# United States Patent [19]

**Zimmerman**

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[54] **RAIN DISCRIMINATING FAST ACTING IMPACT SWITCH**


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[52] **U.S. Cl.**........ **102/70.2 R,** 200/61.04, 200/81 R

[51] **Int. Cl.**...... **F42c 5/00,** F42c 3/00, H01h 35/24

[58] **Field of Search**..... 102/70.2 R, 70.2 GA, 7, 16, 102/17, 54; 200/61.04, 81 R, 81.4


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[57] **ABSTRACT**


A number of spring-mass switches are located around a circumferential line near the forward end of a missile. The switches are connected in series so that detonator energization occurs only when all switches are closed simultaneously. Due to the random nature of rain, all the switches are statistically restricted from being actuated simultaneously by rain. However, when the missile impacts with a large water body, all switches will close simultaneously to effect a fast acting detonation.


**4 Claims, 6 Drawing Figures**

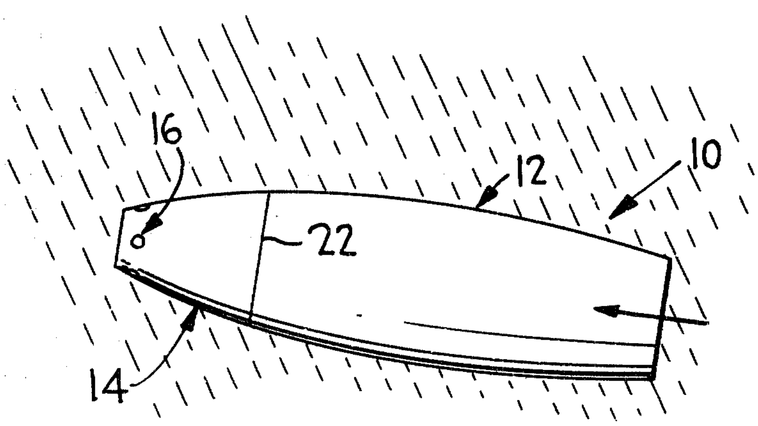


FIG. 1

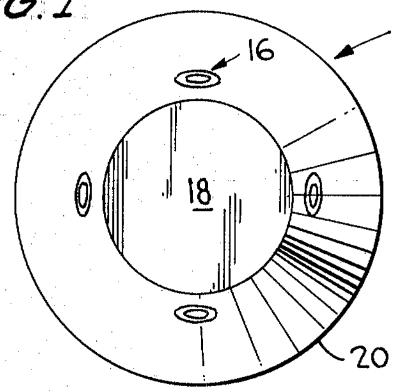



FIG. 2

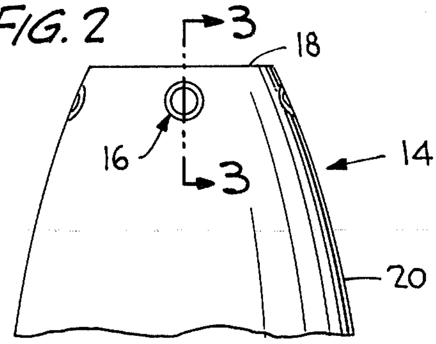



FIG. 3

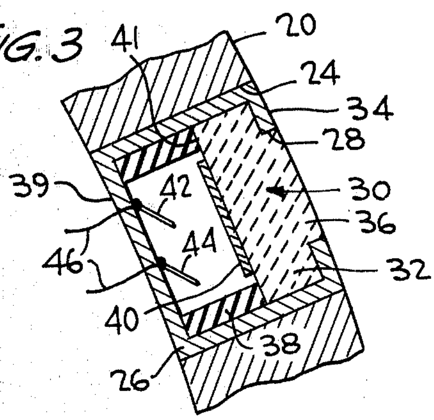



FIG. 4

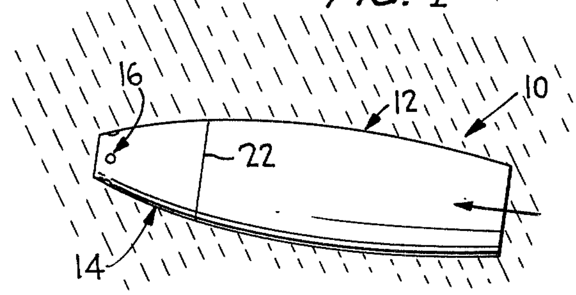



FIG. 5

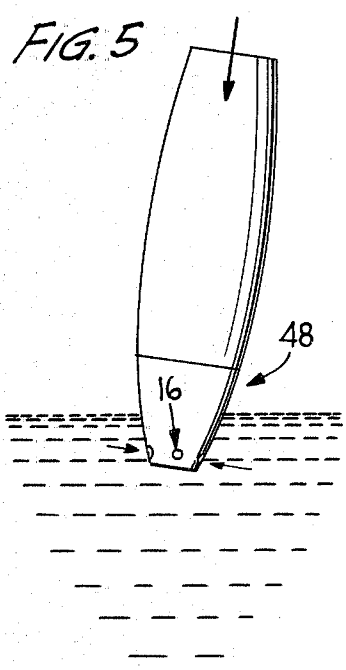
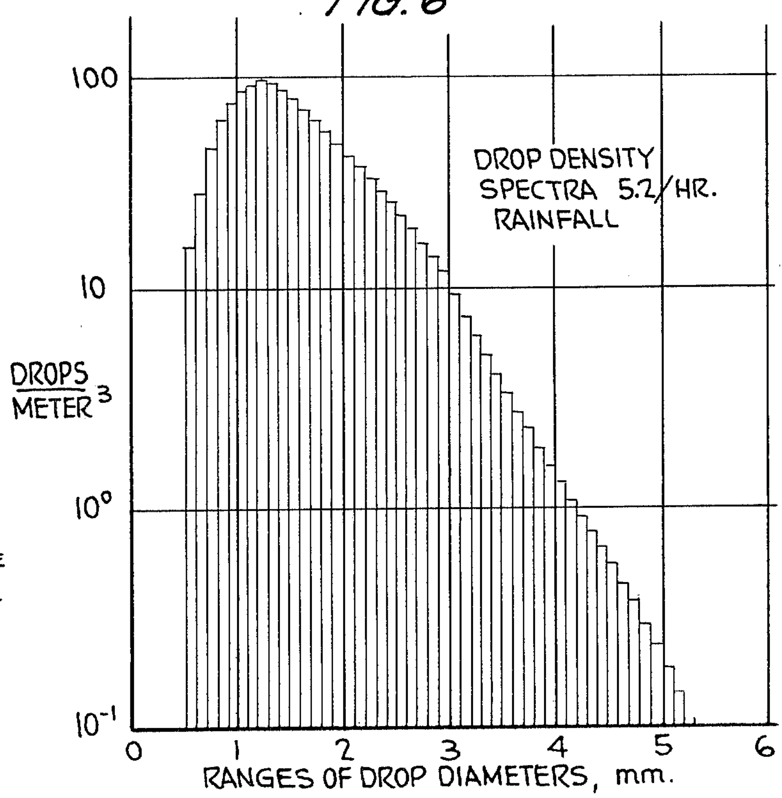



FIG. 6



# RAIN DISCRIMINATING FAST ACTING IMPACT SWITCH

## RIGHTS OF GOVERNMENT

The invention described herein may be manufactured, used and licensed by or for the United States Government for governmental purposes without the payment to me of any royalty thereon.

## FIELD OF THE INVENTION

The following invention is related to artillery fuzes, and more particularly to a rapidly responding impact switch for a fuze detonator which discriminates rain from a large water body.

## THE PRIOR ART

In fuze design, some method must be used to prevent rain impact detonation. When an artillery fuze is to be used over a wide range of velocities, the magnitude of the encountered forces in rain impact overlap the forces occurring during entry into a large water body. In order for the fuze to pass through rain at high velocities without detonating, and be able to detonate on impact with a water body at low velocities, some method other than sensing the magnitude of forces must be used to discriminate between rain and water body impact.

Previous attempts to differentiate between rain and water body impact have approached the problem from the basis of impact duration effects on a spring-mass system. Rain impact is characterized as a transient forcing function which imparts only a limited deflection to the mass. Entry into a large body of water is a static loading that imparts a large motion to the mass. This type of time duration logic inherently delays detonation.

The following discussion is directed to the component design of prior art detonator switches for rain discrimination.

In a first type of prior art switch, a piston element is supported by an inelastic, constant force spring. The resistance of the spring is lower than the static force generated upon impact of a projectile with a large body of water, but also large enough that each transient impulse from raindrops causes only an incremental displacement. This is no recovery of the element after each raindrop impact. As a result, if the missile encounters a great many raindrops detonation will occur before the missile reaches the desired target.

In a second type of design, a piston element is supported by a spring that does rebound after being struck by raindrops. The disadvantage of this design is that a missile flying through sheets of rain caused by wind gusts could experience premature detonation if the frequency of droplet impacts surpasses the natural frequency of the spring-mass system.

Still another approach to the problem has been to employ rain deflectors in front of switch actuators.

## BRIEF DESCRIPTION OF THE PRESENT INVENTION

A number of spring-mass switches connected in series electrically are speced around a circumferential line near the forward end of a missile. Detonator energization occurs when all switches are closed simultaneously. The springs are soft and close to the water target upon impact, so there is no undue delay in detonation. In flight of the missile through rain, the switches close intermittently and the probability that all the switches will not close simultaneously depends upon the number of switches used in the series circuit.



The statistical analysis required to select a number of switches is based upon the assumption that rain is a random phenomena over a given area. This leads to a calculation of the time span between droplet impacts on a switch that may be compared to the duration of closure of the switch impacted. A calculation is then made of the probability that all the switches in series may close simultaneously. If the probability is too high, then more switches must be used.

## BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is a front elevational view of the fuze portion of a mizzile. The impact switch sensors are illustrated in the figure.

FIG. **2** is a side elevational view of the fuze shown in FIG. **1.**

FIG. **3** is a partial sectional view taken along a plane passing through section line **3—3** of FIG. **2.**

FIG. **4** is a perspective view of a missile equipped with the present invention as the missile travels through rain.

FIG. **5** is a perspective view of a missile using the present invention, the view illustrating contact between the impact switch sensors of the invention as the missile impacts with a water body.

FIG. **6** is a statistical plot of the number of drops per cubic meter encountered by a missile fuze as a function of ranges in drop size.

## DETAILED DESCRIPTION OF THE INVENTION

Referring to the figures, and more particularly FIG. **4** thereof, a missile equipped with the present invention is generally indicated by reference numeral **10.** As will be seen, the missile includes an artillery section **12** and a fuze section **14.** A member of pressure sensing switches **16** are disposed about a circumference near the forward end of the fuze **14.** Typically, a fuze section is generally, frusto-conical, with the forward end being blunted at **18.** The side wall **20** of the fuze is contoured outwardly in the conventional manner. As shown in FIG. **1,** four pressure switches **16** are angularly disposed 90° apart about a circumferential line somewhat inwardly from the blunted end **18.** Although four pressure switches are illustrated in the figures, other numbers may be used depending upon the degree of rain safety desired.

Referring to FIG. **3,** the components for each of the pressure switches **16** are clearly illustrated. As shown in the figure, a circular bore **24** is formed in the wall **20** of the fuze section **14.** A cup-shaped metal housing **26** is press fitted or cemented into place within the bore **24.** The outward end of the cup-shaped member **26** has a circular opening **28** formed therein to permit the exposure of a pressure sensitive switch actuator **30.** The actuator is a ceramic mass consisting of a main cylindrical body portion **32** that reciprocates within the cup-shaped member **26** and a raised cylindrical projection **36** which extends outward from the main body portion **32,** the portion **36** being seated within the opening **28.** The outer end of the cup-shaped member **26** may be characterized as an annular flange **34** which functions as a mechanical stop for the actuator **30.**

A cylindrical rubber collar or O-ring, **38** of annular cross section, is lightly compressed between the inward end **39** of the cup-shaped housing **26** and the confronting surface **41** of the switch actuator **30** to effect a moisture seal. The surface **41** mounts a conductive element **40** thereon by suitable means such as cementing, or the like. Angularly positioned switch contact elements **42** and **44** are cantilever mounted to the inward end **39** of the cup-shaped housing **26.** The contacts **42** and **44** are located in parallel spaced relation and in axial alignment with the conductive element **40.** Thus, on application of sufficient pressure to the switch actuator **30,** the actuator moves inwardly and the conductive element **40** is forced into contact closing relationship with the contacts **42** and **44.** The contacts **42** and **44** have leads **46** connected thereto. The leads are in turn connected to detonator circuits, which are not, per se, part of the present invention.

Considering the design criteria of the switch as shown in FIG. **3,** the following must be considered.

When an actuator **30** impacts a raindrop, motion is induced within the cup-shaped housing **26** toward the contact elements **42** and **44.** The amount of motion is calculated by acknowledging the duration of contact of the raindrop on the actuator **30** is very short, so the effect of the impact is to impart an initial velocity to the actuator mass **30.** The value of the initial velocity is calculated by assuming the raindrop impact to be a perfectly inelastic collision. The kinetic energy of the actuator mass **30** is absorbed as potential energy in the rubber collar **38.** The motion of the actuator is then found from the force-deflection curve for the rubber collar **38.**

In the event the actuator **30** is struck by more than one raindrop before it comes to rest, the total motion is still found by assuming initial velocities are applied upon each impact. Knowing the motion of the actuator **30** and the size of the gap between the contacts **40, 42** and **44,** the time spans during which the switch **16** is closed may be calculated.

To make this calculation the droplet density spectrum of a rainfield such as FIG. **6** must be available along with a knowledge of the length of the rainfield, the projectile velocity, and the exposed area **36** of the actuator **30.** By assuming the raindrops are randomly distributed over the area of the fuze **14,** a random number generator computer program may be used to determine the size of drops impacting a pressure switch **16,** the time spans between impacts, and ultimately the time spans of closure.

Since several switches are connected in series electrically, and the raindrops are impacting the fuze **14** in a random fashion, each switch is opening and closing intermittently during flight. A statistical analysis must be performed that compares the time spans of closure to the time spans between impacts for the various switches to determine the probability that all switches may be closed at once and prematurely fire the detonator. If the probability calculation is too low, then an increase must be made in the number of switches, the frontal area **36** may be decreased, and the gap size along with the actuator mass **30** and spring constant of the rubber collar **38** may be increased.

Ideally, the number of switches should be the controlling factor for rain safety since the changes suggested in the switch physicals tend to decrease the sensitivity of the switches to simultaneous closure under the static pressure loading developed upon missile impact into water.

Wherefore I claim the following:

**1.** In a missile fuze, a detonator switch assembly which is capable of discriminating between impact with rain and impact with a body of water, the assembly comprising:

- a plurality of switches located in spaced circumferential relation around the body of a fuze; and
- means connecting the switches in series to ensure completion of a circuit path through the switches for detonator actuation when the switches are simultaneously closed in response to fuze contact with a water body.

**2.** The structure of claim **1** wherein each switch comprises contacts, and a conductive member mounted to a switch actuator, conductive member shorting the contacts upon exertion of sufficient pressure against the actuator.

**3.** A method for energizing a fuze detonator circuit in response to fuze contact with a water body, the method consisting of the following steps:

- sensing simultaneous pressure impulses at each of a plurality of points on a fuze surface; and
- responding to said plural sensing by completing an electrical path through the detonator circuit.

**4.** The subject matter of claim **3** wherein completing an electrical path through the detonator circuit consists of the step of closing pressure responsive switches connected in series along the electrical path.

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