May 31, 1960 J. RABINOW 2,938,461

FREE-FLIGHT ARMING DEVICE

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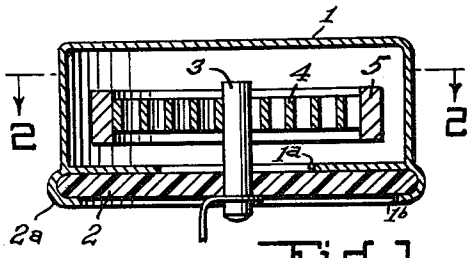


Fig. 1.

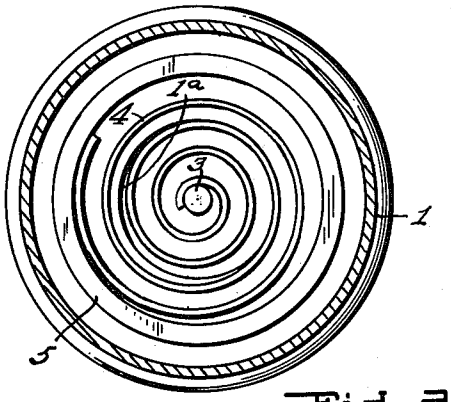


Fig. 2.

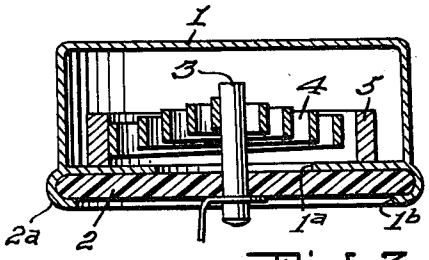


Fig. 3.

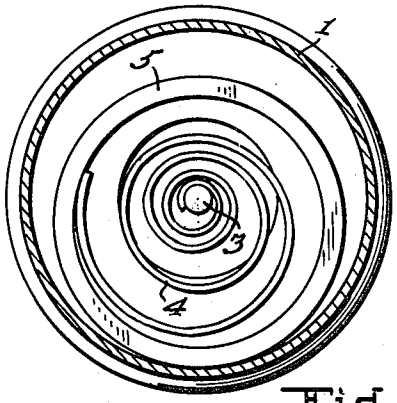


Fig. 4.

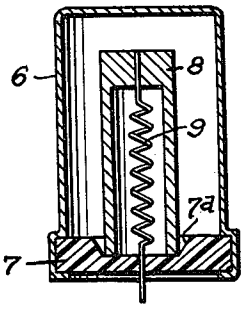


Fig. 5.

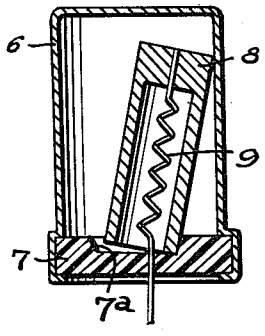


Fig. 6.

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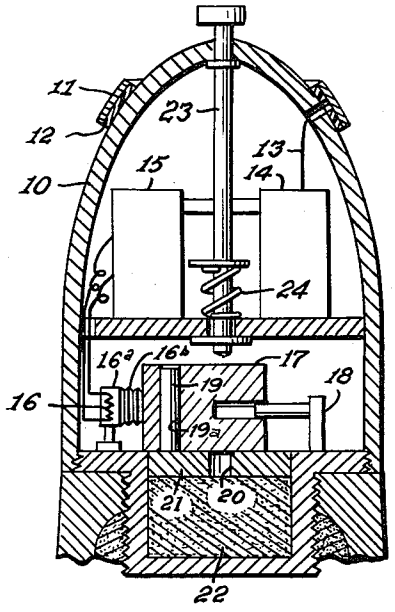


Fig. 7.

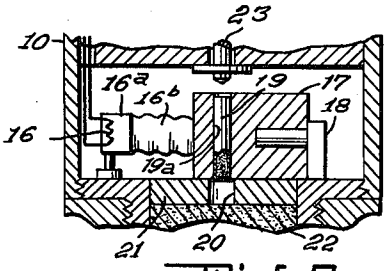


Fig. 8.

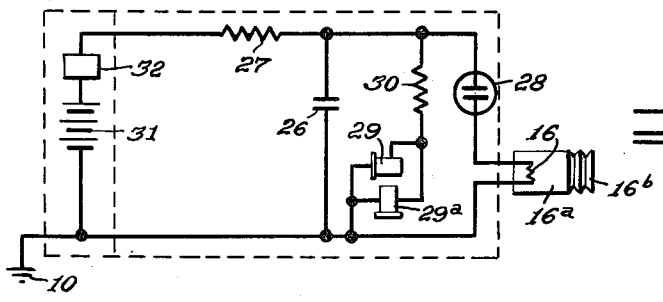


Fig. 10.

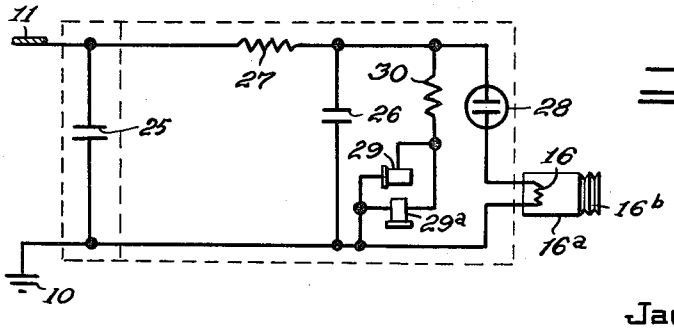


Fig. 9.

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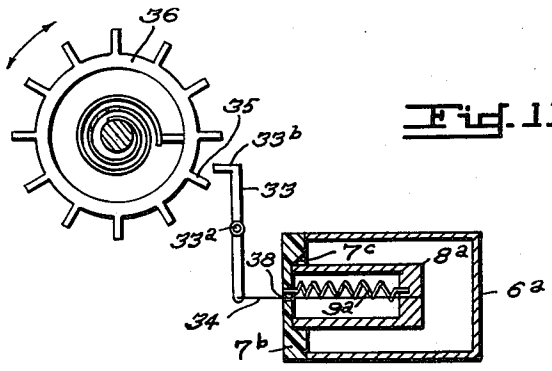


Fig. 11.

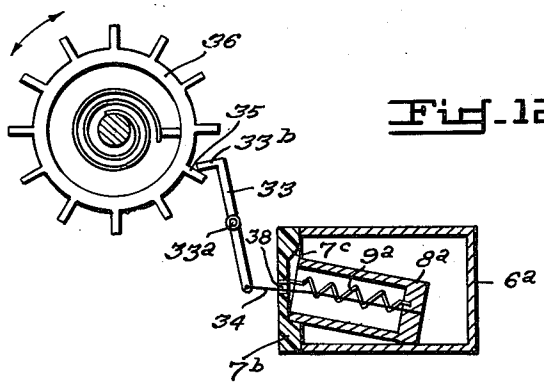


Fig. 12.

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2,938,461

FREE-FLIGHT ARMING DEVICE

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Filed July 5, 1956, Ser. No. 596,118

5 Claims. (Cl. 102—70.2)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured or used by or for the Government for governmental purposes without the payment to me of any royality thereon.

This invention pertains to the art of fuzing projectiles such as bombs, rockets, mortar shells and others. More particularly it relates to safety and arming systems for projectiles. In projectiles of this type, particularly in the case of bombs, the arming cycle of a fuze is usually started by the withdrawal of an arming wire or the charging of a capacitor at the instant of bomb release. Serious accidents have occurred in the past because of the fact that bombs have been accidentally dropped onto airfield runways or decks of aircraft carriers. In such cases the fuzes generally complete their arming cycle even though substantial air travel is normally required. The backwash of propellers or of turbo-jet engines operates arming vanes of such fuzes and duplicates the conditions encountered in proper drops. In some fuzes provision is made to sterilize the fuze if impact occurs before proper arming in order to avoid this disadvantage. This leads to other troubles since such sterilization schemes may result in duds. For example, a bomb may jostle another bomb accidentally immediately after release or a bomb may hit a part of the bomb bay upon its release from the aircraft and thus cause a dud.

To eliminate these disadvantages and to insure much greater safety, the present invention comprises an arming system which makes use of the fact that a bomb or other low velocity projectile in free flight experiences acceleration of less than 1 *g*. I make use of this fact by a special zero *g* device so connected that the bomb must be in free flight for several seconds for arming to occur. If the bomb employing this invention should accidentally fall upon the deck of a carrier or upon an airfield runway it would not arm because it then would be under acceleration of 1 *g* or greater. As described more fully herein, the device can be so arranged that accidental jostling of one bomb by another will not permanently disarm the bomb and proper function will result. This invention of arming a bomb or other projectile under conditions of zero-*g* or fractional-*g* may be employed in either electrical or mechanical form.

One object of this invention, therefore, is an arming system for fuzes adapted to remain inoperative in the event the containing projectile is accidentally dropped upon an airfield runway or aircraft carrier deck.

Another object is an arming system adapted to remain inoperative in the event the fuze is subjected to an acceleration greater than a predetermined amount occurring subsequent to the expiration of a predetermined time.

A further object is a fuze arming system as aforesaid which will arm even though subjected to an excessively great acceleration provided that acceleration occurs prior to the expiration of a predetermined time interval.

A still further object is a safety device for fuze arming systems adapted to prevent fuze arming in the event the containing missile is accidentally dropped upon an airfield or aircraft carrier runway.

The specific nature of the invention as well as other objects and advantages thereof will clearly appear from the following description and accompanying drawings in which:

Figure 1 is a vertical sectional view of one form of my safety switch in the normal condition.

Figure 2 is a cross sectional view of the device of Fig. 1 taken on the lines 2—2 thereof.

Figure 3 shows the switch of Fig. 1 in the actuated condition.

Figure 4 is a view similar to Fig. 2 showing the switch in the actuated condition.

Figure 5 is a vertical sectional view of a second form of my switch in the normal condition.

Figure 6 shows the switch of Fig. 5 in the actuated condition.

Figure 7 is a schematic view of an unarmed fuze embodying the arming system of this invention.

Figure 8 is a fragmentary view of Fig. 7 showing the fuze in the armed condition.

Figure 9 is a schematic diagram of the electrical circuitry of the fuze shown in Fig. 7.

Figure 10 is a variation of the circuit of Fig. 9.

Figure 11 is a schematic view of a mechanical switch which is the equivalent of the electrical switch of Fig. 5.

Figure 12 shows the switch of Fig. 11 in the actuated condition.

Referring now to Fig. 1, a metal electrical conductive housing 1 supports an insulating member 2 within the hollow base 2*a* thereof. Affixed to member 2 centrally thereof and extending upwardly therefrom is terminal 3. A helical spring 4 has its inner end affixed to terminal 3, the outer end of spring 4 having affixed thereto a heavy metal ring 5, the ring being concentric with terminal 3 and normally out of contact with all members other than spring 4. Housing 1 is perforated at 1*a* and 1*b* to prevent electrical contact between housing 1 and terminal 3.

Fig. 3 shows the contact established between ring 5 and housing 1 when the fuze is under an acceleration of one *g* or greater acting in a direction upwardly along the surface of the drawing. If one leg of an electrical circuit, not shown in this figure, terminates at housing 1 and the other leg terminates at terminal 3, the circuit will be completed through spring 4 and ring 5 under the condition described.

Figure 4 shows that electrical contact is made under sidewise acceleration (as compared to the upward acceleration of Fig. 3). Ring 5 now contacts the side, rather than the base, of housing 1.

Referring to Fig. 5, a generally cylindrical housing 6 supports an insulating disc 7 which is provided with a cup-like recess 7*a* in which rests a cylindrical weight 8 axially bored at one end. A tension spring 9 maintains the weight normally in central position by having one end thereof affixed to disc 7 centrally thereof and the other end affixed to the closed end of weight 8.

Fig. 6 shows the action which takes place when the assembly of Fig. 5 is accelerated substantially at a right angle to the axis of the weight 8. Spring 9 is extended by the force exerted upon it by weight 8, the weight being permitted to pivot sidewise on its base and in so doing to contact housing 6. Thus, a circuit is completed through spring 9 and weight 8 when terminated at spring 9 and housing 6.

While one device such as shown in Figs. 5 and 6 is omnidirectional, two devices properly connected and placed at right angles to one another will respond to excessive acceleration regardless of the direction of the acceleration.

Referring now to Fig. 7, a fuze ogive 10 has mounted

upon it a contact ring **11**, insulated from the ogive by a suitable member **12**, and connected by wiring **13** to a power supply **14**, the power supply being grounded to the ogive. Power supply **14**, in turn, is connected to an acceleration-sensitive switch **15**. The switch **15** may be of a type shown in Figs. 1 or 5. Switch **15** is also connected with the heating element **16** of an explosive motor **16***a* which, when activated, will cause the expansion of bellows member **16***b*. The bellows member is so positioned that expansion thereof will cause linear motion of the safety block **17** until that motion is arrested by the stop **18**. When such motion has occurred, explosive detonator **19** in aperture **19***a* of block **17** will be aligned with aperture **20** in safety plate **21**, permitting ignition of the booster charge **22** when firing pin **23**, which is normally biased forwardly by spring **24**, is caused to move rearwardly and engage detonator **19** as a result of impact of pin **23** with a target, not shown. The armed position of explosive motor **16***a* and block **17** is shown in Figure 8.

The electrical circuitry of the system of Fig. 8 as shown in Fig. 9 employs a capacitor **25**, one plate of which is grounded to fuze ogive **10** and the other plate of which is connected with contact ring **11**. A second capacitor **26** has one plate connected to ground and the other plate connected through a resistor **27** with contact ring **11**. Heating element **16** of explosive motor **16***a* is connected in series with diode **28** and these two elements are connected in parallel with capacitor **26**. Safety switches **29** and **29***a*, which are identical in construction, but whose axes are oriented mutually perpendicular, are connected in parallel and the combination connected in parallel with capacitor **26**. A resistor **30** may be connected in series with the switches **29** and **29***a*.

The circuitry of Fig. 10 is a modification of that shown in Fig. 9. The system of Fig. 10 contains its own power supply **31** which is substituted for capacitor **25** in Fig. 9. Safety device **32**, shown here in block form, must be placed in series with power supply **31**, such as a battery, to prevent the fuze from becoming energized prematurely. Device **32** may be operated by the conventional arming wire or any other suitable arming device as known to the art. Contact ring **11** is not required when a self-contained power supply is employed inasmuch as the purpose of the ring is to collect a charge from an external source. A resistor **30** may or may not be employed in series with switches **29** and **29***a* for reasons discussed hereinafter.

Referring again to Fig. 9, as fuze ogive **10** and ring **11** are brought into contact with the terminals of a voltage source, not shown, upon launching, a charge is placed upon capacitor **25**. This charge leaks to capacitor **26** through resistor **27** until the striking voltage of diode **28** has been reached. Upon the attainment of such voltage, diode **28** fires, causing current to flow through heating element **16** of explosive motor **16***a*. If, however, either of the switches **29** or **29***a* should close before firing of the dode **28** occurs, capacitor **26** will discharge through the switch circuit so completed. The time required for capacitor **26** to assume its initial charge, to discharge through one or the other of switches **29**, **29***a*, and to recharge from capacitor **25** after such discharge, is determined by the values of resistor **27** and capacitor **25**, by the voltage on capacitor **25** and by any charge which remains upon capacitor **26** after the switch reopens. The charge which remains upon capacitor **26**, for a given capacitor and voltage, is determined by the duration of closure of switches **29** or **29***a*, up to complete discharge, and by the resistance of the circuit, which may be increased by the addition of a resistor **30** in series with the devices **29** and **29***a*.

The operation of the circuit of Fig. 10 is identical with the operation of the circuit of Fig. 9 with the exception that power in the Fig. 10 circuit is made available to charge capacitor **26** through resistor **27** from power supply **31** upon actuation of safety device **32** whereas in the Fig. 9 circuit capacitor **26** is charged through resistor **27** from capacitor **25** after capacitor **25** has collected a charge from an external source when the projectile is launched.

Now it can be seen that, should a bomb containing a fuze such as that shown in Fig. 7, strike the bomb bay of the airplane upon being released, a part, at least, of the charge upon capacitor **26** will be discharged through one of the switches **29**, **29***a*, which switch was caused to close under an impact of the bomb with the bomb bay. The amount of charge upon capacitor **26** is small at this time inasmuch as the bomb was released only moments before the impact occured. Sufficient charge remains upon capacitor **25** to recharge capacitor **26** after the switch reopens after the bomb moves clear of the airplane. Thus, the fuze is in condition to function properly upon impact with a target later in its flight.

If, however, the bomb should fall upon an airfield runway or upon the deck of an aircraft carrier as the plane is ascending or descending, there is a different result. One of the switches **29**, **29***a* will close as before. The charge upon capacitor **26** will discharge through the closed switch as before. This time, however, capacitor **26** will have drawn from capacitor **25** an amount of charge short of that required to fire diode **28** but sufficient to prevent capacitor **25** from recharging capacitor **26** after the switch reopens upon the abatement of acceleration of 1 *g* or greater. The fuze will, therefore, remain inoperative and safe.

Referring now to Fig. 11 it will be seen that a great similarity exists to the configuration of the device shown in Fig. 5 in that a cylindrical housing **6***a* is provided with a base **7***b* having a cup-like recess **7***c* in which rests a cylindrical weight **8***a* axially bored at one end. A tension spring **9***a*, one end of which is affixed to base **7***b* and the other end of which is affixed to the closed end of weight **8***a*, normally maintains the weight in the central position shown in Fig. 11. In this embodiment, however, it is not necessary that the housing **6***a* or the weight **8***a* be conductive, nor that the base **7***b* be nonconductive, inasmuch as this device operates upon mechanical rather than electrical principles. The weight **8***a* is connected to a lever **33**, pivoted at **33***a*, by means of a motion transmitting linkage **34**, such as a cord or cable, threaded through an aperture **38** provided therefor in base **7***b*. A detent **33***b* is provided at one end of lever **33** to engage a tooth **35** on balance-wheel **36** of a clock-type arming system, not shown.

In Fig. 12 the device is shown being acted upon by an acceleration of 1 *g* or greater directed generally directed perpendicular to the axis of weight **8***a*. Weight **8***a* is driven sidewise by this force and in so doing extends the spring **9***a*. It also exerts a pull upon linkage **34** which is caused to move to the right of the drawing. Lever **33** is caused to rotate counterclockwise about pivot **33***a* so that detent **33***b* engages tooth **35** and arrests the motion of balancewheel **36**. In this manner fuze arming is delayed during the time the fuze is subject to an acceleration of at least 1 *g*.

It will be understood that the embodiments described herein are exemplary only and that other modifications may be made without departing from the spirit and scope of the invention as set forth in the claims.

What I claim is:

1. An arming system for projectile fuzes of the type wherein an explosive detonator is normally misaligned with a booster charge, comprising a source of electrical energy, means for actuating said energy source upon projectile launching, energy storing means adapted to receive energy from said source, additional means disposed between said source and said storing means adapted to impede the transfer of energy from said source to said storing means, explosive motor means adapted to align said explosive detonator with said booster charge and electrically connected to said energy storing means through a

normally relatively high resistance path, a normally open low resistance path arranged in parallel with said explosive motor and said normally high resistance path, said explosive motor means adapted to function by drawing its activating energy from said storing means after the energy in said storing means attains a predetermined value, and acceleration sensitive means in said low resistance path adapted to close said low resistance path and thus draw off a portion at least of the energy from said storing means in the event the acceleration acting upon the projectile exceeds a predetermined amount.

2. An arming system for projectile fuzes of the type wherein an explosive detonator is normally misaligned with a booster charge, comprising an electrical energy source, means for actuating said energy source upon projectile launching, a capacitor connected to be charged by said source, a resistor connected to reduce the charging rate of said capacitor, detonator alignment means comprising an explosive motor having an electrical heating element connected to draw its actuating energy from said capacitor, a diode interposed between said capacitor and said heating element, and an acceleration sensitive electrical discharge device connected in parallel with said capacitor and adapted to remove a portion at least of the charge from the capacitor in the event the acceleration acting upon said projectile exceeds a predetermined amount.

3. The invention according to claim 2 wherein said energy source comprises a second capacitor adapted to be charged from an outside source upon projectile launching.

4. An arming system for projectile fuzes of the type wherein an explosive detonator is normally misaligned with a booster charge, comprising an electrical energy source, means for actuating said energy source upon projectile launching, a capacitor connected to be charged by said source, a resistor connected to reduce the charging rate of said capacitor, detonator alignment means comprising an explosive motor having an electrical heating element connected to draw its actuating energy from said capacitor, a diode interposed between said capacitor and said heating element, and means responsive to abnormal accelerations experienced by said projectile after said launching to disable said arming system.

5. An arming system for projectile fuzes of the type wherein an explosive detonator is normally misaligned with a booster charge, comprising an electrical energy source, means for actuating said energy source upon projectile launching, a capacitor connected to be charged by said source, a resistor connected to reduce the charging rate of said capacitor, detonator alignment means comprising an explosive motor having an electrical heating element connected to draw its actuating energy from said capacitor, a diode interposed between said capacitor and said heating element, said energy source comprising a second capacitor adapted to be charged from an outside source upon projectile launching, and means to prevent the arming of said fuze when said projectile is subjected to acceleration of value other than that of free flight.

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