

UNITED STATES PATENT OFFICE

WILLIAM M. DEHN, OF SEATTLE, WASHINGTON

PROPELLENT EXPLOSIVE

No Drawing.

Application filed October 28, 1929. Serial No. 403,132.

My invention relates to an improvement in propellant explosive compositions and more particularly to propellant explosives of the flashless-smokeless type. The invention comprises both a new composition and the process of making same.

Specifically my invention relates to a new powder comprising ammonium nitrate, colloidized starch and colloidized nitrocellulose. These are so minutely and intimately blended that desirable combustible properties are obtained when dry. Also, in the process of manufacture, while containing the solvents, it yields plastic masses capable of being molded in sizes and shapes commonly used with propellant powders.

The desirable properties obtainable with such blended materials are five-fold. First with proper high concentration of ammonium nitrate, and also starch, in mixtures with nitrocellulose, comparatively low temperatures of combustion are obtained and nozzle flash is eliminated. The effect of lowering the temperature, by the use of ammonium nitrate, is well known with many explosive compositions and was disclosed in colloidized starch-ammonium nitrate compositions in an application filed January 10, 1924, Serial No. 685,455, but is new with the present application for the triple combination above referred to.

Second, both ammonium nitrate and starch contribute to explosion gases an increased concentration of water molecules, because the former contains 45 per cent and the latter, 55 per cent of water. The advantages of such increase of water molecules not only raises the temperature of possible initial luminosity but also yields increased power, because water possesses the highest temperature of initial luminosity and the lowest molecular weight of all explosion gases. More than 10 per cent of increased power was obtained.

Third, ammonium nitrate and starch contribute to the safety qualities of explosive mixtures for the reason that all mixtures of these two components, having the high combined water concentration just referred to,

are not only difficultly combustible but also difficultly detonating.

Fourth, the starch in the gelatinous form not only contributes to the plastic condition of its mixtures in the process of manufacture but also affords a medium for dissolving, comminuting and holding the ammonium nitrate, so as to yield an intimate and compact mass of the three components.

Fifth, ammonium nitrate itself can contribute oxygen to all combustible explosive materials, hence in mixtures with nitrocellulose and starch, the proportions can be chosen so that the hydrogen will burn to water molecules and the carbon will burn to form CO, CO₂, or any intermediate mixture of the latter two molecules. This advantage in various mixtures, therefore, affords control of oxidation, sensitiveness, power and rate of detonation.

It is well known that mixtures of ammonium nitrate and nitrocellulose themselves afford proper regulation of the oxidant and combustible requirements, and it is also well known that all properly blended mixtures of these two must contain more than 36 per cent of nitrocellulose, (compare equations *c* and *d* below), otherwise in the hot explosion gases an excess of free oxygen is formed and this contributes to gun erosion. However, with starch as a component, not only is the water content advantageously increased, but the nitrocellulose content can be decreased, thereby regulating the oxygen requirements, lowering the cost of materials, and greatly lowering the explosion temperature below that producing luminosity and consequently yielding a power that is flashless. That is, in these mixtures, by making starch replace a substantial portion of the nitrocellulose, the flash point is favorably changed without loss of desirable explosive properties. Thus, these mixtures can be made to be sufficiently sensitive to inflammability, and while yielding smokeless, flashless and non-erosive gases, the power can be regulated and, indeed, can be increased through control of oxidant-combustible requirements as indicated by the CO and CO₂ limits of the fol-

lowing equations, in which nitrocellulose of 12.75 per cent N is taken as the basis:

- (a) $C_6H_{10}O_5 + 12NH_4NO_3 \rightarrow 6CO_2 + 29H_2O + 12N_2$ (14.4% starch)
 (b) $C_6H_{10}O_5 + 6NH_4NO_3 \rightarrow 6CO + 17H_2O + 6N_2$ (25.2% starch)
 (c) $2C_{12}H_{18}O_{10}(NO_2)_2 + 24NH_4NO_3 \rightarrow 24CO_2 + 63H_2O + 29N_2$ (36.38% N C)
 (d) $2C_{12}H_{18}O_{10}(NO_2)_2 \rightarrow 23CO + CO_2 + 15H_2O + 5N_2$ (100% N C)

With various concentrations of nitrocellulose; sufficient to sensitize the mixtures, taken as the basis of calculation, as, for example, 15, 20, 25 or 30% of nitrocellulose, it is possible to select the other components so as to yield explosion gases CO or CO₂ or equimolecular mixtures of these two gases, as indicated in the following table:

Nitrocellulose %	15.00	15.00	15.00:20.00	20.00	20.00:25.00	25.00	25.00
Starch %	12.24	10.35	8.46:11.52	9.72	7.92:10.80	8.15	5.50
Ammonium nitrate %	72.76	74.65	76.54:68.48	70.28	72.08:64.20	66.85	69.50
Explosion gases %							
	CO	CO	CO ₂ CO	CO	CO ₂ CO	CO	CO ₂
		CO ₂		CO ₂		CO ₂	
Nitrocellulose	30.00	30.00	30.00				
Starch	10.08	6.30	2.52				
Ammonium nitrate	59.92	63.70	67.48				
Explosion gases	CO	CO	CO ₂				
		CO ₂					

A good example of my new product is that comprising twenty-five per cent of nitrocellulose, 8.15% of starch and 66.85% of ammonium nitrate, the 25% of nitrocellulose being sufficient to sensitize the compositions with the stated contents of starch and ammonium nitrate so that an ordinary rifle cap causes uniform and complete burning of the charge, and the components being proportioned to secure equivalents of CO and CO₂ as oxidation products.

These three materials, being solids, could be ground to minute powders and then intimately mixed, but it is evident that if they could be minutely blended in compact masses the advantages of increased density and molded forms could be obtained.

In my process through the use of two solvents, the three materials are blended and consolidated by means of two miscible solvents, preferably water and acetone. Water is used to dissolve a substantial portion of the ammonium nitrate and to gelatinize the nitrocellulose. Since acetone is soluble in water, mixtures of such two solutions, or concentrated gelatinous forms of the same, can be mingled and blended without flocculation or clotting, when conditions are properly controlled. And I have found that the resulting mass possesses plastic properties suitable for die pressing, or for molding into sizes and shapes commonly used for propellant explosives.

As an example of my method of manufacture, I first make a very concentrated solution of 25 parts of nitrocellulose in acetone. I make an intimate mixture of 66.85 parts of finely ground ammonium nitrate and 8.15 parts of sifted starch. To this mixture, I add substantially 10 parts of water

and heat at 55–100° C. until the mass is uniformly gelatinized. To this I add the nitrocellulose solution, with as complete avoidance of inclusion of air bubbles as practicable, and then mix mechanically, while maintaining the temperature of 55–100° C. The warm smooth resulting plastic is pressed and cut in the customary manner for various propellant explosive purposes and dried. The drying can be effected at ordinary or elevated temperatures or by a combination of the two, or partial drying can be made before the pressed forms are cut.

Owing to hydrolysis and solution of the starch if the mixture is heated too long or at too high temperature, the composition may become too thin for die-pressing. This adverse condition is avoided by employing a suitably lower temperature or cooling to such lower temperature. The pressed forms can either be cut immediately or after such time, cooling and drying as will be necessary with the particular proportion of components used, to yield a mass that can be cut smoothly and show no tendency to distort or stick together.

The example of percentages given herewith is for illustration and affording an understanding of the invention, and can be varied to give powders of varied explosive properties, and yet fall within the scope of my claims.

Having now described my process and new composition of matter, what I claim is:

1. As an improvement in the manufacture of propellant powders, the process comprising the plasticizing of mixtures of starch, an alkali nitrate and nitrocellulose through the use of two miscible solvents, substantially as described.

2. As an improvement in the manufacture of propellant powders, the process comprising plasticizing mixtures of starch, ammonium nitrate and nitrocellulose, whose percentages are within the calculated oxidant-combustible explosive limits, through the use of two miscible solvents, substantially as described.

3. As an improvement in the manufacture of propellant powders, the process comprising blending by mechanical means an acetone solution of nitrocellulose with a heated mixture of water, starch and ammonium nitrate.

4. As an improvement in the manufacture of propellant explosives, the process comprising mixing by mechanical means a concentrated acetone solution of nitrocellulose with a thick, gelatinized mixture of water, ammonium nitrate and starch.

5. As an improvement in the manufacture of propellant explosives, the process comprising gelatinizing a mixture of acetone, nitrocellulose, water, ammonium nitrate and starch, pressing and cutting the same into

shapes and sizes commonly used with propellant powders, and subsequently drying the same.

6. As an improvement in the manufacture of propellant explosives, the process of heating to 55-100° C. a mixture of starch, ammonium nitrate and water and then mechanically mingling with this a concentrated solution of nitrocellulose dissolved in acetone, subsequently shaping this mass into propellant grains and drying the same.

7. A propellant explosive comprising a greatly preponderating proportion of ammonium nitrate in an intimate state and molded form with starch and colloidized nitrocellulose, the quantity of nitrocellulose exceeding that of the starch, substantially as described.

8. A propellant explosive comprising approximately 15-30 parts of nitrocellulose, 12-3 parts of starch, and 60-70 parts of ammonium nitrate.

9. A propellant explosive comprising approximately 25 parts of nitrocellulose, 8 parts of starch and 67 parts of ammonium nitrate.

10. A propellant explosive which will burn without material production of free oxygen, comprising a preponderance of ammonium nitrate, nitrocellulose over 10% and under 36% and approximately $\frac{1}{3}$ as much starch as nitrocellulose.

In testimony whereof, I have signed my name hereto.

WILLIAM M. DEHN.

CERTIFICATE OF CORRECTION.

Patent No. 1,819,458.

Granted August 18, 1931, to

WILLIAM M. DEHN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 23, for the word "nozzle" read muzzle; 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 22nd day of September, A. D. 1931.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.