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EXPLOSIVE COMPOSITION

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This invention relates to a new type of detonating explosive and improved method of preparing the same comprising water soluble nitrates and a non-explosive, combustible, oily material.

An object of the present invention is the production of a water soluble nitrate type explosive having sufficient sensitivity for use as a commercial explosive without the requirement that it be primed with a cartridge of dynamite or the like.

Another object of the invention is the production of such an explosive by the admixture of materials which are in themselves substantially incapable of detonation.

Other objects of the invention will hereinafter more fully appear.

It is known in the explosive art that for explosives to be effective in their use they must possess sufficient sensitivity for satisfactory propagation. Explosive compositions containing a high percentage of ammonium nitrate have been heretofore disclosed, which are not cap sensitive and, for this reason, cannot be used in blasting operations as explosives without an auxiliary priming charge. For example, one proposal utilizes a cap sensitive central core in compressed cylinders of an explosive, wherein the large mass of the charge was insensitive and required the continuous cap sensitive core throughout the cylindrical charge for a satisfactory detonation and propagation of the explosion. Another proposed explosive requires a powerful booster charge for the purpose of propagating the explosion throughout the insensitive material. There have also been proposed explosive compositions of colloidal starch and soluble nitrates which are more sensitive than simple mechanical mixtures of the ingredients, but which require a primer or initial detonating charge or a secondary sensitizing component in order that they may be detonated with assurance.

It is well known in the explosive art that a simple mixture of grained ammonium nitrate and a non-explosive oily substance or a coating of a non-explosive oily substance applied as a coating to the grains of ammonium nitrate has too low a degree of sensitivity to be of practical value as an explosive, especially in small sized cartridges. Now I have found that mixtures of ammonium nitrate and non-explosive oily substances, when mixed and heated, in the presence of water to form a plastic mass which is converted into strings or vermicelli, and then dried or partially dried to a hard state, followed by fragmentation so as to pass a 14 mesh or finer Tyler standard screen, completely detonated (when substantially dry) in a 1¼" x 8" paper cartridge by the initiation of a #8 commercial blasting cap. Although the addition of oxygen consuming ingredients, such as fine carbonaceous materials, to my ultimate mixtures of ammonium

nitrate and oily substances has the effect of reducing the sensitivity, I have found that by incorporating such oxygen consuming ingredients with the ammonium nitrate and non-explosive oily substance during the mixing and heating, explosives may be produced which will completely detonate in a 1¼" x 8" paper cartridge when initiated by a No. 8 commercial blasting cap. The incorporation of these oxygen consuming ingredients is advantageous in that it permits the full development of the disruptive force of the explosive. While the theory of the results which I have obtained in sensitizing mixtures of ammonium nitrate with oily substances and non-explosive components cannot be precisely defined, and I do not want to be bound by any concepts, there are certain outstanding characteristics of the finished product which indicate that the crystals of the ammonium nitrate exist in a minute state of subdivision. The minute crystals in intimate contact with thin films of oil, or fat, are furnished with sufficient oxidizable material in microscopical, or even molecular dimensions, to offer an ideal combination for very rapid decomposition of the constituents when subjected to flame and shock, such as would result from a blasting cap. Grained compositions, by means of agitation and drying, cause comparatively large crystals to be formed without exposed angular surfaces and are coated with an excessive amount of the oily substances which reduces the sensitivity of the particles to detonation. Fragmentation of the hard dried compositions exposes the minute crystals and allows the maximum contact to the propagating wave and flame by outcropping crystals at the surface of the fracture. Moreover, the dried fractured granules present surfaces from the interior which are highly irregular due to the fact that the granules being case hardened before much of the moisture has been removed only permit shrinkage to take place in the interior of the hardened granule shell by the formation of voids which were occupied by the concentrated solutions of the soluble salts. As a result of the more porous structure of the interior of the granule than the surface, the faces of the fractured particles offer more minute projections and undulations, which are sensitive to detonation. This is particularly true when other combustible materials such as starch, cereal flours or gelatine are used. The increased sensitivity and explosive force of the explosive by the use of fuels result from their oxidation by the available oxygen in the soluble nitrates.

The oily material employed in the explosive composition of the present invention may be a fatty oil such as cottonseed oil, sperm oil, castor oil, soya bean oil, linseed oil, coconut oil and the like, or a fatty oil acid, such as lauric, myristic, palmitic, stearic, or oleic, fatty oil acid derivatives such as aluminum stearate, oleate, etc., or

a petroleum oil residue which is non-volatile at ordinary temperatures, such as paraffin or petrolatum. Other non-explosive combustible oily materials will occur to those skilled in the art. Where fatty oil acids are employed, they may be in the form of pure fatty oil acids, obtained by the hydrolysis of naturally occurring vegetable and animal fats and oils. Non-limiting examples of these latter mixtures are coconut oil fatty acid, which generally contains 40-45% lauric acid, as well as lesser amounts of myristic, caproic, caprillic, capric, palmitic, oleic and stearic; and palm oil, which usually contains from 20-50% free fatty acid, about 98% of which is palmitic. Of the fatty oil acids suitable for use, I have found oleic to be highly preferable, and petrolatum of the petroleum residues.

For the carbonaceous ingredients of the main fuel, I prefer a material which has the ability to swell and readily absorb water such as corn starch, tapioca flour, corn flour, gum arabic, glue or gelatin, and materials rich in mannan such as vegetable ivory nut meal, carob beans, coffee berries, and date seeds. I have found that substances such as corn meal, starch and glue, which contain small amounts of ether soluble oils or fats are efficacious in promoting sensitivity.

In addition to the main sensitized ingredient, or ammonium nitrate, I may prefer to add other oxidants consisting of soluble nitrates such as sodium nitrate and potassium nitrate, which will allow the strength of the explosive to vary over a wider range, and meet specific requirements in regard to density, velocity, and fume conditions.

In the preparation of the explosive compositions of the present invention, the water soluble nitrate, and the non-explosive, combustible, oily material (together with additional carbonaceous material as a main fuel where it is desired to provide oxygen balance) are mixed with water, and heated to a temperature in the neighborhood of 120° to 180° F. I have found that the degree of temperature of mixing is not of great importance in securing desirable characteristics of the finished product, but for ease in manufacture by securing an easily workable plastic mass, the temperature may be varied according to the composition. In general I prefer a temperature of from 120° to 140° F. although the invention is not to be considered limited in this respect as explosive compositions, having desirable sensitivities, may be obtained when mixing temperatures as high as 180° F. are used.

During this heating and mixing, the composition becomes a soft, cohesive, plastic mass. Preferably this plastic mass is shredded by slicing with knives, or by extruding it through orifices, so as to provide (shredded) particles or vermicelli-like material having a relatively large surface area for subsequent conditioning. The particles or vermicelli are partially dried to a hard state, and thereafter ground or grained to the desired size, followed by complete drying. The invention is not to be considered as limited to this particular manner of graining and conditioning the material, however, as other methods will readily occur to those skilled in the art. Thus, for example, the plastic shredded mass may be dried and ground to the desired particle size or it may be dried and crushed between rolls to the desired particle size.

The proportion of water employed should be from 5 to 15% of the weight of the other materials employed in the mixture. Maximum sensitivity is obtained when the water employed is in the neighborhood of 11% of the weight of the

other ingredients. The water equivalent may be added in the form of a solution of nitrate of ammonia which serves equally as well as water alone.

The proportion of carbonaceous combustible material such as starch, cereal flour, tapioca flour, and vegetable ivory meal, may vary from 5 to 25% depending on the final oxygen balance of the composite explosive mixture as used in the field.

The non-explosive, combustible, oily material is the sensitizing agent in the explosive composition, and should be present in small amounts within definite limits if optimum sensitivity is to be obtained. Thus, where a petroleum oil residue such as petrolatum or a fatty oil acid is employed in the composition as the sensitizing agent, it should be present in an amount not greater than 3.0% by weight on a dry basis, as it has been found that greater proportions result in an insensitive product. Combinations of 1.0% paraffin and 0.5% oleic acid or 1.0% oleic acid and 0.3% paraffin are excellent sensitizers.

In the preparation of the composition, the water soluble nitrate may be in any of the usual forms commonly employed in the explosive industry, or in the form of a water solution of the nitrate. The term coating as hereinafter used will refer to a mixture of 75% paraffin and 25% petrolatum, which is applied to grained ammonium nitrate for the purpose of preventing moisture absorption in transportation and storage. If desired the ammonium nitrate may be pre-coated with at least part of the oily sensitizer employed. Although water soluble inorganic nitrates other than ammonium nitrate, as for example, nitrate of soda, may be employed along with ammonium nitrate, it has been found that the sensitivity of the explosive composition tends to decrease as the proportion of such other water soluble nitrates is increased. I have found that in order to obtain the desired sensitivity in these explosive compositions, their water soluble nitrate content should consist of at least 60% ammonium nitrate.

Where the composition is deficient in oxidizable matter and there is a substantial excess of oxygen present in the composition, I may add to the dried finely pulverized oil sensitized mixture, fairly coarse vegetable ivory meal, wood pulp, peanut and apricot shell meal, mannite and the like or accelerators in finely divided form such as aluminum, magnesium or ferro silicon, and on the other hand if there is a deficiency of oxygen bearing material in the pulverized oil sensitized mixture, ammonium nitrate, sodium nitrate, potassium nitrate, or similar oxidants, may be added or a combination of both combustibles and oxidants. The addition of such materials permits the proper adjustment to be made for the oxygen balance so that ultimate mixture will exert its full disruptive force in the bore hole. By a variation in the quantity of the various materials as well as their degree of fineness it is possible to vary the strength, density, and velocity of the explosive.

In the following non-limiting examples of explosive compositions of the present invention, and of method of preparing the same, the parts referred to are parts by weight. Where measured in inches, the sensitivities were determined by the space of an air gap measured in inches between two cut ends of an 1¼" x 8" cartridge lying on the ground and joined together by 2½ wraps of 60 lb. shell paper and the detonating wave initiated

by a #6 blasting cap in one of the halves caused complete detonation of the two half cartridges.

Example 1

Ingredient	Gross weight	Dry weight	Dry weight
	Parts	Parts	Percent
Ammonium nitrate (0.3% coating).....	7,000	7,000	98.94
Water.....	400		
Petrolatum.....	75	75	1.06

The ammonium nitrate and water are thoroughly mixed, and then the petrolatum added, and the mixture thoroughly incorporated in a steam jacketed dough mixer, and heated to 150° F. The amount of water present will be approximately 5.35% of the total mixture. The soft semi-plastic mass is forced through a square mesh screen, having .096 in. openings, and .047 in. wire. The grains or vermicelli so produced are partially dried by means of an air blast having a temperature from 80° to 100° F., so that the moisture content is reduced to a point where the grains or vermicelli will not coalesce when submitted to complete drying. The material is further treated at a temperature of 100° to 140° F. for nearly complete removal of the moisture. The dried mass is fragmented by means of a mill, or crushing rolls so as to pass a standard 40-mesh screen.

The fragmented material when packed in 1¼" x 8" paraffin sprayed paper shells gives an average cartridge count of 169 cartridges per 50 lbs., and has a sensitivity of ½".

Example 2

A composition similar to that in Example 1, with the exception that oleic acid is substituted for petrolatum in the same proportion. After preparing the composition in a similar manner, the finished product has equal sensitivity.

Example 3

Ingredients	Gross weight	Dry weight	Dry parts
	Parts	Parts	Percent
Nitrate of ammonia (0.3% coating).....	7,969	7,969	
Ammonium nitrate solution.....	1,983	1,236	
Total nitrate of ammonia and coating.....		9,205	92.05
Water.....	550		
Corn starch.....	785	700	7.00
Oleic acid.....	95	95	0.95

The amount of water present is approximately 12% of the total weight of the mixture. The ammonium nitrate and starch are intimately mixed and warmed in a jacketed dough mixer, and the liquids then introduced. By means of heat from the heating jacket, the temperature of the mass during the mixing is gradually raised to 130° F. At this stage the mixture becomes a soft, cohesive, plastic mass, which is forced through a square mesh screen having .084 in. openings, and wire of .041 in. diameter. The grains or vermicelli so produced are then partially dried by means of an air blast having a temperature from 80° to 115° F., so that moisture content is reduced to about 1.6%. The hard, almost vitreous, grains are then fractured and broken by rubbing them over, and through, a wire screen having openings of .039 in., and a wire diameter of .032 in.. A final drying is carried out at a temperature of 130° F. to 0.44% moisture. The finished product when packed in 1¼" x 8" paraffin sprayed paper shells gives an

average cartridge count of about 166 cartridges per 50#, and has a sensitivity of 1"

Example 4

Ingredient	Gross weight	Dry weight	Dry weight
	Parts	Parts	Percent
Grained nitrate of ammonia (0.3% coating).....	7,600	7,600	
Ammonium nitrate solution.....	1,800	1,100	
Total nitrate of ammonia and coating.....		8,700	87.00
Taploca flour.....	740	660	6.60
Fine nitrate of soda.....	540	540	5.40
Fine ammonium chloride.....	50	50	0.50
Oleic acid.....	50	50	0.50

The dry ingredients of the above composition are thoroughly mixed in the dough mixer as in Example 3 and brought up to a temperature of 180° F. The plastic mass is converted into vermicelli and air treated as in Example 3, and dried at 128° F. The dried material is fragmented in a mill so as to pass a Tyler standard 14 mesh screen. The product packed in 1¼" x 8" paper shells sprayed with paraffin, yields 148 cartridges per 50 lbs., and consistently detonates in the open with a #6 blasting cap.

Example 5

Ingredient	Gross weight	Dry weight	Dry weight
	Parts	Parts	Percent
Grained ammonium nitrate (0.3% coating).....	1,480	1,480	
Ammonium nitrate solution.....	550	359	
Total ammonium nitrate and coating.....		1,839	91.85
Taploca flour.....	165	143	7.15
Palm grease.....	20	20	1.00

The ammonium nitrate and tapioca flour are mixed in a jacketed mixer and the solution and palm grease added, and the mixture heated with mixing to 130° F. The plastic mass is converted into vermicelli and air treated as in Example 3. The grains or vermicelli are dried at 135° F., and passed through crushing rolls so as to pass a Tyler standard 20-mesh screen. The explosive composition so produced when packed in 1¼" x 8" paraffin sprayed paper shells gave 169 cartridges per 50 lbs. and had a sensitivity of ½".

Example 6

Ingredient	Gross weight	Dry weight	Dry weight
	Parts	Parts	Percent
Grained ammonium nitrate (0.3% coating).....	7,980	7,980	
Ammonium nitrate solution.....	1,840	1,233	
Total ammonium nitrate and coating.....		9,213	92.22
Taploca flour.....	785	687	6.88
Sperm oil.....	90	90	0.90
Water.....	100		

The grained ammonium nitrate and flour are mixed in a jacketed mixer and the oil and liquids added, followed by heating and mixing to 170° F. The plastic mass so produced is passed through a square mesh screen having .084 in. openings, and .041 in. diameter wire. This product is partially dried and then grained through a square mesh screen, having .039 in. openings, and .032 in. diameter wire. The grains are finally dried at a temperature of 166° F. When packed in 1¼" x 8" paraffin coated shells the stick count was about 177 per 50 lbs. and these cartridges detonated in the open with a #8 blasting cap.

Example 7

An explosive composition prepared as in Example 6, but having raw linseed oil substituted for the sperm oil. This explosive composition will also consistently detonate in the open with a #8 blasting cap; when packed 170 1/4" x 8" cartridges per 50 lbs.

Example 8

Ingredient	Gross weight	Dry weight	Dry weight
	Parts	Parts	Percent
Grained ammonium nitrate (0.3% coating)	6,000	6,000	
Ammonium nitrate solution	1,430	913	
Total nitrate of ammonia		6,913	91.69
Water	250		
Tapioca flour	590	510	6.78
Aluminum stearate	100	100	1.33

The dry ingredients are thoroughly mixed in a jacketed mixer, and the liquids added, heat is applied and mixing continued, until the temperature of the mixture is 130° F. The plastic mass is extruded into grains of vermicelli, and dried at a temperature ranging from 100° to 140° F. The dried material after being crushed, so as to pass a Tyler standard 40-mesh screen and packed in 1/4" x 8" paraffin coated paper shells, had a sensitivity of 1", when packed to a density of about 163 cartridges per 50 lbs.

Example 9

Ingredient	Gross Weight	Dry Weight	Dry Weight
	Parts	Parts	Percent
Grained ammonium nitrate (0.3% coating)	4,500	4,500	
Ammonium nitrate solution	1,000	1,208	
Water	400		
Total ammonium nitrate and coating		5,708	80.18
Tapioca flour	250	216	2.16
Corn meal	510	459	4.60
Vegetable Ivory meal	1,230	1,295	12.63
Oleic acid	100	100	1.00

The dry ingredients are thoroughly mixed in a jacketed mixer and liquids added with continued mixing and heating to 130° F. The plastic mass is extruded through a 7-mesh screen and the vermicelli treated with air at 80° to 100° F. for solidifying, and then dried at 140° F. The product after crushing, so as to pass a 40-mesh Tyler screen, has a sensitivity of from 1" to 2" when packed 166 1/4" x 8" cartridges per 50 lb. case.

Example 10

Ingredient	Gross weight	Dry weight	Dry weight
	Parts	Parts	Percent
Grained ammonium nitrate (0.3% coating)	1,350	1,350	
Ammonium nitrate solution	350	242	
Water	100		
Total ammonium nitrate and coating		1,592	79.04
Tapioca flour	182	142	7.09
Vegetable Ivory meal	253	240	11.97
Oleic acid	20	20	1.00

The dry ingredients are mixed in a jacketed mixer, and then the liquids added and heated and mixed until a temperature of 130° F. is attained. The mixture would contain approximately 11.1% water. The plastic mass so produced is forced through an extruding machine so as to form square or round vermicelli, having an approximate cross sectional area of 0.0081 sq. in., with air

treatment for case hardening, followed by drying at a temperature from 110° to 170° F. The dried vermicelli is fragmented by crushing or grinding in a mill to pass a 40-mesh Tyler standard screen. The fragmented material when packed 158 1/4" x 8" cartridges per 50 lb. case gives a sensitivity of 2". When packed 147 1/4" x 8" cartridges the sensitivity is about 1/2".

Example 11

Ingredient	Gross weight	Dry weight	Dry weight
	Parts	Parts	Percent
Ammonium nitrate and coating	4,000	4,000	
Ammonium nitrate solution (67% NH ₄ NO ₃)	1,350	904	
Total ammonium nitrate and coating		4,904	65.30
Water	412		
Tapioca flour	600	524	6.95
Vegetable Ivory nut meal	900	882	11.74
Nitrate of soda	1,125	1,125	14.98
Oleic acid	75	75	1.00
Total	8,462	7,510	100.00

The powdered ingredients are mixed together in a jacketed dough mixer for five minutes and then the liquids added. The mixing is continued, with heating by means of the water jacket, until the temperature of the mixture is 130° F. The dough is removed and forced through a screen having .047 inch diameter wire and .096 openings. The vermicelli-like mass is blown with a blast of air at 150° F. for 25 minutes and with cool air for 10 minutes. The material is then transferred to a dry house and dried for 16 hours at 150° F. After removal from the dry house it is cooled and fragmented by means of metal rolls to pass a 40-mesh standard screen. A sensitivity of 2" is obtained with a #6 cap when packed in 1/4" x 8" paper cartridges yielding 163 per 50 lb. case.

It can be seen from the foregoing examples that each of the explosive compositions was capable of being packed in 1/4" x 8" cartridges to a density within the range of from 145 to 185 1/4" x 8" cartridges per 50 lb. case, at which density it was sensitive to detonation with a No. 8 commercial blasting cap.

The method of preparing the explosive compositions and mixtures of the present invention may be controlled to produce ultimate products of various densities, sensitivities, and velocities. The compositions prepared with higher mixing temperatures such as 150° F., generally have a greater density than those prepared with lower mixing temperatures in the neighborhood of 125° F. It is desirable to have the combustible ingredients in as fine a state of subdivision as practical in order to obtain homogeneity.

In many types of blasting operations it is important to have the explosive meet definite requirements with respect to density and sensitivity. In other words, many blasting operations require high bulk strength. That such high density ammonium nitrate explosives are characterized by having a low sensitivity is well known in the art. By controlling the particle size of my ultimate mixture it is possible to regulate these characteristics of the explosive.

Also by mixing the fragmented explosive composition of the present invention with straight ammonium nitrate, a density higher than one or a cartridge count as low as 125 1/4" x 8" cartridges per 50 lbs. may be obtained and particularly when relatively coarse straight ammonium

nitrate is employed as set forth in the following example. Thus one part of the explosive composition of Example 10 (passing a 40 mesh screen) is mixed with one part of grained ammonium nitrate with 0.3% coating, said ammonium nitrate passing a 10-mesh screen and 95% being held on a 60-mesh screen. The resulting explosive has the following approximate analysis on the dry basis:

	Percent
Ammonium nitrate-----	89.7
Tapioca flour-----	3.5
Vegetable ivory meal-----	6.0
Oleic acid-----	0.5
Coating-----	0.3

This mixture packed in 1¼" x 8" paraffin sprayed paper shells gives a cartridge count of about 129 cartridges per 50 lbs., and detonates in the open with a #8 blasting cap. In this embodiment of the invention, the explosive comprising the fragmented product admixed with straight ammonium nitrate is characterized by sensitivity to detonation with a No. 8 blasting cap even though the straight ammonium nitrate is present in proportions as high as 50% by weight of the explosive.

Where referred to in this specification and appended claims, the term "straight ammonium nitrate" means ordinary commercial grade ammonium nitrate such as conventionally grained ammonium nitrate containing a small amount of impurities and which generally is coated with a small proportion of a moisture resisting material such as petrolatum, paraffin, etc.

By these various methods of preparation, a nonexplosive oily substance, soluble nitrates, and combustibles may be combined for compositions of desired sensitivity, with cartridge counts in the 1¼" x 8" size ranging from 125 to 185 and upward, cartridges per 50 lbs. Various combustibles which act as sensitizers and accelerators; as for example, aluminum and ferro silicon powders may be added to the mixture.

In the foregoing examples and discussions of the explosive compositions of the present invention, their embodiment in cartridge form has been illustrated by reference to 1¼" x 8" cartridges. This small cartridge has been chosen for purposes of illustration because the small diameter cartridges are more difficult to detonate than the larger sizes. This is particularly true where a plurality of cartridges are laid end to end, and the detonation of an end cartridge by a blasting cap must be propagated from one cartridge to another, to detonate the series. In this specification, where it is stated that cartridges detonated with a blasting cap it is meant that one or more of a series of cartridges placed end to end completely detonated unconfined, when detonated with the blasting cap. It is obvious that the explosive composition of the present invention may be embodied in larger diameter cartridges, which inherently have a greater ability to propagate the detonating impulse. The explosive compositions are also excellently suited for use in loose granular form to be charged directly into the bore hole.

In the foregoing examples, detonation of the explosive composition and mixtures were obtained in the open. Since propagation of the detonating impulse is always more easily accomplished when the explosive is under confinement of a bore hole, it will be readily apparent to those skilled in the art that the compositions and mixtures of the present invention are of sufficient

sensitivity to make them commercially useful without the requirement that they be primed.

The sensitivity of the explosive composition is believed to be due to its physical characteristics, and to a definite uniform physical relationship of the various particles to each other. Since no localized supersensitivity can occur, the explosive offers a relatively high degree of safety in its use. Furthermore, the handling and transportation of the raw materials necessary for the production of the composition can be safely carried out as the ingredients themselves are substantially incapable of detonation.

Having fully described the invention what I claim is as follows:

1. The process of preparing an explosive composition which comprises intimately incorporating a water-soluble nitrate consisting of at least 60% ammonium nitrate with a small sensitizing proportion of a non-explosive oily material, said incorporation being conducted in the presence of water and heat to form a plastic mass, shredding the plastic mass so produced into coarse, firm particles, drying the particles to a hard state under conditions such that the particles will not coalesce, and fragmenting the hard particles to pass a 14 mesh screen.

2. The process of preparing an explosive composition which comprises intimately incorporating a water-soluble nitrate consisting of at least 60% ammonium nitrate with a small sensitizing proportion of a fatty oil acid, said incorporation being conducted in the presence of water and heat to form a plastic mass, shredding the plastic mass so produced into coarse, firm particles, drying the particles to a hard state under conditions such that the particles will not coalesce, and fragmenting the hard particles to pass a 14 mesh screen.

3. The process of preparing an explosive composition which comprises intimately incorporating a water-soluble nitrate consisting of at least 60% ammonium nitrate with a small sensitizing proportion of petrolatum, said incorporation being conducted in the presence of water and heat to form a plastic mass, shredding the plastic mass so produced into coarse, firm particles, drying the particles to a hard state under conditions such that the particles will not coalesce, and fragmenting the hard particles to pass a 14 mesh screen.

4. The process of preparing an explosive composition which comprises intimately incorporating a water-soluble nitrate consisting of at least 60% ammonium nitrate with not more than about 3% by weight of a non-explosive oily material, said incorporation being conducted in the presence of water and heat to form a plastic mass, shredding the plastic mass so produced into coarse, firm particles, drying the particles under conditions such that the particles will not coalesce, final drying of said particles being conducted at a temperature above 100° F., and fragmenting said particles to pass a 14 mesh screen, said fragmenting being conducted after the said particles have been dried at least sufficiently so that they will not coalesce at a temperature of 100° F.

5. The process as set forth in claim 4 and wherein the incorporation is carried out in the presence of 5% to 12% water and at a temperature ranging from 120° to 180° F.

6. The process of preparing an explosive composition which comprises intimately incorporating a water-soluble nitrate consisting of at least

60% ammonium nitrate with oxidizable material present in an amount at least sufficient to balance the oxygen content of the nitrate, said material including a small sensitizing proportion of non-explosive, oily material, said incorporation being conducted in the presence of water and heat to form a plastic mass, shredding the plastic mass so produced into coarse, firm particles, drying the particles to a hard state under conditions such that the particles will not coalesce, and fragmenting the hard particles to pass a 14 mesh screen.

7. The process of preparing an explosive composition which comprises intimately incorporating a water-soluble nitrate consisting of at least 60% ammonium nitrate with oxidizable material present in an amount at least sufficient to balance the oxygen content of the nitrate, said material including a small sensitizing proportion of fatty oil acid, said incorporation being conducted in the presence of water and heat to form a plastic mass, shredding the plastic mass so produced into coarse, firm particles, drying the particles to a hard state under conditions such that the particles will not coalesce and fragmenting the hard particles to pass a 14 mesh screen.

8. The process of preparing an explosive composition which comprises intimately incorporating a water-soluble nitrate consisting of at least 60% ammonium nitrate with oxidizable material present in an amount at least sufficient to balance the oxygen content of the nitrate, said material including a small sensitizing proportion of petrolatum, said incorporation being conducted in the presence of water and heat to form a plastic mass, shredding the plastic mass so produced into coarse, firm particles, drying the particles to a hard state under conditions such that the particles will not coalesce and fragmenting the hard particles to pass a 14 mesh screen.

9. An explosive composition comprising an explosive component consisting of discrete particles of an intimate mixture prepared in accordance with the process of claim 1, said mixture being free of metal and explosive sensitizer ingredients, said explosive component, per se, being capable of being packed to a density lower than that corresponding to 145 $1\frac{1}{4}$ x 8" cartridges per 50-pound case, at which density and diameter it is consistently sensitive to detonation with a No. 8 cap.

10. An explosive composition comprising an explosive component consisting of discrete particles of an intimate mixture prepared in accordance with the process of claim 2, said mixture being free of metal and explosive sensitizer ingredients, said explosive component, per se, being capable of being packed to a density lower than that corresponding to 145 $1\frac{1}{4}$ x 8" cartridges per 50-pound case, at which density and diameter it is consistently sensitive to detonation with a No. 8 cap.

11. An explosive composition comprising an explosive component consisting of discrete particles of an intimate mixture prepared in accordance with the process of claim 3, said mixture being free of metal and explosive sensitizer ingredients, said explosive component, per se, being capable of being packed to a density lower than that corresponding to 145 $1\frac{1}{4}$ x 8" cartridges per 50-pound case, at which density and diameter it is consistently sensitive to detonation with a No. 8 cap.

12. An explosive composition comprising an ex-

plosive component consisting of discrete particles of an intimate mixture prepared in accordance with the process of claim 4, said mixture being free of metal and explosive sensitizer ingredients, said explosive component, per se, being capable of being packed to a density lower than that corresponding to 145 $1\frac{1}{4}$ x 8" cartridges per 50-pound case, at which density and diameter it is consistently sensitive to detonation with a No. 8 cap.

13. An explosive composition comprising an explosive component consisting of discrete particles of an intimate mixture prepared in accordance with the process of claim 6, said mixture being free of metal and explosive sensitizer ingredients, said explosive component, per se, being capable of being packed to a density lower than that corresponding to 145 $1\frac{1}{4}$ x 8" cartridges per 50-pound case, at which density and diameter it is consistently sensitive to detonation with a No. 8 cap.

14. An explosive composition comprising an explosive component consisting of discrete particles of an intimate mixture prepared in accordance with the process of claim 7, said mixture being free of metal and explosive sensitizer ingredients, said explosive component, per se, being capable of being packed to a density lower than that corresponding to 145 $1\frac{1}{4}$ x 8" cartridges per 50-pound case, at which density and diameter it is consistently sensitive to detonation with a No. 8 cap.

15. An explosive composition comprising an explosive component consisting of discrete particles of an intimate mixture prepared in accordance with the process of claim 8, said mixture being free of metal and explosive sensitizer ingredients, said explosive component, per se, being capable of being packed to a density lower than that corresponding to 145 $1\frac{1}{4}$ x 8" cartridges per 50-pound case, at which density and diameter it is consistently sensitive to detonation with a No. 8 cap.

16. An explosive composition comprising an explosive component consisting of discrete particles of an intimate mixture prepared in accordance with the process of claim 6, said mixture being free of metal and explosive sensitizer ingredients, said explosive component, per se, being capable of being packed to a density lower than that corresponding to 145 $1\frac{1}{4}$ x 8" cartridges per 50-pound case, at which density and diameter it is consistently sensitive to detonation with a No. 8 cap and, admixed with said explosive component, straight ammonium nitrate.

17. An explosive composition comprising an explosive component consisting of discrete particles of an intimate mixture prepared in accordance with the process of claim 6 but wherein the particles are fragmented to pass a 40-mesh screen, said mixture being free of metal and explosive sensitizer ingredients, said explosive component, per se, being capable of being packed to a density lower than that corresponding to 145 $1\frac{1}{4}$ x 8" cartridges per 50-pound case, at which density and diameter it is consistently sensitive to detonation with a No. 8 cap, and, admixed with said explosive component, straight ammonium nitrate present in a proportion not greater than 50% by weight of the explosive, said explosive having a density corresponding to from 125 to 185 $1\frac{1}{4}$ x 8" cartridges per 50-pound case and being sensitive to detonation with a No. 8 cap.

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