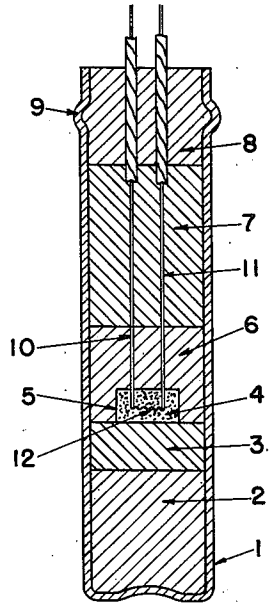
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ELECTRIC BLASTING CAP

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ELECTRIC BLASTING CAP

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This invention relates to the production of an electric blasting cap and more particularly to an electric blasting cap with a very great decrease in the time necessary for firing.

It is well known that electric blasting caps do not fire immediately upon application of the current, but require a short interval of time between the application of the current and the detonation of the cap. This interval of time, to which we shall hereinafter refer as firing time, is most conveniently measured on an oscillograph, and at a given current has a definite value which is characteristic of the cap. At a low current, such as for example, 0.4 ampere, the firing time is relatively long, but as the current is increased, the firing time decreases, at first, rapidly, and then more slowly. For ordinary electric caps, such as those employed in quarrying and mining, the firing time cannot be decreased indefinitely. A limiting firing current is gradually approached so that, for example, at a current of about 5.0 amperes, the firing time of a cap containing mercury fulminate or diazodinitrophenol in the form of crystalline grains is approximately 0.002 second, which cannot be decreased to an appreciable extent by additional increase in the applied current.

Furthermore, it is observed that, at about 5.0 amperes, for example, the bridgewire or resistance wire which serves to ignite the explosive, may reach its fusion temperature in an interval of time shorter than that required to detonate the cap. In the absence of inductance or other effects, the fusion of the bridgewire will interrupt the flow of the firing current and it will then be observed that the opening of the firing line circuit and the detonation of the cap do not coincide.

These short time effects are of little practical importance for the ordinary uses of the electric blasting cap, but in prospecting for oil or minerals by the seismograph method, they are of great importance. In the application of electric blasting caps and explosives to this method, the detonation serves to impart a tremor to the ground, which in traveling downward strikes the sub-surface hard rock structure and is partially reflected. The time of arrival of the reflecting tremor at the surface is recorded, and knowing the instant of detonation and the mean velocity of the propagated wave, the depth of the reflecting structure can be calculated. The instant of detonation can be obtained by several methods, but the one in general use is that of taking the interruption of the firing line current of the electric blasting cap, as the instant of detonation. It will be obvious, because of the fusion of the bridgewire at high currents, that with the usual caps the recorded instant can differ from the true detonation time by an amount which will be nearly as large as the firing time of the cap. For seismograph types of work such differences in time will cause large errors in the location of underground structures.

With reasonably low firing currents or the addition of suitable inductance in the firing line circuit and the adjustment of circuit constants, it is possible to overcome the difficulties mentioned above, but such refinements are sometimes not very practical in the field. In the absence of such precautions, the errors in timing may be prevented by the use of caps containing faster firing compounds, such as lead styphnate or silver fulminate, for example. Lead styphnate has been used in blasting caps for many years and fast firing caps containing it have already found application in the seismograph method of prospecting. This compound, however, is expensive and difficult to manufacture. Furthermore, it is sensitive to friction and therefore adds considerably to the hazards in the manufacture of such blasting caps.

Now, I have found that an electric blasting cap having a very fast firing time at high currents may be produced by using milled diazodinitrophenol with a binder or a milled mixture of diazodinitrophenol and an oxidizing agent which does not decompose the diazodinitrophenol with or without a binder in the form of a mass placed immediately about the bridgewire.

I have found particularly that by milling or grinding ordinary diazodinitrophenol, which has a grain size of about 150–350 microns, to a fineness of about 1 to 40 microns, preferably from about 20 to 40 microns, and then placing this suitably about the bridgewire, that I produce a blasting cap having a rapid firing time. When using diazodinitrophenol alone I find that it is necessary to incorporate a binder, such as, for example, nitrostarch, nitrocellulose, gum arabic, etc., dispersed in a suitable solvent, to form a mass around the bridgewire, in order to achieve a rapid firing time. I may also take a mixture of diazodinitrophenol and an oxidizing agent which does not decompose the diazodinitrophenol in granular form, and mill them together to produce the same effect without the addition of a binder. However, I may also produce the same effect by adding a binder such as, for example, nitrostarch, nitrocellulose or gum arabic to the milled mixture of diazodinitrophenol and an oxidizing agent which does not decompose the diazodinitrophenol.

When using nitrostarch, for example, as a binder with milled diazodinitrophenol I first mill the diazodinitrophenol as a slurry in alcohol in order to obtain the desired grain size, then filter the ground material and dry it. Then as the last operation preparatory to filling the caps, a solution of nitrostarch in butyl acetate, for example, is added to the dried material and thor-

oughly admixed therewith so that about 1% to about 4% of nitrostarch on the basis of the diazodinitrophenol is present. This paste is then worked about the bridgewire and dried, thereby forming a hard mass about said bridgewire. Larger amounts of a binder may be used but in general it will be found that the range above stated is the best for most practical purposes.

Alternatively, instead of milling in alcohol, drying and then adding the binder, I may mill directly in a solution containing the binder, the concentration of binder in the solution being adjusted so that the amount of binder in the finished mixture is within the range above specified.

I have already mentioned before, that, when using a mixture of diazodinitrophenol and an oxidizing agent which does not decompose the diazodinitrophenol I may, if so desired, dispense with the addition of a binder. In this case, I mill the mixture of diazodinitrophenol and said oxidizing agent as a slurry in alcohol until the desired grain size is obtained, then filter and dry the milled mixture. When ready to place this mixture in the cap it is wet with sufficient solvent, such as, for example, butyl acetate, to give a paste which is then placed about the bridgewire and dried. A semi-hard, compact mass is thus formed about the bridgewire. Although a binder of the class before mentioned is not necessary in this case, it may be used, if so desired, about 1% to about 4% of binder on the basis of the diazodinitrophenol being used in this case also.

Where a mixture of diazodinitrophenol and an oxidizing agent which does not decompose the diazodinitrophenol is used, I have found that while there are no critical proportions of diazodinitrophenol and said oxidizing agent which can be used in making my fast firing cap, from a practical standpoint, I prefer keeping the proportion of diazonitrophenol to said oxidizing agent in the range of about 1 to 1 to about 3 to 1.

Among the oxidizing agents which may be used in conjunction with the diazodinitrophenol are, for example, potassium chlorate, potassium dichromate, potassium nitrate, barium peroxide and strontium peroxide. I have found that an oxidizing agent such as potassium permanganate is not suitable for my purpose because it decomposes the diazodinitrophenol. Oxidizing agents producing this effect are therefore not desirable. All of these oxidizing agents do not produce equally fast firing caps when used with diazodinitrophenol and to obtain most consistent results together with the fastest firing caps I prefer using potassium chlorate.

A suitable blasting cap having fast firing properties can be made by placing in a metal shell a main charge, such as tetryl, pentaerythritol tetranitrate, a mercury fulminate-potassium chlorate mixture, or a like material and placing over this a booster or primer charge of ordinary grained diazodinitrophenol, lead azide, mercury fulminate, mercury fulminate-potassium chlorate mixture, or a similar material, and then immediately over this and about the bridgewire in the manner indicated above a small igniter charge which may be composed of a milled mixture of diazodinitrophenol and an oxidizing agent which does not decompose the diazodinitrophenol to which has been added a small amount of a binder, or a milled mixture of diazodinitrophenol and said oxidizing agent without the addition of a binder or milled diazodinitrophenol alone admixed with a small amount of a binder. The binder may be a nitrated carbohydrate, for example, nitrocellulose or nitrostarch or it may be a material such as gum arabic. Only a small amount of the milled material is necessary, because I have found that the firing time is determined by the ingredient immediately surrounding the bridgewire, the form or type of the charge in the main body of the cap being of little consequence.

In order to describe my invention more clearly, I shall refer to the attached drawing which represents a vertical section of an electric blasting cap embodying this invention. 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.

Referring to the single figure of the drawing, the blasting cap comprises a metal shell 1 which may, for example, be made of copper, aluminum or the like. In the base of this shell is placed a main charge 2 which may be, for example, tetryl, pentaerythritol tetranitrate, a mercury fulminate-potassium chlorate mixture, or similar substances and superposed thereon a primer charge 3 which may, for example, be ordinary grained diazodinitrophenol, mercury fulminate or other similar materials. An igniter charge 4 comprising a finely ground mixture of diazodinitrophenol and an oxidizing agent, such as potassium chlorate, at least the major portion of this mixture having a particle size range from about 1 to about 40 microns, with or without a binder, is disposed in a suitable cavity 5 in the base of plug 6 which may, for example, be a sulfur plug. Above plug 6 is a waterproofing composition 7 of any desired composition and the shell 1 is closed at the top by means of a sulfur plug 8 which, when poured, enters the crimp 9 and becomes keyed to the shell.

Lead wires 10 and 11 extend into shell 1 through plug 8, the waterproofing composition 7, the plug 6 into the igniter charge 4. The ends of the lead wires are connected by means of a bridgewire 12, as is usual in cap construction.

Igniter charge 4, in the form of a paste, prepared in the manner before shown, is placed in cavity 5 and worked about the bridgewire 12. It is then allowed to dry and thereby forms a hard mass about the bridgewire. After igniter charge 4 has hardened, the remaining ingredients may be added and the finished cap prepared, in the usual manner.

As a specific illustration of the very different and unusual characteristics introduced by the use of a finely ground mixture as above described, the following data are of interest. Three types of caps, as more specifically described below, were prepared and fired at a current of 5 amperes. All of the caps are of the same general construction and strength but differ as to the form of the diazodinitrophenol and potassium chlorate mixture in which the bridgewire is imbedded. The ratio of potassium chlorate to diazodinitrophenol is the same throughout the three types, being 3 parts of diazodinitrophenol to 1 part of potassium chlorate. Type 1 contains grained diazodinitrophenol in the form commercially used at present in regular blasting caps, this material having a particle size range of about 150 to 350 microns. Type 2 contains grained diazodinitrophenol in a form as fine as it is possible to produce without processing after manufacture, and has a particle size range of about 25 to 200 microns, preferably from

about 50 to 100 microns. Type 3 contains a milled mixture of diazodinitrophenol and potassium chlorate as hereinbefore described having a particle size range of about 1 to 40 microns preferably from about 20 to 40 microns. The firing times of representative members of each type as measured with an oscillograph, are shown in Table 1.

TABLE I

Firing time of caps in seconds

Type 1	Type 2	Type 3
0.0023	0.0027	0.00020
0.0024	0.0020	0.00027
0.0026	0.0024	0.00022
0.0027	----------	0.00022
		0.00020

Average

Type 1	Type 2	Type 3
0.0025	0.0024	0.00022

It is obvious from the above table, that when the finely ground mixture of diazodinitrophenol and potassium chlorate is used about the bridgewire, a blasting cap of remarkably fast firing properties is produced. In fact the distinction from blasting caps containing grained diazodinitrophenol, placed in the cap in a similar manner, is wholly unexpected.

As a further specific illustration caps were made up and fired at a current of 5 amperes. All of the caps were of the same general construction and strength containing the same base charge and priming charge and differed only in the ignition charge placed immediately about the bridgewire. The firing times as measured with an oscillograph are given in Table 2.

TABLE II

Cap No.	Ignition charge	Firing time in seconds
1	Milled diazodinitrophenol / Potassium chlorate (1 to 1)	0.00029
2	Milled diazodinitrophenol / Potassium dichromate (1 to 1)	0.00083
3	Milled diazodinitrophenol 99% / Gum arabic 1%	0.00084
4	Milled diazodinitrophenol 99% / Nitrocellulose (smokeless powder type) 1%	0.00038

It will be appreciated from the foregoing description and examples that the essence of my invention consists in placing about the bridgewire of a blasting cap having a suitable base and primer charge, a small charge of a finely divided diazodinitrophenol admixed with a suitable binder or a finely divided mixture of diazodinitrophenol and an oxidizing agent which does not decompose the diazodinitrophenol with or without the addition of a binder, producing in this manner a blasting cap which can be used in seismographic prospecting at high currents without producing appreciable errors in measurements. The present invention is therefore of great practical value in that it permits the production of a very fast-firing blasting cap by means of a well-known and commonly used explosive.

It will be understood that the details and examples hereinbefore set forth are by way of illustration only and that the invention as broadly described is not to be limited thereby.

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

1. An electric blasting cap including a shell, a detonating charge, a bridgewire and an igniter charge placed about said bridgewire comprising a finely ground mixture of diazodinitrophenol and an oxidizing agent, which does not decompose the diazodinitrophenol at least the major portion of said mixture having a particle size range of about 1 to about 40 microns.

2. An electric blasting cap including a shell, a detonating charge, a bridgewire and an igniter charge placed about said bridgewire comprising a finely ground mixture of diazodinitrophenol and an oxidizing agent, which does not decompose the diazodinitrophenol at least the major portion of said mixture having a particle size range of about 1 to about 40 microns, admixed with a binder.

3. An electric blasting cap including a shell, a detonating charge, a bridgewire and an igniter charge placed about said bridgewire comprising a finely ground mixture of diazodinitrophenol and potassium chlorate at least the major portion of said mixture having a particle size range of about 1 to about 40 microns.

4. An electric blasting cap including a shell, a detonating charge, a bridgewire and an igniter charge placed about said bridgewire comprising a finely ground mixture of diazodinitrophenol and potassium chlorate at least the major portion of said mixture having a particle size range of about 1 to about 40 microns admixed with a binder.

5. An electric blasting cap including a shell, a detonating charge, a bridgewire and an igniter charge placed about said bridgewire comprising a finely ground mixture of diazodinitrophenol and potassium chlorate at least the major portion of said mixture having a particle size range of about 1 to about 40 microns admixed with gum arabic.

6. An electric blasting cap including a shell, a detonating charge, a bridgewire and an igniter charge placed about said bridgewire comprising a finely ground mixture of diazodinitrophenol and potassium chlorate at least the major portion of said mixture having a particle size range of about 1 to about 40 microns admixed with a nitrated carbohydrate.

7. An electric blasting cap including a shell, a detonating charge, a bridgewire and an igniter charge placed about said bridgewire comprising a finely ground mixture of diazodinitrophenol and potassium chlorate at least the major portion of said mixture having a particle size range of about 1 to about 40 microns admixed with nitrostarch.

8. An electric blasting cap including a shell, a detonating charge, a bridgewire and an igniter charge placed about said bridgewire comprising a finely ground mixture of diazodinitrophenol and potassium chlorate at least the major portion of said mixture having a particle size range of about 1 to about 40 microns admixed with a nitrated carbohydrate selected from the group consisting of nitrostarch and nitrocellulose.

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