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PROGRESSIVE BURNING SMOKELESS
POWDER

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This invention relates to a smokeless powder and more particularly to an improved method for the preparation of progressive-burning smokeless powder.

5 It is well known that a progressive-burning smokeless powder should have the characteristics of causing a slow generation of gas during its initial stages of burning, in order to start the projectile charge into motion gradually, because
10 a fast generation of gas, before the projectile charge has moved any appreciable distance, results in high breech pressures due to the limited confinement in which the gas must be accommodated.

15 Various methods have been introduced in the past for controlling the burning speed of smokeless powder. For example, it has been customary to incorporate deterrents in the powder composition, which deterrents may or may not be solvents
20 or plasticizers for the powder composition. In another method, powder grains containing no deterrent, have been surface coated with deterrents to produce the burning speed desired.

25 The control of the burning speed of smokeless powder by these methods depends upon the cooling of the powder gases during the combustion thereof and the lowering of the potential energy of the powder. In powders which are surface coated, the deterring of the burning rate takes
30 place chiefly during the burning of the initial surface layers of the powder. This is desirable because, as pointed out above, the powder is under maximum confinement at this point and a slower burning rate is desirable and, of course, when
35 the confinement is reduced by the charge of shot or bullet moving down the barrel of the gun, a higher burning rate is desired, thus producing a substantially uniform pressure, as the projectile charge moves along the barrel.

40 Powder grains impregnated with a deterrent are as a rule of a too uniform burning rate, so that the rate of evolution of the gas does not increase sufficiently as the confinement is reduced and there is consequently a too rapid fall of the
45 pressure. Such powders are not progressive-burning to the extent that similarly deterrent-coated powders are.

50 In any case, however, both of the above methods for controlling the burning rate of powder suffer from a similar disadvantage, namely, that the burning rate thereof cannot be readily changed after the deterrent-coated or impregnated powder is made. In other words, the proper burning
55 speed of the powder must be decided upon some time in advance of loading requirements.

The object of my invention is to provide a method whereby the disadvantage cited above can be overcome while at the same time producing a satisfactory progressive-burning smokeless powder.

5 I have found that I may mechanically mix or blend with the finished smokeless powder grains, deterrent materials which themselves do not combine with the powder in any manner and
10 which lower the burning temperature of the powder sufficiently to decrease the initial burning rate of the powder. It is to be understood that these deterrent materials are not incorporated into
15 the powder during the manufacture thereof but are mechanically blended with the finished powder grains prior to, or at the time of loading in
20 amount sufficient to produce the burning speed desired for any particular purpose. My method thus obviates the necessity of carrying in stock, in advance of actual loading requirement, various
25 powders of the burning speed required.

Furthermore, I have also found that I may control the degree of progressiveness of burning
30 by controlling the particle size and the physical structure of my deterrents. For example, if a deterrent material requiring considerable oxygen
35 for its combustion, and which will thus cool the powder gases, is reduced to a fine state or is porous so that a flame can come into very intimate contact therewith, I have found that it will be
40 very largely consumed during the initial burning of the powder and will have a reduced effect during the latter stages of burning. In other words
45 the initial pressure will be limited, while the pressure along the barrel will be maintained. Alternatively, the same effect can be obtained by using
50 a material less deficient in oxygen and having a larger particle size.

Among the materials which I have found to act
55 as deterrents for smokeless powder in accordance with my invention are for example: starch, organic ethers and esters thereof; cellulose, organic ethers and esters thereof; gelatin, coal dust, or other carbonaceous materials which are deficient in oxygen when compared with the smokeless
60 powder with which they are to be blended. Of the materials above listed, I prefer using starch, gelatin, starch esters, for example, starch acetate, cellulose ethers, for example, ethyl cellulose, benzyl cellulose, methyl cellulose, etc., cellulose
65 esters, for example, cellulose acetate, cellulose acetobutyrate, cellulose aceto-propionate, etc. I have found that these materials are desirable because they may be formed into grains of a size and shape similar to the smokeless powder grains

with which they are to be mechanically admixed and thus reduce the danger of segregation of the deterrents.

In proceeding in accordance with my invention, I take smokeless powder grains, either of the single base or double base type, which have been made by processes well known in the art, and then mechanically admix said grains, with a deterrent from the group mentioned above. The deterrent used may be in any desirable form, such as, for example, powder, flakes, granules, or grains similar in size and shape to the smokeless powder grains themselves. The amount of deterrent admixed with the powder grain is not a critical quantity but will vary, depending upon the particular type of ammunition for which a charge is designed and the deterrent being used. The deterrents may be mechanically admixed with the powder prior to or at the time of loading.

As an illustrative embodiment of my invention, I will take a double base powder containing 79.25% of nitrocellulose, 20% nitroglycerine and 0.75% of diethyldiphenyl urea, produced and cut to the size desired, in any manner well known to those skilled in the art. In a powder adapted more particularly for shot guns, the above mixture, suitably colloidized, was pressed through a 0.065 inch die having a 0.020 inch pin and the strands so produced were then cut into 325 cuts per inch. After this the powder grains were dried in the usual manner and were then ready to be loaded into shells.

In each of the examples hereinafter shown the charge of powder was loaded into a shot gun shell and fired using the shell, type shot and conditions shown in Example I.

Example I

A portion of the powder, prepared as shown, was thoroughly admixed with 10% by weight of methyl cellulose which had been rolled into thin sheets and then broken into small flakes. 32.5 grains of this mixture was loaded into a 12 gauge shot shell with 1¼ ounces of No. 6 shot and fired. The velocity produced by this charge over a 40 yard range from muzzle to target was 940 feet per second and the breech pressure produced was 9200 pounds per square inch.

The same powder having incorporated therein 10% by weight of methyl cellulose, when fired on a charge of 31.5 grains in the same load, gave a velocity of 917 feet per second and a breech pressure of 11,300 pounds per square inch.

A comparison of the two sets of results clearly indicates the superiority of mechanically admixing the deterrent rather than incorporating it.

Example II

25.4 grains of smokeless powder, prepared as before, to which were added 2.6 grains of powdered starch thoroughly admixed therewith, were loaded into a shot shell and fired. This powder gave a velocity of 894 feet per second and a breech pressure of 10,000 pounds per square inch.

26.0 grains of the same powder, having incorporated therein, 10% by weight of powdered starch, loaded into a shot shell and fired, gave a velocity of 884 feet per second and a breech pressure of 11,800 pounds per square inch.

A comparison of the results, indicates that the detergent, mechanically admixed with the powder, in accordance with my invention, produces a powder of substantially the same velocity as that of the prior art powder, but that it is obtained

with a considerable decrease in the breech pressure developed, which is highly desirable.

Example III

30.0 grains of smokeless powder, prepared as before, to which were added 1.5 grains of powdered coal dust, thoroughly admixed therewith, were loaded into a shot shell under the same conditions as in Example I. When fired, this charge produced a velocity of 956 feet per second with an average breech pressure of 12,500 pounds per sq. in.

35.0 grains of the same powder, having incorporated therein 5% by weight of powdered coal dust, loaded in the same manner as before and fired, produced a velocity of 975 feet per second with an average breech pressure of 12,100 pounds per sq. in.

It is apparent that substantially the same pressures and velocities are obtained in both cases but it must be noted that in the former case this is obtained with about 10% less powder, which means a considerable saving of powder.

Example IV

A double base powder having a composition of 59.25% nitrocellulose, 36.5% nitroglycerine, 2.0% potassium nitrate, 1.5% barium nitrate and 0.75% diphenylamine was suitably colloidized by methods well known to those skilled in the art and after colloidizing was pressed through a 0.065 die having a 0.020 inch pin. The strands so produced were then cut into 375 cuts per inch. The powder grains were then dried and loaded into shot shells mechanically admixed with sheet gelatin about 0.0037 inch thick cut in pieces approximately 1/20 inch square, at the time of loading. These shells were fired, obtaining the results shown in the following table:

Base powder charge, grains	Deterrent	Charge of deterrent, grains	Velocity, ft. per sec.	Breech pressure, pounds per square inch
22.5	None	—	926	10,600
22.5	Gelatin	4.50	876	8,100
22.5	do	2.25	912	9,600

It is seen that gelatin admixed with the powder grain shows definite deterrent action. The above table shows also that 10% by weight of the powder charge of gelatin mechanically admixed therewith produces a powder which gives a substantially reduced pressure over the untreated powder but at the same time gives practically the same velocity.

It will be understood that the velocities and breech pressures given in all of the preceding examples are averages based on the results of the firing of 10 shots.

It will further be understood that broadly my invention covers the mechanical addition of carbonaceous materials of the classes above mentioned, to smokeless powder grains to produce a progressive-burning powder and that it is not limited to the specific details and operations described.

What I claim and desire to protect by Letters Patent is:

1. A progressive-burning propellant smokeless powder charge comprising preformed smokeless powder grains mechanically and loosely admixed with particles, separate from those of the powder grains, of a deterrent selected from the group of carbonaceous materials consisting of starch,

organic esters and ethers thereof, cellulose, organic esters and ethers thereof, gelatin and coal dust.

2. A progressive-burning propellant smokeless powder charge comprising pre-formed smokeless powder grains mechanically and loosely admixed with particles, separate from those of the powder grains, of deterrent grains similar in size and shape, said deterrents being selected from the group of carbonaceous materials consisting of starch, organic esters and ethers thereof, cellulose organic esters and ethers thereof gelatin and coal dust.

3. A progressive-burning propellant smokeless powder charge comprising pre-formed smokeless

powder grains mechanically and loosely admixed with particles, separate from those of the powder grains, of granulated starch.

4. A progressive-burning propellant smokeless powder charge comprising pre-formed smokeless powder grains mechanically and loosely admixed with particles, separate from those of the powder grains, of flaked gelatin.

5. A progressive-burning propellant smokeless powder charge comprising pre-formed smokeless powder grains mechanically and loosely admixed with particles, separate from those of the powder grains, of flaked methyl cellulose.

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