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TREATMENT OF AMMONIUM NITRATE
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mington, Del., a corporation of DelawareNo Drawing. Application July 30, 1937,
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4 Claims. (Cl. 52—21)

This invention relates to a method of treating explosive compositions comprised largely of ammonium nitrate, and particularly to a method of heat treating compositions containing ammonium nitrate as the principal ingredient, together with sensitizing agents, whereby an improvement in the explosive properties of the composition is obtained.

There are two important types of explosives in which ammonium nitrate has been employed, one of which is that of the common ammonia dynamites containing nitroglycerin, in which this latter compound serves as the principal explosive ingredient or as the sensitizer, while ammonium nitrate is used to replace or supplement nitroglycerin. In a second type, ammonium nitrate is the principal ingredient and is used in the absence of nitroglycerin or other similar liquid explosive nitric ester. In such compositions, at least one sensitizing ingredient is used comprising an oxygen-accepting material that utilizes for its combustion the excess oxygen available in the ammonium nitrate.

The ammonium nitrate compositions described above possess high strength as explosives and may be initiated by various means, depending upon the degree of sensitiveness possessed by them. While the ammonia dynamites and dynamites of the ammonia permissible and similar types are readily detonated by means of a commercial blasting cap, even when containing as high as 80% ammonium nitrate, there are ammonium nitrate high explosives in widespread use that are so insensitive that they can not be initiated by the action of a blasting cap or a line of Cordeau. These explosives are capable, however, of propagating the explosion with undiminished velocity throughout their column after detonation has once been initiated, provided a sufficiently large diameter column of explosive is used.

In all its compositions, ammonium nitrate has the property of being readily affected by water, in liquid or vapor form, because of the hygroscopic nature of the material. In the presence of even a small friction of a percent of water, ammonium nitrate after continued storage tends to become hard or "set", due to the solution and recrystallizing processes that take place between the crystals. When set in a hard mass, compositions normally sensitive to the action of a cap or to propagation of the explosion wave throughout the column become insensitive and incapable of functioning satisfactorily. For this reason, ammonium nitrate explosives must be effectively protected against water and moisture. In the case of some compositions high in ammonium nitrate, where the maintenance of a well-defined sensitiveness range is desired, the explosive has been enclosed in waterproof metal

containers. Loss of sensitiveness results also when the density of the ammonium nitrate material exceeds a certain maximum limit.

The object of this invention is a method for physically treating ammonium nitrate explosive compositions, whereby the properties of the finished explosive are favorably affected. A further object is a heating treatment for such compositions, whereby improvement in sensitiveness and velocity results. A still further object is such a method whereby an equalization of density of ammonium nitrate compositions results. Additional objects will be disclosed as the invention is described at length hereinafter.

I have found that the foregoing objects are accomplished in the case of explosive compositions of relatively high density including ammonium nitrate as the principal ingredient and at least one normally solid fusible organic sensitizer by treating said explosive compositions according to the process of our invention, which comprises heating said composition under conditions of confinement to a temperature at which said sensitizing agent is in the liquid state, and subsequently cooling said composition. The process is most effective with ammonium nitrate compositions having a relatively high density, for example 0.90.

The compositions treated according to the foregoing process exhibit a marked increase in velocity, and a greatly improved sensitiveness to propagation.

While the process outlined is one applicable to any such ammonium nitrate explosives containing at least one fusible sensitizing agent, its employment is most desirable in the case of compositions of that type, which are below standard with regard to sensitiveness and velocity. It may, for example, be applied to compositions that are normally sensitive to the action of a commercial blasting cap, in order to make them more sensitive, or to such normally cap-sensitive explosives that have become insensitive or of doubtful sensitivity due to caking, moisture pick-up, or to other reasons. Compositions of this nature include those high in ammonium nitrate and containing a sensitizing agent which is in liquid form at the upper temperature reached. Furthermore, the method may be applied to compositions which are normally insensitive to detonation by a blasting cap, in order to render them cap-sensitive. The method is desirable also in the case of compositions which are normally insensitive to the action of a blasting cap but which are maintained within such a range of sensitiveness that, while incapable of detonation by a cap, they are capable of detonation and of continuous propagation of the explosion when this has once been initiated by means of a suitable booster charge, and when used in columns of

sufficient diameter. When such compositions are treated by my method, they normally become higher in velocity and of a higher degree of sensitiveness to propagation, though still incapable of detonation by a blasting cap.

I have referred particularly in the foregoing to compositions high in ammonium nitrate and containing a suitable fusible sensitizer or oxygen-accepting ingredient. I find the method particularly effective, however, in the case of compositions such as are described by Kirst and Woodbury in U. S. Patent 1,992,217, where ammonium nitrate is present in an amount higher than 85%, together with at least one fusible sensitizing agent, and where the composition is protected by enclosure in a waterproof container, preferably of metal. As a matter of fact, I find that the effectiveness of my invention is greatly increased by the confinement of the material in a rigid container during the heating step. In such compositions as those of Kirst and Woodbury, the degree of sensitiveness is such that the material can not be detonated by means of a blasting cap or by a line of Cordeau but is capable of detonation and propagation throughout the explosion column with undiminished velocity, when once initiated by a suitable booster charge, provided the column is of sufficiently large diameter. A desirable composition for treatment according to my invention will comprise ammonium nitrate in an amount greater than 85%, 0.5 to 10.0% of a nitrated aromatic hydrocarbon, and 0.5 to 10.0% of a normally solid paraffin hydrocarbon. With such compositions, it is desirable to heat to a temperature at which both sensitizing agents are in liquid form and subsequently to cool to a temperature at which one sensitizer becomes solidified.

While improved properties result when such compositions are heated and then cooled through the temperature specified, I find that even better results are obtained when the heating and subsequent cooling are repeated several times, so that as many as three or four cycles of successive heating and cooling may be advantageously carried out.

By way of illustration, a composition comprising 92% ammonium nitrate, 4% dinitrotoluene, and 4% paraffin was enclosed in a tight metal container having soldered seams. The composition had been compressed to an average density of 1.269 and the container was substantially full. The material, at an initial temperature of around 26° C., was heated until a temperature of 50° C. existed throughout, and was then cooled to 30° C. A second cycle consisted of heating to 46° C. and cooling to 31° C., and a third of heating and cooling to 49° C., respectively. The results given below show the effect of the treatment described on the sensitiveness and velocity of the product.

Table I

Status of composition	Velocity in meters/second	Maximum spacing in inches for consistent detonation
Untreated.....	Failure	None
After 1 cycle.....	3645	3
After 2 cycles.....	3670	4
After 3 cycles.....	3788	8

It is apparent from this tabulation that a marked increase in both velocity and sensitiveness to propagation is effected with each additional cycle according to the process of my invention.

The spacing test indicated that although before treatment the explosive failed to be initiated across an air gap, after the first treatment, it was consistently initiated when spaced at 3 inches. Furthermore, this maximum spacing for consistent detonation increased with each cycle.

The previous tabulation shows the advantages of the method of treatment in the case of a composition that is initially ineffective with regard to sensitiveness. The table following indicates that the method is desirable also in the case of initially good material, in order to make it even more effective.

Table II

Status of composition	Velocity in meters/second	Maximum spacing in inches for consistent detonation
Untreated.....	4226	10
After 1 cycle.....	4711	12
After 2 cycles.....	5121	12

A similar improvement in both sensitiveness and velocity is shown in this second table, where the material was generally satisfactory before treatment.

It is noteworthy also that the method of treatment described by me has the additional effect of equalizing the density of compositions so heated, when contained in substantially full metal cans. For example, a column of explosive of 5½" diameter was tested for density in various portions of its length. Whereas an average density of 1.269 was determined for a can of the untreated material, while a maximum density of 1.286 was found, results for average and maximum densities of similarly packed cans that had been subjected to three treating cycles showed 1.243 and 1.250, respectively. Since high density is frequently a cause of insensitiveness in compressed ammonium nitrate compositions, a method that equalizes density throughout such compositions will be very advantageous. Actually, of course, the weight of the ammonium nitrate explosive in the can of definite volume is unchanged. The fact is that the cans are not completely filled before the heat treatment, since no lowering of density could result if such were the case. Heating causes expansion of the material and tight compression against the walls of the container, as well as substantial equalization of the density throughout. On cooling, contraction doubtless tends to take place, not from the container walls but by means of cracks through the hard material. The process therefore has the further merit of reinforcing the walls of the container against external water pressure, in the case of sub-aqueous shots.

From the foregoing description, it will be apparent that results of great practical utility will be obtained by my invention and that it is applicable to a considerable range of high ammonium nitrate compositions. It will be particularly effective when used with compositions of high density, whether in set or unset condition, and regardless of moisture content, though the presence of water is always undesirable. While I have described the invention in considerable detail, it will be understood that many variations may be made in the process with respect to minor factors, without departing from the spirit of the invention. I wish to be limited by the following patent claims.

I claim:

1. The method of treating explosive composi-

tions including ammonium nitrate as the principal ingredient and at least one normally solid fusible organic sensitizing agent, which method comprises enclosing said composition in a substantially filled rigid container, heating the enclosed composition to a temperature at which said sensitizing agent is in liquid state, and subsequently cooling said composition.

2. The method of increasing the sensitiveness to propagation of a relatively high density explosive composition including ammonium nitrate as the principal ingredient, and at least one normally solid fusible organic sensitizing agent, which method comprises enclosing said composition in a substantially filled rigid container, heating the enclosed composition to a temperature at which said sensitizing agent is in liquid state, and subsequently cooling said composition.

3. The method of claim 2, in which the sensitizing agent is a nitrotoluene.

4. The method of increasing the sensitiveness to propagation of an explosive composition of a density greater than 0.90 and comprising more than 85% ammonium nitrate, 0.5 to 10.0% of a nitrated aromatic hydrocarbon, and 0.5 to 10.0% of a normally solid paraffin hydrocarbon, which method comprises enclosing said composition in a substantially filled rigid container, heating the enclosed composition to a temperature at which both the nitrated aromatic hydrocarbon and the paraffin hydrocarbon are in liquid state, and subsequently cooling said composition to a temperature at which at least one of said liquid ingredients becomes solidified.

WILLIAM E. KIRST.