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Suzuki

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[54] **ACCELERATION RESPONSIVE SWITCH WITH MAGNETIC ACTUATOR MEANS**

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[51] **Int. Cl.** **H01h 35/14,** H01h 36/00

[58] **Field of Search** .....200/61.45–61.53, 81.9 M; 335/205

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[57] **ABSTRACT**

An acceleration responsive switching device which comprises a substantially generally cylindrical casing having formed a limited space over its upper peripheral surface and a substantially vertical bore with its one end open extending at a slight distance from a central portion of the limited space, acceleration sensing means accommodated in the limited space, a switch actuating means accommodated in the vertical bore and a switch element provided downwardly of the open end of the vertical bore. The acceleration sensing and switch actuating means are composed of a permanent magnet and a magnet substance, respectively, and vice versa. With this arrangement, the acceleration responsive switching device is actuated by an acceleration exceeding a predetermined level encountered in such moving vehicle as an automobile.

5 Claims, 2 Drawing Figures

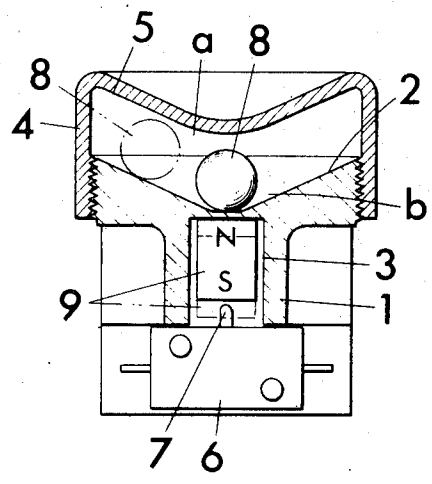


FIG. 1

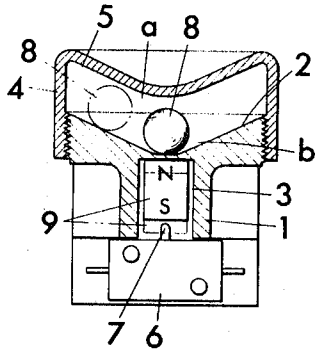
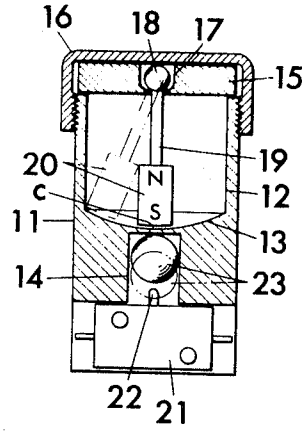


FIG. 2



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ACCELERATION RESPONSIVE SWITCH WITH MAGNETIC ACTUATOR MEANS

This invention generally relates to a switching device and, more particularly, to an acceleration responsive switching device which is adapted to be actuated in response to an acceleration exceeding a predetermined level encountered in accordance with a driving condition of a moving vehicle such as an automobile.

It is an object of the present invention to provide an improved acceleration responsive switching device for use in a moving vehicle such as an automobile.

Another object of the present invention is to provide an acceleration responsive switching device which is operable notwithstanding shocks and impacts and, particularly, vibrations which are all apt to be applied continuously thereto while driving.

The acceleration responsive switching device to achieve these object is basically made up of a substantially generally cylindrical casing having formed a limited space over its upper peripheral surface and a substantially vertical bore with its one end open extending at a slight distance from a central portion of the limited space, acceleration sensing means accommodated in the limitted space, a switch actuating means accommodated in the vertical bore and a switch element provided downwardly of the open end of the vertical bore. It is an important factor here in the present invention that the acceleration sensing and switch actuating means are composed of a permanent magnet and a magnet substance, respectively, and vice versa and, under an inoperative condition of the device, juxtaposed with each other with a relatively thin partition interposed therebetween.

These and other objects and advantages of the present invention will be more clearly appreciated from the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a vertical sectional view showing a preferred example of the acceleration responsive switching device embodying the present invention; and

FIG. 2 is a vertical section of another preferred example of the device according to the present invention.

Referring to FIG. 1, there is shown a preferred example of the acceleration responsive switching device according to the present invention, which device comprises a substantially generally cylindrical casing designated by reference numeral 1. The casing has formed its upper peripheral surface a reverse conical end wall 2 having a lowest or central portion *b*. The reverse conical end wall 2 of the casing 1 defines thereupon a chamber *a* in combination with a cap member 4 which is preferably threadedly fitted to the casing 1, as is shown in the drawing. An inner peripheral wall 5 of the cap member 4 is so configurated as to be equidistantly spaced from the vis-a-vis end wall 2 throughout the total area, viz a conical shape corresponding to the shape of the end wall 2. The casing 1 has further formed therein a substantially vertical bore 3 with its lower end (not numbered) open and extending at a slight distance from the central portion *b* of the end wall 2, thus defining a relatively thin partition.

Designated by reference numeral 6 is a switch element or a microswitch disposed in a manner to close the open end of the vertical bore 3. The microswitch 6 has self-returning push button 7 which is normally

forced outwardly by a spring force, the push button 7 facing the vertical bore 3.

An acceleration sensing means or a weight ball 8 made of steel is snugly accommodated in the central portion *b* of the reverse conical end wall 2 due to its gravitation under normal condition; that is, when the acceleration applied is maintained within the predetermined level in magnitude. The weight ball 8 is capable of moving substantially in all directions throughout the surface of the end wall 2.

It is to be noted here that the weight ball 8 is generally prevented from a vertical movement away from the reverse conical end wall 2 because of the conical configuration of the inner peripheral wall 5 of the cap member 4.

A switch actuating means adapted to actuate the microswitch 6 is composed of a permanent magnet 9 having magnet poles at upper and lower ends thereof. This permanent magnet 9 is accommodated in the vertical bore 3 so as to be juxtaposed with the weight ball normally stationed at the central portion *b* of the end wall 2.

With this arrangement, while an acceleration is maintained within a predetermined level in magnitude, the weight ball 8 in the chamber *a* is positioned stationarily at the central portion *b*, as has precedingly described, so that the permanent magnet 9 accommodated in the vertical bore 3 attracts in this instance the weight ball 8 existing immediately in the above. Since, however, the weight ball 8 is prevented from moving downwardly into the bore 3 by the partition interposed therebetween, the permanent magnet per se is urged upwardly and held in the uppermost portion of the vertical bore 3 in contact with an upper end wall (not numbered) of the bore 3. Consequently, the push button 7 is kept disengaged from the permanent magnet whereby the microswitch is actuated in an operative or inoperative condition.

When, in operation, an acceleration exceeding a predetermined level is caused to the acceleration responsive switching device, the acceleration is detected by the weight ball 8 which is moved through its inertia away from the central portion *b* on the end wall 2 to, for example, a position indicated by a phantom line in the drawing. In this instance, losing an object for attraction, the permanent magnet 9 is urged downwardly in the bore 3 due to its gravity. The push button 7 then is brought into engagement with the permanent magnet and is pressed thereby with the result that the microswitch 6 is actuated.

FIG. 2 illustrates another preferred example of the acceleration responsive switching device embodying the present invention, in which the weight ball made of steel and the permanent magnet used in the preceding example are utilized as a switch actuating means and an acceleration sensing means, respectively, thus a modification being applied to the arrangement and structure of the device per se.

A substantially generally cylindrical casing designated by reference numeral 11 has formed a relatively deep cavity 12 which is open at the upper end (not numbered) and has a concave configuration of its bottom end wall 13. Indicated by reference numeral *c* is a lowest or central portion of the bottom end wall 12. The casing 11 has further formed a vertical bore 14 extending vertically with its lower end (not numbered) open and at a slight spacing from the central portion *c*

of the bottom end wall **12**, thus leaving a relatively thin partition between the cavity **12** and the bore **14**. A closure member **15** provided in a manner to close the upper open end of the cavity **12** is secured to the casing **11** by a cap member **16** which is fitted to the casing **11** preferably through threads, as is shown in the drawing. Centrally of the upper peripheral surface of the closure member **15** is formed a ball bearing surface **17** as a bore in which seated a rotatable spherical member **18**. A non-magnetic rod **19** secured at one end to the spherical member **18** extends midway into the cavity **12**, having secured at the other end thereof a permanent magnet **20** functioning as an acceleration sensing means. The permanent magnet **20** fitted to the lower end of the rod **19** has its magnetic poles at the upper and lower ends, of which lower end faces the bottom end wall **13** of the cavity **12** at a suitable distance therefrom.

Designated by reference numeral **21** is a switch element or a microswitch which closes the open lower end of the vertical bore **14** in the same manner as has been illustrated in accordance with FIG. **1**. Furthermore, the microswitch **21** has a self-returning push button **22** normally extruded into the bore **14**. A weight ball **23** made of steel is movably accommodated in the bore **14** as a switch actuating means, being supported by the push button.

As will now be seen, the permanent magnet **20** supported by the rotatable spherical member **18** through the rod **19** is allowed to have a similar movement to that of a bob fitted to a pendulum, but substantially in all directions with the spherical member **18** as a fulcrum. It is to be understood that the permanent magnet has a stationary position, under the normal condition, corresponding to the lowest or central portion *c* of the bottom end wall **13**. Furthermore, the weight ball **23** made of steel functioning as the switch actuating means is capable of moving in the vertical direction in the bore **14** but, on the other hand, restrained of entering the cavity **12** by the partition provided therebetween.

Thus, under the inoperative condition of the device, the permanent magnet **20** being positioned in the central portion over the bottom end wall of the cavity **12**, the weight ball **23** is held in the uppermost portion of the vertical bore in contact with the upper end wall (not numbered) thereof due to a magnet force of the lower magnet pole so that the permanent magnet is also held unmoved. Under this condition, the push button **22** of the microswitch **21** is maintained its extended position so as to keep the microswitch either operative or inoperative condition.

When, in turn, an acceleration exceeding a predtermined level in magnitude is applied to the acceleration responsive switching device under the above-described normal condition, the permanent magnet **20** is moved by its inertia away from the stationary portion to, for example, a position indicated by phantom line in the drawing. The weight ball **23** released from the magnetic attraction is then urged downwardly due to its gravity with the result that the push button is depressed and, accordingly, the microswitch is actuated.

It is to be noted that an auxiliary support member may be provided downwardly of the vertical bore formed in the casing for the purpose of supplying an additional support for the switch actuating means actuating the switch element, as such will be applied to both of the examples shown in the present specification.

It will now be appreciated from the foregoing description that the acceleration responsive switching device according to the present invention is advantageous in that, since either one of the acceleration sensing means and the switch actuating means is composed of a permanent magnet with the other made of magnetic substance and they are juxtaposed with each other through a desirably thin partition provided therebetween, the acceleration sensing and the switch actuating means restrain each other of unnecessary movements yet without being brought into direct contact with each other with the result that the former and the latter are respectively prevented from dropping into the vertical bore and jumping into the chamber or cavity formed in the casing. Furthermore, the switching operation acording to the present invention is performed through supporting the switch actuating means by the switch element, so that, as a whole, the device of this invention is capable of performing its operation promptly and yet with high accuracy notwithstanding shocks and impacts and, particularly, vibrations applied thereto under driving conditions of the moving vehicle.

What is claimed is:

1. An acceleration responsive switching device, comprising in combination:

a casing having a limited space over the upper peripheral surface thereof, and a substantially vertical bore extending from a central portion of said limited space and separated therefrom by a partition, said bore having an open lower end;

an acceleration sensing means normally located in the central portion of said limited space and laterally displaceable therefrom in response to a predetermined magnitude of acceleration of said device;

a switch actuating means freely movable in said bore and normally held at said partition by magnetic attraction between said acceleration sensing means and switch actuating means, one of said acceleration sensing means and switch actuating means comprising a permanent magnet and the other comprising a magnetically attractable member;

a switch element adjacent the open lower end of said bore and actuable by downward movement of said switch actuating means theretoward resulting from said lateral displacement of said acceleration responsive means from said central portion.

2. An acceleration responsive switching device according to claim **1**, wherein said acceleration sensing means is a steel weight ball and said switch actuating means is a permanent magnet having magnet poles at the upper and lower ends thereof, said limited space accommodating said weight ball comprises a chamber formed by a reverse conical upper end wall of said casing and a cap member, said cap member being configurated in a conical shape corresponding to said reverse conical upper end wall of said casing and being fitted to said casing.

3. An acceleration responsive switching device according to claim **1**, wherein said acceleration sensing means is a permanent magnet having magnet poles at upper and lower ends thereof and said switch actuating means is a steel weight ball, said casing having a concave upper end wall, and further comprising a closure member fitted to the upper end of said casing and defining said limited space as a relatively deep cavity in combination with said concave upper end wall of said

casing, a cap member securing said closure member to said casing, said closure member having a further bore formed centrally of its upper peripheral surface and defining a ball bearing surface, a rotatable spherical member seated on said ball bearing surface and a non-magnetic rod having one end fitted to said spherical member and the other end holding said permanent magnet and extending midway into said cavity.

4. An acceleration responsive switching device according to claim 1, wherein said switching element is a microswitch having a push button normally held in an extended conditin through a spring force.

5. An acceleration responsive switching device according to claim 1, in which said casing is substantially cylindrical and has a concave upper surface, means including a cap threaded to said casing and spaced above said upper surface to define said limited space, said bore being aligned between said central portion and said switch element, said switch actuating means being longitudinally slidably disposed in said bore, whereby said magnetic attraction between said acceleration sensing means and switch actuating means tends to hold the acceleration sensing means at said central portion in the normal unaccelerated condition of said device.

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