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CONDUCTIVE SPRINGS AND BALL ACCELERATION SWITCH

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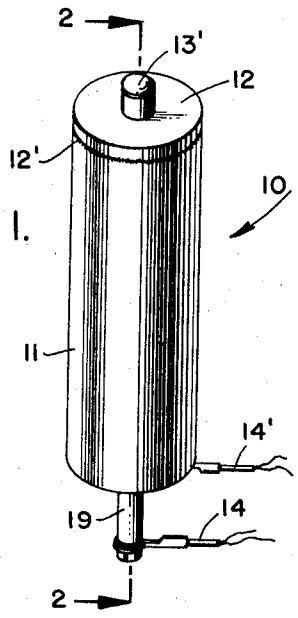
FIG. 1.



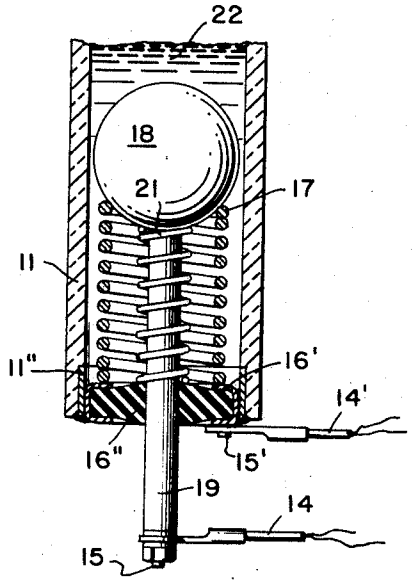
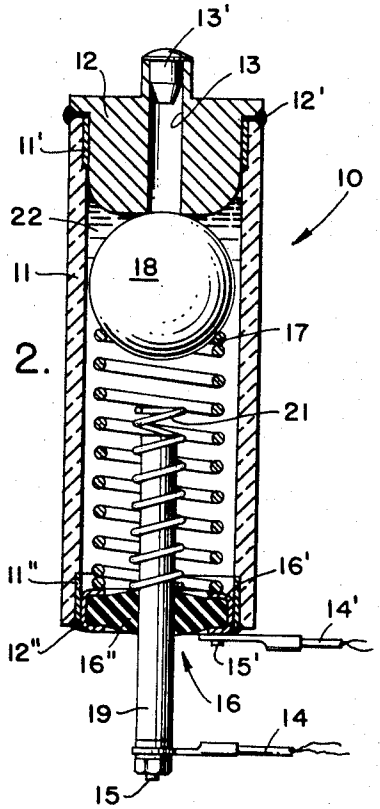


FIG. 3.

FIG. 2.



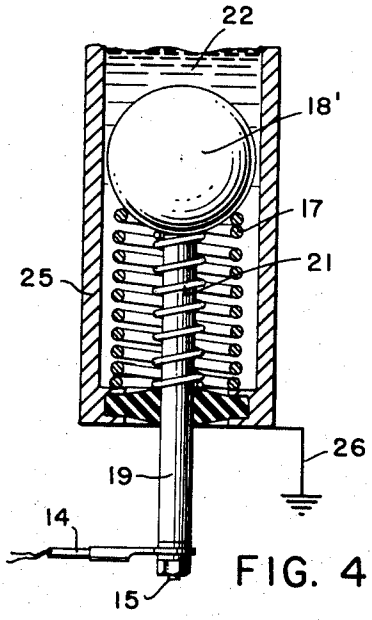


FIG. 4.

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CONDUCTIVE SPRINGS AND BALL ACCELERATION SWITCH

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The invention herein described may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to an acceleration responsive device, and more particularly to a switch which is activated to close an electrical circuit when a desired value of acceleration is imparted, in a predetermined direction, to the switch.

Among the most critical problems confronting designers of acceleration responsive switches has been the lack of sensitiveness and reliability, as well as excessive size and complexity, which is overcome by the present invention.

The general purpose of this invention is to provide a simple, sensitive, compact and inexpensive acceleration switch capable of operating in a reliable fashion even though subjected to conditions of severe vibration.

Therefore, an object of the present invention is to provide an acceleration switch which functions to close an electrical circuit when an accelerating force of a desired value is imposed on the switch in a given direction.

Another object is to provide an acceleration responsive device which is responsive to linear acceleration of a predetermined value while being insensitive to incident shock and vibration.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a perspective view of an assembled switch device of the present invention;

FIG. 2 is a larger scale axial cross sectional view, taken generally along lines 2—2 of FIG. 1, illustrating an open condition of the switch;

FIG. 3 is a fragmentary view similar to FIG. 2 but illustrating a closed condition of the switch; and

FIG. 4 is a view similar to FIG. 3, but of a modification of the device.

Referring now to the drawings, wherein like reference numerals designate like or corresponding parts throughout the several views, there is shown in FIG. 1 a switch, generally designated by reference numeral 10, having a ceramic tubular housing 11, a metallic sealing plug 12, an access port 13 (FIG. 2), an access closure 13', and a pair of electrical leads 14 and 14'.

Turning now to FIG. 2, the metallic plug 12 is secured to the housing 11 by suitable means, such as solder 12', which serves to secure the plug 12 to a metalized insert portion 11' of the housing 11. Leads 14 and 14' are connected to switch terminals 15 and 15', respectively, which serve to couple the switch 10 to a given circuit. The circuit forms no part of the present invention, but it is understood that closing of the switch under predetermined conditions of acceleration causes the circuit to perform various desired functions, such as, for example, controlling ignition of propellants of various stages of multi-stage rocket motors when the motor has had desired acceleration imparted thereto. The terminal 15' is mounted on a disk-like member, generally designated by reference 16, having an electrical contact surface 16'. The disk 16 with its surface 16' is secured by solder 12'', or other suitable

means, to an adjacent metalized insert portion 11'' of the housing 11. A compression-type coil spring 17, calibrated for reasons as will hereinafter become apparent, is seated with one end engaging the surface 16' so as to provide an electrical contact therebetween and to permit a circuit to be established between the terminal 15' and a spherical mass 18 which is seated in electrical contact with the opposite end of the spring 17 in such a manner as to be biased toward plug 12 and away from said disk member 16, for effecting a normally open condition between the terminals of the switch, and in a manner which allows the mass 18 to be stabilized in the normally open condition through contact with the plug 12.

The lead 14 is connected through terminal 15 to one end of a center contact pin or post 19. The opposite end of post 19 extends inwardly into housing 11, within the supported coil 17, through a hermetically sealed, insulator portion 16'' of the disk 16, FIG. 2. Surrounding the inwardly extending end portion of pin or post 19, and in electrical conducting engagement therewith, is a resilient electrical contact in the form of a coil spring 21 having one end seated on the portion 16'' of the disk 16 in such a manner as to be electrically insulated from the surface 16'. The spring 21 extends a short distance beyond the inwardly extending pin 19, as shown in FIG. 2, while being of a length insufficient to contact the mass 18, to thus establish an air gap between the end of the spring 21 and the mass 18, and consequently to thus establish an open circuit. Therefore, it is understood that to bridge the air gap, for completing the circuit between the terminals 15 and 15', the mass 18 is moved axially of the housing 11 to deflect the spring 17 so that the mass 18 may contact the spring 21 to complete the electrical circuit. In order to provide a series of low electrical resistance contacts for the elements disposed between the terminals 15 and 15', it has been found desirable to provide gold plating for the springs 17 and 21, the spherical mass 18, the pin 19, and the surface 16'. This plating, or gold surfacing technique, provides for a circuit of relatively very low resistance, and accordingly relatively low voltage sources may be utilized for affording the numerous advantages normally attending low voltage requirements.

As the switch of the present invention is intended to close an electrical circuit when an accelerating force of a desired value is imposed on the device in a direction such that inertia of mass 18 causes the spring 17 to deflect, it is necessary that both of the springs 17 and 21 be calibrated. The calibration of spring 17 is effected through observing the deflection of the spring acting under a force equal to the mass of the sphere times the acceleration required to close the switch. The value of the spring 17 may be just slightly less than the value required to maintain an open circuit so that contact "chatter" may be obviated at the instant the desired value of acceleration is imposed for closing the switch. When an acceleration value greater than the desired value is imposed on the device, the spherical mass 18 deflects springs 17 and 21 and comes to rest, or seats on the pin 19, FIG. 3, and remains so seated until acceleration diminishes to a value which allows springs 17 and 21 to unseat the mass. The spring 21, however, offers little resistance to the mass 18 and accordingly is calibrated primarily as to length so as to provide an air gap of a dimension dictated by the observed deflection of spring 17. It is understood that the purpose of the spring 21 is to provide a resilient contact which engages the mass 18 to complete a circuit in a manner which tends to obviate contact "chatter" through allowing the mass 18 to be engaged in a "floating" fashion.

An insulating damping fluid 22, which may be a gas or a liquid, such as a well known silicone fluid, is introduced through the port 13 to provide a damping of undesired movements of the mass 18, which may occur in operation

as a result of incident vibrations being imposed thereon. Since the relative dimensions of the cylinder and of the spherical mass 18 may be varied as necessary, fluid passage around the mass may be varied as desired.

Referring now to FIG. 4, a modification of the above-described device utilizes a metallic cylinder or housing 25, which may be gold plated for the purposes hereinabove described, and is provided with a lead 26 connected therewith and extending directly to "ground" in such a manner that the spring 17, which is in normal electrical contact with the cylinder 25, the cylinder 25, and the spherical mass 18' are constantly "grounded" by the given structure to which the device is operatively attached. Therefore, when an acceleration of desired value is attained, the "grounded" mass 18' engages the spring 21 in the manner hereinabove described, and a circuit between the lead 14 and ground lead 26 is completed through the switch.

The device shown in FIG. 4 has been found particularly satisfactory where the device is to be continually re-used, as the metallic walls of the cylinder 25 tend to be less abrasive than the less expensive ceramic cylinder of housing 11, while the ceramic housing material is used primarily for "one shot" operations wherein the device is destroyed.

The operation of the device of the present invention may best be understood with reference being made particularly to FIGS. 2 and 3. The housing 11 is mounted in a manner such that the switch actuating acceleration force is applied in an axial direction extending from the spring 21 to the mass 18. When the force attains a pre-selected value, the pre-calibrated spring 17 deflects under the influence of the mass 18 to the extent necessary for displacing the mass 18, from a stabilized condition adjacent the plug 12, into electrical contact with the spring 21 to close the switch between leads of the circuit to which the switch 10 is coupled. It is noted that the leads 14 and 14', FIG. 3 connect the switch 10 between components of an electrical circuit, while, as shown in FIG. 4, the lead 26 extends from the switch housing 25 directly to ground to establish a circuit between lead 14 and ground. Therefore, it is understood that the mass 18', FIG. 4, may contact the cylinder 25, as well as the spring 17, since the mass 18' is to be continuously connected to ground.

Thus, there has been provided a compact acceleration switch capable of functioning in a reliable manner even though subjected to severe vibration. This function is attained through utilizing a pair of resilient electrical contacts and a metallic mass supported on one of the contacts which serves to deflect for bringing the mass into contact with the other contact of said pair in order that the circuit be closed when acceleration is imposed on the switch in a predetermined direction, thereby providing a "chatter-free" closed switch.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An acceleration responsive switch comprising in combination:

an elongated tubular switch housing having a first and a second end;

a substantially flat, di-electric disk member disposed within the first end of said housing in a plane transverse to the longitudinal axis of said housing and having an opening near the center thereof;

a first electrical conductor having a ring-shaped configuration fixed to said disk member and being disposed within said housing and arranged in co-axial alignment with respect to said opening and radially displaced therefrom;

means fixedly securing said disk member within said first end of said housing;

a second electrical conductor comprising an elongated electrical current conducting post fixed to said disk and disposed to extend in an axial direction through said opening and to terminate at a terminal point located within said housing near the first end thereof and between said first conductor and the second end of said housing;

a third electrical conductor comprising a first elongated coil spring supported at its first end by said first conductor being so disposed as to be co-axially aligned and radially displaced with respect to said second conductor and having its second end disposed in a transverse plane located between the second end of said tubular housing and said terminal point;

a fourth electrical conductor comprising a second elongated coil spring being engaged and supported near its first end by said second electrical conductor in co-axial alignment therewith and in a radially displaced relationship with respect to said third electrical conductor, and being so arranged as to have its second end disposed in a transverse plane located between the second end of said third conductor and said terminal point;

a fifth conductor comprising a movable solid mass seated on and supported by said second end of said first coil spring in a displaced relationship with respect to said second end of said second coil spring to thus establish a switch-open air gap between said mass and second coil spring; and

a damping fluid disposed to surround said conductors, whereby the inertial forces of said mass and given forces of acceleration acting in a predetermined direction may effect a gradual deflection of said first coil spring for thus permitting said mass to seat on the second end of said second coil spring, and, subsequently to deflect said second coil spring for thus permitting said mass to seat in engagement with said second electrical conductor to thus establish an operative closed condition for said switch.

2. An acceleration switch including:

a pair of radially displaced concentrically arranged electrical contacts;

a pair of elongated, concentrically aligned and radially displaced coil spring conductors, each being separately supported at a first end thereof by a given contact of said pair of contacts;

a displaceable solid mass of electrical conducting material seated on the second end of one of said springs and biased thereby to assume a displaced relationship with respect to the second end of the other spring of said pair of coil springs to thus establish an air-gap between the mass and the other spring; and

an electrical circuit lead connected with each contact of said pair of contacts, whereby an electrical circuit may be completed between said leads by causing said mass to act against and compress said one of said springs sufficiently for eliminating said air-gap.

3. A device as defined in claim 2, further including: a housing comprising a sealed cylinder for mounting said switch; and damping fluid disposed within said cylinder so that movement of said mass in said cylinder may be damped against incident vibration.

4. The device as defined by claim 3, further characterized in that the sealed cylinder is formed of ceramic material having metalized sealing portions at each end thereof.

5. The device as defined by claim 3, further characterized in that the cylinder is formed of an electrical conducting metal with one of the leads of said pair being connected to one of said contacts by being connected to said cylinder.

6. The device of claim 5, wherein each of the electrical contact surfaces comprises a gold plated surface.

7. An electrical switch comprising:

support means;

a first electrical contact comprising a first elongated coil spring mounted on said support means;

a second electrical contact comprising a second elongated coil spring mounted on said support means and being generally concentrically disposed and radially displaced with respect to said first contact;

a movable mass of electrically conductive material supported by one end of said first contact and being normally spring-biased in an axial direction away from second elongated coil spring by said first elongated coil spring to assume an axially displaced disposition with respect to the second coil spring to provide an air-gap between the mass and the second coil spring to thus establish a switch-open condition for said switch when said switch is at rest; and

circuit leads connected with said first and said second contacts, whereby the air-gap may function to provide an open-circuit between said leads, and which may be closed by imposing a state of acceleration on said switch for initiating a compression of said first coil spring for seating the mass on said second spring to eliminate said air-gap.

8. In an acceleration switch of the type adapted to provide an open-circuit between switch-connected leads when a state of equilibrium is imposed on the switch and to provide a closed-circuit between the leads when a predetermined state of acceleration is imposed on the switch, means comprising:

a di-electric base member;

a first conductor comprising a post having one end portion fixed to said base and its other end extending normally therefrom;

a second conductor comprising a compressible coil spring seated on the base and coiled about said post in engagement therewith, being adapted to have one end thereof extended beyond the extended end of the post under the influence of spring recovery forces possessed by said spring, and adapted to retract

under the influence of externally applied compression forces directed in a compressing direction against the extended end thereof;

a third conductor comprising a second compressible coil spring seated at one end on said base and extending normally from said base in a surrounding and radially spaced relationship with respect to said first coil spring and adapted to extend the other end thereof beyond the extended end of said first coil spring and adapted to be compressed by compression forces acting against the extended end of the spring in a spring compressing direction;

a fourth conductor comprising a solid mass seated on and operatively supported by the extended end of the second coil spring and being biased to a displaced disposition with respect to the extended end of the first coil spring and the post by the recovery forces possessed by the second coil spring when a state of equilibrium is imposed on said switch, and seated in contact with the post when predetermined forces of acceleration are imparted to the switch for causing the first and second coil springs to be compressed against said mass;

means maintaining the mass in its seated position on said second coil spring; and

a circuit lead connected with said first and said third conductors, whereby an open-circuit may be established between said fourth and said second conductor when a state of equilibrium is imposed on said switch, and a closed-circuit may be established as predetermined acceleration is imposed on said switch for causing said fourth conductor to seat on said first conductor.

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