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Takada, deceased

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[54] **PENDULUM TYPE INERTIA SWITCH**

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[52] **U.S. Cl.** **200/61.48;** 200/61.52

[51] **Int. Cl.** **H01h 35/14**

[58] **Field of Search** ..... 200/61.45 R, 61.48, 61.52

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[57] **ABSTRACT**

A compact pendulum type acceleration and inclination responsive switch includes a vertical cylindrical housing having a medial horizontal partition with a central opening and an upwardly directed short cylindrical wall surrounding the opening and terminating in a beveled top edge. A pendulum is concentric with the partition opening and terminates at its top in a cap member resting in the cylindrical wall with its skirt wall surrounding and spaced from the cylindrical wall, the cap being provided with an upwardly directed central actuating projection. A double throw micro-switch is mounted on the housing top wall and includes a spring switch arm registering with the actuating projection, so that the pivotal movement of the pendulum cap about the cylindrical wall as a multiple fulcrum attendent to a predetermined acceleration or inclination actuates the switch arm.

6 Claims, 3 Drawing Figures

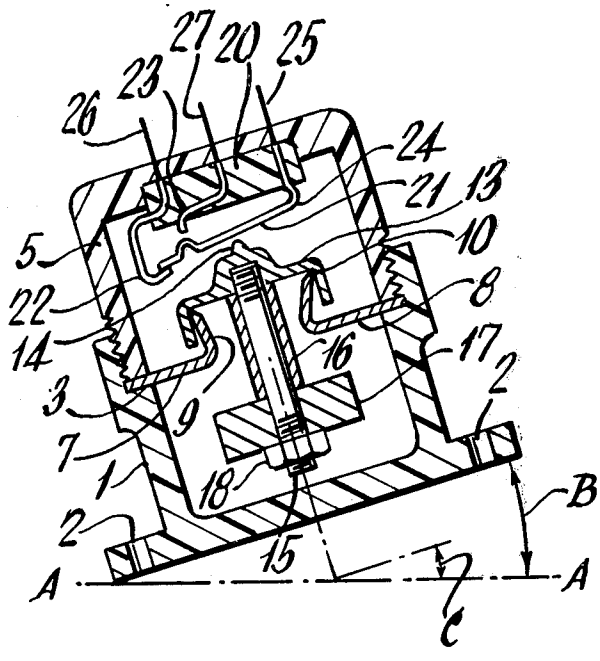


Fig.1.

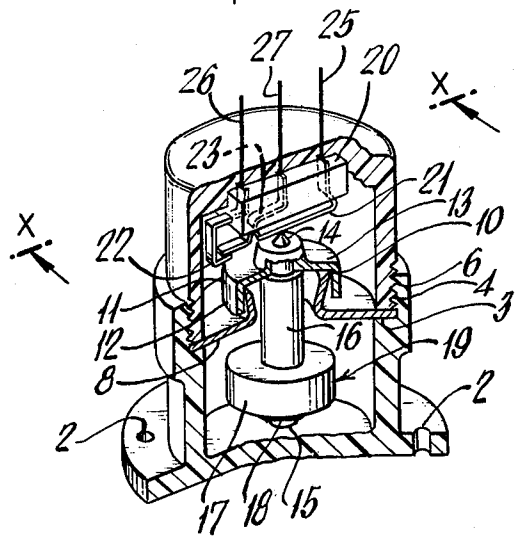


Fig.2.

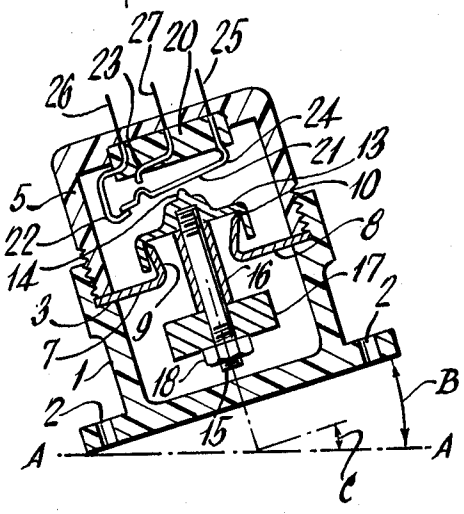
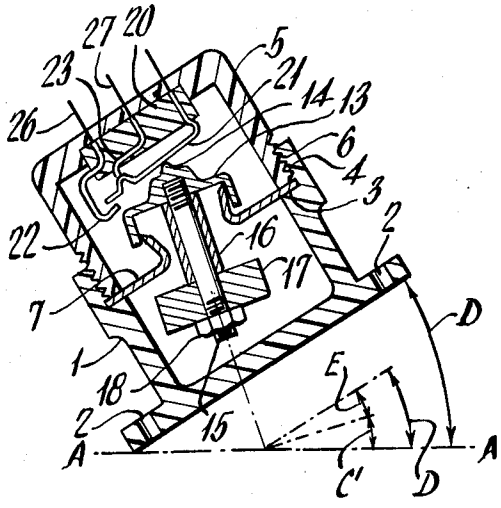


Fig.3.



PENDULUM TYPE INERTIA SWITCH

BACKGROUND OF THE INVENTION

The present invention relates generally to improvements in acceleration sensing devices and it relates more particularly to an improved acceleration and inclination responding switch of the type employing a pendulum sensing member and which is highly useful in controlling the energization of the reel braking or locking solenoid of a vehicle safety belt retracting reel by opening or closing the solenoid energization circuit, so that the reel which normally permits belt withdrawal against the reel spring biased retraction rotation is locked against such withdrawal in the presence of a predetermined positive or negative acceleration or an inclination in excess of a predetermined angle.

In the conventional pendulum type sensors, if the sensor is set to detect a tilting of the vehicle when its static inclination has reached 30°, the sensor does not operateunless the pendulum is inclined from zero to **30** degrees, so that it was necessary to provide the sensor device with ample inner spatial capacity to permit sufficient pendulum swing. Any attempt to miniaturize the device to any significant extent was subject to the restrictive requirements of the material standards and other factors such as arm length, weight configuration, etc., and hence it was practically impossible to produce a sensor with sufficient compactness. Therefore, it was generally difficult to incorporate the sensor in a box housing the associated electrical networks such as the delay circuit advantageously employed and other associated mechanisms. Also, the space for separately installing the sensor to the vehicle structure, for instance, the vehicle floor or seat, is very limited. Thus, the problem of installation space has been most serious in the use of the conventional sensors when employed in the braking control of safety belt retraction reels.

SUMMARY OF THE INVENTION

It is a principal object of the present invention to provide an improved acceleration sensing device.

Another object of the present invention is to provide an improved acceleration and inclination sensing device of the pendulum type.

Still another object of the present invention is to provide a highly compact acceleration and inclination sensing device of the pendulum type which actuates a switch and is highly suitable for use in the control circuit of the reel locking or braking mechanism of a vehicle safety belt retraction reel to thereby lock the reel against belt retraction in the event of a collision or any other high positive or negative acceleration or high vehicle inclining occurrence.

A further object of the present invention is to provide a device of the above nature characterized by its compactness, high reliability, great precision in operation, ruggedness, simplicity and great versatility and adaptability.

The above and other objects of the present invention will become apparent from a reading of the following description taken in conjunction with the accompanying drawings which illustrate a preferred embodiment thereof.

In attaining the above objects, the present invention provides a device which includes an improved pendulum type acceleration sensor which, owing to the provision of a pendulum fulcrum range expanding member,

is capable of precisely sensing the inclination or tilt of a vehicle with a small angle of inclination of the pendulum, that is, when for example, the vehicle assumes a static slant to cause a 30° inclination of the vehicle floor, such inclination is positively sensed with only about a 10° tilt of the pendulum against the sensor casing. This can be accomplished by a very simple mechanism so that the casing in which the sensor is housed can be appreciably reduced in size, and hence it can be conveniently disposed in a box containing the associated electrical components. Also, the sensor can be easily integrated with the assembly of electrical components for easy and convenient installation to, for instance, the vehicle floor. Further, a reel brake actuating solenoid can be adapted for either closed circuit or open circuit arrangement merely by use of a microswitch activated by the sensor.

Accordingly, the present invention, in a sense, contemplates the provision of an inertia switch device comprising a support structure, at least one pair of horizontally spaced fulcrum sections mounted to the support structure, a pendulum disposed between and depending below the level of the fulcrum sections and including proximate its top a transversely extending cross member resting on and alternatively pivotal about the fulcrum sections while disengaging a respectively opposite fulcrum section and a switch mounted to the supported structure and actuated by the swinging of the pendulum about a fulcrum section.

Advantageously, the structure is in the form of a cylindrical casing including a medial partition having a central opening surrounded by a low fulcrum defining cylindrical wall having a top beveled edge. The pendulum cross member is in the form of a cap which rests on the fulcrum wall and has a depending skirt wall coaxial with the fulcrum wall. A double throw microswitch is mounted on the casing top wall and a central projection on the cap engages and actuates the switch arm with the swinging of the pendulum about a point on the fulcrum wall.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view, partially fragmented and in section, of a sensor switch embodying the present invention;

FIG. **2** is a sectional view taken along line X—X in FIG. **1** showing the sensor in a statically inclined position with the sensing pendulum in its non-actuated equilibrium position; and

FIG. **3** is a view similar to FIG. **2** with the sensor inclined past the pendulum equilibrium position and the sensor advanced to its switch actuating position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings which illustrate a preferred embodiment of the present invention, the improved sensor switch unit is housed in and secured in a vertical position to the base of an electric components housing box (not shown) either by screws passed through screw holes **2** formed in the bottom flange of the sensor cylindrical lower casing section **1** or by other means such as by bonding or welding. The components box is fastened, such as by bolting, to the vehicle floor or to other suitable parts of the vehicle, such that the bottom plane of the box will normally lie horizontally with the vehicle being horizontal. The lower casing sec-

tion 1, which may be a resin molding, has provided therein an annular middle shoulder 3 which is parallel to the bottom face of the casing and on which rests a fulcrum carrier 7 secured in position by a screw coupled upper casing section 5. The fulcrum carrier 7 may be made of metal or hard resin and consists of a partition defining annular flange portion 8 and a fulcrum defining upwardly directed coaxial cylindrical portion 9 provided with a beveled upper edge which serves as the fulcrum edge of receiving point 10. It is annular in general configuration and arranged horizontal relative to the lower casing 1. The cylindrical portion 9 is slightly inwardly, downwardly tapered to facilitate the swinging movement of the fulcrum range expanding member 11 when the pendulum 19 has swung to its maximum angle.

The sensing pendulum 19 has the following construction. A fulcrum range expanding member 11 located atop pendulum 19 is formed of a metal or a hard resin molding and is of cap-like general configuration and consists of a cylindrical portion or skirt wall 12, a flange or circular top wall portion 13 and an end upwardly directed projection of protuberance 14, the lower inside face of flange portion 13 resting on the beveled edge 10 of fulcrum carrier 7. Coaxially formed in the underside of fulcrum range expanding member 11 is a threaded bore into which a long screw 15 is screwed or molded simultaneous with the member 11, and a long collar or sleeve 16 engages the long screw 15, the collar 16 being secured to the member 11 by means of a screw provided inside a pendulum weight 17 which, in turn, is secured to the screw 15 by a nut 18 underlying the weight 17. The final centroid position of the pendulum 19 is determined by the length of the long collar 16. In the upper interior of the upper casing section 5 is embedded and bonded or integrally molded a microswitch 20 which includes a transferrable contact piece or arm 21 and is also provided with a normally engaged contact 22 adapted to provide a closed circuit during the unactuated condition or normal operation of the sensor and a sensing normal open disengaged contact 23 designed to provide a closed circuit in an abnormal situation or sensor actuated condition. Conductors 25, 26, 27 connected to said respective contacts extend out from the upper casing section 5 and are connected to an electrical component, such as delay circuit, in the electric component housing box (not shown) and then further connected to a solenoid or the like in safety belt equipment in any desired manner. The underside of the contact piece 21 presents and encompasses a wider planar face than the area through which the protuberance 14 of the fulcrum range expanding member 11 travels with the inclination of the pendulum 19 in any direction. The contact piece or arm 21 normally remains in engagement with the contact 22 under the spring force of the bent portion 24 at the elbow inner end of arm 21 but engages the sensing contact 23 and disengages contact 22 when the pendulum 19 swings to its actuating position. The upper part of the lower casing section 1 is provided an internal thread 4 which is engaged by the corresponding external thread 6 provided at the lower part of the upper casing section 5 thereby to securely fix the flange portion 13 of the fulcrum carrier 7 and to also correctly determine the space between the contact piece 21 and protuberance 14.

In the operation of the sensor device described above, when the sensor device assumes a static inclination of angle B relative to the horizontal A-A, as shown in FIG. 2, the fulcrum edge or receiving point 10 of the fulcrum carrier 7 and the pendulum 19 supported with the wall or flange 13 of the fulcrum range expanding member 11 acting as a lever, are kept in their deactuated or balanced state so that the member 13 does not alter its position relative to the fulcrum carrier until the static inclination reaches the angle B, owing to the pendulum centroid position and other factors. The angle C made by the pendulum 19 with the horizontal is equal to the angle of static inclination B. When the static inclination is further increased to the angle D, as shown in FIG. 3, the angle made by the pendulum 19 with the horizontal A—A remains substantially the same until the inclination reaches a halfway angle C', that is, the angle of inclination B or C in FIG. 2. Therefore, in the case of inclination D, the angle of inclination E of the pendulum 19 relative to the sensor device is obviously less than the angle D through which the device assumes at a static inclination relative to the horizontal A—A. ($\angle E = \angle D - \angle C'$). This slight inclination of the pendulum effects the inclination of the fulcrum range expanding member 11 to raise the contact piece 21 into contact with the sensitive contact 23, thereby forming a closed circuit to the safety belt reel braking solenoid in the event of an occurrence of a collision or other abnormal situation of the vehicle. The above described action initiated by the static inclination is proportional to the action induced by the acceleration applied to the weight 17 of the pendulum 19, and hence the present sensor device is responsive to both the static inclination and the acceleration of the vehicle.

The present sensor device possesses, among others, the following advantages. Owing to the use of a unitary fulcrum range expanding member, inclination of the vehicle can be sensitively and correctly sensed even if the angle of oscillation of the pendulum is small, so that the sensor can be miniaturized to such an extent as has been heretofore considered quite impossible with the conventional pendulum type sensors. Such miniaturized sensor can be easily installed in a small electric components housing box and hence can be provided as an integral unit with the electrical network. Further, the present device can be adapted either in a normally closed circuit or in a normally open circuit within the sensor unit.

While there has been described and illustrated a preferred embodiment of the present invention, it is apparent that numerous alterations, omissions and additions may be made without departing from the spirit thereof.

I claim:

1. In the electrical control of the locking of a safety belt take-up reel against belt withdrawal, an inertia switch device comprising a support structure, an upwardly directed circular fulcrum wall mounted to said support structure and delineating a circular opening, the upper edge of said circular wall being beveled, a pendulum member including a circular section resting on said upper edge of said circular wall and a depending section extending coaxially from said circular section through said opening, and a switch mounted on said support structure and including an actuating member movable from a deactuated to an actuated position in response to the pivotal movement of said pendulum member including said circular section about said top

edge of said circular wall, the locking of said reel responding to the actuation of said switch.

2. The inertia switch device of claim **1** wherein said pendulum circular section comprises a peripheral skirt wall depending from said support member and coaxially surrounding and radially spaced from said circular wall.

3. The inertia switch device of claim **1** wherein said support structure includes a housing and comprising a horizontal partition located in said housing between the top and bottom thereof, and having formed therewith said central circular opening and upwardly directed circular wall, said switch being mounted to said housing above said partition and an actuating element mounted atop said pendulum and swingable therewith into actuating engagement with said switch actuating member.

4. The inertia switch device of claim **3** wherein said switch comprises first and second stationary contact elements and a resilient switch arm normally engaging one of said first contact elements and transferrable into engagement with said second contact element, said arm and contact elements being insulated from each other and said actuating element being movable into actuatable engagement with said switch arm.

5. The inertia switch device of claim **1** including a skirt wall depending from said circular section and surrounding the upper border of said circular wall.

6. The inertia switch device of claim **5** wherein said circular wall flares upwardly and outwardly and terminates in said beveled edge which engages the peripheral inside corner between said circular section and said skirt wall.

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