United States Patent Office

2,865,729

Patented Dec. 23, 1958

2,865,729

COATED SMOKELESS POWDER

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No Drawing. Application April 12, 1955
Serial No. 500,992

2 Claims. (Cl. 52—7)

This invention relates generally to explosives and more particularly to smokeless powder grains having improved ballistic characteristics.

A method for making substantially spherical smokeless powder grains is disclosed in Olsen et al. patent, U. S. 2,027,114, and a method for making dense powder grains of this general type is disclosed by Schaefer in U. S. Patent 2,160,626. The powder grains made in accordance with these processes have been widely adopted for use in both military and commercial cartridges. Cartridges having powder charges composed of such powder grains have many advantages but in many instances it has been necessary to roll the grains in order to obtain the required ballistic characteristics in certain cartridges. Furthermore, in some cartridges, particularly those made for use in match competition where uniform accuracy, velocity, pressure and other ballistic characteristics are a requisite, it has been found that cartridges containing such powder charges are frequently unsuitable. This disadvantageous property is most apparent when cartridges are fired in a gun pointed downwardly and the powder is positioned near the bullet and away from the primer. Often because of these disadvantages, it has been impossible to use the same propellant in cartridges of different calibers and in some instances, it has been impossible to use powder from the same lot in cartridges of the same caliber but having different types of projectiles.

It is therefore an object of this invention to provide a novel smokeless powder grain having improved ballistic characteristics. Another object of this invention is to provide smokeless powder grains particularly well suited for cartridges used in match competition and other cartridges where uniform ballistic properties are requisite. Still another object is to provide substantially spherical smokeless powder grains having such ballistic properties that cartridges of various calibers can be charged therewith and uniformity in ballistic properties will be attained.

The foregoing objects as well as others which will become apparent from the following description are achieved in accordance with this invention, generally speaking, by providing smokeless powder grains having a surface coating of a finely divided metallic oxide. Tin dioxide has been found particularly well suited for this purpose. The surface coating must be substantially uniformly distributed over the surfaces of the grains. The particles of tin dioxide are only partially embedded in the grains so that the greater portion of their surface is uncoated and protrudes from the grain. There is no material advantage in including any metallic oxide in the internal portion of the grain, insofar as this invention is concerned. It is preferred to include a potassium salt in the coating as a flash inhibitor because the mixture of the potassium salt with the tin dioxide results in the best ballistic performance but in some powders the potassium salt can be incorporated uniformly throughout the grain. Any potassium salt of the proper granulation which will improve the ignition properties of the powder grains such as potassium nitrate and potassium sulfate or mixtures thereof can be

utilized. From about 0.3 to about 1.5 parts by weight of tin dioxide should be used and in those powders containing a potassium salt from 0.3 to about 1.5 parts thereof should also be used. The granulation of the potassium salt and the tin dioxide must be less than about 325 mesh, U. S. Tyler screen, or in other words less than about 44 microns. The coating is advantageous on any smokeless powder grains including grains formed from nitrocellulose base and double base smokeless powder grains formed from nitrocellulose and nitroglycerin or other liquid explosive nitric ester.

In a specific example of this invention, about 100 parts by weight substantially spherical nitrocellulose base powder grains formed in accordance with the process disclosed in U. S. 2,160,626 are impregnated with nitroglycerin and coated with a deterrent, dibutylphthalate. The composition of the grains is about 83 percent nitrocellulose, 10 percent nitroglycerin, 6 percent dibutylphthalate and one percent diphenylamine. These grains are placed in a sweetie barrel and a solution of about one part potassium nitrate and 1¼ parts tin dioxide suspended in about 20 parts isopropyl alcohol is poured over the grains and the mixture is tumbled until a substantially uniform coating has been applied to the surface of each grain. Ordinarily, a uniform coating is obtained by heating the contents of the barrel to about 50° C. and tumbling them for about one hour. Tumbling is continued at this temperature another 45 minutes to remove the isopropyl alcohol. The granulation of the potassium nitrate and of the tin dioxide in this embodiment is:

Stokes Diameter Microns	Percent By Weight Below Size Shown
0.8	11.5
2.0	50.0
3.0	75.1
5.0	91.0
10.0	94.8
20.0	95.8

The granulation of the potassium salt and tin dioxide recorded above was determined by sedimentation analysis.

Powder grains having a diameter of between 0.16" and 0.025" made in accordance with the foregoing process were charged in caliber .30 cartridges and fired in comparison with substantially identical cartridges except that the powder charge in the latter cartridges did not have a coating of the potassium nitrate and tin dioxide. Otherwise the composition of the smokeless powder grains in the two groups of cartridges was substantially the same. The following results were obtained when the cartridges were fired in a gun in a substantially horizontal position and the velocity of the projectile was measured in feet per second:

Table I

	Ball Cartridges		Armor Piercing Cartridges	
	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4
	Grains	*Grains*	*Grains*	*Grains*
Charge Weight	51.7	53.3	53.0	54.0
Mean Velocity	2720	2725	2708	2721
Maximum Velocity	2754	2750	2735	2733
Minimum Velocity	2668	2698	2685	2707
Extreme Variation	86	52	50	26
Std. Deviation	22.9	15.6	16.4	8.3

As indicated in the foregoing table, samples 1 and 2 were provided with a "ball" type projectile whereas samples 3 and 4 were loaded with an armor piercing projectile. Sufficient powder was loaded in each cartridge

to provide a mean velocity within the range required by standard specifications for that cartridge. By comparing samples 1 and 2 it is found that the extreme variation in velocity from one cartridge to another in the series fired was 86 feet per second when powder not having the coating provided by this invention was used. The extreme variation was only 52 feet per second in the ball cartridges when powder of this invention was used. Variation in velocity in the armor piercing cartridges making up sample No. 3 and having heretofore conventional powder was 50 feet per second whereas the variation in sample No. 4 having the powder of this invention was only 26 feet per second. Possibly of more significance to the ballistician is the difference between the "standard deviation" of the samples. These results show conclusively that the powders of this invention give more uniform velocity results than the conventional powders. The "standard deviation" is a calculated value customarily used by those skilled in the art as a criterion of ballistic uniformity. This value is obtained by taking the square root of the sum of the squares of the differences between the individual values in a series and the average of values in the series.

In some rifle cartridges the case volume is greater than is required for the powder charge so that the powder charge does not completely fill the available space. As a result, when the gun has its muzzle pointed downwardly there is a tendency for the powder to accumulate at the base of the projectile in the cartridge. Conversely, if the gun is pointed upwardly the powder accumulates at the primer. When the heretofore available powders have been used, the velocity variation between cartridges fired with the powder charge located adjacent to the base of the projectile and at the primer or with the gun in a horizontal position has been appreciable and objectionable. This difference in velocity is less with the powder of this invention as is shown in the following table:

Table II

	Mean Velocity		Difference in Mean Velocity
	Powder at Primer	Powder at Bullet	
Sample #1	2,734	2,629	105
Sample #2	2,723	2,680	43

The cartridges of sample #1 contained conventional powder and sample #2 was composed of cartridges containing powder of the same composition except that the grains were surface coated in accordance with this invention. The velocity obtained when cartridges of sample #1 were fired with the powder adjacent to the bullet was 105 feet per second lower than the velocity of cartridges fired with the powder adjacent to the primer whereas only 43 feet per second difference was found with the cartridges of sample #2. Such results show that orientation of the powder in the cartridge is less effective on the velocity of the cartridge when the powder of this invention is used in preference to the heretofore conventional powders.

It is also to be noted that the performance of cartridges having the powder charge provided by this invention is superior to similar cartridges having uncoated powder grains in the standard hangfire test. This test involves measuring the period of time which elapses between initiation of the primer and ignition of the powder and it has been found that in cartridges which have been cooled to —34° F. an average time of 0.5 millisecond elapses between the initiation of the primer and ignition of the powder in the cartridges not having the coating provided by this invention whereas only 0.38 millisecond elapses with the cartridges having the powder charge of this invention. This characteristic is a very important one and the results of this test indicate that a significant improvement is obtained by coating the grains in accordance with this invention. Comparison of the results shown in Table III below illustrate that the powder having the coating provided by this invention is less effected by orientation within the cartridge than powders in which the tin dioxide has been incorporated throughout the grain's structure. The velocities are reported in feet per second. Sample No. 1 was made up of cartridges loaded with powder grains having 1.25 percent tin dioxide incorporated therein whereas sample No. 2 was composed of cartridges loaded with powder coated with 1.25 percent tin dioxide as provided by this invention. The powders used in the samples were otherwise of the same composition containing about 83 percent nitrocellulose, 10 percent nitroglycerin, 6 percent dibutylphthalate and 1 percent diphenylamine before treating with tin dioxide. A difference of only 49 feet per second was obtained between cartridges having the powder adjacent the primer and cartridges having the powder adjacent the bullet when the powder was of the type provided by this invention whereas a difference of 105 feet per second was obtained under similar conditions with a powder in which the tin was incorporated substantially uniformly throughout the grain. These results show that the powder having the tin dioxide incorporated therein was no better than the conventional powder not containing tin dioxide reported in Table II as sample No. 1.

Table III

	Mean Velocity		Difference in Mean Velocity
	Powder at Primer	Powder at Bullet	
Sample #1	2,688	2,583	105
Sample #2	2,722	2,673	49

The results shown in Table IV below illustrate that powders having tin dioxide incorporated therein do not give results comparable to those results obtained with powders having a coating of tin dioxide. The two samples here were from the same lot as samples No. 1 and No. 2 in Table III with sample No. 1 having 1.25 percent tin dioxide dispersed uniformly in the grain and sample No. 2 having a coating of 1.25 percent tin dioxide. Comparison of the extreme variation and the standard deviation results of these two samples clearly illustrates that a much more uniform velocity was obtained with powders of this invention than with powders containing the tin dioxide within the grain.

Table IV

	Sample No. 1	Sample No. 2
Charge Weight	50.0	51.7
Mean Velocity	2,735	2,743
Extreme Variation	74	47
Standard Deviation	17.1	12.2

The powder grains provided by this invention and one method for making them have been described in considerable detail in the foregoing for the purposes of illustration. It is, of course, to be understood that any suitable process for coating the grains can be utilized and that various liquid carriers can be substituted for the isopropyl alcohol. For example ethyl alcohol, methyl alcohol, benzoyl, toluene, gasoline or any other non-solvent for the smokeless powder grains and for the particles of the potassium salt and the tin dioxide which can be removed from the grains can be utilized. Although the detail description was made with respect to substantially spherical powder grains formed by the process disclosed in U. S. Patent 2,160,626, the coating is advantageous on powder grains made by other processes such as extrusion processes and on grains of any suitable shape.

Many other variations in the invention will occur to those skilled in the art and can be used without departing from the scope of this invention except as it is limited by the appended claims.

We claim:

1. A substantially spherical smokeless powder grain consisting of a nitrocellulose propellent core with a coating of tin dioxide on the surface thereof, said tin dioxide being present in the amount of from about 0.3 to about 1.5 parts by weight per each 100 parts by weight of said grain.

2. A substantially spherical smokeless powder grain consisting of a nitrocellulose propellent core having a surface coating thereon of from about 0.3 to about 1.5 parts by weight tin and from about 0.3 to about 1.5 parts by weight of a potassium salt per each 100 parts by weight of said grain.

References Cited in the file of this patent

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