

[54] **INERTIA-TILT SWITCH**

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1972, Pat. No. 3,763,484.

[52] U.S. Cl. **340/262, 200/61.45**

[51] Int. Cl. **G08b 21/00, H01h 35/02**

[58] Field of Search **340/262; 200/61.45**

[56] **References Cited**

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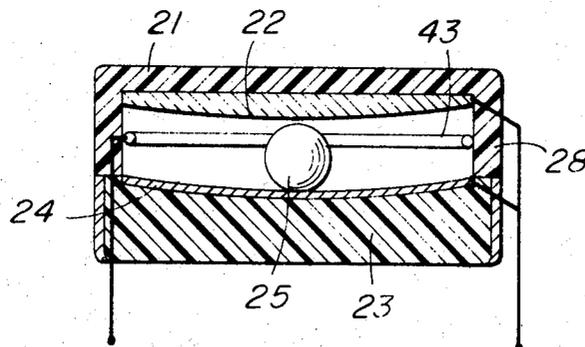
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[57]

ABSTRACT

An inertia and tilt activated switch suitable for use in an alarm system, responsive to small angular and velocity deviations and capable of discriminating against false activation due to sudden jarring, bumping, or the like. A conductive ball rests in a drum-shaped housing, the floor and roof which are diaphragm electrodes. A conductive ring is supported on the wall of the housing between the diaphragm electrodes. The floor electrode is slightly concave, having radius of curvature considerably greater than the diameter of the ball or the diameter of the floor electrode. The concavity allows the ball to roll into simultaneous contact with the ring and at least one of the diaphragm electrodes when the housing is sufficiently disturbed from the resting orientation, thereby completing an electrical circuit. An optional delaying mechanism suppresses output from the system until the circuit has been continuously activated for a predetermined time interval.

6 Claims, 8 Drawing Figures



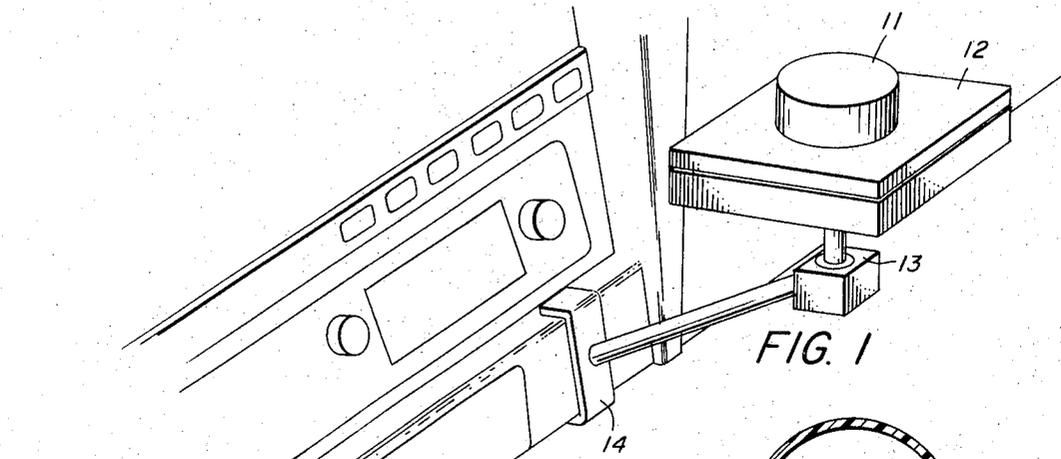


FIG. 1

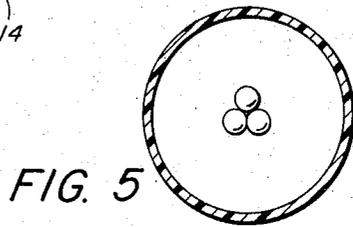


FIG. 5

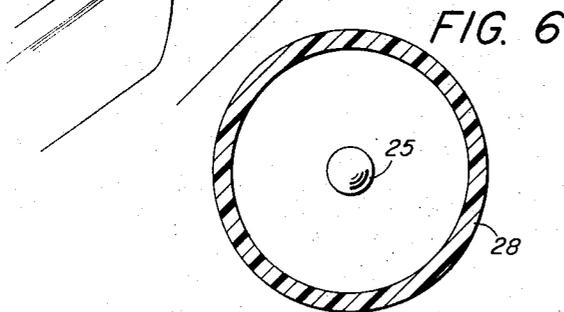


FIG. 6

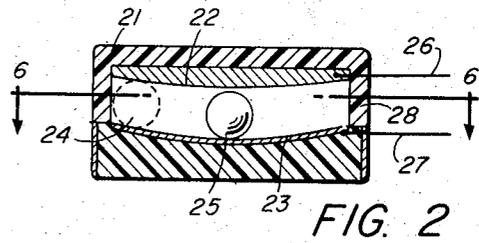


FIG. 2

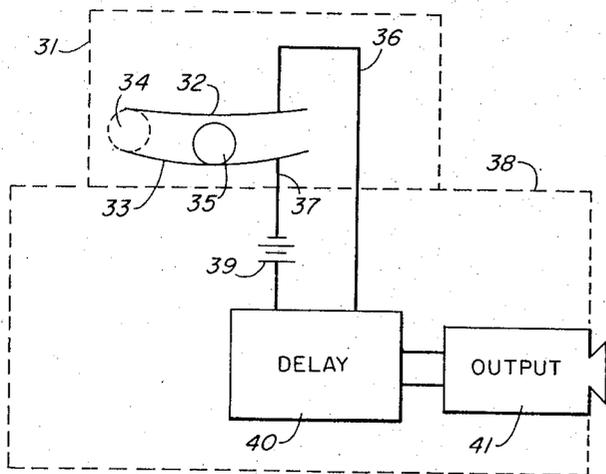


FIG. 3

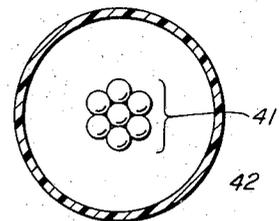


FIG. 4

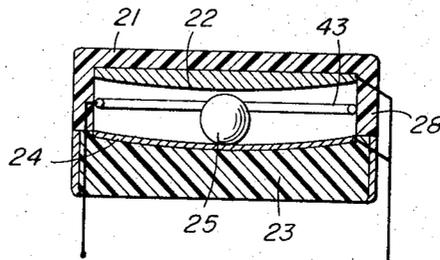


FIG. 7

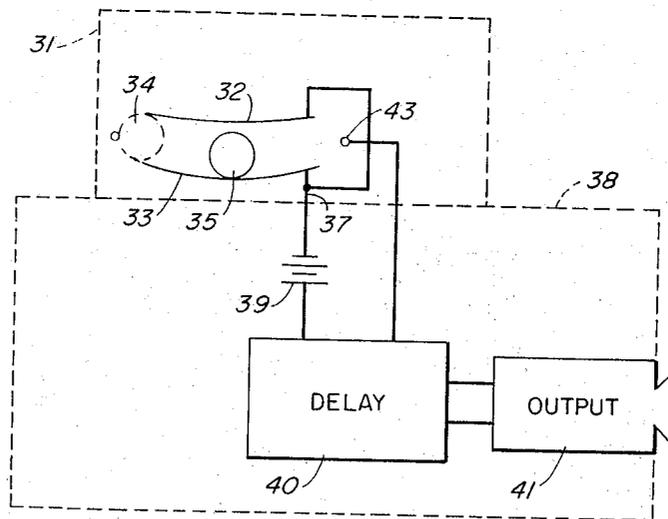


FIG. 8

INERTIA-TILT SWITCH

This is a continuation-in-part of application Ser. No. 203,009, filed Sept. 27, 1972 now U.S. Pat. No. 3,763,484.

BACKGROUND OF THE INVENTION

The present invention relates to an electrical system activated by an inertia-tilt switch and more particularly to an alarm system sensitive to slight deviations in velocity and angular orientation but desensitized to sudden, transient stimuli of the same nature.

Tilt responsive switches and inertia switches (responsive to acceleration and deceleration) generally are known to the art and have been considered useful in monitoring gross deviations from a standard, stable physical condition. For example, precursors of the present invention have been used as ignition cut-off switches for overturned vehicles and as detonation-initiating means in contact sea mines. Some such switches have been employed in tamper-alarm systems where the activity guarded against involves a substantial disturbance of the activating switch or where the normal condition is one of great stability. For example, prior tilt switches may serve to indicate the opening of a hinged lid on a jewelry box.

On the other hand, such switches have heretofore not been considered practicable in alarm systems, stability indicators, or servo-mechanisms required to be sensitive to relatively small disturbances, since the sensitive switch would tend to register "false alarms" caused by innocuous transitory stimuli such as bumping, jarring, etc. An example of such a situation is a theft-alarm system for automobiles in a parking lot or storage area. The switch must be sufficiently responsive to detect unauthorized attempts to push the vehicle, as well as to drive it away, and should also respond to efforts to remove parts from the vehicle or to tamper with the vehicle in various other ways. However, the alarm should not be actuated by a mere casual disturbance of the vehicle, for instance, opening and closing of the doors or hood, or minor shock to the bumpers, tires, or body of the vehicle.

SUMMARY OF THE INVENTION

The present invention provides an inertia-tilt switch which is sensitive to tilting of as little as two degrees, and to correspondingly slight acceleration, while at the same time having the ability to discriminate against stimuli such as transient bumping or jarring.

The switch contains a drum-shaped housing whose floor and roof are conductive electrodes. These are separated by the insulating wall of the housing. Within the housing is a conductive ball freely disposed and able to move under gravitational and inertial influences. The floor electrode is concave, so that when the housing is in an undisturbed horizontal orientation, the ball rests in the center part of the floor, insulated from the roof electrode. The electrodes and the ball are of the proper shape and size that upon tilting the housing a predetermined amount (two degrees in the below-described preferred embodiment) the ball rolls into simultaneous contact with the floor and the roof electrode, thus closing an electrical circuit which activates other parts of the mechanism. The curvature of the floor is quite small relative to the dimension of other components of the apparatus. Thus the switch may be activated by a slight but prolonged disturbance, but

since the ball must travel a relatively great distance from stable to circuit-closing position, a sudden transitory disturbance will not activate the switch. The roof electrode is also slightly curved in the same fashion as the floor electrode, assuring that activation will occur even when the housing is completely inverted.

The switch may also include a delaying apparatus, which suppresses output from the system until there has been continuous activation for a predetermined length of time (approximately $\frac{1}{2}$ second in the preferred embodiment below). This feature further enables the system to avoid responding to short-lived false stimuli which are of sufficient magnitude to activate the switch but which should be screened as unsuitable actuator of the controlled system.

In the preferred embodiment of an automobile theft and tamper alarm system, the switch activates an adjacent radio transmitter. Signals are received by a conveniently-located, near-by apparatus, and an observer is thereby notified of the disturbance of the switch.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 portrays the present invention embodied in an automobile theft and tamper alarm system.

FIG. 2 is a sectional elevation showing the interior of the switch casing.

FIG. 3 is a diagrammatic representation of the systematic organization of the invention.

FIGS. 4 and 5 are views similar to FIG. 6, showing other embodiments of the mechanism.

FIG. 6 is a top section through line 6-6 of FIG. 2.

FIG. 7 is a view, similar to that of FIG. 2, showing a modified embodiment of the invention.

FIG. 8 is a diagram, similar to that of FIG. 3, showing the general circuiting of the modification of FIG. 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows an exterior view of the present invention together with a radio transmitter which incorporates the optional signal delay in the same housing. The entire apparatus is mounted on the dashboard of an automobile by means of a suitable clamping device 14, there to serve as a theft alarm mechanism. The switch 11 is enclosed in an opaque drum-shaped casing, and the workings of the switch are not visible from the outside. The switch is here seated on a radio transmitter 12 although other signaling devices, such as an alarm bell, can be used additionally or interchangeably with the transmitter. The transmitter also houses the delayer which serves the function of suppressing signals from the activated switch for approximately $\frac{1}{2}$ second from the time of activation. The close association between the switch 11 and the transmitter/delayer 12 advantageously allows the wires from the switch to the delaying mechanism to be hidden with the casing of the component making the entire device less susceptible to sabotage. The switch and transmitter are in turn attached to a gimbal mount 13, which facilitates leveling of the apparatus on installation.

As shown in the cross-sectional view of FIG. 2, inside the switch casing 21 is a volume defined by a top diaphragm 22, a bottom diaphragm 23 and the inner wall 28 of the casing. Freely disposed within the volume and able to move under gravitational and inertial influences

is a ball 25. The top diaphragm 22 is convex downward and the bottom diaphragm 23 is concave upward. The diaphragms are disposed in approximately a parallel manner, but the curvature of the bottom diaphragm is somewhat greater than that of the top diaphragm, with the result that the two diaphragms are separated by a lesser distance around their periphery than they are at their centers. The curvature of the diaphragms is quite small in relation to the diameters of the diaphragms and the distance separating the diaphragms. In this respect, FIG. 2 is of necessity rather diagrammatic. In a true embodiment of the invention, the diaphragms appear rather flat upon casual inspection. However, the curvature may be noted by looking at the polished concave surface, for example, and noting that one's reflection is magnified.

In one preferred embodiment of the present invention, the outside casing of the switch is a cylinder of diameter 1 inch and height $\frac{5}{8}$ inch. The ball is of diameter $\frac{3}{16}$ inch. The top and bottom diaphragms are sections of spherical shells, the bottom diaphragm having radius of curvature approximately 6 inches. The perimeter of each diaphragm is a circle of diameter about $\frac{7}{8}$ inch. Thus it is clear that the diaphragm is a relatively small part of a spherical shell, and would appear quite flat. The diaphragms are disposed with the central radii of curvature collinear and normal to the base of the casing, and the diaphragms are separated by a distance of approximately $\frac{1}{4}$ in. between their centers. Thus, when the ball is resting on the bottom diaphragm, with base of the casing horizontally oriented, the ball is stably situated on the center of the bottom diaphragm and is separated from the top diaphragm by a space of about $\frac{1}{16}$ in. However, when the ball rolls toward the periphery of the diaphragms, under the influence of gravitational or inertial stimuli, the ball (24, shown in phantom) eventually makes contact simultaneously with both diaphragms as the space between the diaphragms narrows.

The ball 25 should be quite round, approximating a smooth sphere. It should be sufficiently hard and smooth so that rolling friction between the ball and the floor diaphragm is relatively low. Additionally the ball should be solid, lending substantial inertia which helps to prevent false activation from transitory stimuli.

The surfaces of the diaphragms and the ball are composed of an electrically conducting substance. The inventor has found that gold-plated bronze is particularly suitable, being a good electrical conductor and at the same time highly resistant to corrosion. The wall 28 is an insulator and electrically separates the diaphragms. Thus, when the ball is in simultaneous contact with both diaphragms, an electrical current will be allowed to flow between the diaphragms if there is a voltage differential between the diaphragms. Wires 26 and 27, attached to the top and bottom diaphragms, respectively, electrically connect the ball and diaphragms to other circuit parts.

In the embodiment of FIG. 2, the ball will roll into simultaneous contact with both diaphragms under gravitational influence brought about by an angular deviation of the casing of as little two or three degrees from the horizontal. However, it is to be understood that the scale and curvature of the above embodiment is illustrative and not by way of limitation, and that the above shapes and dimensions may be varied to adapt the invention for particular uses.

An alternative embodiment provides for a plurality of balls in place of a single ball 25. A top view is afforded in FIG. 4, showing seven balls 41 disposed in stable position in the center of the bottom diaphragm 42. In this case, a displacing stimulus would cause simultaneous contact with both diaphragms at a number of loci. In addition, the switch is more sensitive to such stimuli because some balls are closer to the periphery of the diaphragm than is the single ball of FIG. 2. FIG. 5 is a similar view illustrating the rest configuration of a three-ball switch. Note also that three or seven are particularly suitable numbers of balls for use in this circular housing because of the symmetrical "close-packing" arrangement thus possible. However, any number of balls may be employed to achieve various special purposes.

The highly diagrammatic representation of FIG. 3 shows the switch mechanism 31 (described more specifically in connection with FIG. 2) including top and bottom diaphragm/electrodes 32 and 33, respectively, conducting ball 34 in circuit closing and 35 in open-circuit position, and electrical connections 36 and 37 leading to the top and bottom diaphragm/electrodes, respectively. Shell 38 contains the remainder of the electrical components of the system and in the embodiment illustrated in FIG. 1, shell 38 was referred to as the transmitter/delayer mechanism. Possible components are electrical power source 39, a delaying mechanism 40 (optional), and an output mechanism 41, which in the instant embodiment is a radio transmitter, but may equally suitably be an audio- or visual-projector, e.g., alarm bell or light or any suitable communicator. Where a radio transmitter is employed, a receiver (not shown) spaced a distance from the switch and transmitter is also employed. The function of the delayer is to suppress the output for a predetermined time interval immediately after the circuit is closed by the ball moving into circuit-closing position. Thus the output device is activated only after the ball has remained in circuit-closing position for longer than the predetermined time interval. This serves to filter out any transitory, non-significant stimuli which have not already been eliminated by the advantageous design of the switch and which would otherwise result in extraneous output or a "false alarm." The inventor has found that a delay of $\frac{1}{2}$ second serves this purpose well in the car theft alarm system. Of course, a greater or shorter time delay may be provided to serve other particular functions.

It should be understood that although the embodiment herein described of the present invention is of an automobile theft and tamper alarm, the present invention is not limited to such embodiment but may usefully be incorporated in other alarm systems or mechanisms of other types requiring a sensitivity to slight disorientations coupled with the ability to discriminate against transitory disturbance.

While the invention has been described hereinabove with particular reference to a switch in which the motion of a spherical member between two curved diaphragms makes and breaks electrical contact between the two diaphragms, my invention also comprehends a switch having the same construction of sphere and curved diaphragms, but in which the electrical contact to be made and broken is between either diaphragm, on the one hand, and a ring electrode supported between said diaphragms near the peripheries thereof and insu-

lated therefrom, on the other hand. Such a construction is shown in FIGS. 7 and 8. The operation of the switch of FIGS. 7 and 8 is virtually identical to that of FIGS. 2 and 3, since in both cases the switch is closed when the ball 25 is in a peripheral position. In both cases the ball 25 reaches a peripheral position and closes the switch under gravitational influence as a result of either slight tilting or total inversion. The only difference is that in the switch of FIGS. 7 and 8 the contact made by the ball 25 is between either upper diaphragm 22 or lower diaphragm 23, and a ring 43. Said ring 43 may be gold-plated brass wire which is press-fitted or otherwise affixed to the inner surface of the switch casing 21 approximately mid-way between the diaphragms 22, 23: i.e., at a position such that the ball 25 can make contact therewith.

I claim:

1. In an electrically governed system, a gravitationally and inertially activated switch comprising a housing having a bottom conductive diaphragm, concave upward, a top conductive diaphragm, convex downward, each diaphragm having substantially circular perimeter and substantially constant curvature, with the curvature of the bottom diaphragm being greater than that of the top diaphragm, the two diaphragms symmetrically disposed relative to one another such that the distance between them is greatest at the center of the diaphragms and decreases toward the periphery, the diameters of the diaphragms and the distances separating the diaphragms all small relative to the radii of curvature of the diaphragms, a conductive ring having substantially circular perimeter of a diameter substantially the same as that of said diaphragms, The diaphragms electrically connected to one another and electrically separated from said ring by an insulating wall joining the diaphragms along their periphery, said ring being supported on said insulating wall approximately midway between said diaphragms, the diaphragms and the insulating wall thereby defining a volume, a conductive mass freely disposed within the volume,

the mass having physical characteristics such that the mass is in insulated position from the ring when the housing is in undisturbed horizontal orientation but moves into simultaneous contact with said ring and at least one diaphragm when the housing is sufficiently tilted or accelerated.

2. The switch of claim 1 wherein the conductive mass is a conductive ball having diameter smaller than the distance separating the diaphragms near their center but larger than the distance separating the diaphragms near their periphery.

3. The switch of claim 1 wherein the conductive mass comprises a plurality of relatively small conductive balls.

4. The switch of claim 1 further comprising means for suppressing output from the system until the mass has been in simultaneous contact with both diaphragms for an uninterrupted time interval of predetermined length.

5. A theft and tamper alarm system comprising the switch of claim 4 in combination with a radio transmitter activated by the switch, a radio transmission receiver, mounting means for the switch and transmitter including means for permitting the switch to be secured in level, horizontal orientation, means for disposing the switch and transmitter in relation to a desired object such that a disturbance of the object will cause a disturbance of the switch.

6. A switch comprising, at least one conductive sphere and a container, including a pair of opposed conductive diaphragms, enclosing said sphere, said diaphragms being spaced apart at their centers a distance greater than the diameter of said sphere,

said diaphragms being spaced apart at their periphery a distance less than the diameter of said sphere, each of said diaphragms having slight curvature of the same orientation, and conductive ring supported between said diaphragms so as to limit the motion of said conductive sphere to directions substantially parallel to said planes.

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