

[54] **PENDULUM ACTUATED ELECTRICAL SWITCH STRUCTURE**

[76] Inventor: **John Eranosian**, Woodside, Calif.

[22] Filed: **Mar. 17, 1972**

[21] Appl. No.: **235,612**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 97,774, Dec. 14, 1971, Pat. No. 3,669,409.

[52] U.S. Cl. **200/61.51, 200/61.52**

[51] Int. Cl. **H01h 35/02**

[58] Field of Search 200/61.45 R, 61.48, 200/61.49, 61.51, 61.52

[56] References Cited

UNITED STATES PATENTS

2,322,549 6/1943 Sorensen 200/61.51

3,057,976	10/1962	Weaver	200/61.45 R
1,908,430	5/1933	Lapsley	200/61.51
3,218,624	11/1965	Zane	200/61.52
1,175,062	3/1916	Johnson	200/61.52

FOREIGN PATENTS OR APPLICATIONS

42,909	8/1887	Germany	200/61.51
--------	--------	---------------	-----------

Primary Examiner—Robert K. Schaefer

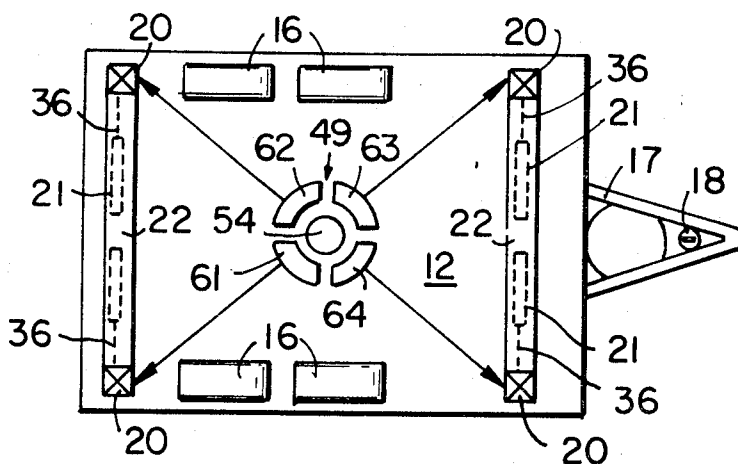
Assistant Examiner—Gerald P. Tolin

Attorney—Robert W. Dilts

[57] ABSTRACT

A novel pendulum actuated electrical control device is disclosed. The use of such device in a system for stabilizing and controlling the attitude of the vehicle with respect to the underlying terrain when stationary is described.

10 Claims, 9 Drawing Figures



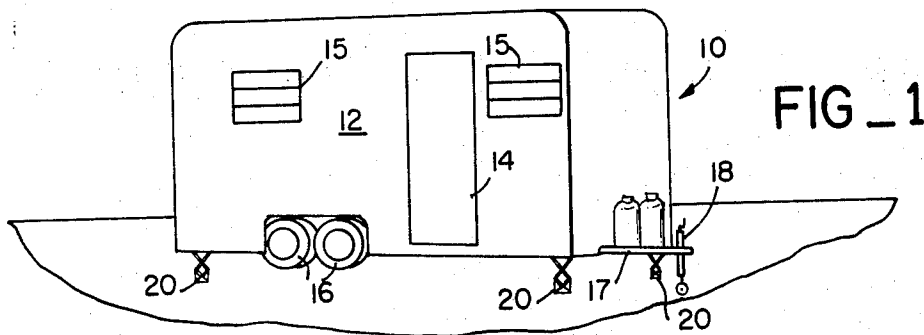


FIG. 1

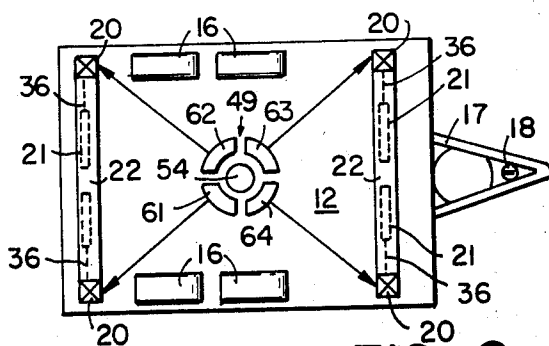


FIG. 2

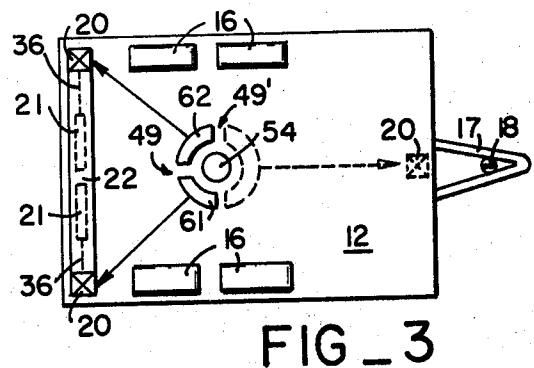


FIG. 3

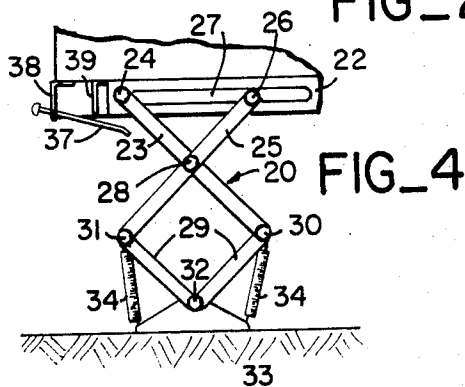


FIG. 4

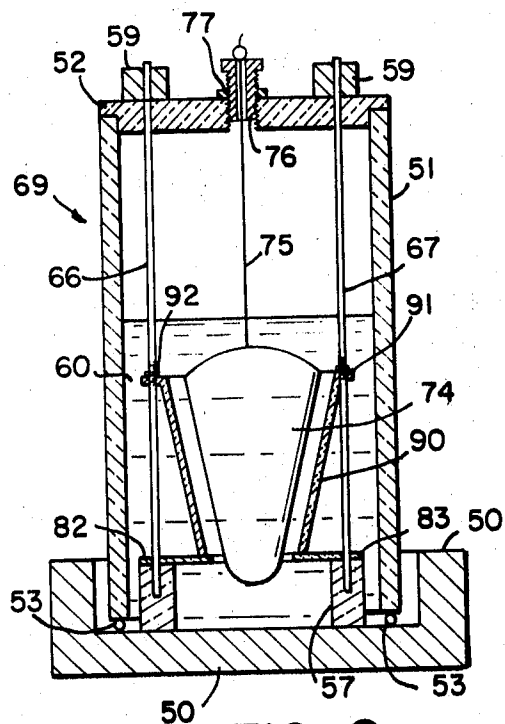


FIG. 8

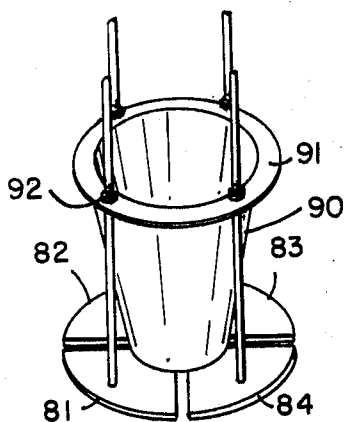


FIG. 9

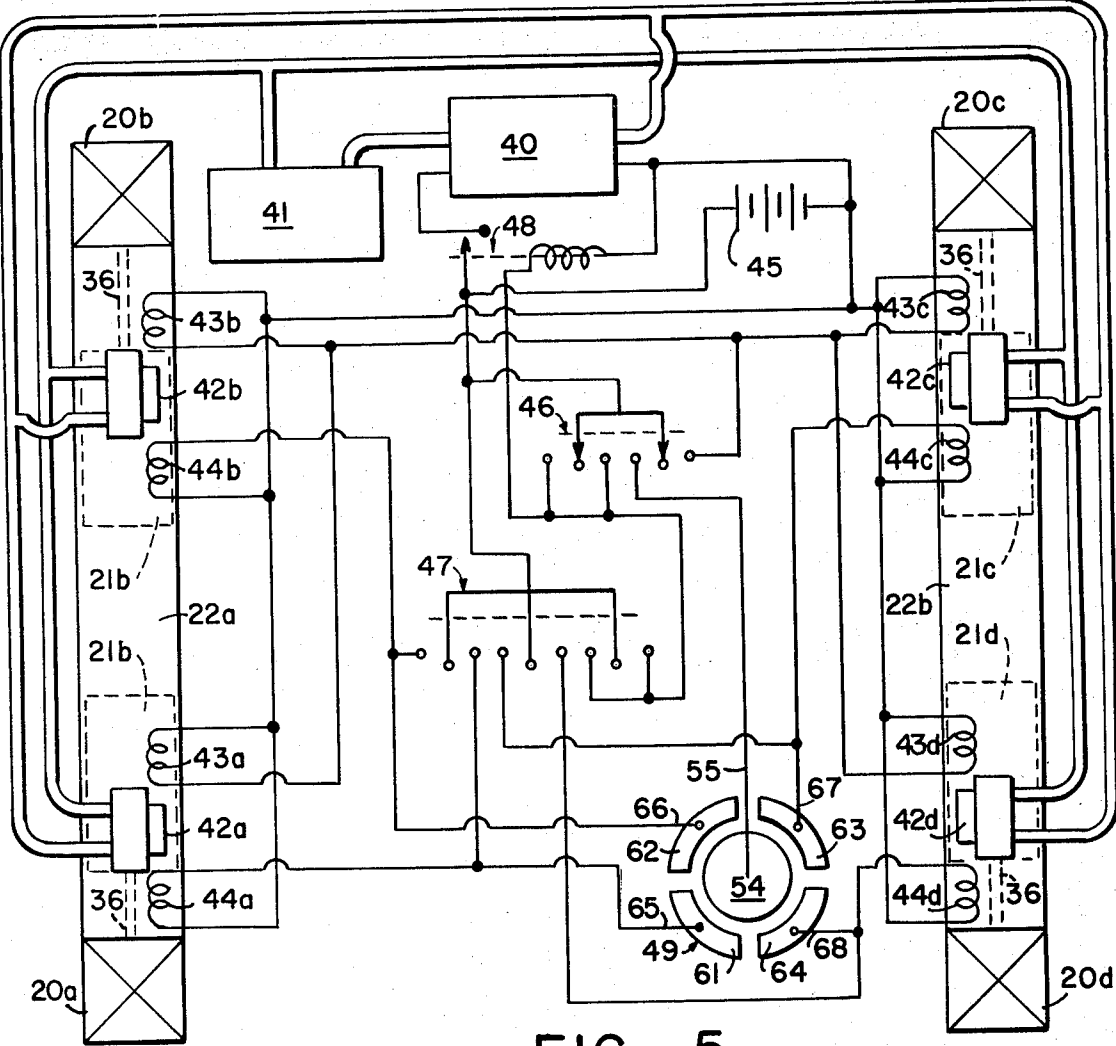


FIG_5

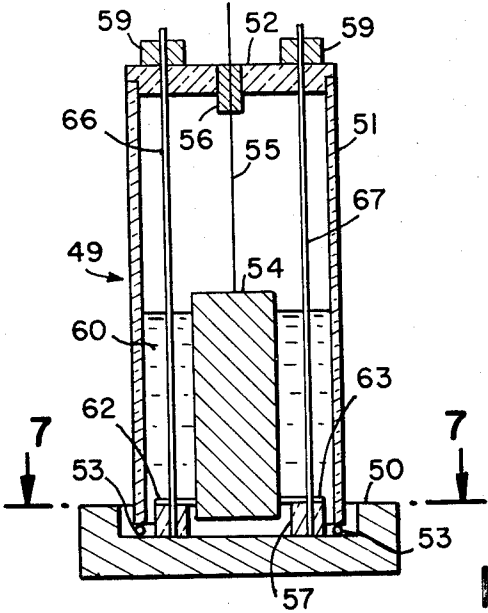


FIG_6

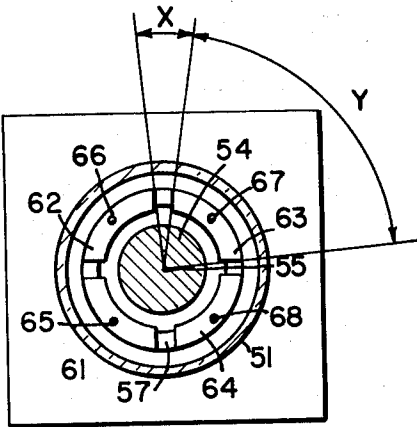


FIG_7

PENDULUM ACTUATED ELECTRICAL SWITCH STRUCTURE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of copending patent application Ser. No. 97,774, filed Dec. 14, 1971, in the name of John Eranosian and entitled "Vehicle Attitude Stabilization and Control System", now U.S. Pat. No. 3,669,409.

BACKGROUND OF THE INVENTION

This invention relates to a pendulum actuated electrical control device and more particularly to a pendulum actuated electrical switch in which the pendulum serves as one of the electrical switch elements thereof.

It is one of the objects of this invention to provide a novel pendulum actuated electrical control device.

It is a further object of this invention to provide a pendulum actuated electrical control device having a plurality of electrical switch elements which may be contacted individually or in pairs by a pendulum which functions as an electrical switch element.

It is a still further object of this invention to provide a pendulum actuated electrical control device including integral means for adjusting the device both in its sensitivity and its relationship to the true horizontal.

It is yet a further object of this invention to provide a pendulum actuated electrical control device which is rugged and relatively insensitive to vibration, shock and the corrosion effects of the atmosphere in use.

SUMMARY OF THE INVENTION

Briefly, a pendulum actuated control device according to this invention comprises a pendulum member and a plurality of electrical contact points defining a first circle of given diameter and radius in a common plane with no one of the electrical contact points spaced more than 15° along the first circle from an adjacent electrical contact point. The electrical contact points are electrically interconnected into two groups of adjacent points, which groups are electrically insulated from each other. Each group of contact points has a contact point spaced not more than 15° along the first circle from the nearest contact point of the other group and each group of contact points includes two contact points spaced from each other at least 60° along the first circle. The pendulum member has an external electrical contact surface defining a second circle having a diameter smaller than the given diameter of the first circle but larger than the given radius of the first circle. The pendulum member is supported for movement in the common plane of the electrical contact points by means adapted to allow the electrical contact surface of the pendulum to move into contact with each of the contact points. The device includes means for making electrical connection to the external contact surface of the pendulum and means for making separate electrical connections to each group of contact points.

DESCRIPTION OF THE DRAWINGS

The foregoing and other objects and features of the subject invention will be more fully understood from the following detailed description when read in conjunction with the drawing wherein:

FIG. 1 is a perspective view of a trailer type vehicle on which a system including a pendulum actuated elec-

trical control device of the invention may be used with advantage;

FIG. 2 is a plan view of the vehicle of FIG. 1 with elements of a system including one embodiment of this invention indicated schematically;

FIG. 3 is a plan view of the vehicle of FIG. 1 with the elements of a system including another embodiment of this invention indicated schematically;

FIG. 4 is a fragmentary view in elevation showing a jack means for use in the system of FIGS. 1-3 in a lowered position;

FIG. 5 is a schematic representation of the electrical and hydraulic circuitry of a system including the pendulum actuated electrical control device in accordance with this invention;

FIG. 6 is a cross-sectional view of one embodiment of the pendulum actuated electrical control device of this invention;

FIG. 7 is a cross-sectional view taken along lines 7-7 of FIG. 6;

FIG. 8 is a cross-sectional view similar to FIG. 6 of a preferred embodiment of the pendulum actuated control device of this invention; and

FIG. 9 is a perspective view of the electrical contact members and funnel member of the device of FIG. 8.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to FIG. 1, a vehicle in connection with which a system including the pendulum actuated electrical control device of this invention may be used with particular advantage is shown in perspective. The vehicle shown is a house trailer 10 comprising a living compartment or body 12 having a floor, walls and roof and provided with a door 14 and windows 15 as appropriate. The body 12 is mounted for movement on its longitudinal axis by means of wheels 16 journaled at the ends of axles extending parallel to the transverse axis of the body 12. As shown in FIGS. 1-3, a pair of wheels is mounted on each side of the longitudinal axis of the body 12. However, many house trailers utilize a single wheel on each side of the longitudinal axis where the weight of the house trailer 10 is low, and it is of course possible to utilize a single wheel located on a longitudinal axis of the trailer. Furthermore, it will be understood that the system shown is applicable to a wide variety of vehicles as well as to a body similar to the body 12 but adapted to be carried on the bed of a truck such as the well-known camper bodies which are widely used with pick-up trucks, for example.

It will be understood that the body 12 is mounted on the wheels 16 through an appropriate spring means to reduce the effect of bumps and jolts (incurred while moving) on the contents of the body 12. The body 12, as shown in FIG. 1, is provided with a tongue 17 by means of which it is connected to the towing vehicle. When disconnected from the towing vehicle, it is customary to support the tongue 17 with respect to the underlying terrain by means of a manually operated jack, as indicated at 18, which jack 18 is usually provided with a wheel for contacting the terrain in order to enable the body to be moved when disconnected from the towing vehicle. It is of course possible to level the longitudinal axis of the body 12 by appropriate manual adjustment of the jack 18. However, the springs by which the body 12 is mounted on the wheels 16 cause such leveling to be unstable at best. In addition, such springs enable the body to sway and jiggle in response to any

change in the distribution of weight within the body, and in fact even wind blowing against the exterior can cause unpleasant swaying due to the resilience of the springs. Furthermore, the attitude of the transverse axis of the body is established by the underlying terrain upon which the wheels 16 rest.

As shown in FIGS. 1-3, the body 12 may be both stabilized and leveled by means of a plurality of jacks 20 extending between the bottom of the body 12 and the underlying terrain. For example, four jacks 20 may be utilized, as shown in FIGS. 1 and 2, one at each of the respective corners of the body 12. By proper adjustment of such jacks 20 with respect to each other, both the longitudinal and transverse axes of the body 12 may be leveled, and in addition the weight of the body may be taken off the springs by which the body is mounted on the wheels 16 to thereby stabilize the body 12 in its level position. However, it will be understood that leveling and stabilization of the body 12 might be accomplished through the use of only two jacks located on opposite sides of the longitudinal axis of the body and both being on the opposite side of the axle (by which the body is mounted on the wheels 16) from the tongue 17 (by which the body is towed), as shown in solid lines in FIG. 3. Successful leveling and stabilization of the body 12 would require that the jack means 18 associated with the tongue 17 be manually adjusted to raise the tongue end of the body 12 above the other end of the body 12 so that when the jacks 20 are subsequently adjusted to provide leveling of the longitudinal and transverse axes of the body 12, the weight thereof would be removed from the wheels 16 and distributed evenly among the jack 18 and the jacks 20.

As best shown in FIG. 4 each jack 20 may comprise a first pair of lever arms 23 pivoted at one of their ends about a pin 24 extending through the end of the tubular metallic beam 22. A second pair of lever arms 25 are pivoted about a pin 26, which is slidably received in a pair of slots 27 in opposite sides of the tubular metallic beam 22. Corresponding lever arms 23-25 of the pairs of lever arms are pivotally connected to each other intermediate their ends by means of a pin 28 which passes through both pairs of lever arms. Thus, when the pin 26 is caused to slide within the slot 27 toward the pin 24, the lever arms 23-25 of respective pairs pivot about the pins 24, 26 and 28 so that the ends thereof move away from the beam 22 in the manner well known in the art. As shown in the figures, two further pairs of lever arms 29 pivoted in the free ends of the pairs of lever arms 23-25 by means of pins 30 and 31 and having their free ends pivoted about a common pin 32 are provided. A foot or bearing member 33 is also pivoted about the pin 32, and springs 34 are connected between opposite sides of the foot 33 and the pins 30 and 31, respectively, to insure that the foot 33 always presents its bearing surface in proper orientation to effectively engage the underlying terrain.

The tubular metallic beam 22 may be square in cross-section and may be affixed to the underside of the floor of the body 12 by any suitable means. The double-acting rams 21 which operate the jacks 20 are contained within the tubular metallic beam member 22. It will be understood that the cylinder of the ram 21 is firmly fastened to the tubular beam member by any appropriate means (not shown) and that the piston rod 36 of the hydraulic ram extends along the longitudinal axis of the tubular beam 22 into operative connection with

the pin 26 of the scissors jack 20. Thus, the extension and retraction of the piston rod 36 of the hydraulic ram 21 forces the pin 26 to slide within the slots 27 toward and away from the pin 24, thereby extending and retracting the jack 20. The scissors jack 20 may be firmly and reliably held in its fully retracted position by means of a rod 37 adapted to extend through apertures in spaced bracket members 38, 39 and under the pin 31 when the jack 20 is in its fully retracted position. Thus, the jack 20 will be prevented from extending into contact with the underlying terrain should the hydraulic pressure in the ram 21 associated therewith decrease while the vehicle is in motion.

As indicated in FIG. 5, all of the hydraulic rams 21 utilized in the system are connected to a common source of pressurized fluid, as indicated by fluid pump 40 and reservoir 41 arrangement. Each of the rams 21 is coupled to the pump 40 and reservoir 41 through a different four-way hydraulic valve 42. Four-way hydraulic valves of many types are well known in the prior art. Such valves include appropriate fluid passageways and mechanical valving elements whereby the pressurized fluid from the pump 40 may be connected to either side of the piston of the hydraulic ram 21, with the other side of the piston of the hydraulic ram 21 being connected to the reservoir 41. In its normal position, the four-way valve, of course, seals both sides of the piston from each other and from the pump and reservoir, thereby enabling the piston of the hydraulic ram to be maintained in a selected position.

It will be understood that if any two jacks 20 of a system in accordance with this invention are simultaneously lowered into contact with the underlying terrain and such underlying terrain is uneven, the downward motion of the first of such jacks 20 to engage the underlying terrain will cease upon engagement until the other jack means has also engaged the underlying terrain. This is due to the fact that any force developed by the first jack means 20 upon engagement with the underlying terrain will be immediately transferred to the second jack means through the hydraulic system. When both jack means are in engagement with the underlying terrain, the force due to the pressurized fluid will be evenly distributed between them so that the vehicle can be raised with respect to the underlying terrain.

It will be understood that each of the hydraulic rams 21 may be actuated independently of the others. The four-way valves 42 are normally closed so that a particular ram will not be connected to the source of pressurized fluid and reservoir unless the four-way valve associated therewith is actuated. Thus, it is possible to exert unequal forces among the various jacks 20 of the system in order to accomplish leveling of the vehicle.

The four-way valves 42 of the system are solenoid-actuated, thus enabling electrical control of the system. The electrical control of the system is particularly desirable in connection with automatic leveling, since it enables the physical location of the various mechanical elements of the system at any point on the vehicle body as convenient or desired. Thus, the four-way valves 42 need not be physically located adjacent the respective rams 21, as suggested by the schematic representation of the system shown in FIG. 10. Instead, the four-way valves may all be physically located in close proximity to the pump 40 and reservoir 41, for example, and appropriate hydraulic lines and electrical wires interconnecting the elements of the system may be mounted on

or under the floor of the vehicle body 12 or on the roof and walls, as convenient and desired.

Referring to FIGS. 6 and 7, one embodiment of the pendulum-actuated electrical switch structure 49 in accordance with this invention is shown. The switch comprises a base 50 which may be of any suitable material, such as metal or plastic, for example a tubular body 51 of insulating material, and a cap 52 of insulating material. One end of the tubular insulating body 51 is sealed to the base 50, as by means of a resilient O-ring, for example, and the cap 52 is fitted into the other end of the tubular insulating body 51. The switch 49 is adapted to be mounted with the longitudinal axis of the tubular insulating body 51 in a vertical position. A pendulum member 54 is suspended within the tubular insulating body 51 from the cap 52, preferably along such longitudinal axis. The pendulum member 54 comprises a heavy mass having a circular electrically conductive surface on the exterior thereof and is suspended from the cap 52 in a manner to enable the mass to swing in any direction. For example, the mass 54 may conveniently comprise a solid metallic cylinder suspended within the tubular insulating body 51 by means of an electrically conductive wire 55 extending between one of its ends and the cap 52. The wire 55 may extend through the cap 52 and is mounted therein by an appropriate insert 56 so that electrical connections may be made to the mass 54. A plurality of metallic electrical contact members 61, 62, 63 and 64 are insulatingly mounted on the base 50 within the tubular insulating member 51 and spaced from each other about the periphery of the mass 54. As shown in FIG. 7, each of the contact members 61-64 provide an arcuate surface adjacent the electrically conducting exterior surface of the mass 54. The contacts are arranged with respect to each other such that the arcuate surfaces each form an arc of a common circle which is concentric with the circular electrically conducting surface on the exterior of the mass 54 and which has a diameter slightly larger than the diameter of the circular electrically conducting surface on the mass 54. The contact members 61-64 may be conveniently mounted on the base 50 by means of a dielectric ring 57, for example, which is appropriately bonded to the base 50. A plurality of electrically conductive rods 65, 66, and 67 and 68, each associated with a different one of the contact members 61-64, extend through the insulating cap 52 and into electrical connection with the contact members 61-64 associated therewith. In addition to providing means for making an electrical connection between elements of the system and the contact members 61-64, the conductive rods 65-68 are mechanically attached to the base 50 and may each have a nut 59 threaded thereon in contact with the insulating cap 52. By selective adjustment of the nut 59 associated with each of the rods 65-68, the longitudinal axis of the tubular body 51 may be adjusted with respect to the base 50 by varying the amount of compression on the resilient O-ring 53 at various points about its periphery. Thus, it will be seen that the relationship between the circular electrically conductive surface on the exterior of the mass 54 and the circle formed by the arcuate inner surfaces of the contact members 61-64 may be adjusted by adjusting the longitudinal axis of the tubular body 51 with respect to the base 50.

It will be seen that if the base 50 of the switch 49 is mounted on a flat surface of the vehicle body 12 which

it is desired to level, then the longitudinal axis of the body 51 is, or can be easily adjusted to be, perpendicular to such flat surface. If the flat surface is not level, then the mass 54 of the pendulum will swing into contact with one of the electrical contact means 61-64, establishing an electrical connection between the electrically conductive surface on the exterior of the mass 54 and the electrically conductive inner surface of the contact means 61-64. In fact, it is possible for the electrically conductive exterior surface of the mass 54 to contact any two adjacent ones of the contact means 61-64 due to the spacing between such contact members. It will be understood that ordinarily the circular exterior surface of the mass 54 would swing into contact with the circular inner surface of a contact member at a single point. However, where such single point of contact between the circular exterior surface of the mass 54 and the circle of which the interior surface of the contact members 61-64 are a part would occur at the space between adjacent contact members, then two points of contact will result, one between each of the adjacent contact members and the circular exterior surface of the mass 54.

It has been found that the amount of spacing X between the contact members 61-64 in order to provide the desired two-point contact under these conditions is not critical. However, such spacing X must be great enough to provide the necessary insulation between the contact members. Similarly, it has been found that the relative diameters of the circular exterior surface of the mass 54 and the circle of which the interior surfaces of the contact members 61-64 are a part is not critical in this regard. However, such relative diameters, the spacing X between contact members, and the length Y of the contact members 61-64 will determine the precision with which leveling may be obtained through the use of the switch 49. It will be understood that the greatest precision in leveling will be obtained where the difference between such diameters and the spacing X between the contact members 61-64 is made as small as practical while making the length Y of the contact members as long as is practical. It has been found that in a practical electrical control device according to the teaching of this invention, the diameter of the mass 54 must be at least equal to the radius of the common circle formed by the arcuate surfaces of contact members 61-64, the spacing X between the contact members 61-64 must not be more than 15° of such common circle and the length Y of contact members 61-64 must be such that each provides at least two contact points spaced from each other by at least 60° along such common circle.

Referring to FIG. 2, it will be seen that, in one embodiment of the system including a pendulum actuated electrical control switch in accordance with this invention, four jack means 20 are used and the switch 49 is provided with four contact members 61-64, each adapted to electrically actuate a different one of the jacks 20, as indicated by the arrows. According to this embodiment of the invention, the jacks 20 are located at the corners of the body 12 of the vehicle, and each of the contact members 61-64 has a circular inner surface forming an arc of more than 80° of the circle of which they each form a part. The switch 49 is positioned so that opposite spaces between the contact members lie on the lines parallel to the longitudinal and transverse axes, respectively, of the vehicle. The switch

49 is connected into the electrical control circuitry of the system such that when the mass 54 thereof swings into contact with one of the contact members 61-64, it will actuate the jack 20 associated therewith, causing the jack to elevate its associated corner of the vehicle body 12. Thus, if the rear of the vehicle body 12 is lower than the forward part thereof, the mass 54 will tend to swing into contact with that contact member 61, for example, corresponding to the lowest corner, thereby actuating the jack located at such corner. As the jack extends, raising the associated corner of the vehicle, the mass 54 will tend to roll or slide along the circular inner surface of the contact member 61 until it reaches the space between the contact member 61 and the contact member 62. The mass 54 then makes electrical contact with both contact members 61 and 62, actuating both jacks simultaneously and raising the rear of the vehicle until it is level with the forward portion of the vehicle, at which point the mass 54 will swing away from both contact members simultaneously.

As shown in FIG. 6, the tubular body 51 may be filled with an insulating oil 60. Such insulating oil will tend to damp any tendency of the mass 54 to oscillate or swing back and forth between contact members in operation. Such insulating oil will also inhibit the formation of insulating coatings on the electrical contact members by corrosion as well as any electrical arcs that might tend to form in air between the mass 54 and a contact member due to the close spacing and electrical potential difference therebetween.

Referring to FIG. 3, it will be seen that a system including the pendulum actuated electrical control switch of this invention may utilize a single pair of jacks 20, one located on each side of the longitudinal axis of the vehicle and rearwardly of the transverse axis thereof. In this embodiment of the invention, the switch 49' would include but two contact members 61 and 62, and the spacing therebetween would lie on a line parallel to such longitudinal axis. As pointed out hereinabove, the jack means 18 associated with the tongue 17 of the vehicle would be used to raise the front of the vehicle body 12 above the rear portion thereof. This would cause mass 54 to swing into contact with one or both of the contact members 61-62 as described above, actuating the jacks 20 to raise the rear of the vehicle body 12 to a level position of the vehicle body 12. As described in connection with the embodiment shown in FIG. 2, the inner surfaces of the contact members 61-62 form arcs of more than 80° of a circle. It will be understood that according to the embodiment shown in solid lines in FIG. 3, automatic leveling of the vehicle body 12 can only occur where the rear of such body 12 is lower than its forward portion. This system could be modified to provide fully automatic leveling by the addition of a single further jack 20, located on the longitudinal axis, as indicated in dotted lines, in which case a third electrical contact member would be included in the switch 49', which third electrical contact member would be provided with an inner surface forming more than 160° of the circle of which the inner surfaces of contact members 61 and 62 are a part. The third contact member would be spaced from contact members 61-62 with such spaces lying on a line parallel with the transverse axis of the vehicle body 12.

Referring to FIGS. 8 and 9, a preferred embodiment 69 of the pendulum actuated electrical control device

according to the teaching of this invention is shown. According to this embodiment of the invention the pendulum 74 is a metal mass having a right conical exterior surface. The contact members 81-84 have arcuate inner surfaces lying in a common plane and each defining an arc of about 80° of a common circle. The exterior surface of the pendulum 74 preferably forms a truncated cone tapering from a base diameter larger than the diameter of the common circle formed by contact members 81-84 to a diameter which is about equal to the radius of such common circle. The truncated apex and of the pendulum 74 is preferably rounded for reasons that will be discussed below. The pendulum member 74 is suspended by an electrically conductive wire 75 extending from the center of its base diameter to a threaded plug 76 which extends through the cap 52 of the device in engagement with cooperating threads in the cap 52. The wire 75 and plug 76 are adapted to suspend the pendulum 74 within the common circle formed by the contact members 81-84. It will be understood that by rotating the plug 76 it may be screwed into or out of the cap 52 and thereby raise or lower the pendulum 74 with respect to the contact members 81-84. This, coupled with conical exterior of the pendulum 74, enables the adjustment of the diameter of the pendulum presented to the contact members 81-84 and the consequent adjustment of the sensitivity of the device. The plug 76 may be provided with a lock nut 77 to enable a given adjustment of the plug 76 to be firmly maintained.

A funnel member 90 having a right conical interior surface disposed congruently about the exterior surface of the pendulum 74 is provided to prevent the pendulum from being permanently displaced from its normal position by shock or vibrational forces incident to its use in vehicles. It will be seen that the minimum and maximum internal diameters of the funnel member 90 are larger than the corresponding minimum and maximum diameters of the pendulum 74. It will also be seen that the minimum diameter of the funnel member is adjacent the contact members 81-84 and slightly larger than the common circle formed by the inner surfaces of such contact members 81-84. The maximum diameter end of the funnel member 90 shown in FIGS. 8 and 9 is provided with an outwardly extending flange 91 having holes therein through which the rods 85-88 pass. The rods 85-88 may be provided with appropriate threads and nuts 92 for securing the flange 91 of the funnel member 90 to hold the funnel member 90 in place. Other appropriate mounting means for the funnel member 90 could, of course, be provided. Thus, if the pendulum member 74 should be jolted in such a way as to cause it to move upwardly against the force of gravity it will tend to be guided back to its normal position by the force of gravity and the interaction of the tapered surfaces of the pendulum 74 and the surrounding funnel member 90. The rounded end of the pendulum 74 will tend to prevent it from wedging in the funnel member or in the common circle formed by contact members 81-84 as it returns to its normal operating position.

It will be seen that the remaining structural elements of the device shown in FIGS. 8 and 9 are substantially the same as those of the device shown in FIGS. 6 and 7. Specifically, the electrical connections may be made in the same way and adjustment of the axis of the tubu-

lar member 51 with respect to the base may be accomplished in the same way.

In the foregoing description, embodiments of the pendulum actuated electrical control device according to this invention are disclosed in but one of the many applications in which such embodiments may be used to advantage. There are, of course, many other electrical systems in which level sensing and control or indication are required or desired. Such additional systems will be obvious to those skilled in the art from the foregoing description and the appended drawings.

It will be understood that the electrical contact members of the pendulum actuated electrical switch according to the teaching of this invention need not be unitary. Instead, it would be possible to construct a pendulum actuated electrical switch according to the teaching of this invention in which the electrical contact members are each made up of a plurality of contact points electrically connected together to form a contact member in accordance with the teaching of this invention provided each electrical contact point is spaced not more than 15° along the circle from an adjacent contact point. It is believed that various modifications in the structural details of a pendulum actuated electrical switch in accordance with the teaching of this invention will be obvious to those skilled in the art and that the pendulum actuated electrical switch of this invention will be modified to adapt it to a wide variety of systems by those skilled in the art.

What is claimed is:

1. A pendulum actuated electrical switch structure comprising:

- a. a plurality of electrical contact defining portions of a first circle of given diameter and radius in a common plane with no one of said electrical contact points spaced more than 15° along said first circle from an adjacent electrical contact point, means electrically interconnecting adjacent ones of said plurality of contact points to each other in two groups, means electrically insulating said two groups of electrical contact points from each other, each of said groups having an electrical contact point spaced not more than 15° along said first circle from the nearest electrical contact point of the other of said groups and each of said groups including two electrical contact points spaced from each other at least 60° along said first circle;
 - b. a pendulum member having an external electrical contact surface defining a second circle, the diameter of said second circle being smaller than said given diameter of said first circle and larger than the radius of said first circle;
 - c. means supporting said pendulum member for movement in said common plane of said plurality of electrical contact points, said supporting means being adapted to allow said electrical contact surface of said pendulum member to move into contact with said electrical contact points;
 - d. means for making electrical connection to said external electrical contact surface of said pendulum member; and
 - e. means for making separate electrical connection to each of said two groups of said plurality of electrical contact points.
2. A pendulum actuated electrical switch structure as claimed in claim 1 wherein each of said two groups of said plurality of electrical contact points and said

means electrically interconnecting said points comprise a unitary metallic member having a concave circular inner surface.

3. A pendulum actuated electrical switch structure as claimed in claim 1 wherein said means supporting said pendulum member comprises a flexible elongated means supporting said pendulum member from a point lying on a line drawn through the center of said first circle and adapted to allow said electrical contact surface of said pendulum member to swing into contact with said electrical contact points.

4. A pendulum actuated electrical switch structure as claimed in claim 1 wherein said pendulum member is made of metal with a conical external surface.

5. A pendulum actuated electrical switch structure as claimed in claim 4 wherein said external surface of said pendulum member forms at least a portion of a right circular cone.

6. A pendulum actuated electrical switch structure as claimed in claim 4 wherein said external surface of said pendulum member forms a truncated cone having a rounded apex.

7. A pendulum actuated electrical switch structure as claimed in claim 1 wherein said plurality of electrical contact points define a full circle and adjacent ones thereof are electrically interconnected into four groups insulated from each other and each group defining an arc of more than 80° of said circle.

8. A pendulum actuated electrical switch structure as claimed in claim 1 wherein said plurality of electrical contact points define a full circle and adjacent ones thereof are electrically interconnected into three groups electrically insulated from each other, two of said groups defining arcs of more than 80° of said circle and the third one of said groups defining an arc of more than 160° of said circle.

9. A pendulum actuated electrical switch structure comprising:

- a. a plurality of electrical contact points defining portions of a first circle of given diameter and radius in a common plane with no one of said electrical contact points spaced more than 15° along said first circle from an adjacent electrical contact point, means electrically interconnecting adjacent ones of said plurality of contact points to each other in two groups, means electrically insulating said two groups of electrical contact points from each other, each of said groups having an electrical contact point spaced not more than 15° along said first circle from the nearest electrical contact point of the other of said groups and each of said groups including two electrical contact points spaced from each other at least 60° along said first circle;
- b. a pendulum member made of metal and having an external electrical contact surface defining a truncated cone with a rounded apex, said truncated cone tapering from a diameter smaller than said given diameter of said first circle to a diameter larger than said given diameter of said first circle;
- c. means supporting said pendulum member for movement in said common plane of said plurality of electrical contact points, said supporting means being adapted to allow said electrical contact surface of said pendulum member to move into contact with said electrical contact points;

11

12

- d. means for making electrical connection to said external electrical contact surface of said pendulum member;
 - e. means for making separate electrical connection to each of said two groups of said plurality of electrical contact points; and
 - f. an insulating member surrounding said pendulum member, said insulating member having a truncated conical internal surface congruous with the external surface of said pendulum member, the minimum diameter of said internal surface of said insulating member being adjacent said first circle and of larger diameter than said first circle.
10. A pendulum actuated electrical switch structure for use in a system for leveling a vehicle, said switch comprising:
- a. a base member having a flat exterior surface adapted to be mounted in contiguous relation to a normally horizontal flat surface of said vehicle;
 - b. a plurality of electrical contact members insulatingly mounted in spaced and electrically insulated relationship to each other on said base member, said electrical contact members each providing a concave electrically conductive surface forming an arc of a common circle of given diameter and radius lying in a plane substantially parallel to the plane of said flat exterior surface of said base;
 - c. a tubular member surrounding said electrical contact members, one end of said tubular member being resiliently mounted on said base with the axis thereof extending in a direction transverse to the plane of said flat exterior surface of said base;
 - d. a cap member closing the other end of said tubular member;
 - e. a pendulum mass having an electrically conductive exterior surface forming a truncated right circular cone tapering at a given angle with respect to the axis thereof from a first diameter which is smaller

- than said given radius of said common circle at the end thereof remote from said cap member to a second diameter larger than said given diameter of said common circle at the end thereof adjacent said cap member, said end of said pendulum mass adjacent said cap member being suspended for free swinging movement in the plane of said common circle from said cap member by an elongated flexible member extending from a point on said cap member lying on the axis of said tubular member to a point lying on the axis of said truncated right circular cone formed by said exterior surface of said pendulum mass;
- f. an insulating funnel member within said tubular member surrounding said pendulum mass and extending from the plane of said common circle toward said cap member, the internal surface of said funnel member forming a truncated right circular cone coaxial with said tubular member and tapering at an angle with respect to the axis thereof at least as great as said given angle of taper of said exterior surface of said pendulum mass from a diameter slightly larger than said given diameter of said common circle at the end thereof adjacent said plane of said common circle to a still larger diameter at the end thereof remote from said plane of said common circle;
- g. means for making electrical connection to said electrically conductive exterior surface of said pendulum mass;
- h. means for making separate electrical connections to said concave electrically conductive surfaces of each of said electrical contact members; and
- i. means for selectively adjusting the transverse direction in which the axis of said tubular member extends with respect to the flat exterior surface of said base.

* * * * *

40

45

50

55

60

65