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PRIMERS FOR USE WITH DELAY ACTION BLASTING CAPS AND PROCESS OF BLASTING USING THE SAME

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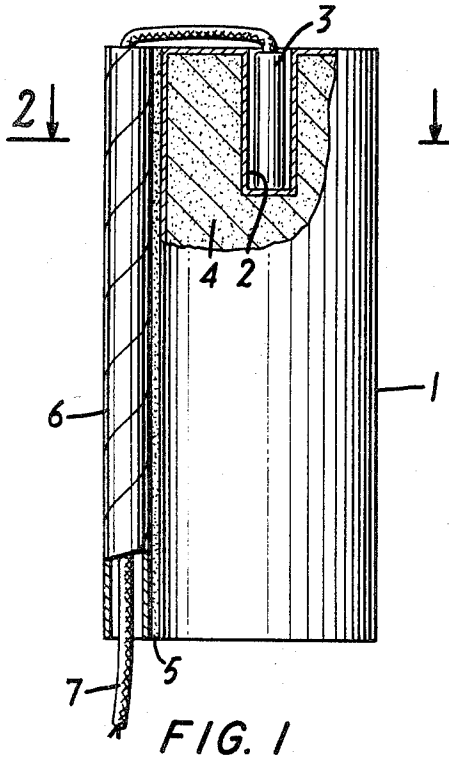


FIG. 1

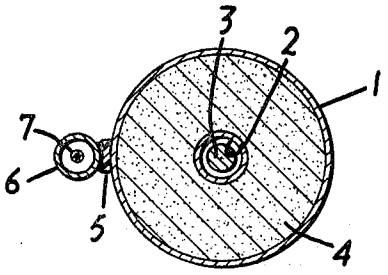


FIG. 2

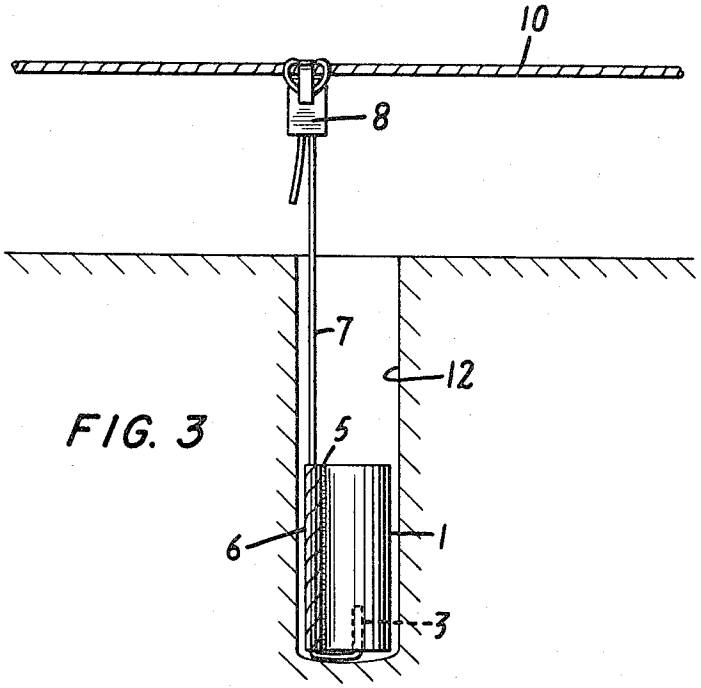


FIG. 3

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PRIMERS FOR USE WITH DELAY ACTION BLASTING CAPS AND PROCESS OF BLASTING USING THE SAME

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ABSTRACT OF THE DISCLOSURE

Primer cartridges are provided adapted for use with nonelectric delay action blasting caps, initiated by low energy detonating cord, and comprising a cartridge for primer explosive, a receptacle in the cartridge for reception of a blasting cap, a layer of energy-absorbing material on the exterior of the cartridge, and a fuse holder means attached to the layer, with the layer interposed in between the fuse holder and the primer cartridge wall. The layer separates the fuse from the primer wall, and prevents detonation of the primer by the fuse.

This invention relates to primers and to primer cartridges especially designed for use with delay action blasting caps initiated by low energy detonating cord, and more particularly to primers and primer cartridges having an energy-absorbing layer attached to the outside wall separating the initiating fuse for the blasting cap from the primer container wall, and to a method of blasting using such primers, which avoids the necessity of threading or lacing the initiating fuse through the primer.

Electric blasting caps are subject to being set off by thunderstorms, stray electric currents, static electricity and RF energy, with a resulting premature explosion. Consequently, for many years the explosive industry has been confronted with the hazards of electric blasting caps under these conditions.

In order to overcome this problem, but still retain the delay characteristics of electric blasting caps, a nonelectrical initiating system has been introduced, employing nonelectric millisecond delay blasting caps for in-hole initiation of explosives. These blasting caps provide the precise timing of electric blasting caps, but are immune to the hazards or effect of extraneous electricity. The system is composed of a length of low energy detonating fuse, with a delay element and a nonelectric blasting cap attached to one end. The other end of the detonating fuse is tied to a standard detonating fuse trunk line, which, when initiated, causes a detonating wave to travel down the low energy detonating fuse to the delay element. The delay element introduces a predetermined delay period, and then initiates the nonelectric blasting cap, thus duplicating the effect that would be obtained by the use of an electric blasting cap in the same location.

In using the system with a conventional primer containing the properly insensitive explosive, the low energy detonating fuse is laced through the cartridge, and the cap inserted in the crimped end of the cartridge. Thus, the fuse actually passes through the explosive at this point, and is intimately in contact with the explosive there. It is not possible to half-hitch the detonating fuse around the cartridge as is usual with electric blasting cap lead wires, since the fuse can cut off at the point of crossover.

As a consequence, the system requires that the primer used be insensitive to initiation by the low energy detonating fuse, but it must readily accept detonation from a No. 6 blasting cap. Conventional nitroglycerine-based

explosives cannot be used under any circumstances, since the fuse in most instances initiates this type of explosive, thus nullifying or short-circuiting the delay element before the cap.

This type of lacing also means that if the primer is used in a water-filled hole, water can penetrate the explosive at the point where the fuse is laced through it, and depending on the type of explosive in the primer, can migrate towards the blasting cap, reach or desensitize the powder around the cap, and cause the primer to misfire.

Considerable private research has been carried out by the inventors in an attempt to overcome the difficulty introduced by threading or lacing the fuse through the cartridge. Relatively insensitive primer explosives have been tried in cast form, such as pentolite, composition B, and trinitrotoluene. However, it was found that the low energy detonating fuse when held in close contact with the cast primer, either by taping, tying, or other means, in from 25 to 50% of the cases would rupture the cast explosive, and cause the primers to malfunction. Cardboard or paper tubes were also inserted in the priming wells, and along the outside wall of the primer, but these steps were equally unsuccessful.

In accordance with the invention, a primer cartridge is provided with means for holding the detonating fuse along the outside wall of the primer while separating it from the wall sufficiently to avoid any danger of detonating the primer, or of rupturing a cast primer explosive. This means comprises a layer of energy-absorbing material, which is attached to the outside wall of the primer cartridge. To this layer is attached means for holding the fuse to the primer, with the layer interposed between the primer wall and the detonating fuse. Thus, the layer separates the fuse from the primer wall, and prevents detonation of the primer by the fuse. It also eliminates the necessity of threading or lacing the detonating fuse through the primer, in order to attach the fuse to the primer in running it to the blasting cap. Means for holding the detonating fuse can be firmly attached to the separating layer, so that the fuse can be firmly affixed to the primer.

The primers of the invention are very easily employed in in-hole initiation of explosives using nonelectric delay blasting caps. The length of low energy detonating fuse of conventional type with a delay element and the nonelectric blasting cap crimped to one end is simply attached to the holding means for such fuse attached to the separating layer, and the blasting cap inserted in the receptacle provided therefor in the primer cartridge. The other end of the detonating fuse is tied to a standard detonating fuse trunk line. This, when initiated, causes the detonating wave to travel down the low energy detonating fuse to the delay element, which imparts a predetermined delay period in the usual way, and then initiates the nonelectric blasting cap. The detonating wave travels safely along the low energy fuse without effecting the primer because of the insulating effect of the separating layer interposed therebetween. The result is a reliable primer for use with delay action blasting caps of all types.

The separating layer can be of any energy-absorbing material. A layer of rubber, either natural or synthetic, will serve. So will a corrugated spacer material that is spaced away from the container wall by the tips of the corrugations, thus insulating and separating the fuse from the container wall by the material and an air gap corresponding to the depth of the corrugations. Other types of spacers can be used. A porous or air-containing or absorbent material such as a plastic sponge is also satisfactory. Foamed materials are particularly suitable, and are preferred.

The foam material is preferably a foamed plastic or rubbery material, such as polyvinyl chloride resin foam, polyurethane resin foam, foam rubber, foam nylon, foam polyethylene, and foam polypropylene.

The layer can be in the form of a wide or narrow strip or tape extending along the outside of the primer cartridge. The entire cartridge can be sheathed in the separating layer material, if desired, but it is usually unnecessary to provide the layer anywhere except just between the fuse and the primer wall.

A preferred form of separating material is a pressure-sensitive tape, such as polyvinyl chloride pressure-sensitive foam tape. This is easily affixed to the outside wall of the primer, pressure-sensitive adhesive side down, attached to the primer wall. The tape can also be attached to the wall by use of an adhesive or bonding agent appropriate for the purpose.

The layer should be of a width at least equal to the diameter of the detonating fuse, so as to insulate it fully from the cartridge wall. It can, if desired, be considerably wider than the detonating fuse, so as to provide an ample area for insulation protection. Its thickness is important, and should be sufficient to furnish the insulating effect required. This will depend on the energy conductivity of the material; a thin layer of a relatively energy absorbing material can be just as effective as a thick layer of relatively better energy-absorbing material, and in either case the layer must be thick enough to insulate the fuse from the container wall, and prevent the fuse from damaging the primer.

It is thought that the separating layer protects the primer explosive against detonation because of the insulating effect of the layer, and because if its compressibility, which enables it to take up some of the shock of the detonating wave traveling down the fuse. Accordingly, the material should be compressible to a considerable degree.

The holding or holder means for attaching the detonating fuse to the layer can take any of several forms.

A preferred embodiment is a tube, such as a spiral wound cardboard tube, extending a substantial part or all of the length of the primer cartridge. The detonating fuse can be threaded through this tube along the outside of the primer cartridge.

In another embodiment, the holder means takes the form of a channel so shaped and sized that the fuse is tightly held therein in a press-fit. The channel can be of resilient plastic material or of metal, and can have a diameter slightly less than the diameter of the fuse, so that the fuse is slightly compressed on insertion in the channel, and the resilient side walls of the channel are correspondingly thrust somewhat apart, due to the relative noncompressibility of the fuse, with a corresponding spring action tending to retain the fuse in the channel.

In still another embodiment, a plurality of loops are provided instead of a continuous tunnel, through which the fuse can be threaded in running it to the blasting cap. Other forms of holder means include pressure-sensitive and adhesive bonded tapes, apertured plates and disks, clasps, clips, hooks, clamps, grips, lugs, helices, slides and coils, and these can be circular, elliptical, or otherwise U- or ring-shaped in cross-section.

The invention is applicable to primer cartridges of all types. The primer cartridge can be made of any material, such as paper, cardboard, metal or plastic, such as aluminum, steel, iron, polyvinyl chloride, polyethylene, cellulose acetate, and ethyl cellulose.

Any primer explosive material can be packaged in the primers of the invention, inasmuch as the explosive need not be insensitive to initiation from the detonating fuse, due to the protection afforded by the separating layer the explosive should be sufficiently sensitive to be reliably initiated by a No. 6 blasting cap, but it can be more sensitive than this, if desired. Typical primer explosives that can be employed include pentolite, composition B, trinitrotoluene, Cyclonite, Tetryl, special explosives and blasting agent combinations, including the nitrocarbonitrates, TNT-sensitized-ammonium nitrate-type slurried high explosives, smokeless powder-sensitized-ammonium nitrate-type slurried high explosives, nitrostarch-sensitized-ammonium nitrate-type slurried high explosives, nitrostarch-sensitized-ammonium nitrate-type slurried high explosives, TNT-ammonium nitrate-pellet-form solid high explosives, and high explosives that include nitrostarch-sensitized-ammonium nitrate-type semi-solid high explosives, nitroglycerine dynamites, such as the semi-gelatins, ammonia gelatins, and ammonia dynamites, pentaerythritol tetranitrate, and Cyclotol.

The drawings illustrate a preferred embodiment of the invention.

FIGURE 1 is a view in elevation, with parts cut away, of an explosive primer cartridge of the invention, showing a delay action blasting cap in position in the well provided therefor.

FIGURE 2 is a cross-section taken along the lines 2—2 of the primer cartridge of FIGURE 1.

FIGURE 3 shows the mode of attachment of the primer cartridge of the invention to a detonating fuse and delay action blasting cap for in-hole initiation.

The explosive primer of FIGURES 1 to 3 includes a spirally wound primer cartridge **1** made of cardboard, equipped with a blasting cap well **2** open to the atmosphere for insertion of a blasting cap **3** with a delay element as a component part thereof. The cartridge is filled with a high explosive **4**, such as pentolite, in cast or powdered form.

Attached to one side of the cartridge, and extending from end to end of the cartridge, is a polyvinyl chloride resin pressure-sensitive foam tape **5**, one-half inch wide and one-quarter inch thick. To this is attached by a suitable adhesive or alternatively by a tape a spiral wound cardboard tube **6** of a diameter sufficient to receive a detonating fuse **7** running to the blasting cap **3**.

If desired, on top of the charge of primer high explosive or blasting agent combination there can be placed a booster cup containing a booster explosive. Any booster explosive can be used, preferably in cast form, such as pentolite or composition B. If used, the detonating velocity of the booster explosive is sufficient to initiate the primer. This booster cup is also sealed in the explosive cartridge, and the blasting cap well is inserted in the booster cup for initiation of the booster.

In practice, as shown in FIGURE 3, a length of low energy detonating fuse **7**, with a delay element-fitted non-electric blasting cap **3** crimped to one end, is threaded through the tunnel **6**, while the blasting cap is inserted in the well **2**. The other end of the detonating fuse is tied via suitable connector **8**, such as a J-connector, to a standard detonating fuse trunk line **10**, to which can be affixed a plurality of such primer assemblies (not shown) with blasting cap attached. The primer is then slipped into a bore hole **12**.

When the detonating fuse trunk line **10** is initiated, the detonating wave travels down it, and then down each of the low energy detonating fuses **7** attached thereto, running to the delay element through the tunnel **6** without affecting the primer. The delay element imparts a predetermined delay period, and then initiates the blasting cap, setting off the primer.

A number of primers were prepared, of the type shown in FIGURES 1 to 3, utilizing strips of a variety of materials as the insulating layer. These were tested to determine resistance of the primer to damage by the fuse. The Primaline PETN detonating fuse was used.

¼ inch thick polyvinyl chloride foam was compared with ⅛ inch thick Armorite rubber, 1/16 inch thick Armorite rubber, ⅛ inch thick Styrofoam (packing block) and ⅛ inch thick corrugated cardboard as an insulator for the energy released from the Primaline. In the test, a ⅜ inch wide strip of the insulating material was affixed to the canister wall of a No. 5 cast pentolite primer. The

Primaline was then affixed to the insulating material. All five materials prevented the wall of the canister from being ruptured when the Primaline detonated. When the Primaline was affixed to the wall of the primer canister without the benefit of an insulator, the wall was torn and the pentolite fractured and partially displaced from the area adjacent to the Primaline.

Compressibilities of the material were measured using a foam and sponge hardness tester in which 100.0 represents maximum hardness and an Arthur H. Thomas micrometer adjustment penetrometer having a 0.125 inch diameter rod and 0.103 gram weight. Penetration is measured in millimeters.

	Hardness tester	Penetrometer, mm.
¼ inch polyvinyl chloride foam	62.0	4.0
⅛ inch Armorite rubber	97.0	0.5
1/16 inch Armorite rubber	97.0	0.5
¼ inch Styrofoam	97.0	1.5
⅛ inch corrugated cardboard	97.0	0.0

Tests were conducted using the ¼ inch thick polyvinyl chloride foam in conjunction with standard nitrostarch sensitized and nitroglycerin base dynamites. In both instances, the Primaline did not rupture the cartridge wall when the foam was interposed between the Primaline and the cartridge. The dynamites tested were:

Type	Cap sensitivity, No.
Nitrostarch-based dynamite	1
Nitroglycerin-sensitized ammonia dynamite	½

These data show the effectiveness of the insulating layer in preventing primer damage.

The water-resistance of the primers in accordance with the invention is greatly enhanced, because the detonating fuse is not laced or threaded through it. Consequently, the primers can be employed in water-filled holes without introducing any problem. All that is necessary is that the primer cartridge itself be water-proof, or sufficiently water resistant so that water does not have time to penetrate to and desensitize the primer before the charge is set off. The primer is sufficiently versatile to permit its use in nonelectrical delay initiation systems of conventional type, employing the usual types of fuse, delay elements of nonelectric blasting caps.

Having regard to the foregoing disclosure, the following is claimed as the inventive and patentable embodiments thereof:

1. A primer cartridge especially adapted for use with nonelectric delay action blasting caps and detonating fuse, comprising a cartridge for a primer explosive having means permitting insertion of a blasting cap in juxtaposition to the primary explosive; fuse holder means on the exterior of the cartridge for guiding a detonating fuse to the blasting cap; and a layer of energy absorbing material attached to an exterior portion of the cartridge and interposed between the fuse holder means and the cartridge so as to protect the cartridge from rupture and inhibit premature detonation of the explosive in the cartridge by a detonating wave along the detonating fuse to the blasting cap, thereby ensuring that the explosive in the cartridge is detonated only after the delay introduced by the blasting cap.

2. A primer cartridge in accordance with claim **1**, in which the holder means is a tube having a diameter slightly larger than the diameter of the detonating fuse.

3. A primer cartridge in accordance with claim **1**, in which the layer of energy absorbing material is a tape.

4. A primer cartridge in accordance with claim **1**, in which the energy-absorbing material is a strip of plastic foam material.

5. A primer cartridge in accordance with claim **4**, in which the strip of foam material is a pressure-sensitive polyvinyl chloride resin foam tape.

6. A primer comprising a primer cartridge in accordance with claim **1**, filled with a primer explosive.

7. A primer in accordance with claim **6**, in which the explosive is in cast form.

8. A primer in accordance with claim **6**, in which the explosive is in powdered form.

9. In the process for blasting using a nonelectric delay action blasting cap, detonating fuse, and a primer explosive in a primer cartridge in which after initiation of the detonating fuse, which initiates the blasting cap, a predetermined delay occurs before the primer explosive in the cartridge is detonated, the improvement which comprises guiding the fuse to the blasting cap along the exterior of the cartridge with a layer of energy absorbing material interposed between the fuse and the cartridge to absorb the force of the detonating wave while the detonating wave is travelling along the fuse to the blasting cap to thereby prevent rupture of the cartridge and, inhibit premature detonation of the primer explosive but permit the blasting cap to be detonated.

10. The process according to claim **9**, in which the absorbing layer is a foam plastic material.

11. The process according to claim **10**, in which the foam material is a pressure-sensitive polyvinyl chloride resin foam tape.

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