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R. P. STROMBERG
WEIGHTLESSNESS SWITCH
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3,141,084

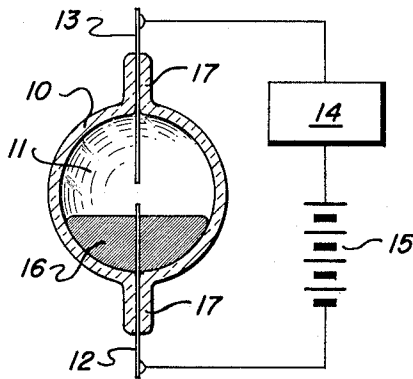


Fig. 1

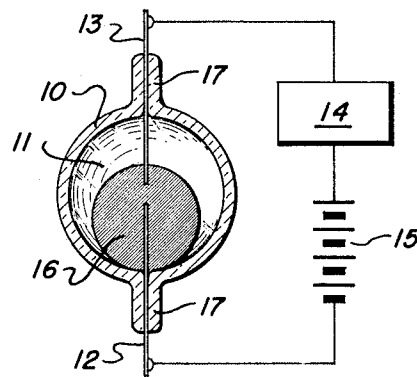


Fig. 2

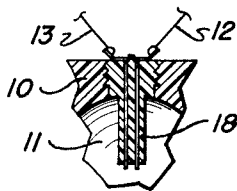


Fig. 3

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WEIGHTLESSNESS SWITCH

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3 Claims. (Cl. 200—152)

This invention relates generally to an electrical switch and more particularly to an environmental controlled weightlessness switch.

In the telemetering field, particularly in the space technology area, there has for some time existed the need for an electrical switch responsive to environmental conditions, i.e., a switch capable of closing or opening an electrical circuit when a desired degree of weightlessness is attained. It is therefore a principal object of the present invention to provide a switching device of relatively simple construction and operation which aims to achieve these and other desiderata by utilizing a high-density conducting liquid within a switch containing cavity so that when the switch approaches weightlessness the shape of the conducting liquid changes due to surface tension to close the switch.

Another object of the invention is to provide a weightlessness switch which may be of very small size.

Another object of the invention is to provide a weightlessness switch of high reliability.

A further object of the invention is to provide a weightlessness switch capable of omnidirectional operation.

A still further object of the invention is to provide a switch which may perform its desired function at a certain degree of weightlessness when positioned in one orientation and at a different degree of weightlessness when in another orientation.

A still further object of the invention is to provide a weightlessness switch which may not only measure the existence of a weightless state, but might also integrate such state with time and thus delay the closing or opening of the switch until the combination of a predetermined degree of weightlessness and time has been observed.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

A preferred embodiment of the invention has been chosen for purposes of illustration and description. The preferred embodiment illustrated is not intended to be exhaustive nor to limit the invention to the precise form disclosed. It is chosen and described in order to best explain the principles of the invention and their application in practical use to thereby enable others skilled in the art to best utilize the invention in various embodiments and modifications as are best adapted to the particular use contemplated.

In the accompanying drawing:

FIG. 1 is a sectional view showing a preferred embodiment of the present invention with the contact closing liquid under the influence of a gravitational field and/or an acceleration field;

FIG. 2 is a sectional view of the device shown in FIG. 1 illustrating the contact closing liquid in a weightless state; and

FIG. 3 is a fragmentary sectional view of a modified form of the invention illustrating a variation of the conductor arrangement.

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Described generally, the present invention is shown comprising a spherical cavity within an insulated body including a pair of normally open contacts extending into the cavity and terminating adjacent to the center thereof. A high-density conducting fluid which is capable of having a high degree of surface tension is placed within the cavity and when there exists a gravitational field and/or an acceleration field which imposes a force upon the liquid, the latter is forced against a side of the cavity and takes on a shape having a substantially flat inwardly facing surface which leaves the switch in an open circuit condition. As the weight of the liquid approaches weightlessness or zero gravity (g), such as, for example, where acceleration is equal to the pull of the gravitational field the surface tension of the liquid forces the liquid to assume a spherical shape, which must always include the center of the cavity, so as to short the switch to close the circuit (FIG. 2). Stating the operation of the switch in another manner, viz., as the relative weight of the conducting liquid approaches a weightless state the surface tension of the liquid, which remains substantially constant at all times, exerts a force upon the surface of the contained liquid causing it to gradually take the shape of a sphere which ultimately reaches a point sufficient to close the switch.

With further reference to FIGS. 1 and 2 the weightlessness switch is shown comprising a body portion 10 having a substantially perfect spherical cavity 11 therein and may be composed of any suitable insulating material, such as, for example, glass or the like. While the outer surface of the body portion 10 is shown generally spherical it will be obvious that the outer surface may be of any desired shape. A pair of conductors 12 and 13 which may be circumferentially spaced 180° apart from each other are adapted to extend into the cavity to where the distal end or tip of each conductor terminates adjacent the center of the cavity 11 while leaving a small gap adjacent to the center of the cavity 11 between the respective conductor tips. The conductors 12 and 13 may be made of any suitable material, such as, platinum or the like, which will not be wetted nor contaminate the liquid. The positioning of the gap between the conductors 12 and 13 near the exact center of the cavity 11 is very desirable in that the switch is then capable of being actuated at the same degree of weightlessness no matter what particular orientation the body 10 assumes. While the conductors 12 and 13 are each shown extending into the cavity 11 from opposite sides of the cavity it will be obvious to others skilled in the art to use any desirable conductor configuration. For example, as shown in FIG. 3 the conductors 12 and 13 may be placed in a side-by-side relation in an insulated body 18 which is adapted to extend into the cavity toward the center thereof and be secured to the body 10 in any suitable manner, such as, for example, by providing the body 10 and the insulated body 18 with mating threads. The tips of the conductors extend inwardly beyond the distal end of the insulated body 18 and terminate adjacent to the center of the cavity 11 so as to be exposed to the conducting liquid 16.

Externally of the body 10 the circuit of a telemetering device or any desired load 14 may be positioned so as to incorporate the conductors 12 and 13 in the voltage supply circuit of the telemetering device 14 or in some other desirable manner couple the conductors 12 and 13 into the circuit so as to permit the switch to control or effect a control of the operation of the telemetering device 14. A suitable method of coupling the weightlessness switch into the circuit is to run one lead from the negative terminal of the voltage supply source 15 to conductor 12 and then couple the telemetering device 14

between the other conductor 13 and the positive terminal of the voltage supply source 15, thus insuring that the conductors 12 and 13 are properly coupled to each other before the potential of the source 15 can be applied to the device 14.

To effect the coupling of the above mentioned circuit a high-density conducting liquid 16 which possesses a high degree of surface tension, such as, for example, mercury or a mercury thallium eutectic mixture, is placed within the cavity 11 at any desirable time which may be preferably prior to the insertion of the conductors 12 and 13 into the cavity 11. The amount of liquid 16 placed within the cavity determines at what point approaching weightlessness the conductors 12 and 13 are to be shorted to complete the circuit. Thus varying the amount of liquid 16 within the cavity 11 provides a means of accurately controlling the actuation of the switch. There should, however, always be sufficient liquid 16 within the cavity so that when weightlessness or zero *g* occurs the resulting spherical shape of the liquid 16 shown is sufficient to contact and short the conductors 12 and 13.

It may be desirable to fill the remaining space in the cavity above the level of the liquid with an inert gas, such as nitrogen or the like, for preventing the contamination of the liquid and the conductors. After the liquid and the gas are placed in the cavity 11 and the contacts are properly oriented within the cavity, the latter may be sealed in any suitable manner, such as, for example by providing the body 10 with a shaft-like portion 17 at each conductor entrance point and then sealing each such shaft with a suitable insulating and bonding agent.

In some instances it may be desired to use a switching device which is capable of being closed at different degrees of weightlessness depending upon the particular orientation of the body 10. The above feature may be attained by using a cavity of a shape other than spherical, such as, for example, the shape of a teardrop (not shown). Thus by first orienting the switch body so that the liquid is positioned within the lobe or smaller portion of the cavity or where the surface of the liquid under the influence of motion effected by gravity or acceleration is at the remotest point possible from the gap between the conductors, the degree of weightlessness at which the conductors are shorted will be closer to zero *g* or complete weightlessness than when the switch is rotated 180° and the liquid is in the relatively shallow or substantially spherical portion of the cavity.

A time delay in the actuation of the switch may be readily attained by replacing the inert gas with a highly viscous non-conducting fluid, such as, for example, silicone oil or the like, which functions to prevent the rapid change in shape of the conducting liquid, thus integrating the existence of a weightless state with a time factor for delaying the shorting of the conductors.

In an environment where shock and/or vibration is present the liquid may short the conductors prematurely for a very short period of time which may, however, be sufficient to activate the load circuit. To overcome this objectionable feature the above mentioned addition of the viscous fluid or the insertion of a delay device in the electrical circuit may be used for preventing the activation of the load until the conductors have been shorted for a predetermined period of time.

It will be seen that the weightlessness switch of the present invention sets forth a very simple and accurate device for indicating a weightless state and activating an electrical circuit when such state is attained. Another highly advantageous feature is that no external source of electrical energy is necessary to excite the switch.

As various changes may be made in the form, construction and arrangement of the parts herein without

departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A device of the character described comprising body means having therein a cavity with interior walls consisting essentially of spheroidal configuration throughout all portions of the cavity, a pair of electrical conductors each extending through said body means and including an exposed conductive end portion disposed in close proximity to the center of said spheroidal configuration, said end portions being spaced apart and normally electrically isolated from each other, a quantity of mercurial liquid within and supported by said spheroidal configuration walls and confined to corresponding conformation at coextensive contacting surfaces at all positions of said body means when exposed to at least normal gravimetric conditions with said quantity being insufficient to contact said end portions during said normal gravimetric conditions irrespective of the position of said body means, and said quantity of mercurial liquid being such that when in generally spheroidal configuration the diameter thereof is greater than the radius of said cavity, said liquid upon approach of the device to a condition less than normal gravimetric conditions assuming a generally spheroidal configuration of diameter less than that of said cavity but greater than the radius of said cavity and bridging the space between said conductor end portions for electrically connecting them.

2. The device claimed in claim 1 wherein switch closing time delay means comprising a viscous non-conducting liquid essentially occupies all portions of said cavity not occupied by said mercurial liquid and delays changes of shape of said mercurial liquid.

3. A device of the character described comprising body means having therein a cavity with interior walls consisting essentially of spheroidal configuration throughout all portions of the cavity, a pair of electrical conductors each extending through said body means and including an exposed conductive end portion disposed in close proximity to the center of said spheroidal configuration, said end portions being spaced apart and normally electrically isolated from each other, insulating means extending inwardly toward the center of the cavity and containing said pair of conductors in a side-by-side relationship with said end portions being exposed at the innermost end of said insulating means, a quantity of mercurial liquid within and supported by said spheroidal configuration walls and confined to corresponding formation at coextensive contacting surfaces at all positions of said body means when exposed to at least normal gravimetric conditions with said quantity being insufficient to contact said end portions during said normal gravimetric conditions, said liquid upon approach of the device to a condition less than normal gravimetric conditions assuming a generally spheroidal configuration of diameter less than that of said cavity but greater than the radius of said cavity and bridging the space between said conductor end portions for electrically connecting them.

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