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BLASTING EXPLOSIVE COMPOSITION

Clarence H. Winning, Woodbury, N. J., assignor to
E. I. du Pont de Nemours & Company, Wilmington,
Del., a corporation of Delaware

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This invention pertains to blasting explosive compositions containing a large quantity of water-soluble constituents, and more particularly to such compositions containing water-soluble, inorganic salts capable of yielding an excess of oxygen on decomposition.

Recent trends in the development of blasting explosives, such as dynamite for example, show that the various formulations contain increasingly large percentages of ammonium nitrate. Since other oxygen-yielding salts such as sodium nitrate are usually present also, the total amount of water-soluble constituents in the composition is considerable. These materials are effective because they are potential oxygen suppliers, have outstanding safety characteristics, and are economical. In addition, ammonium nitrate, upon initiation, is capable of exerting high explosive strength, which renders this material particularly desirable. A disadvantage characterizing the use of these materials resides in the fact that they are water-soluble. As a result, dynamites containing an appreciable quantity of these salts can not be used in the presence of a substantial amount of water because of the danger that the compositions may become insensitive and thus fail to detonate.

As a result of the deleterious effect of water on this type of blasting explosive, various precautions have been taken in order to decrease the affinity for water. Nitrocellulose has been added so that it would form, together with an explosive nitric ester such as nitroglycerin, a film which would tend to coat the water-soluble ingredients and thus protect them from the action of water. Although this method has proved successful so far as the application of the finished explosive is concerned, it entails various steps and equipment in the processing of the explosive which renders it a more complicated procedure than is desired.

An object of the present invention is a novel method for increasing the water resistance of blasting explosives having a high content of water-soluble, oxygen-yielding salts. Another object is an explosive composition containing a large quantity of water-soluble, oxygen-yielding salts, said composition being characterized by high water resistance. A further object is a dynamite containing a substantial quantity of water-

soluble, oxygen-yielding salts, which can be initiated in the presence of water. 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 in the explosive compositions containing water-soluble oxygen-yielding salts, starch and an agent capable of gelatinizing said starch in the presence of water under ordinary atmospheric conditions. The quantity of starch used will vary depending on the formulation of the particular composition with which it is employed. Preferably, it is used in an amount less than 10% by weight, and I find that, for the more common formulations, a quantity between 1 and 7% is effective. Likewise, the amount of the agent employed for gelatinizing the starch varies, depending on the degree of activity which said agent exhibits with respect to the starch. Thus, I have found that additions of 1 to 3% of urea to a blasting explosive composition containing 6% starch result in the formation of a pasty mass, on exposure to water, which affords protection for the water-soluble salts.

Various gelatinizing agents have proved to be efficient. Among these are the thiocyanates, such as ammonium or potassium thiocyanate, dicyandiamide, calcium cyanamide, urea, thiourea, iodides such as sodium and potassium iodide, sodium benzene sulfonate, sodium alpha naphthalene sulfonate, sodium p-toluene sulfonate, zinc chloride, thioacetamide, sodium trichloracetate, thiobarbituric acid, sodium thiobarbiturate, sodium thioglycollate, sodium thiocynoacetate, hexamethylene-tetramine, calcium chloride, and stannous chloride. These agents have the capacity to yield a thick gel when they are added to a mixture of starch and water at ordinary temperatures. The starch paste or gel, when present in an explosive composition, exhibits remarkable properties. Not only does it afford substantial protection to the various water-soluble ingredients, with the result that water penetration of the composition is materially reduced, but, in addition, it tends to inhibit the leaching out of the explosive ingredients which are water-soluble. In addition, it also prevents to a marked extent the displacement or segregation of the sensitizing material, such as nitroglycerin. Con-

sequently, even though the explosive composition becomes very wet, it nevertheless can be detonated by the usual means of initiation.

The application of starch, together with the gelatinizing agent, is illustrated in the following example, which recites compositions of the ammonia dynamite type.

	Nitroglycerin-----	15.0	15.0	15.0	15.0
	Ammonium nitrate--	36.0	36.0	36.0	36.0
10	Sodium nitrate-----	35.3	35.3	35.3	35.3
	Calcium stearate----	0.3	0.3	0.3	0.3
	Starch-----	6.0	6.0	6.0	6.0
	Other carbonaceous				
	ingredients-----	1.9	1.7	1.7	1.7
15	Sulfur-----	5.0	4.2	2.2	3.2
	Chalk-----	0.5	0.5	0.5	0.5
	Urea-----	—	1.0	3.0	—
	Potassium thiocyanate	—	—	—	2.0
20	Ctgs./50 lbs.-----	110	110	109	109

Water resistance:

	1 hr-----	4D			
	2 hrs-----	4F			
25	24 hrs-----		4D	4D	4D
	48 hrs-----		4D	4D	4D

D=detonation.
F=failure.

The improvement wrought in the water resistance of the ammonia dynamite as the result of the addition of the gelatinizing agents, viz., urea and potassium thiocyanate, is apparent, since the compositions containing these, namely B, C, and D, were sensitive to initiation even after a period of 48 hours, whereas composition A, containing no gelatinizing agent, failed to detonate after a period of 2 hours. The foregoing water resistance results were obtained by immersing partly opened dynamite cartridges in water in a metal tube for the time designated. At the end of the period, detonation was attempted by means of a No. 6 blasting cap.

Although the gelatinizing agents may be employed advantageously with essentially any dynamite composition containing a starch product, I prefer to use them in conjunction with those compositions which contain at least 40 parts by weight of a water-soluble constituent, because with such compositions the need for increased water resistance is great, and the effect of the protective pasty mass is more pronounced. Thus, in the compositions cited in the foregoing example, it will be noted that the content of ammonium nitrate and sodium nitrate is about 71 parts by weight. In view of the fact that some of the other ingredients are somewhat soluble in water, it can be appreciated that a major part of the composition is soluble in water, hence would normally be unsuited for use where water was present.

Examination of dynamites made in accordance with my invention reveals that, when said dynamites are subjected to the action of water, a pasty mass results because of the gelatinizing of the starch, said pasty mass in effect comprising a binder and coating which serves to protect the water-soluble constituents. Also, even though there be an appreciable infiltration of water, by preventing segregation of ingredients the explosive remains sensitive to initiation, so that failures are reduced to a minimum.

As stated in the foregoing, I am aware of the fact that the water resistance of dynamite compositions has been increased by the addition of

nitrocellulose which combines with nitroglycerin or its equivalent to yield a colloided mass which coats the water-soluble salts and thereby renders them less susceptible to the deleterious action of water. This class of explosives is known as the gelatin type and such explosives have no need of the increased water resistance contemplated by the present invention. Instead, I am concerned with explosive compounds high in water-soluble ingredient content which do not contain nitrocellulose gelatinized with nitroglycerin.

Although I have described my invention in detail, it will be clear to those skilled in the art that my description permits of variations, without departing from the spirit of the invention. As an example, known gelatinizing agents for starch other than those set forth in the foregoing description may be employed. Likewise, variations may be made in the manner of adding the gelatinizing agents and the starch, the sole requisite being that the starch and the gelatinizing agents be in close contact with each other in substantially uniform distribution throughout the explosive mass. I intend therefore to be limited only in accordance with the following patent claims.

I claim:

1. A blasting explosive comprising an explosive ingredient, a water-soluble oxygen-yielding inorganic salt, starch, and an agent capable of gelatinizing said starch in the presence of water at ordinary temperatures.
2. A blasting explosive composition comprising an explosive nitric ester, ammonium nitrate, starch, and an agent capable of gelatinizing said starch in the presence of water at ordinary temperatures.
3. A blasting explosive composition comprising an explosive liquid nitric ester, at least 40 parts by weight of a water-soluble oxygen-yielding inorganic salt, starch, and an agent capable of gelatinizing said starch in the presence of water at ordinary temperatures.
4. A blasting explosive composition comprising nitroglycerin, at least 40 parts by weight of a water-soluble oxidizer including ammonium nitrate, starch in finely-divided condition, and an agent capable of gelatinizing said starch in the presence of water at ordinary temperatures.
5. The explosive composition of claim 4, wherein the gelatinizing agent comprises a thiocyanate.
6. The explosive composition of claim 4, wherein the gelatinizing agent comprises dicyandiamide.
7. The explosive composition of claim 4, wherein the gelatinizing agent comprises urea.
8. A blasting explosive composition comprising nitroglycerin, ammonium nitrate, less than 10 parts by weight of finely-divided starch, and 1 to 5 parts by weight of an agent capable of gelatinizing the starch in the presence of water at ordinary temperature.
9. A blasting explosive comprising a water-soluble, oxygen-yielding inorganic salt, starch, and an agent capable of gelatinizing said starch in the presence of unheated water.
10. A blasting explosive comprising ammonium nitrate, starch, and an agent capable of gelatinizing said starch in the presence of unheated water.

CLARENCE H. WINNING.