

[54] **FLUIDIC FREE FLIGHT SENSOR**

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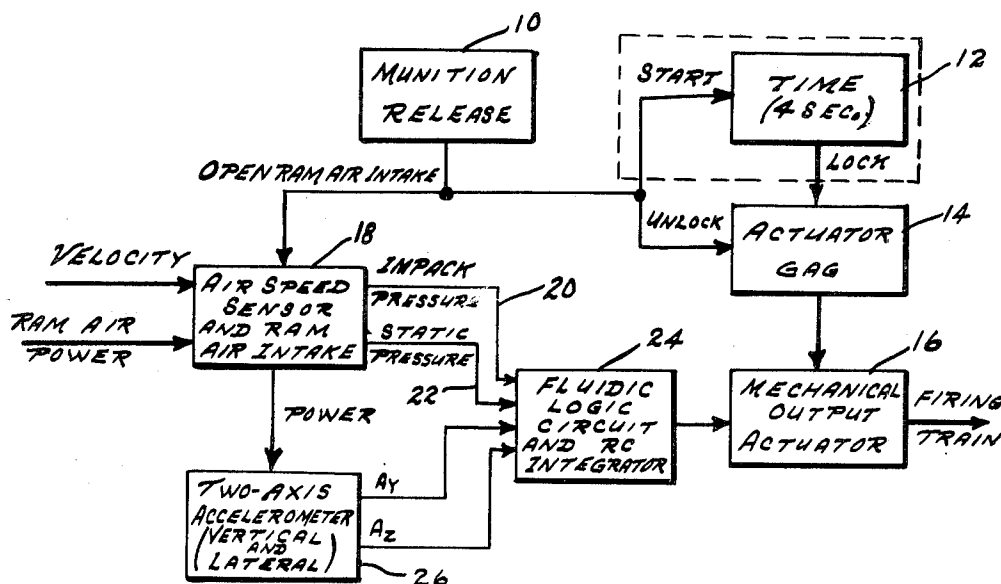
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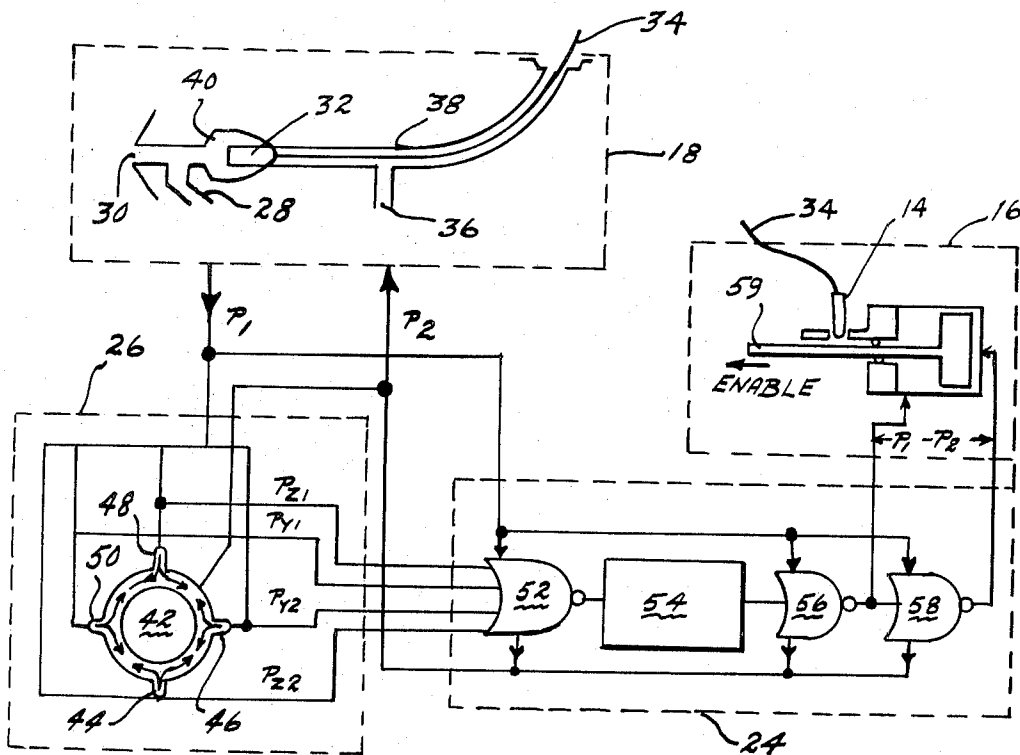
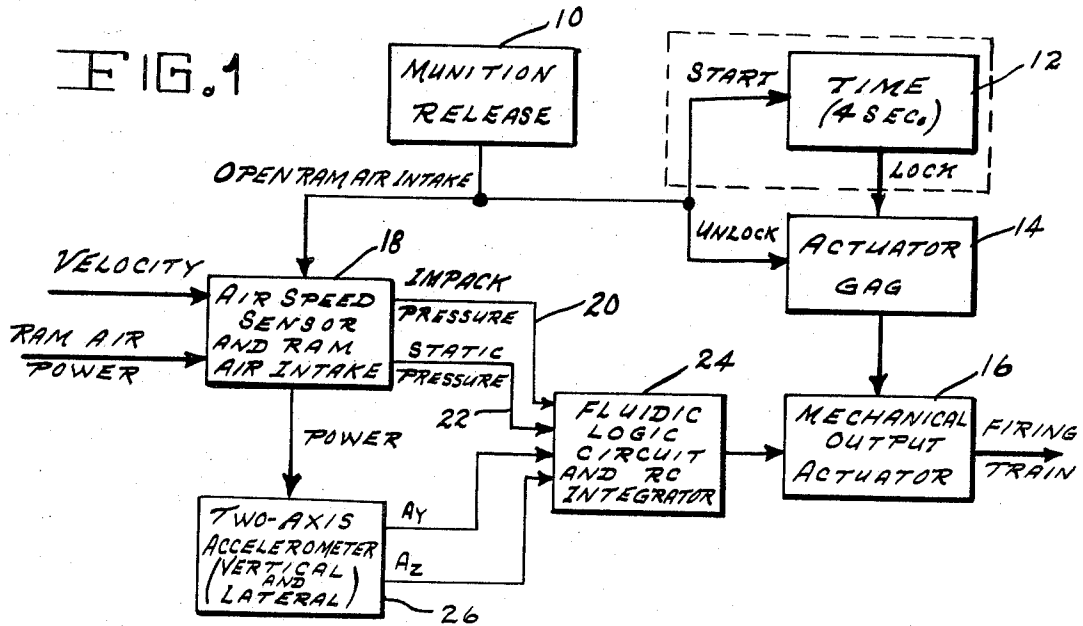
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ABSTRACT

A free flight sensor adapted for use in munitions utilizing ram air power to operate a mechanical safing means, sensing vertical velocity with a pitot-static pressure system and a two-axis fluidic accelerometer to sense vertical acceleration.

3 Claims, 2 Drawing Figures





FLUIDIC FREE FLIGHT SENSOR

BACKGROUND OF THE INVENTION

This invention relates generally to munition arming systems and more particularly to a fluidic free flight sensor for use in airborne delivered munitions.

When dealing with the field of munitions the most important aspect involved in each munition system is the safety and arming subsystem. Each munition has its own characteristic features dependent to a great extent upon the delivery system. Examples may be seen in, the demolition munition which utilizes safety pins and a timing clock, the land mine utilizes mechanical pressure, while the artillery shell incorporates ballistic spin and the airborne delivered munition utilizes a lanyard-gravity approach.

Obviously there are many modifications of these safety and arming subsystems due in part to the variety of special needs of munition users and also to the various modified delivery systems available. Particularly true of the latter is the airborne munition which may be carried on a variety of vehicles ranging from the large bomber whose flight path varies only in small degrees from the horizontal and has low acceleration forces, to the fighter bomber that might change attitude from vertically up to vertically down in a matter of a few seconds. Further, high performance aircraft apply forces equal to a great many times the force of gravity during a normal flight.

It can be seen then that for airborne munitions many forces must be considered when a safety and arming system is constructed.

SUMMARY OF THE INVENTION

The invention is applicable particularly to airborne munitions that are carried by and released from high performance aircraft, although it may be utilized with all airborne delivered munitions equally as well.

The invention is a fluidic free flight sensor and it has the purpose of establishing that the munition has been safely released from the delivery system. The invention first determines that the munition is traveling at a particular velocity by means of sensing its dynamic pressure. Second, the invention determines that the munition is in a free fall condition for at least two seconds. This is done by means of sensing vertical acceleration of the munition. When these conditions are met a conventional mechanical arming system is allowed to begin the process of arming the munition.

The velocity is determined by obtaining a differential pressure signal through a pitot-static pressure system. The differential pressure is used to power the fluidic circuit and to provide sufficient force to move the actuator when the airspeed reaches a minimum value.

Free fall is detected by means of a two-axis fluidic accelerometer measuring the zero vertical acceleration, a condition associated with a freely falling munition. When the accelerations measured in both axis are essentially zero a fluidic switch is turned on. The "on" signal is integrated in a fluidic resistor-capacitor circuit. When an accumulated "on" time of approximately 2 seconds is obtained, the integrator has charged to a level sufficient to activate a second switch, which indicates that the zero vertical acceleration requirement has been satisfied. When both the minimum airspeed and zero vertical acceleration requirements

are satisfied, the logic circuit produces a pressure output to the mechanical arming output actuator.

It is therefore an object of the invention to provide a new and improved safety and arming system for munitions.

It is another object of the invention to provide a new and improved safety and arming system for munitions that establishes that the munition has been safely released from an airborne delivery system.

It is a further object of the invention to provide a new and improved safety and arming system for munition that utilizes ram air power.

It is still another object of the invention to provide a new and improved safety and arming system for munition that determines when the munition is at a velocity greater than a certain predetermined minimum velocity.

It is still a further object of the invention to provide a new and improved safety and arming system for airborne munitions that senses free fall of the munition for a predetermined time.

It is another object of the invention to provide a new and improved fluidic free flight sensor for use with airborne delivered munitions.

It is another object of the invention to provide a new and improved fluidic free flight sensor which is economical to produce and utilizes conventional, currently available components that lend themselves to standard mass production manufacturing techniques.

These and other advantages, features and objects of the invention will become more apparent from the following description taken in connection with the illustrative embodiment in the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of the invention.

FIG. 2 is a schematic representation of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown in block representation the fluidic free flight sensor. The invention detects and uses both the velocity and zero vertical acceleration environments associated with a freely falling munition before mechanical arming can occur. These operations, including the mechanical output, are accomplished using ram air power from the bomb slip stream, thereby eliminating the need for a stored energy mechanism within the fuse safety system.

As the munition is released from the aircraft the ram air intake is opened and simultaneously a four second timer starts controlling the actuator gag. After the time has elapsed, the gag is removed from the mechanical output actuator and the aspect of the safing system is removed.

With the ram air intake open, the airspeed sensor is exposed to the ram air and begins to function. The airspeed sensor is a conventional pitot-static pressure instrument and produces a differential signal which is a function of air speed. The pressures are fed via the fluidic logic circuit. The differential pressure is used to power the fluidic circuit and to provide sufficient force to move the mechanical output actuator when the airspeed reaches a minimum value (200 feet per second).

To detect the zero vertical acceleration condition associated with a freely falling munition a two-axis fluidic

accelerometer 26 is utilized. A two-axis sensor is used to a continuous reading of a vertical acceleration in case the munition rolls after release. When the accelerations measured in both axis are very approximately zero, a fluidic switch is turned on. This "on" signal is integrated in the fluidic resistor-capacitor (orifice-volume) circuit 24. When an accumulated "on" time of approximately 2 seconds is obtained, the integrator has charged to a level sufficient to activate a second switch, which indicates that the zero vertical acceleration requirement has been satisfied. When both the minimum airspeed and zero vertical acceleration requirements are satisfied, the logic circuit produces a pressure output to drive the mechanical output actuator 16.

FIG. 2 shows a schematic representation of the fluidic free flight sensor. The airspeed sensor 18 consists of a ram air port 28 located at the nose 30 of the package. Prior to initiation, the sensor nose is blocked with a nylon plug 32 attached to the end of the lanyard wire 34. The sensor has also a static pressure port 36 connected to the internal lanyard plumbing 38, which connects the nose fuse well with the charging well on the side of the munition. Prior to initiation, both the internal impact pressure port 28 and the static pressure port 36 are connected to ambient pressure through the lanyard plumbing tube 38. At initiation (or release) the plug is pulled out of the nose ram air port 30 and seats in the converging section below the contamination collection cavity 40. This separates the impact pressure port from the static pressure port and applies a differential pressure to the fluidic components initiating sensor operations.

The two-axis accelerometer 26 consists of a ball 42 in a cylindrical cavity, with four equally spaced ports, 44, 46, 48, 50 located around the cylinder midway between its ends. The ball acts as a two-dimensional flapper in this flapper-nozzle circuit. Air enters through the four ports, flows around the ball, and exhausts through ports at the ends of the cylindrical cavity which are connected to the static pressure manifold 36. Under a one-g gravity field, the ball bottoms in the cylinder, covering one of the ports and producing a high pressure at one of the outputs. For the zero vertical acceleration environment associated with a free-fall condition, the ball is floated by the incoming air flow, producing a low pressure at all four of the outputs. This state is detected by the fluidic logic through the use of a four-input NOR

circuit 52.

The four-input NOR circuit produces an ON output only when all four of the input signals are low. This output ON signal, which takes the form of a pressure signal equivalent to the difference between P_1 and P_2 , starts charging the resistor-capacitor circuit (orifice-volume) 54. When the pressure in the capacitor reaches a specific level (after it has been on approximately 2 seconds), the two series NOR elements 56, 58 switch, reversing the pressure difference across the output actuator 16. This pressure difference will drive the actuator 59 to an "enable to arm" position if it is large enough to overcome the locking force of the actuator detent 60. The detent would be set to release for a pressure difference produced by an airspeed of 200 ft/sec or greater.

Once the mechanical output actuator is in the "enable to arm" position the munitions conventional arming system will be allowed to function in a normal manner.

Although the invention has been described with reference to a particular embodiment, it will be understood to those skilled in the art that the invention is capable of a variety of alternative embodiments within the spirit and scope of the appended claims.

We claim:

1. A fluidic free flight sensor for air dropped munition fuses comprising: means for allowing ram air to enter the sensor; means for allowing static air to enter the sensor; means connected to said ram air means and said static air means for determining a differential pressure; and activating means connected to the differential pressure determining means; a two axis accelerometer means connected to the activating means, and a mechanical actuator means connected to the activating means output to cause the said mechanical actuator to function when preset conditions are met in the differential pressure determining means and the accelerometer means.

2. A fluidic free flight sensor for air dropped munition fuses according to claim 1 wherein the two axis accelerometer is fluidic cavity-ball sensing accelerometer.

3. A fluidic free flight sensor for air dropped munition fuses according to claim 1 wherein the activating means is a fluidic logic circuit and resistance-capacitor integrator circuit.

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