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PROPELLENT POWDER AND PROCESS OF MANUFACTURE

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5 Claims. (Cl. 52—6)

This invention relates to the manufacture of propellant explosives and has for its objects the prevention of metallic fouling in the bore of guns or rifles and, particularly, the reduction of erosion of the bore.

It has already been proposed to incorporate in a propellant powder a small proportion of finely powdered metallic tin or tin alloy or tin compound, for the purpose of preventing the formation of metallic fouling in the bore of the gun or rifle. A further advance in the art is set forth in British Patent No. 346,295, according to which the solid particles of tin, tin alloy or tin compound are replaced by an organo-metallic derivative of tin, e. g. tetra n-butyl stannane, whereby metallic fouling of the bore of the gun or rifle is prevented. In all these propellant explosives the material which prevents the metallic fouling, i. e. the tin, tin alloy, tin compound or organo-metallic derivative of tin, is distributed as uniformly as possible throughout the composition and grain structure of the propellant explosives.

We have now discovered that when the anti-fouling agent, i. e. the tin, tin alloy, tin compound or organo-metallic derivative of tin, is applied to the surface of each grain of the propellant explosive, the amount of erosion of the bore of the gun or rifle is very greatly reduced while the property of preventing metallic fouling in the bore remains unimpaired or is even improved. This reduction of erosion of the bore is a very important factor as the life and efficiency of the gun or rifle becomes very considerably increased.

According to the invention, therefore, an anti-fouling propellant explosive characterized by low erosive power is produced by applying to the surface of the powder grains, an anti-fouling agent comprising one or more of the following:—tin, tin alloys, inorganic and organic compounds of tin, and organo-metallic derivatives of tin. By the expression "organo-metallic derivatives of tin" we mean compounds containing one or more organic radicles and in which tin is directly linked to carbon, as for example tetra-n-butyl stannane, $\text{Sn}(\text{C}_4\text{H}_9)_4$. By the expression "organic compounds of tin" we mean compounds containing one or more organic radicles, in which tin is not directly linked to carbon, as for example tin methyl phthalate.

If desired the anti-fouling agent employed according to the invention is applied in conjunction with a surface moderant, i. e. any relatively non-volatile compound having a gelatinizing action upon nitrocellulose, for example dibutyl phthalate, di-ethyl diphenyl urea, or dinitrotoluene.

The anti-fouling agent itself, in some cases, may function as such surface moderant and in these cases other surface moderants may be dispensed with.

The application of the anti-fouling agent to the surface of the grains of a propellant explosive, for example, a nitrocellulose powder for use in small arms, rifles, or machine guns, may be performed in several ways, such as the following.

The tin, tin alloy or tin compound, for example, finely divided metallic tin or tin oxide, may be mixed with any surface-moderating agent, for example di-ethyl diphenyl urea, and this coating applied to the individual grains of the propellant explosive by any of the methods well known in the art. Thus 100 parts of base grain nitrocellulose powder are placed in a rotating pan at about 45° C., 10 parts of ethyl alcohol containing 3 parts of di-ethyl diphenyl urea in solution are added and 1 part of finely divided metallic tin is sprinkled in. The pan is closed and run in this condition for 30 minutes, after which the lid is removed and the alcohol allowed to evaporate. When the powder grains have become sufficiently dry, 0.5 parts of graphite are added and the pan is rotated for a further period of about two hours. The powder is then removed to a drying stove to eliminate the alcohol, and is finally cooled, sifted and exposed to the atmosphere until it has reached its normal moisture content.

Organic salts of tin, for example, tin oxalate, or organo-metallic derivatives of tin, for example, tetra-n-butyl stannane, may be mixed with or dissolved in any surface moderating agent, for example, dibutyl phthalate, and this coating applied to the individual grains of the propellant explosive by any of the methods well known in the art.

For example, 1.5 parts of tetra-n-butyl stannane, and 1.5 parts of dibutyl phthalate are dissolved in 10 parts of ethyl alcohol and the solution applied to 100 parts of nitrocellulose powder base grain by the coating method given above.

Those organic salts of tin, for example, stannous methyl phthalate, or organo-metallic derivatives of tin, for example, tributyl stannyl malonic ester, which themselves have a solvent action or gelatinizing action on nitrocellulose and are therefore themselves capable of acting as surface moderating agents, may be applied as a coating to the individual grains of the propellant explosive by any of the methods well known in the art, without the use of other surface moderants.

For example, 2 parts of tributyl stannyl malonic ester are dissolved in 10 parts of ethyl alcohol, and the solution applied to 100 parts of nitrocellulose powder base grain by the coating method described above.

The presence of a specific surface moderating agent as defined above is, however, not essential to the invention. The tin, tin alloy, tin compound, or organic metallic derivative of tin may be applied together with an adhesive to the surface of the powder grains, as is shown in the following example:

100 parts of a propellant powder are placed in a revolving copper pan maintained at 35° C., and 3 parts of alcohol and 1 part finely divided tin are added. The powder is then sprayed with 10 parts of a 3% collodion solution containing 0.5 parts of graphite in suspension. The pan is run in the closed condition for a period of 15 minutes after the addition of the collodion solution. The lid is then removed, an additional 0.5 part of graphite is added and the pan is run open for a further 2 hours. The powder is then transferred to a drying stove until the volatile matter is eliminated. It is then removed and allowed to cool and finally conditioned to normal moisture content.

The sequence of events, which occur when our new type of propellant explosive is fired in a gun or rifle may be illustrated as follows. As the powder grains become ignited by the priming composition and commence to burn, the tin present in the form of metallic tin, tin alloy, tin compound or organo-metallic derivative of tin, becomes vaporized. As the anti-fouling agent lies at or near the surface of the individual powder grains, the tin vapours form in relatively high concentration in the powder gases in the early stages of combustion of the propellant explosive, the powder gases being then comparatively cool and under comparatively low pressure; the vaporizing of the tin will itself cause a cooling of the powder gases at this stage. As the projectile commences to move, the bore of the gun or rifle, at or near the lead and immediately in front of the cartridge case, becomes exposed. The tin vapors become condensed on the cool surface of the bore thus exposed and are deposited as a layer on the surface of the bore. Normally, it is this portion of the bore of the gun or rifle which is most open to attack by the powder gases which cause erosion. The layer of tin deposited from our new type of propellant explosive, therefore, protects the bore of the gun or rifle in its most sensitive part from the subsequent action of the powder gases at high temperature and under high pressure which are formed in the later stages of combustion of the propellant explosive. Further, as the tin layer is formed on the bore right up to the mouth of the cartridge case, metallic fouling is prevented throughout the full length of the barrel of the gun or rifle. In the later stages of combustion of the propellant powder the deposited

tin or a portion of it may become revaporized under the action of the hot powder gases. By this time, however, the projectile will have traveled some distance down the bore, leaving a greater length of the bore exposed to the action of the hot gases while the pressure will have become considerably reduced. At this stage, therefore, the erosive action of the powder gases is very greatly diminished and its effect upon the bore is negligible. Further, on account of the heat of vaporization of tin, the revaporizing of the deposited tin withdraws heat from the portion of the bore affected and cools its surrounding parts.

A further advantage in the use of our new type of propellant explosive is that there is no dilution of the energy in the interior of the powder grain, since the diluting material is situated at or near the surface of the powder grains.

Propellant explosives prepared according to any of the methods described above are suitable for use in military small arms cartridges such as the British .303 cartridges. Following their use metallic fouling is practically eliminated, while the erosive effect on the barrel is considerably reduced.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. The process of producing an anti-fouling propellant explosive having low erosive power which comprises applying to the surface of the powder grains an anti-fouling agent comprising one or more compounds taken from a group consisting of tin, tin alloys, inorganic and organic compounds of tin, and organo-metallic derivatives of tin.

2. The process of producing a propellant explosive which comprises treating the surface of the powder grains with an anti-fouling agent taken from a group of compounds consisting of tin, tin alloys, inorganic and organic compounds of tin, and organo-metallic derivatives of tin.

3. The process of producing an anti-fouling propellant explosive having low erosive power which comprises applying to the surface of the powder grains, in the presence of a surface moderating agent, an anti-fouling agent comprising one or more compounds taken from a group consisting of tin, tin alloys, inorganic and organic compounds of tin, and organo-metallic derivatives of tin.

4. The process of claim 3 in which the surface moderating agent is a non-volatile compound having a gelatinizing action upon nitrocellulose.

5. The process of claim 3 in which the surface moderating agent is taken from a group consisting of dibutyl phthalate, di-ethyl diphenyl urea, and dinitrotoluene.

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