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## HIGH-DENSITY EXPLOSIVE CHARGE

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This invention relates to high density explosive charges and more particularly to methods of preparing such charges in a form adapted to fill readily into containers.

High density is an essential characteristic of many types of explosive charges since it permits the attainment of high bulk strength. In shell charges for military use, for example, the highest density consistent with satisfactory initiating and propagating ability is desirable. Cast explosives represent one effective method of obtaining this result. A high density charge may be prepared by exposing a mixture of more than one compound of a predetermined blend to a temperature at which one of the compounds becomes at least partly molten. The composition can then be readily loaded into the desired container, the molten portion functioning as solvent or lubricant for the material still in solid form. The military explosive, amatol, may be charged in the latter manner where the composition may be 40-80 parts ammonium nitrate and 60-20 parts trinitrotoluene. While such a method can be carried out satisfactorily if suitable precautions of continuous and thorough mixing are taken, there is danger of segregation of the separate components when materials are used which are not mutually soluble. Such segregation would defeat the purpose of the careful blending and would cause a lack of uniformity in propagating power and dispersion of the composition.

An object of the present invention is a high density blended explosive of uniform composition. A further object is a method of producing explosives of relatively high density under such conditions that the tendency toward segregation is eliminated. A still further object is such a method of producing high density blends of uniform composition containing ammonium nitrate and a normally solid sensitizing agent. Additional objects will be disclosed as the invention is described more in detail hereinafter.

We have found that the foregoing objects are attained and the disadvantages of the prior art overcome when we prepare blends comprising an inorganic oxidizing agent and a normally solid organic sensitizer therefor, first subjecting the blend to a temperature at which at least one of the above compounds is partly or entirely in molten condition. At the same time a compound is maintained in the blend capable of promoting dispersion of one of the two normally solid compounds in the molten portion of the

second compound. The mixture is subsequently cooled and thereby solidified. The solidification to a firm mass may take place in any desired container, compacting being effected by pressing, tamping, extruding, or by any suitable method.

We find ammonium nitrate to be a highly desirable inorganic oxidizing agent for use in the blends prepared according to our method, particularly because of the fact that it lends explosive strength to the mixture when properly primed. While it is essential to the invention that one of the ingredients of the blends be in a state of at least partial fusion during the preparation of the explosive, this molten compound may be either a normally solid organic sensitizer or the ammonium nitrate or other oxidizing agent, or other compound. Several variations of the invention are possible, according to the state in which the several ingredients are present.

According to one embodiment, the ammonium nitrate is liquefied, while the organic sensitizer remains in the solid state. Since the normal fusion point of dry ammonium nitrate is above 169° C., it is essential in such a case to use with the ammonium nitrate a fusion point depressant, such as an inorganic nitrate or any compound organic or inorganic which is soluble in molten nitrate, for example, water, urea, acetamid, dicyandiamid, guanidine, and the like. In this way, fusion may be brought about at temperatures between 70° and 100° C. Suitable sensitizing agents for blends thus prepared would be pentaerythritol tetranitrate, ammonium picrate, trinitronaphthalene, tetryl, trinitrobenzene and the like.

In another embodiment we prepare the blend by employing such compositions and conditions that both ammonium nitrate and organic sensitizer are in molten form. Again it would be essential to use a fusion point depressant for the ammonium nitrate. As sensitizing agent, organic materials having a melting point below 100° C. would preferably be used, for example, dinitrotoluene, trinitrotoluene, the lower nitronaphthalene, meta-dinitrobenzene, organic fuels such as diphenylamine, paraffin, and the like.

In a third embodiment we prepare the explosive by maintaining the ammonium nitrate in solid form throughout, while effecting fusion of the organic sensitizer. The same sensitizing and dispersing agents are applicable here as in the previous case. Our preferred composi-

tion would fall in this class comprising ammonium nitrate and trinitrotoluene, which would be maintained at a temperature between 80° and 100° C.

It will be understood that other inorganic oxidizing agents than ammonium nitrate may be employed under this third embodiment. We may use, for example, sodium nitrate, potassium nitrate, calcium nitrate, ammonium perchlorate, and the like. With such agents, the amount and type of sensitizer will have to be chosen to give the proper degree of sensitiveness to the finished explosive charge.

Our invention covers also compositions in which two organic compounds are included, preferably two explosive compounds, in the absence of ammonium nitrate or other inorganic oxidizing agent. Such a composition may comprise trinitrotoluene, dinitrotoluene, or one of the lower nitronaphthalenes as a material of low fusion point, together with a higher melting compound having ordinarily not more than a limited solubility in the low-melting material. The preferred composition would be solid pentaerythritol tetranitrate dispersed in molten trinitrotoluene, for example in a 10-90 ratio.

As stated in the foregoing, this invention comprises a promotion of dispersion of one of the components of the blend throughout that component which is in molten form by means of a chemical agent capable of furthering such dispersion. Various types of materials are suitable for this purpose taken from the group of compounds that function effectively as surface-active agents, wetting agents, detergents, emulsifying materials, and the like. We may, for example, employ various higher fatty alcohol sulfates, for example, sodium lauryl sulfate and its mixtures with higher and lower homologs, various aliphatic and aromatic sulfonates such as sodium alkyl naphthalene sulfonates; fatty acid soaps, and the like. The dispersing agent may be one possessing no solubility for either of the ingredients, merely functioning as a wetting agent, or it may be one having some dissolving power for at least one of the ingredients.

The following examples will serve as specific embodiments for carrying out our invention:

#### Example 1

The following composition was prepared and heated to a temperature of about 82° C.

|                                    | Per cent |
|------------------------------------|----------|
| Ammonium nitrate.....              | 75       |
| Sodium hyposulfite (hydrated)..... | 6        |
| Trinitrotoluene.....               | 19       |

A small amount of a sodium alkyl naphthalene sulfonate was added, and the blend was agitated. The composition was introduced into a suitable container and tamped, using the above cooled and solidified composition in a container 5" in diameter and 24" long. This explosive, when primed with amatol, gave a velocity of detonation of 5000 m./sec. The density of the explosive was 1.52. No segregation of ingredients took place such as would result when this composition was prepared in the same manner without the use of the dispersing agent.

#### Example 2

An explosive composition was prepared by heating the following blend to a temperature of around 85° C.

|                                 | Per cent |
|---------------------------------|----------|
| Ammonium nitrate.....           | 79       |
| Sodium acetate (anhydrous)..... | 6        |
| Trinitrotoluene.....            | 15       |

A sodium alkyl naphthalene sulfonate in small amount was likewise added to this composition. The density of the solidified explosive was 1.50, and a velocity of 5000 m./sec. was obtained, when primed similarly to the composition of Example 1 and shot in the same dimension column. No segregation of fusible ingredient took place.

#### Example 3

The following composition was blended and heated to a temperature of around 85° C. with addition of a dispersing agent similar to that used in Examples 1 and 2.

|                       | Per cent |
|-----------------------|----------|
| Ammonium nitrate..... | 74       |
| Lead nitrate.....     | 5        |
| Urea.....             | 8        |
| Trinitrotoluene.....  | 13       |

The density of the solidified composition was 1.52, and a velocity of 3800 m./sec. was obtained. No segregation of components resulted.

#### Example 4

A 65-35 blend of ammonium nitrate and trinitrotoluene was prepared and the trinitrotoluene content brought to fusion by subjection to a temperature of 85° C. When this blend was poured in order to bring about solidification, separation of the fusible component resulted when no dispersion agent was used. The addition of either a sodium alkyl naphthalene sulfonate or a sodium sulfonate of an N-substituted oleic acid amide gave effective results in preventing separation. It will be realized that the use of the dispersing agent in the foregoing examples prevents the separation of two phases after pouring, and eliminates any necessity of vigorous and continuous stirring.

Our invention has been disclosed at length in the foregoing but it will be apparent that many variations may be adopted in compositions, specific dispersing agents, and in procedures without departing from the scope of the invention. We intend to be limited therefore only by the following patent claims:

We claim:

1. The method of preparing relatively high density explosive compositions, which comprises subjecting an inorganic oxidizing material and a normally solid organic sensitizer therefor to a temperature at which at least a portion of one of said compounds is in molten condition, maintaining in contacting relationship therewith a dispersing agent taken from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids, and subsequently cooling and solidifying the resulting blend.

2. The method of preparing a blend of two normally solid nitrated organic compounds, which comprises subjecting said compounds to a temperature at which at least a portion of one of said compounds is in molten condition, maintaining in contacting relationship therewith a dispersing agent taken from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids, and subsequently cooling and solidifying the resulting blend.

3. The method of claim 2, in which a solid explosive compound is dispersed in molten trinitrotoluene.

4. The method of claim 2, in which pentaerythritol tetranitrate is dispersed in molten trinitrotoluene.

5. The method of preparing a blend of ammonium nitrate and a normally solid organic sensitizer therefor, which comprises subjecting said compounds to a temperature at which at least a portion of one of said compounds is in molten condition, maintaining in contacting relationship therewith a dispersing agent taken from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids, and subsequently cooling and solidifying the resulting blend.

6. The method of blending ammonium nitrate and a normally solid organic sensitizer therefor, which comprises subjecting ammonium nitrate, a fusion point depressant therefor, and said organic sensitizer to a temperature at which the ammonium nitrate becomes molten at least in part, while the organic compound remains in solid form, maintaining in contacting relationship therewith a dispersing agent taken from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids, and subsequently cooling and solidifying the resulting blend.

7. The method of claim 6, in which the solid organic sensitizer is pentaerythritol tetranitrate.

8. The method of blending ammonium nitrate and a normally solid organic sensitizer therefor, which comprises subjecting ammonium nitrate, a fusion point depressant, and said organic sensitizer to a temperature at which both the ammonium nitrate and the sensitizer become molten, at least in part, maintaining in contacting relationship therewith a dispersing agent taken from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids, and subsequently cooling and solidifying the resulting blend.

9. The method of claim 8, in which the solid organic sensitizer is trinitrotoluene.

10. The method of blending ammonium nitrate and a normally solid organic sensitizer therefor having a melting point below 100° C., which comprises subjecting ammonium nitrate and said or-

ganic sensitizer to a temperature at which the sensitizer becomes molten at least in part, while the ammonium nitrate remains unfused, maintaining in contacting relationship therewith a dispersing agent taken from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids, and subsequently cooling and solidifying the resulting blend.

11. The method of blending ammonium nitrate and trinitrotoluene, which comprises maintaining said compounds at a temperature between 80 and 100° C. in the presence of a compound selected from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids, and subsequently cooling and solidifying the resulting blend.

12. A relatively high density explosive charge, which comprises an inorganic oxidizing agent, a normally solid organic sensitizer therefor, and a compound selected from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids.

13. A relatively high density explosive charge, which comprises ammonium nitrate, a normally solid organic sensitizer therefor, and a compound selected from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids.

14. A relatively high density explosive charge, which comprises ammonium nitrate, trinitrotoluene, and a compound selected from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids.

15. The method of preparing relatively high density explosive compositions which comprises subjecting two solid chemical compounds, at least one of which is a nitrated organic compound, to a temperature at which at least a portion of one of said compounds is in molten condition, maintaining in contacting relationship therewith a dispersing agent taken from the group consisting of sulfates of fatty alcohols, organic sulfonates and soaps of fatty acids, and subsequently cooling and solidifying the resulting blend.

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