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EXPLOSIVE AND METHOD OF MANUFACTURE THEREOF

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This invention relates to a new and improved explosive and method of manufacture thereof, and more specifically to a new and improved explosive containing ammonium nitrate of increased sensitivity to detonation.

Heretofore, dynamite has been prepared with high contents of ammonium nitrate, because of the advantageous cost and low density of the ammonium nitrate, for example with ammonium nitrate content as high as 80%. However, dynamites containing high proportions of ammonium nitrate have suffered from the disadvantage of insensitivity to detonation, and require about 10% of their composition to be nitroglycerin, nitroglycol, or the like, to impart sufficient sensitiveness to detonation to enable such dynamites to be detonated by the usual No. 6 blasting cap or to propagate explosion from one cartridge to the next when in a borehole.

Ammonium nitrate alone, while capable of detonation by an extraordinarily high initial shock or impulse, is unsuitable by itself for commercial explosives, because it is too insensitive to detonation by the means ordinarily employed, and also because it will not propagate explosion from one cartridge to the next when in a borehole.

In addition to the ordinary means of increasing the sensitiveness of high ammonium nitrate mixtures, i. e., admixture of nitroglycerin and the like, various attempts have been made to increase the sensitiveness to detonation of ammonium nitrate by other means, but none of these are satisfactory or have achieved commercial application. For example, alkali metal nitrates, particularly sodium nitrate and potassium nitrate, have been used extensively in explosive compositions, primarily on account of their cheapness and the fact that such mixtures with carbonaceous materials are effective absorbents for liquid explosives and, at the same time, contribute energy to the explosion. U. S. Patent 1,568,324 discloses a process of manufacture of conglomerate masses of ammonium nitrate and sodium nitrate for explosive purposes, which comprises partial or complete fusion of the dry salts, rapid cooling of the melt, and pulverizing the product. The use of water to make the above mixture is excluded, because the masses were difficult to dry and hopelessly insensitive to detonation.

My invention involves broadly coating a metal nitrate on ammonium nitrate crystals preferably without substantial alteration of the shape or size of the ammonium nitrate crystals, and the product obtained thereby. I thereby obtain an ammonium nitrate of highly increased sensitiveness to detonation, capable of incorporation with other substances normally used in dynamites, or, if nitroaromatic compounds or like sensitizers commonly used in explosives, be added, with the use of smaller amounts of such sensitizer than heretofore found necessary.

Wholly contrary to expectation, I have found that my sensitization of ammonium nitrate crystals by coating with a metal nitrate is effective in connection with the use of added sensitizers having a large negative oxygen balance, e. g., organic nitrocompounds, such as the nitrotoluenes, nitroxylenes, nitronaphthalenes, etc., or diethyleneglycol dinitrate, but is not effective with sensitizers having a low oxygen deficiency or an oxygen excess, e. g., nitroglycerin, nitroglycol, nitrolactose, and the like. However, I may use the latter, if desired, in combination with oxygen-deficient organic nitrocompounds, if the oxygen-deficiency of the mixture be great. I am unable to give a reason for this effect, but state it as a fact found by lengthy experiment.

Contrary to prior art, I have found, much to my surprise, that I may use aqueous solutions of metal nitrates to deposit crystals of metal nitrates on ammonium nitrate to increase the sensitiveness to detonation of the latter, and I find the use of water, as the solvent for metal nitrates applied to ammonium nitrate crystals, highly desirable, since it affords a substantial increase in the safety of the operation by reducing the temperature required to bring the metal nitrate into proper contact with the ammonium nitrate.

As a specific example of the process in accordance with my invention I prepare a solution by dissolving 132 parts by weight of ammonium nitrate and 50 parts by weight of sodium nitrate in 66 parts by weight of water at about 27° C. This solution is saturated with respect to ammonium nitrate and almost saturated with sodium nitrate. This solution is applied at 27° C. to 950 parts by weight of dry, granular ammonium nitrate of such particle size that over 95% will pass a 40 mesh screen, about 30% will pass a 100 mesh screen, and less than 10% pass a 200 mesh screen. After thorough mixing, the crystals may be dried by passing through the mass a current of dry air about 50–60° C. with continuous stirring. After 3–4 hours, the moisture content is less than 0.2%.

Similarly, I may use as the coating solution a water solution of ammonium nitrate and nitrate of copper, lead, zinc, potassium, cadmium, nickel, or any metallic nitrate. I prefer to have such

coating solution saturated with respect to ammonium nitrate, so that it will exert a minimum of solvent action upon the ammonium nitrate grains with which it comes in contact, altho I do not so limit myself. For example, the coating solution may contain no ammonium nitrate, or may contain less than the amount required for saturation. In this event, some of the ammonium nitrate crystals to which the solution is applied will be partly dissolved, but the coating solution should preferably be of such volume and concentration that the greater part of the ammonium nitrate to which it is applied remains undissolved.

I do not limit myself to drying the coated ammonium nitrate crystals by passing air therethrough, but the drying may be done by merely heating the coated crystals, and in such case I prefer to heat the coating solution before applying the same to the ammonium nitrate crystals, to facilitate drying. I prefer to have the coating solution almost saturated with the coating salt, to minimize the amount of water to be evaporated and to minimize the solvent action on the ammonium nitrate crystals. I may apply the coating solution more than once, to increase the amount of coating salt deposited on the ammonium nitrate crystals.

I have found that it is unnecessary to have the ammonium nitrate crystals completely dry before application of the coating salts. For example, the ammonium nitrate crystals may contain enough adhering moisture to dissolve the required amount of metal nitrate, which latter may then be added in a dry state, stirred until dissolved by the adhering mother liquor, and the mixture then dried.

I may disperse or dissolve carbonaceous or organic sensitizing ingredients in the coating solutions. Such may be done safely at temperatures below 100° C., but would be very dangerous if the sensitizing agents were added to the ammonium nitrate crystals by a fusion process, e. g., according to the process disclosed in U. S. Patent 1,568,324.

To determine the sensitiveness and efficiency of explosives made from ammonium nitrate sensitized according to my improved process, I prefer to use the small lead block compression test as described in U. S. Bureau of Mines, Bulletin No. 346, pages 106–108, 1931 edition. In this test, a short column of the explosive (100 grams) at the desired density is placed on top of a vertical, lead cylinder 1.5 inches in diameter and 2.5 inches high, capped with a steel disc ¼ inch thick. The explosive is detonated by a blasting cap, the detonation drives down the steel disc and compresses the lead cylinder by an amount commensurate with the velocity of detonation and completeness of detonation of the explosive. Since an increase in the density of loading of an explosive markedly desensitizes ammonium nitrate explosives, it is possible to estimate the sensitization produced by the coating on the ammonium nitrate by determining the limiting density at which detonation is accomplished by a No. 6 or a No. 8 blasting cap. In the following, the above method of determining sensitiveness has been employed.

For the purpose of illustrating the increased sensitiveness to detonation of my coated ammonium nitrate, I prepared a series of explosives containing 92 parts by weight of screened ammonium nitrate, coated with about 5% of metal nitrates as heretofore described, 5 parts by weight of dinitrotoluene oil, and 3 parts by weight of ground soft coal. The explosive containing uncoated ammonium nitrate I designate, in the following table, as A, that coated with sodium nitrate B, with copper nitrate C, with lead nitrate D, with zinc nitrate E.

TABLE I

Small lead block compression tests

Explosive	A	B	C	D	E
Coating	None	$NaNO_3$	$Cu(NO_3)_2$	$Pb(NO_3)_2$	$Zn(NO_3)_2$
Limiting density (g./cc.) for No. 6 cap	0.90	1.08	1.15	1.15	1.15
No. 8 cap	0.97	1.24	1.24	1.24	1.24
Max. compression (in.)	0.40	0.50	0.52	0.43	0.49

Comparison of the sensitiveness to No. 6 or No. 8 blasting caps of composition A, with compositions B to E shows clearly the advantages in sensitiveness to detonation gained by coating the ammonium nitrate with various metal nitrates. Although not shown in the table, similar increases in sensitiveness were obtained with coatings of nitrates of potassium, cadmium, nickel, iron, calcium and magnesium.

To illustrate the improvement in sensitiveness to detonation accomplished by my coating process, as compared to mixtures of ammonium nitrate and a metal salt, an explosive was made up on the same composition as B, in Table I, but with the sodium nitrate added dry to the ammonium nitrate, after screening through a 100 mesh screen. This explosive composition detonated partially with a No. 6 blasting cap at a density of 1.02 g./cc., and failed to detonate with a No. 8 blasting cap at a density of 1.08 g./cc. Furthermore, in this explosive, the presence of the fine sodium nitrate caused greatly increased "setting" difficulties, i. e., greatly increased caking or hardening of the explosive during storage.

The amounts and kind of metal nitrate applied as coating on the ammonium nitrate determines the degree of sensitization to detonation of the ammonium nitrate. For example, an explosive made up on the same general composition as explosive E in Table I, except that only 1% of zinc nitrate coating was on the ammonium nitrate, had a limiting density of 1.02 g./cc. for a No. 6 blasting cap.

Although, in the foregoing, I have illustrated only dinitrotoluene oil and coal as the sensitizing agents to add to my sensitized ammonium nitrate to produce a commercial explosive, I may use other carbonaceous ingredients than coal, e. g., charcoal, corn meal, flour, wood pulp, etc., and in place of the dinitrotoluene oil I may use solid dinitrotoluene, trinitrotoluene, dinitronaphthalene, and other liquid and solid nitro-compounds, incorporated by the use of heat, for example in amounts depending upon the type of dynamite and on the sensitiveness requirements of the trade.

What I claim and desire to protect by Letters Patent is:

1. The method of increasing the sensitiveness to detonation of ammonium nitrate comprising adding to ammonium nitrate crystals a solution of a metal nitrate and drying the mixture.

2. The method of increasing the sensitiveness to detonation of ammonium nitrate comprising adding to ammonium nitrate crystals a solution containing ammonium nitrate and a metal nitrate, and drying the mixture.

3. The method of increasing the sensitiveness to detonation of ammonium nitrate comprising adding to ammonium nitrate crystals a metal nitrate solution saturated with ammonium nitrate, and drying the mixture.

4. An explosive composition sensitive to detonation comprising ammonium nitrate particles coated with a metal nitrate.

5. An explosive composition sensitive to detonation comprising ammonium nitrate crystals coated with crystals of a metal nitrate.

6. An explosive composition comprising ammonium nitrate crystals coated with crystals of a metal nitrate, and an organic sensitizer having a high oxygen deficiency.

7. An explosive composition comprising ammonium nitrate crystals coated with crystals of a metal nitrate, an organic sensitizer having a high oxygen deficiency, and a carbonaceous ingredient.

8. An explosive composition comprising trinitrotoluene, a carbonaceous ingredient, and ammonium nitrate crystals coated with crystals of a metal nitrate.

9. An explosive composition comprising nitronaphthalene, a carbonaceous ingredient, and ammonium nitrate crystals coated with crystals of a metal nitrate.

10. An explosive composition comprising a carbonaceous ingredient, dinitrotoluene, and ammonium nitrate crystals coated with crystals of a metal nitrate.

11. An explosive composition comprising a carbonaceous ingredient, dinitrotoluene, and ammonium nitrate crystals coated with crystals of zinc nitrate.

12. An explosive composition comprising ammonium nitrate crystals coated with crystals of calcium nitrate, a carbonaceous ingredient, and dinitrotoluene.

13. An explosive composition comprising a carbonaceous ingredient, dinitrotoluene, and ammonium nitrate crystals coated with crystals of magnesium nitrate.

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