

[54] AIR-DRIVEN TURBINE SAFE AND ARM ARRANGEMENT FOR A FREE-FALLING ORDNANCE DEVICE

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[51] Int. Cl. **F42c 15/12**

[58] Field of Search 102/812, 82, 83, 84, 81.6; 58/65, 68, 82 A

[56] **References Cited**

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Primary Examiner—Samuel W. Engle

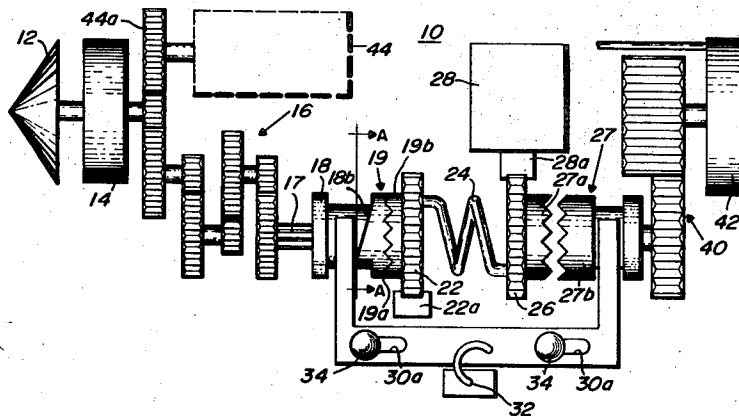
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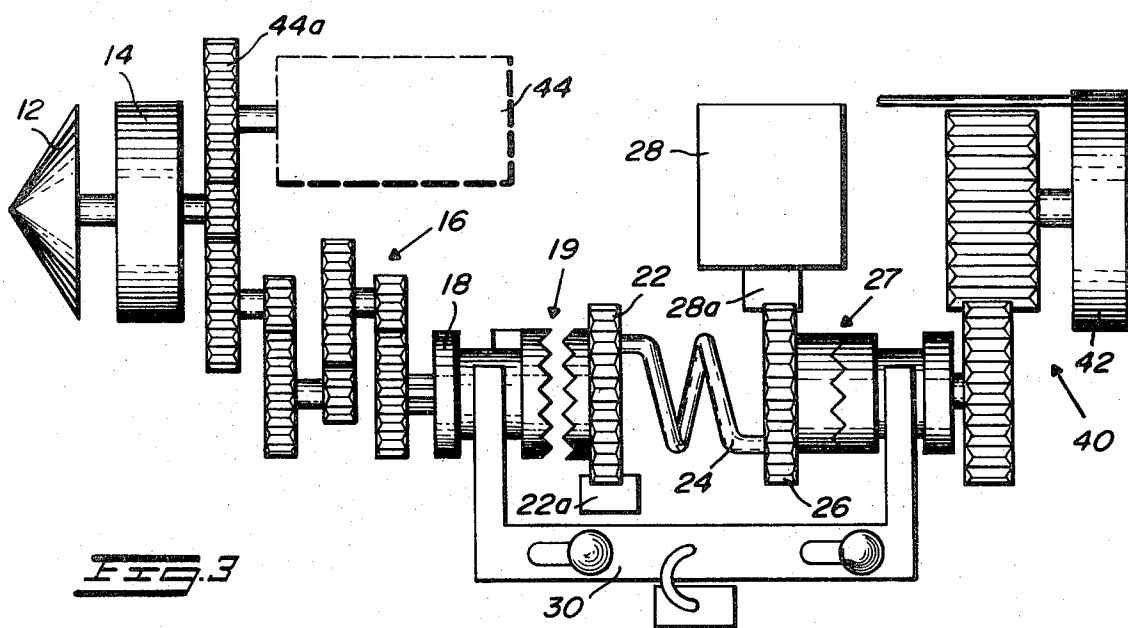
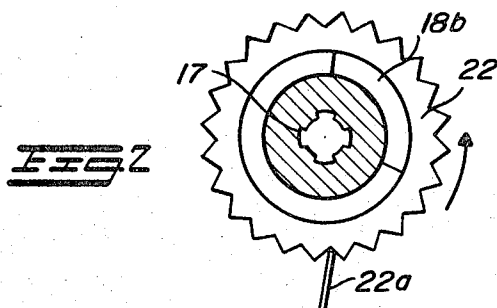
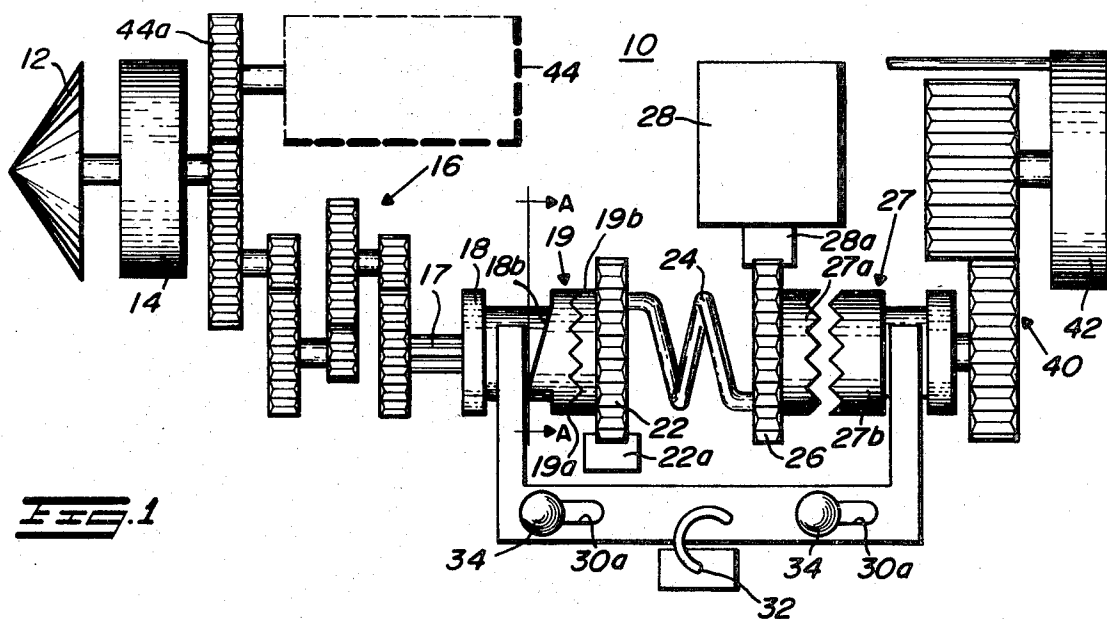
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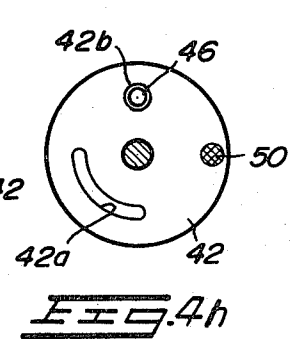
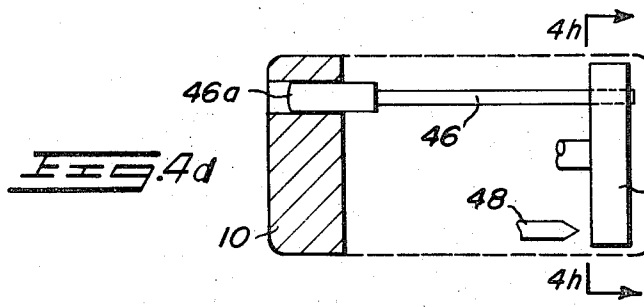
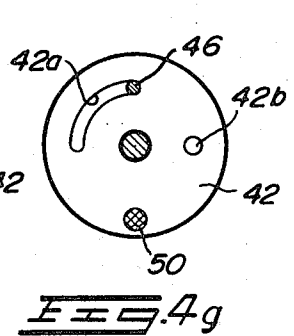
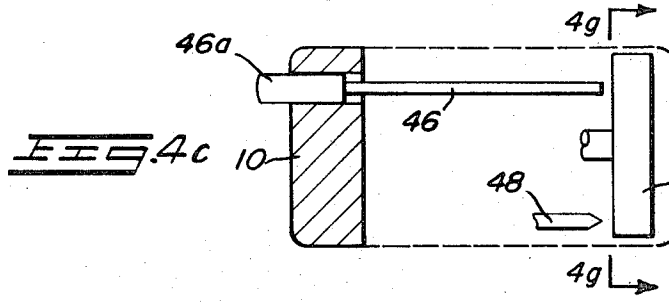
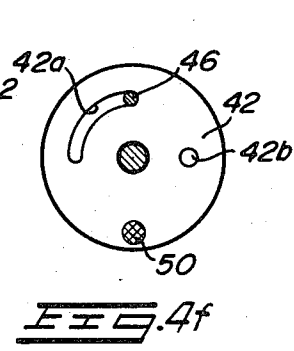
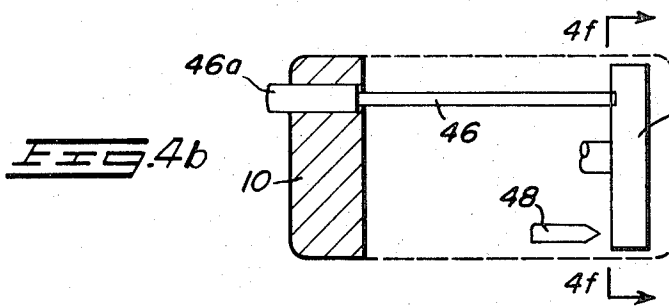
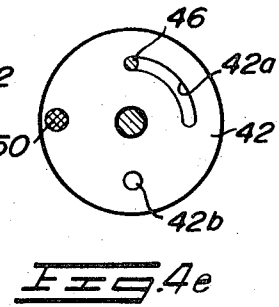
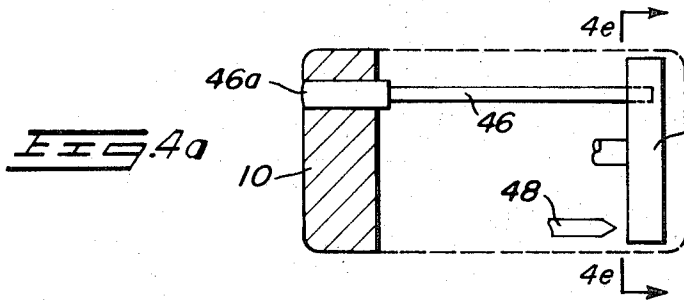
ABSTRACT

A fail-safe, ordnance fuzing apparatus for a free-falling missile. The apparatus is characterized in that the arming arrangement does not utilize stored energy but instead relies upon the necessary energy being extracted from the air stream itself during free-fall. Two independent mechanisms must properly interact during the appropriate arming cycle. The first is a torsion spring mechanism activated by an air turbine during a predetermined time interval. The second is a clock timer apparatus which releases the torsion spring to complete the remainder of the arming cycle. The failure of either independent mechanism results in the failure of the ordnance device to be properly armed.

10 Claims, 7 Drawing Figures







AIR-DRIVEN TURBINE SAFE AND ARM ARRANGEMENT FOR A FREE-FALLING ORDNANCE DEVICE

BACKGROUND OF THE INVENTION

This invention relates in general to fuzing apparatus for munitions and other explosive ordnance devices and in particular to an improved fail-safe fuze arming arrangement for such devices which utilizes energy extracted from the air stream itself during free-fall to initiate the actual arming operation.

Present day munition and other ordnance devices customarily require energy of one sort or another to be stored in the device prior to release so as to permit the arming operation therefor. A common arrangement utilizes the movement of a turbine or air vane to unlock a mechanism which by itself or in cooperation with other apparatus effects the required arming of the associated ordnance device. Usually some timing apparatus is incorporated to establish a predetermined timing period within which the arming operation must take place.

All of these prior systems, however, are characterized by the fact that they depend upon stored energy in the form of a wound torsion spring or other mechanical contrivance which is set before the release of the munition or ordnance device. Should a malfunction occur in the associated timer apparatus used to restrain the torsion spring, a zero or prematurely short arm time may be the result creating an immediate and present danger. Moreover, the prior art systems are rather complex and, as a rule, expensive to fabricate. Even so, many are simply not fail-safe and do not have an acceptable method of disarming once the ordnance device has been armed during the preliminary stages prior to release.

Accordingly, it is an object of the present invention to provide an improved fuze arming arrangement for a free-falling missile or ordnance device which does not exhibit the foregoing deficiencies.

A more particular object of the present invention is to provide a fuzing arrangement for an associated ordnance device having an improved arming arrangement which requires the proper actuation of two independent mechanisms to effect arming such that no single failure can give rise to inadvertent and otherwise premature arming of the ordnance device.

Another object of the present invention is to provide an improved fuze arming arrangement of the foregoing type for an ordnance device wherein stored energy is not required prior to release to effect arming, but instead relies upon the necessary energy being extracted from the air stream itself during free-fall.

Yet another object of the present invention is to provide an improved fuze arming arrangement of the foregoing type for an ordnance device wherein the energy from the air stream must be extracted within a first predetermined time interval and wherein the extracted energy is then channeled to complete the arming operation by a mechanically actuated control mechanism at a second time interval which encompasses at least the first time interval.

Still another object of the present invention is to provide an improved fuze arming arrangement of the foregoing type for an ordnance device which includes

means for effecting a visual indication of the operational condition of the ordnance device at all times.

A further object of the present invention is to provide an improved fuze arming arrangement of the foregoing type for an ordnance device wherein manually actuated release means are included to permit quick and convenient disarming of an inadvertent or otherwise armed fuze.

A still further object of the present invention is to provide an improved fuze arming arrangement of the foregoing type for an ordnance device which is simple yet reliable in operation, fail-safe in function, and relatively inexpensive to manufacture.

A feature of the present invention is an arming arrangement for an ordnance device which includes an air turbine actuated by energy extracted from the air stream during free-fall and an escapement type, mechanically actuated clock timer, which apparatus are designed to operate in parallel with one another.

Another feature of the present invention is a fuze arming system for an ordnance device wherein a twin clutching arrangement is utilized to simultaneously disengage the turbine while engaging a rotatable control element to be driven by the turbine wound torsion spring following a predetermined number of turns of the air turbine but within a given time interval.

SUMMARY OF THE INVENTION

The invention in its broader aspects is directed to a fail-safe fuze arming arrangement for an explosive ordnance device which requires no stored energy prior to release. That is, an air turbine extracts what energy is required from the air stream itself during free-fall. The turbine winds a helical torsion spring within a first time interval after release of the ordnance device. The torsion spring is restrained by a second, but operationally independent clock or timing mechanism which may be actuated by a lanyard-pull or other appropriate mechanical contrivance at a time prior to release of the ordnance device.

The timer releases the wound helical torsion spring at a time following the first-mentioned time interval. Thus, the two independent mechanisms must time out in the proper time sequence to effect arming of the ordnance device. Zero or short arming time by reason of a run away or malfunctioning clock timer is effectively precluded. An interconnected twin clutching apparatus is utilized to disengage the air turbine at the appropriate time and, in turn, engage a rotatable control element which when subjected to the energy of the coiled torsion spring operates to complete the arming cycle or procedure for the associated ordnance device.

The disclosed fuzed arming arrangement further includes an arm indicator rod which not only provides an effective visual indication of the operational condition of the associate ordnance device at all times, i.e., whether armed or unarmed, but further provides a ready and convenient means of disarming an otherwise inadvertently armed fuze. Upon manual actuation and release of the indicator rod, a spring biased rotor mechanism within the ordnance device moves to a position interposed between the firing pin and detonator.

BRIEF DESCRIPTION OF THE DRAWINGS

Features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention itself, however, together

with further objects and advantages thereof, may best be understood by reference to the following description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a diagrammatic representation of a fuze arming arrangement constructed in accordance with the present invention and illustrating a first operational mode thereof;

FIG. 2 shows a partial cross-sectional view in elevation taken along lines 2—2 of FIG. 1;

FIG. 3 is a partial diagrammatic representation for the fuzing arrangement of FIG. 1 and which illustrates a second operational mode thereof;

FIGS. 4a—4d illustrate the various functional positions of the arm indicator and safing apparatus comprising a part of the fuzing arrangement of FIG. 1; and

FIGS. 4e—4h are sectional views taken substantially in the direction of arrows 4(e)—4(e), 4(f)—4(f), 4(g)—4(g) and 4(h)—4(h) of FIGS. 4a, 4b, 4c and 4d respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, a fuze arming arrangement, indicated generally at 10, is shown in FIG. 1 for arming an explosive missile or other ordnance device, which fuzing arrangement has been constructed in accordance with the present invention. As heretofore mentioned, the apparatus of the present invention is characterized in that no stored energy is required within the ordnance device prior to release. It is intended that the necessary energy to initiate the arming operation be conveniently extracted from the air stream itself during free-fall.

To this end, an air vane or turbine 12 is included which is caused to rotate by the air stream during free-fall. The rotational speed of the turbine 12 is effectively maintained at a substantially constant r.p.m. by a centrifugal weight governor 14. The regulated rotational output from the speed governor 14 is then utilized to drive a gear reduction train indicated generally at 16, which gear train drives a cam wheel 18. The gear train is chosen such that the cam wheel 18 is rotated one revolution during a given time interval t_1 . Cam wheel 18 terminates in a plurality of clutch teeth 19a forming a part of a clutch device 19, which teeth are positioned to engage complementary clutch teeth 19b, forming the other part of clutch 19 and which is coupled to a ratchet wheel 22. Ratchet wheel 22 is in turn attached to one end of a helical torsion spring 24. Rotation of cam wheel 18 thus effects rotation of the ratchet wheel 22 when clutch 19 is suitably engaged. However, ratchet wheel 22 may rotate in only one direction. This is because of the one way ratchet 22a positioned to engage the associated gear teeth of the ratchet wheel 22. This may be more readily appreciated by reference to FIG. 2.

The rotation of ratchet wheel 22 will be seen to wind the torsion spring 24. This is because the other end of the torsion spring 24 is attached to a ratchet wheel 26 similar to that of ratchet wheel 22. Ratchet wheel 26 is restrained in a fixed position by a projecting escape-ment or pawl 28a forming a part of a clock timer apparatus 28. Accordingly, it is arranged that torsion spring 24 will be wound one full turn by the turbine 12 and

gearing 16, 18 and 20, during the referenced first time interval t_1 .

As the cam wheel 18 and ratchet wheel 22 approach the three-quarter revolution mark, a camming surface 18b is brought to a position where it begins to bear against the inner surface area of an upstanding arm of a generally U-shaped clutch slider assembly 30, as shown. Initially, the clutch slider 30 is maintained in a position shifted fully to the right by the action of an over-center spring 32. The sides of a pair of spaced slots 30a in the lower or horizontal arm of slider 30 bear against associated slider pins 34 acting as stops.

When cam wheel 18 approaches one full revolution, however, cam 18b is positioned to push clutch slider 30 past its toggling or center position such that over-center spring 32 now drives clutch slider 30 to its full left position, as illustrated in FIG. 3. In this position, forward clutch 19 is disengaged which, in turn, disconnects cam wheel 18 from the ratchet wheel 22. At the same time, a rear clutch assembly 27 is caused to be engaged so as to intercouple ratchet or clock release wheel 26 and gear drive train 40, to which a rotor mechanism 42 is operatively connected. It is thus apparent that the mechanical design arrangement of clutch slider assembly 30 is such that the forward clutch 19 and the rear clutch 27 cannot be simultaneously engaged. The forward clutch 19 must disengage to permit the rear clutch 27 to be engaged. Moreover, the switch-over and clutching action occurs only when cam wheel 18 rotates one full turn, or within the prescribed first time interval t_1 , after air turbine is actuated by the air stream during free-fall. It might also be pointed out that one-way ratchet 22a on ratchet wheel 22 effectively prevents torsion spring 24 from driving the ratchet wheel 22 backwards, or in the reverse direction, during the time interval forward clutch 19 is operatively disengaged.

Simultaneously with the release of the ordnance device, the clock timer 28 is actuated by some convenient control function, such as perhaps, by lanyard-pull. Lanyards attached to the ordnance device have been used previously to initiate some control function upon release of the ordnance from the transportation vehicle. Accordingly, further and more detailed consideration should not be necessary for present purposes. However, a more complete treatment of a system directed to the use and release of lanyard apparatus to initiate a control action is set forth in a copending application filed in behalf of Charles H. McGuire, on Apr. 9, 1973, Ser. No. 349,521, and assigned to the assignee of the present invention.

In any event, control timer 28, upon being actuated, runs for some predetermined time t_2 before releasing pawl 28a. The running time t_2 for clock 28 is set at or after loading the ordnance device on a transportation vehicle. The time t_2 must of course encompass at least the first time interval t_1 . This allows the energy wound into torsion spring 24 to drive gears 40 which in turn rotates rotor 42 from its initial out-of-line, or safe, position as shown in FIG. 4a, through some 90° of rotation to its in-line, or armed, position as shown in FIG. 4b.

If, on the other hand, the time interval t_2 does not occur subsequent to time interval t_1 , or if the air velocity is interrupted before t_1 , torsion spring 24 will not be fully wound and the clutch slider assembly 30 will not be moved to the position to clutch in torsion spring 24 to rotor 42. As a consequence, when clock timer 28 re-

leases at t_2 , there will be a lack of energy available to properly drive rotor 42 to its required position and the fuze mechanism will of course not arm.

Accordingly, it will be appreciated that the system is therefore fail-safe since energy from the air stream is required for sufficient length of time to both wind the torsion spring 24 and move the clutch slider assembly 30 to a position to effect the remaining procedure for the arming cycle. Likewise, the fuze system protects against a zero or prematurely short arming time as a result of a malfunction in the clock timer 28. If timer 28 fails, i.e., t_2 is less than t_1 , torsion spring 24 is released before slider mechanism 30 connects the torsion spring 24 to the rotor gear train 40. Consequently, the energy in spring 24 is simply dissipated and no energy will be available to rotate rotor 42 for arming at the appropriate time.

It might also be mentioned at this point that if electrical power is desired for effecting control functions of one sort or another within the ordnance device itself, a generator can be conveniently added, such as that indicated at 44 in phantom line. Generator 44 can be suitably operated off of gear train 16 through an additional drive gear 44a, as shown.

As previously mentioned, the fuze arrangement as constructed in accordance with the present invention includes means to provide a visual indication of the operational state of the ordnance device at all times, i.e., whether it is armed or unarmed. This arrangement further includes a simple and convenient method of disarming the ordnance device at any time prior to release. As shown in FIGS. 4a through 4b, the fuze system includes an arm indicator rod 46 operating in conjunction with the rotor 42 and a firing pin 48. As will also be noted, rotor 42 includes an arcuate slot 42a at a location near its periphery and extending over approximately one-fourth its circumferential path, or approximately 90°. Rotor 42 further includes a detonator 50 and a circular opening 42b at locations substantially as illustrated.

In a safe or unarmed condition, as depicted in FIG. 4a, rotor 42 is positioned such that arm indicator rod 46 is at the left side of rotor slot 42a. Firing pin 48 cannot come into contact with detonator 50. At the same time, an arm indicator 46a on the end of indicator rod remote from rotor 42 is at a position substantially flush with the surface of the fuze surface 10, and which is effective to indicate that the ordnance device is unarmed or in the safe condition.

In the fully armed position, rotor 42 is rotated by drive gearing 40 some 90° where the right side of slot 42a now bears against the arm indicator rod 46. This aligns firing pin 48 directly with detonator 50. Additionally, arm indicator rod 46 is moved slightly to the left (as viewing FIG. 4b), whereby arm indicator 46a will now protrude a given amount from fuze surface 10. This results from the fact that the depth of slot 42a progressively decreases as the rotor 42 is rotated from the position as shown in FIG. 4a to that of FIG. 4b, thereby serving a camming action on rod 46. This, of course, indicates the fully armed condition for the associated ordnance device.

To disarm the ordnance device, the arm indicator 46a need only be grasped and pulled out a short distance as indicated in FIG. 4c. This clears the end of rod 46 from the slot 42a of rotor 42 and the latter is permitted to rotate an additional 90° by residual energy in tor-

sion spring 24 to an alternate safe position, as depicted in FIG. 4d. The arm indicator 46a may then be released and spring bias drives the end thereof into the now-aligned circular opening 42b. Arm indicator 46a is now below the surface 10, constituting the safe-locked condition for the associated ordnance device.

Accordingly, while only a particular embodiment of the invention has been shown and described herein, it will be obvious that certain modifications may be made without departing from the invention in its broader aspects and, accordingly, the appended claims are intended to cover all such changes and alternative constructions that may fall within the true scope and spirit of the invention.

What is claimed is:

1. Fail-safe fuze apparatus for a free-falling ordnance device wherein energy extracted from the air stream may be utilized for the arming thereof, said apparatus including in combination:

- an air turbine energized by the air stream during free-fall of the ordnance device;
- a helical torsion spring;
- means for coupling said air turbine to said torsion spring to effect the continuous winding thereof and consequent storage of a certain amount of energy therein during a first time interval;
- timing means for releasing the stored energy in said torsion spring following a second time interval which encompasses at least said first time interval;

arming means utilizing said torsion spring stored energy to effect arming of the ordnance device; and

clutch means for totally disengaging said arm turbine and coupling said torsion spring to said arming means prior to the release of said torsion spring by said timing means.

2. Fail-safe fuze apparatus in accordance with claim 1 wherein said clutch means includes a slider mechanism selectively biased between respective operational modes by an over-center spring and which further includes camming means for effecting the transition between said operational modes at said first time interval.

3. Fail-safe fuze apparatus in accordance with claim 1 wherein said arming means includes a firing pin and selectively positionable rotor means carrying detonator means, said ordnance being armed when said rotor is positioned to align said detonator means with said firing pin.

4. Fail-safe fuze apparatus in accordance with claim 1 wherein said means for utilizing said air stream energy includes a cam wheel releasably coupled to air turbine by an associated gear train.

5. Fail-safe fuze apparatus in accordance with claim 4 wherein said clutch means includes a forward clutch for selectively intercoupling said air turbine and said cam wheel and a rear clutch for selectively intercoupling said helical spring and said arming means, and wherein means are included to prevent engagement of said forward and rear clutches simultaneously.

6. Fail-safe fuze apparatus in accordance with claim 1 wherein said means for releasing the energy of said torsion spring includes a lanyard-pull actuated clock mechanism with retractable pawl for releasing at said second time interval.

7. Fail-safe fuze apparatus for a free-falling ordnance device wherein energy extracted from the air stream may be utilized for the arming thereof, said apparatus including in combination:

- an air turbine energized by the air stream during free-fall of the ordnance device;
- a helical torsion spring;
- means for coupling said air turbine to said torsion spring to effect the continuous winding thereof and consequent storage of a certain amount of energy therein during a first time interval;
- timing means for releasing the stored energy in said torsion spring following a second time interval which encompasses at least said first time interval;

arming means utilizing said torsion spring stored energy to effect arming of the ordnance device;

clutch means for totally disengaging said air turbine and coupling said torsion spring to said arming means prior to the release of said torsion spring by said timing means;

means for providing a visual indication of the opera-

tional condition of the fuze apparatus at all times; and

manual release means for quick disarming the ordnance device where once armed.

8. Fail-safe fuze apparatus in accordance with claim 7 wherein said means for effecting said visual indication includes an arm indicator rod intercoupled to said arming means, the selective position of said rod providing the desired indication of the operational condition of said fuzing apparatus.

9. Fail-safe fuze apparatus in accordance with claim 8 wherein the armed condition is indicated by a portion of said arm indicator rod projecting a given amount above the surface of said fuzing apparatus.

10. Fail-safe fuze apparatus in accordance with claim 9 wherein said manual release means comprises said arm indicator rod in conjunction with spring bias means included in said arming means, means for pulling out said arm indicator rod a predetermined distance so as to permit said spring bias means to drive said arming means to an alternate safe position.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,842,743 Dated Oct. 22, 1974

Inventor(s) Cyrus M. Zittle

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Enter after, "[21] Appl. No.: 364,996", on title page, the following:

--[73] Assignee: Motorola, Inc.
Chicago, Illinois--

Signed and sealed this 11th day of February 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,842,743

DATED : October 22, 1974

INVENTOR(S) : Cyrus M. Zittle

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Claim 1, column 6, line 35; change "arm" to --air--.

In Claim 4, column 6, line 54; add --said-- after "coupled to".

Signed and Sealed this
seventeenth Day of February 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

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