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EXPLOSIVE

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My invention relates to improvements in explosives and more particularly relates to novel explosive compositions possessing exceptional toughness, cohesiveness, elasticity and extensibility or "stretchability". One of the objects of my invention is to provide explosive compositions of great cohesiveness, that can be greatly distorted in shape, without losing any fragments or portions of the explosive material. Another of the objects of my invention is to provide explosive compositions that are permanently elastic and deformable, and that do not lose their sensitiveness to detonation even after long storage.

My present invention rests upon my discovery that although rubber and sensitive high explosives cannot be directly incorporated by ordinary mixing operations, or even by the "milling" operations that are used in incorporating zinc oxide, carbon black, and other materials into rubber, it is possible to intimately and safely incorporate highly sensitive materials into rubber that is in distended or "latex" condition in an aqueous suspending material such as water, or in a non-aqueous suspending material such as gasoline, and that upon thereafter removing from the incorporated mixture the excess of the distending agent to form solid rubber, the high explosive material is left in this solid rubber in finely divided condition, the solid rubber acting as a matrix to hold the crystalline or amorphous particles of the high explosive material. The matrix of rubber serves not only as a binding agent and a bonding agent for the individual particles of the high explosive, but apparently also serves the very interesting and important purpose of reducing the tendency of the high explosive particles to rub or grind against one another with the production of a high friction hazard.

Ordinary caoutchouc or rubber may be employed as the vehicle or matrix for holding the pulverulent explosive materials, and the explosives produced in accordance with my present invention possess the ability to detonate with relatively high velocity and also possess the exceptionally valuable and unique property of being capable of being twisted, bent and otherwise distorted, without losing any of the pulverulent explosive material to which they owe their explosive action. This is a matter of great importance in some specific applications of explosives, where it is highly desirable that no portions of the explosive material should be cracked off or separated from the remainder of the explosive material as a result of stresses or accidental pressure or blows met with in the course of manufacture, transportation or use.

In the simplest form of my invention, I admix a concentrated natural rubber latex, or an equivalent latex containing synthetic rubber or a rubber surrogate with a solid pulverulent explosive material of the class of initial detonating agents. I prefer to employ a rubber latex containing from 15% to 50% of rubber content, and I prefer to admix the solid pulverulent initial detonating explosive constituent until I obtain the consistency of cream. For special uses I may employ still higher concentrations of the explosive constituent, so as to produce pastes having consistencies similar to those of soft shaving cream and still stiffer pastes having the consistency of tooth paste, or I may use still higher percentages of explosive constituent to produce tough, dough-like pastes.

Although I prefer to employ aqueous rubber suspensions and aqueous suspensions of rubber-like materials as my vehicle or matrix, my invention is not limited to aqueous latex products, and I may employ suspensions or distensions of rubber in non-aqueous "solvents" such as gasoline, kerosene, benzene or other like solvents. With explosives which tend to coagulate aqueous suspensions of rubber, I prefer to employ non-aqueous suspensions of rubber in so-called solvents such as kerosene or benzene, but I may intentionally employ latex-coagulating explosives, as a means of obtaining an intimate admixture of the explosive and the coagulated rubber. For example, sodium azide dissolves readily in an aqueous suspension of rubber of the latex type, without producing any coagulation of the rubber, but the addition of lead acetate to this solution of sodium azide in rubber latex produces the simultaneous formation of lead azide and the coagulation of the rubber, the lead azide being precipitated in the coagulated rubber as it separates from the aqueous latex condition.

The pulverulent explosive materials which may be satisfactorily used in the practice of my present invention are those quite sensitive explosive materials which are collectively known as initial detonating agents, and of which the best known and most commonly used are the fulminates of cadmium, silver, gold and mercury, the azides of cadmium, silver, lead and mercury, nitrogen sulfide, silver acetylide, the organic initial detonating agents of which the best known are nitrodiazobenzene perchlorate, trinitrotriazidobenzene, cyanuric triazide, diazobenzene nitrate, dinitroquinonediazide or "diazodinitrophenol", benzoyl

peroxide, hexamethylenetriperoxidediamine, and carbohydrate nitrates such as starch nitrate, mannitol hexanitrate and sucrose octanitrate and organic nitrates such as pentaerythritol tetranitrate, etc., the carbohydrate nitrates and pentaerythritol tetranitrate being relatively much less sensitive than the fulminates and azides. My invention is broadly applicable to the use of any initial detonating agent finally present as the pulverulent material in a solid matrix consisting predominately of extensible rubber or rubber surrogate, after the removal of the distending agent. With highly sensitive initial detonating compounds the percentage of rubber can be relatively high with the production of physically relatively strong mechanical aggregates of rubber in the explosive, but with less sensitive explosives the desensitizing effect of rubber becomes more marked, and it is necessary to employ higher percentages of the explosive, and lower percentages of the rubber, in order to obtain products that will detonate satisfactorily. The relative percentages of rubber and explosive which will give the best results depends upon the physical characteristics that are desired in the finished product and the sensitiveness of the explosive agent which is employed, and are of course individual to each specific explosive. Very sensitive explosives such as lead azide and mercury fulminate and initial detonating agents of substantially this same degree of sensitivity, and particularly explosives of high sensitiveness having an oxygen excess, give sensitive products in the presence of proportions of rubber up to 50% or even 60% or higher by weight, the proportions named being the rubber in the finished product after the separation or removal of the distending agent by evaporation or other means.

The proportions of rubber and pulverulent explosive that may be used in the practice of my present invention are exceptionally wide, and although I prefer to employ compositions containing from 10% of rubber to 40% of rubber, and from 90% to 60% of pulverulent explosive, I have obtained products possessing sufficient sensitiveness to detonate satisfactorily that contain materially more than 60% of rubber, and I have obtained products containing from 5% to 10% of rubber which still possess a considerable measure of the peculiar cohesiveness and plasticity which characterize the products of my present invention. It will of course be evident that small amounts of oxidizing agents, such as potassium chlorate or lead nitrate as specific examples, may be added to my compositions where it is desired to improve the oxygen balance of such products, or for any other reason, but in the preferred form of my invention my products consist exclusively or at least predominately of mixtures of natural rubber or the equivalent synthetic rubbers and rubber surrogates with pulverulent detonatable explosive materials of the class of initial detonating agents, the pulverulent explosive initial detonating agent preferably constituting half or more of the entire composition in its dry state, or after the evaporation or removal of the water initially present in the latex, or after the removal of the gasoline, kerosene, benzene, or other solvent or distending agent initially present in the non-aqueous rubber suspension.

The characteristic feature of my invention is a solid explosive consisting predominately of a mixture of rubber or an equivalent synthetic rubber or rubber surrogate and discrete pulverulent particles of a sensitive explosive such as mercury fulminate, lead azide, or other highly sensitive explosive material of the class of initial detonating agents, the rubber or its equivalent acting as a vehicle or matrix to physically hold the individual particles of the explosive material in relatively fixed position with relation to adjacent particles, but the mechanical aggregate so produced being capable of being deformed, stretched, twisted, etc. without losing its explosive characteristics, and without permitting the explosive particles to spall off, break off, fall off, or otherwise become separated from the main portion of the explosive material.

Explosives made in accordance with my present invention are not only useful when packaged as explosive cartridges but are particularly valuable for use in the preparation of non-rigid detonating trains of explosive material, for use in ordnance, mining and the like. I may form tapes, sheets, cords or trains of my explosive products, either alone or associated with reinforcing members of any desired type, and such sheets, tapes, cords or trains may be bent, twisted or otherwise distorted without any risk of destroying their explosive continuity through the breaking off or the separating of flakes or particles of the explosive material. Explosives made in accordance with my present invention avoid the hazard that is commonly associated with the handling of highly sensitive detonatable materials, where minute particles of the highly-sensitive explosive material may break off or separate from the main quantity of the material and may be a cause of accident through being stepped upon or otherwise accidentally subjected to pressure or friction. Products made in accordance with my present invention are tougher, and more coherent than most types of explosives now in commercial use, and the solid rubber matrix left after the removal of the distending agent holds the individual particles of the granulated or pulverulent explosive material with such tenacity that portions of the explosive material do not readily separate from the main portion of the material except as a result of intentional operations such as the cutting or sawing of the material.

It will be evident that many modifications may be made within the scope of the disclosure as herein described without departing from the characteristic features of my invention, and accordingly no limitations should be placed upon my invention except such as are indicated in the appended claims.

I claim:

1. As a new composition of matter, a tough, elastic, extensible, detonatable solid consisting predominately of a mechanical mixture of a finely divided pulverulent initial detonating agent and a non-detonatable elastic material selected from the group of natural rubber, synthetic rubber and rubber surrogate.

2. As a new composition of matter, a tough, elastic, extensible, detonatable solid consisting predominately of a mechanical mixture of a finely divided pulverulent detonatable explosive selected from the group of initial detonating agents present as discrete particles in a matrix of a non-detonatable elastic material selected from the group of natural rubber, synthetic rubber and rubber surrogate.

3. As a new composition of matter, a solid, tough, non-rigid, elastic, extensible, detonatable train relatively long in one dimension as compared with its other two dimensions and capable of being bent or twisted without losing its ex-

plosive or detonatable continuity and consisting predominately of a mixture of pulverulent particles of an initial detonating agent held in a non-detonatable elastic matrix comprising a material selected from the group of natural rubber, synthetic rubber and rubber surrogate.

4. As a new composition of matter, a solid, tough, non-rigid, elastic, extensible, detonatable train relatively long in one dimension as compared with its other two dimensions and capable of being bent or twisted without losing its explosive or detonatable continuity, comprising from 90 parts by weight to 60 parts by weight of discrete pulverulent particles of an initial detonating agent held in from 10 parts by weight to 40 parts by weight of a non-detonatable elastic and extensible matrix of a material selected from the group of natural rubber, synthetic rubber and rubber surrogate.

5. As a new composition of matter, a solid, tough, non-rigid, elastic, extensible, detonatable material capable of being distorted without the separation of flakes or particles of its mass and without losing its explosive or detonatable continuity, consisting predominately of a mixture of pulverulent particles of an initial detonating agent held in a non-detonatable elastic matrix comprising a material selected from the group of natural rubber, synthetic rubber and rubber surrogate.

6. As a new composition of matter, a solid, tough, non-rigid, elastic, extensible, detonatable train relatively long in one dimension as compared with its other two dimensions and capable of being bent or twisted without the separation of flakes or particles or its material and without losing its explosive or detonatable continuity, comprising from 90 parts by weight to 60 parts by weight of discrete pulverulent particles of an initial detonating agent held in from 10 parts by weight to 40 parts by weight of a non-detonatable elastic and extensible matrix of a material selected from the group of natural rubber, synthetic rubber and rubber surrogate.

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