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SAFETY AND ARMING MECHANISM

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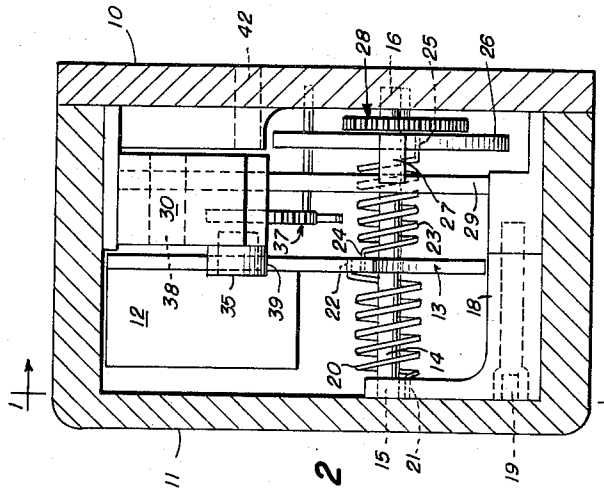


FIG. 2

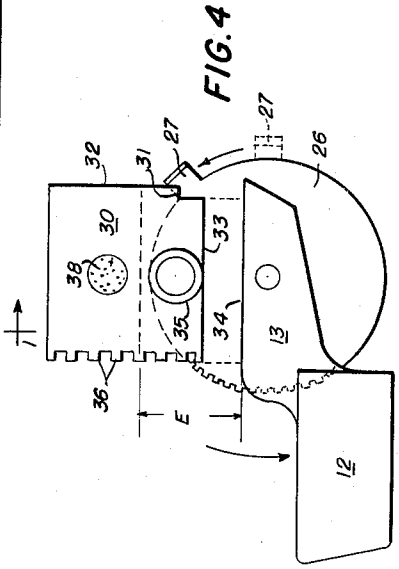


FIG. 4

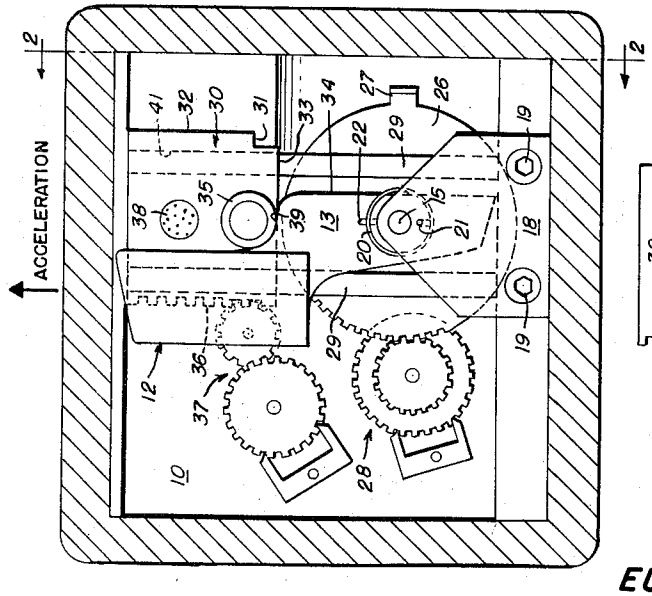


FIG. 1

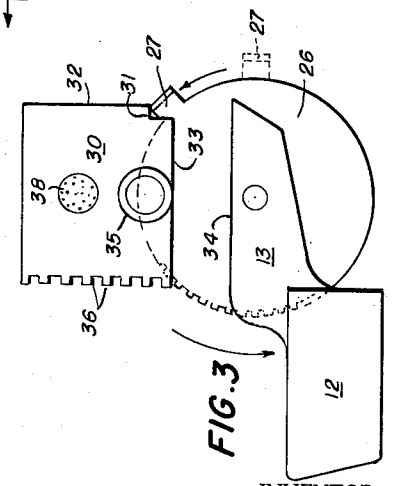


FIG. 3

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SAFETY AND ARMING MECHANISM

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1 Claim. (Cl. 102—78)

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

This invention relates to an arming system which can be incorporated in a missile.

In certain military applications it is required that an arming system provide arming only when the missile has travelled a predetermined constant distance through the air at some predetermined minimum average velocity. The prior art has not been successful in providing a missile arming system which will meet these requirements, and it is therefore the object of this invention to provide an arming system which will do so.

According to this invention, an acceleration-responsive weight element, which is caused to move proportional to the air distance travelled by the missile, is combined with a timing means which prevents the weight element from reaching a final position where it would arm the missile, should the weight element fail to reach this final position within a predetermined period of time. Since incremental movements of the weight element represent substantially proportional distances traveled by the missile, arming at a predetermined distance is assured. Also, since the timing means prevents arming unless the missile has reached this predetermined distance within some predetermined minimum time, this effectively prevents the missile from arming unless it has travelled at some predetermined minimum average velocity in reaching this predetermined distance.

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

Fig. 1 is a side view of the arming system of this invention with the cover removed.

Fig. 2 is an end view of Fig. 1, taken through lines 2—2 of Fig. 1, with the cover in place.

Fig. 3 shows the position of the weight element and a timing gear should the missile burn-out during the arming period.

Fig. 4 shows the relative positions which the weight element and the timing gear assume if the missile is traveling at the proper velocity during the arming period.

Referring now to Figs. 1 and 2, an embodiment of the arming system in accordance with the invention is shown as comprising a base **10** and a cover **11** (Fig. 2) which fits tightly over base **10**. Housed within base **10** is weight **12** eccentrically depending from arm **13** which is journaled on shaft **14** (Fig. 2). Arm **13** thus will rotate counterclockwise (as viewed in Fig. 1) on shaft **14** in response to missile acceleration in the direction of the arrow.

Shaft **14** (Fig. 2) has two ends, **15** and **16**, which are respectively held by bracket **18** and base **10** by any suitable means. Bracket **18** is fixed to base **10** by means of machine screws **19**. Coil spring **20** is coaxially wrapped around shaft **14** and has two ends, **21** and **22**, which are

affixed to bracket **18** and to the arm **13**, respectively. Spring **20** resiliently urges arm **13** clockwise as viewed in Fig. 1. Shoulder **39** formed by a curvature in arm **13** is urged in engagement with cylinder **35** by spring **20**. Cylinder **35** is fixed to weight **30** which is movable along rods **29** passing through bores **41** in the weight **30** in response to acceleration in the direction of the arrow (Fig. 1). Weight **30** is locked against downward movement from its initial or unarmed position (as shown in Fig. 2) by shoulder **39** engaging cylinder **35**.

Weight **30** is a conventional form of acceleration-responsive weight element which is modified by forming a rectangular slot **31** in edges **32** and **33**. Weight **30** is adapted to carry a detonator **38** downwardly from the unarmed position shown in Fig. 1 when cylinder **35** is released by rotation of shoulder **39** and arm **13** in response to missile acceleration. When weight **30** travels through distance E (Fig. 4), edge **33** will abut surface **34** on arm **13** because arm **13** will have rotated counterclockwise (Fig. 4) as a result of missile acceleration acting upon eccentric weight **12**. When edge **33** abuts surface **34**, detonator **38** will align with an explosive train **42** (Fig. 2) leading to the missile warhead in a conventional manner, thereby arming the missile.

Another edge of weight **30** is provided with a rack **36** which is engaged by conventional flutterbar or starwheel escapement mechanism **37** which substantially performs the function of a double integrator so that weight **30** moves through incremental distances proportional to the distances traveled by the missile, and at a velocity proportional to the velocity of the missile.

Now if a tab **27** is suitably positioned as shown in Fig. 1 and provided with a suitable angular velocity, after some predetermined time, tab **27** will either engage edge **33** or slot **31** so as to lock the weight **30** from further movement (Fig. 3), or fail to contact edge **33** or slot **31** (Fig. 4) and contact smooth edge **32** so as to permit the weight **30** to travel the distance E and arm the missile (Fig. 4). It should be evident to those skilled in the art that since the weight **30** moves proportionally to the velocity of the missile, the above described arrangement assures that arming will occur only if the missile has travelled at a predetermined average velocity in reaching the predetermined distance. Thus the missile must travel at some predetermined minimum velocity during the arming period and for some predetermined minimum distance or weight **30** will be locked against downward movement to the armed position by tab **27**.

Timing gear **26** (Fig. 2) on which tab **27** is located is driven by means of coil spring **23**. Coil spring **23** has ends **24** and **25** which are affixed to arm **13** and to gear **26**, respectively. Spring **23** is under no initial tension and winds only when arm **13** rotates counterclockwise (Fig. 1). Flutterbar escapement mechanism **28** is provided to restrain spring-biased rotation of gear **26** so that tab **27** moves at essentially constant velocity and can either engage or fail to engage edge **33** or slot **31**.

The operation of the above-described arming system of this invention can be summarized as follows. The base **10** is properly positioned in the missile so that missile acceleration acting in the direction shown by the arrow in Fig. 1 causes counterclockwise rotation of eccentric weight **12**. Rotation of weight **12** causes rotation of arm **13** which winds spring **23**. Spring **23** upon winding, resiliently urges timing gear **26** to rotate counterclockwise as viewed in Fig. 1. Also, rotation of arm **13** causes shoulder **39** to disengage from cylinder **35** which is fixed to weight **30**. Weight **30** is thereby released for downward movement along rods **29** in response to forces of setback acting opposite in direction to that of the arrow in Fig. 1.

Flutterbar escapement mechanism **37** can be designed

to substantially perform the function of a double integrator. Thus although it is missile accelerative forces (setback) which act upon weight **30** and cause this weight to begin its downward movement because of its inertia, the actual travel of weight **30** against the travel-inhibiting action of the flutterbar mechanism **37** is proportional to the distance of travel of the missile since the flutterbar mechanism is substantially doubly integrating the effect of the accelerative forces acting on weight **30**. On the other hand, tab **27** is being driven independently by spring **23** at a constant angular rate. The distance travelled by tab **27** is therefore substantially independent of all other forces developed during missile launching. The action of tab **27** can be regarded as that of a clock, or timer which times the downward travel of weight **30** and thus the travel of the missile from launching. Since the travel of weight **30** is being compared to the time it takes to travel an incremental distance, the rotative movement of tab **27** acting against the linear travel of weight **30** determines whether or not the average velocity of weight **30**, and of the missile, is of some predetermined minimum value.

If the average velocity of the missile is below a predetermined minimum value, the downward distance travelled by weight **30** will not be sufficient to prevent tab **27** from rotating to a position under weight **30** to engage edge **33** or slot **31** and lock the weight **30** from further movement, thereby preventing arming as shown in Fig. 3. When the missile is flying at a proper average velocity, however, weight **30** will travel a sufficient velocity to prevent tab **27** from engaging either edge **33** or slot **31** with the result that tab **27** will only contact edge **32**. Edge **32** is smooth so that weight **30** can continue its downward movement even though tab **27** is riding against this edge. Weight **30** is thereby free to travel the distance E which will cause arming of the missile.

It will be evident from the foregoing that the present invention achieves the requirement of providing arming only when the missile has travelled a constant predetermined distance at some predetermined minimum average velocity. It is to be understood that for a given missile the movement of the weight **30** in relation to the angular velocity of the tab **27** may be chosen to provide any desired predetermined distance and predetermined minimum average velocity for which arming will be permitted to occur.

It is also to be understood that the embodiment shown is only exemplary and that various modifications can be made in construction and arrangement within the scope of the invention as defined in the appended claim.

I claim as my invention:

An arming system for use in a missile adapted to arm said missile only when said missile has traveled a predetermined constant distance at some predetermined average velocity, said system comprising: a base, a shaft fixed to said base at one end thereof, an arm mounted for rotation on said shaft, an eccentric weight fixed to one end of said arm for causing rotation thereof in response to forces of acceleration produced by missile launching, a gear mounted for rotation on said shaft, an escapement mechanism engaging said gear and limiting rotation thereof to a predetermined angular velocity, spring means connecting said gear to said arm and adapted to wind and thereby rotate said gear when said arm rotates in response to acceleration, a weight element movable towards said shaft from an initial to a final position in response to missile acceleration, a detonator housed in said weight element and movable therewith, an explosive train communicating with said detonator when said weight element reaches said final position, a rack on one edge of said weight element, a flutterbar escapement mechanism engaging said rack and adapted to oscillate and thereby inhibit travel of said weight element to said final position, said flutterbar escapement mechanism being so constructed that the accelerative forces on said weight element are substantially doubly integrated, travel of said weight element thereby representing proportional travel of said missile, a tab extending from said gear and rotatable therewith, said tab extending to lock said weight element against movement upon rotation of said tab through a predetermined angle, said tab permitting movement of said weight element to said final position when said weight element travels at least some predetermined distance relative to the time required before said tab rotates through said predetermined angle.

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