

UNITED STATES PATENT OFFICE

2,220,892

METHOD OF PREPARING AMMONIUM
NITRATE EXPLOSIVES

Melvin Alonzo Cook, Clyde Oliver Davis, and
Walter Eastby Lawson, Woodbury, N. J., as-
signors to E. I. du Pont de Nemours & Company,
Wilmington, Del., a corporation of Delaware

No Drawing. Application August 9, 1939,
Serial No. 289,188

8 Claims. (Cl. 52—19)

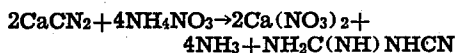
This invention relates to a new and improved method of preparing ammonium nitrate explosive compositions and more especially to the preparation of explosives possessing superior sensitiveness properties, particularly at high densities.

In the case of existing ammonium nitrate high explosives sensitized by means of non-explosive solid sensitizers, very careful control and handling are necessary in order that the product shall maintain its explosive properties unimpaired during storage. The affinity of ammonium nitrate for water makes this particularly important, since ammonium nitrate has a tendency to become hard and insensitive in the presence of even small amounts of water.

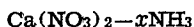
The object of the present invention is a novel method of preparing explosives of high ammonium nitrate content. A further object is a method of preparing such explosives whereby they possess improved sensitiveness characteristics, particularly at high densities. Additional objects will be disclosed as the invention is further described hereinafter.

The foregoing objects are accomplished by the method of our invention whereby ammonium nitrate and a sensitizer therefor are heated with an additional inorganic salt capable of reacting with ammonia and are maintained exposed to the action of ammonia gas during at least a portion of the heating. While the above procedure is our preferred one, in some cases heating of the mixture is unnecessary.

Various methods are available for carrying out our invention. One desirable procedure comprises including a metal cyanamide as an ingredient of the ammonium nitrate composition. Calcium cyanamide, for example, on heating to 80–85° C., reacts as follows with ammonium nitrate:



(The calcium cyanamide acts also as a fusion point depressant of the ammonium nitrate, as do also the various reaction products shown above; hence the addition of the cyanamide contributes in addition, a definite degree of plasticity to the ammonium nitrate compositions.) If the heating of the blend of ingredients is carried out in a closed container, substantially no ammonia escapes; yet there is no considerable increase in pressure. Presumably there is formation of a calcium nitrate ammoniate or an ammine of calcium nitrate, for example of the formula:



The same effect would be obtained when other metal cyanamides than that of calcium were used,

for example the cyanamides of barium, strontium, zinc, and copper.

While the use of a metal cyanamide, and particularly calcium cyanamide, is a convenient and preferred embodiment of our invention, the desired results may be obtained by other means. We may, for example, include in the ammonium nitrate composition an inorganic salt capable of forming an ammoniate with ammonia, or of reacting otherwise, and then introduce gaseous ammonia, whether formed externally or as a product of a reaction taking place within the mixture. Salts which are effective for the purpose include calcium nitrate, barium nitrate, strontium nitrate, zinc nitrate, lead nitrate, cobalt nitrate, copper nitrate, cobalt perchlorate, and the like.

In carrying out our invention we find its greatest advantage to lie in its application to ammonium nitrate compositions of a relatively low order of sensitiveness. By the employment of our method, greatly increased sensitiveness is obtained. It is particularly applicable in high density ammonium nitrate compositions, and by its use densities may be employed satisfactorily that would otherwise be too high to be practical. The invention is therefore of great utility, since it allows the concentration of the ammonium nitrate explosive charge to a much greater degree than has been possible heretofore. In other words, it makes possible a considerable increase in the bulk strength of ammonium nitrate explosives without impairment of propagation properties.

A suitable composition of explosive for use according to our invention may include a preponderant amount of ammonium nitrate, an organic sensitizing ingredient, such as dinitrotoluene for example, an inorganic salt reactive with ammonia, and ammonia from some source. The following will serve as specific embodiments.

Example 1

Ammonium nitrate in the amount of 17.6 lbs. was introduced into a mixing vessel having a tight cover and adapted to be closed tightly and was heated to 80° C. 2.4 lbs. of dinitrotoluene was then added and the mix was maintained at a temperature of 80° C. for 15 minutes. It was then allowed to cool to 35° C. The material was packed into water-tight metal containers of 2-inch diameter at a density of 1.20. Powder thus packed was tested for propagation when primed with a high velocity charge of TNT of the same diameter. Samples of this powder at a density of 1.20 detonated with a velocity of 2150 meters per second, while at a density of 1.22 the explosive failed to shoot. This example illustrates the relative insensitiveness of such a composition of the prior art at a density around 1.20.

Example 2

Ammonium nitrate in the amount of 17.0 lbs. was introduced into the mixing vessel of Example 1 and heated to 80° C. A mixture of 2.4 lbs. of dinitrotoluene and 0.6 lb. of calcium cyanamide was added to the heated ammonium nitrate, and the mixer closed. The whole was maintained at 80° C. for 15 minutes, after which it was allowed to cool to 35° C. The powder was packed in metal containers of 2" diameter at a density of 1.37. When tested at this density, the explosive propagated at a velocity of 3495 meters per second. This example illustrates the increased sensitiveness and propagating power, at high packing densities, of explosive compositions according to our invention.

Example 3

A blend of 17.3 lbs. of ammonium nitrate and 0.3 lb. of paraffin was introduced into a mixing vessel adapted to be closed tightly, and was heated to 80° C. A mixture of 1.8 lbs. of dinitrotoluene and 0.6 lb. of calcium cyanamide was then added to the heated blend and the whole was maintained at 80° C. for 15 minutes. The blend was allowed to cool to 35° C. and was packed to various densities in metal containers of 2" diameter. The material was insensitive to the action of a No. 8 blasting cap at a density of 1.0, but at as high a density as 1.35 detonated with a velocity of 3400 meters per second when primed with a booster charge similar to that used in Example 1. At a density of 1.30, the material propagated across an air gap of 4 inches.

Example 4

Ammonium nitrate in the amount of 12.8 lbs. was introduced into a mixing vessel such as used in Example 1, and was heated to a temperature of 80° C. A blend of 1.5 lbs. of trinitrotoluene, 0.45 lb. of calcium cyanamide, 0.225 lb. of brewers' grits, and 0.03 lb. of a coating material was then added to the heated ammonium nitrate, and the entire mixture was maintained at 80° C. for 15 minutes with continuous agitation. The blend was allowed to cool to 25° C., and was then packed into 1 1/4 x 8" cartridges of a density such that the average weight per cartridge was 168 grams. Under such conditions, the cartridges were sensitive to, and capable of initiation by, a commercial blasting cap, showing a velocity of 4100 meters per second. The sensitiveness by the whole-stick propagation test was 10 inches, and the explosive showed a comparatively good degree of water resistance.

Example 5

A mixture was made, in a mixing vessel capable of being closed tightly, of 16.3 lbs. of ammonium nitrate, 2.4 lbs. of dinitrotoluene, and 1.0 lb. of hydrated cupric nitrate. Sufficient gaseous ammonia was introduced to constitute slightly more than 0.3 lb. The container was maintained tightly closed for a short period of time, and the powder was then packed to a density of 1.30 in metal containers of 2" diameter. At this density the explosive gave consistent high velocity detonations when suitably primed. It was demonstrated that the reaction product of ammonia with the cupric nitrate had effected a sensitization of the explosive, since a similar composition, with the only difference that no ammonia was introduced, failed to detonate consistently at densities above 1.20.

Example 6

Ammonium nitrate in the amount of 16.6 lbs. was blended with 1.8 lbs. dinitrotoluene, 0.3 lb. paraffin, and 1.0 lb. calcium nitrate in a mixing vessel capable of being closed tightly. Sufficient gaseous ammonia was introduced to comprise slightly more than 0.3 lb. and the container was closed. After being maintained for a period of time in the presence of ammonia gas, the powder was packed into metal containers of 2" diameter. At a density of 1.3, the velocity of detonation was determined at 3200 meters per second. This example illustrates an embodiment of the invention in which the ingredients were mixed cold.

In the foregoing examples the sensitizers have been nitro-aromatic compounds, and specifically nitrotoluenes. It should be understood, however, that various organic sensitizers are available and applicable other than nitrotoluenes, for example, the various nitronaphthalenes, diphenylamine, diphenyl, and the like. The organic sensitizer is preferably one having a melting point such that the material is at least partially fused at the temperature of mixing of the explosive; hence it should desirably have a fusion point below 100° C. In carrying out our method likewise, where the ingredients are heated together under confinement, it will be desirable to maintain the temperature below 100° C. It will be understood also that inorganic sensitizers may be used, for example, aluminum, ferrosilicon, calcium silicide, sulfur, and the like.

The compositions according to our invention will contain more than 50% ammonium nitrate and preferably more than 75%. The organic sensitizer will desirably be present in an amount between 0.5 and 20%, while the product of the reaction between the inorganic salt and ammonia should be present in an amount between 0.1 and 10%. Specific favorable compositions are shown in the examples cited previously.

The advantages of our invention are very considerable. By way of illustration, certain types of ammonium nitrate explosives are disclosed in the art which are sensitized by means of non-explosive sensitizers. Compositions of this type are generally relatively insensitive. Certain of them are so much so that they are incapable of detonation by means of a commercial blasting cap but can be detonated when initiated by a suitable amount of a booster charge of trinitrotoluene, and then explode with undiminished high velocity. Explosives of this type are particularly effective in quarry blasting, and it is frequently desirable to obtain as high a loading density as possible in the borehole in order to secure the maximum blasting execution. With explosives of such a relatively low order of sensitiveness, however, densities greater than 1.15 are generally undesirable in the case of compositions of the prior art, since there is too great a chance of failure to detonate. Operating in accordance with the present invention, however, densities up to 1.7 are practically utilizable. Preferably the explosive will be enclosed in a completely water-tight container, such as a metal can. Not only is the invention applicable to cap-insensitive explosives, but it is effective also in the case of cap-sensitive explosives which are thereby made more certainly detonable. It may likewise be utilized to sensitize cap-insensitive compositions and make them sensitive to commercial blasting caps. Furthermore, it is ap-

plicable in the case of certain explosives of high ammonium nitrate content, which thereby become practical for use in smaller diameters than would otherwise be possible.

5 The method of our invention is applicable to the preparation of the explosive compositions disclosed in our copending application, Serial No. 289,187, dated August 9, 1939.

We have described our invention at length in 10 the foregoing, but it will be understood that many variations in procedures and compositions may be introduced without departure from the spirit of the invention. We wish to be limited, therefore, only by the following patent claims.

15 We claim:

1. The method of preparing explosive compositions of high ammonium nitrate content, which method comprises mixing together ammonium nitrate, an organic sensitizer therefor, an inorganic nitrate other than those of the alkali metals and capable of reacting with ammonia, and ammonia, and maintaining said mixture in the presence of gaseous ammonia.

2. The method of preparing explosive compositions of high ammonium nitrate content, which method comprises heating together ammonium nitrate, an organic sensitizer therefor, and an inorganic nitrate other than those of the alkali metals and capable of reacting with ammonia, maintaining said mixture exposed to the action of ammonia gas during said heating, and cooling said mixture while still in the presence of gaseous ammonia.

3. The method of claim 2, in which the inorganic nitrate is calcium nitrate.

4. The method of preparing ammonium nitrate explosive compositions, which method com-

prises mixing together a preponderant amount of ammonium nitrate, an organic sensitizer therefor, and a fusion point depressant for the ammonium nitrate comprising a metal cyanamide, heating said mixture under confinement to a temperature not in excess of 100° C., and cooling said mixture while still under confinement.

5. The method of claim 4, in which calcium cyanamide is the metal cyanamide.

6. The method of preparing ammonium nitrate explosive compositions, which method comprises mixing together a preponderant amount of ammonium nitrate, an organic sensitizer therefor, and a metal cyanamide, heating said mixture and maintaining the same exposed to the action of ammonia gas during said heating, and cooling said mixture while still in the presence of gaseous ammonia.

7. The method of preparing ammonium nitrate explosive compositions, which method comprises mixing together a preponderant amount of ammonium nitrate, an organic sensitizer therefor, and calcium cyanamide, heating said mixture, and maintaining the same exposed to the action of ammonium gas during said heating, and cooling said mixture while still in the presence of gaseous ammonia.

8. The method of preparing explosive compositions of high ammonium nitrate content, which method comprises mixing together ammonium nitrate, an organic sensitizer therefor, an inorganic nitrate other than those of the alkali metals and capable of reacting with ammonia, and heating said mixture in a closed system.

MELVIN ALONZO COOK.

CLYDE OLIVER DAVIS.

WALTER EASTBY LAWSON.

35