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BLASTING DEVICES

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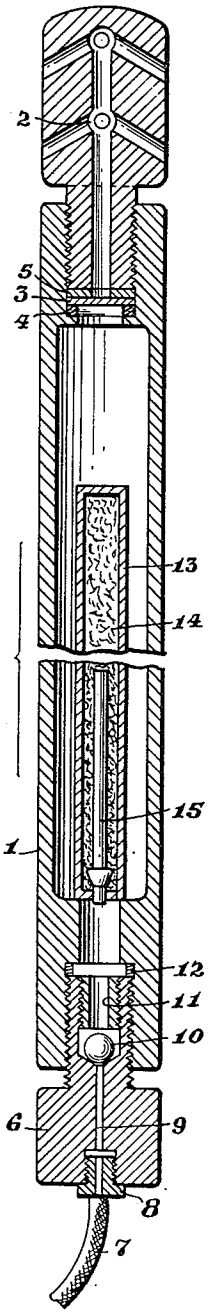

Fig. 1.

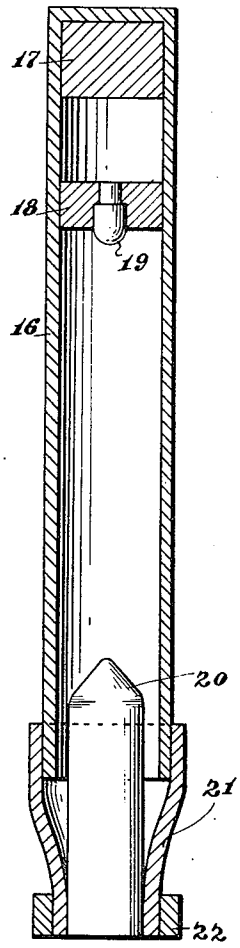

Fig. 2.

INVENTOR
Kenneth Ashbrooke Smith

BY Cushman, Darby & Cushman

ATTORNEYS

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BLASTING DEVICES

Kenneth Ashbrooke Smith, West Kilbride, Scotland, assignor to Imperial Chemical Industries Limited, a corporation of Great Britain

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12 Claims. (Cl. 102—25)

The present invention relates to blasting devices of the kind in which a charge of a non-detonating gas-producing composition, together with a suitable initiating means, is enclosed in a rigid cylindrical container provided with a closure member adapted to release the gases produced on reaction of said charge from the container at a predetermined pressure so that a blasting effect is produced in a borehole, the body of the container being sufficiently strong to withstand the pressure developed and being capable of re-utilisation.

Such blasting devices are well-known and widely used for example in the production of lump coal. Normally the gas release member takes the form of a rupturable disc sealing off the container from a venting head, which is screwed to the container and thereby holds the rupturable disc in position, the seal being made gas-tight by the provision of a resilient gasket on one or both sides of the disc. As the non-detonating gas-producing charges, equimolecular mixtures of ammonium chloride and sodium nitrite with a small proportion of alkaline stabiliser, such as magnesium-oxide, have been widely used but other compositions having similar properties can also be used. The initiation of the reaction of these charges, which can be effected at atmospheric pressures, is normally achieved by a local heating element which is actuated electrically and it is customary to load these charges above-ground. Some non-detonating gas-producing charges, however, have the extremely valuable property, which renders them suitable for underground loading even in gassy atmospheres, in that their self-propagating decomposition requires in addition to local heating a super-atmospheric pressure and for these it is desirable that the local heating element should produce sufficient gas to give the required pressure for the reaction of the charge to proceed quickly at a useful rate.

It is desirable to be able to fire blasting devices of the kind wherein the charge requires a super-atmospheric pressure for self-propagating decomposition without having recourse to electricity since the use of electricity has certain inherent dangers, for example, in gassy mines.

According to the present invention the improved blasting device of the kind in which a charge of a non-detonating gas producing composition capable of self-sustained and self-propagating gas producing reaction when merely locally heated under super-atmospheric pressure together with a local heating element is enclosed in a rigid cylindrical container closed or fitted with a gas-tight closure at one end and fitted at the other end with a venting head separated from the container by a rupturable disc is characterised in that the local heating element has actuating means responsive to fluid pressure and in that the container at the end which is closed or fitted with a gas-tight closure permits said actuating means to be connected to an external source of fluid pressure.

When said fluid is a gas said actuating means permits the introduction and non-return of gas into the container. On the other hand when said fluid is a liquid said actuating means excludes the introduction of liquid into the container. The local heating element should preferably then be one which generates the necessary gas pressure to enable said charge to undergo a self-sustained and self-propagating gas-producing reaction.

The embodiment of the invention in which an external source of gas supply is used to cause the required super-atmospheric pressure in the container has the advantage that said super-atmospheric pressure is maintained in the container notwithstanding leakages and ensures that the sudden gas evolution from the self-propagating decomposition of the charge will cause the bursting disc to rupture quickly.

The invention also consists in a local heating element for blasting devices of the aforesaid kind comprising a heating charge and means for the actuation thereof responsive to the application of fluid pressure. A preferred form of local heating element comprises, in a sealed container, a heating charge, a percussion cap positioned to initiate the reaction of said heating charge and a projectile positioned so that on the application of fluid pressure the projectile fires said percussion cap. The heating charge in these local heating elements may be of a gas-producing type or may be of a kind which reacts exothermically with the evolution of substantially no gas. Suitable compositions include mixtures of antimony and potassium permanganate and mixtures of silicon with an oxidising agent such as red lead. The amount of heating charge is sufficient to evolve about 70–100 calories.

The rupturable disc and venting cap in the blasting devices of the invention may be conventional, for example, the rupturable disc may be of mild steel or of a filled or unfilled synthetic resin such as "Tufnol" (registered trademark), a synthetic resin bonded paper product, adapted to burst at a pressure of the order of 10 tons/sq. in.

The non-detonating gas-producing charge capable of a self-propagating gas-producing reaction when locally heated under super-atmospheric pressure may be for example the ammonium nitrate compositions claimed in co-pending applications Nos. 388,841, now Patent No. 2,769,701, issued November 6, 1956, and 408,102, filed February 4, 1954. It is preferred that the charge should be in a pre-packaged form and it is also preferred that the local heating element be embedded in a suitably shaped cavity at one end thereof. If desired furthermore the charge in pre-packed form can be a cylinder having a diameter to form a close fit in the rigid cylindrical container.

Although water under pressure may be used to actuate the actuating means responsive to fluid pressure of the local heating element in the blasting device of the invention it is preferred to use a gas as for example compressed air. It is further preferred to use an inert gas, as for example carbon dioxide or nitrogen gas. If air is used it is usually necessary to adjust the composition of the gas-producing charge. The gas pressure required to actuate the actuating means of the local heating element should preferably be of the order of the super-atmospheric pressure required in the container. To permit the charge to undergo self-propagating decomposition quickly at a useful rate this gas pressure may range from 100 to 1800 lbs./sq. in.

The following table gives the time interval between the application of local heating to 570 grams of a gas-producing charge consisting of 49% by weight ammonium

nitrate, 34% by weight magnesium nitrate hexahydrate and 17% by weight woodflour in a cardboard container and the bursting of the rupturable disc for different gas pressures in the container of 3 litres capacity of a blasting device at the moment of application of the local heating.

TABLE

The gas pressure in the container of the blasting device before decomposition of the charge (lbs./sq. in.)	The time interval (in secs.) between application of local heat and bursting of the rupturable disc (secs.)
10	No reaction
20	60
50	19
100	12
200	7
305	4
500	3
1,500	1 to 2

The invention is illustrated with reference to the diagrammatic drawings accompanying the specification in which **1** is a high tensile steel container, **2** is a venting head, **3** is a mild steel disc adapted to yield at a predetermined pressure of the order of 15 tons/sq. in., **4** and **5** are gaskets and **6** is a firing head to which a flexible pressure tube **7** is attached by means of the nipple **8**. **9** is a conduit leading from the nipple **8** to the interior of the firing head **6**, **10** is a ball valve held in position by the sleeve **11** in such a way that it acts as a non-return pressure valve, **12** is a gasket, **13** is a fireproofed cardboard container for the main charge **14** and **15** is a local heating element in accordance with the invention. In Fig. 2 (which shows the details of the local heating element **15**) **16** is a metal casing, **17** is a heating charge capable of evolving about 70 calories on reaction, **18** are supports for a percussion cap **19**, **20** is a metal projectile held in position by the rubber tube **21** and the metal band **22** which is crimped round the rubber tube **21** so that an appreciable pressure is required to dislodge the projectile **20** and cause it to strike the percussion cap **19**. To operate the local heating element **15** gas pressure, for example compressed air, within the range 100–1800 lbs./sq. in. is applied through the tube **7** and valve **10** whereupon the projectile **20** fires the percussion cap **19** causing the reaction of heating charge **17** to take place. The heat thus formed induces the reaction of the main charge **14** and thus the bursting of the disc **3**.

The invention is also illustrated by the following examples.

Example 1

A charge of 20 oz. of a non-detonating gas-producing composition consisting of 49% by weight ammonium nitrate, 34% by weight magnesium nitrate hexahydrate and 17% by weight woodflour in a cardboard container into one end of which is inserted a safety igniter of the kind illustrated in Fig. 2 containing a heating charge consisting of 0.25 g. of a composition containing 45% by weight antimony and 55% by weight potassium permanganate is inserted into the pressure resistance steel container **1**.

Carbon dioxide is introduced through tube **7** and valve **10** at a pressure of 650 lbs./sq. in. by the sudden opening of a valve (not shown) in tube **7** and this causes the projectile **20** to strike the percussion cap **19** and thus to initiate the reaction of the heating charge **17** and at the same time to produce a pressure of about 650 lbs./sq. in. within the steel container **1** thereby to permit the charge **14** to undergo quickly self-propagating decomposition due to the heat evolved from the reaction of the heating charge **17**. The time interval between the connecting of the steel container **1** to the supply of carbon dioxide by the sudden opening of the valve (not shown) in tube **7** and the rupturing of the bursting disc **3** is 4 seconds.

Example 2

If instead of carbon dioxide, nitrogen at 1,000 lbs./sq. in. is used in the same manner as in Example 1 to cause the projectile **20** to strike the percussion cap **19** and to produce a pressure of about 1000 lbs./sq. in. in the steel container **1** the time interval between the connecting of the steel container **1** to the supply of nitrogen by the sudden opening of the valve (not shown) in tube **7** and the rupturing of the bursting disc **3** is 2 seconds.

What I claim is:

1. A blasting device comprising a rigid hollow container, a charge of non-detonating, gas-producing composition capable of self-sustained and self-propagating gas-producing reaction only when locally heated under a super-atmospheric pressure disposed within said rigid container, a local heating element contained within said rigid container, pressure-responsive means for actuating said heating element, and gas-tight closures sealing both ends of said container, one of said closures being provided with means providing gas under pressure to operate the actuating means of the local heating element and to subject the charge to said super-atmospheric pressure.

2. A blasting device as defined in claim 1 wherein the other of said end closures comprises a rupturable member and a venting head separated from the interior of the container by said rupturable member.

3. A blasting device as defined in claim 1, wherein said gas-producing composition and said heating element are unitarily packaged so as to offer no effective resistance to the entry of gas under pressure into said container.

4. A blasting device as defined in claim 3, wherein said heating element is embedded in one end of said gas-producing composition charge.

5. A blasting device as defined in claim 1, in which said heating element comprises a pressure-operated striker, a percussion cap positioned for actuation by said striker and a heating charge positioned for initiation by said percussion cap.

6. A blasting device as defined in claim 5, wherein said striker is partially exposed for actuation by entry of compressed gas into said container.

7. A blasting device as defined in claim 1, wherein said gas-providing means comprises a one-way valve which is interposed between said container and an external source of gas under pressure.

8. A blasting device as defined in claim 1, wherein the gas pressure utilized to operate the actuating means of the heating element is approximately equal to the super-atmospheric pressure required to initiate the chemical reaction of the gas-producing composition.

9. A blasting device as defined in claim 1, wherein the gas pressure required in the container to enable said charge to undergo self-propagating decomposition ranges from 100 to 1800 pounds per square inch.

10. A blasting device as defined in claim 1, wherein said charge of gas-producing composition comprises at least one of the hydrated nitrates of metals of low atomic weight of the group magnesium nitrate hexahydrate and aluminum nitrate nonahydrate, and a non-explosive organic fuel consisting substantially of a dried vegetable carbohydrate material, wherein the number of moles of combined water in the metal nitrate per mole of ammonium nitrate lies between 1 and 3 and wherein the proportion of the organic fuel in the pulverulent mixture is such that the gases from the charge and said heating element consist at the bursting pressure of said blasting device substantially of steam, carbon dioxide and nitrogen.

11. A blasting device as defined in claim 1, wherein

the charge of gas-producing composition consists essentially of ammonium nitrate in amount from about 55 to 75% by weight, and calcium formate in amount from about 45 to 25% by weight.

12. A blasting device as defined in claim 1, wherein said local heating element includes a charge comprising 0.25 gram of a composition consisting of 45% by weight antimony and 55% by weight potassium permanganate.

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