Feb. 26, 1952 H. M. KERR ET AL 2,586,959

DELAY ELECTRIC BLASTING CAP

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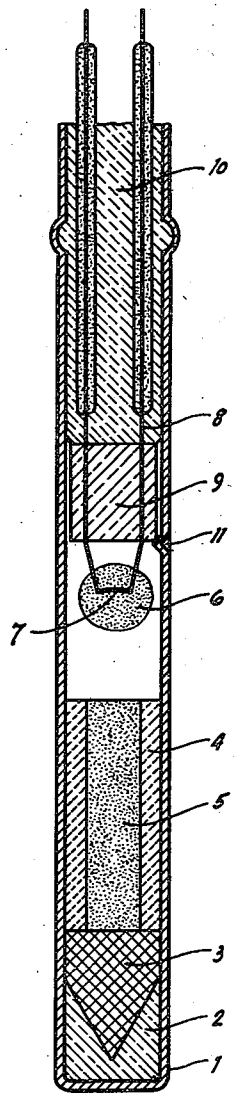


FIG-1

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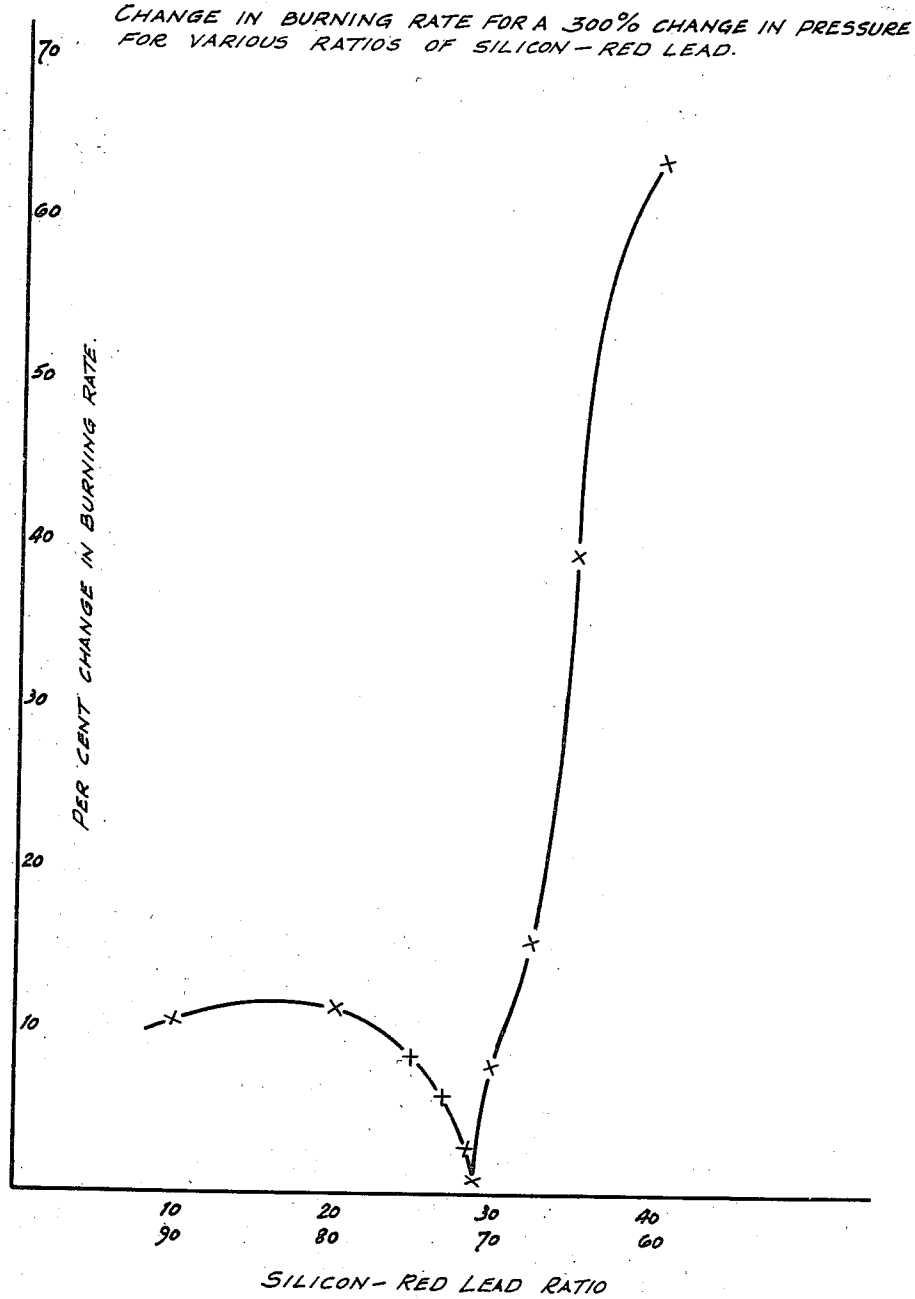


FIG — 2

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DELAY ELECTRIC BLASTING CAP

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4 Claims. (Cl. 102—28)

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This invention relates to an improvement in delay electric blasting caps, and more particularly to new delay compositions for use therein.

The present application is a continuation-in-part of our copending application Serial No. 35,218, filed 25th June, now abandoned.

Delay electric blasting caps as used in present practice comprise essentially an ignition charge, a detonating charge and a delay element through the medium of which the detonating charge is fired. The delay element is customarily a fuse of such length and composition as will afford the desired delay interval between firing of the ignition and detonating charges.

Compositions heretofore used in delay elements are for example, mixtures of barium peroxide, selenium metal powder and talc, or potassium permanganate and antimony metal powder, either one of which compositions in burning produces very little gas on combustion and hence may be used in ventless delay caps.

Black powder, either compressed in a carrier or spun in a fuse which is then sized into a metal carrier and cut into appropriate lengths, has also been used as a delay composition. However, due to the large volume of gases evolved in combustion of black powder, the cap casing must in this instance be provided with a vent to permit the free escape of gases which, if not thus released, would cause irregularities in the burning rate of the delay composition with consequent defects in the order of firing of a series of such caps. The vent in the cap casing is usually sealed with a rupturable membrane to prevent entrance of moisture. In such caps there is a tendency toward overlapping due to the effect of back pressure on the rate of burning of the delay composition. Also, because of the open vent there is a frequent occurrence of misfires in wet ground due to shock from previous blasts.

In either vented or ventless delay electric blasting caps, the delay compositions as used in the prior art burn at a rate of several seconds per inch of length, the desired delay periods being obtained by increasing the length of the delay element and hence, as the delay periods become longer, the length of the cap is increased to the point where it becomes inconvenient to handle in priming explosive charges. Another disadvantage is that, due to the use of a minimum one-half second interval between successive periods, the "scatter" of times about the mean of any one period has resulted in low efficiency on the part of the blasting explosive. A further disadvantage to delay caps of the prior art has been the questionable stability of the mixtures due to the use of oxidizers and metals which may be adversely affected by small amounts of moisture.

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An object of our invention is, therefore, a new and improved ventless delay electric blasting cap assembly containing a delay composition the combustion of which results in much shorter delay periods than heretofore known. A further object of our invention is the provision of novel delay compositions which burn at such high temperatures that there is no possibility of misfires due to failure of the delay composition after ignition. A still further object is the provision of a short period delay electric blasting cap, the use of which results in considerable reduction in ground vibrations which is an important factor in quarrying operations. Another object is to obtain a series of successive delays using a composition which burns at such an even rate that the "scatter" about the mean time obtained from any selected element length is reduced to a minimum. Additional objects of our invention will become apparent as the description proceeds.

The foregoing objects are accomplished by the use of a delay composition designed to function in such a way that the delay intervals obtained in rotational firing of the caps of our invention are in the order of thousandths of a second instead of the approximate one second intervals heretofore considered standard.

The delay composition of our invention is a fast and hot burning relatively gasless homogeneous mixture of silicon metal powder and red lead to which may be added suitable inert diluents such as, for example, silicon dioxide which acts as a further regulator for variation of the burning periods.

The preferred delay compositions of our invention are those shown in the formulae of the following table:

Table 1

Composition No.	Silicon, Percent	Red Lead, Percent	Silicon Dioxide, Percent
1	40	60	
2	28	55	17
3	26	52	22
4	30	70	
5	18	70	12
6	12	70	18

Our invention may be understood more readily by reference to the accompanying drawing which serves to illustrate the invention in its preferred form.

Figure 1 shows a longitudinal sectional view of a delay electric blasting cap in which (1) is a solid drawn cylindrical metal shell in the base of which is pressed a suitable charge of detonating explosive such for example as tetryl or pentaerythritol tetranitrate (2). Directly above the base charge (2) is pressed a suitable priming charge (3) on top of which is pressed a delay element (4) containing the delay composition (5) of Table 1. The priming charge (3) may for example be a mixture of lead azide and lead styphnate or the like, while the delay element (4) comprises a lead tube containing the delay composition (5). Arranged at a distance above the delay element (4) is shown the ignition means which comprises a low tension relatively gasless match head assembly (6) to which are attached two insulated cap wires (8) held in position by means of a sulphur plug (9) on top of which is an asphaltic waterproofing (10). The whole ignition means is positioned at the desired distance from the delay element (4) by means of two indents (11) in the shell (1) which act as a stop for the sulphur plug (9).

Our invention is more specifically illustrated by reference to the following table in which the delay element used has the following general dimensions, viz. outside diameter 0.257 inches and inside diameter ⅛ inches. The delay element is prepared by tamping the loose delay composition into a large diameter lead tube which is subsequently sized down by rolling, drawing or rotary swaging to the correct diameter followed by cutting the element from the sized tube to the desired length. With regard to the preparation of the compositions of our invention, both silicon and red lead are ground to pass a 250 mesh Tyler screen having an opening of 0.0024 inches, following which the silicon is blended with the red lead according to the proportions as illustrated in Table 1. Using these compositions a series of 15 periods is obtained as shown in the following table:

Table 2

Period (No.)	Composition (No.)	Element Length (inches)	Mean Period (milliseconds)
1	1	0.260	50
2	1	0.490	105
3	1	0.750	167
4	2	0.250	235
5	2	0.310	310
6	2	0.375	392
7	2	0.450	482
8	2	0.535	582
9	2	0.630	692
10	2	0.735	815
11	3	0.580	905
12	3	0.660	1,040
13	3	0.750	1,185
14	3	0.850	1,345
15	3	0.960	1,525

The results shown in the above table are obtained by using a uniform size match head assembly (6) and a uniform distance between the top of the delay element (4) and the bottom of the sulphur plug (9). These two factors greatly affect the burning rate of the delay composition since any variation in either one changes the pressure in the blasting cap in the area indicated and thence the burning rate of the delay composition. Unless these two factors are held constant, therefore, a wide scatter about the mean for each period will take place even to such an extent that one period may overlap

with another which, of course, is highly undesirable.

We have found however, that the difficulty of maintaining a uniform size match head assembly can be overcome by keeping the red lead portion of the delay composition constant at about 70% as shown in compositions 4, 5 and 6 of Table 1. At this point, the burning rate of the delay composition remains constant despite minor variations in the size of the match head assembly. The percentage of red lead in the delay composition may in fact vary from 70 to 75% but a lower or higher percentage very markedly changes the burning rate of the delay composition as shown in Figure 2 of the attached drawings. Accordingly, a series of 15 periods based on compositions 4, 5 and 6 of Table 1 is obtained as shown in the following table using a ¼" spacing between the plug (9) and delay element (4) but without maintaining an exact uniformity in size of the match head assembly.

Table 3

Period (No.)	Composition (No.)	Element Length (inches)	Mean Period (milliseconds)
1	4	0.200	25.2
2	4	0.400	49.7
3	4	0.600	75.3
4	4	0.800	96.8
5	5	0.320	119.4
6	5	0.380	145.0
7	5	0.460	177.9
8	5	0.525	207.1
9	5	0.700	293.0
10	6	0.345	352.7
11	6	0.420	433.4
12	6	0.495	516.5
13	6	0.570	596.6
14	6	0.660	681.1
15	6	0.765	781.0

While the above may be taken as an embodiment of our invention in its preferred form, it will be apparent to those skilled in the art that other complete series of less or more than 15 periods having any other desired delay intervals in milliseconds between period means may be obtained by selecting various proportions of ingredients and/or adjusting the length of the delay element as well as the space between the plug and delay element which may vary from ¼" to ¾" maximum.

The delay compositions of our invention are particularly advantageous in that on burning, substantially no gas is produced and hence they can be used in a ventless delay electric blasting cap assembly with the attendant advantages of this type of cap. A further advantage of our invention lies in the fact that the compositions disclosed burn at high temperatures and thus are not subject to variation in rate of burning due to varying temperature conditions encountered in mining operations. Furthermore the stability of the delay compositions of our invention is such that it is relatively unaffected by the presence of small amounts of moisture. A still further advantage of our invention resides in the fact that the duration of the delay interval can be readily varied to give any desired interval in the range of times most desired for various types of mining operations.

Obviously other powdered metals or metal alloys such as aluminium, iron, ferro-silicon and so on may be substituted in whole or in part for the metallic silicon powder to give the desired burning rate for short period delay intervals. Sim-

ilarly inert diluents other than silicon dioxide may be used such for example as limestone, mica, iron oxide, clay or talc.

It is to be understood that the details disclosed in this specification are for the purpose of illustration only and that the invention is not to be limited to the specific disclosures but may be modified and embodied in various other forms without departing from its intended scope.

We claim:

1. In a delay electric blasting cap, a finely divided inorganic delay composition consisting essentially of 70–75% by weight of red lead, 30–12% by weight of silicon and 0–18% by weight of silicon dioxide, said red lead and silicon being of sufficiently fine particle size as to pass a 250 mesh screen.

2. In a delay electric blasting cap, a delay composition consisting of 70% by weight of red lead, 18% by weight of silicon and 12% by weight of silicon dioxide, said red lead and silicon being of sufficiently fine particle size as to pass a 250 mesh screen.

3. In a delay electric blasting cap, a delay composition consisting of 70% by weight of red lead, 12% by weight of silicon and 18% by weight of silicon dioxide, said red lead and silicon being of sufficiently fine particle size as to pass a 250 mesh screen.

4. In a delay electric blasting cap, a delay composition consisting of 70% by weight of red lead and 30% by weight of silicon, said red lead and silicon being of sufficiently fine particle size as to pass a 250 mesh screen.

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