Patented Nov. 9, 1943 2,333,637

UNITED STATES PATENT OFFICE

2,333,637

EXPLOSIVE COMPOSITION

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No Drawing. Application August 3, 1940, Serial No. 351,212

4 Claims. (Cl. 52—11)

This invention relates to a new explosive composition comprising a water soluble nitrate intimately associated with a carbonaceous combustible material such as starch and to a process of preparing the same.

An object of the present invention is the production of a water soluble nitrate, starch explosive composition of increased sensitivity and which may be used with great advantage in explosives generally, and more particularly to replace water soluble nitrate, carbonaceous material mixtures.

Another object of the invention is the production of a water soluble nitrate, starch explosive composition characterized by relatively low detonating velocity and which may be sensitized to propagation sensitiveness with a comparatively small amount of a nitric ester such as nitroglycerine.

Other objects of the invention will hereinafter more fully appear.

Ammonium nitrate explosive mixtures having low velocity of detonation are well known in the art. In producing these mixtures, primary consideration was given to the physical characteristics of the ammonium nitrate, particularly with respect to the relative coarseness of the nitrate particles. Although some of these explosive mixtures contained a limited amount of sensitizing agent, such as nitroglycerine, they were not consistently capable of detonation, being entirely ineffective when used in cartridges of less than 1¾ inches in diameter. Simple mechanical mixtures of water soluble nitrate and starch have also been proposed for the purpose of producing a low detonating velocity explosive. These mixtures, however, have been very unsatisfactory since their sensitivity is too low for practical purposes.

Explosive compositions of colloidal starch and soluble nitrates have been previously proposed. While such compositions are more sensitive than simple mechanical mixtures of the ingredients and may be sensitized with secondary components such as nitroglycerine, I have found that in accordance with the present invention mixtures of starch and a water soluble nitrate consisting of at least 60% ammonium nitrate may be prepared which have greatly increased sensitiveness and reliability.

In accordance with the present invention starch and a water soluble nitrate consisting of at least 60% ammonium nitrate are thoroughly mixed in the presence of sufficient water to produce a dough-like plastic mass. Generally I prefer to carry out this mixing operation at a temperature above 80° F. in order to facilitate thorough incorporation of the ingredients. The plastic mass so produced is then passed through a screen or the like to form grains or vermicelli which is dried at least sufficiently to case harden the particles. The case hardened particles art then fragmented, preferably by rubbing them through a screen of finer mesh than that of the screen employed to form the grains or vermicelli from the plastic mass. Of the fragmented product so produced I employ as the explosive composition of the present invention any or all of that portion substantially all of which passes an 8 mesh sieve and is retained on a 30 mesh sieve. While I found that the entire portion passing an 8 mesh sieve and retained on a 30 mesh sieve is excellently suited for use in various explosives, it is to be understood that smaller portions as, for example, that passing a 10 mesh sieve and held on a 20 mesh sieve may be used to thereby control the density and other characteristics of the ultimate explosive in a manner well-known to those skilled in the art.

While the theory of the results which I have obtained cannot be precisely defined and I do not want to be bound by any theoretical concept, the greatly increased sensitiveness of the explosive composition of the present invention is probably caused by the existence of exposed minute crystals of the water soluble nitrate. The crystals of water soluble nitrate are in intimate contact with the oxidizable starch in microscopical or even molecular dimensions which offers an ideal combination for rapid decomposition of the constituents when subjected to flame and shock such as the result from a blasting cap. Grained compositions, by means of agitation and drying, cause comparatively large crystals to be formed without exposed angular surfaces. In accordance with the present invention the crystals are minute and in intimate contact with the starch and the fragmentation of the case hardened granules or vermicelli exposes the minute crystals and allows 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.

In order to more clearly point out the invention, the following illustrative examples are given in which all parts are parts by weight.

EXAMPLE 1

147 parts of ammonium nitrate coated with 0.3% of a mixture of 75% petrolatum and 25% paraffin, and 15 parts of corn starch containing 12.3% moisture were thoroughly mixed in a jacketed dough mixer, and 61.5 parts of a solution of ammonium nitrate containing 64.4% of NH_4NO_3 were added and kneading and mixing continued, with hot water in the jacket, until the mixture had become of a dough-like consistency, and attained a temperature of 120° F. The dough was removed from the mixer and forced through a flat iron screen by means of revolving paddles set at angles less than 90° to the screen. The screen was of the square mesh steel wire type, having openings 0.104 inch x 0.104 inch, and the diameter of the wires 0.063 inch. The dough came through the screen in the form of strings or vermicelli, and approximately 45 minutes were required for this operation during which time the shredded dough was exposed to a current of air at 74° F., which cooled and case hardened the vermicelli. This material was then transferred to the grainer provided with a steel wire screen having square openings of 0.093 inch, and wires by 0.032 inch in diameter. The case hardened, cooled, and partially dried vermicelli were broken up, and forced through the screen by means of fingers and ploughs on revolving arms. The moisture content of the material at this step of the process was between 7 and 8%. The granules passing through the screen were placed in drying trays to a depth of 1½ to 2 inches and dried for 20 hours at a temperature of 135° F. During the drying the material became caked, and upon removal from the dry house it was broken up in the same graining machine, using a screen having square openings of 0.102 inch, which allowed all of grained material to pass through. The final treatment was the screening of the granular free-flowing mass through a standard 8 mesh screen and over a 30 mesh screen. The moisture content was 0.31%.

EXAMPLE 2

65.5 parts of a solution containing 43.23 parts of ammonium nitrate were put into a jacketed dough mixture, and 23 parts of coated ammonium nitrate added with the mixer in operation and hot water in the heating jacket until the temperature of the mixer contents was 150° F. At this stage 120 parts more of ammonium nitrate and 15 parts of corn starch, containing 12.7% moisture, were added with continued mixing and heating until the temperature of the dough was 120° F. The dough was then forced through a steel wire screen having 0.102 x 0.102 inch square openings, and 0.041 inch diameter wires. During this operation which required 45 minutes the material was blown with air at 88° F., and an additional period of one hour for case hardening. This operation was followed by treating the vermicelli on a graining machine equipped with a wire screen having square openings of 0.093 inch, and wire 0.032 inch in diameter. The grained granular material was put in drying trays and allowed to stand at room temperature for 17 hours, and then blown in a container for 4 hours with air at 145° F. The dried product was passed over a U. S. Std. 30 mesh sieve.

EXAMPLE 3

70 parts of coarse ammonium nitrate, 97% passing through a standard 14 mesh sieve and 13% through a 40 mesh, coated with 0.3% of a mixture of 75% petrolatum and 25% paraffin, and 4:1 parts of corn starch, containing 12.2% moisture, were placed in a warm jacketed dough mixer and thoroughly mixed. 4.5 parts of water were added with continued kneading, followed by the addition of 12.3 parts of fine ammonium nitrate of such a fineness that 68% passed through a 100 mesh standard sieve, and 22.5 parts of fine material passing a standard 30 mesh sieve, obtained by screening the dried grained product having a similar composition and method of preparation as now being described. The total time of the mixing required about 3 minutes. 2.0 parts more of water were added with continued mixing for 1 to 2 minutes. The temperature of the mixture at this stage was 86° F. The moistened mass was rubbed through a flat screen having 0.132 inch square openings, and 0.035 inch diameter wires. The resulting granular mass was placed in drying trays to a depth of 1½ to 2 inches and dried at 160° F. for 10 hours. The dried porous cakes composed of granules were rubbed through a screen having 0.093 inch square openings and 0.032 inch diameter wires. This product was passed over a vibrating screen having 0.0326 inch openings and 0.023 inch diameter wires. 88 parts of the desired product remained on the screen, and 10 parts passed through which would be used in a subsequent batch.

EXAMPLE 4

4250 parts of coarse ammonium nitrate similar to that used in Example 3 and 300 parts of corn starch, containing 12.2% moisture, were thoroughly mixed in a jacketed dough mixer and then 300 parts of water added with continued kneading, followed by the addition of 750 parts of fine ammonium nitrate 68% passing a 100 mesh standard sieve, and 1200 parts of fine material passing a 30 mesh sieve, obtained by screening the dried grained product having a similar composition and method of preparation as now being described. Heat was applied to the batch by means of the steam jacket of the mixer, and the temperature of the charge raised to 90° F. in 7 minutes with kneading. 200 parts of water were added at this stage and the kneading continued for 10 minutes. The final temperature of the batch was 93° F. The soft moist batch was rubbed through a screen having 0.130 inch square openings and 0.035 inch diameter wires. The resulting granular product was put on trays to a depth of from 1½ to 2 inches and dried in a dry house for 5½ hours at 160° F. The porous cake made up of granules, after cooling, was broken up and passed through a screen having 0.113 inch square openings, and 0.054 inch diameter wires. This product was screened over a sieve having 0.0326 inch openings. 4767 parts of the desired coarse granular product were obtained and 1186 parts of fine material which was used in a subsequent batch.

In each of the foregoing examples, the starch was present in the ultimate composition in a small

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CROSS REFERENCE Search ROOM

proportion insufficient in amount to combine with all of the oxygen capable of being liberated by the water soluble nitrate but sufficient in amount to bind the ammonium nitrate granules together. The relatively coarse ammonium nitrate granules retained their identity in the finished product. The starch and the fine ammonium nitrate (or the ammonium nitrate of the ammonium nitrate solution) formed a binder for the coarse ammonium nitrate granules, the final product being in the form of fragmented agglomerates consisting essentially of water soluble nitrate granules bound together by a starch-water soluble nitrate binder.

The following table represents the standard screen analysis of the products resulting from the above examples:

Table I

	Example			
	1	2	3	4
Passed U. S. std. sieve:	*Per cent*	*Per cent*	*Per cent*	*Per cent*
8-mesh	100.0	100.0	100.0	97.0
10-mesh	77.7	80.1	90.0	81.0
14-mesh	39.6	48.4	67.0	56.0
20-mesh	22.4	46.2	34.0	28.0
30-mesh	None	None	None	None
Apparent density	0.65	0.67	0.71	0.67

The apparent density was determined by placing the material in a 1¾" diameter cylinder and applying pressure of 5 pounds per square inch on each 2 inch increment (depth) of material filled into the cylinder until a column 10" high was produced. The weight of the charge was then divided by the weight of an equal volume of water at 16° C.

The explosive composition of the present invention gives great reliability due to its sensitiveness when used per se as an explosive fired by a booster. However, I have found that its greatest applicability is for the replacement of water soluble nitrates in permissibles and the like in which case the composition of the present invention is used with other ingredients commonly employed as, for example, oxygen consuming ingredients, oxygen suppliers, sensitizers, etc., as will be apparent to those skilled in the art.

Having described my invention what I claim is as follows:

1. The process of preparing starch-water soluble nitrate explosive compositions which comprises mixing starch and granular water soluble nitrate consisting of at least 60% ammonium nitrate, in the presence of water to a plastic consistency, the starch being present in a small proportion insufficient in amount to combine with all the oxygen capable of being liberated by the water soluble nitrate but sufficient in amount to bind the ammonium nitrate granules together, drying a relatively large surface area of the plastic mixture so produced at least sufficiently to case harden the same and to form agglomerates consisting essentially of water soluble nitrate granules bound together by a starch-water soluble nitrate binder, and fragmenting the case hardened mixture.

2. The process of preparing starch-water soluble nitrate explosive compositions which comprises mixing starch and granular water soluble nitrate consisting of at least 60% ammonium nitrate, in the presence of water to a plastic consistency, the starch being present in a small proportion insufficient in amount to combine with all the oxygen capable of being liberated by the water soluble nitrate but sufficient in amount to bind the ammonium nitrate granules together, passing the plastic mixture so produced through a sieve to provide grains, drying masses of the said grains at a temperature of at least 135° F. to provide porous cakes consisting essentially of agglomerates of water soluble nitrate granules bound together by a starch-water soluble nitrate binder.

3. A starch-water soluble nitrate explosive composition wherein the water soluble nitrate consists of at least 60% by weight of ammonium nitrate and the starch is present in a small proportion insufficient in amount to combine with all the oxygen capable of being liberated by the water soluble nitrate but sufficient in amount to bind the ammonium nitrate granules together, said composition being in the form of fragmented irregular agglomerates consisting essentially of water soluble nitrate granules bound together by a starch-water soluble nitrate binder, said agglomerates being of such size as to pass an 8-mesh sieve and be retained on a 30-mesh sieve and having an apparent density no greater than .71.

4. A starch-water soluble nitrate explosive composition wherein the water soluble nitrate consists of at least 60% by weight of ammonium nitrate and the starch is present in a small proportion insufficient in amount to combine with all the oxygen capable of being liberated by the water soluble nitrate but sufficient in amount to bind the ammonium nitrate granules together, said composition being in the form of fragmented irregular agglomerates consisting essentially of preformed water soluble nitrate granules of a size that would be held on a 40-mesh sieve, said granules being bound together by a starch-water soluble nitrate binder, said agglomerates being of such size as to pass an 8-mesh sieve and be retained on a 30-mesh sieve and having an apparent density no greater than .71.

CLAUDE H. CAREY.

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CERTIFICATE OF CORRECTION.

Patent No. 2,333,637. November 9, 1943.

CLAUDE H. CAREY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 8, for "art" read --are--; page 3, second column, line 26, claim 2, after "binder" and before the period insert --, and fragmenting the cakes to pass an 8-mesh sieve--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of January, A. D. 1944.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.