July 13, 1937. L. A. BURROWS 2,086,530

ELECTRIC BLASTING INITIATOR

Filed Oct. 30, 1935

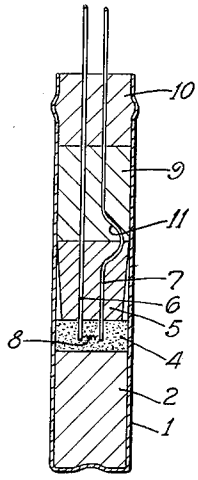


FIG. 1

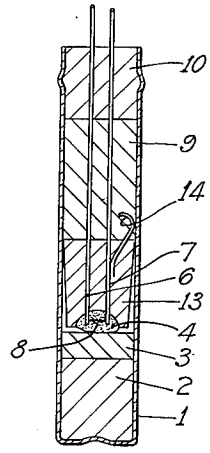


FIG. 2

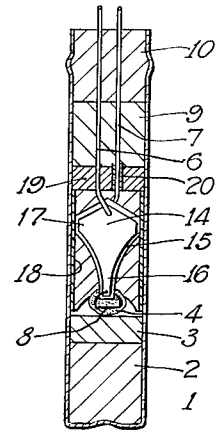


FIG. 3

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ELECTRIC BLASTING INITIATOR

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17 Claims. (Cl. 102—10)

The present invention relates to electric blasting initiators generally, and more particularly to an electric blasting cap without appreciable time lag and substantially free from susceptibility to static electricity.

Electric blasting caps of all types may be classified as relatively "fast" and relatively "slow" caps on the basis of the time required for the cap to detonate after the firing current has been applied. Such a classification is made to distinguish between blasting caps which are suitable for ordinary blasting operations and those which are adaptable to rather special uses, as, for example, in seismographic exploration for mineral or other deposits where the necessary record of the exact instant of detonation is most conveniently made by recording the instant of rupture of the bridge wire. Heretofore, however, this distinction between "fast" and "slow" caps has been rather qualitative in nature, since all the available electric blasting caps possessed an inherent, measurable, and significant time lag or interval between the instant the firing current was applied and the instant the blasting caps detonated.

The time lag above referred to is the overall lag resulting from two separate factors, the first of which is the interval of time between the application of the firing current and the breaking or fusion of the high resistance bridge wire. This interval, which we may term the "bridge wire lag" is generally dependent upon the firing current used. For many practical purposes, however, the "bridge wire lag" is not significant, since in seismographic explorations and other types of work requiring a "fast" cap, the instant the bridge wire breaks or fuses may be conveniently assumed to be the instant of detonation.

A far more serious factor affecting the overall time lag, and one which is of great significance in the special uses above referred to, is the interval of time between the breaking of the bridge wire and the actual detonation of the cap. This lag, which we shall hereinafter refer to as the "induction period", depends to a certain extent on the amperage of the firing current. At a given amperage, however, the "induction period" is a definite characteristic property of the ignition composition employed. Thus certain materials have an inherently long "induction period", whereas in others this period is not measurable.

Although a number of materials of the latter type are available, the use of these "fast" ignition agents has heretofore involved a considerable danger from the point of view of static electricity, for it has been found that ignition compounds which have a negligible or immeasurable "induction period" are very susceptible to static electricity; that is to say, electrostatic charges of low voltage, which are well within the range of that which may be accumulated by a man of ordinary electrical capacity, are capable of igniting these "fast" ignition compounds and thereby initiating the blasting cap. While, in general, it appears that all ignition compositions can be fired by an electrostatic discharge, this susceptibility to static electricity increases very markedly as the "induction period" approaches zero. These rapid ignition compounds can not, therefore, be employed safely in electric blasting caps unless the electrostatic susceptibility of the finished blasting cap is substantially reduced or eliminated by means which are certain in effect and sufficiently rugged in construction to withstand mechanical handling in the field. Such means are disclosed and claimed generally in co-pending application, Serial No. 47,385 filed October 30, 1935.

The object of the present invention is a new and improved electric blasting cap which is substantially free from susceptibility to electrostatic charges. A further object is an electric blasting cap without an appreciable "induction period", and substantially free from susceptibility to static electricity. A still further object is an electric blasting cap containing an improved ignition composition possessing very rapid ignition characteristics, the electrostatic susceptibility of said cap being substantially eliminated by means which are certain in effect and sufficiently rugged in construction to withstand mechanical handling in the field. Additional objects will be apparent as the invention is hereinafter more fully described.

I have found that these objects may be accomplished by providing an electric blasting initiator containing a lead salt of a nitrophenol with a means for substantially reducing the electrostatic susceptibility of said initiator. This means may comprise any of the embodiments of the invention disclosed and claimed generally in co-pending application Serial No. 47,385 filed October 30, 1935.

The lead salts of various nitrophenols may be employed in accordance with my invention. Thus I may use the lead salts of various polynitrophenols, as for example, the lead salts of the polynitro-monohydric phenols such as picric acid, picramic acid, dinitrosalicylic acid and the like; or the lead salts of the polynitro-dihydric phenols such as trinitroresorcinol and the like; or the lead

salts of the polynitro-polyhydric phenols such as trinitrophloroglucinol and the like. I prefer, however, to employ the lead salts of trinitrophenol, commonly known as lead picrate; and the lead salts of trinitroresorcinol, commonly known as lead styphnate. Either the normal or the basic lead salts may be used as desired.

These lead salts of nitrophenols may be employed, if desired, as the ignition composition in all types of electric blasting initiators, including electric squibs, electric blasting caps, and delay electric blasting caps, whether of the bridge plug, the concave plug, or the match-head type. In order to produce an electric blasting initiator, however, which is substantially free from susceptibility to static electricity, it is necessary to provide the firing circuit of the initiator with one of the embodiments of the invention disclosed in the co-pending application above referred to.

Although my invention is applicable to all types of electric blasting initiators, it is particularly applicable to electric blasting caps, since the lead salts of nitrophenols are more especially useful in this type of initiator. The resulting detonators according to my invention have the advantage not only of being substantially free from susceptibility to static but also of being very rapid, without appreciable time lag. The invention therefore makes it possible to produce a safe, reliable electric blasting cap, suitable for certain special uses where the speed of detonation is an important consideration.

My invention comprises an electric blasting initiator containing an ignition composition comprising a lead salt of a nitrophenol, for example lead styphnate or lead picrate. The firing circuit of the initiator is provided with a means whereby the susceptibility of the initiator to static electricity is substantially eliminated or reduced. The means provided cause the static charge to pass harmlessly to the shell wall at a point outside the locus of the ignition composition, and may be formed by two general types of procedure, as more fully described in the co-pending application, Serial No. 47,385 filed October 30, 1935. In the first place, the static electricity may be caused to pass to the shell wall by forming an actual, physical electrically-conducting connection between the shell wall and one of the leg wires at a point outside the locus of the ignition composition. In the second place, the static electricity may be caused to pass to the shell wall by forming a spark gap or arc between the shell wall and one of the leg wires at a point outside the locus of the electrostatic-susceptible ignition composition, such that the resistance across the arc provided is substantially less than that of the arc formed by the firing circuit and the shell wall at the locus of the ignition composition. In either case, the static electricity will pass harmlessly to the shell wall, where it will be effectively grounded.

In order to describe my invention more clearly, I shall refer to the attached drawing, which represents several embodiments thereof. It is to be understood, however, that this is done solely by way of illustration, and is not to be regarded as a limitation upon the scope of my invention which has many important applications other than those herein particularly illustrated.

Referring generally to the drawing, Figures 1, 2, and 3 represent respectively vertical sections of a bridge plug type, a concave plug type, and a match-head type of electric blasting cap, in accordance with my invention. Similar characters are used throughout the several views and in the accompanying description to indicate corresponding parts.

Referring now particularly to Figure 1, the blasting cap illustrated comprises a capsule or shell 1 of a suitable electrically-conducting material, such as a metal, as for example copper, aluminum, and the like. In the base of the shell 1 is placed a base charge 2 consisting of 80% mercury fulminate and 20% potassium chlorate, and an ignition composition 4 comprising a lead salt of styphnic acid, as for example the red crystalline modification of basic lead styphnate. The latter surrounds the bridge wire 8, attached to the ends of the leg wires 6 and 7. These wires are held in fixed space relationship by means of the bridge plug 5. The cap is closed by means of the waterproofing composition 9 and the sulfur seal 10. The leg wire 7 is provided with an elbow 11 which forms with the shell wall 1 an arc, the resistance of which is substantially less than that of the arc formed by the shell wall 1 and the firing circuit at the locus of the ignition composition 4. If desired, the elbow may contact the shell wall and form an electrical connection therewith.

In the electric blasting cap as illustrated in Figure 1, charges of static electricity which may be inadvertently applied to the shell wall 1, or the leg wires 6 and 7, will be harmlessly discharged across the arc formed between the elbow 11 and the shell wall 1 without firing the ignition composition 4 and detonating the blasting cap. The electric blasting cap in accordance with my invention is therefore substantially free from susceptibility to static electricity. It is also apparent that, since the means provided is effectively sealed within the blasting cap, it can not be subsequently impaired by handling in the field.

Referring now to Figure 2, the base charge 2 consists of tetryl, and the priming charge 3 of lead azide. The bridge wire 8, connected between the ends of the leg wires 6 and 7 is surrounded by an ignition composition comprising a lead salt of picric acid, as for example normal lead picrate gelatinized with nitrostarch and applied preferably in an amyl acetate suspension. The leg wires are held in fixed space relationship by the concave plug 13, and the cap is sealed by the waterproof composition 9 and the sulfur seal 10. Affixed to one of the wires 7 by suitable means, as for example by solder, is a short length of wire 14 which forms an electrically-conducting connection between the shell wall 1 and the leg wire 7. By this means, the blasting cap will be effectively protected from inadvertent firing by static electricity, since the charge will pass to the shell wall 1 through the connection 14, and thence to the ground, without affecting the ignition composition 4.

In Figure 3, the match-head type of electric blasting cap illustrated comprises a detonating base charge 2 of tetryl, a priming charge 3 of hexanitromannite and a match-head flash or ignition composition 4 comprising a lead salt of styphnic acid, as for example, the yellow variety of basic lead styphnate. Disposed within the paper cylinder 18 is the match-head, which comprises two metal plates or foils separated by a strip of insulating material 15. One leg wire is connected to each plate, and the bridge wire 8 forms the connection between the foils. In the diagram, only the forward plate 14 is represented.

The blasting cap is closed with the waterproof composition 9 and the sulfur seal 10.

The ignition composition 4 may comprise lead styphnate gelatinized with any suitable gelatinizing agent, but I prefer to employ a composition comprising approximately 95% lead styphnate and 5% nitrostarch applied in an amyl acetate suspension, since the resulting composition has been found to be very rapid in ignition.

In Figure 3, the plates or foils of the match-head, as for example the forward foil 14, are provided with long handles or tabs 16 and rather broad shoulders 17 which extend substantially to the paper tube 18, which is in contact with the shell wall 1. The shell wall 1 and the shoulders 17 will therefore form a low-resistance arc or spark gap which is well outside the locus of the ignition composition 4. The static charge will therefore jump across this arc without affecting the ignition composition 4. It is of course essential that the ignition composition 4 should cover only the lower part of tab 16 of the match-head, and should not be disposed between the shoulders 17 and the shell wall 1. In shape, the match-head shown is somewhat different from the conventional design in that the shoulders 17 are appreciably wider and the tab or handle 16 somewhat longer. This change, though apparently slight mechanically, is nevertheless of great significance from the point of view of static susceptibility, for it substantially prevents the shoulders 17 from being inadvertently covered with the ignition composition 4, which condition I have found will render the finished cap so sensitive to static that charges of low voltage, well within the range of that which a man of average capacity can accumulate, will invariably fire the ignition composition and detonate the cap.

As an additional precaution against static, the electric blasting cap as illustrated in Figure 3 is provided with a plug of electrically-conducting material 19, which engages the leg wire 6 and the shell wall 1 in electrically-conducting relationship. The plug 19 is separated from the leg wire 7 by the insulation 20. If desired, the plug 19 may consist of a low-melting metal or alloy, as for example Babbitt metal, which is poured into the cap about the dielectric material 20 surrounding the leg wire 7. The plug 19 may also consist of compressed graphite or other electrically-conducting material, if desired.

I have illustrated my invention with particular reference to electric blasting caps as the preferred embodiment thereof. It is apparent, however, that the invention may also be employed in other electric blasting initiators such as electric squibs, delay electric detonators, and the like, since the electrostatic susceptibility of all initiators employing a lead salt of a nitrophenol in the ignition composition may be substantially reduced by employing any of the means disclosed herein or in co-pending application, Serial No. 47,385 filed October 30, 1935. Again, the invention is equally applicable to the concave plug type, the bridge plug type, or the match-head type of electric blasting initiator. Furthermore, it may be employed regardless of the base or priming charge used. Thus, for example, I may employ any of the well-known base charges such as tetryl, trinitrotoluene, picric acid, nitromannite, pentaerythritol tetranitrate, and the like. I may use likewise any of the well-known priming compositions, as for example lead azide, diazodinitrophenol, mercury fulminate, nitromannite, and the like.

All of the electric blasting caps illustrated in the drawings and described in the foregoing paragraphs possess a number of very desirable properties. In the first place, all have an overall time lag of less than 6×10^{-4} seconds, when fired at 12 amperes. In the second place, the "induction period" of the caps according to my invention is negligible or immeasurable when a firing current of 12 amperes is used. Thus, for example, the cap illustrated in Figure 2 has no measurable "induction period", which implies that the bridge wire break is either caused by, or is simultaneous with, the detonation of the cap. Finally, the finished electric blasting initiators in accordance with my invention are substantially free from susceptibility to static electricity. The voltage required to detonate the blasting caps of my invention is far beyond that which a man of ordinary capacity can accumulate. It is apparent, therefore, that the detonators may be used under normal conditions without danger from electrostatic discharge.

The advantages in the use of my invention are numerous and important. It provides a permanent, simple, easily-manufactured, and effective means for substantially completely eliminating the hazards involved in the use of the lead salts of the nitrophenols. The invention therefore makes it possible to produce an electric blasting cap without appreciable time lag and substantially free from susceptibility to static. Heretofore such a blasting cap could not be manufactured by any known means.

In the foregoing detailed description of my invention, it is apparent that many variations may be made without departing from the spirit and scope thereof. I therefore intend to be limited only in accordance with the following patent claims:

I claim:

1. An electric blasting initiator containing an ignition composition comprising a lead salt of a nitrophenol, the firing circuit of said initiator being provided with a means whereby the susceptibility of the initiator to static electricity is substantially reduced.

2. An electric blasting cap containing an ignition composition comprising a lead salt of a nitrophenol, the firing circuit of said blasting cap being provided with a means whereby static electricity is caused to pass harmlessly to the shell wall of said blasting cap at a point outside the locus of said lead salt.

3. An electric blasting cap containing an ignition composition comprising a lead salt of a polynitrophenol, the firing circuit of said blasting cap being provided with a means whereby static electricity is caused to pass harmlessly to the shell wall of said blasting cap at a point outside the locus of said lead salt.

4. The blasting cap of claim 3, in which said polynitrophenol comprises a polynitro-monohydric-phenol.

5. The blasting cap of claim 3, in which said polynitrophenol comprises a polynitro-dihydric-phenol.

6. The blasting cap of claim 3, in which said polynitrophenol comprises a polynitro-polyhydric-phenol.

7. An electric blasting cap of the concave plug type containing an ignition composition comprising a lead salt of a polynitrophenol, the firing

circuit of said blasting cap being provided with a means whereby static electricity is caused to pass harmlessly to the shell wall of said blasting cap at a point outside the locus of said lead salt.

8. The electric blasting cap of claim 7, in which said polynitrophenol comprises styphnic acid.

9. The electric blasting cap of claim 7, in which said polynitrophenol comprises picric acid.

10. The electric blasting cap of claim 7, in which said polynitrophenol is gelatinized with nitrostarch.

11. An electric blasting cap of the bridge plug type containing an ignition composition comprising a lead salt of a polynitrophenol, the firing circuit of said blasting cap being provided with a means whereby static electricity is caused to pass harmlessly to the shell wall of said blasting cap at a point outside the locus of said lead salt.

12. The electric blasting cap of claim 11, in which said polynitrophenol comprises styphnic acid.

13. The electric blasting cap of claim 11, in which said polynitrophenol comprises picric acid.

14. An electric blasting cap of the match-head type provided with an ignition composition comprising a lead salt of a polynitrophenol, the firing circuit of said blasting cap being provided with a means whereby static electricity is caused to pass harmlessly to the shell wall of said blasting cap at a point outside the locus of said lead salt.

15. The electric blasting cap of claim 14, in which said polynitrophenol comprises styphnic acid.

16. The electric blasting cap of claim 14, in which said polynitrophenol comprises picric acid.

17. The electric blasting cap of claim 14, in which said polynitrophenol is gelatinized with nitrostarch.

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