



US 20160025473A1

(19) **United States**

(12) **Patent Application Publication**  
**Rastegar**

(10) **Pub. No.: US 2016/0025473 A1**

(43) **Pub. Date: Jan. 28, 2016**

(54) **ELECTRICAL SETBACK DETECTION SWITCH**

(52) **U.S. Cl.**  
CPC ..... *F42C 15/24* (2013.01)

(71) Applicant: **Jahangir S. Rastegar**, Stony Brook, NY (US)

(57) **ABSTRACT**

(72) Inventor: **Jahangir S. Rastegar**, Stony Brook, NY (US)

(73) Assignee: **OMNITEK PARTNERS LLC**, Ronkonkoma, NY (US)

(21) Appl. No.: **14/752,977**

(22) Filed: **Jun. 28, 2015**

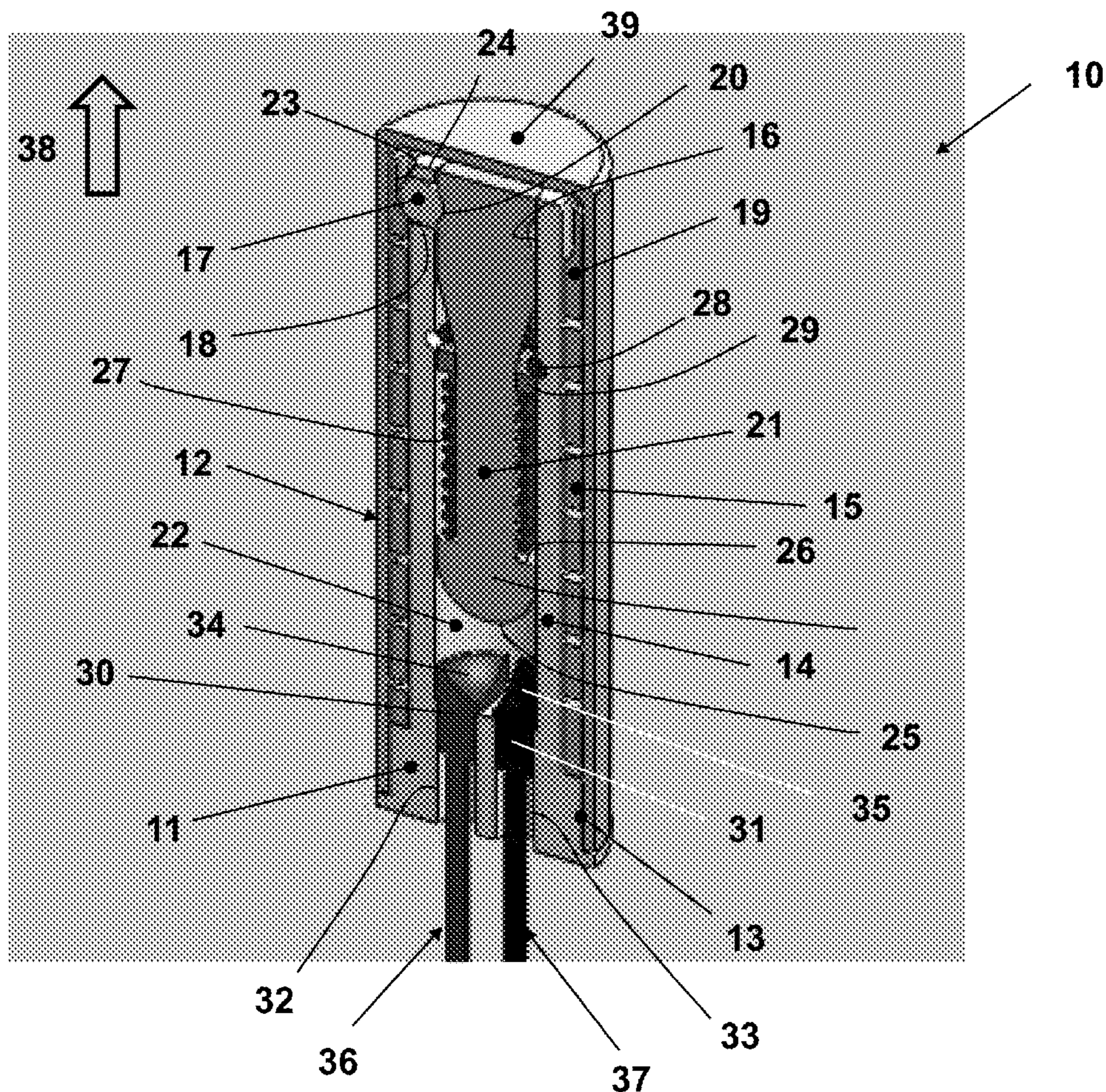
**Related U.S. Application Data**

(60) Provisional application No. 62/027,748, filed on Jul. 22, 2014.

**Publication Classification**

(51) **Int. Cl.**  
*F42C 15/24* (2006.01)

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.



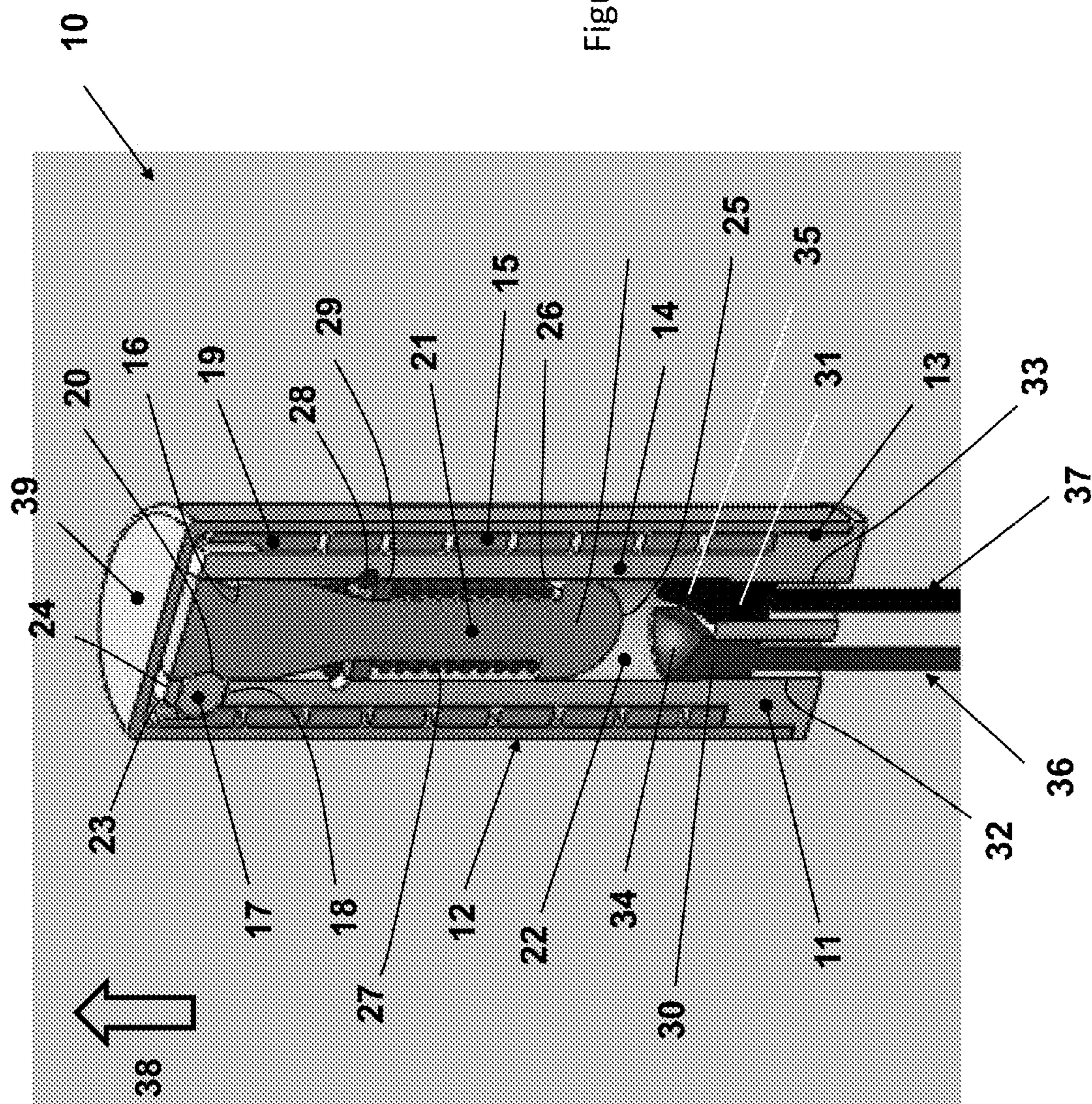


Figure 1

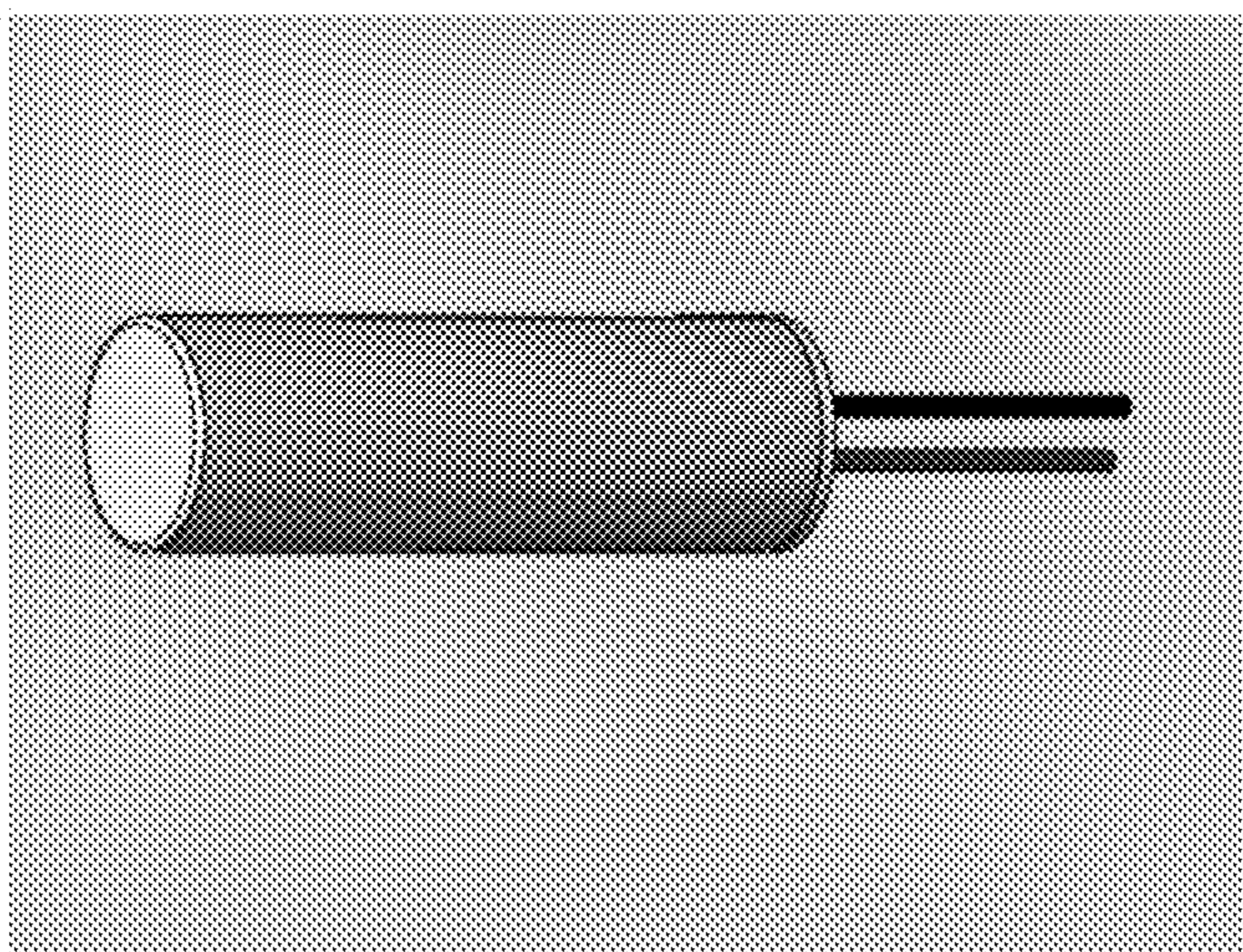


Figure 2

## 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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