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TIME FUSE ELEMENT
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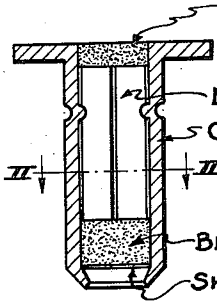
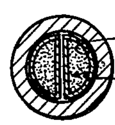


FIG. 1

FIG. 2



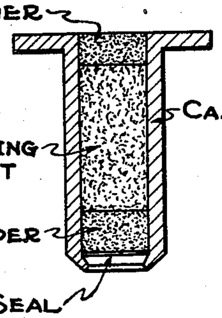


FIG. 3

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TIME FUSE ELEMENT

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7 Claims. (Cl. 52—2)

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This invention relates to fuses of the types used with explosives, in pyrotechny, and for related purposes, and more particularly to time fuses, or time elements, such as are used with military grenades or flares, or for other purposes where a timed fuse action is involved.

Although the invention is applicable to the various uses to which fuses are put, and may be embodied in the various forms which fuses take, it is especially adapted to suppression or elimination of the shortcomings of time fuses used with grenades, signal flares, and similar military equipment, for which reason it will be described in detail with reference thereto by way of illustration but not of limitation.

The invention will be described with reference to the accompanying drawings in which Fig. 1 is a longitudinal sectional view through a parachute flare time delay fuse element of standard type; Fig. 2 a transverse sectional view through the fuse taken on line II—II, Fig. 1; and Fig. 3 similar to Fig. 1 showing the invention applied to a parachute flare time delay fuse.

Fuses of the type mentioned are subject to two major requirements. First, they must burn, after ignition, for an accurately predetermined period of time. This period may not be too short lest the device, such as a grenade, acts prematurely, nor too long because the proper effect may not be had, e. g., the action of a grenade may be escaped or it may be returned in the direction of the hurler. Second, they must be positive in action so that once the fuse has been ignited reliance can be placed upon the fact that the device will act after the proper time interval.

A standard form of time fuse element which has been used heretofore with parachute flares is shown in Figs. 1 and 2. It comprises, as shown, a tubular metallic casing member provided at its upper end with an outwardly projecting flange. The lower end is sealed, as with a disk of paper coated or impregnated with shellac. Mounted above the seal is a charge of black powder whose object is to effect ignition of the flare candle. This powder charge is ignited by a so-called spitter fuse which is mounted above the black powder charge and commonly takes the form of two lengths of thin walled lead tubing of semicircular cross section in which the fuse charge, ordinarily black powder, is compacted. The fuse is set in action by an igniter element of one type or another, such as a primer charge mounted on top of the spitter fuse to be ignited by a match member, not shown. The casing is preferably

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provided with an inwardly extending crimp for a purpose presently to be described.

In the use of such a fuse member the heat liberated by combustion of the spitter fuse causes the lead shell to melt as combustion proceeds lengthwise of the semicircular fuse members. The molten lead is supposed to collect in the crimped portion of the fuse element and to seal the casing off at that point to prevent blowback when the ignition charge is ignited. Should blowback occur, there is the likelihood that the flare will not be ignited. This type of fuse has been subject to the disadvantage that blowback may and does occur, despite the body of molten lead, so that the flare fails of its intended purpose. Particularly, although the lead may collect in the crimped portion, experience has shown that severe shock may cause the lead to become dislodged and extinguish the fuse, so that the flare is a "dud."

For these reasons fuses of the type described have been shown to be unreliable. Nevertheless, they have continued to be used for lack of any better or more reliable type of fuse. Another disadvantage of fuses of this type is that the black powder gives off gaseous products of combustion, which may be objectionable for some purposes. Still another disadvantage of fuses of the type shown in Figs. 1 and 2 is that the rate of combustion of a given lead spitter fuse is fixed per unit of length so that if a greater time interval is needed, the length of the fuse element must be increased correspondingly. This may involve constructional complexities for some purposes.

A major object of the present invention is to provide fuses which are of simple construction and wholly reliable in action, in which blowback is avoided, and whose performance is not affected by shock.

Still another object is to provide fuses whose burning time per unit of length can be varied within broad limits whereby different burning intervals can be had with fuses of fixed length.

A special object of the invention is to provide timer fuses which additionally have the advantage that they become sealed off as combustion progresses, and which evolve substantially no gaseous products of combustion.

This invention is predicated upon our discovery that its stated objects are attained by the use of fuse compositions comprising finely divided metallic nickel and an oxidizing agent. Fuses made from such compositions avoid the foregoing disadvantages of prior types of fuses, and particularly it becomes possible to provide timer fuses for grenades, flares and the like in which blowback is prevented, which undergo self-sustaining combustion, and which are not extinguished by shock or other extraneous influences. Combustion of such mixtures produces a solid, non-volatile product which consolidates under the heat of combustion and acts to seal the container in which the composition is mounted, thus eliminating blowback. The composition itself supplies the oxygen necessary for combustion so that this sealing action does not interfere with the functioning of the fuse. No gaseous products of combustion are released, the residue being oxide of the metal used together with whatever product remains from the oxidizing agent. Thus these compositions provide fuses which are positive in action and continue to burn to their ends once they have been ignited.

The nickel should be highly subdivided, or powdered, although the exact particle size will depend in part upon the particular oxidizing agent used, and upon such other factors as the starting or igniting means, the rate of combustion desired, the presence or absence of inert material, and related factors. Likewise, it may be subdivided for use in various ways. Most suitably, however, it is prepared by the procedure disclosed in our Patent No. 1,893,879, granted January 10, 1933. Briefly, that process comprises preparing a nickel amalgam which is then subjected to distillation, preferably under high vacuum, to volatilize all of the mercury, the nickel remaining as an exceedingly fine powder. Nickel prepared in that manner is characterized by exhibiting unusually high surface activity, and by very strong tendency to react with oxygen, but we have found that it may be stabilized, so that it can be handled freely in air, by passing carbon dioxide into contact with the metal subsequent to the amalgam distillation and prior to contact with oxygen.

A variety of oxidizing agents are satisfactorily applicable to the purposes of this invention such, for example, as manganese dioxide, sodium nitrate, and others well known to chemists. Preferably, however, we make use of salts of oxygen-containing acids which are capable of carrying on a self-sustained combustion with metal, and most suitably persalts, e. g., the alkali and alkali metal chlorates and perchlorates. Thus, there may be used potassium permanganate or potassium chlorate or, and most suitably for many purposes, potassium perchlorate.

The rate of combustion of a unit quantity of such compositions may be controlled by modifying the ratio of oxidizing agent to metal, by the use of powders of different metals or combinations of different powdered metals, by the use of combinations of oxidizing agents, or by the addition of inert diluents, i. e., materials which do not enter into the reaction and serve simply to dilute the active ingredients and thus reduce the intensity or rate of their reaction, examples being such materials as iron oxide, feldspar, infusorial earth, and the like. Variation is possible also by modifying the particle size, e. g., of the diluent, and by the surface character of the particles of metal.

As exemplifying the practice of the invention and the manner in which the rate of combustion may be controlled, we now prefer to make up a base mixture of 1 mol of potassium perchlorate and 4 mols of finely powdered nickel made in the manner described above. These are the proportions which correspond to theoretically perfect combustion. Two parts by weight of the base mixture mixed with one part by weight of infusorial earth provides a fuse composition which will burn at the rate of three seconds per inch. On the other hand, a mixture of seven parts by weight of the base mixture, three parts by weight of iron oxide, and two parts by weight of diatomaceous earth provides a composition which will burn at the rate of six seconds per inch.

The use of diatomaceous earth as an inert diluent is especially desirable because it prevents the composition from packing too tightly.

The starting temperature may likewise be varied by alterations in the composition. For example, sodium nitrate compositions possess quite high starting temperature as compared with those containing chlorates or perchlorates. The starting temperature may be dependent upon the particle size of the metal powder, but if the powder becomes too coarse it may be extremely difficult, if not impossible, to ignite the mixture by any practical means.

Such compositions possess notable advantages. They are not difficult or dangerous to handle, i. e., they are not ignitible by friction or shock, and they are positive in action because once started they are not extinguishable, either through absence of air, by shock, or by accumulation of oxidation products, whereby blow-back and other troubles encountered with previous fuses are avoided. Also, the products of combustion are not gaseous and they tend to consolidate and seal off the container as combustion progresses through the fuse, which is advantageous when fuses are used in flammable or explosive atmospheres. A particular advantage is that when using a unit fuse length the burning time may be varied within considerable limits by appropriate modification of the composition, which is of importance not only in making it possible to use fuse casings of a given size for a variety of differently timed operations, but also because it standardizes structural details of flares and other similar devices. Moreover, ordinary spitter fuses are known to be susceptible to variations in humidity due to their content of black powder. Tests have shown that fuses constructed in accordance with this invention are apparently stable under widely varying atmospheric conditions. Thus, exposure to humid air has not affected the operation of compositions described above. Also, fuses made in accordance with the invention have been chilled with carbon dioxide ice, which tends rapidly to draw moisture from the air and freeze it on the chilled objects, but after hours of treatment in that manner the fuses provided by the invention operated as satisfactorily as before.

As noted above, the invention may be applied to any form of fuse, or to fuses for any use. Thus, the compositions may be substituted for the spitter fuse of the element shown in Figs. 1 and 2. Simplification is to be had, however, by omitting the crimp of that fuse and using the composition as a filler for the casing in the manner shown in Fig. 3. Or, the compositions may be used for the filling of other types of casings or fuse containers, both metallic and non-metallic. They are easy to ignite, and various igniting means may be provided for grenade, flare and the like fuses, depending upon their mode of use, or where used for blasting or pyrotechny they can be ignited by a flame.

Although the invention has been described with reference to compositions comprising nickel and an oxidizing agent capable by self-sustained reaction of converting it to nickel oxide, which constitutes the preferred embodiment, it is possible to use other metals in finely divided form for making fuse compositions in accordance with the principles and embodying the advantages described above, or similarly to use mixtures or alloys of metals. Such compositions are susceptible to the modifications described, e. g., with reference to modification of burning time, starting temperature, effect of particle size, and the like. For many purposes we prefer to use those metals whole oxides have a heat of formation not exceeding that of iron oxides because the oxides formed tend to consolidate as described above, with resultant advantage where the heat of formation of the oxide is greater than that of iron the reaction products tend to liquify, which is disadvantageous for most purposes.

According to the provisions of the patent statutes, we have explained the principle, mode of compounding and mode of operation of our invention and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. A fuse element composition comprising an intimate mixture of finely divided nickel produced by distillation of mercury from a mercury-nickel amalgam, and an oxidizing agent which reacts exothermically with said nickel, a unit quantity of said mixture burning in a confined unit of space during a predetermined period of time and with production of substantially no gaseous products of combustion.

2. A composition according to claim 1, said oxidizing agent being a per-salt of an oxygen-containing acid.

3. A composition according to claim 1, said oxidizing agent being an alkali metal perchlorate.

4. A composition according to claim 3, the composition containing also diatomaceous earth.

5. A composition according to claim 1 including also an inert diluent.

6. A composition according to claim 1, said oxidizing agent being an alkali metal perchlorate, and the nickel and perchlorate being present in substantially stoichiometrical proportions.

7. A composition according to claim 6, the composition containing also diatomaceous earth as an inert diluent.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,331,623	Cartwright	Feb. 24, 1920
1,949,841	Nash	Mar. 6, 1934
2,185,371	Burrows	Jan. 2, 1940

FOREIGN PATENTS

Number	Country	Date
259,539	Great Britain	July 13, 1926
703,809	France	Feb. 10, 1931