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EXPLOSIVE COMPOSITION

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The present invention relates to an improved dynamite composition. This application is a continuation-in-part of our copending application Serial No. 450,271, filed August 16, 1954, now abandoned.

The dynamite compositions of greatest commercial importance consist essentially of a high explosive sensitizer and a mixture of inorganic oxidizing salts and carbonaceous combustibles. The explosive sensitizer, usually a liquid explosive nitric ester such as nitroglycerin, facilitates initiation of the composition and provides explosive strength. The oxidizing agents and combustibles contribute to the strength of the explosive composition and also provide a means for regulating the gaseous products of combustion to eliminate or reduce obnoxious gases. Other additives, such as gelling agents, antacids, plasticity promoters and the like are frequently included in dynamite compositions.

The sensitivity or propagating power of a dynamite composition is closely related to the density of the composition, the relationship being that increasing density decreases the sensitivity, all other things being equal. For the foregoing reason, many types of low-density ingredients have been investigated and evaluated for use in dynamite composition. The low-density ingredient should preferably contribute to the strength or performance of the composition and should not impart undesirable properties to the composition. The density of the nitroglycerin ester cannot be materially changed, and only slight changes in the density of the inorganic oxidizing salts can be achieved. Therefore, the greatest amount of density control must be provided by selection of the combustible ingredients if the preferred result is to be achieved.

Carbonaceous materials such as wood pulp and various vegetable fibers have a relatively low density in their dry form, but are so absorbent that the nitroglycerin is drawn

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U.S. Patent 1,963,622, expanded cereal products have been found to be less absorbent than the pulps and fibers, so that reduced density can be obtained and the cartridge properties retained. However, upon storage, a gradual absorption of the nitroglycerin does occur even in the case of the expanded cereal products, thus diminishing the effectiveness of the low-density ingredient. In addition, exposure to moisture during storage and subjecting the composition to considerable pressure while immersed in water results in the absorption of water by the combustible ingredient to such an extent that the propagating power is greatly reduced.

Accordingly, an object of the present invention is to provide a dynamite composition which does not lose propagating power when subjected to immersion in water even under great pressures. A still further objective is to provide a dynamite composition having the foregoing characteristics and which retains the desired plasticity and cartridge properties. Other objects will become apparent as this invention is more fully described.

We have found that the foregoing objects are achieved when we prepare a gelatin dynamite composition wherein a low-density ingredient comprises a water-insoluble thermosetting synthetic resin in the form of hollow spherical balloons having a diameter in the range of from 2 to 360 microns, the bulk density of said balloons being less than 0.3 gram per cubic centimeter. A gelatin dynamite composition prepared in accordance with this invention will contain from 0.25 to 4% by weight of the balloons. Additional combustible ingredients will normally be included, the amount and nature being determined by the requirements of the composition.

In order to more fully describe the present invention, reference is now made to the following examples. These examples represent specific embodiments of this invention, the invention not being limited to the proportions and ingredients named.

The gelatin dynamite compositions described in the following table were prepared in a conventional manner on standard dynamite machinery and packaged in 2 1/4 inch diameter shells approximately 24 inches in length, the shells consisting of spirally-wound paraffin-sprayed tubes. The weight of each cartridge was approximately 5 pounds.

Pressure and velocity tests results were obtained by

Table I
[Percent]

Ingredients	Composition							
	A	B	C	D	E	F	G	H
Nitroglycerin ¹	50.0	50.0	50.0	40.0	40.0	40.0	30.5	30.
Nitrocellulose.....	2.2	2.2	2.2	1.8	1.8	1.8	0.6	1.
Sodium nitrate.....	32.8	32.8	32.8	29.3	29.3	29.3	30.2	26.
Ammonium nitrate.....				14.0	14.0	14.0	26.5	31.0
Chalk.....	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.4
Starch.....	4.5	6.0	4.5	6.0	5.5	5.5	6.1	4.7
High density meal.....	4.3	6.5	6.0	6.5	5.0	5.0	4.6	4.0
Wood pulp.....		1.0		1.0				
Expanded cereal.....	5.7					4.0	1.0	
Resin balloons ²		1.0	4.0	1.0	4.0			2.0
Total.....	100	100	100	100	100	100	100	100

¹ A nitrated mixture of 80% glycerin and 20% ethylene glycol.
² The resin balloons used were commercially sold under the Standard Oil of Ohio trademark "Microballoons" and were manufactured by the Bakelite Company, a Division of Union Carbide and Carbon Corporation. The balloons were prepared from a Bakelite Company phenol-formaldehyde formulation and had the following specifications:
Bulk density, 8.7 lb. per cu. ft.
Particle density, 9.3 lb. per cu. ft. in oil.
Average particle size (dia.), 0.0013 inch.
Size range (dia.), 0.0002 to 0.0036 inch.

into the pulp or fiber to such an extent that the resultant composition not only remains at high density, but also becomes dry and difficult to cartridge. As described in coupling two cartridges in end-to-end relation by means of a cardboard tube, inserting an electric detonator at the outside end of one cartridge, attaching two recording tar-

gets (small shells designed to close a circuit when collapsed) at a predetermined spacing on the second cartridge, and inserting the described assembly into a 4-inch diameter steel tube. The ends of the tube were gasketed and sealed, the wires leading to the detonator and the targets passing between two gaskets. The tube was then filled with water and immersed into the testing pond after which additional water was pumped into the tube until the specified pressure was attained. The target wires were connected to a recording chronograph and the detonator wires were connected to an energy source. After immersion at the stated pressure for the specified period, the detonator was initiated and the record made. The results were as follows:

Composition A.—A fresh sample detonated at a velocity of 2400 meters per second after 15 minutes immersion at 250 pounds per square inch.

A sample stored for one month at 100° F. in a humid atmosphere did not propagate detonation after 15 minutes immersion at only 150 pounds per square inch and detonated at a velocity of 4880 meters per second after 15 minutes immersion at 100 pounds per square inch.

Composition B.—A fresh sample detonated at a velocity of 6350 meters per second after 15 minutes immersion at 250 pounds per square inch, and at 5600 meters per second under the same conditions after 1 month storage at 100° F. in a humid atmosphere.

Composition C.—A fresh sample detonated at a velocity of 5900 meters per second after 15 minutes immersion at 250 pounds per square inch, and at 5200 meters per second under the same conditions after 1 month storage at 100° F. in a humid atmosphere.

Composition D.—A fresh sample detonated at a velocity of 6680 meters per second after 15 minutes immersion at 250 pounds per square inch, and at 5640 meters per second under the same conditions after 1 month storage at 100° F. in a humid atmosphere. After 18 hours immersion at 250 pounds per square inch, a sample which had been stored for 1 month at 100° F. in a humid atmosphere detonated at a velocity of 6190 meters per second.

Composition E.—A fresh sample detonated at a velocity of 5520 meters per second after 15 minutes immersion at 250 pounds per square inch. A sample stored 1 month at 100° F. in a humid atmosphere detonated at a velocity of 6040 meters per second after 18 hours immersion at 250 pounds per square inch.

Composition F.—The fresh sample detonated at a velocity of 5900 meters per second after 15 minutes immersion at 250 pounds per square inch pressure. After storage for one month at 100° F. in a humid atmosphere, the composition failed to propagate detonation at a pressure of 250 pounds per square inch.

Composition G.—The fresh sample failed to propagate detonation after 15 minutes immersion even at only 150 pounds per square inch, a satisfactory detonation was obtained when the pressure was 87 pounds per square inch.

Composition H.—A fresh sample detonated at a velocity of 5640 meters per second after 15 minutes immersion at 250 pounds per square inch. A sample stored 1 month at 100° F. in a humid atmosphere detonated at a velocity of 6680 meters per second under the same conditions.

The foregoing examples clearly illustrate the improved storage characteristics imparted to the compositions by relatively small amounts of the resin balloons. Composition A is representative of a typical gelatin dynamite composition using the low-density ingredients of the prior art in a sufficient proportion to provide the desired propagating power even at high pressures. The storage test conclusively shows that the propagating power is severely decreased after a month's storage. Compositions B and C are fully equivalent to that of Composition A except for the presence of the resin balloons, yet the storage test shows that excellent retention of propagating

power was attained. Compositions D, E, F, and G are representative of the so-called "ammonia gelatin" dynamites. Composition F is representative of the compositions known to the art, and the propagating power test, even on a fresh sample, shows that the sensitivity after immersion under pressure is undesirably low. The incorporation of the resin balloons not only increases the initial propagating power, but the new sensitivity is retained after adverse storage.

The compositions described above used a nitrated mixture of glycerin and ethylene glycol as the sensitizer. Such nitrated mixtures, and other nitrated mixtures of glycerin and compounds such as sugar, polyglycerin, polyethylene glycol, etc., are known to the art by the general term "nitroglycerin." We intend the term to have this meaning when used throughout this description. The composition of this invention will generally contain from 20 to 80% by weight of nitroglycerin. Many types of high density combustibles (0.6 or more grams per cubic centimeter) are known to the art. Typical high density combustibles are starch, ivory nut meal, apricot pit meal, walnut shell meal, soybean meal, wheat flour, etc. Low-density combustibles frequently used in dynamites include, in addition to expanded cereals, wood pulp, ground cork, bagasse pith, and the like. The inclusion of both high density and low density combustibles in addition to the resin balloons is within the scope of the present invention as is shown by compositions B and D. This permits adjustment of the oxygen balance for fume control and explosive strength without requiring large amounts of the resin balloons. This is important from both an economic standpoint and for density control. Preferably, the dynamite composition should have a density greater than 1 in order to permit ready submergence in water. The combustible content of the composition of this invention will generally be from about 5 to 20% by weight.

The composition in accordance with the present invention will contain from 10 to 70% by weight of an inorganic oxidizing salt. The usual salts used in explosive compositions are ammonium nitrate and sodium nitrate because they are the least expensive and have the desired reactivity with fuels. Additives such as antacids, e.g., chalk, and gelling agents, e.g., nitrocellulose, will be present in quantities required for their proper functioning.

The present invention is primarily applicable to gelatin dynamite compositions because these compositions are most subject to loss of propagating power on storage and because gelatin compositions are more frequently used where water-resistance is a factor. The gelatin dynamite compositions generally contain from 0.5 to 6% by weight of nitrocellulose as the gelling agent to gelatinize the nitroglycerin.

The compositions of the present invention are adapted to be prepared by conventional mixing equipment and to be loaded by the usual loading devices. The resin balloons, despite their very thin walls, have a very high resistance to crushing and will not be broken during the mixing and loading operations. Because of their smooth spherical form, they can be thoroughly mixed into the dynamite composition.

As previously indicated, the resin balloons used were prepared from a phenol-formaldehyde formulation. "Microballoons" manufactured by the Carlton Company of Cleveland, Ohio, of a urea-formaldehyde resin formulation are also available and have essentially the same physical characteristics and properties. The "Microballoons" are commercially manufactured for use as a floating roof on volatile petroleum to reduce evaporation losses. Obviously, neither the resin formulation nor the method of manufacture of the balloons is within the scope of this invention, provided the resin is water- and nitroglycerin-insoluble. The particle size and bulk density are critical, however. Particles larger than about 360

microns can not withstand the crushing action encountered both in the preparation and underwater use of the dynamite composition unless they have relatively thick walls. As the walls of the balloons become thicker, the bulk density increases, and the hollow spaces in the balloons become less effective as localized "hot spots" due to compression of a gas when the dynamite is initiated. Resin balloons less than about 2 microns in diameter contain insufficient entrapped gas for the desired maintenance of propagating power. The requirement that the bulk density be less than 0.3 gram per cubic centimeter is a control on the wall thickness, and therefore the amount of hollow space in the balloons.

The quantity of resin balloons used must be at least 0.25% by weight based on the total composition to impact improvement in propagating power to the composition. Inasmuch as the resin itself is combustible, very large quantities can be used without deleterious effect on the strength of the dynamite; however, because the resin balloons are much more costly than other well-known combustibles, and because no beneficial result is obtained by the use of more than about 4% by weight of the total composition, the preferred composition will contain between 0.25 and 4% by weight of the resin balloons.

The invention has been fully described in the foregoing. We intend, therefore, to be limited only by the following claims.

We claim:

1. A gelatin dynamite composition comprising about from 20 to 80% by weight of nitroglycerin, about from 0.5 to 6% by weight of nitrocellulose, about from 10 to 70% by weight of an inorganic oxidizing salt, and about from 0.25 to 4% by weight of the entire composition of a water and nitroglycerin insoluble polymerized thermosetting resin selected from the group consisting of urea-formaldehyde and phenol-formaldehyde resins in the form of thin-walled, hollow, spherical balloons, said balloons having a bulk density of less than about 0.3 gram/cc. and a diameter between 2 and 360 microns, said gelatin dynamite composition having a bulk density of greater than 1.

2. A gelatin dynamite composition comprising about from 20 to 80% by weight of nitroglycerin, about from 0.5 to 6% by weight of nitrocellulose, about from 10 to 70% by weight of an inorganic oxidizing salt, and about from 0.25 to 4% by weight of the entire composition of a water and nitroglycerin insoluble polymerized thermosetting urea-formaldehyde resin in the form of thin-walled, hollow, spherical balloons, said balloons having a bulk density of less than about 0.3 gram/cc. and a diameter between 2 and 360 microns, said gelatin dynamite composition having a bulk density of greater than 1.

3. A gelatin dynamite composition comprising about from 20 to 80% by weight of nitroglycerin, about from 0.5 to 6% by weight of nitrocellulose, about from 10 to 70% by weight of an inorganic oxidizing salt, about from 5 to 20% by weight of at least one combustible material selected from the group consisting of starch, ivory nut meal, apricot pit meal, walnut shell meal, soy bean meal, wheat flour, cereals, woodpulp, ground cork and bagasse pith, and about from 0.25 to 4% by weight of the entire composition of a water and nitroglycerin insoluble polymerized thermosetting urea-formaldehyde resin in the form of thin-walled, hollow, spherical balloons, said balloons having a bulk density of less than about 0.3 gram/cc. and a diameter between 2 and 360 microns, said gelatin dynamite composition having a bulk density of greater than 1.

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