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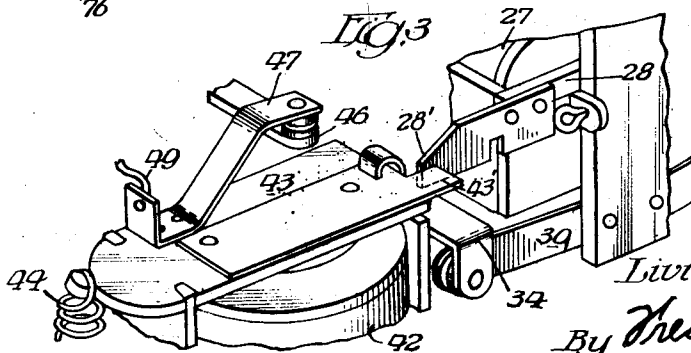
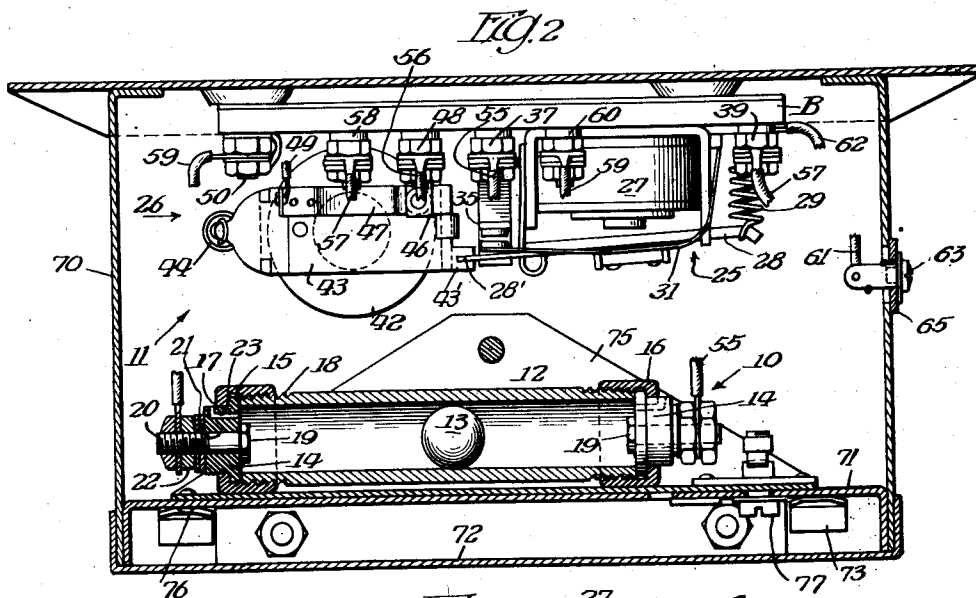
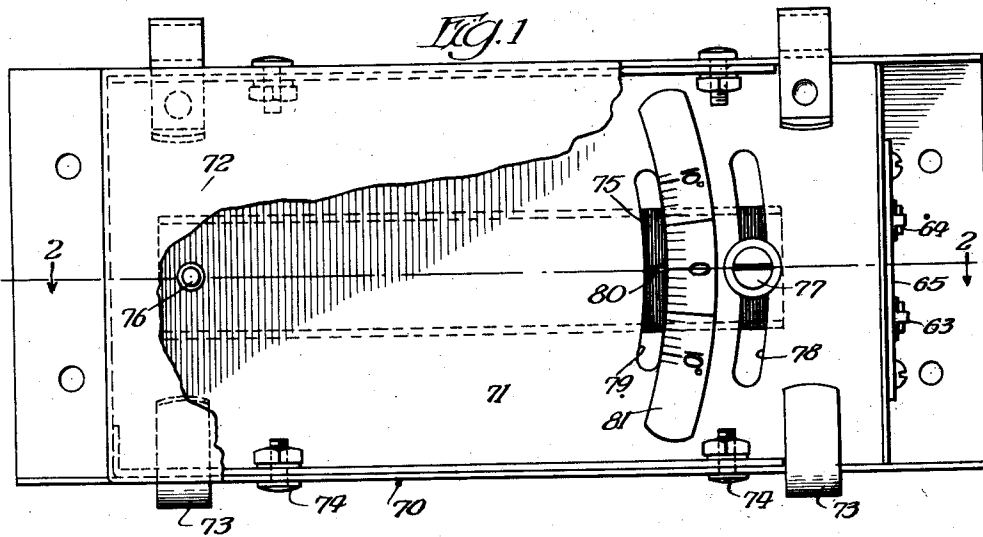
L. L. RICE

2,383,889

GRAVITY ACTUATED SWITCH

Filed April 30, 1943

2 Sheets-Sheet 1



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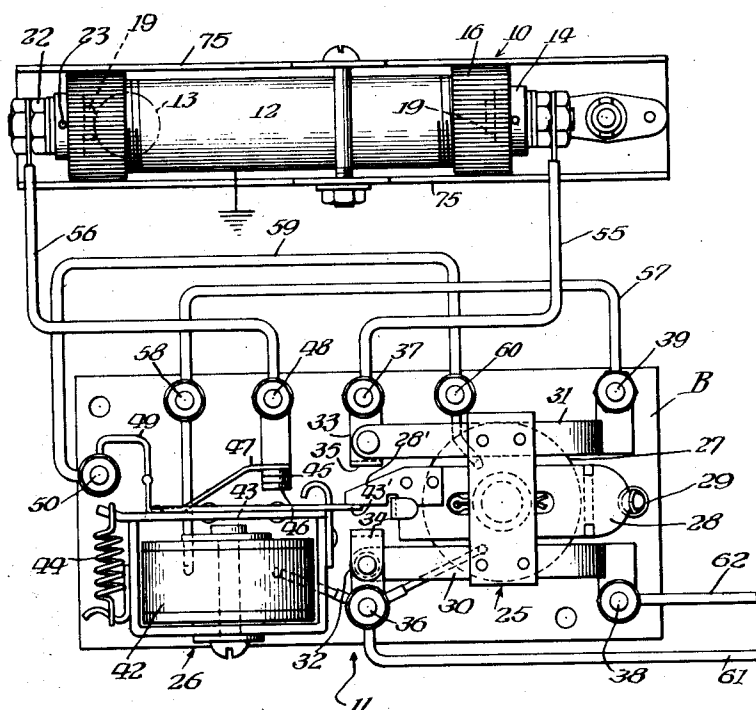
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Fig. 4



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UNITED STATES PATENT OFFICE

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GRAVITY ACTUATED SWITCH

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7 Claims. (Cl. 200—52)

The invention relates generally to switches and more particularly to a gravity controlled switch.

One object of the invention is to provide a gravity controlled switch of new and improved construction, reliable in operation, easily repaired and serviced, and reasonable in cost of manufacture.

Another object is to provide a gravity controlled switch that possesses a high degree of sensitivity yet is not affected by vibration or similar adverse conditions to which it may be subjected.

A further object is to provide a gravity controlled switch that is consistent in its response and positive in its operation.

Other objects and advantages will become apparent from the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a front elevational view of a switch embodying the features of my invention, with an external cover partially broken away to reveal a sub-cover.

Fig. 2 is a horizontal section taken approximately along the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary and slightly enlarged perspective view showing the interlocking ends of the armatures in a position opposite to that shown in Fig. 2.

Fig. 4 is a partially diagrammatic view showing the wiring of the switch. The view is taken in the same direction as Fig. 1 with a portion of the switch shifted vertically, better to show the wiring connecting it to the remaining portion of the switch.

While the invention is susceptible of various modifications and alternative constructions, it is here shown and will hereinafter be described in a preferred embodiment. It is not intended, however, that the invention is to be limited thereby to the specific disclosure made. On the contrary, it is intended to cover all modifications and alternative constructions falling within the spirit and scope of the invention as defined in the appended claims.

As shown in the drawings for purposes of disclosure, the switch comprises generally a positional and hence gravity responsive means, generally designated 10, and translating or multiplying means, generally designated 11, associated with and controlled by the means 10. The gravity responsive means 10 comprises a tubular member 12 which herein is a straight cylindrical tube approximately three inches long and .750 of an inch in outside diameter, with

walls initially one-sixteenth of an inch thick. Within the tubular member 12 is a solid element 13 movable, under the influence of gravity and with a change in position of the tubular member 12 relative to the horizontal, from end to end of the tubular member. Herein the solid element 13 takes the form of a ball to increase the sensitivity of the gravity responsive means. Though the tubular member 12 and the ball 13 are both preferably made of bronze or brass, the interior of the tube and the ball are each given a silver plating 0.0005 of an inch thick in order to enhance the electrical conductivity of the parts.

Each end of the tubular member 12 is closed by a spool 14 of an insulating material having at one end a radially outwardly extending flange 15 with an outside diameter equal to the outside diameter of the tube 12. Each spool is held in place closing an end of the tube 12 by a knurled conduit nut 16 having a radially inwardly extending flange 17 overlying the flange 15 of the spool 14 when the parts are in position. To receive the conduit nuts, each end of the tubular member 12 is formed with external threads 18. Disposed at each end of the tubular member 12 and supported centrally of the member and in spaced, insulated relation thereto is an electrical contact 19 preferably of brass and also silver plated 0.0005 of an inch. The contact is for convenience formed from a commercial hex-head bolt 20 mounted with its head on the inner side of the spool 14 to form the contact 19 and projecting outwardly through a central bore 21 formed in the spool. A nut 22 secures the contact in the spool and the projecting portion of the bolt 20 provides a convenient place for the attachment of a lead wire.

Before the interior of the tubular member 12 is silver plated, as above stated, it is reamed to an exact inside diameter of .634 of an inch. The ball 13 is made to an exact initial diameter of five-eighths of an inch so that with the silver plating the total diameter of the ball is .626 of an inch. It will thus be seen that in the finished means there will be a clearance of but .007 of an inch between the ball and the tube. This close fit between the ball and the tube is provided in order to attain some degree of damping effect by the air in the tube as the ball rolls from end to end thereof. In order that this effect may not be too great, a vent passage 23 is provided in each spool 14. These vent holes, by allowing circulation of air, serve the further purpose of preventing condensation which would interfere with

the functioning of the switch. It is believed apparent from the above that the means 10 will be sensitive and positive in its action, due to the weight and shape of the element 13, while at the same time it will not be affected by vibration or other conditions to which it may be subjected as are the switches of the prior art. This means, moreover, is equally operative whether in normal or inverted position, thus adapting it particularly well for use in aeroplanes where flight sometimes is upside down.

The translating means 11, for which the gravity responsive means 10 acts as an exciter or controller, comprises generally a pair of electrically energized devices which herein preferably take the form of relays, generally designated 25 and 26. The relay 25 comprises an energizing coil 27 and a pivoted armature 28 biased to a normal position by a tension spring 29. The armature 28 is operatively associated with a pair of leaf elements 30 and 31 forming the movable contacts, respectively, of switches 32 and 33. The stationary contacts 34 and 35 of the switches 32 and 33, respectively, are formed by brackets upstanding from a base B upon which the relays 25 and 26 are mounted. The contact 34 overlies the contact 30, while the contact 35 underlies the contact 31, so that the switch 32 is closed when the armature 28 is in normal position and open when the armature is in actuated position, while just the converse is true for the switch 33. The contacts 34 and 35 are at their point of attachment to the base B provided with terminals 36 and 37, respectively, and contacts 30 and 31 are likewise at their point of attachment to the base provided with terminals 38 and 39, respectively.

The relay 26 is similar to the relay 25 and comprises a coil 42 and a pivotally mounted armature 43 biased by a tension spring 44 to a normal position. This relay controls but a single switch 45, the stationary contact 46 of which is formed by a bracket upstanding from the base B, while the movable contact 47 is carried by the armature 43. The stationary contact 46 is at its point of mounting on the base B provided with a terminal 48, while the movable contact 47 is through a flexible lead 49 connected to a terminal 50 on the base.

The relays are provided with a mechanical interlock whereby the relays are mutually operative to retain one or the other of the armatures of the relays in actuated position, even though both relays are deenergized. Such a mechanical interlock is herein effected in a simple and expeditious manner by the armatures of the relays. To that end, the relays are mounted at right angles to one another with the relay 25 herein mounted with the axis of its coil at right angles to the base B and the relay 26 mounted with the axis of its coil parallel to the base B. As clearly seen from Fig. 2, the free end 28' of armature 28 in its normal position overlies the free end 43' of the armature 43 when in its actuated position. However, when the armature 28 is moved to its actuated position it clears the armature 43 and permits the same to be returned to normal position under the influence of its spring 44, as shown in Fig. 3. Conversely, as clearly seen from Fig. 3, the free end of the armature 43 in normal position overlies and retains the armature 28 in actuated position and again clears the armature 28 and permits it to return to its normal position when the armature 43 is attracted by the coil 42.

As best seen in Fig. 4, the gravity actuated exciter or control means 10 is connected to the means 11 in a manner to energize one or the other of the relays, depending upon which end of the tubular member 12 the ball 13 is in. To that end, a lead 55 connects the right hand contact 19, as viewed in Fig. 4, to the terminal 37, while a lead 56 connects the left hand contact 19 to the terminal 48. Terminal 38 is by lead 57 connected to a terminal 58 and terminal 50 is by a lead 59 connected to a terminal 60. The wiring is completed by connecting the ends of the coil 27 to the terminals 36 and 60 and the ends of the coil 42 to the terminals 36 and 58. It is believed apparent from the foregoing that the switch 32 constitutes the main switch to be controlled, while the switch 33 is disposed in the energizing circuit for the coil 42 and the switch 45 is disposed in the energizing circuit for the coil 27. At times it may prove desirable to have leads 61 and 62, running respectively from the terminals 36 and 38 to terminals 63 and 64, mounted on a separate base 65 for positioning on the outside of a casing or housing in which the mechanism so far described may be enclosed (see Figs. 1 and 2).

Herein the switch is disclosed as housed in a casing 70 which includes a sub or interior cover 71 and an external cover 72. The external cover 72 is secured by spring clips 73 for ready removal or replacement, while the interior or sub-cover 71 is more permanently secured as by means of bolts 74. The sub-cover forms a support on which the tubular member 12 is adjustably mounted through the medium of a channel shaped, clamp-like holder 75. The holder 75 is somewhat longer than the tubular member 12 and is near one end pivotally connected as by means of a rivet 76 to the sub-cover 71. The other end of the holder carries a screw 77 which projects outwardly through an arcuate slot 78 formed on the sub-cover 71 and centered on the rivet 76. Also formed in the sub-cover 71 radially inwardly of the slot 78 is a second arcuate slot 79 also centered on the rivet 76. Placed on the holder 75 to be visible through the slot 79 is a marking 80, while on the sub-cover between the arcuate slots is a scale 81 by which the angular position of the tubular member 12 may be determined. By loosening the screw 77 the tubular member 12 is readily and conveniently adjusted to form any desired angle with the horizontal and the same may then be secured in that adjustment by tightening the screw 77. Base B is secured to the bottom of casing 70 by suitable bolts.

The switch mechanism above described has, of course, a variety of applications and is particularly adapted for use in conjunction with some member, vehicle or the like which is either to be maintained in some position relative to the horizontal, or to initiate or arrest operation of some related device when the member or vehicle with which the switch is associated departs from a predetermined or desired position. By way of example, the switch may be employed in an aeroplane for the purpose of controlling a pump, control rudder, or the like, when, for example, the nose of the aeroplane drops a predetermined number of degrees below the horizontal. Let it be assumed, therefore, for the purpose of describing the operation of the switch that the same is to be employed in conjunction with an aeroplane. Under those circumstances, the unit is attached in the position shown in Fig. 1

and with the right hand end of the unit, as viewed in Fig. 1, directed toward the nose of the aeroplane. As a result, the gravity responsive means 10 assumes a position generally parallel with the longitudinal center line of the aeroplane and also generally horizontal. With the entire unit attached by securing the casing 70, the external cover 72 is removed to give access to the adjusting screw 77 projecting through the internal cover 71. With the three-point or grounded position of the aeroplane known and with the degree of drop of the nose of the plane below the horizontal at which the pump or the like is to come in operation also known, the mechanic can readily by means of the calibrated scale 81, simply by loosening the adjusting screw 77 and moving the same in the arcuate slot 78, give to the tubular member 12 the exact position which will result in operation of the pump or the like when the nose of the plane drops the predetermined number of degrees below the horizontal.

Under the conditions above assumed, and with the plane in horizontal flight or climbing, the right hand end of the tubular member 12, as viewed in Figs. 1 and 4, will be higher than the left hand end and hence the ball 13 will occupy its terminal position at the left end of the tube, that is, in the position shown in Figs. 1 and 4, namely, in contact with the left one of the contacts 19. This will complete an energizing circuit for the coil 27 of relay 25. This circuit may be traced as follows: From the terminal 36 which is intended to be connected to the positive side of a battery through coil 27, terminal 60, lead 59, terminal 50, lead 49, switch 45, terminal 48, lead 56, contact 19, ball 13, and tubular member 12 which is grounded. Switch 45 was closed because through the mechanical interlock between the two relays armature 28 of relay 25 was holding armature 43 in actuated position even though coil 42 was not energized. With the energization of coil 27, armature 28 is, of course, actuated thereby, first of all, opening switch 32 to break the circuit to the pump or other device controlled by the switch 32. At the same time switch 33 is closed to condition a circuit for the energization of the coil 42 at such time that the ball 13 is by change in position of the tubular member 12 caused to engage the right hand contact 19. Also at the same time this movement of the armature 28 to actuated position moves it out of its interlocking relation to the armature 43 and thereby renders that armature free to return to its normal position under the influence of the spring 44 so long as the coil 42 is not energized. So long as the ball 13 does not engage the right hand contact 19, coil 42 is deenergized and hence the armature 43 now moves into interlocking relationship to the armature 28. The armature 28 thus is held in actuated position and the switches 32 and 33 remain open and closed, respectively, even though the coil 27 is deenergized by opening of the switch 45 which takes place as an incident to return of the armature 43 to its normal position. It will be appreciated that the armature 43 passes into interlocking relationship with the armature 28 before the switch 45 is opened.

Should now the nose of the aeroplane drop more than the predetermined amount, the ball 13 will roll to the right and make engagement with the right hand contact 19 to complete the previously conditioned energizing circuit for the coil 42. This circuit may be traced from terminal 36 through coil 42, lead 57, switch 33 which,

as previously stated, is now closed, lead 55, right hand terminal 19, ball 13, and tubular member 12 which is at ground potential. With the energization of the coil 42 the armature 43 is attracted to actuated position, thereby releasing armature 28 for return to its normal position. With such return the switch 32 is closed to complete the circuit to be controlled, namely, the circuit to the pump or other device initiating operation thereof. At the same time, switch 33 is opened to break the circuit to the coil 42 but, of course, the armature 43 remains in actuated position because the armature 28 had previously moved into interlocking relation with the armature 43. The switch 45 is again closed to condition the energizing circuit for the coil 27. When the plane again returns to horizontal flight, ball 13 will, of course, return to the left end of the tubular member 12 and the relays will assume the condition initially described, thereby arresting operation of the pump or other device initiated by closure of the switch 32.

I claim:

1. In a gravity controlled switch, a straight tubular member, an element responsive to gravity mounted within said member and movable longitudinally thereof as said member changes position relative to the horizontal, said element conforming in transverse cross section to the transverse cross section of the space within said member and having a maximum cross sectional area slightly less than the cross sectional area of the space within said member whereby pneumatically to retard longitudinal movement of the element within the member, and means forming an electrical contact supported on and electrically insulated from said tubular member, at an end thereof, in position to be engaged by said element when at said end.

2. In a gravity controlled switch, a straight tubular member closed at each end, an element responsive to gravity mounted within said member and movable longitudinally thereof as said member changes position relative to the horizontal, said element conforming in transverse cross section to the transverse cross section of the space within said member and having a maximum cross sectional area slightly less than the cross sectional area of the space within said member, an electrical contact mounted at an end of said member in position to be engaged by said element when the same is at said end of the member, and a bleed opening in said tubular member near each end thereof whereby to allow longitudinal movement of the element, in the tubular member, toward and away from said contact, at a pneumatically retarded rate.

3. In a gravity controlled switch, a member comprising electrically conducting material and having a channel therein of uniform sectional size and shape throughout said channel, an electrical contact carried by said member in insulated relation thereto, said contact being exposed in said channel and a solid electrically conductive element mounted within said member and movable, under the influence of gravity as the member changes position relative to the horizontal, longitudinally of said member into and out of engagement with said contact, said element having a sectional size and shape substantially filling said channel whereby the rate of travel of the element longitudinally of said channel is pneumatically controlled.

4. In a gravity controlled switch, a member comprising electrically conducting material and

having a channel therein of uniform sectional size and shape, an electrical contact carried by said member in insulated relation thereto, said contact being exposed in said channel, and a solid electrically conductive element mounted within said member and movable, under the influence of gravity as the member changes position relative to the horizontal, longitudinally of said member into and out of engagement with said contact, the surfaces of said member defining said channel, the surfaces of said conductive element and of said contact being coated with a layer of high electrical conductivity, whereby said conductive element forms a movable switch element electrically connecting said member with said contact when said element engages the contact.

5. In a gravity controlled switch, a straight tubular member having a cylindrical interior space closed at each end, a ball mounted within said member and rollable longitudinally thereof as said member changes position with respect to the horizontal, the external and internal surfaces at least of said ball and of said member respectively being electrically conductive, said ball and the internal surface of said member having a clearance only of the order of .007 of an inch whereby the air in said member serves slightly to damp the movements of said ball, an electrical contact extending into said tubular member in insulated relation thereto in position to be contacted by said ball while in electrical contact with said member, and a bleed opening in said tubular member near each end thereof.

6. In a gravity controlled switch a member comprising electrically conducting material and having a channel therein of uniform sectional size and shape, a ball mounted in said channel and rollable longitudinally thereof as said member changes position with respect to the horizontal, the surfaces of said ball and channel being electrically conductive and the clearance area surrounding the ball within the channel being of the order of less than 3% of the sectional area of the channel whereby the air in said channel serves to retard movement of said ball longitudinally of the channel, and an electrical contact exposed in said channel at an end thereof and in insulated relation with respect to said member in position to be engaged by said ball while in electrical contact with said member.

7. In a gravity controlled switch, a length of cylindrical metal pipe externally threaded at its opposite ends, plugs of electrically insulating material closing the opposite ends of said pipe, collars threadedly engaging the ends of said pipe to hold said plugs in place, studs of electrically conducting material extending axially in said plugs and having heads exposed in the pipe inwardly of the plugs and portions exposed outwardly thereof, and a ball having surfaces of electrically conducting material within said pipe and rollable therein to engage either of said studs by tilting the pipe, said pipe being accurately sized to snugly enclose said ball with sufficient clearance to allow the ball to roll within the pipe at a pneumatically retarded rate.

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