United States Patent

Held

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[54] **ELECTRICAL SWITCH ACTING WITH THE FORCE OF INERTIA**

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[51] **Int. Cl.**.....**F42b 5/08,** H01h 35/14

[58] **Field of Search**.....200/61.45–61.53; 340/261, 262; 102/70.2 R, 70.2 A, 70.2 GH, 70.2 G, 70.2 P

[56] **References Cited**

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[57] **ABSTRACT**

An inertia switch for the closing of an electrical circuit. Said switch comprises an electrically conductive cup-shaped inertia body supported on and resiliently urged toward an electrically non-conductive support means. Said support means has a recess receiving said inertia body and said recess is provided with angular sides. The inertia mass is surrounded by an electrically conducted casing spaced slightly therefrom. The inertia mass is normally held against the support means and away from contact with said casing but a disturbance thereof either axially or radially will move the support means against such resilient urging either axially or radially to effect contact between said inertia mass and the casing whereby to complete the electrical circuit.

3 Claims, 2 Drawing Figures

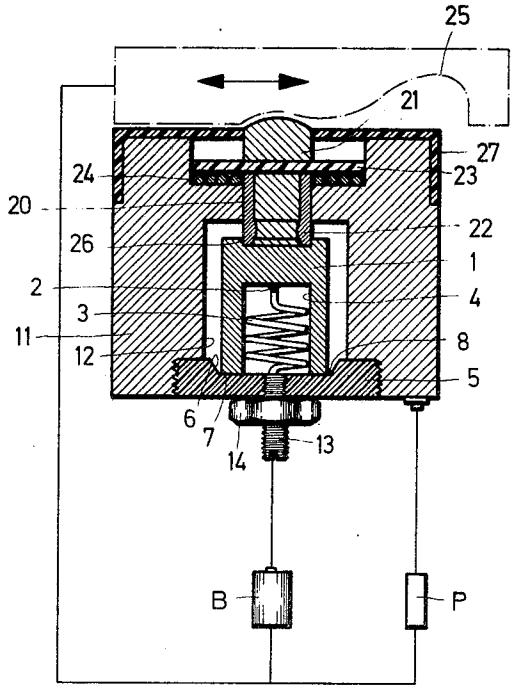


Fig.1

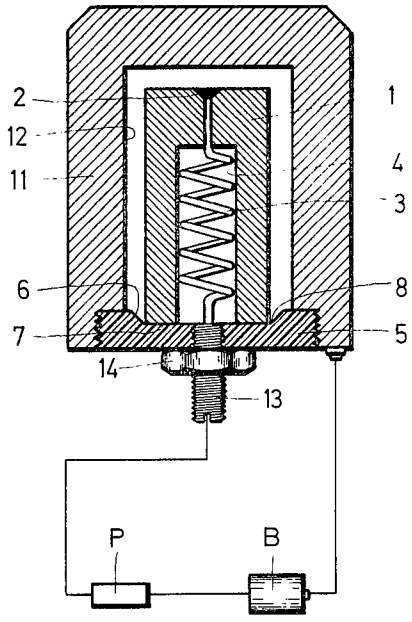
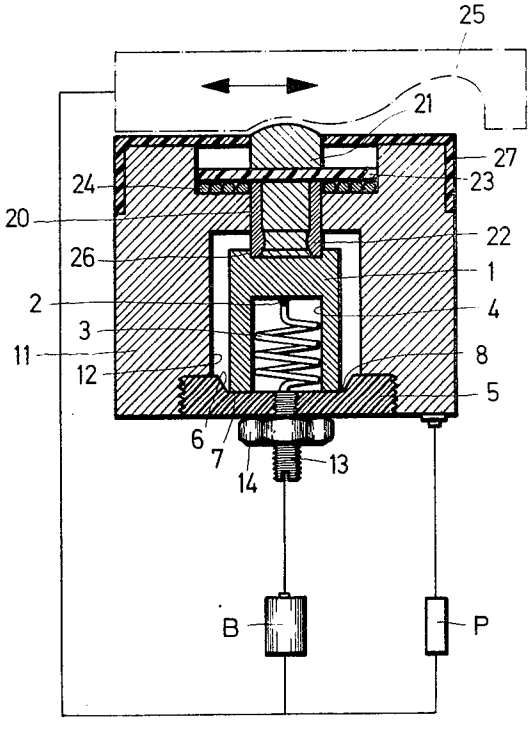


Fig.2



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ELECTRICAL SWITCH ACTING WITH THE FORCE OF INERTIA

This invention refers to a switch for the closing of an electric circuit. Said switch is provided with an inertia mass acting as one switch contact and contained in a switch housing acting as the other switch contact. Further, said switch is held by a coil spring in an electrically insulated rest position from which it may be disengaged in response to a disturbance.

Such switches placed in the heads of explosive projectiles must have a varying degree of sensitivity to contact, due to the varying angles with which the projectile is aimed at the intended target, so that, for example, the electric ignition circuit can be closed even when the projectile hits the target only at a very small angle, such as 15°, in relation to the trajectory of the projectile. In this case the switch has to function properly, even with only a relatively small transverse acceleration.

In German Patent—schrift No. 1,176,029, a switch of the above-mentioned type is shown wherein the inertia mass is a ball which is held in a ring or groove shaped support by means of a helical spring gripping its circumference. The contact sensitivity of the switch in axial direction is determined by the tension of the helical spring, and the contact sensitivity perpendicular thereto in radial direction partially by the tip momentum of the ball, that is, by the ratio of the diameter of the ball to the inner diameter of the support and partially by the spring tension.

In order to keep the ball stable in rest position on the support so that it does not, for example, tip with respect to the support during transportation of the projectile or through possible oscillation of the helical spring, the inner diameter of the support may not be made too small; the above-mentioned ratio of the ball diameter to the inner diameter of the support for this reason cannot be made variable within the limits desired in actual use.

In case the projectile hits the target in such an angle that the force of inertia acts on the ball within an angular zone determined by the cone of tangents of the circle of contact with the support, the ball will not be tipped about any point along this circle of contact, not even when the lateral momentum for the radial contact sensitivity would be sufficient, but instead will be lifted from the support in the direction of the force of inertia. Because the above-mentioned cone may have an open angle of 90° or more, the contact sensitivity, in this angle zone is not determined by the tip momentum, but only by the tension of the helical spring, so that even with an angular trajectory of the projectile hitting the target; the entire spring tension must be overcome by the force of inertia. In unfavorable cases, therefore, it could happen that the ignition circuit will not be closed despite a lateral acceleration which would actually be sufficient to activate the switch.

Besides these deficiencies, it is not advantageous for the helical spring to grip the ball at its circumference, that is, very far from the center of gravity. Small deviations of the helical spring from its axial installation position, which can occur during the installation of the switch if same is not provided with a stop, or which can occur due to vibrations during transport or even through a mask hit, may cause a radial force component on the helical spring, acting on a relatively long

leverage arm and additional to the axial force component, which can considerably change the contact sensitivity of the switch, particularly the radial contact sensitivity.

The objective of this invention, therefore, is to avoid the above-mentioned disadvantages of the known switch, and to create a space saving switch of the above type, which guarantees an exact and variable adjustment of contact sensitivity, particularly of the radial contact sensitivity.

According to the invention, this objective is achieved by giving the inertia mass the shape of a cup within which is placed the helical spring, and the support has a conical indentation with a flat support surface, the diameter of which at that point is equal to that of the inertia mass.

As can easily be seen, a switch constructed according to the invention offers more exact possibilities of varying the contact sensitivity by adjusting the spring tension and the shape of the inertia mass. While the axial contact sensitivity is determined simply by the weight of the inertia mass and the tension of the helical spring, the radial contact sensitivity is determined, in addition to the diameter of the support surface and a portion of the spring tension, primarily by the mass distribution of the inertia mass in the axial direction. The cup shape of the inertia mass offers for this purpose, many possibilities to adjust the radial contact sensitivity and to balance it with the axial contact sensitivity in such a way that all the demands of the contact sensitivity of the switch which arise out of practical use can be completely fulfilled.

In one embodiment of the switch according to the invention, besides the centering effect due to the conical indentation of the support, an exactly centered and perfect fit of the inertia mass in the support is assured and it is impossible for same to be disturbed even by vibrations or frequencies of the helical spring which is attached either at or very near to the center of gravity of the inertia mass. The contact sensitivity, therefore, remains unaffected by the above-mentioned variables even when the inertia mass is improperly installed.

The centering effect of the conical indentation of the support has the additional advantage that an angular hit of a target by a projectile containing this switch will cause the inertia mass to tip exactly about the edge which is the limitation of the support, particularly when the open angle of the conical indentation is made very small, that is, only big enough that in the event of a tipping motion of the inertia mass, the sides of the indentation are touched as well as the switch casing. Thus, the angular area in which the inertia mass can move from its point of support after the projectile hits the target can be kept narrow.

When handling a projectile which is equipped with such a switch within its ignition circuit, for safety reasons it is desirable to have the switch in locked position, that is, at least until the firing of the projectile. In order to avoid a closing of the switch, for example, due to shock effect, while handling the projectile and to prevent ignition of the explosive chamber, the inertia mass is held motionless with the aid of a lock mechanism up to the time of fire preparation. For this purpose, according to a preferred embodiment of the invention, the wall opposite to the support has an open-

ing in which a spring held slug is arranged so that it can be moved and put in a lock position. Means providing a small indentation are so arranged that the slug can grip into it while in the locked position.

In addition to this mechanical safety device, according to an additional embodiment, an electrical safety means is provided, which shorts out the ignition circuit by bypassing the ignition unit, until the mechanical lock is disengaged. This is accomplished by having the electrically conducting slug insulated from the switch casing by means of an electrically non-conducting covering.

All details about the invention are contained in the following description of two working models, as illustrated in the accompanying drawings. These show respectively:

FIG. 1: a cross-section of a switch built according to the invention.

FIG. 2: the switch shown in FIG. 1 with a safety device.

An electrically conductive cup-shaped inertia mass 1, in this case with a cylindrical exterior profile, is held by a helical spring 3 arranged on the inside 4 of the inertia mass 1 and soldered on one of its ends at 2. It is further connected in an electrically conductive manner to an electrically insulated support 5. A conical indentation 6 is cut into the support 5, the flat surface 7 of which supports the inertia mass 1. The diameter of the flat surface 7 which is limited by the edge 8 of the conical indentation is equal to the diameter of the inertia mass 1 at that point, so that the inertia mass 1 is held exactly centered on the support 5. The support 5 is screwed into an electrically conducting switch casing 11, the interior 12 of which has a cylindrical inner opening to receive the inertia mass 1 and which will surround the inertia mass 1 with a slight distance therebetween.

The inertia mass 1, the helical spring 3 and the switch casing 11 are part of an ignition circuit containing an ignition battery B and an ignition capsule P of a projectile (not illustrated) which will be closed as soon as the inertia mass 1 is lifted from the support 5 in response to a disturbance and touches the switch casing 11.

The contact sensitivity of the switch is adjusted by selecting the tension of the helical spring 3 so that under normal conditions, that is, during transportation, during the firing and flight of the projectile, the inertia mass does not move from the support 5, thus does not close the ignition circuit B, P, 11, 1, 3. For fine adjustment of the spring tension, the length of the helical spring can be altered by placing a threaded pin 13 into the support 5 to the other end of which the helical spring is attached. After the fine adjustment of the spring tension, the threaded pin 13 is held secure by a nut 14 to guard against change in adjustment.

When the projectile containing the switch hits a target, during a direct frontal hit, the restraining force of the helical spring tension which holds the inertia mass 1 on its support 5, is overcome, so that the inertia mass flies forward and touches the switch casing 11, whereby the ignition circuit B, P, 11, 1, 3 is closed and the ignition capsule P explodes.

In any hit of a target of the projectile, other than a direct frontal hit, the conical indentation 6 (for purpose of illustration, shown somewhat larger than actually intended) will prevent the inertia mass from lifting off the support 5 in the direction of impact; it will instead, because of the centering effect of the indentation tip about a point along the edge 8 and will thus also touch the switch casing 11.

In order to secure the switch by electrical and mechanical means, a movable slug 21 is placed in a bore 20 in the wall of the switch casing 11 (see FIG. 2) directly opposite the support 5. The electrically conductive slug 21 is covered with an insulation layer 22 to insulate it from the switch casing and carries an insulated plate 23 below which is a conical spring 24 supported by the switch casing. A plate slide 25, schematically indicated in FIG. 2, presses the slug 21 into a cylindrical indentation 26 of the inertia mass 1, by overcoming the tension of the conical spring 24 and holds it in position in the manner as illustrated in FIG. 2. When the plate slide 25 is moved out of the safety position, the conical spring 24 moves the slug 21 upwardly through an electrically insulated cover plate 27 of the switch casing 11, so that the inertia mass 1 is now unrestrained. While in safety position, the firing circuit is shorted out by way of the electrically conducting plate slide 25, the slug 21, the inertia mass 1, the helical spring 3 and the ignition battery B. This short is overcome as soon as the mechanical safety device is disengaged.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an acceleration sensitive device having a hollow electrically conductive switch casing, an electrically insulated support member defining a base for said switch casing, a generally cup-shaped inertia mass arranged coaxially in said switch casing, said mass having an open end normally resting upon said insulated base, a tension spring enclosed within said mass and having one end connected to said insulated base and the other end connected to the closed end of said mass remote from said insulated base, the improvement comprising:

means defining an opening in the wall of said switch casing at a location axially aligned with and remote from said insulated base;

an electrically conductive slug slidably received in said opening and releasably mechanically and electrically connected to said mass to restrain said mass;

electrical insulation means for electrically insulating said slug from said switch casing; and

releasable holder means for releasably holding said slug in mechanical and electrical connection with said mass to restrain the movement of said mass, a release of said holder means effecting a release of said mechanical and electrical connection between said slug and said mass to thereby free said mass from restrainment.

2. A device according to claim 1, wherein said tension spring, said mass, said slug and said holder means define an electrical series connection; and

including first contact means defining electrical connections on said spring means and said holder means; and

including second contact means defining an electrical connection on said switch casing.

3. A device according to claim 2 including a source of electrical power connected between said first contact means and including an ignition capsule connected between said second contact means and said source of electrical power whereby said series connection defines a short circuit across said source of electrical power to thereby prevent an inadvertent energization of said ignition capsule until the mechanical connection between said slug and said mass is released.

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