July 22, 1952 B. J. SEVOLD 2,604,044

BLASTING CAP

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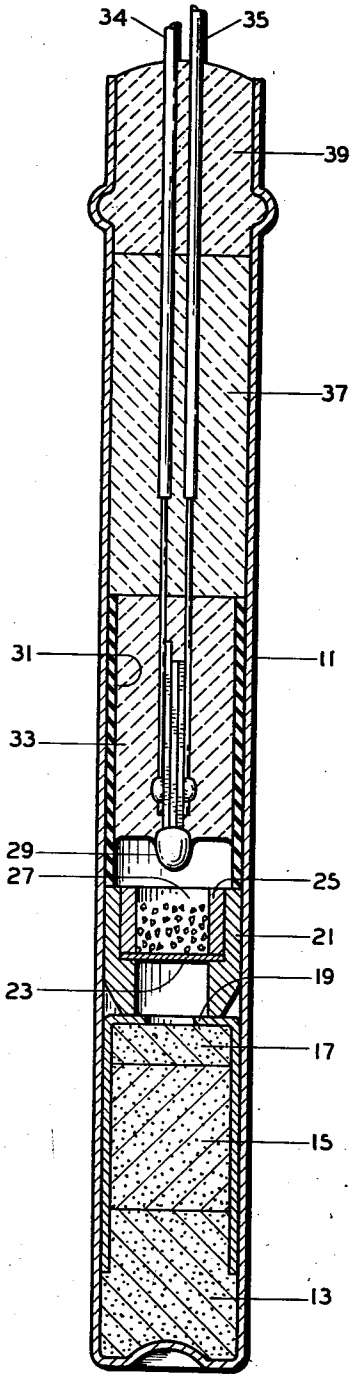


Fig. 1

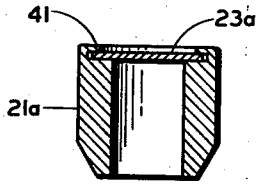


Fig. 2

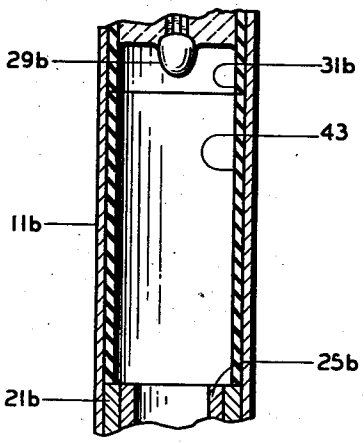


Fig. 3

Boyd J. Sevold,
INVENTOR.
BY Rogers & Morton
ATTORNEY

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BLASTING CAP

Boyd J. Sevold, Chicago, Ill., assignor to Atlas Powder Company, Wilmington, Del., a corporation of Delaware

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11 Claims. (Cl. 102—28)

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The present application relates to a delay electric blasting cap.

An object of the invention is the provision of an electric blasting cap having a delay period between its initiation and detonation.

Another object of the invention is the provision of a delay electric blasting cap having a short delay period.

A further object of the invention is the provision of a delay electric blasting cap having a relatively uniform delay time.

Other objects of the invention will be apparent from the following description.

Electric blasting caps usually include tubular closed metal shells into the bottom of which are pressed one or more detonating explosive charges. An electric ignition element, usually made up of a bridge wire surrounded by a flash composition, is sealed into the top of the cap to provide a means for initiating the explosive when the cap is to be used.

Sometimes it is desirable to provide a delay period between the time the cap is initiated by firing the ignition element and the time of detonation of the explosive in the cap. In the last few years delay electric blasting caps having delay periods of the order of a few milliseconds have found considerable use.

In the usual delay cap the delay period is obtained by inter-positioning a train of combustible material between the ignition element and the detonating explosive. The ignition element initiates the delay train, and, after burning through, the delay train in turn initiates the detonating explosive.

In accordance with the present invention, a delay period is provided by a rupturable membrane located between an ignition element and a detonating explosive. The electric ignition element is located in a gas-tight chamber and separated from the detonating explosive by the rupturable membrane. The membrane is provided with an unsupported portion on the side adjacent the detonating explosive. On actuation of the ignition element, gas pressure builds up behind the rupturable membrane until the membrane breaks permitting the flame from the ignition element to pass and to initiate the detonating explosive.

A propellent fuel, such as black powder or smokeless powder, may be located adjacent the ignition element to assist the development of gas pressure.

A preferred membrane material for use in the caps of this invention is metal foil. It is easily

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obtained in uniform thickness; it is easily secured in the cap; and it provides desirable rupturing characteristics. Such metals as brass, aluminum, copper, tin, zinc, gold, and silver are desirable foil materials. However, frangible plastic materials also may be employed.

While the rupturable membrane may be secured in the cap by any convenient means, in a preferred embodiment of the invention, a tubular element is fitted tightly into the cap and the membrane is positioned so as to span the tubular element.

The invention will be further understood by reference to the drawings in which:

Figure 1 is an enlarged sectional side elevational view of a delay electric blasting cap of the invention.

Figure 2 is an enlarged sectional view of a modified type of membrane assembly.

Figure 3 is an enlarged sectional view of a modified arrangement of the cap parts.

Referring to Figure 1 of the drawings, 11 is a conventional detonator shell made of gilding metal and dimensioned about 0.260" in inside diameter and about 3" in length. Loaded into the bottom of shell 11 is tetryl base charge explosive 13. Over base charge 13 is loaded nitromannite primary detonator charge 15, and on top of charge 15 is loaded flash charge 17 made of a mixture of diazo-dinitrophenol and nitromannite. Over all these charges is placed metal inner capsule 19, and the capsule and charges are pressed against the bottom of the shell. 21 is a brass tube 0.265" in diameter which is pushed in a press fit into shell 11 until it rests on inner capsule 19. Tube 21 is provided with a bore 0.140" in diameter and is counter-bored from the top to a diameter of 0.200". On the shoulder produced by the difference in diameter between the bore and counter-bore rests brass foil diaphragm 23. Tube 25 is pushed down into the counter-bore of tube 21 in a press fit until it rests upon and secures foil 23 in gas-tight relation. Over foil 23 is placed a small charge 27 of loose black powder. Conventional match type electric ignition element 29 held in paper insulating tube 31 by poured sulphur 33 is slipped into the cap above charge 27. Insulated wires 34 and 35 are connected to electric ignition element 29 and lead outside of the cap. The top of the cap is sealed by poured asphalt seal 37 and poured sulphur seal 39.

In operation of the cap electric current is applied to wires 34 and 35. This current initiates ignition element 29 which bursts into flame thereby igniting black powder charge 27 and

building up gas pressure behind foil 23 until the foil breaks. After the breaking of the foil the flame reaches flash charge 17, and the cap is detonated. Black powder charge 27 does not provide any appreciable delay function. It merely serves to assist in the development of gas pressure behind diaphragm 23. It is omitted in some embodiments of the invention.

Figure 2 shows a modified form of support for the foil membrane. Tube 21*a* is similar to tube 21 except that it is counter-bored only for a short distance, and the bore is sufficiently large in diameter that the remaining wall, designated as 41, is but 0.01'' thick. After the foil, designated as 23*a*, is put in place, thin wall 41 is crimped over to secure the foil in place.

It is sometimes desirable to enlarge the gas space behind the membrane. Figure 3 shows this space enlarged by means of a tube spacer 43, $\frac{9}{16}$'' long and positioned between tube 21*b* and insulating tube 31*b* which contains ignition element 29*b*.

It will be obvious that the invention is applicable to many types of electric blasting caps.

The materials of the construction and the dimensions shown are only exemplary and may be varied as is convenient. For example, many types of explosive charges, of shell materials, and of sealing materials may be substituted for those shown, as will be understood by those skilled in the art.

Similarly the invention may be employed with many different types of ignition elements. For example, the bridge plug type, the cavity plug type, or the bead type may be employed in place of the match type illustrated.

In general, the sealing means used should be sufficiently tight that adequate rupturing of the membrane takes plate. It is not necessary for the obtention of the delay function that the cap be gas tight on the side of the membrane where the detonating composition is located. However, it is usually preferred that the cap as a whole be ventless and gas tight so as to prevent any egress of flame from the cap prior to its detonation.

The membrane thickness may be varied depending on the area the membrane is to span, on the amount of pressure which is built up, and on the strength of other parts of the cap. Thicknesses between about .0008 inch and about 0.003 inch are generally satisfactory. The free space between the membrane and the detonating explosive need only be sufficient to permit adequate rupturing.

The following examples illustrate specific embodiments of the invention.

Example 1

9 caps similar to that described in connection with Figure 1 of the drawing were made. The brass foil was 0.001'' in thickness. Loose black powder in the amount of 0.010 gram was placed over the foil in each cap. When these caps were detonated it was found that they had an average delay period of 5.0 milliseconds, the longest delay period was 7.0 milliseconds, and the shortest was 3.0 milliseconds.

Example 2

5 caps were made up similar to those described in Example 1 except that no black powder was included. These had an average delay period of 4.0 milliseconds, the longest period being 7.0 milliseconds and the shortest 1.0 millisecond.

Example 3

10 caps were made up similar to that described in connection with Figure 1 of the drawing, except that the spacer tube arrangement described in connection with Figure 3 of the drawing was employed. The foil was 0.002'' in thickness, and loose black powder in the amount of 0.010 gram was included over the foil. These caps had an average delay period of 12.0 milliseconds, the longest period being 18.0 milliseconds and the shortest being 9.0 milliseconds.

Example 4

28 caps were made up similar to that described in connection with Figure 1 of the drawing, except that they included the delay element construction described in connection with Figure 2 of the drawing in place of that shown in Figure 1. The foil was 0.001'' in thickness, and 0.010 gram of loose black powder was included over the foil. These caps on being detonated showed an average delay time of 4.8 milliseconds, the longest time being 8.0 milliseconds and the shortest time being 3.0 milliseconds.

Example 5

23 caps were made up similarly to those made up in accordance with Example 4 except that the foil used was 0.002'' thickness. When these caps were detonated they showed an average delay time of 5.5 milliseconds, the longest time being 8.0 milliseconds and the shortest time being 4.0 milliseconds.

What is claimed is:

1. A delay electric blasting cap comprising a shell, a gas-tight chamber in said shell, said chamber comprising free space for gas expansion, a gas-producing electric ignition element in said gas-tight chamber, said chamber including a metal foil wall, a detonating explosive in said shell outside of said chamber, said foil having an unsupported portion on the side adjacent said detonating explosive and having a strength such that it ruptures due to gas pressure produced on the functioning of said ignition element, thereby permitting initiation of said detonating explosive.

2. A delay electric blasting cap according to claim 1 in which a propellent powder is included in said chamber.

3. A delay electric blasting cap comprising a shell, a gas-producing electric ignition element in a gas-tight chamber in said shell, said chamber comprising a thin partition and free space for gas expansion, a detonating explosive in said shell outside of said chamber, said ignition element, but for said thin partition, being in direct flame communication with said detonating explosive, said partition having an unsupported portion on the side adjacent said detonating explosive and having a strength such that it ruptures due to gas pressure produced on the functioning of said ignition element, thereby permitting initiation of said detonating explosive.

4. A delay electric blasting cap comprising a shell, a gas-tight partition in said shell including a metal foil, a gas-producing electric ignition element sealed in a gas-tight manner in said shell on one side of said partition, there being free space for gas expansion adjacent said ignition element, a detonating explosive in said shell on the other side of said partition, said foil having an unsupported portion on the side adjacent said detonating explosive and having a strength such that it ruptures due to gas pressure produced on the functioning of said ignition element, thereby permitting initiation of said detonating explosive.

5. A delay electric blasting cap according to

claim 4 in which a propellent powder is included on the side of said partition where said ignition element is located.

6. A delay electric blasting cap comprising a shell, a gas-tight partition in said shell including a thin portion, a gas-producing electric ignition element sealed in a gas-tight manner in said shell on one side of said partition, there being free space for gas expansion adjacent said ignition element, a detonating explosive in said shell on the other side of said partition, and but for said thin portion being in direct flame communication with said ignition element, said thin portion having an unsupported portion on the side adjacent said detonating explosive and having a strength such that it ruptures due to gas pressure produced on the functioning of said ignition element, thereby permitting initiation of said detonating explosive.

7. A delay electric blasting cap comprising a closed shell, a detonating explosive in said shell, a gas-producing electric ignition element in said shell, free space for gas expansion adjacent said ignition element, a tube fitting in said shell in gas-tight relation, a metal foil spanning the inside of said tube in gas-tight relation and located between said ignition element and said explosive, said foil having an unsupported portion on the side adjacent said detonating explosive and having a strength such that it ruptures due to gas pressure produced on the functioning of said ignition element, thereby permitting initiation of said detonating explosive.

8. A delay electric blasting cap according to claim 7 in which a propellent powder is included on the side of said foil where said ignition element is located.

9. A delay electric blasting cap comprising a closed shell, a detonating explosive in said shell, a gas-producing electric ignition element in said shell, free space for gas expansion adjacent said ignition element, a tube fitting in said shell in gas-tight relation, a thin membrane spanning the inside of said tube in gas-tight relation and located between said ignition element and said explosive, so that, but for said membrane, said ignition element is in direct flame communication with said detonating explosive, said membrane having an unsupported portion on the side adjacent said detonating explosive and having a strength such that it ruptures due to gas pressure produced on functioning of said ignition element, thereby permitting initiation of said detonating explosive.

10. A delay electric blasting cap comprising a closed shell, a detonating explosive in said shell, a gas-producing electric ignition element in said shell, free space for gas expansion adjacent said ignition element, a tube fitting in said shell in gas-tight relation, the inside of said tube including a shoulder, a metal foil spanning the inside of said tube and resting on said shoulder, a second tube fitting inside said first tube and holding said metal foil in gas-tight relation therein, said metal foil being located between said ignition element and said detonating explosive, and said foil having an unsupported portion on the side adjacent said detonating explosive and having a strength such that it ruptures due to gas pressure produced on functioning of said ignition element, thereby permitting initiation of said detonating explosive.

11. A delay electric blasting cap according to claim 10 in which a propellent powder is included in direct communication with said ignition element.

BOYD J. SEVOLD.

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