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(54) **ELECTRICAL SETBACK DETECTION SWITCH**

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(57) **ABSTRACT**

A switch including: a first body having holes located at a longitudinal position; a movable second body having a concavity corresponding to the holes; a retaining ball positioned in the holes and corresponding concavity for restraining the second body from movement relative to the first body; an elastic element disposed on the body; a mass disposed on the elastic element, the mass moving the elastic element upon an acceleration event; and first and second electrical contacts positioned on the body such that when the acceleration event has a predetermined magnitude and duration, the mass moves past the longitudinal position to permit the retaining ball from releasing from the holes, thereby permitting the second body to move towards the first and second electrical contacts; wherein the second body includes a conductive portion for closing an electrical circuit between the first and second electrical contacts.

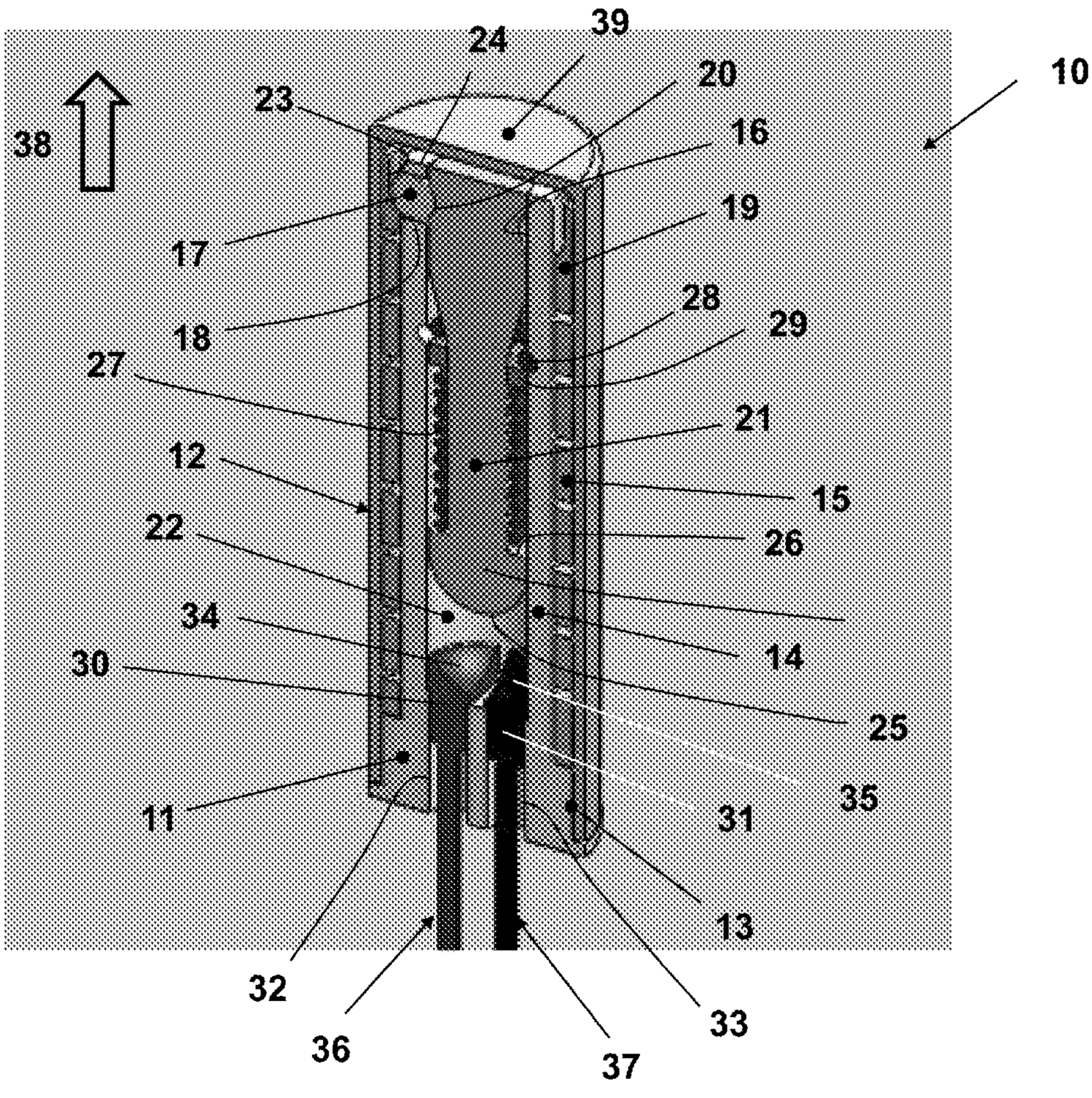
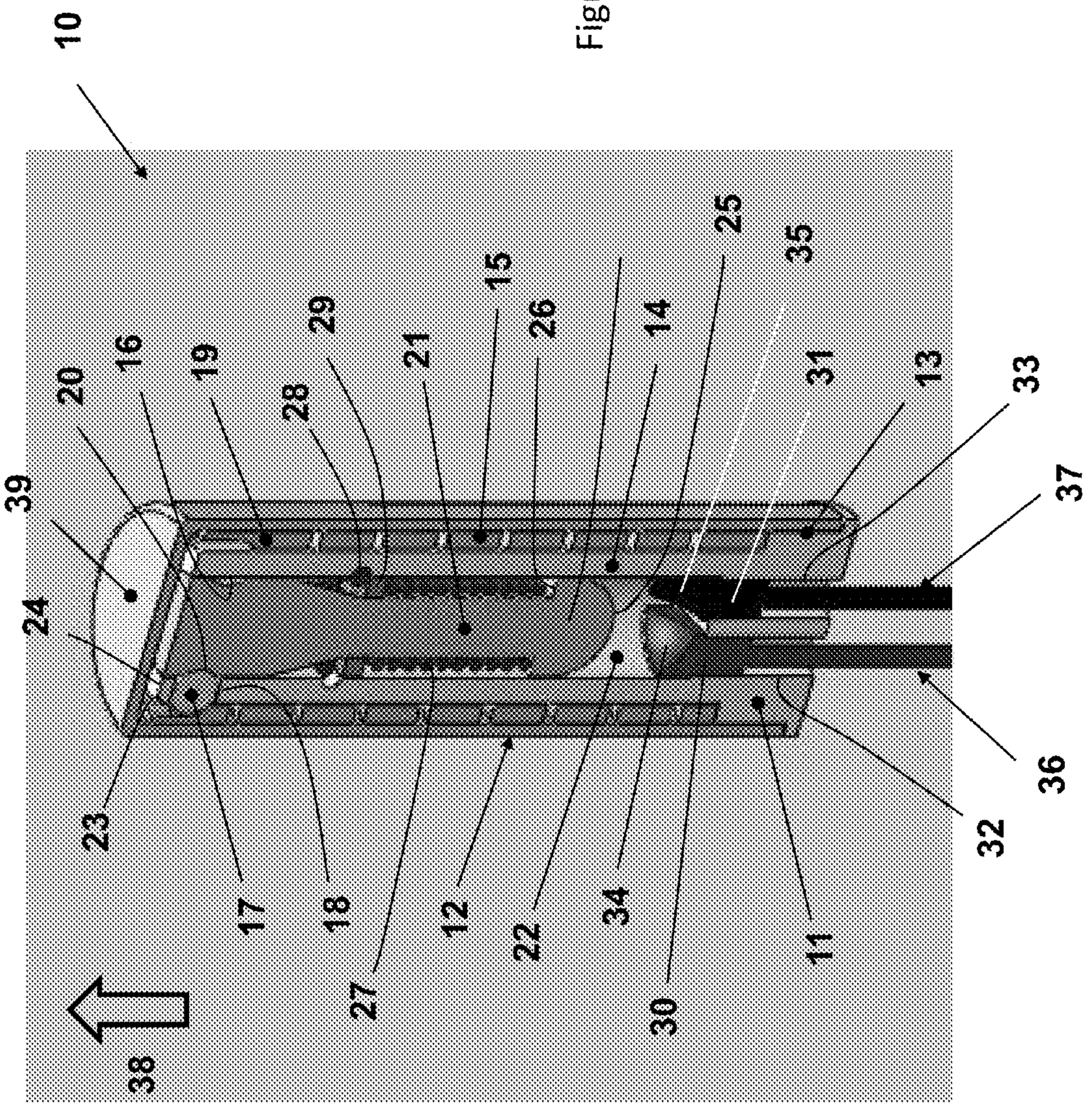


Figure 1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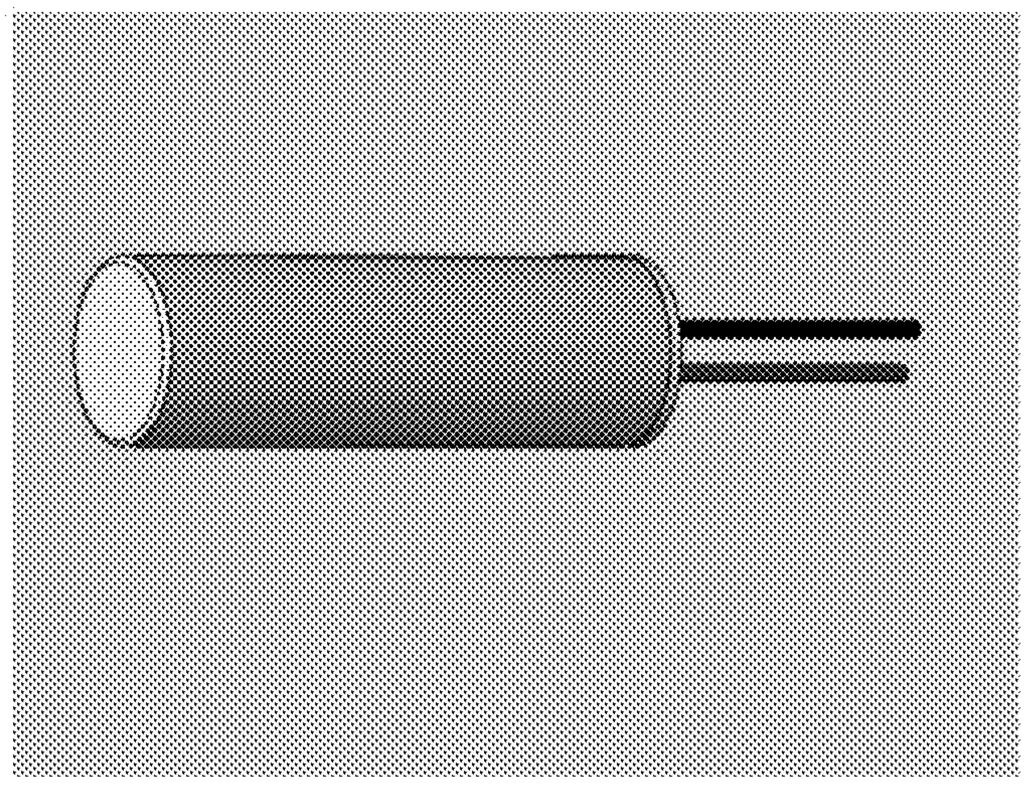

Figure 2

ELECTRICAL SETBACK DETECTION SWITCH

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of earlier filed provisional application No. 62/027,748 filed on Jul. 22, 2014, the entire contents of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present disclosure relates generally to electrical switches, and more particularly, to electrical setback detection switches used in munitions.

[0004] 2. Prior Art

[0005] Electrical setback switches are used, for example, in munitions to close or open an electrical circuit upon detection of an acceleration profile, usually indicated by a nominal peak setback acceleration level and its duration.

[0006] Currently available devices, usually called G-switches, only detect the peak acceleration for switching action without any measure of the peak acceleration duration. In many munitions and other similar applications (such as in machinery), the device may be subjected to high peak acceleration due to accidents such as dropping on a hard surface or impact by other hard objects, which could trigger switching.

SUMMARY OF THE INVENTION

[0007] Accordingly, a switch comprising: a first body, the first body having one or more holes located at a longitudinal position of the first body; a second body movable relative to the first body, the second body having a concavity corresponding to each of the one or more holes; a retaining ball positioned in each of the one or more holes and corresponding concavity for restraining the second body from movement relative to the first body; an elastic element disposed on the body; a mass disposed on the elastic element, the mass moving the elastic element upon an acceleration event acting on the first body; and first and second electrical contacts positioned on the body such that when the acceleration event has a predetermined magnitude and duration, the mass moves past the longitudinal position to permit the retaining ball from releasing from the one or more holes, thereby permitting the second body to move towards the first and second electrical contacts; wherein the second body includes a conductive portion for closing an electrical circuit between the first and second electrical contacts.

[0008] The switch further comprising a casing for enclosing the body.

[0009] The one or more holes can comprise three holes.

[0010] The elastic element can be a helical spring. The mass can be one of a solid portion of the helical spring or a more closely wound portion of the helical spring than other portions of the helical spring.

[0011] The elastic element can be a first elastic element and the switch can further comprise a second elastic element for biasing the second body towards the first and second electrical contacts.

[0012] The conductive portion can have a shape for mating with a shape of the first and second electrical contacts.

[0013] Unlike the prior art switches, the electrical setback switches disclosed herein switch, not only when a prescribed setback acceleration has been reached, but also when the peak acceleration has a certain minimum duration. For example, if the setback acceleration is 1000 Gs for a minimum duration of 5 milliseconds, then the present electrical setback switches will switch and close a circuit when subjected to such a setback acceleration profile (impulse level). However, for example, if the switch is subjected to even 2,000 Gs but for a shorter duration of 0.5 millisecond, then it would not switch.

[0014] Such electrical switches can also be used in any device and machinery which may be subjected to certain shock (relatively high acceleration) loading that lasts at least a prescribed length of time. In many devices and machinery high G shock loading that is very short duration would not cause damage or trigger other unwanted events. But currently available G-switches would trigger even when the shock duration is very short. The disclosed switches overcomes this shortcoming of G-switches and can be designed to switch at a prescribed peak acceleration as well as its duration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] These and other features, aspects, and advantages of the apparatus and methods of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings where:

[0016] FIG. **1** illustrates a cross-sectional view of an embodiment **10** of the electrical setback switch.

[0017] FIG. **2** illustrates an isometric view of the switch of FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] The cross-sectional view of an embodiment **10** of the electrical setback switch of the present invention is shown in FIG. **1** (FIG. **2** shows an isometric view of the switch of FIG. **1** showing an exemplary circular cross section of the switch). The electrical setback switch **10** consists of a main body **11** and a casing **12**, which is fixedly attached to the body around its base **13**, for example welding, soldering or using adhesives or by press fitting or the like, depending on the size, application and the setback acceleration level to be experienced.

[0019] The body **11** of the electrical setback switch **10** is provided with a cylindrical section **14**, over which a machined helical spring **15** is provided. The machined helical spring **15** is preferably fabricated with more than one strand for increased lateral stability. The machined helical spring **15** is provided with a top solid wall section **19** (or more closely wound portion as compared to the remaining portions of the helical spring). Alternatively, the top solid wall section **19** may be replaced with a separate mass. Close to the top of the main body **11** is provided at least one hole **18** and preferably three holes **18** around the diameter of the main body for insertion of balls **17**. The balls **17** are positioned inside the holes **18** and held in place on one side by the inner wall **16** of the upper solid wall section **19** of the machined helical spring **15** and on the other side by the mating dimples **20**, provided in the element **21**, which is constructed to travel easily inside the cylindrical hole **22** inside the main body **11**. As a result, in the configuration shown in FIG. **1**, the element **21** is locked to the cylindrical section **14** of the body **11** by the at least one ball **17**. The inner surface of the top solid wall section **19** of the helical machined spring **15** may be provided with a groove

23 within which the ball 17 can ride, and which runs all the way to the top surface 24 of the helical machined spring 15.

[0020] The element 21 is also provided with a head portion 25, which is provided with a step reduction 26 in the diameter in the mid-section as shown in FIG. 1. A preloaded compressive spring 27 is positioned between the surface of the step 26 and the retaining ring 28 provided inside the cylindrical hole 22 inside the main body 11. A retaining washer 29 may also be provided between the preloaded compressive spring 27 and the retaining ring 28 to better support the spring force.

[0021] Two conductive elements 30 and 31 which are protected inside thin layers of insulating material (not shown) are mounted inside the openings 32 and 33, respectively, provided on the base of the main body 11 as shown in FIG. 1. The two conductive elements 30 and 31 are provided with curved surfaces 34 and 35, respectively, which are preferably spherical surfaces and match the surface 25 of the element 21. On the opposite side, the conductive elements 30 and 31 are connected to the wires 36 and 37, respectively, which are insulated to prevent electrical contact with each other as well as with the main body 11.

[0022] In operation, when the object (platform) to which the electrical setback switch 10 is mounted is accelerated in the direction of the arrow 38, the acceleration would act on the top solid wall section (mass) 19 of the helical machined spring 15, causing it to deflect downwards, i.e., in the opposite direction as the arrow 38. In general, the helical machined spring 15 is preloaded against the inside surface of the top surface 39 of the casing 12 so that until a certain level of acceleration is reached, the top solid wall section 19 of the helical machined spring 15 would not begin to displace downward. However, if the prescribed level of acceleration in the direction of the arrow 38 is reached, then the top solid wall section 19 of the helical machined spring 15 will begin to travel downward. Now if the acceleration level persists for long enough amount of time within the design specifications of the electrical setback switch 10, i.e., if the so-called all fire condition has been reached, then the top solid wall section 19 of the helical machined spring 15 would travel down enough to clear the balls 17 to be pushed out of engagement with the dimples 20 by the forces exerted by the surfaces of the dimples, thereby freeing the element 21 to travel downward. The preloaded compressive spring 27 will then force the surface 25 of the element 21 to come into contact with the conductive surfaces 34 and 35 and be pressed against the conductive surfaces by the biasing spring 27. As a result, the circuit to which the wires 36 and 37 are connected is closed. On the other hand, if the duration of the acceleration in the direction of the arrow 38 is not enough even in the presence of higher peak acceleration level, i.e., under no-fire conditions, the top solid wall section 19 of the helical machined spring 15 will not travel down enough to release the locking balls 17 and thereby the element 21 remains locked to the main body 11 of the electrical setback switch 10.

[0023] It is appreciated by those skilled in the art that the helical machined spring 15 may be machined in any pattern other than helical as long as it provides the desired axial stiffness and equivalent axial inertia to achieve the desired deformation response to the prescribed axial acceleration level.

[0024] While there has been shown and described what is considered to be preferred embodiments of the invention, it will, of course, be understood that various modifications and changes in form or detail could readily be made without departing from the spirit of the invention. It is therefore intended that the invention be not limited to the exact forms described and illustrated, but should be constructed to cover all modifications that may fall within the scope of the appended claims.

What is claimed is:

1. A switch comprising:

a first body, the first body having one or more holes located at a longitudinal position of the first body;

a second body movable relative to the first body, the second body having a concavity corresponding to each of the one or more holes;

a retaining ball positioned in each of the one or more holes and corresponding concavity for restraining the second body from movement relative to the first body;

an elastic element disposed on the body;

a mass disposed on the elastic element, the mass moving the elastic element upon an acceleration event acting on the first body; and

first and second electrical contacts positioned on the body such that when the acceleration event has a predetermined magnitude and duration, the mass moves past the longitudinal position to permit the retaining ball from releasing from the one or more holes, thereby permitting the second body to move towards the first and second electrical contacts;

wherein the second body includes a conductive portion for closing an electrical circuit between the first and second electrical contacts.

2. The switch of claim 1, further comprising a casing for enclosing the body.

3. The switch of claim 1, wherein the one or more holes comprises three holes.

4. The switch of claim 1, wherein the elastic element is a helical spring.

5. The switch of claim 4, wherein the mass is one of a solid portion of the helical spring or a more closely wound portion of the helical spring than other portions of the helical spring.

6. The switch of claim 1, wherein the elastic element is a first elastic element and the switch further comprising a second elastic element for biasing the second body towards the first and second electrical contacts.

7. The switch of claim 1, wherein the conductive portion has a shape for mating with a shape of the first and second electrical contacts.

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