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ZERO GRAVITY SENSING DEVICE

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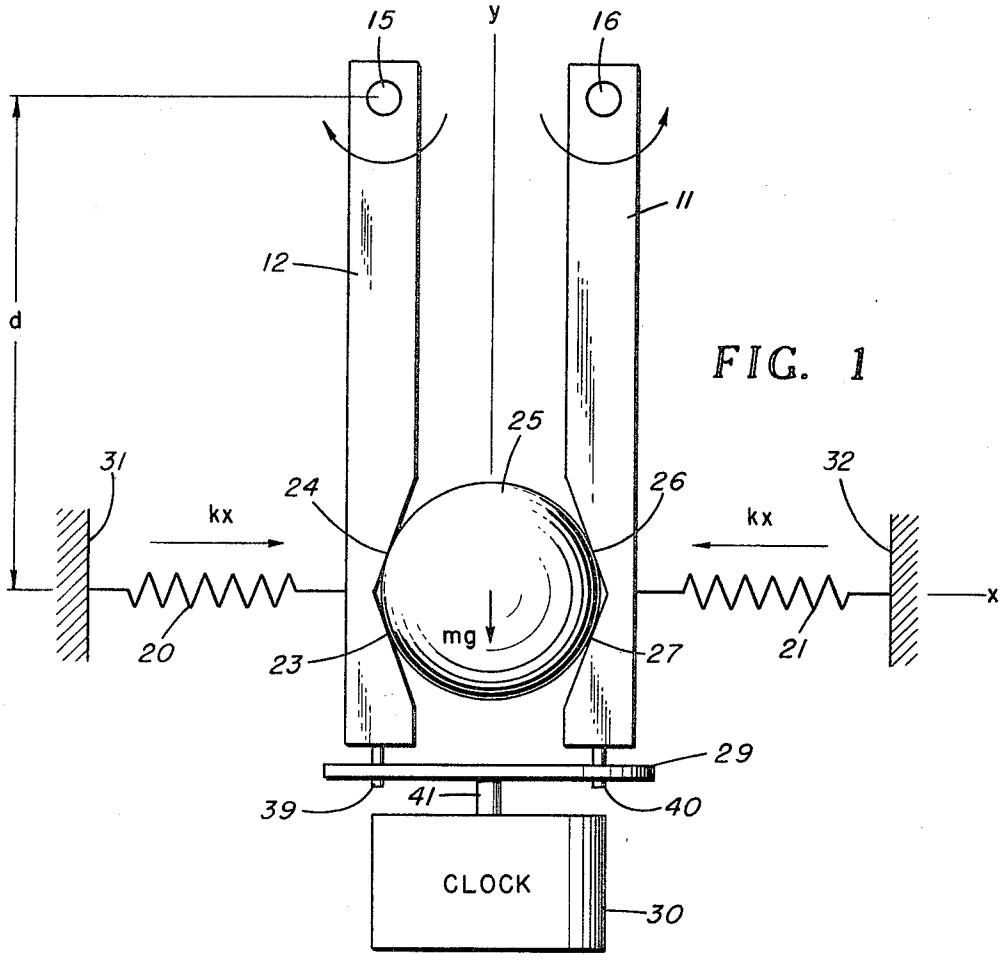


FIG. 1

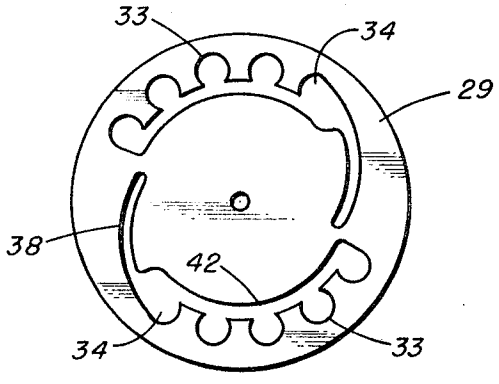


FIG. 2

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ZERO GRAVITY SENSING DEVICE

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ABSTRACT OF THE DISCLOSURE

An omnidirectional safing and arming mechanism sensitive to zero gravity having a ball held between two conical surfaces on pivoted plates which have compression springs opposing their outward movement until the weightlessness of the ball at zero gravity forces the plates outward to release a timer device.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a ballistic missile safety and arming device and more particularly to a gravity sensing device for detecting weightlessness, or zero gravity, of a missile for safety and arming purposes.

Ballistic missiles in flight experience the phenomenon of weightlessness when the missile velocity and radius of curvature are such that the centrifugal force equals the gravitational force; that is, when the re-entry body is in the vacuum portion of its ballistic trajectory and freely falling. The missile re-entry body may, of course, take any random orientation due to energy imparted to it at separation and will have a slight gravity loading resulting from its own spin or tumbling at the sensor location.

Zero gravity sensing devices are well known and in the past arming systems have utilized the zero gravity phenomenon. These devices, however, have not been entirely satisfactory in providing a sensing device which is omnidirectional; that is, senses the gravity level regardless of orientation, and which senses the gravity level for a predetermined length of time prior to arming while permitting a plurality of safety locking positions if a sensed gravity level becomes undesirably greater than zero.

This invention provides a safety and arming device which utilizes a sensor mechanism similar to that disclosed in Patent No. 2,949,783 issued on Aug. 23, 1960, to N. C. Butler. A tungsten carbide ball is held between two parallel pivoted plates which are countersunk to accept the ball and which are restrained from rotating outward by compression springs confined between the plates and a housing. A unique cam design enables a timer to normally move the device into a safety position until zero gravity is sensed by the tungsten ball whereupon the cam is unlocked for a period of time prior to arming as long as a zero gravity level is sensed. Should a weight environment be sensed while the timer is running, the plates will force pins into recesses in the cam, locking it and thereby safing the missile.

An object of the invention is to provide a safety and arming device for a ballistic missile which utilizes the zero gravity phenomenon.

Another object is the provision of a cam arrangement which locks gravity sensing mass in place until it is desired to sense the gravity level, which forces a gravity sensing device into a fail-safe position initially, and which provides a plurality of safety locking positions after a weightless environment has been detected.

Still another object is to provide a safety and arming device for a ballistic missile which senses the gravity level of the missile during free fall and acts to arm the missile if a weightless environment is detected for a predetermined length of time; but, which locks the arming section in a fail-safe position if a weight environment is detected during said predetermined length of time.

With these and other objects in view, as will hereinafter more fully appear, and which will be more particularly pointed out in the appended claims, reference is now made to the following description taken in connection with the accompanying drawings in which:

FIG. 1 illustrates an embodiment of the invention; and

FIG. 2 illustrates a top view of the cam in FIG. 1.

The device is shown in FIG. 1 wherein a tungsten ball **25** is held between two parallel, pivoted plates **11** and **12** which are countersunk to accept the ball. Plate **11** is restrained from rotating outward about pin **16** by compression spring **21** confined between the plate **11** and a housing wall **32**; likewise, compression spring **20** between housing wall **31** and plate **12** restrains the plate from moving outward about pivot **15** in the direction shown.

In operation, ball **25** exerts a force on the sloping surface of plates **11** and **12** acting at points of tangency **23**, **24**, **26** and **27** depending on orientation of the sensor. If the force of gravity on ball **25** is in the direction shown, forces will act at points **23** and **27**, perpendicular to the points of tangency, resulting in torques about pivots **15** and **16**, rotating their respective plates outward. Pins **39** and **40** are attached to the plates at the end of the plates, and project through slots in cam **29** which is attached to axle **41** of clock **30**.

When either plate **11** or **12** rotates it encounters ever increasing resistance by the compression spring force kx acting at a fixed distance d from its respective pivot **15** or **16**. The spring torque kxd is independent of gravity varying only with plate separation or amount of spring compression. The ball **25** torque, however, varies with gravity, the point of contact between the ball and plate surface, and the plate separation. Thus, plates **11** and **12** experience forces on one side due to the weight of the ball which varies with gravity and also a force on the other side due to a compression spring which is independent of gravity. It should be noted that no matter what the direction of gravity, ball **25** is an omnidirectional sensor since there will always be a force due to the ball acting on one or both plates caused either by wedging action or by the ball **25** acting directly on one or both plates.

The opposing torques, that of the ball tending to move the plates outward and that of the springs tending to move the plates inward, are designed to be in equilibrium at a predetermined g level, for example, .15 g. for weight mg. applied in the direction shown. The wedge angles in the plates **11** and **12** are chosen so that the net force on a plate arm when gravity acts along the y axis is equal to the net force when gravity acts along the x axis.

FIG. 2 shows the cam used with clock **30**. Initially, before the missile reaches a free fall environment, pins **39** and **40** will be projected through cam **29** in slots **38**. As the timer **30** rotates cam **29**, pins **39** and **40** are cammed outward into locking positions **34**. At this point if a weightlessness environment is sensed the compression torque will move pins **39** and **40** toward the center of cam **29** for movement along arming slots **42**. If, after pins **39** and **40** are in slots **42**, an environment is detected which gives ball **25** weight, torque due to the ball will force pins **39** and/or **40** into one of the notches **33** thereby safing the device. Notches **33** are locking notches so that the device is permanently locked after a pin is forced into a notch.

Many modifications will be obvious to those skilled in the art. The number of safing slots, for example, could be greater than five depending upon the physical size and limitations of the cam. Any suitable timer which develops the required torque and has an appropriate timing rate

might be used. A tungsten carbide ball has been used in the present embodiment, but it is within the scope of this invention to use any suitable ball material.

From the foregoing it is apparent that a novel zero sensing device has been developed which is omnidirectional and acts to safe or arm a ballistic missile during free fall depending on the environment detected. It should be understood, of course, that the foregoing disclosure relates to only a specific embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. A free fall gravity sensing safety and arming device comprising a pair of parallel elongated plates pivotally mounted at one end thereof having wedge shaped recesses formed in a surface of each of said plates at the opposite extremity thereof,

a pair of complementary resilient springs engaging said plates for urging said plates toward each other,

a spherical mass movably positioned between said plates in said recesses,

said spherical mass when subjected to normal gravitational forces arranged to overcome the inward force of said springs urging said plates away from each other, and said mass when subjected to below normal gravitational forces arranged to reduce the outward urging of said plates permitting said plates to move inward,

a pair of pins inserted one in each of the ends of said plates at the furthermost extremity of said plates from the pivot ends and radially extending in a direction perpendicular to the direction of movement of said plates about their pivot positions,

timer means,

a cam having a first pair of slots, diametrically oppositely located, and a second pair of slots, diametrically oppositely located, through which said pins are extended for controlling safety and arming equipment,

a plurality of notches for locking said pins in a safety position,

a first one of said notches communicating with said first and second slots, said first slots guiding said pins for a predetermined length of time toward said first notches, said second slots guiding said pins toward an arming position when gravitational forces below said predetermined range are detected; and,

said plurality of notches adapted to lock said pins at any time after said initial low gravity sensing if a gravitational force is detected which is greater than said predetermined range.

2. A safety and arming device responsive to near zero gravity forces for arming purposes comprising,

a spherical mass for detecting gravitational forces,

lever means in contact with said detecting means having pins for actuating safety and arming equipment,

timer means,

a cam control havin ga pair of first slots, diametrically oppositely located, and a second pair of slots, diametrically oppositely located, through which said pins are extended for controlling safety and arming equipment,

a plurality of notches for locking said pins in a safety position,

a first one of said notches communicating with said first and second slots, said first slots guiding said pins for a predetermined length of time toward said first notches, said second slots guiding said pins toward an arming position when gravitational forces below said predetermined range are detected; and,

said plurality of notches adapted to lock said pins at any time after said initial low gravity sensing if a gravitational force is detected which is greater than said predetermined range.

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