Aug. 5, 1958 S. H. DAVIDSON ET AL 2,845,833

METHOD FOR PRODUCING EXPLOSIVE ELEMENTS

Filed Sept. 12, 1955

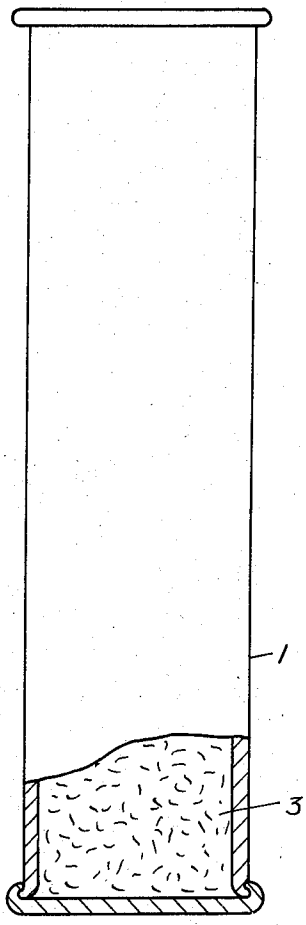


FIG. 1

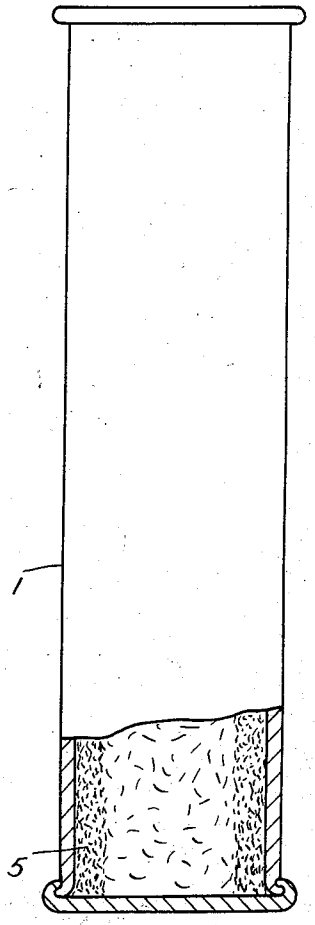


FIG. 2

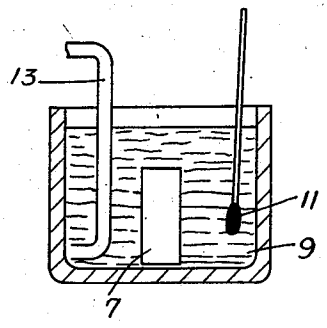


FIG. 3

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United States Patent Office 2,845,833 Patented Aug. 5, 1958

2,845,833

METHOD FOR PRODUCING EXPLOSIVE ELEMENTS

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Application September 12, 1955, Serial No. 533,907

Claims priority, application Great Britain November 8, 1954

5 Claims. (Cl. 86—20)

This invention relates to new and improved explosive elements for blasting under conditions of substantial hydrostatic pressure and in which the explosive charge comprises an ammonium nitrate blasting explosive.

Compressible ammonium nitrate blasting explosives, such as loosely packed ammonium nitrate powders of bulk densities up to about 1.3, comprising ammonium nitrate and oxidisable ingredients, with if desired the addition of other salts, in tinplate or similar thin sheet metal canisters when used under considerable hydrostatic pressures as in seismic prospecting or well blasting operations, fail to provide effective internal support for the canister in the blasting situation so that the canister may collapse sufficiently to open its seams and thereby allow the inlet of water which may seriously reduce the effectiveness of the blast or may even cause the explosive to fail to explode. Although it is possible to overcome this disadvantage with canisters of increased thickness and hence greater strength such canisters are not readily available, are considerably more expensive than those of the thicknesses normally used and make the explosive more difficult to initiate from outside the canisters. Another method of overcoming this disadvantage would be to introduce the explosive charge under pressure into the canister while suitably supporting the canister and wherein the pressure is of the order of that expected to occur in use. This method would require special machinery which would again add considerably to the cost and would increase the density of the explosive and would thus decrease its sensitivity and so make it more difficult to initiate from outside the canister. Methods have also been proposed for preparing high density explosive charges in a form adapted to fill readily into containers, as for example by preparing a blend of ammonium nitrate and a normally solid organic sensitiser therefor by subjecting said compounds to a temperature at which at least a portion of one of said compounds is in a molten condition, maintaining in contacting relationship therewith a dispersing agent and subsequently cooling and solidifying the resulting blend.

The object of the present invention is to provide a more convenient method than heretofore for the production of explosive elements for use at a high hydrostatic pressure from a compressible ammonium nitrate powder explosive in a thin metal canister.

According to the present invention the method of producing explosive elements particularly suitable for use at high hydrostatic pressure comprises packing a charge of an ammonium nitrate powder explosive containing a small amount of water, preferably not less than 0.1% and not more than 1.0% by weight of the ammonium nitrate, into a thin, for example 0.012 inch thick, sheet metal canister, subjecting the canister after sealing to such a temperature and for such a period of time that at least the thin layer of the explosive which is closest to the sides of the canister attains a temperature which is at least the transition temperature for

ammonium nitrate IV to ammonium nitrate III, i. e. 32.3° C., is below the fusion point of any solid fusible organic sensitising agent which may be included in the explosive, and does not exceed 80° C., and thereafter allowing the canister to cool so that the explosive which is at least at said transition temperature is converted into hardened explosive.

Preferably the ammonium nitrate powder explosive contains at least 75% ammonium nitrate.

The ammonium nitrate powder explosive may include ingredients commonly used in such explosives, as for instance, solid organic substances such as vegetable tissue material, sugar, starches and trinitrotoluol; metal powders for example aluminum powder; and organic liquids such as liquid nitro-aromatic compounds as for example ortho-nitrotoluol, dinitrotoluol oils and the like. Other exidising salts than ammonium nitrate and cooling salts may also be included.

The heating of the filled sealed canister may be carried out by any convenient means, for example by heating in air, water or other liquid. It is, however, preferred to carry out the heating by total immersion in a liquid, preferably water, as this method is inherently safer and also enables the container to be simultaneously tested for leaks since any air inside will expand on heating and, if any leaks exist, will emerge as bubbles in the heating liquid.

For explosives containing ammonium nitrate which has not been treated with a crystal habit modifier only a very small water content, e. g. 0.1% by weight of the ammonium nitrate, is necessary whereas using explosives containing ammonium nitrate which has been treated with a crystal habit modifier a greater water content with respect to the ammonium nitrate may be necessary. With untreated ammonium nitrate the amount of water picked up from the atmosphere during handling may often be enough. The water content should never be sufficient to destroy the powder character of the composition at ordinary temperatures.

The thickness of the hardened layer desired will depend on the pressure the container is required to withstand but it is preferred that the explosive should be hardened throughout. The thickness of the layer of hardened explosixe obtained will depend on the time to which the explosive is subjected to the heat treatment and on the temperature thereof. Thus for ammonium nitrate compositions in tins of diameter 2 inches immersed in water at 70 C. immersion times of 1, 3 and 6 minutes give hardened layers of thickness 0, 0.5 and 0.8 cm. respectively.

For said tins containing ammonium nitrate compositions which are at a temperature of 19° C. before their immersion in the water at 70° C. the temperatures as recorded by thermocouples are at the end of one minute against the inside wall 49.1° C. and 5 mm. from inside wall 24.4° C; at the end of 3 minutes against the inside wall 57.3° C., 5 mm. from inside wall 37° C., and 8 mm. from inside wall 25.7° C.; and at the end of 6 minutes against the inside wall 61.1° C., 5 mm. from inside wall 45.7° C., 8 mm. from inside wall 34.5° C., and 15 mm. from inside wall 23.7° C.

Temperatures of heating in the range 60–70° C. are preferred since the times required in this range are reasonably short and suitable for practical working.

Referring to the drawing, Figure 1 shows a part section through an explosive element of the kind described in the specification, which has not been treated according to the invention. As indicated heretofore, it is simply a cylindrical sheet metal canister **1**, filled with a charge **3** of an ammonium nitrate powder explosive. Figure 2 shows the same canister **1** after treatment according to

the invention whereby, as shown, a cylindrical layer 5 of the explosive adjacent to the sides of the canister 1 is converted into hardened explosive.

Figure 3 illustrates one method of carrying out the invention. A canister 7 is submerged in a water bath 9, provided with a thermometer 11, and means for raising the temperature of the water by the required amount, e. g., a live steam pipe 13. The water bath could, of course, equally well contain any number of canisters and the orientation of the canisters in the water bath is of no consequence.

As noted throughout the specification, the drawing illustrates only one embodiment of the invention, since, for example, the heating of the filled sealed canister may be carried out by any convenient means.

The invention is illustrated by the following examples in which all parts are by weight.

Example 1

An explosive composition is made by compounding together 90.0 parts of ammonium nitrate of particle size such that 100% by weight passes a No. 30 B. S. S. sieve, 98% passes a No. 60 B. S. S. sieve, 83% passes a No. 100 B. S. S. sieve, 70% passes a No. 120 B. S. S. sieve, 34% passes a No. 170 B. S. S. sieve and 7% passes a No. 240 B. S. S. sieve and containing 0.05% by weight of acid magenta, 2.4 parts of water-wet nitrocellulose containing 66^2/3% by weight of nitrocellulose, and 7.6 parts of orthonitrotoluol. This composition is loaded into 1 lb. tins of diameter 2 inches on to which lids are sealed by a roll seam. A number of the canisters thus filled are submerged under 200 ft. of water at 15° C. for 1 hour after which only 65% of the tins fire. All the tins collapse and 35% of the collapsed tins have leaks sufficient to cause failure. A number of similarly filled tins are immersed in hot water at 70° C. for 3 minutes and cooled. Upon examination some of these tins are found to have a hardened layer of 0.5 cm. thickness against their walls. The unexamined tins are thereafter submerged under 200 ft. of water for 1 hour after which 95% fire. 95% of the tins show no signs of collapse before firing. The remaining 5% have sufficient leaks, due for example to defective seaming, to cause failure.

Example 2

An explosive composition consisting of 92.5 parts ammonium nitrate of the same particle size as that used in Example 1 and containing 0.05% by weight acid magenta, 5.5 parts anthracite, 2 parts orthonitrotoluol and 0.25 part water is packed loosely into 1 lb. tins of 2 inch, i. e. 50 mm., diameter which are sealed by roll seaming. The tins so charged are immersed in water at 30° C., 34° C., 37° C. and 40° C. for one hour and subsequent to cooling are cut open. The walls of these tins are 0.012 inch thick and are of tin plate. The contents of the tins which are treated at 37° C. and 40° C. are set solid whereas the contents of the tins which are treated at 34° C. give only a thin layer of hardened explosive against the walls of the tins and those of the tins treated at 30° C. show no signs of being hardened. Further tests are then carried out by immersing tins so charged in water at 30° C. and 34° C. for 5 hours. Subsequent to cooling these tins are cut open. The contents of the tins which are treated at 34° C. are set solid whereas those which are treated at 30° C. show no signs of being hardened.

With the thermocouples inserted at 0 mm., 5 mm., 8 mm., 15 mm., and 25 mm. from the inside wall of the tins packed loosely with the above explosive composition which are at a temperature of 19° C. before they are immersed in water at the above mentioned temperatures of 34° C., 37° C. and 40° C. and by recording the temperatures at said distances at various time intervals it is found that when the water is at 40° C. at the end of 14 minutes 8 mm. from the inside wall is 32.1° C. and 25 mm. (i. e. the centre) from the inside wall is 27.1° C.; at the end of 18 minutes 8 mm. from the inside wall is 33.2° C. and 25 mm. from the inside wall is 28.9° C.; and at the end of 24 minutes 25 mm. from the inside wall is 32.3° C.; that when the water is at 37° C. at the end of 18 minutes 8 mm. from the inside wall is 31.5° C. and 25 mm. from the inside wall is 28° C.; at the end of 24 minutes 25 mm. from the inside wall is 30.2° C.; and at the end of 40 minutes 25 mm. from the inside wall is 33.0° C.; and that when the water is at 34° C. at the end of 22 minutes the inside wall is 32° C., 8 mm. from the inside wall is 30.3° C. and 25 mm. from the inside wall is 28° C.; and at the end of 60 minutes 25 mm. from the inside wall is 32° C.

Example 3

100 two inch diameter 1 lb. tins made of 0.012 inch thick tinplate are filled with an explosive containing 8% by weight trinitrotoluol, 88.5% by weight ammonium nitrate of the same particle size as in Example 1 and containing 0.15% water, and 3.5% by weight pulverised anthracite, made by milling the ingredients together in an edge runner mill. The lids are sealed on by a roll seam. The tins are then heated overnight at 60° C. and after cooling are subjected to 130 lbs./sq. in. water pressure, i. e. 300 feet of water, for 20 hours. The tins show very little signs of collapse and only 2 tins fail to initiate from a No. 8 A. S. A. detonator. Tins which are filled with the same explosive composition and are not subsequently heat treated collapse and leak under 130 lbs./sq. in. water pressure so that initiation of the composition is impossible.

Example 4

An explosive composed of 91% by weight pulverised ammonium nitrate of the same particle size as in Example 1, containing 0.05% by weight acid magenta, 0.15% water, and 9% by weight orthonitrotoluene is made by mixing the ingredients in a Werner Pfleiderer type mixer. 2 inch diameter 1 lb. tins made of 0.012 inch thick tinplate are filled with the explosive and the tins are then sealed by a roll seam. When the composition is "set-hard" by heating overnight at 60° C. the tins show no signs of collapse under 130 lbs./sq. in. water pressure and the composition can be initiated by a No. 8 A. S. A. detonator in conjunction with a primer which is made from the explosive referred to in Example 3. Similarly filled tins which are not heat treated collapse and leak under this pressure of water.

Regarding the nomenclature "ammonium nitrate III and IV," respectively, ammonium nitrate IV is known in the art as an ammonium nitrate having a crystal form which is stable over the temperature range, −18° C. to +32° C. For ammonium nitrate III, the corresponding temperature range is +32° C. to +84° C.

What we claim is:

1. A method of producing explosive elements particularly suitable for use at high hydrostatic pressure which comprises packing a charge of an ammonium nitrate powder explosive containing at least 75% by weight of ammonium nitrate IV and a small amount of water into a thin sheet metal canister, subjecting the canister after sealing to such a temperature and for such a period of time that at least a layer of the explosive close to the sides of the canister attains a temperature which is at least the transition temperature for ammonium nitrate IV to ammonium nitrate III, is below the fusion point of any solid fusible organic sensitising agent which may be included in the explosive, and does not exceed 80° C., and thereafter allowing the canister to cool so that the explosive which is at least at said transition temperature is converted into hardened explosive.

2. A method as claimed in claim 1 wherein the amount of water in the powder explosive is not less than 0.1% and not more than 1.0% by weight of the ammonium nitrate.

3. A method as claimed in claim 1 wherein the ammonium nitrate powder explosive contains oxidising salts other than ammonium nitrate.

4. A method as claimed in claim 1 wherein the heating of the filled sealed canister is carried out by total immersion in a liquid.

5. A method as claimed in claim 1 wherein the temperature of heating for the canister after sealing is in the range 60° to 70° C.

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