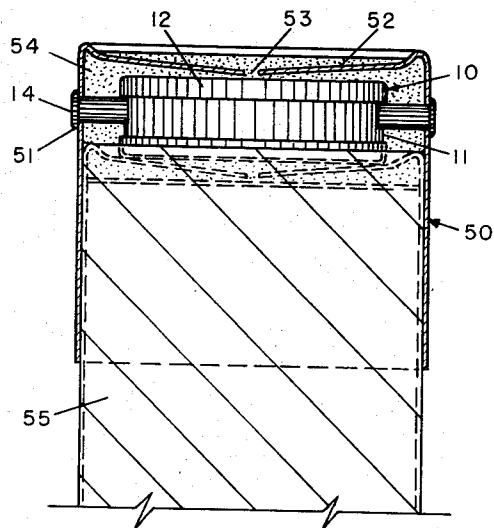


FIG. 5

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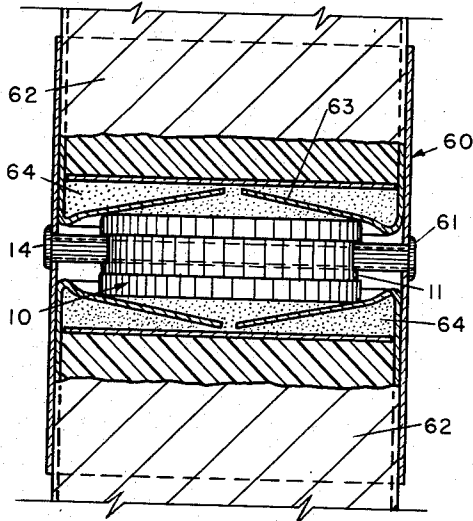


FIG. 6

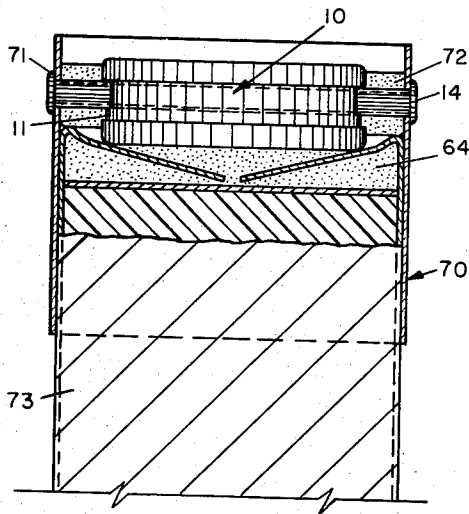


FIG. 7

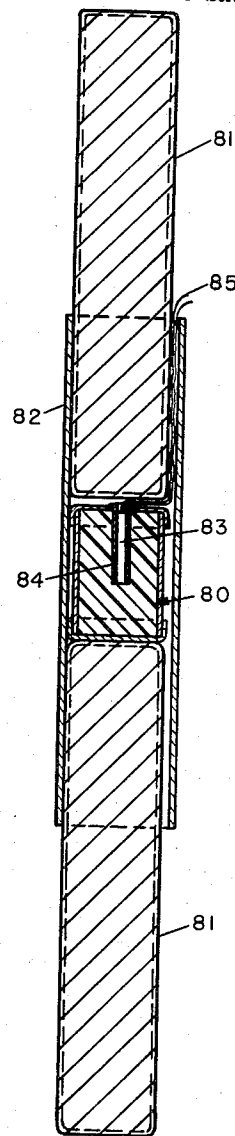


FIG. 8

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2,944,485

EXPLOSIVE DEVICE

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4 Claims. (Cl. 102—24)

This invention relates to an improved means of priming relatively insensitive explosives and blasting agents and more particularly to improved primer units and primed blasting assemblies.

In recent years the relatively insensitive blasting explosives, consisting primarily of ammonium nitrate and various sensitizing materials, have enjoyed an ever increasing popularity. Once these insensitive explosive compositions are brought to detonation, they shoot at a high rate and in many cases may be substituted in blasting operations for the blasting cap sensitive type of explosive formerly used.

The relatively insensitive powders, however, have several unfortunate characteristics which must be overcome to render their use completely satisfactory. In the first place, the insensitivity of these compositions requires an initiating means considerably stronger than the commercially available blasting cap. The art has, therefore, found it necessary to employ special priming means such as extra large booster caps containing sizable base charges of sensitive explosive such as pentaerythritol tetranitrate or RDX (cyclotrimethylene trinitramine). Alternatively, cartridges of cap-sensitive explosive have been employed to initiate the main charge of cap-insensitive explosive. Many of these cap-sensitive compositions are also of very high ammonium nitrate content. Metal cans filled with TNT have also been used as primers for insensitive compositions. These cans are normally employed to prime insensitive compositions also packed in metal cans and are sometimes equipped with threads for engagement with mating threads on the cartridges. Such structures are undesirably expensive.

All of these insensitive compositions are by their very nature highly hygroscopic and extreme precautions must be taken to prevent the entry of water and even moisture into the cartridge prior to detonation. Some of the cartridges of insensitive explosive have been furnished with detonator wells to receive booster caps. It is common practice, moreover, to actually slit the side of cartridges and insert the booster cap or other priming means into the interior of the charge, despite the possibility that severe moisture or water conditions will be met prior to detonation of the charge. The provision of detonator wells or tunnels for detonating fuse adds both to the expense of the production of the individual cartridge, and, what is probably even more important, provides additional joints between materials of construction where leaks can occur with resultant entry of moisture or water into a cartridge.

It will, therefore, be seen that a really satisfactory priming means for the insensitive hygroscopic blasting compositions is not presently available. Not only do most of the present methods of priming and cartridgeing invite the entry of water and moisture but, moreover, additional components in the form of powder punches, boosters, extra priming cartridges and the like are necessary.

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Now in accordance with the present invention, priming means for water-sensitive, cap-insensitive explosives have been discovered which are themselves readily initiated by a blasting cap or a detonative fuse such as Primacord and furthermore give positive initiation to insensitive powders without in any way endangering the waterproofing of the cartridge in which the composition is furnished.

Generally described, in its simplest embodiment, the present invention is a primer unit for detonating explosives and adapted to being attached to blasting cartridges which comprises a container, a solid charge of blasting cap and detonative fuse sensitive explosive composition disposed within the container, and a passageway for an initiating means passing through a wall of the container and extending at least partially through the charge, said charge comprising the polymerization product of a mixture of polymerizable, normally liquid vinyl material and sufficient blasting cap-sensitive, nonaromatic, crystalline high explosive to render the solid charge at least as sensitive to detonation as a polymerization product containing 60% pentaerythritol tetranitrate and 40% polymer or 40% of a combination of polymer and plasticizer. If the passageway extends only part way through the priming charge, a well is thus provided for a blasting cap. On the other hand, if the passageway extends completely through the charge and its container, detonative fuse, such as Primacord, also may be readily threaded through the passageway. In either event, the initiating means is in close propagating relationship with the priming charge. The well or passageway may be lined with metal, paper or plastic and the like, or may be unlined as may be desired. The priming charges themselves may be prepared from any polymerizable or monomeric vinyl substance in admixture with the desired amount of crystalline high explosive. The invention is limited to the vinyl type of polymerizable substance since these materials polymerize readily at low temperature by linear addition and/or crosslinking and without the generation of undesired gaseous or liquid by-products as contrasted with materials such as urea-formaldehyde or phenol-formaldehyde resins which cure by a condensation reaction, give off the undesired gaseous or liquid by-products, and require curing temperatures which are generally unsafe in the presence of crystalline high explosives such as pentaerythritol tetranitrate and the like.

In accordance with other and more specific embodiments of the invention, the primer unit may be placed within a sleeve which in the field may be readily slipped over the end of an explosive cartridge to bring the primer unit into priming and propagating relationship with the main explosive charge in the cartridge. The priming unit may be sealed in place in the sleeve by adhesive, wax-like substances which will provide strength and waterproofing to the structure. As a further alternative, the priming unit of the invention may be employed between explosive cartridges in blasting assemblies built up by use of connecting sleeves which extend across the ends of the explosive cartridges and the primer unit disposed therebetween.

Having generally described the invention, more specific description of several embodiments is presented with reference to the accompanying drawings, in which like symbols refer to like structural elements. In Figs. 1 through 4, a preferred embodiment of the basic primer structure is shown. In Figs. 5, 6 and 7, part sectional part elevational views of more specific embodiments of the invention are shown. In Fig. 8 another embodiment of a priming unit is shown.

In Figs. 1 through 4, a basic primer structure is illustrated in which a cylindrical paper tube 11 is provided with two slots 13 disposed at points 180° apart on the

cylinder. A paper cover 12 is press fitted over each end of the cylinder 11 and an aluminum tube 14 passes through slots 13 and extends beyond the cylinder wall 13. A solid block of cap-sensitive explosive composition 15 is disposed within the container 10 and about the tube 14. The unit shown is preferably prepared by initially placing one cover 12 in position on the end of the cylinder 11 opposite the slots 13. The aluminum tube 14 is then placed in the slots 13 and allowed to extend the desired distance on either side of the cylinder 11. The explosive composition 15 is then prepared by admixing 79.5 parts of pentaerythritol tetranitrate, 2.5 parts of diallylphthalate, 17.7 parts of styrene-glycol maleate (70/30) and .3 part of methyl ethyl ketone peroxide. This mixture is a stiff, moldable plastic mass. The composition is loaded into the cylinder 11 and packed around the aluminum tube 14. The second cover 12 is then placed in position as shown in Fig. 2 and the entire unit is maintained at a curing temperature, preferably at a temperature of about 15° to 50° C., until a solid polymerization product is obtained.

In the structure described, the primer is suitably initiated by passing a detonative fuse such as Primacord through the tube 14. The primer unit 10 may be attached to the explosive cartridge or charge to be initiated by any suitable means, particular embodiments of which will be subsequently described. The tube 14 may be replaced by one or more initiator wells if desired and initiation may be obtained through the action of an ordinary blasting cap instead of detonative fuse.

In Fig. 5 is shown a preferred embodiment of a more specific priming unit which may be readily attached to an explosive cartridge without in any way defacing the cartridge or altering its waterproof characteristics. A priming unit 10 similar to that described in Figs. 1 through 4 is diametrically centered within a spirally wrapped paper sleeve 50 and adjacent one end of the sleeve. The aluminum tube 14 extends through the walls of the sleeve at points 180° apart and is secured at each end to the sleeve by being flared as at 51. The end of the sleeve 50 is crimped inwardly to form a fluted crimp 52 which in this instance substantially closes one end of the sleeve leaving only a small orifice 53 in the center of the crimp 52. A body of adhesive, waxlike sealing compound 54 is disposed in a continuous form about the unit 10 within the sleeve and above and below the fluted crimp 52 to provide a rigid and waterproof seal about the unit 10 and in the end of the sleeve 50. An explosive cartridge 55 with an external diameter substantially the same as the internal diameter of the sleeve 50 is disposed in snug slidable relationship within the sleeve 50 with the lower surface of the primer unit 10 in juxtaposition to the upper surface of the cartridge.

In Fig. 6, a primer unit 10 equipped with tube 14 is diametrically centered within a sleeve 60 at approximately the mid point of the sleeve. The ends of the tube 14 are again secured to the outer surfaces of the tube 60 by being flared as at 61. An explosive cartridge 62 having an external diameter substantially the same as the internal diameter of the sleeve 60 is inserted into each end of the sleeve 60 until the ends of the cartridges 62 are in juxtaposition to the upper and lower surfaces of the primer unit 10. The ends of the cartridges are sealed by means of a fluted crimp 63 and a continuous layer 64 of adhesive, waxlike material is disposed above and below the crimp and in the orifice formed in the center of the crimp 63.

In Fig. 7, a primer unit similar to that shown in Figs. 1-4 and employed in Figs. 5 and 6 is disposed substantially concentrically within a sleeve 70 and at substantially the end of the sleeve. The ends of the tube 14 pass through the wall of the sleeve 70 at points 180° apart and are secured in place by means of grommets 71. A continuous body 72 of adhesive, waxlike compound is

disposed about the container 11 in the tube 14 forming a rigid and waterproof seal adjacent the end of the tube 70. An explosive cartridge 73 having an outside diameter substantially equal to the inside diameter of the sleeve 70 is disposed within the sleeve 70 with the upper end of the cartridge being in juxtaposition to the lower surface of the priming unit 10.

In Fig. 8, a priming unit 80 similar to that shown in Figs. 1 through 4, except for having a detonator well 84 extending downwardly into the interior of the unit, is disposed between two explosive cartridges 81 in end to end abutting relationship. A connecting sleeve 82 is disposed about the ends of the cartridges 81 and the priming unit 80 to form a rigid connecting explosive column. A blasting cap 83 is disposed in the well 84. Lead wires 85 lead from the blasting cap, between the cartridge 81 and the sleeve 82, and are connected to a power source. The explosive assembly of Fig. 8 is especially adapted for use in seismic prospecting operations.

In all of the units shown in Figs. 5, 6, 7 and 8, the sleeves may be adhesively secured to the cartridges. The use of adhesives is normally not preferred, however, unless the cartridge-primer structure is to be stored, shipped and furnished in the field as a unit.

In the structures of the invention as illustrated by the embodiments described, it is preferred that the containers for the plastic explosive composition and the sleeves employed for attaching the primer units to explosive cartridges be made from paper, cardboard or other cellulosic materials. However, sleeves and containers for the plastic explosive may also be made from metal or plastic. The detonator wells and fuse tubes which pass into or through the plastic polymerization product also may be metal, plastic or paper. The cartridge shells and connecting sleeves are also preferably made of paper or other cellulosic material, although they too may be made from plastic or metal if desired.

The polymeric binding material acting as a matrix for the particulate high explosive will be prepared from monomeric or further polymerizable vinyl substances which readily form linear or cross-linked type polymers in the presence of a polymerization catalyst at low temperatures. Such substances include the acrylic type of materials such as methyl, ethyl and butyl acrylate, ethyl, methyl, and butyl methacrylate, and the like; styrene; styrene-polyesters, acrylonitrile and the like. Preferred styrene-polyesters will contain about 30-70% styrene and about 70%-30% of polyester. The preferred polyesters are the reaction products of ethylene glycol, diethylene glycol or propylene glycol with maleic, fumaric or phthalic acid. Crosslinking agents such as diallylphthalate and triallyl cyanurate may also be included. Commercial types of styrene-polyesters which give excellent results are Stypol 107E, manufactured by H. H. Robertson Co., Selectron 5003, manufactured by Pittsburgh Plate Glass Co., and Vibrin 121, manufactured by Naugatuck Chemical Co. The commercial products often contain a polymerization accelerator such as cobalt naphthenate. More than one of the above and equivalent polymerizable materials may be copolymerized if desired. As previously mentioned, the materials which harden by condensation type reactions are not operable in the invention since in general they require undesirably high temperatures for the reaction and invariably evolve undesirable gaseous or liquid by-products which adversely affect the physical properties of the final polymerization product.

The priming compositions of the invention are prepared by admixing the particulate explosive with the polymerizable material and catalyst and then curing the mixture to obtain a solid body. Preferably, the mixture will be cured in its final paper, metal or plastic container. If desired, however, the polymerization products may be formed in special molds and then loaded into their containers.

The usual polymerization catalysts known and employed by the art for the polymerization of vinyl type materials may be employed in preparing the explosive compositions of the invention. Such catalysts include benzoyl peroxide, cumene hydroperoxide, methyl ethyl ketone peroxide and the like. As catalysts, benzoyl peroxide and methyl ethyl ketone peroxide are preferred.

While any blasting cap-sensitive, nonaromatic crystalline high explosive is operable in preparing the priming charges of the invention, the more sensitive explosive such as pentaerythritol tetranitrate and RDX (cyclotrimethylene trinitramine) are preferred. However, such other materials as sucrose octanitrate, lactose octanitrate and mannitol hexanitrate may also be employed. For best results the crystalline explosive should not contain more than about 1% moisture. Aromatic explosive compounds are not operable in the invention since the aromatic nucleus inhibits polymerization of the vinyl material and thus prevents satisfactory consolidation of the charge.

It has been found that in order to obtain the desired physical strength the plastic explosives employed in the primer units of the invention should contain at least 10% of polymeric material. The upper limit of polymeric material will depend upon the sensitivity desired in the polymerization product. In general, to be sensitive to Primacord or No. 6 Cap, the composition should contain at least 60% of pentaerythritol tetranitrate or an amount of other crystalline explosive which will result in a sensitivity equivalent to a composition containing 60% of pentaerythritol tetranitrate and 40% of polymeric material.

Although the priming units of the invention are primarily intended for use with the blasting cap or detonative fuse insensitive explosive compositions, these units may, if desired, be employed with other explosive compositions of greater sensitivity where more positive priming is deemed desirable. For example, they provide an excellent priming means for gelatinous explosives which are desensitized by pressure. The primers of the invention are relatively unaffected by water or pressure and have been shot under a pressure of 500 p.s.i. by a No. 6 Cap after being exposed to a water pressure of 500 p.s.i. for more than one week. As a result of these properties, the primers of the invention are already widely used in seismic prospecting operations to initiate gelatin explosives.

Since the invention as described will be subject to considerable modification by those skilled in the art, it is intended that the invention be limited only by the scope of the appended claims.

What we claim and desire to protect by Letters Patent is:

1. A primer unit especially adapted for detonating cylindrical explosive cartridges comprising, in combination, a flat, cylindrical body member having a length substantially less than its diameter essentially consisting of a covered unitary mass of a fissure-free synthetic waterproof, self-sustaining, resinous polymerization product containing dispersed therein at least 60% of a particulate, nonaromatic, crystalline high explosive, and a longitudinal, substantially imperforate tube to receive explosive initiating means therein embedded substantially midway of the length of the flat, cylindrical body member and diametrically extending entirely through said body member.

2. A primer unit in accordance with claim 1 in which each end of said longitudinal tube passes through and supports a sleeve element concentrically positioned about the primer unit.

3. A primer unit in accordance with claim 2 in which the primer unit is rigidly secured to the sleeve element by a sealing compound cast thereabout within the sleeve.

4. A primer unit in accordance with claim 3 in which one end of the sleeve is inwardly crimped over the primer unit and the sealing compound extends above said crimp.

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