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## EXPLOSIVE

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1 Claim. (Cl. 52—5)

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This invention relates to a novel and improved propellent powder and more particularly to one having superior ballistic properties.

In formulating powders for use in small arms, it is desirable to control the ballistic properties so that combustion will be uniform and progressive and so that unduly high temperatures and pressures will not be attained within the gun barrel. In order to promote progressive burning, it has been the practice to apply coatings of deterrent materials to the surface of the smokeless powder grains. This has been done in the case of both single base and double base powders and has been particularly desirable with the latter type because of the high potential of propellants containing nitroglycerin.

Several types of deterrent have been used in the past, all of which suffer important disadvantages, especially when applied to nitroglycerin powders. Centralite, for example, introduces manufacturing hazards because it must be applied at temperatures of 70° C. or above. Dinitrotoluene tends to penetrate completely through the powder grain and thus to destroy the progressive-burning property of the powder.

An object of the present invention is a propellent smokeless powder of improved ballistic properties. A further object is such a powder composition having burning characteristics that give the powder outstanding superiority. A still further object is a smokeless powder having its grains surface-coated with a new type of deterrent material, and a method of applying such coating. Additional objects will be disclosed as the invention is described more fully in the following.

I have found that the foregoing advantages are accomplished when I prepare smokeless powder grains and impart to them a coating of a substantially water-insoluble ester of a dicarboxylic aliphatic acid, desirably one having a melting point below 100° C. While varying amounts of such ester may be used and will provide an effective deterrent coating to the powder, I prefer to maintain an amount of the ester on the grains amounting to between 0.2% and 10.0% of the total weight of powder. Moreover, the coating material may be applied to any type of propellent smokeless powder, whether to single base powders, where nitrocellulose is the only nitric ester, or to double base powders, in which nitroglycerin or other high explosive nitric ester is present with the nitrocellulose. It may well be used also for cellular type powders, either single or double base, where a cellular structure has been

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obtained by first including a water-soluble material in the composition and subsequently removing said material by leaching.

The materials adapted for use as coating materials according to my invention are water-insoluble, relatively non-volatile esters of dicarboxylic aliphatic acids. Nonvolatility is desirable, as it means that there will be substantially no loss of coating material during manufacture and storage, hence no change in ballistic properties for such reason. Water-insoluble coatings are desirable, as they favor decreased hygroscopicity of product. As examples of esters suitable for use, we may cite dibutyl tartrate; the tartaric acid di-ester of ethylene glycol monobutyl ether better known as di(butylcellosolve) tartrate; the sebacic acid di-ester of ethylene glycol monobutyl ether known as di(butylcellosolve) sebacate; dibutyl adipate; the adipic acid di-ester of ethylene glycol monoethyl ether known as dicellosolve adipate; fumaric acid esters; and many others. Certain mixtures of lower esters of dicarboxylic acids higher than adipic have likewise been found advantageous. Desirably the coating agent will possess a certain degree of solubility for nitrocellulose, but this is not essential.

Various methods may be employed in coating the powder grains. One applicable method consists in preparing water slurries containing the powder and suspended ester. Preferably, however, I agitate the powder with about an equal weight of water in a tumbling and mixing device such as a sweetie barrel and spray the coating agent in liquefied form onto the powder surfaces. In order to obtain uniform distribution at temperatures which are not too high for safety, I prefer to use a coating agent that is liquid at temperatures of 20° C. or lower, and in any case one that has a melting point below 100° C. If desired, the spraying operation may be facilitated by diluting the deterrent with a volatile liquid of low viscosity, such as ethyl alcohol.

The following examples will serve to illustrate specific embodiments of methods of carrying out the invention, but are not to be taken as limiting it in any way.

*Example 1*

A smokeless powder colloid containing 16% finely divided potassium nitrate was pressed and cut into grains of diameter 0.050 in. and length $\frac{1}{125}$ in. The potassium nitrate was then extracted in water and the powder impregnated with 15% nitroglycerin. Part A of the powder was finished in the usual manner comprising the operations of air drying, glazing, and sieving.

Part B was introduced into 5 parts of water at room temperature and agitated for 2 hrs. During the first 1½ hrs., 4%, on the weight of the powder, of dibutyl adipate was added dropwise to the slurry. At the end of the coating treatment the powder was air dried, glazed and sieved in the usual manner.

The samples were then fired in a caliber .22 gun, using "long rifle" components, and 40-gr. lead bullets, with the following results:

| Part | Powder Coating | Charge, grains | Velocity, ft./sec. | Pressure, lb./sq. in. |
|---|---|---|---|---|
| A | None | 1.82 | 1,323 | 27,510 |
| B | Dibutyl adipate | 2.50 | 1,326 | 23,510 |

These ballistics show the value of the coating agent in that a very appreciable decrease in pressure was obtained with a slightly increased velocity.

*Example 2*

A powder similar to that of Example 1, but pressed and cut to a diameter of 0.041 in. and a length of $\frac{1}{125}$ in., was treated as follows:

Part A was finished by air drying, glazing with graphite and calcium stearate, and sieving.

Part B was introduced into a sweetie barrel with 10% water. The wet powder was then tumbled for 25 min. while a 50–50 solution of di(butylcellosolve) tartrate and ethyl alcohol was sprayed onto the powder at room temperature. The di(butylcellosolve) tartrate was used in the amount of 2.75% of the dry powder weight. After the addition of the coating agent, the powder was tumbled an additional hour. It was then removed from the barrel and finished in the same manner as part A.

The powders showed the following ballistics in the caliber .22 rifle:

| Part | Powder Coating | Charge, grains | Velocity, ft./sec. | Pressure, lb./sq. in. |
|---|---|---|---|---|
| A | None | 1.80 | 1,242 | 22 860 |
| B | Di(butylcellosolve) tartrate. | 2.20 | 1,370 | 22,580 |

Again a very marked improvement in ballistics was obtained by use of the coating agent. The coated powder had a much higher velocity at a lower pressure.



The foregoing examples have illustrated the invention by reference to propellants containing nitroglycerin, but it will be apparent that advantages will be obtained equally with single base powders. The water-insoluble ester applied will be mainly on the surface of the treated powder but will, of course, penetrate the wet powder slightly. The material applied will, however, be definitely present as a coating and not as a blended ingredient.

The advantages of the invention are apparent in that it allows the preparation of a propellent smokeless powder of superior ballistic properties. Since the coating materials are in liquid form at moderate temperatures of application, the necessity is avoided of heating the powder to elevated temperatures during the treatment. This avoids all safety hazards from elevated temperature treatment, as well as loss of nitroglycerin, when double-base powders are coated, by volatilization or solubility in excessively hot water.

While the invention has been described in full in the foregoing, it will be apparent that many variations in details of compositions and procedures may be introduced without departing from the scope of the invention. I intend to be limited, therefore, only by the following claim.

I claim:

A propellent powder composition comprising smokeless powder grains having a surface coating of di(butylcellosolve) tartrate, said coating being present in an amount between 0.2 and 10.0% of the total weight of the powder.

DON CHESTER LINDSTEN.


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