Aug. 30, 1955 R. H. HEISKELL 2,716,599

DARK BURNING IGNITER COMPOSITION

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FIG. 1.

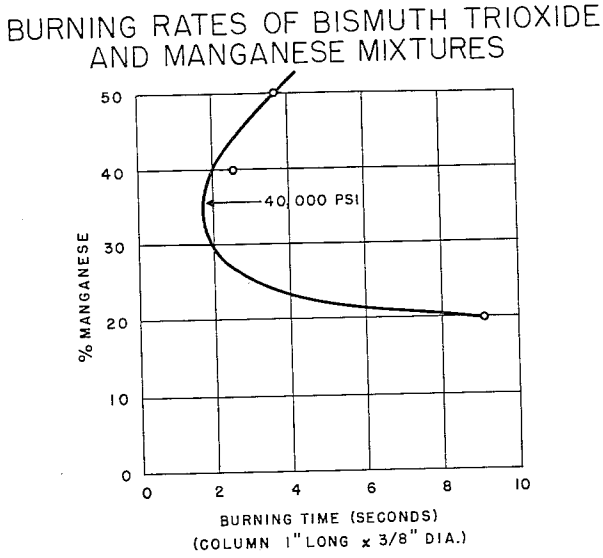
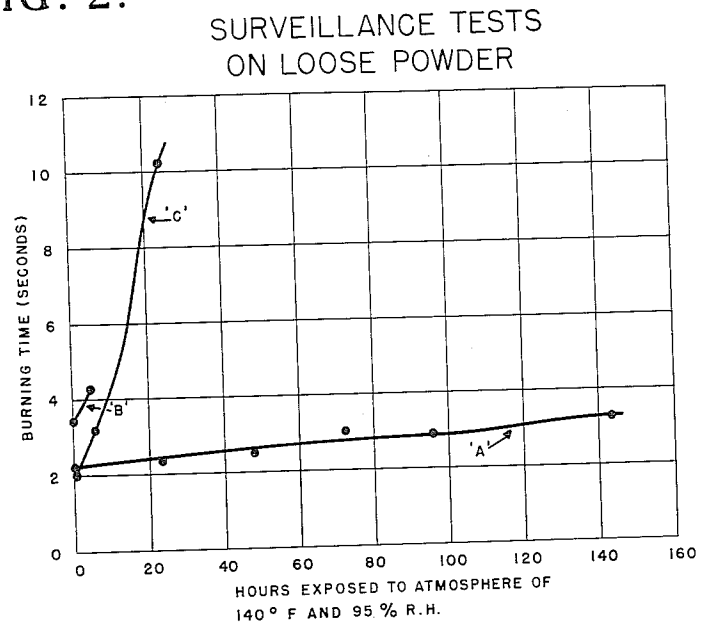


FIG. 2.



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DARK BURNING IGNITER COMPOSITION

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8 Claims. (Cl. 52—2)

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This invention relates to an igniting mixture and more particularly it concerns a dark burning non-flash igniter composition adapted to ignite the tracer composition arranged within the projectile.

Heretofore tracer ammunition used by our armed forces proved unsatisfactory especially when used in night encounters, in that, under conditions of darkness, the ignition of the igniter composition which ignites the main tracer charge causes a blinding flash and too much light streak at the muzzle of the gun, thus illuminating and disclosing the position of the gun to the enemy and confusing and misleading the gunner or fire director when aiming of the gun is accomplished by observation of the tracer streak.

Various attempts have been made to produce an igniter for a tracer composition which burns without any visible flame. The U. S. Patent to Stevenson et al. No. 2,115,047 discloses an igniter composition which is of the dark burning type. In my copending application Serial Number 35,960 filed June 29, 1948, for Composition for a Tracer Unit and in my copending application Serial Number 35,961 filed June 29, 1948, for a Pyrotechnic Mixture for a Projectile, further compositions are disclosed which have the property of burning without visible flame. These prior art compositions, while possessing the desired dark burning qualities, lack to a large degree stability under conditions of high temperature and high humidity. The compositions of the present invention are designed to eliminate the disadvantages inherent in prior art compositions of the dark burning type, namely, their lack of stability under adverse temperature and humidity conditions.

Accordingly, it is an object of the present invention to provide an improved dark burning non-flash igniter composition which will serve to ignite the basic mixture of a tracer shell.

Another object is to provide a new and improved dark burning igniter composition for a bright burning tracer composition employed in a projectile and adapted to delay ignition of the tracer composition therein for a predetermined period of time after the projectile has been fired from a gun and traveled a short distance from the muzzle thereof.

Still another object is to provide a new and improved delay non-flash igniter composition for a tracer ammunition which will not deteriorate when stored for a long period of time and is not effected by atmospheric conditions such, for example, as high temperature and high humidity.

Still another object of the invention is to provide a new and improved dark burning igniter composition which has high stability under adverse storage conditions and which has a relatively fast burning speed which makes it suitable for use as an igniter in a high velocity projectile in that it burns at such a speed as to provide the proper time delay between the firing of the projectile and the ignition of the light emitting tracer composition.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same

becomes better understood by reference to the following detailed description and by reference to the drawing in which:

Fig. 1 is a graph illustrating the manner in which the burning speed of the composition of the present invention varies in accordance with varying percentages of the ingredients.

Fig. 2 is a graph illustrating the stability of the composition of the present invention.

In accordance with the present invention the new and improved dark burning non-flash igniter composition is adapted to be ignited by the propellent charge of the projectile as the gun is fired and burn dark or without a visible flame therefrom, and to cause ignition of the tracer composition following a predetermined time delay after ignition of the igniter composition.

In an igniter composition of this type there are three characteristics which are essential to its proper functioning.

1. The composition must have the quality of burning without a visible flame and yet with a flame hot enough to ignite the tracer composition.

2. The composition must burn at the proper speed to give the required time delay between the firing of the projectile and the ignition of a tracer composition.

3. The composition should have high stability under adverse conditions of temperature and humidity to assure that the igniter will function under any conditions which might be encountered in combat areas.

The composition of the present invention which combines all three of the desired characteristics listed above comprises a mixture of bismuth trioxide as the oxidizing agent, and metallic manganese as the fuel or reducing agent. Optionally, a small quantity of a binder or lubricant may be employed with the mixture, the lubricant being adapted to make the loading operation of the mixture easier and eliminate any possibility of ignition while pressing or consolidating the mixture; and a binder being employed to permit the formation of the powder into pellet form. Graphite forms an excellent lubricant while some substances such, for example, as stearic acid perform the function both of a lubricant and a binder.

The ingredients of the composition described above may be varied within the limits listed below:

	Per cent
Bismuth trioxide (Bi_2O_3)	85 to 45
Manganese (Mn)	15 to 55
Binder or lubricant	0 to 10

Fig. 1 graphically illustrates the manner in which the burning speed of the composition varies as the percentage of manganese varies. In compiling the data graphically illustrated in Fig. 1, a column one inch long and three-eighths of an inch in diameter was loaded with a number of mixtures of Bi_2O_3 and Mn having varying percentages of manganese. The exposed top layer of the column of igniter composition was ignited by any convenient means, and the time required for the composition to burn to the bottom of the column recorded. The material was loaded into the test cup at a pressure of 40,000 pounds per square inch. From an inspection of the graph it will be apparent that a composition of desired burning speed may be selected by varying the percentage composition of the ingredients. In a composition designed for use as a tracer igniter, a relatively short burning time is the most desirable since the main tracer component, giving a bright visible trace, must be ignited at a short distance, for example 100 yards, from the muzzle of the gun in order to give the gunner ample opportunity to observe the trace of the projectile. Thus, the preferred composition of the present invention for use as a dark igniter for high velocity projectile such as the 20 and 40 millimeter

type will have the minimum burning time indicated by the graph (approximately two seconds when loaded as described above) and will have a composition as follows:

	Per cent
Bismuth trioxide (Bi_2O_3)	65
Manganese (Mn)	35

Obviously, other mixtures having slower burning speeds may be used and in some cases may be desirable when a longer time delay is required. However, when these compositions are used as dark burning tracer igniters, fast burning speeds are required since the time delay between the firing of the projectile and the ignition of the bright burning main tracer charge will be in the order of only a fraction of a second. In tests made to determine the burning speed of various mixtures of bismuth trioxide and manganese, a column of the igniter composition one inch long was employed. As indicated above, in a column of this length the minimum burning speed is two seconds. Obviously, shorter time delays are obtained by shortening the length of the column of the igniter composition. If the column is made too short, however, the igniter will function erratically. Thus, when short time delays are required, a fast burning composition is the most desirable since the length of the column of igniter composition can be made relatively longer and thus the danger of erratic behavior when employing columns which are very short will be obviated.

Another preferred composition, which has the desired burning characteristics and which employs graphite as a binder is as follows:

	Per cent
Bismuth trioxide (Bi_2O_3)	63
Manganese (Mn)	35
Graphite	2

Referring now to Fig. 2 which illustrates the high stability of the composition of the present invention under severe conditions of temperature and humidity, curve A represents the curve developed by a composition compounded according to the present invention and comprising:

	Per cent
Bismuth trioxide (Bi_2O_3)	65
Manganese (Mn)	35

Curve B represents the curve developed by a composition similar to that described in my copending application Serial No. 35,960, above referred to, and having the following composition:

	Per cent
Barium peroxide (BaO_2)	76
Antimony sulphide (Sb_2S_3)	23
Graphite	1

Curve C represents the curve developed by another composition similar to that described in my copending application Serial No. 35,960 and having the following composition:

	Per cent
Barium peroxide (BaO_2)	78.4
Antimony sulphide (Sb_2S_3)	18.4
Graphite	1.0
Magnesium (Mg)	2.2

The last two compositions are both dark igniter compositions for tracer units which were developed by me prior to the development of the composition of the present invention. These compositions possess the desirable qualities of burning without a visible flame and yet with a flame hot enough to ignite the tracer composition, and of burning at the proper speed to give the required time delay between the firing of the projectile and the ignition of the tracer composition, but lack the third desideratum, namely stability under adverse conditions of temperature and humidity. These compositions will function effectively after long periods of storage if they have been carefully sealed, but if accidentally or otherwise exposed to the atmosphere they will soon lose their sensitivity and fail to function.

In making the tests, the results of which are graphically illustrated in Fig. 2, the above compositions, in the form of loose powder, were exposed for a number of hours to a temperature of 140° Fahrenheit and at a relative humidity of 95%. Periodically, samples of the above compositions were removed from the testing chamber and loaded into testing cups at pressures of 40,000 pounds per square inch and ignited and the burning time clocked. As can be seen clearly by observation of curve A, the composition of the present invention burned at almost the same speed after over 140 hours of exposure. The first of my prior compositions, namely that which developed curve B, began to lose its burning speed very quickly. In the tests, after four hours of exposure its burning time had risen from 2.8 seconds to 4.4 seconds and after 24 hours' exposure this composition failed to ignite at all. The composition which developed curve C also rapidly underwent a decrease in burning speed. From a burning time at 0 hours of exposure of two seconds, its burning time increased to 10.4 seconds after 24 hours of exposure; and after 48 hours of exposure this composition failed to ignite at all. It can readily be seen that the composition of the present invention has a very marked stability under conditions of high temperature and high humidity and represents a marked improvement over prior compositions.

In preparing the ingredients comprising the delay non-flash igniter mixture of the invention it has been found that the most satisfactory results are obtained when the bismuth trioxide and manganese are of such a particle size as to pass through a U. S. standard sieve, mesh size $\frac{325}{000}$. To insure such a particle size, the ingredients are first sifted. When sifting of the ingredients has been completed the ingredients are then thoroughly mixed in any suitable manner but preferably by placing them in a mixing churn, the churn being of any type suitable for the purpose such, for example, as the type known in the trade as the "Abbe" mixer churn. The time period required to mix the aforesaid ingredients thoroughly when the churn is set in operation is approximately 30 minutes.

A small percentage of graphite or stearic acid may be added to the mixture to reduce the frictional sensitivity of the particles of which the delay non-flash igniter is composed, sufficiently low to prevent premature detonation of the mixture during pressing thereof into the tracer cavity of the projectile or when consolidating the mixture into pellet form, the stearic acid being adapted to act as both a lubricant and binder.

In loading the delay non-flash igniter mixture into the tracer cavity of the projectile it has been found that the best result was obtained when the mixture was pressed into the cavity at a pressure of 10,000 to 40,000 p. s. i. If desired the mixture may be pressed into pellets at a pressure sufficient to consolidate the mixture whereupon a combination binder and lubricant is employed therewith such, for example, as the aforesaid stearic acid. In loading the delay non-flash mixture in pellet form into the tracer cavity of the projectile the pellet is pressed in abutting engagement with the tracer mixture at a pressure in the neighborhood of 40,000 p. s. i.

From the foregoing description it will be understood that a delay non-tracing mixture for tracer ammunition has been compounded and constructed which is sufficiently stable to permit the tracer ammunition to be stored over a long period of time and is sufficiently sensitive to be ignited by the propellent charge as the projectile is fired from the gun and which will burn without a visible flame so as not to disclose the gun position or blind the gunner and which burns sufficiently rapidly and with a flame hot enough to initiate ignition of the tracer mixture after a predetermined time delay.

Obviously, the composition of the present invention

may be applied to other uses than as an igniter composition for a tracer unit where characteristics similar to those possessed by the composition of the invention are desirable, and it is apparent that many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

The invention hereindescribed and claimed may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A highly stable dark burning igniter composition comprising from 85 to 45% of bismuth trioxide and from 15 to 55% manganese.

2. A highly stable dark burning igniter composition comprising from 85 to 45% of bismuth trioxide, from 15 to 55% manganese, and up to 10% of a binder.

3. A highly stable dark burning igniter composition comprising from 85 to 45% of bismuth trioxide, from 15 to 55% manganese, and up to 10% of a lubricant.

4. A highly stable dark burning igniter composition comprising about 65% of bismuth trioxide and about 35% of manganese.

5. A highly stable dark burning igniter composition comprising about 63% of bismuth trioxide, about 35% of manganese, and about 2% graphite.

6. A highly stable dark burning igniter composition comprising from 85 to 45% of bismuth trioxide, from 15 to 55% of manganese and up to 10% of stearic acid.

7. A highly stable dark burning igniter composition comprising from 85 to 45% of bismuth trioxide, from 15 to 55% of manganese, and up to 10% graphite.

8. A highly stable dark burning igniter composition comprising about 63% of bismuth trioxide, about 35% of manganese, and about 2% of stearic acid.

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