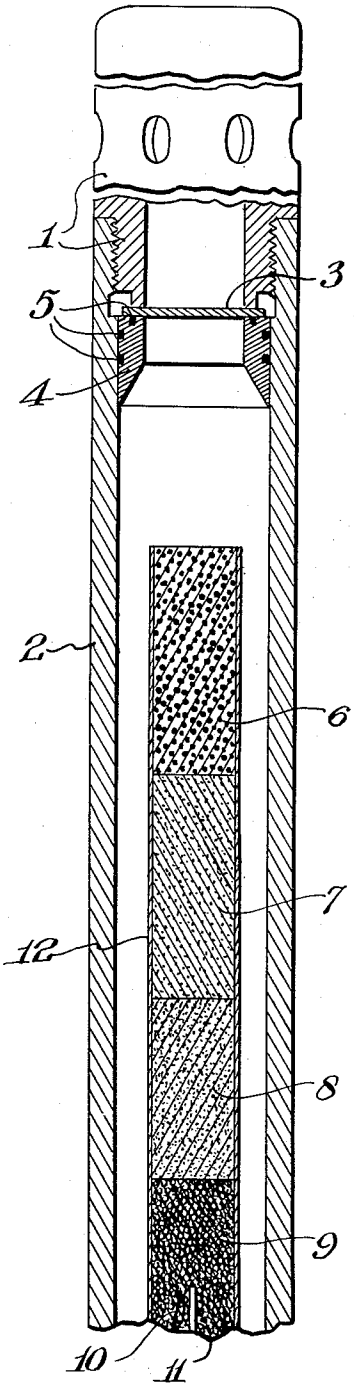
Jan. 31, 1956 D. L. COURSEN 2,732,800

BLASTING ASSEMBLY

Filed March 11, 1953




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United States Patent Office 2,732,800
Patented Jan. 31, 1956



2,732,800

# BLASTING ASSEMBLY

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Application March 11, 1953, Serial No. 341,769

3 Claims. (Cl. 102—25)

The present invention relates to an improved pressure-resistant blasting cartridge assembly, and, more particularly, to such assembly wherein the discharge of gases under high pressure is substantially free of any flame or spark.

The use of reusable pressure-resistant blasting cartridges has been known for a number of years. The earliest forms utilized a charge of liquid carbon dioxide, which, when heated, produced gas under extremely high pressure inside the tube. By means of pressure responsive discharge means, such as a rupturable metal disc across one end of the blasting tube, the gases were suddenly released into a discharge head containing venting ports. By inserting the cartridge into a borehole, such as in a coal face, so that the discharge venting ports were toward the inner end of the borehole, the sudden release of gas under high pressure produced a highly satisfactory shattering action without any danger of setting a dusty or gassy mine on fire. Blasting cartridge assemblies of this type are in use today, particularly in dangerous coal mines.

Because of the handling and charging costs of the liquid carbon dioxide blasting charge, efforts have been made to produce a blasting cartridge assembly wherein the gases are produced by the chemical decomposition of solid materials. Ammonium nitrate compositions have been favored because of the comparative ease of producing a self-sustaining reaction and the favorable oxygen balance. Ammonium nitrate, however, possesses the property of being capable of detonation under proper conditions of confinement and density, so that the early attempts were not fully successful.

It is, accordingly, an object of the present invention to provide a blasting cartridge assembly of the type described above wherein substantially the entire composition and all of the packaging materials are fully consumed prior to the attainment of pressure sufficient to actuate the pressure-responsive discharge means. Additional objects will become apparent as the invention is further described.

I have found that the foregoing objects may be attained when I provide an assembly comprising in combination with a pressure-resistant blasting tube and discharge means a gas generating charge containing as a gas-producing ingredient ammonium nitrate, said charge being composed of at least three compositions, the first of which is capable of self-sustaining deflagration at atmospheric pressure, and each succeeding composition being capable of self-sustained deflagration only at or slightly below the temperature and pressure produced by the deflagration of the preceding charge or charges. The compositions will preferably be arranged to form a linear charge having the composition capable of self-sustained deflagration at atmospheric pressure at one end, and the compositions following in order of ascending pressure and temperature requirements for self-sustaining deflagration. In this arrangement, the composition and reactivity of the charge changes along the length of the charge, and only a portion of the charge will be undergoing decomposition at any given time. The charge will preferably be cylindrical with a



diameter not exceeding ¾ of the inside diameter of the blasting tube, the cross-sectional density of the ammonium nitrate within the tube being less than 0.5 at any point. The charge is preferably contained in a combustible wrapper, such as paraffin paper, and will include an electrically actuated initiating element, such as a heating wire, imbedded within the section of the charge containing the composition capable of self-sustaining deflagration at atmospheric pressure.

In order to more fully describe the present invention, reference is made to the accompanying drawing, which is intended to be illustrative only, the invention not being limited to the specific embodiment depicted therein.

In the drawing, **1** represents the discharge head which is threadedly engaged to tube body **2**, and holds rupture disc **3** in position against sleeve **4**. The sealing elements **5** make this assembly pressure-tight. Within tube body **2** is the charge composed of compositions **6**, **7**, **8**, and **9**, the latter containing imbedded therein a heating ribbon **10** supported by rod **11**. The compositions are enclosed in wrapper **12**, of combustible material to form a unit charge.

In the charge illustrated, composition **9** is one which can be initiated at atmospheric pressure and its decomposition will be self-sustaining once initiated. Composition **8** is capable of self-sustained deflagration only at some pressure and temperature condition which will be produced within tube **1** by the decomposition of composition **9**. Until composition **8** has been substantially completely consumed, the pressure and temperature conditions within tube **1** will be below the level at which composition **7** will become initiated and undergo self-sustained deflagration. Composition **6** is so unreactive that it requires the combined pressure and temperature produced by each of the preceding compositions to become initiated and sustain the deflagration. Throughout this description the term "self-sustained deflagration" is intended to mean the composition, once initiated, will be completely consumed without requiring additional initiation from some other source. A portion of a very unreactive material can be initiated by being in close proximity to a localized high temperature source, but the deflagration will cease as soon as the local high temperature drops or ceases to act directly on the material.

Ammonium nitrate compositions are made more reactive, i. e., become capable of self-sustained deflagration at less severe pressure and temperature conditions, by including an oxidizable fuel such as, for example, wood pulp, starch, sulfur, etc. As the percentage of the fuel is increased, the reactivity increases until an optimum percentage of fuel is reached. Ammonium nitrate compositions are rendered less reactive by including an inert material, such as an inorganic salt, which acts as cooling agent. An increase in the quantity of the inert material decreases the reactivity.

A typical four component charge such as illustrated in the drawing might have the following compositions:

| | Percent |
|---|---|
| Composition 6: | |
| Ammonium nitrate | 75 |
| Calcium carbonate | 25 |
| Composition 7: | |
| Ammonium nitrate | 100 |
| Composition 8: | |
| Ammonium nitrate | 88.2 |
| Starch | 11.8 |
| Composition 9: | |
| Ammonium nitrate | 73.0 |
| Sodium nitrate | 10.0 |
| Starch | 5.0 |
| Wood pulp | 11.8 |
| Calcium stearate | 0.2 |

A typical three component charge might be identical with

the foregoing, omitting composition 7, i. e., the 100% ammonium nitrate. Generally speaking, at least one composition in the charge will be more reactive than pure ammonium nitrate and at least one composition will be less reactive.

The amount of each composition present must be adjusted so as to provide the conditions within the tube required by the next composition for self-sustained deflagration, and the total decomposable material present must be sufficient to produce the amount of gas under pressure required to actuate the pressure-responsive discharge unit, i. e., between 15,000 and 25,000 pounds per square inch. Obviously, a wide range of compositions and of amounts of each can be selected. The number of compositions used is entirely a matter of choice with the limitation that at least three of varying degrees of reactivity be involved. If desired, a charge can be made in which the composition is varied gradually throughout the length of the charge instead of in sections.

The effect obtained with a charge in which only a portion is capable of self-sustained deflagration as the pressure and temperature rise within a blasting cartridge tube is to cause the rise in pressure to be much less rapid, thereby insuring the complete combustion of the fuels in the more reactive portions and of the combustible shell wrapper. Any portion of the charge which is not completely consumed when the gases are released is so unreactive at the reduced pressure and temperature that it cannot produce a flame or spark.

The ammonium nitrate is the essential gas-producing material and will be present in a quantity of not less than 50% of the weight of the composition. When the ammonium nitrate composition is to be made more reactive, up to 30% by weight of a fuel such as carbon, carbonaceous materials, and sulfur may be added. To decrease the reactivity of the ammonium nitrate, up to 50% by weight of an inert material such as an inorganic metal carbonate, sulfate, chloride, silicate or oxide may be used. The reactivity of an ammonium nitrate composition can also be increased by including up to 20% by weight of sodium or potassium nitrate along with the fuel.

While the size or shape of the ammonium nitrate particles is not critical, small size particles produce smaller voids and channels within the charge. Large voids or channels cause the deflagration to proceed with greater rapidity than is desired. The particle size of the inert material should not exceed 0.3 millimeter in diameter for maximum effectiveness. The particle size of the fuel depends upon the nature of the fuel, the degree of reactivity desired, etc.

The composition of the present invention may be cast or pressed, but it is preferred to pack them loosely into a cylindrical container. The density of the compositions will vary according to the method of packing and the ingredients.

It is not necessary to separate the individual compositions from each other, and therefore the charge can be easily prepared. As previously indicated, the preferred arrangement involves positioning the charges in order of their reactivity, this arrangement is not essential, however. The charge must have a diameter of less than ¾ of the inside diameter of the blasting tube in which it is to be used, and the loading density of the gas-producing portion charge within the tube at any cross sectional area may not exceed 0.5 gram per cubic centimeter. These limitations as to density and diameter ratios are critical in order to avoid the possibility of localized high pressure and temperature conditions producing a detonation of the charge instead of the deflagration desired.

In order to obtain better fume control, it may be desirable to include small amounts of a fuel in each composition. The fuel will reduce the formation of nitric oxide by accepting some of the excess oxygen produced by the decomposition of the ammonium nitrate. For this fuel, paraffin oils or waxes are preferred, since they will vaporize at the high temeprature, and thus be completely consumed.



In copending application Ser. No. 174,818, filed July 20, 1950, by C. O. Davis, R. C. Glogau, F. A. Loving and J. P. Swed, a blasting cartridge assembly is disclosed which uses a charge comprising ammonium nitrate, wherein the charge is distributed along the axis of the tube in such manner that the density of the ammonium nitrate at any cross section of the inside of the tube does not exceed 0.5 gram per cubic centimeter, and the charge is so disposed as to provide passage for gases along the length of the charge. The assembly described functions well and is completely safe. The present invention, of course, is an entirely different structure from that disclosed in the copending application, and also offers substantial advantage over the prior art. Also, for instance, with the structure of the present invention, any portion of the charge which is not completely consumed when the gases are released is so unreactive at the reduced pressure and temperature that it cannot produce a flame or spark. Accordingly, there is less likelihood of incompletely consumed particles of packaging materials being ejected with the released gases. This eliminates a hazard which was connected with many of the prior art devices which attempted to use ammonium nitrate compositions and other solid compositions in devices of this general nature.

The invention has been fully described in the foregoing. In view of the many variations and modifications which can be made without departure from the scope of the present invention, I intend to be limited only by the following claims.

I claim:

1. A blasting cartridge assembly comprising in combination with a pressure-resistant blasting tube and pressure-responsive discharge means, of a substantially cylindrical gas-generating charge having a diameter not exceeding three-quarters of the inside diameter of said tube, said charge containing in linear arrangement at least three compositions, each containing at least 50% by weight of ammonium nitrate, the first of said compositions at one end of said charge containing up to 30% by weight of an oxidizable fuel and being capable of self-sustained deflagration at atmospheric pressure, the second composition at the opposite end of said charge containing up to 50% by weight of an inert cooling salt and being capable of self-sustained deflagration only at approximately the temperature and pressure produced within the tube by the deflagration of all of the other compositions, and at least one composition containing a combustible fuel interposed between said first and second composition capable of self-sustained deflagration only at approximately the temperature and pressure produced within the tube by the deflagration of said first composition.

2. An assembly as claimed in claim 1, wherein said first composition includes up to 30% by weight of a carbonaceous material and up to 20% by weight of an alkali metal nitrate.

3. An assembly as claimed in claim 1, wherein a heating wire is embedded in said first section.

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