

Sept. 9, 1952

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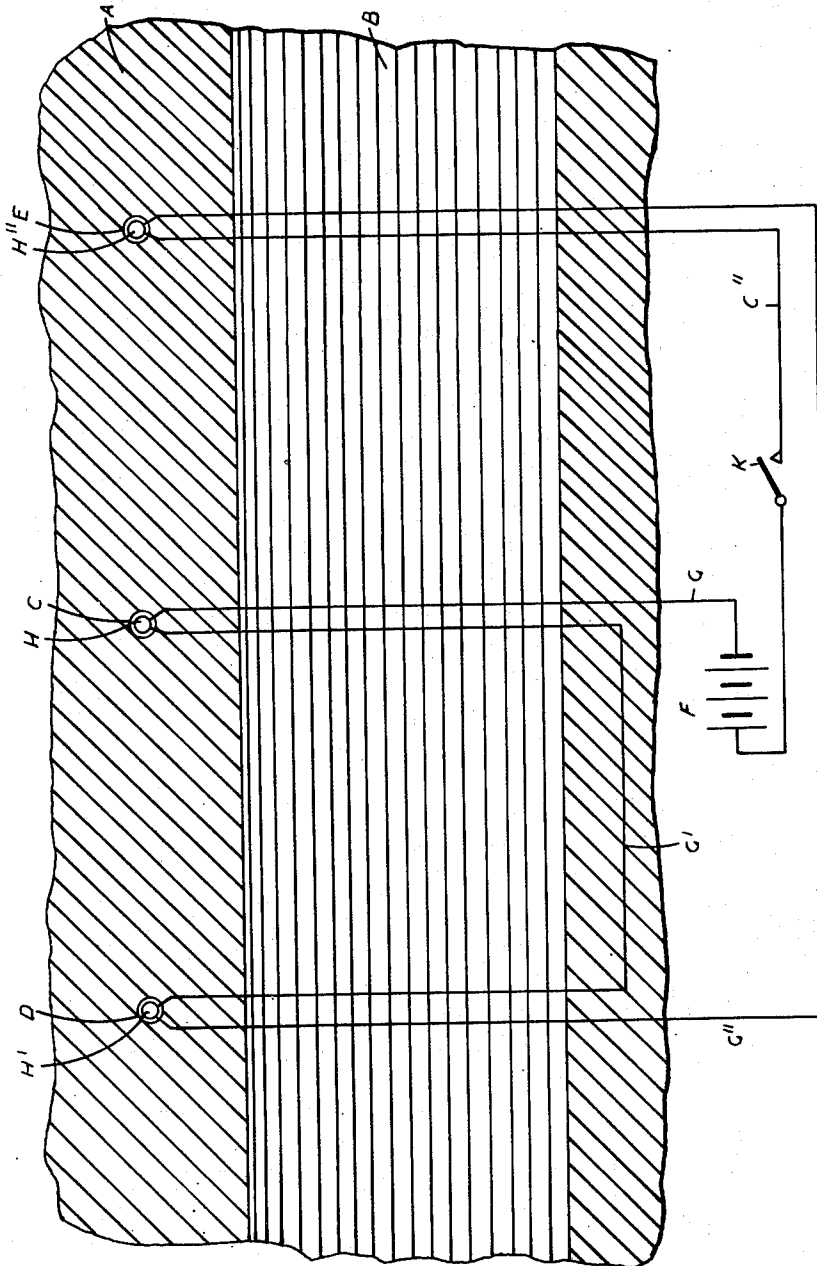
2,609,751

SAFETY BLASTING OPERATION AND BLASTING ASSEMBLY FOR USE THEREIN

Filed June 10, 1947

2 SHEETS—SHEET 1

FIG. 1.



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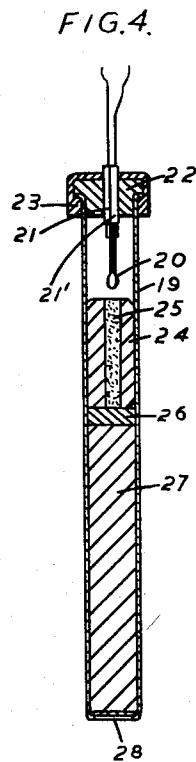
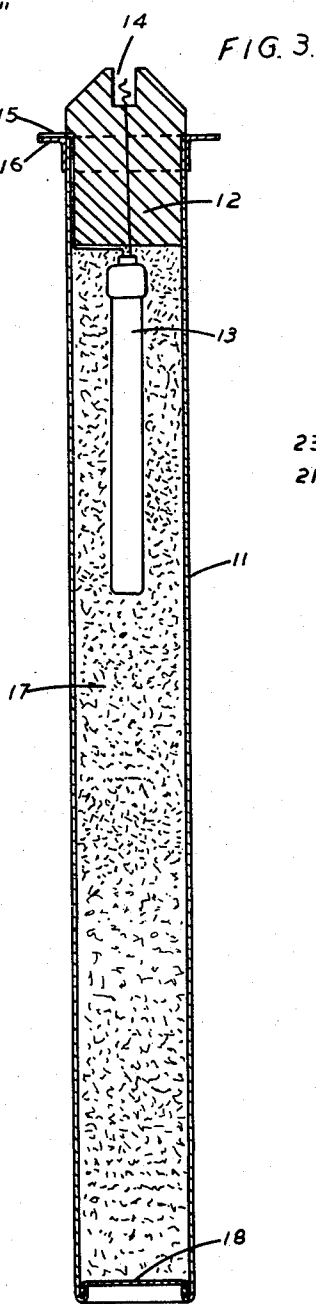
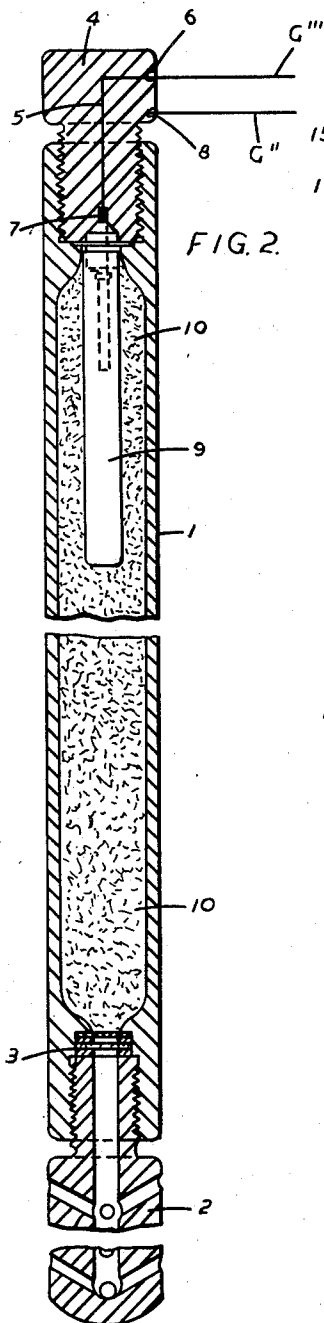
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2 SHEETS—SHEET 2



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2,609,751

SAFETY BLASTING OPERATION AND BLAST-
ING ASSEMBLY FOR USE THEREIN

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Application June 10, 1947, Serial No. 753,618
In Great Britain July 26, 1946

7 Claims. (Cl. 102—25)

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The present invention relates to safety blasting operations in the winning of coal and to new and improved blasting assemblies suitable for the winning of coal where firedamp or coal dust is prevalent.

Blackpowder cannot be used in fiery or dusty atmospheres and the usual practice is to employ the so called permitted explosive compositions, which, unlike blackpowder, are detonating explosives and contain flame quenching ingredients. More recently, however, there have been proposed blasting devices of the kind embodying a pressure resisting steel container separated from a perforated discharge head by a closure adapted to yield at a predetermined internal gas pressure produced rapidly but without detonation from a charge of material within the container. The charge is of such nature that the gases emerging through the discharge head into the borehole after the closure has yielded and thereby causing a blasting effect are unaccompanied by flame. The present invention relates more particularly to blasting assemblies embodying blasting devices of the kind described.

Two of these devices have come into practical use, namely the "Cardox" blasting device, in which the gas producing charge comprises a heating charge of a composition capable of strong exothermic decomposition when ignited and a contiguous charge of liquefied carbon dioxide which is gasified by the heating charge and quenches the flame from it; and the "Hydrox" blasting device in which the charge comprises essentially a solid powder mixture of sodium nitrite and ammonium chloride, which when locally heated at atmospheric pressure is capable of sustaining its own decomposition at a visible rate with the evolution of nitrogen and steam. Under the rising pressure conditions in the pressure resisting container the pressure required to cause the closure to yield is built up in a fraction of a second and without flame. Hydrox blasting assemblies and compositions are described and claimed for instance in British Patent Specifications Nos. 431,935 and 461,647. Other gas producing charges capable of self-sustained decomposition for use in blasting devices of the aforementioned kind have also been proposed.

Whereas in the case of detonating explosives the gas pressure in the borehole is instantaneously developed, in blasting devices of the aforementioned kind the discharge of the gases from the container into the borehole takes a sensible time, and the blast obtained has the general

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character of a gentle heaving action that favours the production of lump coal rather than the pulverisation of the material in the neighbourhood of the borehole. This is an especially attractive feature of these blasting devices.

The fact that the compositions employed in these devices are not explosive is an advantage from the point of view of handling and storage. It is also a cognate advantage that the necessary decomposition can be started without the use of detonators, and it is usual to employ as the electrical initiating device an electric powder fuse. The electric powder fuse comprises essentially a paper package containing a charge of blackpowder in direct ignition relationship with an electric fusehead. Terminals are provided on the pressure resisting container to which the leading wires from the electric powder fuse within the container and the cables from a battery or exploder outside the device are attached.

In many cases it would be desirable to arrange that a plurality of shots laid in a single circuit in different boreholes should take effect at short intervals of time one after the other, for instance so that shots containing charges suitable for cutting, easing and trimming could all be fired after a single shot-laying operation and consequently so that the operations of cutting, easing and trimming could be carried out without the delays incidental to the successive laying experienced when single shot-firing is carried out.

Hitherto, however, it has only been known to do this in the case of detonating explosives and in the case of non-detonating cartridges that cannot be used in fiery or dusty atmospheres; and it is an object of the invention to provide means whereby series firing may be carried out in fiery or dusty atmospheres without the use of detonating explosives.

The invention consists of an assembly of safety blasting devices of the kind embodying a pressure resisting steel container separated from a perforated discharge head by a closure adapted to yield at a predetermined gas pressure and a charge of non-detonating material capable of producing a blasting effect unaccompanied by flame in which assembly the said safety blasting devices are electrically connected to permit them to be fired simultaneously and some at least of the said charges of non-detonating material are each in association with a non-detonating delay electric initiator of a predetermined delay time-interval in initiating relationship with its associated charge.

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It will be understood that in the assembly of blasting units arranged to give successive blasts there need not be a delay fuse element in the initiator in that unit which is required to be the first to blast.

The non-detonating delay electric initiator suitably has a delay fuse element interposed between its primary electric ignition element and its main initiating charge in such manner that the delay fuse element must be consumed before said main initiating charge can be ignited, and the term "non-detonating delay electric initiator" will be used hereinafter in that sense.

The individual delay fuse elements of the non-detonating delay electric initiators in the set employed in the blasting round are varied in length and/or composition so as to provide the desired differing time intervals, which may for instance range from about $\frac{1}{2}$ second to 5 seconds. In the case of the "Cardox" blasting device there may be employed as the non-detonating delay electric initiators for instance delay electric powder fuses, which consist essentially of thin metal tubes each containing a blackpowder charge separated from an electric fusehead by a delay fuse element. The delay electric powder fuse may be inserted into the customary heating charge, advantageously so that it is wholly surrounded by the heater composition. For the first shot there may be used an ordinary electric powder fuse. For the "Hydrox" blasting device it is important that the main initiating charges of the non-detonating electric initiators should have an effective bulk heating action so that the time taken for the decomposition of the charge consisting essentially of sodium nitrite and ammonium chloride within the pressure resisting container, once it has begun, will be negligible in comparison with the shortest of the delay intervals provided by any of the delay fuse elements, and for this purpose a blackpowder charge such as is present as the main initiating charge in the electric initiators ordinarily used for "Hydrox" which usually amounts to about 60 grains may be suitably modified or replaced or reinforced by a more effective heating composition. Delay electric powder fuses may be used, for instance, in conjunction with charges of a more effective heating composition surrounding them. This more effective heating composition may for instance be one adapted to produce the required heating effect by chemical reaction between its own constituents alone, or between its own constituents and the surrounding charge of "Hydrox." In the latter case the said more effective heating composition may for example be based on ammonium perchlorate or potassium perchlorate. For the first shot an electric powder fuse without a delay element but having its main initiating charge similarly modified, replaced or reinforced may be used.

The electrical connections may be made so that the shots can be fired in series or in parallel or in any combination thereof. By means of the invention blasting effects not hitherto attainable with blasting devices of the aforesaid kind may be achieved.

The invention will be further understood by reference to the diagrammatic drawings accompanying the specification whereof Figure 1 represents an elevation of an undercut rock face showing a set of "Hydrox" blasting devices in a plurality of shot holes connected up in series, Figure 2 represents a longitudinal view mostly in section of one of the "Hydrox" blasting de-

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vices in the set, Figure 3 is a relatively enlarged longitudinal view partly in section of a non-detonating delay electric initiator suitable for use in the "Hydrox" blasting device of Figure 2, while Figure 4 is a further enlarged vertical section showing a delay electric fuse forming a portion of the delay electric initiator of Figure 3.

In Figure 1, C, D, and E are bore holes in the rock B, which is undercut so as to overhang a coal seam A. The firing ends of three "Hydrox" blasting devices H, H' and H'' are seen protruding from these boreholes. The non-detonating initiating devices of these blasting devices, which are not visible in the figure, are connected in series with a battery F by cables G, G', G'', and G''' through a firing switch K. The non-detonating initiator for the blasting device H comprises no delay fuse element, so that this blasting device fires immediately the circuit is completed, whereas the non-detonating electric initiators for the blasting devices H' and H'' have delay fuse elements interposing delays respectively of one second and two seconds from the time the circuit is completed until these blasting devices function, so that the three blasts take place at one second intervals.

In Figure 2, 1 is the tubular portion of the pressure resisting container, 2 is the discharge head and 3 the closure disc yieldable at a predetermined internal pressure of several tons per square inch, and 4 is the metal firing head. 5 is a conductor insulated from the metal of the firing head 4, leading from an external terminal socket 6 to a plug electrode 7, both insulated from the firing head 4. 8 is a socket return terminal. 9 is the non-detonating delay electric initiator, the construction of which is seen in greater detail in Figure 3, this non-detonating delay electric initiator being in circuit with the firing heads G''' and G''. 10 is a charge of "Hydrox Powder No. 1" which fills the available space in the container.

In Figure 3, 11 is a paper cylinder, 12 is a wooden plug, 13 is a delay electric powder fuse in greater detail in Figure 4 from which the bared end of one of the leading wires is coiled as it enters the recess 14, where it makes contact with the plug electrode 7 seen in Figure 2. The return leading wire from the delay electric powder fuse is expanded to a terminal strip 15 which is led between the plug 12 and the tube 11 and soldered over a flanged copper ring 16 crimped around said plug and tube, thereby forming a connection to the terminal 8 through the metal of the firing head 4 shown in Figure 2, when the latter is screwed home. 17 is the main charge of the initiating composition and 18 is a paper disc over which the end of the wall 11 is turned.

In Figure 4, 19 is a thin metal tube, made of a ductile copper alloy, within which is located a low tension electric fusehead 20. The leading wires from the fusehead are insulated with resilient tubing as shown at 21 and 21' where they pass through a perforated plug 22, also of resilient insulating material, which is crimped between them and the wall 19, and also where they pass through the perforated lead cup 23 which is crimped over the plug 22 and the wall 19. 24 is a metal delay sleeve and 25 is a delay fuse composition providing the desired delay period in this case of 1 second, compressed into the sleeve 24. 26 is an igniting composition and 27 a charge of loose blackpowder, advantageously amounting to about 60 grains. 28 is a

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metal closure disc over which the end of the wall 19 is turned.

We claim:

1. An assembly of safety blasting devices each of the kind embodying a pressure resisting steel container separated from a perforated discharge head by a closure adapted to yield at a predetermined gas pressure and containing a charge of non-detonating material capable on initiation of undergoing self-sustained reaction yielding gaseous products whose emergence from said discharge head produces a blasting effect unaccompanied by flame, in which assembly the said safety blasting devices are electrically connected to permit them to be fired simultaneously and at least some of said charges of non-detonating material are each in association with a non-detonating delay electric initiator comprising a shell, containing therein a main initiating charge, a primary electric ignition element, and a delay fuse element positioned for ignition of said main initiating charge, said delay fuse element comprising a second shell containing therein a sleeved first initiating charge, means associated with the electric ignition element for igniting said sleeved first initiating composition, and a second initiating composition positioned for ignition by said first initiating composition, said main initiating charge being separated from said primary electric ignition element by said delay fuse element in such manner that the delay fuse element must be consumed before said main initiating charge can be ignited, thereby providing a predetermined delay time interval between firing and initiating of the main non-detonating blasting charge.

2. An assembly as claimed in claim 1, wherein the non-detonating fuse elements form a set in which the said elements are of varied lengths.

3. An assembly as claimed in claim 1, wherein the non-detonating fuse elements form a set in which the said elements are of varied compositions, said compositions having different combustion speeds.

4. An assembly as claimed in claim 1, wherein the time interval for combustion of said delay fuse elements ranges from $\frac{1}{2}$ second to 5 seconds.

5. An assembly as claimed in claim 1, wherein the charge of non-detonating material capable of producing a blasting effect comprises a composition capable of strong exothermic decomposition and liquid carbon dioxide.

6. An assembly of safety blasting devices of the kind embodying a pressure resisting steel container separated from a perforated discharge head by a closure adapted to yield at a predetermined gas pressure and a charge of solid powder mixture of sodium nitrite and ammonium chloride capable of producing a blasting effect unaccompanied by flame in which assembly the said safety blasting devices are electrically connected to permit them to be fired simultaneously and at least some of said charges are used in association with non-detonating electric initiator comprising a shell, containing therein a main

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initiating charge, a primary electric ignition element, and a delay fuse element positioned for ignition of said main initiating charge, said delay fuse element comprising a second shell containing therein a sleeved first initiating charge, means associated with the electric ignition element for igniting said sleeved first initiating composition, and a second initiating composition positioned for ignition by said first initiating composition, said main initiating charge being separated from said primary electric ignition element by said delay fuse element in such manner that the delay fuse element must be consumed before said main initiating charge can be ignited, thereby providing a predetermined delay time interval between firing and initiation of the main non-detonating blasting charge.

7. A safety blasting device comprising a pressure resisting steel container separated from a perforated discharge head by a closure adapted to yield at a predetermined gas pressure and containing a charge of non-detonating material capable on initiating of undergoing self-sustained reaction yielding gaseous products whose emergence from said discharge head produces a blasting effect unaccompanied by flame and a non-detonating delay electric initiator in association with said non-detonating material, said non-detonating delay electric initiator comprising a shell, containing therein a main initiating charge, a primary electric ignition element, and a delay fuse element positioned for ignition of said main initiating charge, said delay fuse element comprising a second shell containing therein a sleeved first initiating charge, means associated with the electric ignition element for igniting said sleeved first initiating composition, and a second initiating composition positioned for ignition by said first initiating composition, said main initiating charge being separated from said primary electric ignition element by said delay fuse element in such manner that the delay fuse element must be consumed before said main initiating charge can be ignited.

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