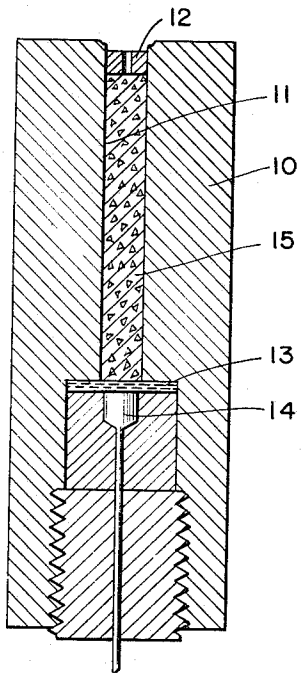
Dec. 23, 1958 H. P. JENKINS ET AL 2,865,726

EXPLOSIVE CHARGE FOR DELAY FUZE

Filed June 3, 1952

Fig. 1.



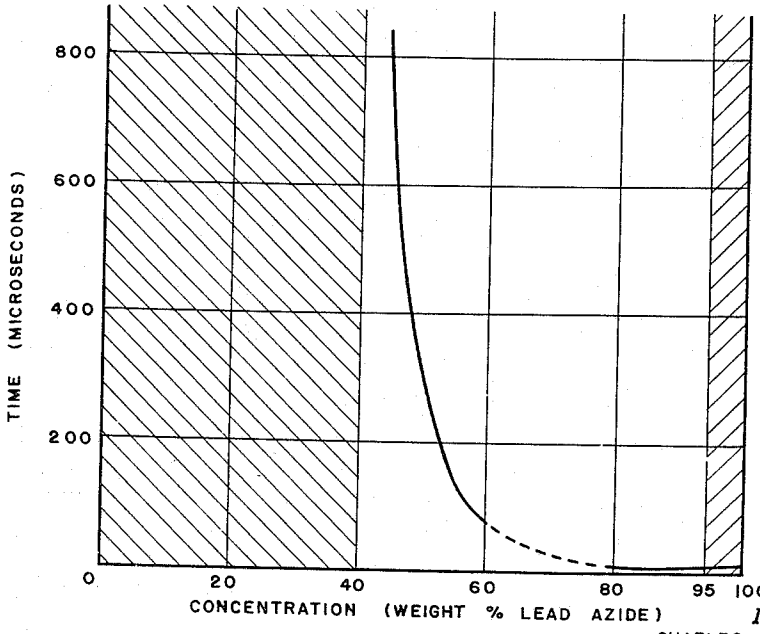


Fig. 2.

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EXPLOSIVE CHARGE FOR DELAY FUZE

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The invention described herein 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.

This invention relates to a method for controlling the rate of detonation of explosives; to new explosive compositions, and articles made therefrom.

There are many applications of explosives wherein control of their detonation rate is highly advantageous. This is particularly true in the use of military explosive missiles where penetration of the target before explosion is often necessary in order to realize the maximum effect. The ordinary primary explosives such as lead azide when used alone have too short a delay for use in fuzes to give maximum effect against certain targets which are frangible, such as airplane wings.

In the past, delay in fuzes has usually been obtained by such devices as pyrotechnic trains, baffle elements, mechanical devices and others. These prior devices have many disadvantages for this use, including the fact that they do not give reproducible delays and, generally, short delays cannot be obtained with them. In addition, the mechanical devices have restricted application because of space requirements. In general, delays have not been obtained in fuzes for military explosive missiles by modification of the composition of the initiating explosive.

It is an object of this invention to provide a method for controlling the rate of detonation of initiating explosives.

The above and other objects are accomplished by adding to the primary explosive a waxy material in amounts determined by the rate of detonation required.

The waxy materials include fatty acids such as stearic acid, metallic salts of fatty acids such as aluminum stearate and many others, the essential requirement being that the material have waxy properties so that the particles of explosives are coated and the interstices between the particles are filled up. The invention has direct applicability to primary explosives such as lead azide and mercury fulminate, but could conceivably be used to modify the detonation rate of other types of explosives.

The invention is illustrated by reference to the tabulated results set forth in Tables I and II below and the accompanying drawings hereby made a part of this specification in which,

Fig. 1 is a vertical section of the apparatus used to test the explosive mixtures, and

Fig. 2 is a graph of the results given in Table I in which delay time is plotted against percent lead azide in the mixtures.

Various mixtures of lead azide and aluminum stearate and lead azide and stearic acid were tested by measuring the time elapsing between initiation and detonation of a small column of each mixture.

Referring to Fig. 1, the numeral 10 designates an outer wall of strong material such as brass or stainless steel having a cylindrical chamber 11 therein. The exit of the chamber is partially closed with a metal plug 12

which is crimped in place as shown. The initiating device 13 such as a graphite igniter bridge is placed at the opposite end of the chamber, and is provided with an ignition device 14 which may be of the electrical or other type. The lead azide mixture 15 was placed inside the chamber 11 in contact with the graphite igniter bridge. The length of the column, as shown in the tables, was about .9" long. The described test device could be used as a delay element for a fuze. The column of explosive was initiated by a condenser discharge which also started two timing devices, each adapted to record the time interval between initiation of the explosive, and the arrival of a detonation wave at the exit of the column. Two RCA type WF99B counters, connected in parallel, were set to start on one electrical pulse and to stop on the second. A make-type switch was used at the exit of the column. It consisted of two leaves of 0.004-inch copper foil, separated by a 0.004-inch-thick paper washer fastened together with a single wrapping of scotch tape. This switch was then clamped down on top of the bomb with the vent hole in line with the center of the paper washer. The blast from the vent effected a contact between the two copper strips, completing the stop-circuit and sending a pulse to stop the counters. This arrangement, when tested, always gave a positive, reproducible operation. The timing circuit is not shown as it is considered standard apparatus. The interval between two pulses was read directly from the indicating decades of the counters. The accuracy claimed for the counters is one millionth of a second. The two counters were used as checks against each other and when one of the counters failed to start or stop, or the readings disagreed by more than 5 microseconds, the readings were discarded.

It should be noted that the instruments measure the lapse of time between a sending of a pulse to fire the explosive and a receiving of a return signal. In addition to the time required to detonate the column of lead azide after initiation, this time interval includes, of course, the times required to send a pulse to the igniter bridge, to explode the graphite film, to initiate the lead azide, to send the shock wave through the brass plug, to close the make-switch, and to send a stop pulse back to the counters. In order to ascertain the magnitude of these additional time intervals, a special bomb with an explosive column only 1/16 inch long was fired. The time for the detonation to travel through the 1/16 inch column was considered negligible. The total time lapse, as read on the counters, was only 16 microseconds. This indicated that the timing system was satisfactory in that this time interval was small compared with the recorded times of several hundred microseconds usually obtained.

Standard military lead azide was used in all the compositions. Usually one gram of azide was weighed accurately and mixed thoroughly with a calculated amount of the diluent. Mixing was accomplished by a small tumble mill designed for the purpose. The azide mixtures were loaded into the bombs by increments, the increment being compressed on top of the igniter bridge by a polished 1/8-inch steel plunger, the second increment on top of the first, and so on, until the column was filled under 12 tons per square inch pressure. A greater degree of homogeneity in the column was obtained by this method of loading. In general, the compressed material was a hard mass, which did not lose its form when the pressure was removed. The aluminum stearate powder used was a Braun Corporation product. The stearic acid was a reagent-grade material purified by distillation.

The results obtained on a number of compositions are given in the following tables.

TABLE I

Lead azide-aluminum stearate mixtures

Mixture Composition (wt. percent azide)	Length of Charge (in.)	Time (microsec.)	Average (microsec.)	Standard Deviation (microsec.)
44.44	0.906	671	816	108
	0.906	881		
	0 871	944		
	0.920	836		
	0.920	749		
50.00	0.906	517	354	161
	0.894	430		
	0.891	190		
	0 923	173		
	0.891	461		
57.14	0.884	148	108	35
	0.910	83		
	0.913	92		

TABLE II

Lead azide-stearic acid mixture

Mixture Composition (wt. percent azide)	Weight of Charge (g.)	Length of Charge (in.)	Time (microsec.)	Average (microsec.)
44.44	0.292	0.890	no fire	591
50.00	0.324	0.915	652	
50.00	0.317	0.898	530	

It will be noted from the tables that the optimum composition of lead azide and aluminum stearate is one containing about 44.44 percent lead azide wherein an average delay of 816 microseconds is obtained with a standard deviation of 108 microseconds between the tests. With a 50 percent mixture of lead azide, an average delay of 354 microseconds is obtained with a standard deviation of 161 microseconds. With a composition containing 57.14 percent azide, an average delay of 108 microseconds is obtained with a standard deviation of 35 microseconds. The standard deviation is lower than any heretofore obtained for this short delay and is quite small for this type of statistical phenomenon.

Referring to Fig. 2, it will be noted from the graph that, as would be expected with nearly pure lead azide, extremely short delays are obtained. This delay does not increase appreciably until the percentage of lead azide decrease to about 60. At somewhere between 60 and 40 percent lead azide, there is a sharp deviation in the delay time and delays of 800 seconds and above are reached within this percentage range. It will be noted that if the results for stearic acid were also plotted on the graph, the critical range would also fall within the 40 and 60 percent lead azide range, as the mixture did not fire at 44.44 percent lead azide and two firings of a 50 percent lead azide mixture gave an average delay of 591 seconds.

Although the cause of this unexpected phenomenon is not definitely known, it is believed to be due to a

changeover from detonation to deflagration at somewhere above 60 percent of lead azide. This would seem to be substantiated by the fact that, as is well known, lead azide can be dead pressed to the point where it cannot be detonated but can be deflagrated. This result has been explained by the fact that loose explosives are most readily detonated because of the possibility of formation of pressure gradients in the interior of the mass. Applying this theory to the instant invention, it is believed that the use of the waxy materials fills the interstices between the particles, thus preventing the formation of pressure gradients so that deflagration and not detonation occurs with the result that delays are obtained.

As is illustrated by the above results, it is an advantage of the invention that the rate of detonation of a primary explosive such as lead azide can be reproducibly controlled, depending upon the desired delay, by the addition of the type diluents disclosed herein. This is a far more reliable method of obtaining reproducibility than that of compressing the explosive and the use of the other prior methods mentioned above with their attendant disadvantages. Another advantage is the fact that extremely short controlled delays can be obtained with this invention. A further advantage of the invention is that its use reduces space requirements for fuzes, as the space for the delay train is dictated only by the amount of explosive mixture used.

Obviously, 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.

What is claimed is:

1. An explosive charge for use as a short time delay fuze consisting essentially of a compressed mass of homogeneously mixed particles of lead azide and a material chosen from the class consisting of aluminum stearate and stearic acid, the particles of said material being present in an amount from about 40% to about 60% by weight.

2. An explosive charge for use as a short time delay fuze consisting essentially of a compressed mass of homogeneously mixed particles of lead azide and aluminum stearate, the aluminum stearate particles being present in an amount from about 40% to about 60% by weight.

3. An explosive charge for use as a short time delay fuze consisting essentially of a compressed mass of homogeneously mixed particles of lead azide and stearic acid, the stearic acid particles being present in an amount from about 40% to about 60% by weight.

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