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EXPLOSIVE

Milton F. Lindsley, Jr., Kings Mills, Ohio, assignor to The King Powder Company, Kings Mills, Ohio, a corporation of Ohio

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This invention relates to explosives, primarily of the type used in blasting for mining and quarrying purposes and is particularly directed to an explosive adapted to be set off by a standard detonating cap as distinguished from an ignition fuse. The invention further relates to compositions which provide, with safety, appreciably more disrupting and shattering effect than any of the other various explosive compositions presently known, when used for purposes such as quarrying.

In modern mining and quarrying operations, the method of blasting most frequently used is known as the "well drill" method. This method employs drill holes which range in diameter from 3 to 8 inches, bored to a depth of as much as 150 to 200 feet or more. Where the material of the strata being bored is hard, it is very desirable that the number of holes and their respective diameters be kept as small as possible because of the expense, difficulty, and consumption of time of the boring operation. The bore holes, after completion, are loaded with cartridges of explosives which are fired to constitute the blast.

In recent years commercial high power explosives have been compounded to have a sensitivity responsive to detonation by means of a No. 6 or a No. 8 blasting cap or by a length of detonating fuse, which cap or fuse is fired electrically, or by safety fuse, to initiate the explosion. Since this practice is relatively standard in most blasting operations it is desirable that any new explosive be susceptible to detonation in this manner.

The principal factors which govern the choice of a blasting explosive for a specific purpose are the power of the explosive, the velocity of detonation, the density, and, of course, the price. Sensitivity, stability, and the nature of the products of decomposition are also to be considered, in so far as these factors bear relation to the other factors discussed and to the particular work to be accomplished. As an illustration of the relationship of these factors, an explosive of a powerful, shattering characteristic is desired in the blast quarrying of very hard rock. For softer varieties of rock the bore holes in which the explosive is placed can be made larger without undue inconvenience, and consequently the density, power, and, velocity of the explosive are of relatively less importance. In coal mining and earth removal operations, non-detonating explosives, such as black blasting powder, are often used.

But in every instance the efficiency and effectiveness of an explosive is determined by the

amount of material a given quantity of explosive is capable of removing, and by the general condition of the material removed after the blast, that is to say, the size of the fragments of the shattered whole mass. After a particular blast has been executed, the material dislodged is removed from the scene of operations by manual methods or through the employment of loading machines or steam shovels. In either of these cases, fragments of small size, whether the material be rock, coal, or ore, are desired since they are scooped up at much greater speed and with much less effort than large blocks or pieces of unbroken material.

Of these various characteristics of commercial explosives, in so far as they relate to and govern generally the efficiency of mining and quarrying, the present invention pertains particularly to (1) explosive power, (2) speed of detonation, and (3) sensitivity of the explosive.

The term explosive power, as it is used in this disclosure, relates to the disrupting action of high explosives. The degree of explosive power is directly measured by the standard Du Pont Ballistic Pendulum.

The rate of detonation, as the term is used in the following specification, refers to the velocity with which the explosion wave of the explosive reaction travels through a given charge of explosive. This velocity is measured in definite terms of speed by firing 1¼ inch cartridges of proper length, by use of the Cordeau Bickford method. The numerical detonating speeds referred to hereinafter were determined with this method, using 1¼ inch by 8 inch cartridges.

The methods for determining explosive power and rate of detonation are disclosed in the United States Bureau of Mines Bulletin No. 346, "Physical Testing of Explosives".

Sensitivity of explosives is intended to describe the ease, or difficulty, with which a detonating wave may be set up in a given high explosive. In the following specification, the words "sufficiently sensitive" are used to apply to an explosive which is detonatable by a No. 6 blasting cap under atmospheric conditions.

So called black blasting powder is non-detonating. It burns under confinement at a rate of about 1500 to 1800 feet per second and is relatively low in strength. Because of these characteristics, black blasting powder lacks the capacity to shatter and reduce the harder varieties of strata into fragments of such size that they may be handled and removed in a manner which is efficient and convenient.

For example, if one attempted to use black blasting powder in quarrying hard limestone, a considerable number of bore holes of large diameter would have to be drilled, at considerable expense, to accommodate a charge capable of effecting the removal of any appreciable quantity of the rock. Even then the major proportion of the hard rock blasted would remain in the form of relatively large and cumbersome chunks. Moreover, there is another disadvantage attendant the use of black blasting powder. Although it is slow burning as an explosive, it is highly inflammable and consequently hazardous to store and dangerous to use.

The so called high explosives on the other hand, that is to say, those explosives of the type exemplified by nitroglycerin and nitrostarch, are characterized by exceedingly high detonating speeds—from 9,000 to 16,000 or more feet per second. These explosives have been used because those skilled in the art have considered high rate of detonation necessary for breaking the mass into small fragments especially in hard rock blasting. Citing the blasting of limestone rock, again, as an example, it has been the preferred practice to drill into the hard rock the smallest number of holes possible, each of the smallest possible diameter, and to load these with high velocity explosives in order that the material blasted be broken down and disintegrated. In addition to standard grades of nitroglycerin and nitrostarch powders, (which may or may not contain varying quantities of ammonium nitrate), there are a number of commercial explosives in which a dominating quantity of ammonium nitrate is used, but, with these, nitroglycerin or a like volatile sensitizing agent is generally present. These latter explosives unavoidably diminish in sensitivity upon extended storage and are considered unreliable after they have been in storage longer than a year.

I have discovered that these exceedingly high detonating speeds are neither requisite nor desirable in obtaining good yields in blasting many varieties of strata including limestone and like hard rock formations. This invention is predicated upon the determination that excellent yields of material of desirable fragment size are obtainable through the use of explosives of from 20% to 70% strength, adjusted and controlled to detonate at from approximately 2,500 to approximately 8,000 feet per second. Otherwise expressed, I have discovered that best practical results are obtained in many cases, such as hard rock blasting, by using explosives of substantially standard power but of detonating speed falling within the gap between the burning speed of black powder, on the one hand and the detonating speed of standard strength nitro explosives on the other hand.

It is an object, therefore, of the present invention to provide safe explosives capable of being detonated in the usual manner, with a No. 6 blasting cap or a length of Cordeau fuse, which explosives have a detonating speed varying from about 2,500 to about 8,000 feet per second which are capable of dislodging and disrupting greater tonnage per unit of explosive than existing explosives of equivalent strength. Another object of the invention is to provide a series of explosives ranging from about 20% to about 70% in strength but not subject to appreciable loss of sensitivity during extended storage.

The problem of compounding commercial explosives of relatively standard power, and requiring

site sensitivity but detonating at speeds in the desired range, is one of complexity. If a detonatable but insensitive type of explosive is selected, then special detonating means are made necessary. If this type of explosive is sensitized in the conventional manner by intermixing therewith an appropriate sensitizing agent, then the detonating speed of the resultant composition is too great. On the other hand, approaching the problem in contemplation of the adaptation of black powder explosives, one immediately encounters the fire hazard connected with their use and also the impracticability of obtaining an explosive of adequate strength.

The explosive of the invention by which these problems are overcome may be said to comprise, broadly speaking, an explosive agent which is inherently capable of being detonated but too insensitive to propagate detonation with a No. 6 (or in certain instances a No. 8) blasting cap, and a sensitizer associated with the explosive thus produced for rendering it sensitive to such a blasting cap without substantially increasing the speed of the resultant finished product, so that the final rate is within the range of approximately 2,500 to 8,000 feet per second.

The method by which an explosive of the specified characteristics is provided comprises providing an explosive base or admixture which is inherently capable of being detonated to provide the desired power. This base or admixture may comprise a single ingredient, or an admixture thereof with fuels and oxidizers, or an admixture of materials adapted when admixed to provide an explosive exhibiting potentially, the characteristics hereinbefore defined. This explosive base or admixture is then formed into grains which are in general too large in size to permit detonation by standard blasting caps. The grain size selected determines, generally speaking, the speed at which a cartridge filled with these grains would detonate, if set off by special means, the speed being inversely proportional to the size of the grains. Then the grains are surface sensitized with any one of several well known sensitizing agents by depositing a surface coating or film of the sensitizing agent over the surfaces of the grains. In this way, the explosive is rendered sufficiently sensitive (the explosive is brought back to the point where it can be detonated by a conventional No. 6 blasting cap), but the speed of detonation is not increased in proportion to the increase in sensitivity.

Otherwise expressed, if a detonatable explosive base or admixture is sensitized by an agent incorporated uniformly throughout the admixture, sensitivity and speed are increased substantially in the same proportion; but, on the other hand, if the grain size is selected to provide a relatively slow speed of detonation (2,500 to 8,000 feet per second), then surface sensitizing the grain increases the sensitivity of the explosive to such a degree that it can be detonated readily without increasing the rate of detonation outside of the desired range.

The chemical characteristics of the ingredients selected in the preparation of explosive responsive to the concepts of the invention, their physical consistency, and the nature and composition of the sensitizing agents chosen, are unimportant except in so far as their individual characteristics and their co-relation influence, and control the power, speed, and sensitivity of the explosive desired. The preferred characteristics and co-relation of the constituting components of such an

explosive are discussed briefly in the following sections.

Chemical composition

In general, the chemical ingredients comprising an explosive composition determine primarily its explosive strength or power, its sensitivity and detonability, and the speed at which it detonates. In the preparation of explosives responsive to the invention herein disclosed, ingredients are selected which combine to provide an explosive equivalent to dynamite of 20-70% strength, inherently capable of being detonated but too insensitive to propagate detonation with a No. 6 blasting cap standardized to comprise 90% fulminate mercury and 10% potassium chlorate. The term ingredients, as it is used in this section, refers primarily to the material or materials comprising the main explosive composition itself, as distinguished from the sensitizing agent subsequently referred to.

A compound or mixture susceptible to explosive chemical reaction for blasting purposes generally comprises a principal detonating agent or agents and such fuels and oxidizing agents as may be desired. The purpose and theory of blending fuels and oxidizing agents is well known in the art.

Of the detonating agents presently available, I prefer to use ammonium nitrate as the principal explosive ingredient. For certain technical reasons hereinafter discussed it exhibits many desirable qualities. Economically, its price facilitates its use in blasting explosives for large scale commercial purposes.

There are, however, a number of other substances susceptible to use as dominant or secondary ingredients in the preparation of an explosive admixture or base explosive exhibiting the qualities defined. The mixture of a chlorate or perchlorate with a readily oxidizable carbonaceous or hydrocarbon substance is exemplary in this respect. TNT or nitrostarch and similar substances are likewise susceptible to use. Furthermore, there are a number of organic nitro-compounds useful as servant explosive ingredients in the preparation of explosives of the type described, among which may be mentioned such materials as nitroglycerin, nitrocellulose, di-nitrotoluene, di-nitrobenzine, etc.

Ammonium nitrate by itself possesses desirable characteristics from the point of view of potential explosive strength. This material, like the other of the agents suggested for use as principal detonating agents, is, however, too insensitive to be detonated in the usual manner. Furthermore, very few, if any of these materials, have a balanced oxygen value when disintegrated; therefore, it is usually desirable to add fuels, or oxidizers, or both, to produce the desired oxygen balance. It should be noted that fuels or oxidizers may, in certain instances, partially sensitize the explosive compositions in which they are used.

As fuel ingredients, charcoal, chars of various kinds, popcorn, sulphur, potassium, wood-meal, ivory-meal, dextrin, lignin, paraffin, hydrocarbons in general, and substances of similar combustible nature are satisfactory. In my copending application, Serial No. 3644, entitled "Explosive", and filed January 26, 1935, of which this application is a continuation in part, the utility of tar-char as a fuel ingredient is disclosed. This substance is obtained by the distillation of coal tar or petroleum tar residues, at elevated temperature. It possesses the capability of rendering ammonium nitrate appreciably less hygroscopic

and also functions as a binding agent. It may be stated also that the explosive composition generally disclosed in my copending application is susceptible to use as an explosive, responsive to the concepts of the invention herein disclosed.

Attention is also invited to Peters and Lindsley United States Patent No. 977,545 in which an explosive compound of the ammonium nitrate type, fundamentally susceptible to use in the preparation of explosive compositions to which the present invention relates, is likewise disclosed.

Among the materials which I find satisfactory and available to use as oxidizing agents may be listed the nitrates of sodium, potassium, barium, lead, and the like, and generally the chlorates, perchlorates, and oxalates of similar metals. The inorganic nitrates as a class are preferred for the reason that these substances generally contain an available oxygen content which is relatively high per unit of weight of oxidizing agent used. Sodium nitrate as an oxidizer has the advantage not only that it is practical from a hygroscopic standpoint, but also that its price is attractively lower than that of the other oxidizing substances mentioned.

Of the various compositions heretofore disclosed which may be used with satisfactory results for explosives, that is, base compositions responsive to the invention, the following formulas are disclosed as examples.

Example A

	Strength				
	20%	30%	40%	60%	70%
Ammonium nitrate.....	25.7	40	57.5	85.0	98.5
Paraffin.....	2.5	2.5	2.5	2.5	-----
Sulphur.....	3.0	3.0	3.0	1.5	-----
Tar char.....	13.6	9.15	6.5	3.0	-----
Sodium nitrate.....	53.7	43.85	29.0	6.5	-----

Example B (strength 40%)		Example C (strength 40%)	
Ammonium nitrate ..	57.5	Ammonium nitrate ..	57.5
Sodium nitrate.....	21.0	Sodium nitrate.....	15.0
Ivory meal.....	16.5	Potassium nitrate....	6.5
Dextrin.....	2.0	Popcorn.....	18.0
Sulphur.....	1.5	Paraffin.....	1.0

In the compositions of Example A the ingredient completing the formula in each instance comprises 1½% aluminum sensitizing agent. Likewise, in the B composition the same quantity and the same sensitizing agent was used, while in C, 2% of aluminum completes the formula. The quantity, nature, and effects of sensitizing agent are discussed hereinafter.

Example D

To indicate the use of nitro-compounds for an explosive of the type to which the invention relates, the following explosive, useful or feasible in some instances, is disclosed. TNT is grained for passage through a 3 x 3 screen to carry on a 6 x 6 screen, Tyler Standard, to appropriately reduce its potential detonating speed. Then the grains are sensitized by the addition of 1.5% aluminum in the form of a surface coating. The explosive so prepared has a detonating rate of 2800 feet per second, but it is quite expensive.

It should be understood that the formulae listed above are disclosed as examples only and that I do not intend to be limited to these alone. The skilled in the art upon understanding my invention will be able to prepare other explosive compositions exhibiting speed and strength char-

acteristics within the ranges which I have found to substantially increase the yields of explosion operations.

Physical composition

While the chemical ingredients determine within certain ranges the strength and the detonative or non-detonative ability of a given composition, its physical characteristics and consistency play a part equally, if not more important in controlling its detonability by conventional caps. In the practice of the invention, a chemical admixture inherently capable of being detonated is provided, and then this explosive admixture is formed into grains which are too large in size to be detonated by the conventional No. 6 blasting cap.

The speed of the explosive, if and when set off, generally is a function of the size of the powder grains. The grain size in other words is a primary control of speed detonation. As the grain size decreases, the speed of detonation increases, or conversely, the larger the size of the particular particles constituting the explosive, the slower is the speed at which these particles detonate once detonation is initiated.

The following table, which is illustrative of this effect, shows the results obtained in firing 40% explosives, analogous in composition to Example A, first sensitized with 1½% aluminum and then classified as to grain size. A coating uniform in thickness was present on all the grains, irrespective of size. The smaller grains, of course, due to variation in the surfaces exposed contained a greater percentage of sensitizer in proportion to their total composition.

Coating on grains uniform in thickness

Grain size (Tyler standard)	Screen analysis	Speed of detonation in feet per second
	Percent	
6x10.....	50.0	2,700
10x16.....	25.0	2,900
16x24.....	8.0	3,400
24x32.....	4.0	4,500
32x50.....	3.5	6,500
50x70.....	2.5	8,500
70x125.....	2.0	10,600

In general it may be stated in respect to explosives of the ammonium nitrate type that a grain of about 5 x 5 size (according to the standards of the W. S. Tyler Co.) is as large a grain as can be used to advantage in the preparation of grain which is responsive to the invention, and, also, that grains of approximately 70 mesh granulation, Tyler Standard, are about as small in size as it is advantageous to use, because the exposed surface of the small grain is so great that too large a quantity of sensitizing agent is required. The size as it is expressed refers to meshes per square inch.

As the grain size increases, the thickness of the sensitizer coating increases, when the percentage of coating with respect to the grain composition is held constant. Because of this, actual surface of larger grains is more sensitive than the actual surface of smaller grains, even though the smaller grains themselves are more sensitive. This condition helps offset the inherent low sensitivity of larger grains. The following tabulation of results obtained from firing sized explosives of Example A composition, all sensitized by the addition of 1½% powdered aluminum coating, is indicative.

Coating on grains uniform in percentage (thickness varying with size)

Grain size (Tyler standard)	Speed of detonation in feet per second				
	20%	30%	40%	60%	70% (pure ammonium nitrate grain)
Strength.....					
5 x 6.....	*	*	*	2900	*
6 x 10.....	*	2600	2800	3400	*
10 x 16.....	2800	3600	4300	4500	4300
16 x 24.....	3700	4000	4200	5000	5000
24 x 32.....	4000	4300	5000	5400	5000
32 x 50.....	4200	5100	5200	5800	5100

* Not sensitive enough with particular amount of sensitizer used to detonate properly under atmospheric conditions.

The strength of the explosive in the foregoing table is expressed in per cent of the strength of standard dynamite.

The inherent sensitivity of explosives of any given composition is likewise influenced to a major degree by the size of the explosive grains. As the grains decrease in size they become more sensitive or susceptible to detonation when packed in a cartridge or bore hole, until the point is reached where further decrease in size causes a compacting and consequent destroying of granular characteristics, at which point sensitivity rapidly drops off. This condition is, in reality, again that of a large mass or grain. It should be understood that precise limitations, other than those given, are not available in this respect because of the inherent variations possible in chemical consistency. For example, one explosive may contain ingredients which render it insensitive to detonation from a No. 6 blasting cap, when it has a grain size as large as 5x5 on the Tyler Standard, whereas another explosive of different composition may be equally insensitive to detonation with a No. 6 blasting cap but inherently detonatable, even though its grain size is approximately 70x70 on the same standard basis.

From the commercial and practical aspects of explosive manufacture and use, the grains of any explosive should be adapted to packaging in the conventional cartridge manner; that is to say, assemblage into a cartridge-like stick, wrapped by a covering of paper or the like. Although ammonium nitrate is extremely hygroscopic in nature, the use of a fuel such as tar char, an oxidizing agent such as sodium nitrate, and a sensitizer coating in conjunction therewith, effectively cooperate to reduce undesirable deliquescence.

Sensitivity

The explosive chemical admixture, inherently capable of being detonated, is formed into grains too large in size to be detonated in the conventional manner, and the composition then is sensitized to such a degree that it will propagate detonation with a conventional No. 6 blasting cap and at a speed within the range which I have discovered is desirable.

A sensitizing agent selected for this purpose must be adapted to offset the large size of the grain and render the explosive detonatable in the conventional manner. The final explosive composition, as stated, should not exhibit speeds beyond the range approximating 2500 to 8000 feet per second in order to obtain the blasting results which I have found it possible to secure. If too little sensitizing agent is used, then special detonating equipment is necessitated. For

example, in one of the very recent of modern explosives a secondary or booster charge of TNT or its equivalent is required to propagate detonation, but in spite of this unusual degree of insensitivity the explosive speed is still too high to produce the superior results which are otherwise obtainable. The use of special detonating means is undesirable in working where only conventional caps are available. If too much of a sensitizing agent is used, the speed which the sensitizing agent imparts to the composition too greatly increases the detonating speed of the composition as a whole.

The final control of the speed and the sensitivity, according to the present invention, lies in the nature and relation of the sensitizing agent associated with the blasting explosive composition. I prefer to form explosive grains of the sizes previously disclosed, then surface coat these grains for sensitization.

For such surface coat sensitizing purposes, finely divided or powdered aluminum is well adapted to use, powdered magnesium is likewise suitable although its price somewhat detracts from its desirability. Moreover, I find that nitroglycerin, nitroglycerin colloided with nitrocellulose or combinations of these with finely divided aluminum or magnesium also are useful.

In so far as speed characteristics are concerned, the size of the explosive particles when sensitized with such an agent is closely related to their speed of detonation. A decrease in particle size increases the area of explosive subject to sensitizer coating. In this event, the physical relationship between the explosive grains and the sensitizing agent disposed over the surface thereof more nearly approaches a physical intermixture and the control to be obtained through surface coating is commensurately diminished.

In general, I have found that the quantity of sensitizing agent used for coating explosive grains, particularly of the smaller sizes, should be as small as convenient or necessary to produce the desired velocity and sensitivity characteristics. The following table is exemplary in this respect. In determining these results a substantially uniform grain size of 24x32 (Tyler Standard) was used.

Percent of sensitizer (aluminum)	Strength				
	20%	30%	40%	60%	70%
Speeds in ft. per second					
0	•	•	•	3300	•
.25	•	•	•	4100	•
.50	•	3700	4100	4600	•
.75	•	4100	4710	5200	•
1.0	•	4500	4800	5200	•
1.25	3900	4800	4900	5200	•
1.50	4000	4700	4900	5300	5000
1.75	4200	4800	5100	5500	5100
2.0	4500	4900	5200	5800	5200
2.50	4800	5100	5300	5900	5500
3.0	4900	5400	5800	6300	6100

The explosives are of Example A composition. The strength of the explosives is expressed as per cent of the strength of standard dynamite.

The upper limit upon the amount of sensitizer which may be used for coating is determined by the inherent degree of sensitivity of the particular composition prepared or selected for sensitization, by the speed limitations of the final product, as already discussed, and by cost.

From the discussion appearing in the foregoing sections, it is apparent that explosive compositions within the velocity and power ranges indicated are not only feasible but conveniently practical. Each of the principal factors governing the utility of the explosive is controllable by the selection and adjustment of the chemical composition, the physical composition and the sensitizing agent and further by adjustment of the relationship between these primary controls.

In preparing explosives having characteristics of the type described, any one of the following methods is preferred.

(1) The component parts, that is to say, the principal explosive ingredient and such fuels and oxidizing agents as may be necessary or desired, are incorporated together in a wheel mill, then pressed under hydraulic pressure, grained to the desired particle size in a corning mill and finally dried and sized in a classifier.

(2) If popcorn or like cereal grain is desired as a fuel, it is first popped, then ground and sized. The sized particles are placed in a mixing tank to which is added the principal explosive ingredient and such other fuels and oxidizers as may be desired or required, and also an amount of water, which, after melting of the mixture, will furnish a composition of the desired consistency. This molten mass is next thoroughly agitated until the popcorn is thoroughly impregnated with explosive compositions. Finally the excess of moisture is driven off until a firm grain of powder results.

(3) The component parts of the explosive mixture, including the principal explosive ingredient and such fuels and oxidizing agents as may be desired or required, are mixed with a desired percentage of water and then heated until molten and then cast. The cakes thus formed are ground to the proper granulation. As a variation in this process, instead of casting, the molten mass is introduced slowly onto a heated revolving or inclined surface, facilitating grain formation and facilitating the removal of excess moisture; or, the molten mass is dropped through a screen, if desired, to cause the formation of round grains, which are further dried until they are firm.

(4) The next step in the preparation of an explosive responsive to the invention is the sensitizing step. In this operation the explosive grains, preferably formed by one of the methods expressed in (1), (2) or (3), or by any other suitable method, are subjected to surface coating with a sensitizer.

If aluminum or magnesium or like powdered sensitizing agent is to be used to effect sensitization, then the explosive after graining to appropriate size, and preferably after drying, is moistened with water and next subjected to dusting or tumbling with the sensitizing agent to accomplish the application of the surface coat thereof. After this the whole may be dried if desired and finally packed into cartridges. A liquid sensitizing agent, such as nitroglycerin or the same colloided with nitrocellulose, is most easily applied by spraying of the grains with such solution which, if desired, may be thinned by benzine or the like. If a sensitizing agent such as aluminum is to be used in conjunction with a liquid sensitizing agent such as nitroglycerin or nitroglycerin colloided with nitrocellulose, then it is preferable to first spray with the liquid, then dust, and, if necessary, finally dry the grains.

The characteristics which identify the explosives of the invention herein disclosed, render them useful in munitions such as high explosive

shells and torpedoes where brisance, power, and spread of explosive rupture are of extreme importance.

Having described my invention I claim:

- 5 1. An explosive adapted for blasting purposes comprising an explosive composition which is inherently capable of being detonated but which is comprised of grains too large in size to detonate with a No. 6 blasting cap, said explosive
10 having a strength of about 20% to about 70% as determined by the Du Pont Ballistic Pendulum method, said explosive exhibiting a speed, when detonated, of from about 2500 to about 8000 feet
15 per second as determined by the Cordeau Bickford method the grains of the explosive on their surfaces carrying a coating of a sensitizing agent sufficient in amount to render the explosive composition sensitive to detonation with a No. 6
20 blasting cap.
2. An explosive adapted for blasting purposes comprising a granular substance inherently capable of being detonated but comprised of grains
too large in size to detonate with a No. 6 blasting cap, the grains of said explosive surface coated
25 with a sensitizing agent, sufficient in amount to render the explosive detonatable by a No. 6 blasting cap, the explosive when sensitized exhibiting a rate of detonation of approximately
30 2500 to 8000 feet per second as determined by the Cordeau Bickford method.
3. A granular explosive adapted for blasting purposes, comprising an inherently detonatable substance, the size of the grains of which are
too large to permit detonation with a No. 6 blasting cap, in which explosive the insensitivity due
35 to large grain size is offset by a surface coating of a sensitizing agent on the grains the said explosive when detonated exhibiting a rate of detonation of approximately 2500 to 8000 feet per
40 second.
4. The method of making an explosive having a rate of detonation of about 2500 to 8000 feet per second as determined by the Cordeau Bickford
method and adapted for blasting purposes, said
45 method comprising, establishing an explosive composition which is inherently detonatable, forming said substance into grains too large to permit detonation with a No. 6 blasting cap, then
surface treating said grains with a sensitizing
50 agent sufficient in amount to offset the insensitivity due to large grain size but insufficient in amount to increase the rate of detonation above the range of about 2500 to 8000 feet per second.
5. An explosive having a rate of detonation of

approximately 2500 to 8000 feet per second as determined by the Cordeau Bickford method, said explosive comprising a composition which is inherently capable of being detonated but comprised of grains too large in size to detonate with
5 a No. 6 blasting cap, the grains of explosive coated with a sensitizing agent sufficient in amount to offset insensitivity due to large grain size and render the explosive detonatable with a
10 No. 6 blasting cap.

6. A method of making an explosive having a rate of detonation of about twenty-five hundred (2500) to eight thousand (8000) feet per second as determined by the Cordeau Bickford method, said method comprising establishing an explosive
15 composition which is inherently detonatable and which contains a substantial portion of ammonium nitrate, forming said substance into grains too large to permit of detonation with a
20 Number 6 blasting cap, then surface treating said grains with a surface sensitizing agent sufficient in amount to offset the insensitivity due to large grain size, but insufficient in amount to increase
25 the rate of detonation above the range of about twenty-five hundred (2500) to eight thousand (8000) feet per second.

7. An explosive having a rate of detonation of approximately twenty-five hundred (2500) to eight thousand (8000) feet per second as determined by the Cordeau Bickford method, said explosive comprising an ammonium nitrate composition which is inherently capable of being
30 detonated, but comprised of grains too large in size to be detonated with a No. 6 blasting cap, the grains of the explosive coated with a sensitizing agent sufficient in amount to offset insensitivity
35 due to large grain size and render the explosive detonatable with a No. 6 blasting cap.

8. An explosive having a rate of detonation of approximately twenty-five hundred (2500) to eight thousand (8000) feet per second as determined by the Cordeau Bickford method, said explosive comprising a composition containing a
40 substantial quantity of ammonium nitrate, which composition is inherently capable of being detonated, but is comprised of grain too large in size to be detonated with a No. 6 blasting cap, the grains of the explosive coated with finely
45 divided aluminum sufficient in amount to offset insensitivity due to large grain size and render the explosive detonatable with a No. 6 blasting
50 cap.

MILTON F. LINDSLEY, JR.