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SLOW-BURNING POWDER FOR FUSES, ETC.

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This invention relates to fuses and, more particularly, to safety or blasting fuses, such as are employed for the delayed firing of bodies of explosive in mining, quarrying, construction, and like fields. In general, however, it relates to all fuses, whether in the field of ordnance, of blasting, of pyrotechnics, or elsewhere. The invention consists in a modification of the composition of black powder, in consequence of which such fuses may be improved in safety and in the accuracy of their functioning. This application is in part a continuation of an application filed by me September 11, 1934, Serial No. 743,555.

A safety fuse or blasting fuse includes as its essential feature an elongate body of combustible material which, being ignited at its proximate end, burns gradually, and at length imparts to a body of explosive situated adjacent its remote end the desired ignition. The material originally, and still chiefly, employed as the material for such a fuse is essentially black powder.

There are difficulties and inadequacies incident to the use of black powder for this purpose, such as to have caused a great deal of study and experimentation; but, for all that, no adequate and satisfactory substitute for black powder has been found. The difficulties alluded to that have attended the use of black powder as fuse material are, chiefly, the readiness with which it takes up moisture, with consequent impairment of efficiency; its tendency to age—that is to say, to change, in the essential characteristic of rate of burning, as it continues unused; and the voluminousness of the gaseous products of its combustion. Such fuse material is contained within sheaths or envelopes of considerable strength; and, under such conditons of confinement, the gases generated in the burning of the fuse bring about pressure conditions at the point of burning such as to accelerate combustion, and so to alter the rate of burning.

Substitutes have been proposed—thermite, nitrocellulose compositions, and others. These all lack one characteristic that black powder possesses, and it is a characteristic of great practical value. A fuse of black powder, when it burns to the end, gives an "end spit"—it projects a spurt of flame and incandescent particles upon the adjacent body to be fired. It is by virtue of this characteristic that black powder has continued in the field, not successfully displaced as a fuse material.

Black powder is, typically, a composition of sodium or potassium nitrate, charcoal, and sulphur; and it is mainly by varying the ratio of the ingredients that the rate of burning for safety-fuse and time-fuse services is varied. It is not difficult to produce a composition of fast rate of burning—a "high-speed" powder—that is relatively permanent and satisfactory; the difficulty lies in producing relatively slow burning powders. The best results in the matter of permanence are got by preparing fuse material in which are combined a fast and a slow powder. And it is the slow component in which the difficulties and drawbacks to the fullest measure of success and satisfaction are found.

Slow powder is commonly prepared by increasing the sulphur content of the composition relatively to the charcoal and the nitrate contents. Attempts have been made to reduce the rate of burning, and to produce a slow powder, not by varying the ratio in which the ingredients are compounded, but by introducing into the composition other and inert material, diluting the mass. As diluents, brick dust has been proposed, soapstone, and rosin. But these attempts have not been successful. It has been found that if added in quantities as great as 10% they render the functioning of the fuse uncertain: the continuity as a combustible body is disturbed. and the fuse is liable to burn irregularly and may go out when only partially burned. And the small permissible quantities of diluent have been found to be inadequate for the intended purpose: the rate of burning is not greatly changed. By such dilution the material, not greatly improved in the way intended, is appreciably impaired in other and unintended ways.

I have discovered that there are substances, other than those last alluded to, which, being brought to proper physical condition and added as diluents to black powder, have the desired slowing effect; and, which, even though added in large quantities, do not have prejudicial effect upon the burning. I have explored the field and have found that the diluents that I have found to be successful stand contrasted with diluents heretofore proposed (but found inadequate), not in their chemical constitution merely. I have found my successful diluents to have physical characteristics of significance not hitherto recognized.

I have been able successfully to control and lengthen the time of burning of black-powder fuses by the addition of specific substances to the powder composition. I have used with success the sulphates of particular metals, and, specifically, of barium and of lead. Either of these two sulphates may be used alone or they

may be used together. These substances, it will be remarked, are, within the temperature range of the preparation of black powder and of service, inert; they are insoluble in water; and they all have common specific-heat characteristics, as presently will be more fully explained. In a companion application, Serial No. 20,889, I claim as my invention the use of titanium oxide and of the preparation called Titanox B, which is a preparation of titanium oxide, precipitated upon or mingled with barium sulphate.

In addition to inertness and insolubility, it will be remarked of the sulphates named that they are heat stable (their melting-points exceed 800° C.); and that in each instance the specific heat is not less than 0.08 calorie per gram nor more than 0.23 calorie per gram, when measured at 0° C.

In the matter of physical condition, I have found the diluent material of my invention to be notably effective when brought to exceedingly finely divided and flake-like condition. Such condition is characteristic of the compounds named, when produced by precipitation.

The diluents heretofore proposed may not, for the reasons stated, be added in quantities as great as 10% by weight. I find no such practical limitation upon the addition of the materials I have named, in the enjoyment of my invention. I have found that the heavier the material employed, the larger the percentage should be, in order to achieve the result. In the case of barium sulphate, I have found an addition of 9% to be effective, substantially to reduce the rate of burning. Obviously, in the use of either particular compound, the percentage will be varied to afford variation in, and to control, the rate of burning.

For purposes of study and comparison a standard mode of testing has been established. Lead tubes of specified size are filled with powder, and, after being filled, are closed at the ends. The tubes are then drawn through dies of specified size and reduced in diameter and elongated. Measured lengths are cut from the test pieces so prepared, the trains of powder within them ignited, and the rates of burning are noted. A powder that under such test burns at the rate of 80 seconds to the yard is a relatively fast powder. I have found that if to a powder having the rate of burning of 80 seconds to the yard I add either of the specific compounds named in the ratio of 30%, I reduce the rate of burning by substantially doubling the seconds per yard.

It has already been remarked that the relatively fast burning powders are the more stable, and, accordingly, it is better to practice the invention upon powders that otherwise are of fast-burning composition; a like retarding effect, however, may be gained in the case of powders that otherwise are of a relatively slow-burning composition.

The 30% addition is named by way of illustration. As I have said, the addition being greater or less, the degree of retardation so effected will be greater or less.

Suitable methods of procedure are (1) to introduce the slowing agent into the wheel mill used in the production of black powder, along with the charcoal, the sulphur, and the alkali-metal nitrate, and to mix the whole at once; (2) to introduce the slowing agent into the mill after the charcoal, the sulphur, and the alkali-metal nitrate have been mixed and brought to the condition of a cake, and to effect the incorporation of the slowing agent into the cake by continued mill operation; and (3) to add the slowing agent to the charcoal and the sulphur while in a ball mill, prior to the wheel-milling operation. In any case the slowing agent is incorporated while the powder is in course of preparation, regardless of whether it is to be a simple contact mixture or an incorporation by a milling process; for after that the slowing agent may not be so effectively introduced.

The addition to black powder of any of the substances that I have specified has the effect of lowering the powder's total heat of reaction, its burning temperature, and its rate of burning.

The burning temperatures of the slow powders of this invention are lower than that of the black powder from which they are produced. The reason for this is that the slow powders always contain less combustible material than the undiluted black powders; they, therefore, produce less heat from the same mass. Since temperature is the ratio of heat to mass, the slow powders have lower burning temperatures. Accordingly, they cause less charring of the fuse structure, and less gas is evolved from the burned fuse materials. The powders of the invention produce less gas when burned in lead tubes, both because the burning temperatures are less and because there is less combustible material per unit of mass than is the case with ordinary black powder.

The powder of my invention takes up moisture less readily than does unmodified black powder; its deterioration with age is less; and the burning pressures, built up by generated gases, are less.

Within the term "black powder" I mean to include powders compounded of sulphur, carbon, and alkali-metal nitrate. And, furthermore, the alkali-metal nitrate being replaceable by other nitrate or oxidizing agent, I intend to bring such substitutions also within the field of enjoyment of my invention.

I claim as my invention:

1. A slow-burning powder composition consisting of black powder modified by the addition of a metal sulphate of a group that consists of barium and lead.

2. A slow-burning powder composition consisting of black powder modified by the addition of barium sulphate.

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