Patented Feb. 11, 1941 2,231,043

UNITED STATES PATENT OFFICE

2,231,043

HIGH EXPLOSIVE COMPOSITION

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No Drawing. Application August 3, 1939, Serial No. 288,131

12 Claims. (Cl. 52—14)

This invention relates to high explosive compositions containing an explosive ingredient and a water-soluble inorganic salt, and more particularly to ammonium nitrate high explosives having improved properties.

Ammonium nitrate is the most extensively used ingredient in present day high explosives of the dynamite type. It has replaced nitroglycerin in increasingly larger proportions for a number of reasons, notably because it possesses high explosive strength, has outstanding safety properties, and is economically attractive. Ordinarily it is used with a small amount of nitroglycerin or other nitric ester as sensitizing agent. While ammonium nitrate explosives have been used with great success, one disadvantage of this ingredient has always been noted, namely that it has a great affinity for water. Because of this fact, there is a tendency for explosive compositions high in ammonium nitrate to become hard and set on storage in the presence of even small amounts of moisture. This brings about a decreased sensitiveness of the explosive and a lesser degree of uniformity in performance. The water resistance of ammonium nitrate explosives is generally low because of the presence of this very soluble salt.

An object of the present is an ammonium nitrate explosive of improved water resistance. A further object is an explosive relatively high in ammonium nitrate content and possessing a decreased tendency to set after storage. A still further object is a high explosive of the semi-gelatinous type having decreased setting tendencies and of a higher degree of plasticity than similar compositions of the prior art. Additional objects will be disclosed as the invention is described more in detail hereinafter.

I have found that the foregoing objects are accomplished by including, as an ingredient in explosive compositions containing an explosive nitric ester and ammonium nitrate, a starch product in a state of sub-division such that the major portion will pass a 60-mesh screen, capable of forming a cohesive paste or of gelatinization by means of unheated water, and acting thereby as a protecting agent for the ammonium nitrate against water. Preferably this starch product is used in an amount less than 10% by weight, and I find a suitable quantity to be between 1 and 7%, depending somewhat on the type of ammonium nitrate explosive. While I find the use of this starch product by itself to be advantageous, preferably I introduce also into the explosive composition a small amount of a water-insoluble metal soap, which will act as a coating and protecting agent for the ammonium nitrate. Calcium stearate is my preferred material for such use. The presence together of the two ingredients named brings about very beneficial results.

In order to be effective, the starch used must have been previously treated so that it is capable of gelatinization by means of unheated water. This may be accomplished by pregelatinization processes, for example by heating the starch to a temperature of around 85° C., the exact temperature depending upon the amount of water or other material present, whereby a swelling and bursting of the granules takes place, due to the water content of the starch. The method of pregelatinization, however, is not a part of this invention. While a cornstarch product such as is obtained in the flaking process will give excellent results, I may employ equally well a pretreated cereal product obtained from wheat or oat kernels, or a starch from any other source. The essential is that the starch product be capable of forming a cohesive paste by means of unheated water.

Since the starch product of my invention is intended to function as an anti-setting agent for the ammonium nitrate or other water-soluble ingredient, it is necessary that it be in a relatively fine state of subdivision. A coarse product will not accomplish the objects of my invention, and I find it necessary to employ a starch product of the type described of such a degree of comminution that the major portion of it, that is more than 50%, will pass a 60-mesh screen. Preferably I use a product such that the major portion will pass a 100-mesh screen. This starch product should not be confused with the coarse, low density starch products of the prior art, commonly employed in low density powders, for the purpose of achieving high stick counts. Such light coarse material is inoperable for the purpose of the present invention.

As an illustration of the application of my invention, I find my novel starch product a de-

sirable addition to the type of dynamite designated as ammonia dynamites, which are nitroglycerin dynamites in which a portion of the nitroglycerin has been replaced by ammonium nitrate. When used in such compositions, it appears that the entrance of moisture brings about gelatinization of a portion of the starch, and this gelatinization aids in preventing segregation of the nitroglycerin content of the explosive and in maintaining it uniformly distributed. The starch-containing gel or paste also decreases the loss, by dropping, of solid or liquid ingredients from partly opened cartridges. Leaching of soluble salts by diffusion is likewise lessened by the paste. As specific examples of the advantages resulting from my invention in such dynamites, the following will serve, in which A is an ammonia dynamite according to the prior art, while B and C are corresponding compositions containing the pregelatinized starch of my invention.

	A	B	C
Nitroglycerin	14.0	14.0	14.0
Ammonium nitrate	36.5	36.5	36.5
Calcium stearate	0.3	0.3	0.3
Sodium nitrate	35.8	35.8	35.8
Starch	2.0		0.9
Pregelatinized starch		3.5	4.0
Other carbonaceous ingredient	4.9	3.5	2.0
Sulfur	6.0	5.9	6.0
Chalk	0.5	0.5	0.5
Cartridges per 50 lbs	110	111	108
Water resistance:			
½ hr	*4		
1 hr	**4		
7 hrs		*4	
24 hrs			*4

*Detonation.
**Failure.

The improvement in water resistance brought about by the presence of the pregelatinized starch in samples B and C above is apparent. The water resistance results were obtained by immersion of the partly opened dynamite cartridge in water in a metal tube for the time designated. Detonation was brought about by the use of a blasting cap.

I find my invention to be of great advantage also in the case of the special type of ammonia dynamites designated as semi-gelatins. These explosives are intermediate between ammonia dynamites high in ammonium nitrate content and the gelatin dynamites. Ordinarily they contain less than 22% nitroglycerin, between 60 and 70% ammonium nitrate, and a very small amount of nitrocellulose as gelatinizing agent for the nitroglycerin. The introduction of the nitrocellulose in the form of nitrocotton imparts a certain degree of gelatinization to the explosive, which improves the water resistance and makes these explosives load better in upwardly directed boreholes. The presence of finely divided, pretreated starch in such compositions brings about an improvement in two respects; namely, in decreasing the tendency of the explosive to set, and in aiding the working properties in manufacture, that is to say the plasticity. In the case of such explosives, I find it desirable also to introduce with the pregelatinized starch product a lubricating agent therefor, for example a vegetable oil or a petroleum fraction. As examples of suitable oils for such use I may cite castor oil, palm oil, soy bean oil, coconut oil, petroleum fractions, and the like. Solid lubricants may also be used. Desirably the pregelatinized starch product is treated or impregnated with the lubricating agent previous to its introduction into the explosive. The oil or other lubricating agent brings about an improvement in plasticity.

As an illustration of the advantage of my invention in this type of explosive, the following will serve, where A designates an explosive of the prior art and B one according to my invention.

	A	B
Nitroglycerin	20.0	20.0
Nitrocotton	0.3	0.3
Ammonium nitrate	63.0	62.4
Calcium stearate	0.6	0.5
Pregelatinized starch		2.0
Castor oil		0.1
Other ingredients	16.1	14.7
Hardness after 3 months*	50+	9
Appearance	Set hard	Plastic and soft

*In the hardness values above, the results were obtained on samples which had been stored at 95° F. for a period of three months. The values indicate the relative pressures required to be exerted on the explosive for the penetration of a standard punch one inch into the explosive. It is apparent that the presence of the pregelatinized starch has kept the semi-gelatin soft and plastic.

The foregoing discussion and examples show plainly the advantages of my invention. The specific embodiments cited have comprised explosive compositions containing both nitroglycerin and ammonium nitrate, and I find particular application for my invention in such compositions. The pregelatinized starch product, however, may be used to advantage also in ammonium nitrate explosive compositions in which sensitizing agents other than nitroglycerin have been employed, for example ammonium nitrate-nitrostarch compositions. It may find application also in explosive compositions containing water-soluble ingredients other than ammonium nitrate, for example sodium nitrate, soluble chlorates and perchlorates, and the like. In other words, it will be efficacious in all explosive compositions where setting problems may be present, or where protection against water penetration is desired.

I have described my invention in detail in the foregoing. It will be understood, however, that many variations may be introduced in compositions and procedures without departure from the scope of the invention. I wish, therefore, to be limited only by the following patent claims.

I claim:

1. A high explosive composition which comprises an explosive ingredient, a water-soluble inorganic salt, and a protecting agent for said inorganic salt comprising a starch product capable of forming a cohesive paste with unheated water, said starch product being of such a state of comminution that the major portion thereof will pass a 60-mesh screen.

2. A high explosive composition which comprises a liquid explosive ingredient, a water-soluble explosive inorganic salt, and a protecting agent for said inorganic salt comprising a starch product capable of gelatinization by unheated water, said starch product being of such a state of comminution that the major portion thereof will pass a 60-mesh screen.

3. A high explosive composition which comprises a liquid explosive ingredient, ammonium nitrate, and a protecting agent for said ammonium nitrate comprising a pretreated cereal product capable of gelatinization by unheated water, said cereal product being of such a state of comminution that the major portion thereof will pass a 60-mesh screen.

4. A high explosive composition which comprises an explosive ingredient, ammonium ni-

trate, and a starch product capable of forming a cohesive paste with unheated water, said starch product being of such a state of comminution that the major portion thereof will pass a 60-mesh screen.

5. A high explosive composition characterized by improved non-setting characteristics, said composition comprising a liquid explosive ingredient, ammonium nitrate, and not more than 10% of a starch product capable of gelatinization by unheated water and of such a state of subdivision that the major portion thereof will pass a 60-mesh screen.

6. A high explosive composition which comprises a liquid explosive ingredient, ammonium nitrate, a starch product capable of gelatinization by unheated water and of a state of subdivision such that the major portion thereof will pass a 60-mesh screen, and a lubricating agent for said starch product.

7. A high explosive composition of the semi-gelatinous type, which comprises nitroglycerin, nitrocellulose, ammonium nitrate, a starch product capable of gelatinization by unheated water and of a state of subdivision such that the major portion thereof will pass a 60-mesh screen, and a lubricating agent for said starch product.

8. The explosive composition of claim 7, in which the lubricating agent is a vegetable oil.

9. The explosive composition of claim 7, in which the lubricating agent is a petroleum fraction.

10. A high explosive composition which comprises a liquid explosive ingredient, ammonium nitrate and a protecting agent for said ammonium nitrate comprising a pretreated cereal product capable of gelatinization by unheated water, said cereal product being of such a state of comminution that the major portion thereof will pass a 100-mesh screen.

11. An explosive composition which comprises a water-soluble inorganic salt, and a protecting agent for said inorganic salt comprising a starch product capable of forming a cohesive paste with unheated water, said starch product being of such a state of comminution that the major portion thereof will pass a 60-mesh screen.

12. An explosive composition which comprises ammonium nitrate and a protecting agent for said ammonium nitrate comprising a starch product capable of forming a cohesive paste with unheated water, said starch product being of such a state of comminution that the major portion thereof will pass a 60-mesh screen.

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