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Rehbock

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[54] **ELECTRONIC PROXIMITY FUSE INCORPORATING MEANS FOR PREVENTING PREMATURE DETONATION BY ELECTRONIC COUNTER MEASURES**

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[52] **U.S. Cl.** ..... **102/70.2 P;** 343/7 PF

[51] **Int. Cl.²** **F42C 13/04**

[58] **Field of Search** ..... 343/5 R, 7 PF, 11 R, 12 R, 343/13 R; 102/70.2, 70.2 P

[56] **References Cited**

UNITED STATES PATENTS

2,403,567	7/1946	Wales	343/7 PF X
2,699,543	1/1955	Naumann et al.	343/7 PF
2,903,534	9/1959	Bleakney et al.	102/70.2 R X
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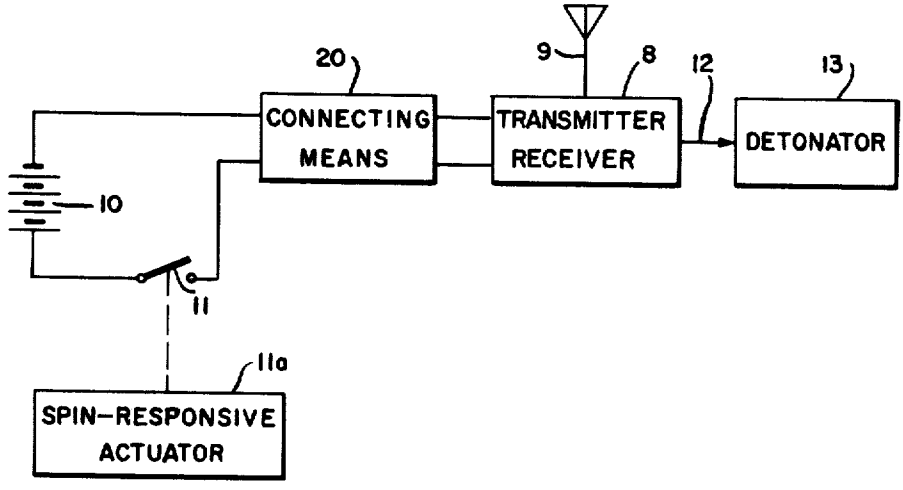
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EXEMPLARY CLAIM

1. In a projectile, the combination which comprises:
   a. an electronic proximity fuse circuit including
      1. a detonator and
      2. a Doppler-frequency responsive transmitter-receiver connected to said detonator for applying a trigger signal thereto when the projectile is near the target; and
   b. means for applying electric power to said fuse circuit only when the projectile is near its target, in consequence of which the time interval during which an electronic counter measure device may act on said transmitter-receiver for purposes of prematurely detonating said detonator, is short.

9 Claims, 3 Drawing Figures



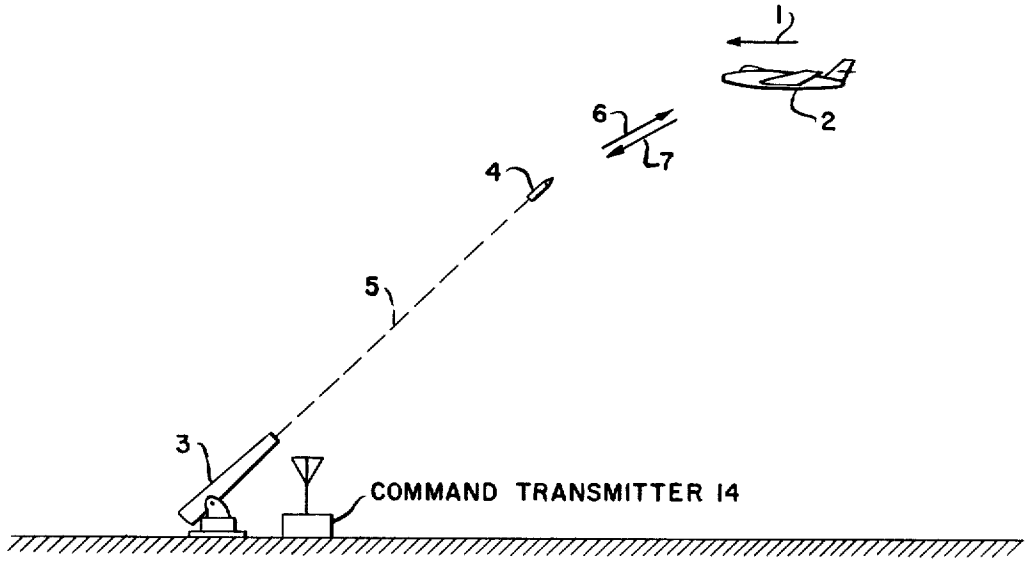


FIG. 1.

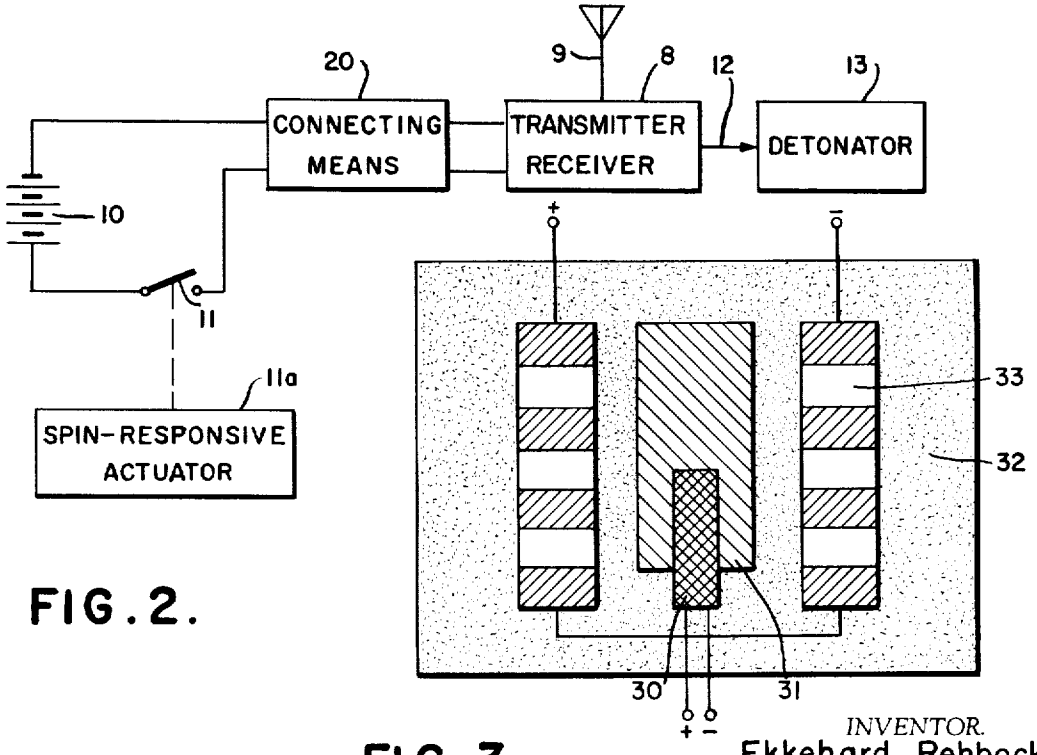


FIG. 2.

FIG. 3.

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ELECTRONIC PROXIMITY FUSE INCORPORATING MEANS FOR PREVENTING PREMATURE DETONATION BY ELECTRONIC COUNTER MEASURES

The present invention relates to a method for triggering the electronic detonating means of an uncontrolled or remotely controlled projectile or missile, as well as to an arrangement carrying out such method.

There exist electronic proximity fuses which operate as follows: a self-oscillating mixer stage emits a HF output of about **10** to **100** milliwatts via a small antenna located at the front end of the projectile; when the projectile passes close to a target, a receiver carried by the projectile will pick up a portion of the energy reflected by the target; this reflected signal, whose frequency will differ from that of the transmitted signal by the Doppler frequency, is mixed with the transmitted signal frequency. The thus-obtained beat frequency is known to behave as follows: When the detonator approaches the target, the beat frequency at first increases, or even first becomes discernible from noise; the frequency will then, near the critical point at the target, very rapidly fall to zero; after the critical point is passed, the frequency will very rapidly increase; whereafter, the frequency will continue to decrease, or be lost in noise. This frequency is subjected to low frequency amplification and is utilized for triggering the detonator.

These known arrangements have a supply battery which is activated by the effect of the acceleration to which the projectile is subjected when it is fired. In practice, such a battery may be of the chromic acid type and incorporate a glass ampoule which is shattered as a result of this acceleration. In general, such projectiles will also include a safety device which is turned off (meaning that it is switched to a position wherein it will permit the detonator to explode), after the projectile has left the weapon by which it is fired, by the spin which is imparted to the projectile in the firing tube.

One serious drawback of the above-described arrangement is that the enemy against whom the projectile is directed can, by means of electronic countermeasures involving the use of sensitive receivers, detect the transmitter frequency of the detonator and activate a wobble transmitter which simulates the Doppler frequency, thereby prematurely triggering the detonator at a time when the projectile is not yet within effective striking distance of the enemy. Another drawback of known arrangements is the fact that mortars firing the projectiles launch the projectiles with relatively low acceleration, so that the ampoule is not ruptured and the battery is not activated, thereby leaving the projectile unarmed.

It is, therefore, an object of the present invention to provide an electronic proximity fuse arrangement which avoids the drawbacks of known detonators and which, in addition thereto, can be made at low cost, is of small size, and is of light weight.

With the above object in view, the present invention resides mainly in an arrangement, suitable for use in a projectile, and comprising an electronic proximity fuse circuit including a detonator and a transmitter-receiver which is responsive to reflected energy, i.e., a Doppler-frequency responsive transmitter-receiver, the latter being connected to the detonator for applying a trigger signal thereto when the projectile is near the target. The arrangement further comprises means for applying

electric power to the fuse circuit only when the projectile is near its target, in consequence of which the time interval during which an electronic counter measure device may act on the transmitter-receiver, for purposes of prematurely detonating the detonator, is short. The means for applying electric power to the fuse circuit may include a battery as well as means for connecting the battery to the fuse circuit not at the time of firing but only when the projectile is near its target, or, in the absence of such connecting means, the battery can be of a type which can be caused to change over from a deactivated condition to an activated condition, in which case the battery will normally be in its deactivated condition but be activated when the projectile is near its target. The present invention further resides in a method of triggering an electronic proximity fuse circuit of a projectile, which comprises the steps of applying electric power to the fuse circuit only when the projectile is near its target, and triggering the fuse circuit by a reflected energy signal when the projectile is near the target.

Additional objects and advantages of the present invention will become apparent upon consideration of the following description when taken in conjunction with the accompanying drawings in which:

FIG. **1** is a diagrammatic showing of the firing of the projectile.

FIG. **2** is a schematic diagram of an electronic proximity fuse arrangement according to the present invention.

FIG. **3** is a schematic diagram of a semiconductor thermoelectric battery which may be used in a proximity fuse according to the present invention.

Referring now to the drawings and FIG. **1** thereof in particular, the same shows an enemy aircraft **2**, flying in the direction of arrow **1**, which aircraft is to be shot down by a friendly antiaircraft gun **3** shooting a projectile **4** along a trajectory **5** intended to bring the projectile on a collision course with the aircraft. The projectile sends out a transmitter frequency f_o directed, inter alia, toward the target aircraft, as indicated by arrow **6.** A part of the signal is reflected, as indicated by arrow **7,** the returning signal being shifted by the Doppler frequency dictated by the relative speed components and picked up by a receiver in projectile **4.**

FIG. **2** shows the circuitry carried by the projectile, the same including a transistorized transmitter-receiver **8** having an antenna **9** for transmitting and receiving signals. The power supply voltage for the transistors is derived from a battery **10,** the electrical connection between the transmitter-receiver **8** and battery **10** being closed by actuation of a safety switch **11.** The latter is mechanically coupled to and actuated by a conventional spin-responsive actuator **11a** which causes the switch **11** to close after the projectile has received its spin in the gun **3.**

The beat frequency obtained by mixing the transmitted and received frequencies is applied, via a line **12,** to the actual detonator **13.** When this beat frequency reaches a predetermined value, as, for example, zero, the detonator will receive a trigger signal.

According to the present invention, premature triggering of the detonator by means of a wobble transmitter is prevented by not supplying electric power to the transmitter-receiver **8** as soon as the projectile leaves the gun **3,** but only when the projectile is near the target at which the detonator is intended to be triggered.

In this way, there is no way for the enemy counter measures to interfere with the electronic circuitry of the projectile. Therefore, a suitable control device **20** is interposed between the transmitter-receiver **8** and the battery **10.** The control device **20** may be constituted by a remote-controlled switching circuit, or a preset time fuse or other time-controlled mechanism. If the circuit **20** is to be controlled from the ground, this can be done by an appropriate command transmitter **14** (FIG. 1). Alternatively, the control device **20** can be dispensed with and the battery **10** can be of a type which is not activated until the projectile is in the vicinity of the target. To this end, the battery will not be a conventional chromic acid battery of the type referred to above, but a battery which is activated, for example, by a coarsely adjustable time fuse. Batteries which are particularly useful for this purpose are the thermal or so-called pyrotechnic batteries whose electrolyte consists of melted salts which are heated, during the activating time, by burning nitrated paper serving as the electrolyte carrier. The activating time is of the same order of magnitude as the short time interval, usually not more than **10** seconds, that elapses between the firing of the projectile and the instant at which the transmitter-receiver circuit is to be energized.

The parts **8, 11***a*, and **13** are conventional. For example, the transmitter-receiver **8,** being the usual Doppler radar set, may operate as described in U.S. Pat. No. **2,699,543,** issued Jan. **11**th, **1955,** column **2,** lines **23** to **57;** the spin-responsive actuator **11***a* may be as the switch shown in U.S. Pat. No. **2,903,534,** issued Sept. **8**th, **1959;** and the actual detonator **13** may include circuitry as shown in FIG. **2** of U.S. Pat. No. **2,403,567,** issued July **9**th, **1946.**

FIG. **3** shows a semiconductor thermoelectric battery, which may be used in combination with the invention.

The battery consists of an activator which normally may be of the quick-match-type or the electric pill-type **30,** an exothermic charge **31** which may consist of thermite, a heat moderator-accumulator **32** and the battery of semiconductor elements **33.**

It has been found that a fuse arrangement according to the present invention can be made smaller and lighter than heretofore known arrangements, so that a projectile having the same ballistic characteristics can contain substantially more explosive than was previously possible. Moreover, the efficacy of enemy electronic counter measures is substantially reduced, if not eliminated.

It will be understood that the above description of the present invention is susceptible to various modifications, changes, and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

What is claimed is:

1. In a projectile, the combination which comprises:

a. an electronic proximity fuse circuit including

1. a detonator and

2. a Doppler-frequency responsive transmitter-receiver connected to said detonator for applying a trigger signal thereto when the projectile is near the target; and

b. means for applying electric power to said fuse circuit only when the projectile is near its target, in consequence of which the time interval during which an electronic counter measure device may act on said transmitter-receiver for purposes of prematurely detonating said detonator, is short.

2. The combination defined in claim **1** wherein said means for applying electric power to said fuse circuit include

1. a battery, and

2. means for connecting said battery to said fuse circuit only when the projectile is near the target.

3. The combination defined in claim **2** wherein said connecting means comprise a preset time fuse.

4. The combination defined in claim **2** wherein said connecting means comprise a time-controlled mechanism.

5. The combination defined in claim **2** wherein said connecting means comprise a remote-controlled electronic circuit which is responsive to a signal transmitted by a command transmitter apart from the projectile.

6. The combination defined in claim **1** wherein said means for applying electric power to said fuse circuit include a battery connected to said proximity fuse circuit for applying electric power thereto, said battery being of a type which can be caused to change over from a deactivated condition to an activated condition and being normally in its deactivated condition, said battery being activated only when the projectile is near its target.

7. The combination defined in claim **6** wherein said battery is one whose electrolyte consists of melted salts which are heated, during the activating time, by burning nitrated paper serving as the electrolyte carrier.

8. The combination defined in claim **6,** wherein said battery is one whose activation is effected by pyrotechnic devices and which includes of semiconductor thermoelectric elements.

9. A method of triggering an electronic proximity fuse circuit of a projectile, comprising the steps of applying electric power to the fuse circuit only when the projectile is near its target, and triggering the fuse circuit by a reflected energy signal when the projectile is near the target, in consequence of which the time interval during which an electronic counter measure device may simulate a reflected energy signal and thereby prematurely trigger the fuse circuit, is short.

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