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A FINE-GRAINED ORGANIC SENSITIZER

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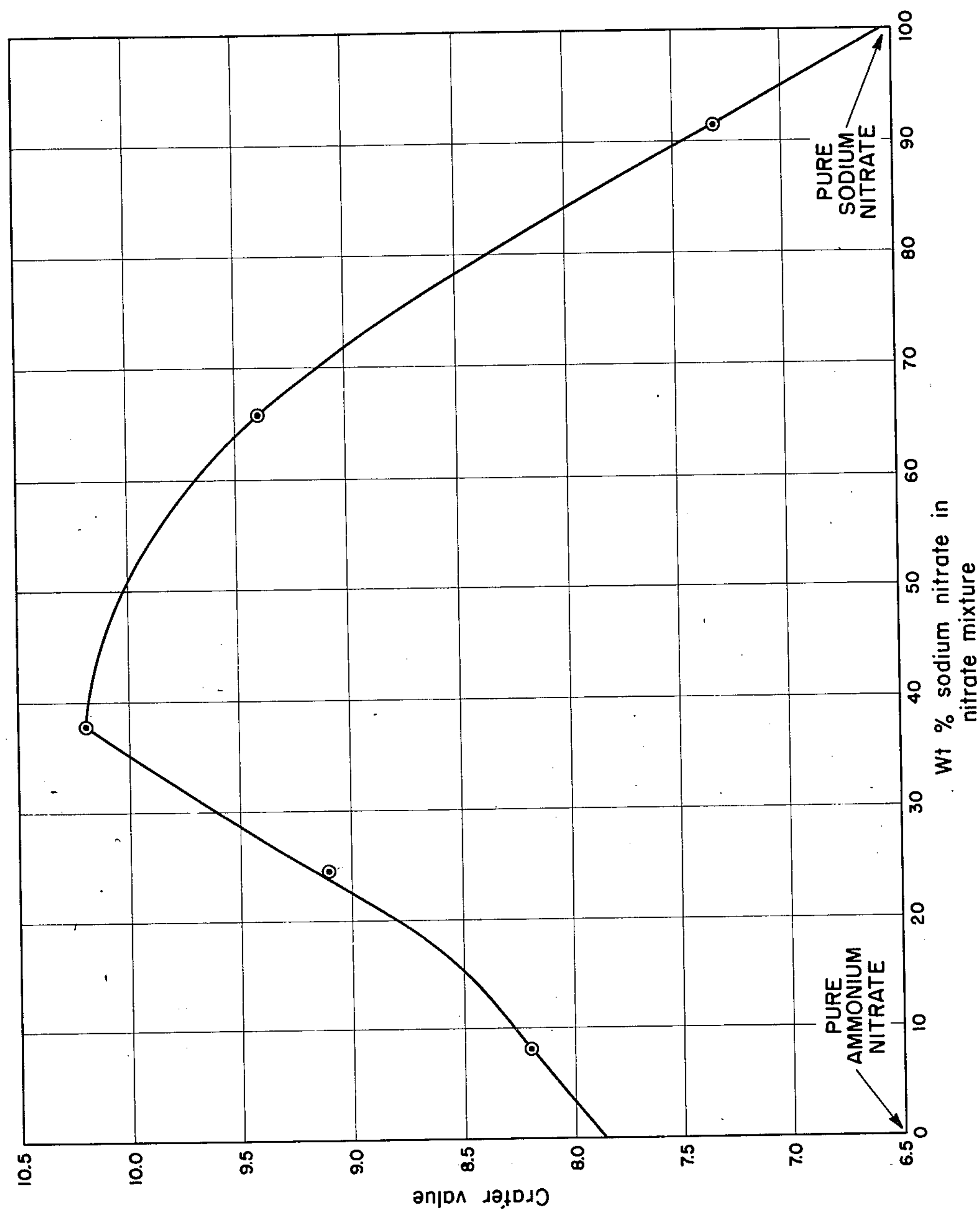

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BLASTING AGENT AND EXPLOSIVE COMPOSITIONS CONTAINING A FINE-GRAINED ORGANIC SENSITIZER

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This application is a continuation-in-part of Serial Number 42,521 filed July 13, 1960, now abandoned.

This invention relates to explosive compositions and to blasting agents comprising the explosive compositions, and to a method of rendering certain explosive compositions more sensitive to detonation.

Aqueous explosive compositions have recently come into wide use in industrial applications. These aqueous explosive compositions or "explosive slurries" as they are frequently called, have greater versatility than dry mixtures because they can be used under conditions where water cannot conveniently be excluded. Such aqueous explosive slurries contain more water than that which is absorbed by the components of the mixture, the water therefore being sufficient to act as a suspending agent for the other components.

The exact amount of water employed, generally in excess of about 10%, will vary with the material present in the mixture, and the consistency desired of the final explosive slurry.

In the commonly known explosive slurries, two major components are present along with the water. One component is an inorganic ammonium oxidizing salt, usually ammonium nitrate, although ammonium chlorate or ammonium perchlorates have also been employed for this purpose.

The other necessary component of the explosive slurries is an explosive sensitizer for the ammonium nitrate. These explosive sensitizers are well known materials and include materials such as trinitrotoluene, a conventional high explosive, and other high explosives containing trinitrotoluene. Representative of such prior art explosive slurries are the explosive slurries described in Patent No. 2,930,685 to Cook and Farnam, patented March 29, 1960.

Water is known to have a desensitizing effect upon both inorganic oxidizing salts such as ammonium nitrate and upon high explosives such as trinitrotoluene. This desensitization manifests itself most severely in aqueous slurries containing fine grained explosive sensitizers, i.e., explosive sensitizers having a particle size finer than that which would be retained on a 30 mesh sieve. In fact, this desensitization tendency manifests itself to such an extent that Cook and Farnam report in their patent as did Cook in his book, The Science of High Explosives, pp. 317-321 (Reinhold, 1958), that slurries containing water, ammonium nitrate and either trinitrotoluene or trinitrotoluene-containing explosives in the fine grained form, either cannot be detonated at all under conventional detonation conditions, or can be detonated only with so much difficulty or with such little explosive power as to render such compositions substantially impractical from a commercial standpoint. This finding is confirmed in a subsequently filed and issued patent by Cook and Collins, No. 3,096,223, indicating that the same desensitizing effect of water applies when the ammonium nitrate is replaced by ammonium chlorate or ammonium perchlorate.

This factor has prevented a more widespread acceptance of explosive slurries of this type since trinitrotoluene and other explosives are conventionally available in the fine grained form, and if a coarser grained material were required, e.g. TNT having a particle size greater than 30 mesh, such as 5 or 10 mesh, such a material would have to be specially prepared at a much greater expense, thereby increasing the cost of the final product.

It has now been found, unexpectedly, that the desensitization effect that water contained in explosive slurries has on fine grained explosive sensitizers can be overcome in the case of ammonium-nitrate based slurries if the slurry contains in addition to the usual three components, i.e. ammonium nitrate, water and explosive sensitizer, one or more other inorganic nitrates such as one or more alkali and/or alkaline earth metal nitrates, as for example, sodium or potassium nitrate. In the case of explosive slurries sensitized with a fine grained explosive sensitizer, the presence of the other nitrates in addition to the ammonium nitrate not only serves to prevent desensitization of the compositions, but actually serves to increase the sensitivity of the composition to a level above the sensitivity of explosive slurries sensitized with coarse grained explosive sensitizers, and even above the sensitivity of explosive compositions containing a coarse grained sensitizer and the mixture of nitrates. Furthermore, this increase in sensitivity of the compositions prepared in accordance with this invention is coupled with an increase in the explosive power of the slurries, and an increase in the rate of detonation as compared with the identical slurries containing coarse grained explosive sensitizers in place of fine grained explosive sensitizers.

The relative proportions of the ammonium nitrate and the other inorganic nitrate or nitrates in the mixture are important to the explosive effect. The ammonium nitrate should be in a proportion within the range from about 5 to about 95%, and the other nitrate or nitrates in a proportion within the range from about 95 to about 5%. For optimum power, the proportions are from 25 to 75% ammonium nitrate and from 75 to 25% of the other nitrate or nitrates. An approximately 50%–50% mixture is in most cases the best. The particular proportions of these oxidizers selected within these ranges will depend upon the sensitivity and explosive effect desired, and these in turn are dependent upon the particular nitrate or nitrates used.

Any inorganic nitrate can be employed as the oxidizer in conjunction with the ammonium nitrate. Nitrates of the alkali and alkaline earth metals, such as sodium nitrate, potassium nitrate, calcium nitrate, magnesium nitrate, strontium nitrate and barium nitrate, are exemplary additional inorganic nitrates.

The inorganic nitrates may be fine, coarse or a blend of fine and coarse materials. Mill and prill inorganic nitrates are quite satisfactory.

The high power of these compositions is shown by the crater values, which give a true picture of the power from the standpoint of the practical application. It has been found that the ballistic pendulum test, normally relied upon to estimate power, is misleading in the case of the sensitized explosive slurries of the invention, and in many cases suggests a low power which is not confirmed by the crater test. Details of the crates test are given below in conjunction with the examples.

The explosive slurries of the invention contain enough water to act as a suspending medium for the solid ingredients. Some explosives and explosive sensitizers are capable of absorbing surprisingly large amounts of water. The water added in the slurries of the invention is always enough more than this amount to suspend the mixture. Usually, 7% water is enough to barely slurry the mixture, but more may be required to make the slurry flowable. The practical upper limit is set by excessive dilution and dissipation of the explosive power, taking into account any loss of water by volatilization and absorption into the ground. In most cases, the preferred range of water content will be from about 10% to 40%, although in some cases as much as 50% can be used.

The explosive sensitizer employed in the slurries of this invention can be any of those chemicals known as explosive sensitizers for ammonium nitrate. It is essential to achieve the benefits of this invention, that the explosive sensitizers employed be of the fine grained type. Fine grained explosive sensitizers have a sufficiently small particle size so as to be able to pass through a standard thirty mesh sieve. As is well known, the larger the mesh number of the sieve, the smaller the particle size of the material passing through. Trinitrotoluene is the most conveniently available explosive sensitizer in the fine grained form, and for that reason is preferred. Other explosive sensitizers, in addition to trinitrotoluene also give good results, including, for example, dinitrotoluene, pentaerylthritol tetranitrate, pentolite (an equal parts by weight mixture of pentaerythritol tetranitrate, and trinitrotoluene), cyclonite (RDX, cyclotrimethylene trinitroamine), composition B (a mixture of up to 60% RDX, up to 40% TNT, and 1 to 4% wax) cyclotol (composition B without the wax, and tetryl.

The relative proportions of mixed nitrates and sensitizer will depend upon the sensitivity and explosive effect desired, and again, these in turn are dependent upon the particular nitrates and sensitizer. The proportions are not critical in any way. For optimum effect, the mixed nitrates are used in an amount within the range from about 50 to about 75%, and the sensitizer in an amount within the range from about 15 to about 25%. The preferred ratios of nitrates:sensitizer are from 5:1 to 2:1. From about 35 to about 75% mixed nitrates and from about 10 to about 30% sensitizer give quite satisfactory results in the slurried explosive mixtures of the invention. About 80% mixed nitrates and 20% sensitizer give the best results. When the amount of sensitizer is in the lower part of the range, a larger booster is needed, so that a slurry in a 2½ to 3 inches hole containing only 10% nitrostarch requires a 60 g. pentolite booster. At amounts beyond 20%, the sensitizing effect falls off, and is no longer proportional to the amount of sensitizer added. Thus, a slurry containing 30% nitrostarch requires a 2 g. pentolite booster, whereas one containing 20% nitrostarch requires a 3 g. pentolite booster. Thus, amounts beyond 20% may not be economically advantageous.

In addition to these materials, which are the essential ingredients, the explosive slurries may include one or more fuels. Illustrative are particulate metals, for example, aluminum powder, flake aluminum, and ferrosilicon. A metal fuel when present will usually comprise about 10 to about 25% of the mixture. Also useful are carbonaceous materials such as powdered coal, petroleum oil, such as paraffin oil, coal dust, charcoal, bagasse, dextrin, starch, wood meal, flour, bran and pecan meal or similar nut shell meals. The carbonaceous fuel when present will usually comprise from 5 to about 10% of the mixture. Mixtures of such metal and carbonaceous fuels can also be used, in amounts from about 5 to about 25%.

An antacid, such as zinc oxide, may be added if desired.

The consistency of the composition for any given amount of water can be increased to meet any need by incorporating a thickening or gelatinizing agent. In this way, it is possible to prepare a thick slurry containing a large proportion of water for use in bulk in dry bore holes. The thickening agent is water-soluble or water-dispersible, and inert to the other ingredients present. These are well known materials, and any of these known to the art can be used, such as carboxymethyl cellulose, methyl cellulose, guar gum, psyllium seed mucilage, and pregelatinized starches such as Hydroseal 3B. The amount of thickening agent will depend on the consistency desired, and if employed, will be within the range from 0.5 up to about 5%.

The explosive mixture is readily prepared by simple mixing of the ingredients. The solid materials, including the inorganic nitrate mixture, sensitizer and fuel, and antacid, if any, would usually be mixed first to form a homogeneous blend, and then sufficient water and thickener or gelatinizing agent, if required, would be added to bring the mixture to the desired consistency, which can range from a thick, barely pourable mixture to a quick flowing liquid.

The explosive slurry will ordinarily be fired with the aid of a booster charge, and combinations of the explosive slurry and a booster in the same container or separately packaged as a composite in one container can be prepared and marketed as a combined blasting agent. Any conventional booster charge available in the art can be employed, of which pentaerythritol tetranitrate and pentolite are exemplary. Blasting caps can be used as the booster when the slurry is sufficiently sensitive.

The following examples in the opinion of the inventor represent the best embodiments of his invention.

The power of the explosive slurries of the examples was determined by a cratering test which was carried out as follows. The slurry was loaded into a polyethylene-lined cartridge 4½ inches in diameter and 15 inches long. This cartridge was placed upright in a hole in the ground 30 inches deep, and was tamped firmly in place with loose dirt until the level of tamping reached that of the surrounding ground. A 1 pound cast pentolite (mixture of equal parts pentaerythritol tetranitrate and trinitrotoluene) booster at the top of the cartridge was used for initiation. The volume of earth moved in cubic feet is then determined, with a correction made for the booster, and the number of cubic feet of earth moved per pound of explosive is taken as the crater value. This value shows the power of the explosive slurry from the standpoint of practical application.

In addition to crater value, the standard tests for determining ballistic pendulum value, sensitivity in a 2 inch pipe, and rate of detonation in a 2 inch pipe, were also employed. In the sensitivity tests, when the scope of the standard caps had been passed there were used progressively, as more powerful initiators, 3 g. PETN [1] booster, and then 5, 10, 15, 20, 25, 30, 40, 50, 60, 75, 100, 125, 150, 200 and 250 g., and then ½ pound, 1 pound, and 2 pound, cast pentolite boosters.

EXAMPLE 1

A slurry was prepared using a mixture of mill ammonium nitrate and mill sodium nitrate, and fine grained trinitrotoluene having the following screen analysis:

Mesh size [2]	Percent by weight
−30 +40 mesh	0.25
−40 +50	26.25
−50 +70	59.00
−70 +100	12.25
−100 +120	2.00
−120 +200	0.25
−200 +230	Trace
−230	Trace
	100.00

[1] Pentaerythritol tetranitrate.
[2] U.S. Standard screens.

The three solid materials were mixed thoroughly. There was then added zinc oxide, bagasse, cornstarch and Hydroseal 3B, and then the water was added. The proportions of the final explosive slurry were as follows:

	Parts by weight
Fine TNT	20.0
Mill ammonium nitrate	56.5
Mill sodium nitrate	5.0
Zinc oxide	0.3
Bagasse	1.0
Cornstarch	3.2
Hydroseal 3B	2.0
Water	16.0
	104.0

The comparative tests gave the following results on this slurry:

Density	1.36.
Ballistic pendulum value	10.45.
Sensitivity in 1¼ inch pipe	10 g. pentolite.
Rate of detonation in 3 inch pipe at the density noted above in m./sec.	5203 (3 inch).
Crater value (cubic feet of earth per pound)	8.2.

When the procedure of this example was duplicated using coarse grained 14 mesh TNT in place of the fine TNT employed in this example, the following results were obtained:

Density	1.410.
Ballistic pendulum value	9.5.
Sensitivity in 2 inch pipe	1 lb. pentolite booster.
Crater value (cubic feet of earth per pound)	7.2.
Rate of detonation in 3 inch pipe at the density noted above in m./sec.	4644.

This confirms that compositions containing fine grained trinitrotoluene and a mixture of nitrates are both more sensitive and more powerful than compositions containing coarse grained TNT and the same mixture of nitrates.

EXAMPLE 2

A slurry was prepared of the same type as that of Example 1, employing different proportions of the nitrates, and having the following composition:

	Parts by weight
Fine TNT	20.0
Mill ammonium nitrate	47.2
Mill sodium nitrate	15.0
Zinc oxide	0.3
Bagasse	1.0
Cornstarch	2.5
Hydroseal 3B	2.0
Water	16.0
	104.0

The comparative tests gave the following results on this slurry:

Density	1.445.
Ballistic pendulum value	9.6.
Sensitivity in 1¼ inch pipe	10 g. pentolite.
Rate in pipe at the density noted in m./sec.	4753 (2 inch).
Crater value (cubic feet of earth per pound)	9.1

EXAMPLE 3

A slurry was prepared of the same type as that of

Example 2, employing different proportions of the nitrates, and having the following composition:

	Parts by weight
Fine TNT	20.0
Mill ammonium nitrate	39.5
Mill sodium nitrate	24.2
Zinc oxide	0.3
Bagasse	1.0
Hydroseal 3B	3.0
Water	16.0
	104.0

The comparative tests gave the following results on this slurry:

Density	1.47.
Ballistic pendulum value	9.5
Sensitivity in 1¼ inch pipe	3 g. PETN.
Rate in 2 inch pipe at the density noted above in m./sec.	4663.
Crater value (cubic feet of earth per pound)	10.2.

A slurry having an identical composition except containing coarse (14 mesh) TNT in place of fine TNT yielded the following results, again confirming the superiority in sensitivity and power of the material containing fine grained TNT and a mixture of nitrates:

Density	1.50.
Ballistic pendulum value	9.4.
Sensitivity in 1¼ inch pipe	20 g. pentolite.
Rate in 2 inch pipe at the density noted above in m./sec.	4380.
Crater value (cubic feet of earth per pound)	10.4.

EXAMPLE 4

A slurry was prepared of the same type as that of Example 1, employing different proportions of the nitrates, and having the following composition:

	Parts by weight
Fine TNT	20.0
Mill ammonium nitrate	20.7
Mill sodium nitrate	40.0
Zinc oxide	0.3
Bagasse	1.0
Hydroseal 3B	3.0
Oil No. 5	1.0
Sea coal	1.0
Water	18.0
	105.0

The comparative tests gave the following results on this slurry:

Density	1.48.
Ballistic pendulum value	8.1.
Sensitivity in 1¼ inch pipe	30 g. pentolite.
Rate in pipe at the density noted above in m./sec.	4604 (3 inch).
Crater value (cubic feet of earth per pound)	9.4.

EXAMPLE 5

A slurry was prepared of the same type as that of Example 1, employing different proportions of the nitrates, and having the following composition:

	Parts by weight
Fine TNT	20.0
Mill ammonium nitrate	5.2
Mill sodium nitrate	55.0
Zinc oxide	0.3
Bagasse	1.0
Hydroseal 3B	3.0
Oil No. 5	2.0
Sea coal	1.5
Water	19.0
	107.0

The comparative tests gave the following results on this slurry:

Density	1.48.
Ballistic pendulum value	6.6.
Sensitivity in 1¼ inch pipe	Failed with 150 g. pentolite.
Rate in pipe at the density noted above in m./sec.	4413 (3 inch).
Crater value (cubic feet of earth per pound)	7.3.

A comparison of Examples 1 to 5 shows that at amounts of ammonium nitrate and sodium nitrate within the preferred proportions of from 25 to 75% of each, the crater values are at an optimum. The ballistic pendulum values, on the other hand, fall steadily as the amount of ammonium nitrate is decreased and the amount of sodium nitrate increased, showing the misleading character of this test as applied to explosive slurries. A comparison of these examples shows that the maximum crater value is obtained at approximately a 50%–50% mixture of sodium and ammonium nitrates.

EXAMPLE 6

A slurry was prepared by the same method of Example 1, based upon a mixture of mill ammonium nitrate and mill sodium nitrate with 50 mesh pentaerythritol tetranitrate as the sensitizer, and having the following composition:

	Parts by weight
Pentaerythritol tetranitrate	20.0
Mill ammonium nitrate	56.5
Mill sodium nitrate	5.0
Zinc oxide	0.3
Bagasse	1.0
Cornstarch	3.2
Hydroseal 3B	2.0
Water	16.0
	104.0

The comparative tests gave the following results on this slurry:

Density	1.44.
Ballistic pendulum value	10.1.
Sensitivity in 1¼ inch pipe	3 g. PETN.

EXAMPLE 7

A slurry was prepared by the same method as in Example 1, based upon pentaerythritol tetranitrate as the sensitizer and a different proportion of ammonium and sodium nitrates. The slurry had the following composition:

	Parts by weight
Pentaerythritol tetranitrate	20.0
Mill ammonium nitrate	36.7
Mill sodium nitrate	23.0
Zinc oxide	0.3
Bagasse	1.0
Hydroseal 3B	3.0
Oil No. 5	1.0
Sea coal	3.0
Water	19.0
	107.0

The comparative tests gave the following results on this slurry:

Density	1.47.
Ballistic pendulum value	9.4.
Sensitivity in 1¼ inch pipe	2 g. PETN.

EXAMPLE 8

A slurry was prepared by the same method as in Example 1, based upon 40 mesh cyclonite as the sensitizer, and having the following composition:

	Parts by weight
Cyclonite	20.0
Mill ammonium nitrate	56.5
Mill sodium nitrate	5.0
Zinc oxide	0.3
Bagasse	1.0
Cornstarch	3.2
Hydroseal 3B	2.0
Water	16.0
	104.0

The comparative tests gave the following results on this slurry:

Density	1.435.
Ballistic pendulum value	9.9.
Sensitivity in 1¼ inch pipe	5 g. Pentolite.

EXAMPLE 9

A slurry was prepared by the same method as in Example 1, based upon cyclonite (30 mesh), and different proportions of ammonium and sodium nitrates. The slurry had the following composition:

	Parts by weight
Cyclonite	20.0
Mill ammonium nitrate	37.7
Mill sodium nitrate	23.0
Zinc oxide	0.3
Bagasse	1.0
Hydroseal 3B	3.0
Oil No. 5	1.0
Sea coal	2.0
Water	17.0
	105.0

The comparative tests gave the following results on this slurry:

Density	1.47.
Ballistic pendulum value	9.3.
Sensitivity in 1¼ inch pipe	3 g. PETN.

EXAMPLE 10

A slurry was prepared as in Example 1, and similar in formulation to Example 3, but based upon a mixture of mill ammonium nitrate and anhydrous strontium nitrate. This slurry had the following composition:

	Parts by weight
Fine TNT	20.0
Mill ammonium nitrate	39.5
Anhydrous strontium nitrate	24.2
Zinc oxide	0.3
Bagasse	1.0
Hydroseal 3B	3.0
Water	16.0
	104.0

The comparative tests gaves the following results on this slurry:

Density	1.67.
Ballistic pendulum value	9.5.
Sensitivity in 1¼ inch pipe	3 g. PETN.
Rate in pipe at the density noted above in m./sec.	4663 (2 inch).
Crater Value (cubic feet of earth per pound)	10.2.

EXAMPLE 11

A slurry was prepared as in Example 1 and similar in formulation to Example 3, but based upon a mixture of mill ammonium nitrate and anhydrous barium nitrate. This slurry had the following composition:

	Parts by weight
Fine TNT	20.0
Mill ammonium nitrate	39.5
Anhydrous barium nitrate	24.2
Zinc oxide	0.3
Bagasse	1.0
Hydroseal 3B	3.0
Water	16.0
	104.0

The comparative tests gave the following results on this slurry:

Density	1.76.
Ballistic pendulum value	9.5.
Sensitivity in 1¼ inch pipe	3 g. PETN.
Rate in pipe at the density noted above in m./sec.	4663 (2 inch).
Crater Value (cubic feet of earth per pound)	10.2.

EXAMPLE 12

The enhanced effect obtainable by the combination of ammonium nitrate and another inorganic nitrate is shown in this example, in which a series of formulations were prepared, each containing varying amounts of ammonium nitrate and sodium nitrate, together with fine grained trinitrotoluene. The compositions and crater values obtained are tabulated below in Table I.

Table I

	Parts by Weight				
	A	B	C	D	E
Fine TNT	20.0	20.0	20.0	20.0	20.0
Mill ammonium nitrate	56.5	47.2	39.5	20.7	5.2
Mill sodium nitrate	5.0	15.0	24.2	40.0	55.0
Zinc oxide	0.3	0.3	0.3	0.3	0.3
Bagasse	1.0	1.0	1.0	1.0	1.0
Cornstarch	3.2	2.5	-------	-------	-------
Oil No. 5	-------	-------	-------	1.0	2.0
Hydroseal 3B	2.0	2.0	3.0	3.0	3.0
Sea coal	-------	-------	-------	1.0	1.5
Water	16.0	16.0	16.0	18.0	19.0
Total	104.0	104.0	104.0	105.0	107.0
Wt. percent sodium nitrate in nitrate mixture	8.1	24.4	38.0	65.9	91.4
Wt. percent ammonium nitrate in nitrate mixture	91.9	75.6	62.0	34.1	8.6
Crater value	8.2	9.1	10.2	9.4	7.3

The crater values obtained are plotted in FIGURE 1 as a function of weight percent sodium nitrate in the nitrate mixture. From this figure it is easily apparent that the two nitrates act in a synergistic fashion to yield unpredictable results in the presence of a fine grained TNT sensitizer. Thus, the power, as evidenced by the crater values, of the slurries based upon the two nitrates is greater than the power manifested by a slurry based on one or other of the nitrates alone. This enhanced effect is obtained with relatively small quantities of one or the other of the nitrates, i.e. as low as 5% by weight of one or the other, but is particularly manifest in the range of 25 to 75% by weight of one nitrate, and correspondingly 25 to 75% by weight of the other nitrate.

All proportions in the specification and claims are by weight of the entire explosive slurry.

I claim:

1. An aqueous explosive slurry consisting essentially of from about 35% to about 75% by weight of a mixture of inorganic nitrates, the mixture of inorganic nitrates containing from about 5 to about 95% by weight of ammonium nitrate, and from about 95% to about 5% of other inorganic nitrate, and from about 10% to about 30% by weight of a fine grained explosive sensitizer selected from the group consisting of dinitrotoluene, trinitrotoluene, pentaerythritol tetranitrate, pentolite, cyclonite, composition B, cyclotol and tetryl, and having a sufficiently small particle size to pass through a standard 30 mesh sieve, and sufficient water, within the range of from about 7% to about 50% by weight of the composition, to form a slurry.

2. An aqueous explosive slurry in accordance with claim 1 wherein the explosive sensitizer in trinitrotoluene.

3. An aqeuous explosive slurry consisting essentially of from about 35% to about 75% by weight of a mixture of inorganic nitrates, the mixture of inorganic nitrates containing from about 25% to about 75% by weight of ammonium nitrate, and from about 75% to about 25% of other inorganic nitrate, from about 10% to about 30% by weight of a fine grained explosive sensitizer selected from the group consisting of dinitrotoluene, trinitrotoluene, pentaerythritol tetranitrate, pentolite, cyclonite, composition B, cyclotol and tetryl, and having a sufficiently small particle size to pass through a standard 30 mesh sieve, and sufficient water, within the range of from about 7% to about 50% by weight of the composition, to form a slurry.

4. An aqueous explosive slurry in accordance with claim 3 wherein the explosive sensitizer is trinitrotoluene.

5. An aqueous explosive slurry in accordance with claim 3 wherein the inorganic nitrate oxidizer mixture is a mixture of from 25% to 75% by weight of ammonium nitrate and from 25% to 75% of inorganic nitrate selected from the group consisting of alkali and alkaline earth metal nitrates.

6. An aqeuous explosive slurry in accordance with claim 3 wherein the other inorganic nitrate is sodium nitrate.

7. An aqueous explosive slurry is accordance with claim 3 including from about 5% to about 25% of a carbonaceous fuel.

8. An aqueous explosive slurry in accordance with claim 3 including from about 5% to about 25% of a particulate metal.

9. An aqueous explosive slurry in accordance with claim 8 wherein the particulate metal is particulate aluminum.

10. An aqueous explosive slurry in accordance with claim 3 also including an amount up to 5% by weight of a thickening agent to appreciably increase the viscosity of the slurry.

11. A blasting agent comprising an aqueous explosive slurry in accordance with claim 1 in combination with a booster charge.

12. A blasting agent in accordance with claim 11 in which the booster is pentaerythritol tetranitrate.

13. A blasting agent in accordance with claim 11 in which the booster is pentolite.

14. An aqueous explosive slurry consisting essentially of from about 50% to about 75% of an inorganic nitrate oxidizer mixture, the inorganic nitrate oxidizer mixture containing from about 25% to about 75% by weight of ammonium nitrate, and from about 75% to about 25% of other inorganic nitrate, from about 15% to about 25% of a fine grained explosive sensitizer selected from the group consisting of dinitrotoluene, trinitrotoluene, pentaerythritol tetranitrate, pentolite, cyclonite, composition B, cyclotol

and tetryl, and having a sufficiently small particle size to pass through a standard 30 mesh sieve, from about 5% to about 25% by weight of a fuel selected from the group consisting of carbonaceous fuels and particulate metals and sufficient water, within the range from about 7% to about 50% by weight of the composition, to form a slurry.

15. An aqueous explosive slurry in accordance with claim **14** in which the fuel is a carbonaceous material.

16. An aqueous explosive slurry in accordance with claim **14** in which the fuel is particulate aluminum.

17. An aqueous explosive slurry in accordance with claim **14** wherein the explosive sensitizer in trinitrotoluene.

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CARL D. QUARFORTH, *Primary Examiner.*