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[54] **ENVIRONMENTALLY ENERGIZED ARM-FIRE DEVICE ACTUATOR**

[75] Inventor: **John H. France**, Ogden, Utah

[73] Assignee: **The United States of America as represented by the Secretary of the Navy**, Washington, D.C.

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[51] **Int. Cl.**[4] **F42C 5/00**

[52] **U.S. Cl.** **102/224**

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Primary Examiner—David H. Brown

Attorney, Agent, or Firm—Robert F. Beers; W. Thom Skeer; Stephen J. Church

[57] **ABSTRACT**

A fluid oscillator having a tube provided with a slit which is pivotable into a boundary layer of air flowing over a missile for arming and is pivotable from the missile exterior. The tube is configured so that the boundary layer excites oscillations within the tube at a predetermined velocity at which the missile is to arm.

10 Claims, 4 Drawing Figures

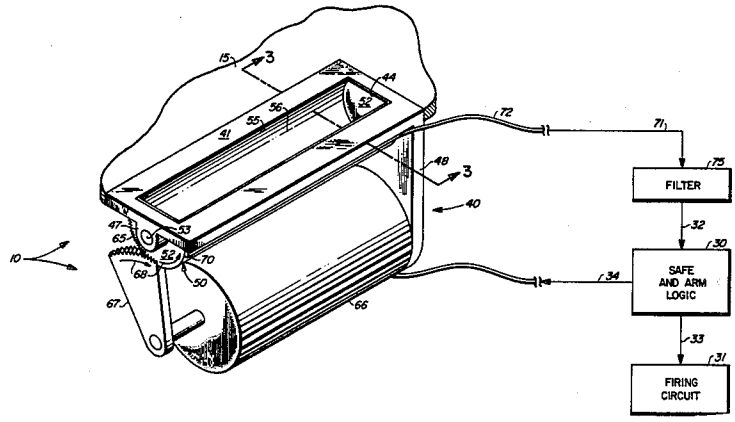


Fig. 1

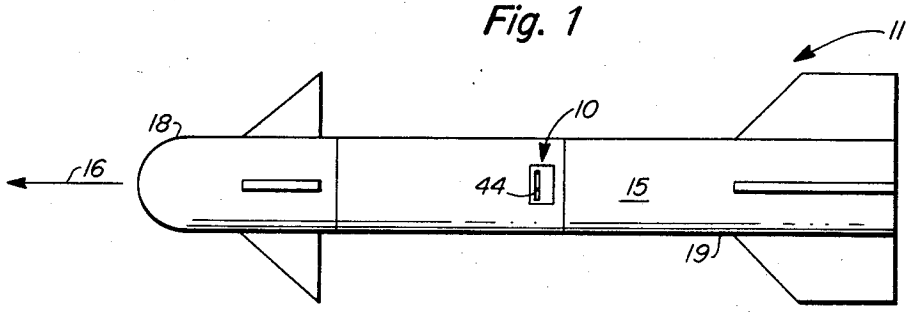
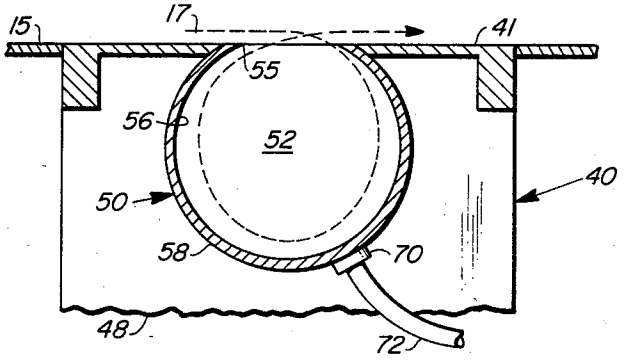


Fig. 3



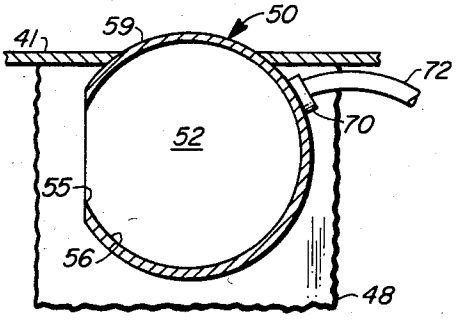


Fig. 4

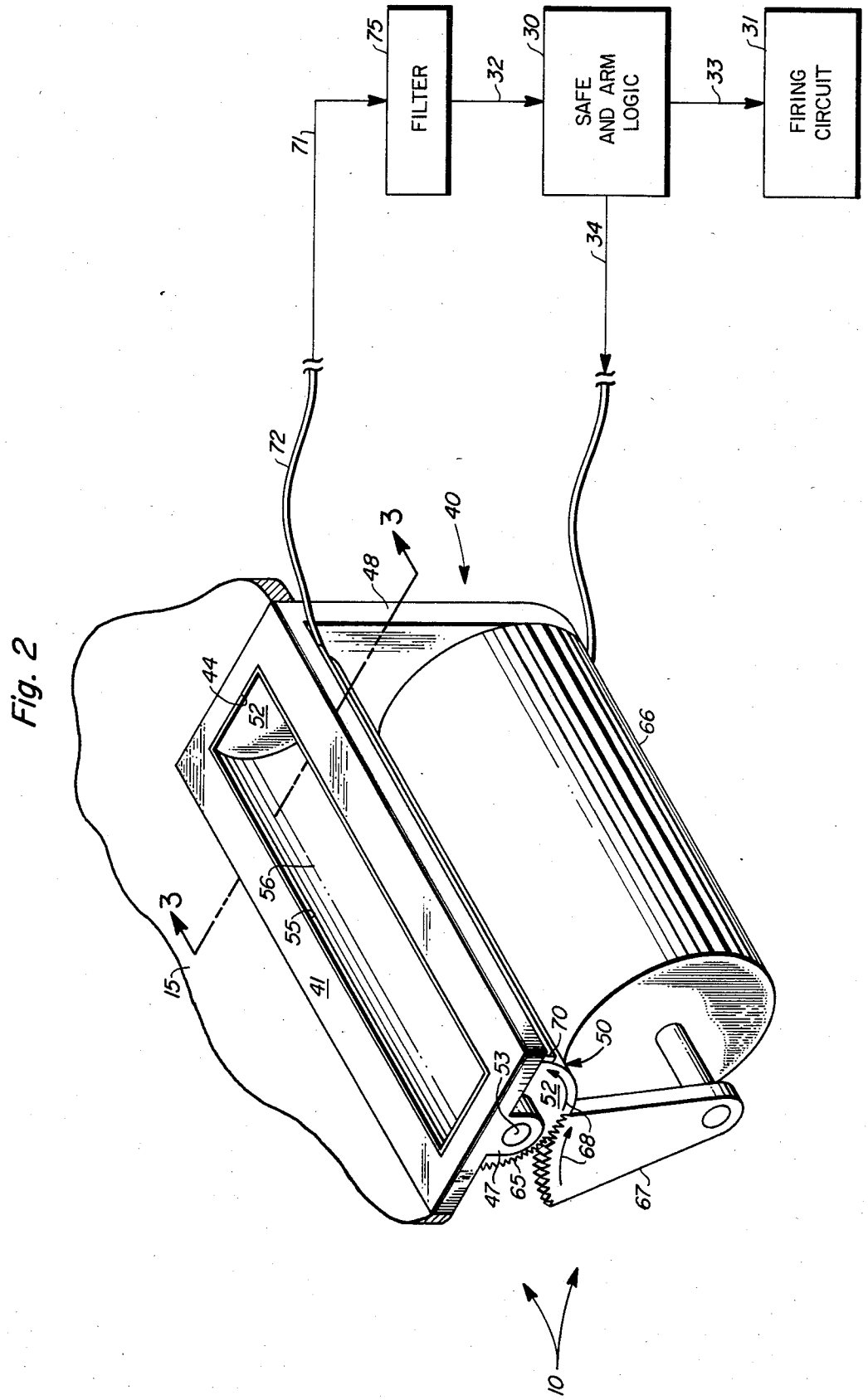

FILTER
SAFE AND ARM LOGIC
FIRING CIRCUIT
75
30
31
32
33
34
71
72
40
48
3
44
52
56
55
41
15
66
70
50
53
47
65
68
67
10

Fig. 2

ENVIRONMENTALLY ENERGIZED ARM-FIRE DEVICE ACTUATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to the field of ammunition and explosives. More particularly it pertains to the field of arming devices incorporating a fluidic device.

2. Description of the Prior Art

It is well known to utilize fluidic oscillators to arm a weapon at a predetermined velocity thereof through the air, the oscillator being configured so as to be driven into oscillation by air flow at such velocity and an acousto-electrical of acousto-mechanical transducer being used to sense the oscillations. The use of fluidic oscillators or other devices sensing weapon velocity in this manner is advantageous in that the weapon not only does not arm until it attains such velocity but may be arranged to disarm when the velocity becomes less then such velocity, a feature particularly useful with an aircraft borne missile which should arm when the carrying aircraft is at flight speed and, preferably, should disarm automatically on landing if the aircraft returns with the missile unfired.

Insofar as known to the applicants, prior art fluid oscillators used for arming or disarming a weapon and driven by ram air require either an air inlet at the forward weapon end or a probe extended transversely of the weapon. Both of these arrangements present disadvantages with certain weapon configurations. One disadvantage is that such arrangements may not function properly at a high angle of attack. Another disadvantage is that a forward end inlet is inconvenient in a typical missile having its forward portion, devoted to guidance equipment and having an arming device located rearwardly in a warhead or a rocket motor which is directly controlled by the arming device and is usually stored separately from the guidance portion. Still another disadvantage is that transversely extended probes and elements of some forward inlets are commonly made retractable to save storage space and to avoid damage in handling. The arrangements required to provide for such retraction utilize space and weight which are at a premium in a missile.

SUMMARY OF THE INVENTION

The subject invention involves a cylindrical tube having a slit in one side and moveable between an operating position, in which the slit opens transversely of a missile or the like into a boundary layer of air flowing along the missile to excite oscillation in the tube, and an inactive position in which the slit is not open to the environment. The tube is configured so that such oscillations are not excited until the missile has a predetermined forward velocity corresponding to a point in a mission when it is safe to complete arming of the missile.

It is an object of the subject invention to provide an environmentally energized arm-fire device actuator providing a signal at a predetermined velocity of a weapon mounting the actuator.

Another object is to provide such an actuator having an opening which is conveniently and selectively closeable to prevent arming and to avoid blockage prior to velocity determination.

A further object is to provide such an actuator which has the above advantages and which is compact, light in weight, and fully effective in carrying out its intended purpose.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, advantages, and novel features of the subject invention will become apparent from the following detailed description of the invention when considered with the accompanying drawings in which:

FIG. 1 is a side view of a missle mounting a fluid oscillator apparatus embodying the subject invention;

FIG. 2 is a perspective view of such apparatus and an adjacent region of the skin of the missile together with schematically represented circuits and devices associated with the apparatus;

FIG. 3 is a section taken on line 3—3 of FIG. 2 showing a cylindrical tube of the apparatus in an operating position;

FIG. 4 is a section, similar to FIG. 3, showing the tube in an inactive position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 a fluid oscillator apparatus **10** embodying the principles of the subject invention is depicted mounted in a missile **11** which is a representative operating environment for the apparatus. Missile **11** has an exterior skin **15** and is moveable through the air along a predetermined direction of movement **16** so as to induce air flow along skin **15** in a boundary layer indicated by arrow **17** in FIG. 3. Missile **11**, which is elongated in direction **16**, terminates forwardly in a guidance portion **18** and terminates rearwardly in a motor portion **19**.

Missile **11** has an arm-fire or a safe and arm device mounted therein and schematically represented in FIG. 2 by safe and arm logic **30** and a firing circuit **31** of any suitable construction adapted to the function of missile **11** and to function with apparatus **10** as described in greater detail below. Logic **30** is receptive to an electrical signal **32** and, typically, outputs such a signal **33** to circuit **31** which, in turn, initiates operation of motor portion **19**. Logic **30** also provides a signal **34** to apparatus **10**, and this logic and the apparatus are, typically, disposed between missile portions **18** and **19** adjacent to the latter portion as shown in FIG. 1 for apparatus **10**.

As best shown in FIGS. 2 and 3, apparatus **10** has a housing **40** mounted on missile **11** and bearing a peripheral surface **41** aligned with the exterior surface of skin **15** so that air from boundary layer **17** flows over surface **41**. Housing **40** is of any suitable construction and may, of course, be unitarily constructed with the portion of skin **15** in the vicinity of apparatus **10**. Housing **40** has a rectangular opening **44** through surface **41** with the longer dimension of the opening extending normally to air flowing in layer **17** and thus transversely of direction **16** and missile **11**. Housing **40** is depicted in FIG. 2 as having a shorter lug **47** and a longer lug **48** disposed longitudinally oppositely of opening **44** and extending inwardly of missile **11** from surface **41**.

Apparatus **10** has a cylindrical tube, indicated generally by numeral **50**, mounted on housing **40** with the axis of the tube extended parallel to opening **44** and spaced from surface **41** substantially the radius of tube **50**. The axis of tube **50** is thus disposed generally parallel to surface **41**. Tube **50** is closed at its opposite axial ends by disks **52** which, typically, are integral with the circumferential portion of the tube. Each disk **52** bears a pivot **53** received in the adjacent lug **47** or **48** so that tube **50** is mounted on housing **40** for pivotal movement about

the axis thereof, only the pivot **53** associated with lug **47** being shown in the drawings. It is evident that other arrangements than disks **52** and pivots **53** may be provided for closing the ends of a tube corresponding to tube **50** and for pivotally mounting such tube on a missile such as missile **11**. One side of tube **50** is configured as if the tube were cut away along a plane corresponding to surface **41** so that tube **50** defines a slit **55**, which opens from a cavity **56** defined within the tube. By pivoting tube **50**, slit **55** may be disposed, as best shown in FIG. **3**, so that the slit opens from cavity **56** through opening **44** and through skin **15** into boundary layer **17**. It is evident that tube **50** circumscribes cavity **56** and that slit **55** is elongated so as to extend axially of tube **50**. When so pivoted, tube **50** is in an operating position **58**, shown in FIGS. **2** and **3**, in which slit **55** is disposed at boundary layer **17** and is aligned with opening **44**. Tube **50** is pivotable from position **58** to an inactive position **59**, shown in FIG. **4**, in which slit **55** is disposed away from opening **44** and interiorly of skin **15**.

Apparatus **10** is provided with any suitable mechanism for selectively pivoting tube **50** between positions **58** and **59** in response to signal **34**. A representative such mechanism is shown in FIG. **2** and includes a sector gear **65**, which is disposed circumferentially of tube **50** at the end thereof adjacent to lug **47**, and a pivotal actuator **66** of any suitable construction mounted on lug **48** and receptive to signal **34**. Actuator **66** has a toothed sector **67** engaging gear **65** so that, as indicated by arrows **68**, movement of sector **67** in one direction pivots tube **50** toward position **59** and opposite movement pivots tube **50** toward position **58** from position **59**.

When tube **50** is in operating position **58**, air flowing in boundary layer **17** past slit **55** excites fluid pressure or acoustic oscillations in cavity **56**. The diameter and length of tube **50** are dimensioned and proportioned so that, when missle **11** has a predetermined velocity in direction **16** and boundary layer **17** is in a state associated with such velocity, the oscillations have a predetermined frequency and so that, when missile **11** has a velocity in direction **16** less than the predetermined velocity, no oscillations are generated at the predetermined frequency. Apparatus **10** has an acousto-electrical transducer **70**, best shown in FIG. **3**, mounted on tube **50** for driving by acoustic oscillations therein to provide a signal **71** at the frequency of the oscillations. Transducer **70** is depicted in FIG. **2** as having a strip-like configuration commonly used with ceramic piezoelectric transducers; however, other configurations or other types of piezoelectric transducers may be used in practicing the subject invention so long as the transducer is adapted for mounting in juxtapositioned relation to cavity **56** to generate a signal **71** corresponding to acoustic oscillations therein. With such other configurations a suitable transducer may be mounted on one of the disks **52** or a plurality of transducers of the same or different configurations may be employed. Signal **71** is, typically, output from transducer **70** through a flexible conductor **72**, shown in FIGS. **2** through **4**, to accommodate movement of transducer **70** with tube **50** between the tube positions **58** and **59**.

It will be apparent to one skilled in the art of slit tone oscillators that a number of modes of oscillations are excited in cavity **56** and that the particular mode may vary, as in a wind musical instrument, with air velocity over slit **55**. However, the position of transducer **70** on tube **50** and the construction of the transducer may be such that the transducer is most receptive to oscillations having the frequency of a mode corresponding to the predetermined missile forward velocity of interest. Preferably, apparatus **10** is provided with any suitable band pass filter **75**, shown in FIG. **2**, and connected electrically between transducer **70** and logic **30**. Filter **75** is tuned to pass such a frequency and thus generate signal **32** so that logic **30** only receives signal **32** when missile **11** attains said predetermined velocity and does not receive signal **32** when the missile has a velocity substantially less than said predetermined velocity.

OPERATION

The operation of the described embodiment of the subject invention is believed clearly apparent and will be breifly described.

During storage, tube **50** is kept in its inactive position **59**, shown in FIG. **4**, to prevent contamination or blockage of cavity **56**. When a missile, such as **11**, bearing an apparatus **10**, is readied for operation, tube **50** may be pivoted to position **58** in any desired manner, for example manually on mounting the missile on an aircraft or by energizing actuator **66** from within the aircraft. Cavity **56** is, typically, configured so that the frequency of a mode of oscillation, which corresponds to a predetermined flight speed of the aircraft and is passed by filter **75**, results in signal **32** to logic **30** that conditions are suitable for the arming of the missile. When the aircraft subsequently lands without releasing the missile, the lower landing speed does not produce oscillations at such frequency thereby signalling logic **30** to safe the missile without human intervention. Logic **30** can, of course, be arranged to signal actuator **66** to position tube **50** in its operating position **58** until signal **32** is generated and then signal actuator **66** to position the tube in its inactive position **59**. After a missile, such as **11**, attains a velocity at which signal **32** is generated, the missile may accelerate to a higher velocity such that a mode of oscillation occurs in cavity **56** at a frequency not passed by filter **75** or such that there is no oscillation. In such event logic **30** may be arranged to arm the missile when signal **32** is first generated and to resafe the missile when signal **32** is again generated as an aircraft bearing the missile slows for landing.

Obviously, many other variations and modifications of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the following claims the invention may be practiced otherwise than specifically described.

What is claimed is:

1. In combination,

a missile having a skin and moveable through the air so as to induce air flow in a boundary layer along the skin;

a safe and arm device mounted in the missile and receptive to an electrical signal;

a transducer for generating such a signal when subjected to air pressure oscillations, and a fluid oscillator apparatus comprising:

means, which define a cavity adjacent to said skin and define a slit opening from the cavity through the skin into the boundary layer, for generating air pressure oscillation in said cavity due to air flow in said boundary layer past the slit; and

means for mounting the transducer in juxtapositioned relation to said cavity for reception of said oscillations so that such a signal is generated by the transducer when said oscillations occur.

2. The combination of claim 1 wherein said means for generating air pressure oscillations comprises a cylindrical tube circumscribing said cavity and having said slit extending axially of the tube in one side thereof.

3. The combination of claim 2 wherein the fluid oscillator apparatus further comprises:

means mounting said tube for pivotal movement about the axis thereof, and

means for pivoting said tube between an inactive position in which the slit is disposed interiorly of the skin and an operating position in which the slit is disposed at the boundary layer.

4. The combination of claim 1 wherein said cavity and said slit are dimensioned and proportioned so that said oscillations are generated when air flow in said boundary layer attains a predetermined state corresponding to a predetermined forward velocity of said missile and are not generated when the missile has a velocity less than said predetermined forward velocity.

5. The combination of claim 1 wherein said cavity and said slit are dimensioned and proportioned so that said oscillations have a predetermined frequency when the missile has a predetermined forward velocity and wherein the combination includes a band pass filter tuned to said predetermined frequency and connected electrically between the transducer and the safe and arm device so that said device receives such a signal when the missile attains said predetermined velocity and does not receive such a signal when the missile has a velocity substantially less than said predetermined velocity.

6. The combination of claim 1:

wherein the missile is elongated along a predetermined direction of movement through the air, the missile terminating forwardly in a guidance portion and terminating rearwardly in a motor portion; and wherein the fluid oscillator apparatus is disposed between said portions and said slit opens transversely of the missile.

7. A fluid oscillator excited by fluid flowing in a boundary layer in a predetermined direction along an exterior surface of an object, the oscillator comprising:

a housing mounted on the object, the housing bearing a peripheral surface, which is aligned with said exterior surface so that fluid from the boundary layer flows over said peripheral surface, and the housing defining an opening through said peripheral surface;

a cylindrical tube defining a slit extending axially of the tube in one side thereof;

means for mounting the tube in the housing with the axis of the tube extending transversely of said direction and generally parallel to said peripheral surface, said axis being spaced from said peripheral surface substantially the radius of the tube;

means mounting the tube for pivotal movement about said axis between an inactive position, in which the slit is disposed away from said opening, and an operating position, in which the slit is aligned with said opening so that fluid flowing in said boundary layer excites acoustic oscillations within the tube; and

means for selectively pivoting the tube between said positions.

8. The oscillator of claim 7 further comprising means mounted on said housing for closing the opposite axial ends of the tube.

9. The oscillator of claim 7 wherein the diameter and the length of the tube are selected so that said oscillations have a predetermined frequency when said object has a predetermined velocity generally in said direction.

10. The oscillator of claim 7 further comprising acousto-electrical transducer means juxtapositioned to said tube for driving by said oscillations to provide an electrical signal corresponding thereto.

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