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[21] Appl. No. **82,967**
 [22] Filed **Oct. 22, 1970**
 [45] Patented **Dec. 28, 1971**
 [32] Priority **Nov. 27, 1969**
 [33] **Japan**
 [31] **44/095279**

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[54] **BURGLAR ALARM SWITCH**
10 Claims, 5 Drawing Figs.

[52] U.S. Cl..... **310/8.1,**
310/8.4, 310/8.5, 340/276, 340/280
 [51] Int. Cl..... **H01v 7/00**
 [50] Field of Search..... **310/8, 8.1,**
8.3, 8.4, 8.5, 8.6, 8.7; 340/261, 272, 276, 280, 282

ABSTRACT: A burglar alarm switch is mounted on an object to be protected. It comprises a vibration producer for converting any tilting movement of the object into vibrations and a piezoelectric element associated therewith for transducing the vibrations into an electric warning voltage.

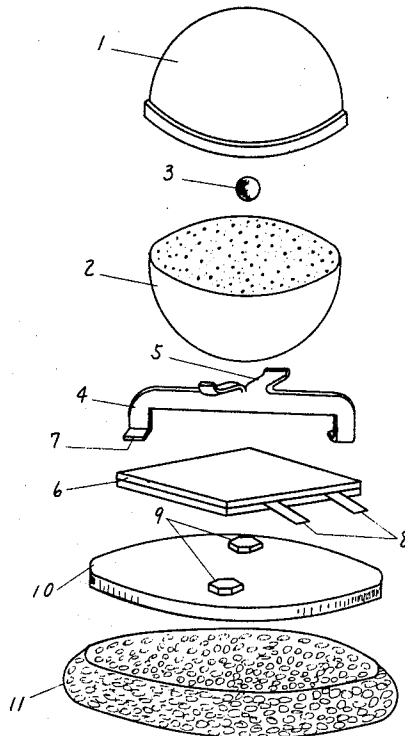
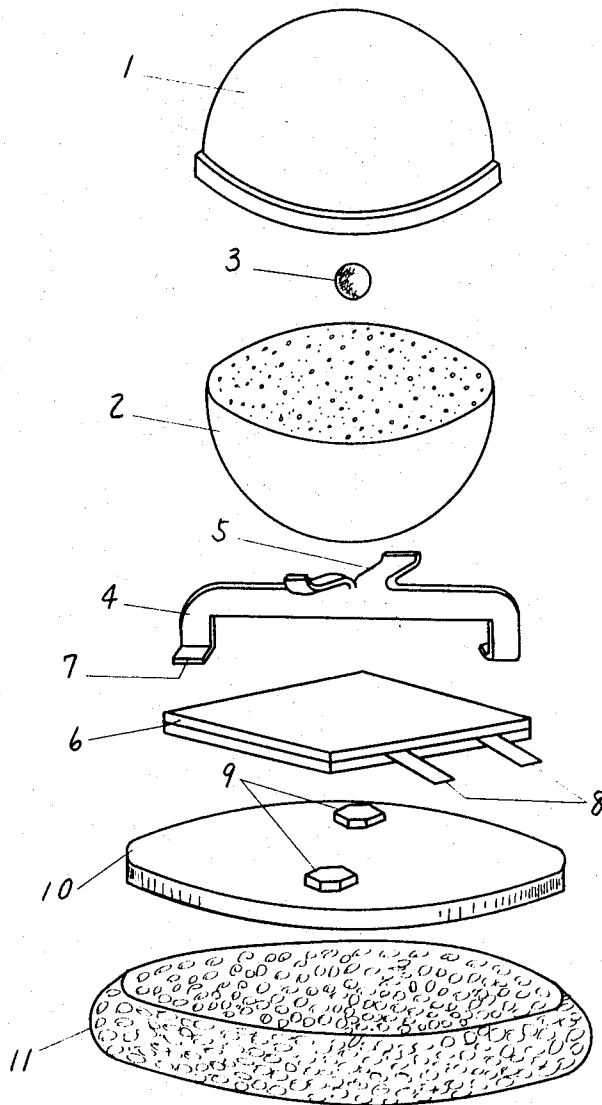


Fig. 1



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Fig. 2

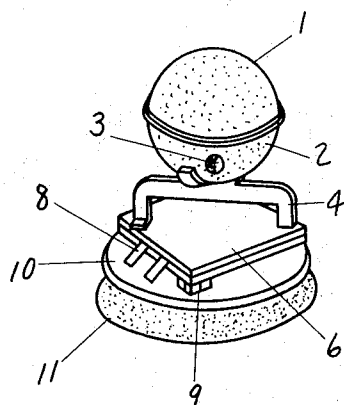


Fig. 3

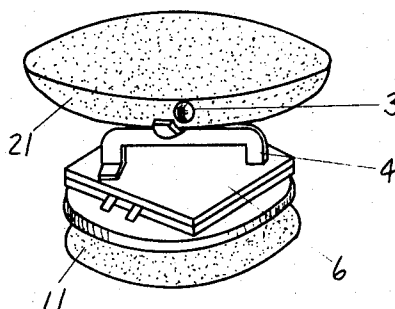


Fig. 4

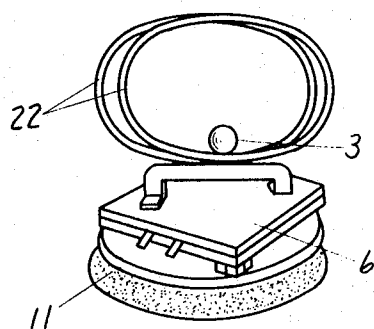
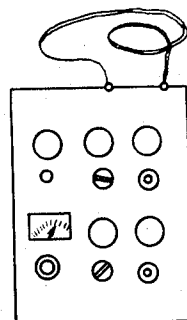


Fig. 5



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BURGLAR ALARM SWITCH

The present invention relates to improvements in burglar alarms, and more particularly to a burglar alarm switch which is placed directly on a valuable object to be protected, such as a work of art.

In accordance with this invention the burglar alarm switch comprises a piezoelectric element having output terminals, a concave race defining a support surface, a ball having a contact surface and being arranged for free-rolling movement on the concave race, either the support surface or the ball contact surface being rough, and means fixedly mounting the concave race on the piezoelectric element.

When the object whereon the switch is placed is tilted during any movement thereof, an angular movement of the race in relation to the ball will occur, causing the contact surface of the ball to move over the support surface of the race so as to produce vibrations due to the roughness of one of the surfaces. The vibrations are transduced by the piezoelectric element to produce an output voltage at the terminals. Means are connected to the terminals for producing an alarm signal in response to the output voltage.

According to one embodiment of the invention, the concave race is a roughened inner face of a hemisphere or a relatively flat, dished member. A mating hemisphere or cover may be positioned thereover.

In another embodiment, the concave race is the inner face of a curvilinear loop and two intersecting loops.

Ready testing of the burglar alarm switch is possible if the ball of ferromagnetic material, in which case a magnetic field may be applied to the switch to move the ball and thus to ascertain that the device is in standby condition.

The means for fixedly mounting the concave race on the piezoelectric element is a mount capable of transmitting the vibrations to the piezoelectric element.

In accordance with a preferred feature of the present invention, the piezoelectric element is fixedly mounted on a vibration absorber to which a baseplate is attached and which, in turn, supports the element, preferably resiliently.

The objects and advantages of this invention, as well as the above and other features thereof, will become more apparent from the following detailed description of certain now preferred embodiments thereof, taken in conjunction with the accompanying drawing wherein

FIG. 1 is an exploded view of a burglar alarm switch according to one embodiment illustrating the principle of the present invention,

FIG. 2 is a perspective view showing the switch of FIG. 1 in assembled condition,

FIGS. 3 and 4 shown other embodiments of the present invention, and

FIG. 5 is a front view of a burglar alarm system in which the present invention is incorporated.

In the drawings like reference numerals designate like parts functioning in a like manner in all figures. In FIG. 1, 1 and 2 are mating, hollow hemispheres of a nonmagnetic material with the inner faces thereof being rough and enclosing a movable ball 3 freely rolling inside the sphere. A press fitting 4 is provided with a mount 5 for fixedly supporting the vibrating hemispheres. The fitting has a base 7 fixed on the surface of a piezoelectric element 6 which has output terminals 8. The piezoelectric element 6 is resiliently supported on a pair of rubber elements 9 provided on the surface of a baseplate 10. A vibration absorber 11 of urethane foam or similar materials is glued to the bottom of the baseplate 10 with a suitable bonding agent, the above-mentioned parts being joined together, as shown in FIG. 2, to constitute a burglar alarm switch operating as follows:

The assembled burglar alarm switch is placed on an object to be protected which is put in a suitable case and remains stationary. If the object is moved, conveyed or vibrated, it will be tilted so that the movable ball inside the hollow hemispheres will roll therein and thus come into contact with the rough inner face of the hollow hemispheres to give rise to a slight impact vibration. This slight vibration will be transmitted to the

piezoelectric element 6 through the press fitting 4, generating electromotive force at the output terminals 8 of element 6. The terminals are connected to a transmitter which is part of a burglar alarm system, together with a modulator, switch and a power source (refer to FIG. 5). Each time the movable ball 3 rolls and impinges on the inner face of the hollow hemispheres, an electromagnetic wave will be radiated from the transmitter. This alarm is received by a receiver located at a position distant from the object to put a burglar alarm light, bell or the like in operation.

The impact between the movable ball and the rough faces, due to any variation of the angle of inclination to the piezoelectric element 6, will be transmitted regardless of the direction in which the object moves, thus ensuring operation under all conditions. It should, of course, be understood that the same action and effect can be obtained by roughening the surface of the movable ball. The impact can be selected by varying the radius of curvature and the roughness of the vibrating hemispheres and/or the movable ball and the mass of the movable ball according to the purpose aimed at.

When a flat rough dish 21 is used in place of the vibrating hemisphere 2 to enlarge the ratio of the radius of curvature of the vibrating hemisphere to the movable ball 3, as shown in FIG. 3, the rolling and movement of the movable ball becomes more sensitive, resulting in providing a burglar alarm switch capable of sensing the slightest variation of an angle of inclination.

When the movable ball 3 is placed on two circular rails instead of mounting in on the vibrating hemisphere 2, as shown in FIG. 4, the sensitivity of the switch to vibration becomes directional. In the embodiment depicted, the switch responds to impact, vibration and displacement in the direction parallel to the plane of the drawing but hardly senses impact, vibration and displacement in the direction perpendicular thereto.

It is possible by selecting the material and thickness of the vibration absorber 11 so as to absorb impact below a certain level to generate an output from the terminals 8 of the piezoelectric element 6 only when it is subjected to impact above a certain energy level, thereby preventing erroneous operations, for instance, when the burglar alarm switch is mounted on an article displayed at an exhibition and the switch is subjected to slight vibration caused by visitors walking nearby.

The piezoelectric element 6 used in this invention is so designed, in respect of its electric characteristics, as to generate high voltage between the terminals thereof only when it is subjected to mechanical impact from outside. Accordingly, economy in power consumption is practiced as compared with prior detecting devices using a photoelectric cell, capacity change detection and the like, in which electric current is kept flowing continuously to maintain the standby condition of the device.

Since the burglar alarm switch provided by this invention comprises a vibrating concave race whereon a small movable ball is capable of rolling in all directions, it is effective regardless of the position or direction in which it is mounted on an object. In case it is subjected to vibration or impact from outside, it will assume a standby condition by itself immediately after the source of the vibration or impact ceases to exist, thereby eliminating the necessity of removing this source and resetting the switch to the next standby position each time the switch functions, as in the case of prior burglar alarm switches.

Another advantage of the burglar alarm switch provided by this invention is that, when the movable ball 3 is made of iron, nickel or other ferromagnetic substances, the movable ball 3 will move on the inner face of the concave race under the influence of a magnetic field as well as the impact due to inclination caused by external force, so that an output is generated from the piezoelectric element 6. Thus, it is possible to inspect and confirm whether the burglar alarm switch provided in this invention is in the standby position for perfect functioning simply by applying a magnet to the race. This method only requires the use of a magnet which will be moved toward the hemispheres 2 of the burglar alarm switch of this invention.

The output terminals 8 of the burglar alarm switch of this invention can be used only by incorporating in a burglar alarm system comprising an oscillator, modulator, switch and power source, as shown in FIG. 5, but also by connecting it to the detecting circuit of various types of equipment with lead wires.

I claim:

1. A burglar alarm switch comprising
 1. a piezoelectric element having output terminal means;
 2. a concave race defining a support surface;
 3. a ball having a contact surface and being arranged for free rolling movement on the concave race,
 - a. at least one of the surfaces being rough;
 4. means fixedly mounting the concave race on the piezoelectric element,
 - b. angular movement of the race in relation to the ball causing the contact surface of the ball to move over the support surface of the race so as to produce vibrations, and said vibrations being transduced by the piezoelectric element to produce an output voltage at the terminal means; and
 5. means connected to the terminal means for producing an alarm signal in response to said output voltage.
2. The burglar alarm switch of claim 1, wherein the concave

race is a roughened inner face of a hemisphere.

3. The burglar alarm switch of claim 2, further comprising a mating hemisphere positioned over the first-mentioned hemisphere.

4. The burglar alarm switch of claim 1, wherein the concave race is a roughened inner face of a relatively flat, dished member.

5. The burglar alarm switch of claim 1, wherein the concave race is the inner face of a curvilinear loop.

6. The burglar alarm switch of claim 1, wherein the ball is of ferromagnetic material.

7. The burglar alarm switch of claim 1, wherein the means fixedly mounting the concave race on the piezoelectric element is a mount capable of transmitting the vibrations to the piezoelectric element.

8. The burglar alarm switch of claim 1, further comprising a vibration absorber, and means for fixedly mounting the piezoelectric element on the vibration absorber.

9. The burglar alarm switch of claim 8, wherein the last-named means comprises a baseplate attached to the vibration absorber and supporting the piezoelectric element.

10. The burglar alarm switch of claim 9, wherein the piezoelectric element is resiliently supported on the baseplate.

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