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PROPELLANT SMOKELESS POWDER

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This invention relates to the manufacture of propellant powders, and more particularly to smokeless powder of improved physical and ballistic properties for use in small arms ammunition.

Among the several properties of small arms powder which must be carefully regulated, two of the most important are its ballistic performance and its behavior in cartridge loading machines, that is to say the tendency of its grains to flow smoothly and consistently from a loading machine into successive similar cartridges. In the past, the burning rate has been rendered more or less progressive by choice of a suitable grain shape or by treating the grain surface with a burning deterrent which is a plasticizer of nitrocellulose, for example, dinitrotoluene. Furthermore, it has been customary to glaze the powder with graphite in an effort to make the grains flow smoothly. Powders manufactured according to these procedures have substantial disadvantages. In many cases, it is necessary to add so large a proportion of formerly known deterrents that a tarry residue remains in the gun barrel after firing; likewise, powders of small grain size, glazed with graphite, tend to stick or "set" in shipping containers and to load to non-uniform weight in successive cartridges.

An object of the present invention is a propellant smokeless powder composition of improved characteristics. A further object is such a powder composition glazed with an added material for improving its flowing properties. A still further object is a propellant powder so treated that it possesses superior burning characteristics when fired in small arms and shotguns. Additional objects will be disclosed as the invention is described more at length in the following.

I have found that the foregoing objects are accomplished and that an improved smokeless powder composition is obtained when I employ as a glaze for said powder a finely divided solid material substantially insoluble in water, said material comprising a metal salt of a higher monobasic aliphatic acid, particularly of stearic, palmitic, or oleic acid. As a suitable material for such purpose, I may use various compounds, for example, lead oleate, ferric oleate, calcium palmitate, stearates of calcium, magnesium, barium, zinc, and aluminum, and the like. Preferably I employ calcium stearate because of its effectiveness and its availability. The water-insoluble metal soap of my invention may be applied to the surface of the powder grain by any of several

methods well known in the art, and in any desired stage of powder manufacture after the powder grain has taken essentially its final shape. Preferably, however, the material is added after graphite glazing or in the latter part of the usual glazing operation.

The following examples will serve as specific embodiments of methods of carrying out the invention. It should be understood, however, that they are illustrative only and are not to be taken as limiting the invention in any way.

Example 1

A pistol powder was used having a grain made by rolling colloided nitrocellulose into a sheet of 0.01 inch thickness and breaking the sheet by mechanical means into flakes of such fineness that all would pass an 18-mesh screen. Dried grains in the amount of 4515 lbs. were introduced into a glazing barrel, along with 60 lbs. of graphite. The barrel was then rotated for 1 3/4 hours at a speed of 20 R. P. M. The operation was then stopped and 11.5 lbs. of finely divided calcium stearate was added, after which the barrel was rotated for an additional 3/4 hour. The glazed grains were removed from the barrel, sieved, and packed. The finished powder was loaded in caliber .45 cartridges and fired in the automatic Colt's pistol, with the results shown in Table I. Sample A is the powder of this example; while sample B is a powder of exactly similar manufacture except that it did not contain the added glazing agent of this invention.

Table I

Sample	Calcium stearate content	Charge weight	Projectile velocity	Pressure
	Percent	Grains	Ft. per s.	Lbs./sq. in.
A	0.25	6.0	802	13,120
B	None	6.0	813	14,620

The powder of Example 1 exhibited remarkably smooth flowing properties in comparison with powder of conventional composition. The improvement was apparent, not only on casual inspection, but also in actual cartridge loading machine tests. When 100 caliber .45 cartridges were machine-loaded with the conventional powder, the extreme variation in charge weight was 0.13 grain. Under the same conditions, and in the same loading machine, the powder of Example 1 displayed an extreme variation of only 0.09 grain.

Example 2

In this experiment, the powder was of cellular structure, in the form of discs about 0.05" in diameter and 0.008" thick. It contained 15% of nitroglycerin. The dry powder in the amount of 4243 lbs. was placed in a glaze barrel and 63.5 lbs. of graphite was added. The barrel was rotated at 22 R. P. M. for a period of one hour. The barrel was then stopped and 10.5 lbs. of calcium stearate added, after which the barrel was again rotated for ½ hour. The charge was finished by the usual methods of sieving through suitable screens. The finished powder was loaded into center-primed metallic cartridges and fired in the 9 m./m. Parabellum pistol, with the results shown in Table II. Sample A is the powder of this example; while sample B is a powder of exactly similar manufacture except that it did not contain the added glazing agent of this invention.

Table II

Sample	Calcium stearate content	Charge weight	Projectile velocity	Pressure
	Per cent	Grains	Ft. per sec.	Lbs./sq. in.
A-----	0.25	6.0	1,415	36,030
B-----	None	6.0	1,431	37,410

As compared with powder of conventional composition, the superiority in flowing property of the powder of Example 2 was very marked. In the case of glazed powder of the prior art, the grains tended to hang in large clusters which suddenly broke up when sufficient force was applied from above. On the other hand, the grains of Example 2 flowed smoothly and continuously, much as though the entire mass were in liquid form. Moreover, the presence of calcium stearate eliminated the tendency of the powder to "set" or cake during storage in shipping containers.

The foregoing examples have illustrated particularly the advantages of metal soaps as aids to flowing properties, when such materials are used in amounts between 0.1% and 1.0% of the weight of the propellant powder. I have discovered also that the same materials act as combustion rate deterrents and that they are effective in improving the progressive burning property of smokeless powder when it is fired in shotguns and rifles. Generally speaking, the metal soaps are several times as effective in the latter respect as are the previously known deterrents; that is to say, the application of 2% by weight of calcium stearate has been found to yield the same velocity-pressure relationship as about 5% of centralite or about 10% of dinitrotoluene, for example. Thus, it is evident that powders of this invention possess advantages in simplicity of manufacture and lessened gun fouling. When metal soaps are used to control ballistic performance, they are applied in amounts preferably between 0.1% and 10.0% of the weight of the finished powder.

Example 3

A shotgun powder in the form of irregular flakes 0.005" thick, containing 25% nitroglycerin and 2% incorporated dinitrotoluene, and which had previously been glazed with graphite in the conventional manner, was tumbled in a "sweetie barrel" with 2% by weight of calcium stearate. The powder was then loaded into primed 12-gauge shotshells; suitable wads were placed on top of the powder, 1¼ ounce of No. 6 shot was added above the wads, and the shells were closed and crimped in the normal way. The shells were

fired in a shotgun, the pressure in the gun chamber and the shot velocity being measured. In Table III, sample A is the powder of this example; while sample B is a powder of similar type, except that it contained 11.8% dinitrotoluene and no special glazing agent. The shot velocity was substantially the same for both samples, but the pressure developed by the powder of this example was 1500 lbs./sq. in. lower than that developed by the conventional powder. Moreover, sample A was unusually clean-burning, leaving practically no smudge in the gun barrel.

Table III

Sample	Calcium stearate	DNT	Charge wt.	Shot velocity	Pressure
	Per cent	Per cent	Grains	Ft./sec.	Lbs./sq. in.
A-----	2	2.0	29.5	943	10,100
B-----	0	11.8	29.5	947	11,600

Example 4

Two samples of a cellular nitrocellulose-nitroglycerin powder, in the form of discs 0.05" in diameter and 0.008" thick, were glazed with calcium stearate in the proportions of 2% and 3%, respectively. The finished samples were loaded in caliber .22 long rifle rim fire cartridges, with 40-grain lead bullets. The result of firing these cartridges in a caliber .22 rifle is shown in Table IV, where the sample designations refer to the following powders:

Sample A: The powder used in this example, before applying calcium stearate.

Sample B: The powder of this example, glazed with 3% calcium stearate.

Sample C: A powder of the prior art, with similar grain form.

Table IV

Sample	Calcium stearate	DNT	Nitro-glycerin	Chg. wt.	Proj. vel.	Pressure
	Per cent	Per cent	Per cent	Grains	Ft./sec.	Lbs./sq. in.
A-----	0	0	15	1.95	1,337	24,670
B-----	3	0	15	2.23	1,358	21,670
B-----	3	0	15	2.27	1,397	24,640
C-----	0	6	15	2.11	1,300	25,000

The value of metal soaps for improving rifle powders is particularly apparent on comparing sample A, Table IV, with sample B, from which it is evident that the use of 3% calcium stearate permitted a 60-foot increase in velocity with no increase in pressure. Moreover, the use of calcium stearate in place of formerly known deterrents results in a markedly superior velocity-pressure relationship, to the extent that a velocity is attained which is beyond the reach of previously known powders, fired at a safe pressure.

Smokeless powder having a graphite glaze usually possesses a relatively high electrical conductivity, which is generally advantageous in discharging static electricity. In certain applications, however, low conductivity is desired, for example, when the powder is used in guns for perforating oil well casings. In a typical oil well perforating gun, several powder charges are arranged to be fired singly by remote control of a single electrical circuit. Since the powder itself forms a part of the circuit, the use of a conducting powder sometimes results in premature firing of one or more charges. I have found the present invention useful in overcoming this difficulty.

If, instead of graphite, I use calcium stearate, for example, as the sole glazing agent, the resulting powder has very low or negligible conductivity, while at the same time it is smooth flowing and free from sticking. Such a powder, used in a perforating gun, has no tendency to fire prematurely or out of the predetermined order, and is particularly satisfactory for that reason. In using the powder of my invention for this purpose, it is unnecessary to make any change in the ignition means normally employed, the usual hot-wire or other arrangement being entirely satisfactory.

Several advantages of my invention have been disclosed in detail in the foregoing. It is clear that the invention may be used with substantially equal benefit in a wide variety of propellant powders whether single or double base, whether of rolled sheet, dense pressed and cut, cellular, or other grain form, and whether or not containing other previously known deterrents incorporated or surface-coated. Powders manufactured according to the invention are suitable components of ammunition for rifles, pistols, shotguns and like weapons. Furthermore, the successful performance of said powders is distinctly contemplated in completed ammunition of various types, such as rim fire, center fire metallic, and shotshell cartridges, equipped with primers and projectiles of various compositions and shapes. It may be stated that the improved procedure and compositions described herein are advantageous not only in their effect on flowing properties, inhibition of caking, and burning rate, but that the use of metal soaps is desirable also for their tendencies as coolants and preventives of muzzle flash and erosion.

It will be understood that many variations may be introduced in exact procedures and composi-

tions without departure from the scope of the invention. I intend to be limited, therefore, only by the following patent claims.

I claim:

1. A propellant smokeless powder having a surface glaze of substantially water-insoluble metallic salt of a higher monobasic aliphatic acid.
2. A propellant smokeless powder whose grains have a surface glaze of a substantially water-insoluble salt of a higher monobasic aliphatic acid in an amount between 0.1% and 10% of the weight of the powder.
3. A propellant smokeless powder whose grains have a surface glaze of a metallic salt of a higher aliphatic acid taken from the group consisting of stearic, palmitic, and oleic acids, said salt being substantially insoluble in water and in an amount between 0.1% and 10% of the weight of the powder.
4. The smokeless powder of claim 3, in which the metallic salt is barium stearate.
5. The smokeless powder of claim 3, in which the metallic salt is magnesium stearate.
6. The smokeless powder of claim 3, in which the metallic salt is calcium stearate.
7. A propellant smokeless powder having a surface glaze comprising graphite and a substantially water-insoluble metallic salt of a higher monobasic aliphatic acid.
8. A propellant smokeless powder having a graphite glaze on the surface and a superimposed glaze of a substantially water-insoluble metallic salt of a higher monobasic aliphatic acid.
9. The smokeless powder of claim 8, in which the metallic salt is calcium stearate in an amount between 0.1% and 10% of the weight of the powder.

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