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EXPLOSIVE COMPOSITION AND METHOD OF PRODUCING SAME

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Our invention consists in a new and useful improvement in explosive composition and method of producing same and is particularly designed to produce a novel form of composition which is characterized by extremely low sensitizer content and high sensitivity to detonation. This character of our improved composition is due both to the nature of the composition and the method of its production. Our improved composition is suitable for all types of blasting and is peculiarly valuable for use in certain types of mining requiring the use of explosives having the special characteristics possessed by our improved composition. The particularly novel and valuable feature of our invention is the material reduction of the proportion of sensitizers in our composition, by reason of the use of a very small proportion of aluminum powder, and the novel method of producing our composition hereinafter fully disclosed.

Ammonium nitrate compositions containing low contents of sensitizers have long been in use. But these compositions have been characterized by such low sensitivity that their application has been greatly restricted. For example, free-running dynamites, packed in bags, are poured into relatively large diameter bore holes of the well drill type, or poured into the cavity produced by springing a small diameter bore hole with a preparatory charge of more sensitive dynamite. The column of explosives is never of small diameter or cross-section at any point. The recommended practice in the use of this type has been to initiate detonation by means of a cartridge or cartridges of highly sensitive type, such as standard 40% N. G. or 40% ammonia dynamites. Permissible ammonium nitrate compositions containing low contents of sensitizers have been used in mining coal. The minimum recommended diameter of the most desirable type has been set at 1¾". In spite of this recommendation, however, some have been used in 1½" or even 1¼" diameters. A great deal of trouble, due to unexploded cartridges by reason of insensitivity of the compositions, has been experienced in all the sizes used. Our invention is an improvement in such compositions and method of production, whereby the content of sensitizers is greatly reduced, and yet the composition possesses a high degree of sensitivity.

There has long been a demand from users of explosives for non-headache causing explosive compositions. This characteristic is one of the strongest sales arguments for explosive compositions of the nitro-starch type. The compositions of our invention contain such small quantities of sensitizers capable of causing headaches in workers handling them, and the headache causing sensitizers are applied in such a manner, that while they can not be described as strictly non-headache causing compositions, they are materially improved in this respect.

Our compositions may be prepared in strengths from 20% to 65%. We give below examples of our compositions in approximately 40%, 50% and 60% strengths:

	60%	50%	40%
Nitroglycerin	3.00	4.00	5.00
Dry nitrocotton	.05	.05	.05
Ammonium nitrate	87.50	73.00	60.00
Sodium nitrate	2.00	12.50	20.00
Cornstarch	5.50	6.00	5.00
Sulphur	------	2.50	8.00
Aluminum	1.00	1.00	1.00
Calcium carbonate	.95	.95	.95

If the above described compositions should be prepared according to the methods ordinarily used in explosive plants, viz., placing the dry ingredients in the mix bowl, followed by the liquid explosive, compositions of a low degree of sensitivity, lacking the ability to bridge an air gap in the halved cartridge method, or at best a gap of a few inches, would be produced.

If, however, the ammonium nitrate and the sodium nitrate are placed in the mix bowl, the nitroglycerin and nitrocotton are gelled separately for three minutes in a suitable container and then poured into the mix bowl, and mixing is performed for three minutes, then the remaining ingredients, except the aluminum, are added, and mixing continued for another three minutes, after which the aluminum is added and incorporated for three minutes, compositions of high sensitivity are produced. The composition, according to the 60% formula, thus produced, possesses sensitivity to detonation of 14" by the halved cartridge method; similarly the composition according to the 50% formula a sensitivity of 16", and the composition according to the 40% formula

a sensitivity of 16''. The sensitivity tests were made in 1¼ x 8'' size by the halved cartridge method. The compositions of the formulae used as examples have the following stick counts in 1¼ x 8'' size per 50 lbs.: 60%, 136; 50%, 123; 40%, 118. These stick counts are not to be construed as limitations. By the use of other formulae, we may increase the number of 1¼ x 8'' sticks per 50 lbs. and still obtain compositions which are highly sensitive.

For example, the following compositions:

	60%	50%	40%
Nitroglycerin	3.50	5.00	5.00
Dry nitrocotton	.05	.05	.05
Ammonium nitrate	89.00	76.00	60.00
Sodium nitrate	1.50	8.50	16.00
Cornstarch	2.00	1.50	3.50
Ivory meal		3.00	4.50
Sulphur		2.00	7.50
Regranulated cork	2.00	2.00	1.50
Aluminum	1.00	1.00	1.00
Calcium carbonate	.95	.95	.95

Using the method above described for the previous examples, the following sensitivity and stick counts in 1¼ x 8'' size per 50 lbs. were obtained: 60%, 16'', 142 sticks; 50%, 16'', 143 sticks; 40%, 12'', 137 sticks. Again the tests refer to the halved cartridge method in 1¼ x 8'' size.

The characteristics of our compositions may be further varied by using ammonium nitrates of different degrees of coarseness. In the above examples, ammonium nitrate of fairly fine grain was used. Rates of detonation were, in the first set of formulae: 60%, 6,320 ft./sec.; 50%, 6,610 ft./sec.; 40%, 7,710 ft./sec.; in the second set of formulae: 60%, 7,200 ft./sec.; 50%, 7,650 ft./sec.; 40%, 7,440 ft./sec. These rates were determined by the D'Autriche method. The rates of detonation may be varied over a fairly wide range by suitable formula changes.

By using extremely coarse ammonium nitrate, compositions exhibiting low rates of detonation and high degrees of sensitivity may be obtained.

For example:

Nitroglycerin	3.00	3.00	3.00
Nitrocotton	.05	.05	.05
Coarse ammonium nitrate	89.00	89.00	86.75
Sodium nitrate	2.50	2.00	3.25
Cornstarch	1.00	1.00	1.75
Fine sawdust	2.00	2.50	2.25
Aluminum	1.50	1.50	2.00
Calcium carbonate	.95	.95	.95
Sensitivity	12	12	14
Rate of detonation	4,380 ft./sec.	4,243 ft./sec.	4,656 ft./sec.
Stick count, 1¼ x 8''/50 lbs.	140	140	136

Thus, by using extremely low amounts of sensitizers and our improved method of production, using coarse ammonium nitrate, we have obtained highly sensitive compositions of surprisingly low rate of detonation. Heretofore, rates of detonation in the neighborhood of 6,000 ft./sec. have been considered very low; and at the same time compositions having such rates have possessed low sensitivity.

It is obvious from the foregoing that our invention makes it possible to furnish the coal mining industry with explosive compositions which are safe in the presence of dusty or gaseous atmospheres, and which will be capable of producing large lumps of coal with a minimum of fines, without the difficulty of unexploded cartridges.

We have used the term "nitroglycerin" in the sense of liquid explosive. It includes mixtures of glycerin tri-nitrate and ethylene glycol di-nitrate, mixtures of glycerin tri-nitrate, ethylene glycol di-nitrate and nitroaromatic compounds and/or nitro-paraffine, nitro-sugars and the like.

We may also find it advantageous to use other oxidizers replacing sodium nitrate. The nitrates of the other alkali metals and those of the heavy metals may be employed. Similarly, clorates and perchlorates may be used instead of sodium nitrate.

The types of carbonaceous materials used in the foregoing examples are not to be considered limiting. To impart the desired characteristics for specific blasting conditions, we may employ comminuted apricot meal, almond meal, rice hulls, wood flour and the like. In place of wood pulp, we may employ mallow pith, bagasse, expanded cereals, and the like.

We have used finely powdered aluminum in our compositions, but relatively coarser particles of aluminum, such as turnings, filing, etc. may be used. We have used percentages of aluminum ranging from 1% to 8%. In our more desirable compositions we have found from 1% to 3% to be satisfactory. We do not wish to be limited as to the amounts of aluminum we employ. It is to be understood that the mechanism of the detonation depends on the particles of aluminum transmitting the wave of detonation through the inert materials to the sensitized grains of ammonium nitrate and sodium nitrate. The particles of aluminum have such covering power that some of them adhere to the already sensitized grains. It is not necessary that both the ammonium nitrate and the sodium nitrate be placed together in the mix bowl and the gelled explosive added thereto. In producing certain compositions, we find it advantageous to put only the ammonium nitrate in the bowl, add the gelled explosive, perform the mixing thereof, and then add the sodium nitrate at a later stage of the mixing process.

Having described our invention, what we claim is:

1. An explosive composition containing from 60% to 89% ammonium nitrate grains coated with a gelatinized explosive nitric ester, containing .05% nitrocotton to which particles of aluminum adhere, distributed throughout a matrix of sodium nitrate, aluminum particles and inert material, the aluminum particles being from 1% to 2%.

2. An explosive composition containing from 3% to 5% of a liquid explosive nitric ester in which has been gelled .05% nitrocotton, the remainder of the explosive strength being engendered by from 60% to 89% ammonium nitrate grains, in which substantilly all the gelled liquid explosive nitric ester is adhered to the ammonium nitrate grains which are distributed throughout a matrix of from 2% to 20% sodium nitrate, inert materials and from 1% to 2% aluminum powder, said matrix containing substantially little gelled liquid explosive nitric ester.

3. The method of producing an explosive composition which consists in mixing from 60% to 89% of ammonium nitrate grains and from 3.05% to 5.05% of a gelled liquid explosive nitric ester so as to coat the grains with the explosive nitric ester; mixing the coated grains with from 2% to 20% of sodium nitrate grains and a quantity of inert material to form a matrix throughout which the ammonium nitrate grains are thoroughly distributed; and adding from 1% to 2% of aluminum particles so that they are distributed throughout said matrix and that certain of said particles adhere to the ammonium nitrate grains.

4. The method of producing an explosive composition so as to impart thereto a high degree of sensitivity, which consists in mixing from 60% to 89% of ammonium nitrate grains and from 3.05% to 5.05% of a gelled liquid explosive nitric ester so as to coat the grains with the explosive nitric ester; mixing the coated grains with from 2% to 20% of sodium nitrate grains and a quantity of inert material to form a matrix throughout which the ammonium nitrate grains are thoroughly distributed; and adding from 1% to 2% of aluminum particles so that they are distributed throughout said matrix.

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