

Patented May 10, 1927.

1,627,692

UNITED STATES PATENT OFFICE.

FRANCIS I. DU PONT AND ERNEST DU PONT, OF WILMINGTON, DELAWARE, ASSIGNORS,
BY MESNE ASSIGNMENTS, TO U. S. F. POWDER COMPANY, OF WILMINGTON, DELA-
WARE, A CORPORATION OF DELAWARE.

SMOKELESS EXPLOSIVE POWDER AND PROCESS OF MAKING SAME.

No Drawing. Original application filed January 24, 1919, Serial No. 272,857, renewed April 5, 1921, Serial No. 458,695. Renewed October 19, 1921, Serial No. 508,832. This application filed May 3, 1922. Serial No. 558,252.

The object of our invention is to produce a smokeless explosive powder which, when used as a propellant charge in ordnance, will approximately eliminate, or at least very materially reduce, the muzzle flash. To accomplish this it is necessary that the powder should be substantially consumed before the gaseous mass emerges from the muzzle of the gun. It is not merely sufficient that the composition and structure of the powder should be such as to promote rapid burning and early combustion, but it is also essential that this rapid burning should be effected without substantial increase of chamber pressure in order thereby to avoid erosion of the gun barrel.

It is the usual practice to effect the burning of ordnance powder in a progressive way by manufacturing the grains or units with perforations through the grains, so that they will burn from the inside as well as from the outside, thus exposing to the flame, as the burning proceeds, a progressively increasing superficial area. There is a progressive acceleration of combustion.

We have discovered that the rate of progression and acceleration of the burning in this type of powders may be substantially increased, without increase of chamber pressure, by distributing in a colloid mass of nitrocellulose powder a flame propagating agent which will carry the flame from the exposed surfaces, through a multitude of minute progressively developed channels or cavities, into the interior of the powder grains, thereby bringing about an earlier combustion and effecting a more complete consumption of the powder than is the case where reliance is had solely upon relatively large and coarse mechanical perforations.

It has been assumed that the flash of light produced at the muzzle of a gun is due to the fact that propellant powders composed substantially entirely of nitrocellulose have an actual deficiency of oxygen below that which would be necessary to burn all of the carbon, or its equivalent in combustible products, and that minute particles of carbon, intensely heated, actually escape from the muzzle of a gun and combine with the oxygen of the atmosphere in precisely the same way as do the particles of carbon in an ordinary flame of illuminating gas.

While this may be a correct explanation of the phenomenon, we have found by prolonged experiment that it is not essential for our purposes that the ingredients added shall actually contain an excess of oxygen capable of compensating for this excess of carbon. In fact, we have used with equal success one flame propagating agent having an excess of oxygen and another in which there is no oxygen available for the nitrocellulose.

It is not sufficient, however, that the added flame propagating agent shall merely be effective to expedite the consumption of the nitrocellulose, but it must be such an agent as will do this without substantially increasing the chamber pressure, without seriously fouling the gun and without producing an excess of smoke. This not merely materially narrows the range of substances which would be otherwise available, but after the proper substances have been ascertained by experiment, the further problem arises of adding them in proper proportions to the nitrocellulose. Finally, after this information is acquired, the addition of the flame propagating agent to the nitrocellulose must precede any substantial colloidizing of the nitrocellulose.

We have discovered that a mixture of barium nitrate and potassium nitrate, added to soluble nitrocellulose and then colloidized, will render it substantially flashless provided the proportions are carefully determined and provided they are properly incorporated.

The characteristics of these two fire propagating agents are, of course, quite dissimilar, the most notable difference being that the latter has an excess of oxygen, which is evolved when heated, while the former is a complete explosive and has no available oxygen.

Where a mixture of the two salts above named is used, we prefer to use about two parts of the barium salt to one part of the potassium salt, although these proportions may be varied. The total of the two ingredients should form preferably from about 8 to 12 per cent. of the entire explosive. In no case should it exceed 20 per cent., while we distinctly prefer not to exceed 15 per cent. On the other hand, the proportion may be

as low as 4 per cent. and still very materially reduce the flash, although we prefer a minimum of about 7 or 8 per cent. The objection to using a large proportion of this fire propagating agent is that it results in objectionably fouling the gun, and, moreover, a relatively large proportion produces no useful effect in the elimination of the flash, this being, for all practical purposes, attained by a relatively small proportion.

The process of adding the flame-propagating agent to the nitrocellulose is of great importance. Unless the agent be so added as to effect a very thorough and intimate association of the particles, the finished powder will give non-uniform and uncertain results as a commercial product, in which uniformity and certainty of action are essential.

In carrying out our process it is necessary, in order to secure certain and uniform results, to thoroughly incorporate the flame propagating agent with the nitrocellulose before colloidizing. We proceed by taking soluble nitrocellulose and add thereto the specified proportion of the flame producing agent, wet it with about thirty per cent of a suitable blending liquid, such as water or gasoline, and incorporate the same in a standard black powder wheel mill for about an hour or an hour and a quarter. The liquid added should be one which does not chemically combine with the explosive ingredients, or does not combine with them except to form a solution from which the solvent may be expelled by drying or by displacement otherwise. We prefer to use gasoline. Without the thorough moistening of the powder, the mixing operation, in any mill of the kind specified, would be attended with serious danger.

After the ingredients are thus thoroughly incorporated, the added liquid, or most of it, is expelled by drying or otherwise and then the colloidizing agents, ether and alcohol, are added, and the entire mixture is thoroughly and completely colloidized in a kneading machine for about an hour. After the powder has been formed into grains, a considerable proportion of alcohol and ether is distilled off, a certain proportion remaining in the finished product.

The removal of the alcohol and ether should not be effected in any way which will cause the removal of the fire carrying agent, as that would produce a certain undesirable porosity in the finished powder, whereas porosity, or porosity alone, is not the result desired, but rather a proper dissemination of the fire propagating agent through the colloidized nitrocellulose. The thorough incorporation of the ingredients is of the utmost importance, and it seems to be practically essential to first thoroughly incorporate the fire propagating agent with the nitro-

cellulose and afterward colloid: in other words, to rather closely adhere to the procedure above described.

The resultant powder is, to all intents and purposes, "flashless", there is no serious fouling of the gun, and the smoke produced is so limited in volume as to be unobjectionable.

We do not herein claim, broadly, the addition of black powder, barium and potassium nitrates, or other flame propagating agents, to any of the so-called smokeless or semi-smokeless powders, as these have been added in other proportions and in other ways and for other purposes to certain of such explosives. In our invention, the bodies are associated in a particular way.

While we have herein described black powder, barium and potassium nitrates as illustrative of a suitable flame-propagating agent, it is herein intended to restrict the claims to that specific embodiment of the invention comprising the use of barium nitrate and potassium nitrate. In another application filed April 24, 1920, as Serial No. 376,267, we have claimed the use of a flame-propagating agent broadly and have also claimed the use of black powder specifically.

Having now fully described our invention, what we claim and desire to protect by Letters Patent is:

1. The process of making "flashless" smokeless propellant powder which comprises adding to and thoroughly incorporating barium nitrate and potassium nitrate with soluble nitrocellulose, and afterward completely colloidizing said nitrocellulose with ether and alcohol to produce a homogeneous body retaining the said barium nitrate and potassium nitrate distributed through the finished explosive.

2. The process of making "flashless" smokeless propellant powder which comprises adding barium nitrate and potassium nitrate to soluble nitrocellulose, moistening with a suitable liquid and thoroughly incorporating, expelling the liquid, and afterward colloidizing with ether and alcohol.

3. The process of making "flashless" explosive powder which comprises so mixing soluble nitrocellulose with barium nitrate and potassium nitrate and a nitrocellulose colloidizing agent that the action of the colloidizing agent will take place substantially after distribution of the said nitrates throughout the nitrocellulose, and forming the colloidized nitrocellulose into grains, whereby the colloidized cellulose grains will be intercellularly impenetrated with the said nitrates and the rapid combustion of the latter will carry the flame rapidly from the exposed surfaces into the interior of the grains and effect a relatively early complete consumption of the powder.

4. The process of making "flashless"

smokeless propellant powder which comprises adding to and thoroughly incorporating with soluble nitrocellulose between four and twenty per cent of a mixture of the nitrates of barium and potassium and completely colloidizing said nitrocellulose. 15

5. The process of making "flashless" smokeless propellant powder which comprises adding to and thoroughly incorporating with soluble nitrocellulose from eight to twelve per cent of a mixture of the nitrates of barium and potassium. 20

10 6. A "flashless" smokeless propellant powder, which comprises completely colloidized

nitrocellulose containing four to twenty per cent of a mixture of the nitrates of barium and potassium distributed therethrough.

7. A "flashless" smokeless propellant powder, which comprises completely colloidized nitrocellulose containing eight to twelve per cent of a mixture of the nitrates of barium and potassium.

In testimony of which invention, we have hereunto set our hands, at Wilmington, on this 22nd day of January, 1919.

FRANCIS I. DU PONT.
ERNEST DU PONT.