Jan. 19, 1960 R. M. ZIEGLER, JR 2,921,999

INERTIA SWITCH

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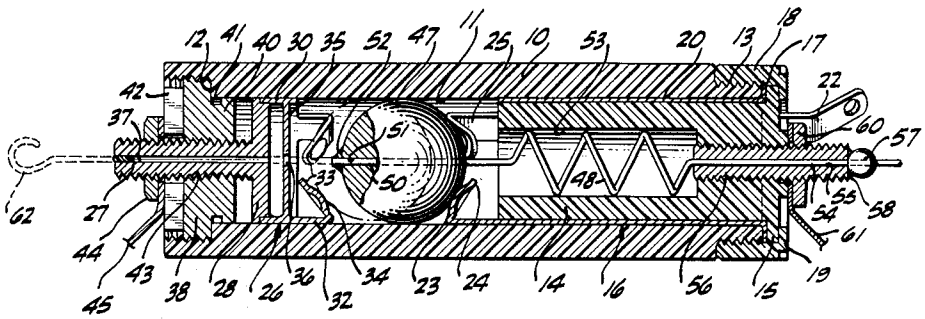


Fig. 1.

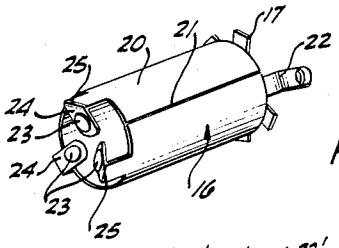


Fig. 2.

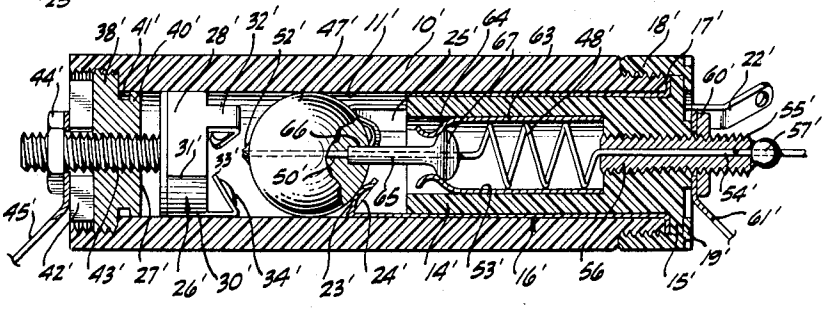


Fig. 4

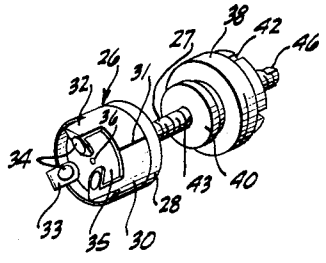


Fig. 3.

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INERTIA SWITCH

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The present invention relates generally to switch mechanisms and relates more specifically to switches of the inertia type, physical movement thereof being adapted to effect interconnection between contact elements.

Heretofore, inertia type switches have been known that employ moving elements, at least a portion of which comprises a weight member. These weight members are usually connected to shafts or arms and movement thereof under inertia induced forces serves to move the weight and shaft or arm. The shafts or arms used in this type of mechanism have generally been arranged in such a manner as to effect closure of contact members. These prior structures have had numerous disadvantages inasmuch as high friction forces are usually present, thus to create lubrication problems. Additionally, these structures have been heavy, physically of a large size, employed many small complex parts, required considerable wiring operations during assembly and were not well suited for mass production manufacturing techniques. In operating characteristics of prior devices, it has been common to employ at least 50% of the weight mass in order to produce a contact force and when this factor is coupled with problems relating to contact cleanliness, many failures of the prior structures have resulted. In prior mechanisms that employ springs of various types, it is desirable that suitable preloading of the springs be accomplished before use of the switch. Prior devices have been constructed in such a manner as to prevent adequate and reliable adjustment means for setting spring preloading.

It is, accordingly, one object of the invention to provide an inertia switch mechanism having features of novelty and functional characteristics to overcome the beforementioned difficulties and problems associated with prior devices intended for a similar purpose.

It is another important object of the invention to provide an inertia switch mechanism that is extremely simple in construction, reliable in operation, efficient in use, relatively inexpensive and of a nature enabling manufacture thereof in mass production situations.

It is a further important object of the invention to provide an inertia switch mechanism wherein a weight member acts physically to connect a plurality of contacts and wherein a wiping action is established between the weight member and the contacts, thereby to promote efficient electrical connection between the contacts and the weight member.

It is still another object of the invention to provide an inertia switch mechanism wherein many of the components thereof are structurally combined, thus to reduce the over-all number of components and provide a more simple and inexpensive structure.

A further important object of the invention is to provide a switch mechanism adapted for operation upon application of inertia forces thereto and wherein a spring biasing means applied to a movable weight may be adjusted for preloading thereof, thus to establish more nearly linear spring rate characteristics.

Other and further important objects of the invention will become apparent from the disclosures in the following detailed specification, appended claims and accompanying drawing, wherein:

Figure 1 is a longitudinal sectional view of the switch mechanism of the present invention and showing the components in position prior to inertia induced movement thereof;

Fig. 2 is an isometric view showing one of the composite contact members;

Fig. 3 is an isometric view showing a subcombination of the assembly of the present switch together with another of the composite contact members; and

Fig. 4 is a longitudinal sectional view similar to Fig. 1, showing a modification of the invention.

With reference to the drawing, it is to be noted that the present inertia switch mechanism comprises a tubular member **10** that may be constructed from any suitable material and is preferably nonconductive. The tubular member **10** has an internal cylindrical bore **11** and a recess **12** with one end thereof. The other end of the member **10** is reduced in diameter and threaded as at **13**.

An insert **14**, of nonconductive material, is disposed in the cylindrical bore **11** and has a flange **15** that is adapted to overlie an end of the member **10**. A contact member **16** is disposed about the insert **14** and between the outer surface of the insert and the bore **11**. The contact member **16** has a plurality of tabs **17** bent from one end thereof and adapted for disposition between the one end of the member **10** and the flange **15**. A threaded sleeve **18** is adapted to engage the threads **15**, the sleeve having a radially inwardly extending flange **19** that is in turn adapted to engage an outer surface of the flange **15** whereby to secure the insert **14** and the contact member **16** in position within the bore **11**. The sleeve **18** is also constructed from a nonconductive material. As shown primarily in Figs. 1 and 2, the contact member **16** further includes a tubular portion **20** that is constructed from a flat sheet of material and rolled into the tubular form, thus defining longitudinally extending, adjacently disposed free edges **21**. To enable electrical connection to the metallic contact member **16**, an integral lug **22** is disposed therefrom and extends through a suitable slot (not shown) in the flange **15**. In accordance with the usual practice, the lug **22** is provided with an opening therethrough to facilitate attachment of a wire lead. The end of the cylinder **20**, remote from the tabs **17**, integrally supports a plurality of contacts **23** that are supported on angularly inwardly directed end portions **24** formed from integral extension portions **25**. The contacts **23** are in the form of dimples in the material of the contact member **16** and the outer raised portions thereof may either be coated with a highly conductive material such as silver or the like, or may have a finite layer of silver deposited thereon.

Another contact member is indicated generally at **26** and is disposed in an end of the bore **11** remote from the insert **14**. With reference to Figs. 1 and 3, the contact member **26** comprises a threaded shank portion **27** having a disc **28** formed integrally on one end thereof. A cylindrical contact carrying member **30** is disposed in an annular groove in the disc **28** and secured thereto as by soldering, for example. The member **30** is similar in construction to the previously described cylinder **20**, being constructed from a rolled sheet of material and having adjacent longitudinal edges **31**. A plurality of integral extension portions **32** are disposed from one edge of the member **30** and have angularly, radially inwardly directed portions **33** integrally disposed therefrom. The portions **33** are adapted to carry dimpled contacts **34**. As shown in Fig. 1, a transversely disposed supporting web **35** is positioned within the member **30** and secured therein by

means of soldering or the like. Additionally, the web 35 is provided with a central opening 36, the shank 27 also being provided with an axial bore 37, the bore 37 and opening 36 being in coaxial alignment.

The cylinder member 20 and the member 30, together with the extension portions 25 and 32 and portions 24 and 33 may be made in a similar manner. The integral nature of the construction enables production thereof in a flat configuration and from a continuous strip that may thereafter be cut off at desired lengths and formed into the final illustrated configuration. Thus, a continuously operating die arrangement may be used, whereby to effect high rate mass production of these integral components. While the contact members hereof are shown as being provided with three equally circumferentially spaced contacts that are carried by the angularly disposed members, it is to be understood that any number of contacts may be provided commensurate with the ultimate use thereof in particular structures. The triangular arrangement of the contacts and the angular disposition thereof provides a kinematic structure as is desirable in the present instance.

An end closure member 38 is threadably disposed in the recess 12 in one end of the tubular member 10, the closure member having a reduced diameter portion 40 which extends into the bore 11. A sealing ring member 41 is disposed in a suitable groove in the portion 40 for cooperation between the closure member 38 and the bore 11. The outer end surface of the member 38 is provided with cross cut grooves 42 to enable application of tools for disposing the closure member in the recess 12. The closure member 38 has a central threaded bore 43 in which the shank 27 is threadably disposed, the outer end of the shank extending beyond the outer surface of the member 38 and having a nut 44 carried thereby, a contact terminal 45 being adapted for disposition between the nut 44 and the outer surface of the member 38, thereby to provide an electrical connection for the contact member 26. The nut 44 also serves to lock the shank 27 with respect to the closure member 38, the shank 27 being provided with flattened areas 46 on the exposed end thereof, whereby to permit application of tools for turning the shank and the contact member 26.

With reference again to Fig. 1, a weight in the form of a sphere 47 is disposed within the bore 11 and intermediate the contacts 23 and 34. The sphere 47 may be made from any suitable preferably dense metallic material, thus to enable both a weight function and a contact connecting function. A tension spring 48 has one end 50 disposed through a bore 51 in the sphere 47 and connected to the sphere as by soldering 52. The spring 48 extends through a central area between the contact portions 24 and is confined within a bore 53 in the insert 14. Another end of the spring 48 has an extension portion 54 that is disposed through a central bore 55 in a threaded stud 56. The stud 56 threadably engages the insert 14 and extends outwardly therefrom. The spring portion 54 has a ball 57 secured thereto and disposed outwardly from the outer end of the bore 55. The ball 57 is secured to the stud 56 as by soldering 58. The outer end of the stud 56 is also fitted with a nut 60 that is adapted to secure the stud against rotation relative to the insert 14 and to confine a terminal 61 about the stud. The terminal 61 serves to provide means for establishing electrical connection with the sphere 47 by way of the stud 56 and spring 48.

In initial assembly of the present device, the contact member 16 and insert 14 are secured in position, together with the sphere 47 and associated spring 48. The portion 50 of the spring 48 is extended outwardly through the opening 36 and bore 37 in the contact member 26 and closure member 38 respectively and provided with a hook shown by the dotted lines at 62 in Fig. 1. The hook 62 serves to provide means by which a predetermined tension may be applied to the spring 48, whereby to establish the force of the sphere 47 against the contacts 23. Thereafter the end portion of the spring 48 is cut off adjacent the soldered joint 52 and the contact member 26, together with the end closure member 38, are again installed in position. The outer end of the bore 37 may thereafter be closed as by any suitable material.

Under influence of acceleration in an axial direction of the tubular member 10, and rightwardly as shown in the drawing, the sphere 47 will be moved leftwardly against the tension of the spring 48 and at a predetermined value of acceleration, whereby to break the normal contact between the sphere and the contacts 23. At a higher value of acceleration, the sphere will have completed its leftward movement to the position shown by the dotted lines in Fig. 1, whereby to make contact with the contacts 34. The relative axial positions of the contacts 23 and 34 are adjusted by use of the shank 27. It is to be noted that as the sphere 47 makes contact with the contacts 23 or 34, the angularly disposed portions 24 or 33 respectively will be deformed, whereby to provide a wiping action between the contacts and the surface of the sphere 47. The spring characteristics of the material of the cylinder 20 and the member 30 serves to return the portions 24 and 33 to their original positions following disengagement thereof by the sphere 47. The sphere 47 is maintained in axial alignment with the contacts 23 and 34 by close confinement thereof within the bore 11. Due to this particular construction, movement of the sphere 47 may be accomplished only upon axial movement of the tubular member 10 and associated structure, lateral movement of these structures having no effect upon the contacts.

In connection with the specific functional characteristics of the present switch arrangement, it should be pointed out that the contact closing value of acceleration is a function of the rate of the spring 48, the mass of the sphere 47 and the spacing between the sphere and the contacts. Additionally, the acceleration sensitivity of such a structure is a function of the mass of the sphere and the spring rate. In many installational situations, the desired spring rates for a particular range of acceleration may easily be obtained through use of beryllium copper springs, thereby to minimize the series resistance to the moving contact as defined by the sphere 47. The contact portions 24 and 33 are preferably flexible enough to deflect slightly upon contact by the sphere, thus to provide the before-mentioned wiping action. The use of the present axially movable contacts not only permits a lower contact resistance but also insures greater reliability for the structure. Additionally, accurately dimensioned spheres are readily obtainable and are relatively inexpensive and compact, as compared to pivoted weight arrangements. The particular kinematic arrangement of the contacts and the specific structural characteristics thereof serve to eliminate any tendency of the sphere to bounce relative to the contacts and no damping of the action is required. The relatively large available adjustment of the axial relative positions of the contacts 23 and 34 serves to compensate for tolerance differences in the device and for varying spring rates. Furthermore, since the connections are relatively widely spaced, insulation resistance as between these contacts is relatively high and the possibility of voltage breakdown is extremely low.

In Fig. 4 a modification of the invention is shown wherein like parts are indicated by single primed reference characters. In this form of the invention, the insert 14′ has a spring element 63 disposed within the recess 53′ and secured therein by means of a press fit. A plurality of spring members 64 are disposed from one end of the spring element 63. Additionally, a portion 50′ of the spring 48′ has a sleeve 65 secured thereto, one end of the sleeve being disposed in a suitable recess 66 in the sphere 47′. The other end of the sleeve 65 is provided with an annular enlargement 67 that normally is contained within the confines of the spring members 64.

In this modified form of the invention, it may thus be seen that as inertia forces are applied to the sphere 47′,

the force of the spring member **64** must be overcome before the sphere may move in a leftward direction. When the force of the spring members **64** is overcome, the enlargement **67** will be pulled therethrough, thus providing a snap action for engagement of the sphere **47'** with the contacts **34'** and for separation of the sphere from the contacts **23'**. The spring member **64** serves also to retain the sphere **47'** in contact with the contacts **34'** until a reduction in inertia forces reaches a level to permit the spring **48'** to again draw the enlargement **67** through the spring member **64**. A construction of this type insures positive action of the device when engaging the contacts and less time between release of one set of contacts and engagement with another.

Having thus described the invention and the present embodiments thereof, it is desired to emphasize the fact that many further modifications may be resorted to in a manner limited only by a just interpretation of the following claims.

I claim:

1. An inertia electrical switch apparatus comprising, in combination: an elongated tubular housing; closure members threadably engaging each longitudinal end of said housing; a pair of contact carrying structures, one of said structures comprising a tubular portion having means for retaining said portion in association with one of said closure members and in one end of said housing, the other of said structures comprising a tubular portion; means for longitudinally adjustably connecting said other of said structures to another of said closure members; a plurality of contacts carried by each of said structures and disposed in opposed spaced relationship within said housing; a spherical weight disposed in said housing intermediate said contacts; tension spring means connected with said weight and said one of said closure members for biasing said weight into normal contact with contacts carried by one of said structures, inertia forces being adapted longitudinally to move said weight into contact with contacts carried by said other of said structures; and means for providing independent electrical connection with said contact structures and said weight, said connection with said weight including said tension spring means.

2. An inertia electrical switch apparatus comprising, in combination: an elongated tubular housing; closure members threadably engaging each longitudinal end of said housing; a pair of contact carrying structures, one of said structures comprising a tubular portion having means for retaining said portion in association with one of said closure members and in one end of said housing, the other of said structures comprising a tubular portion; means for longitudinally adjustably connecting said other of said structures to another of said closure members; a plurality of contacts carried by each of said structures and disposed in opposed spaced relationship within said housing, said contacts being disposed at an acute angle relative to an axis of said housing and in spaced circumferential relationships to each other on each of said structures; a spherical weight disposed in said housing intermediate said contacts; tension spring means connected with said weight and said one of said closure members for biasing said weight into normal contact with contacts carried by one of said structures, inertia forces being adapted longitudinally to move said weight into contact with contacts carried by said other of said structures; and means for providing independent electrical connection with said contact structures and said weight, said connection with said weight including said tension spring means.

3. An inertia electrical switch apparatus comprising, in combination: an elongated tubular housing; closure members threadably engaging each longitudinal end of said housing; a pair of contact carrying structures, one of said structures comprising a tubular portion having means for retaining said portion in association with one of said closure members and in one end of said housing, the other of said structures comprising a tubular portion; means for longitudinally adjustably connecting said other of said structures to another of said closure members; a plurality of resilient contacts carried by each of said structures and disposed in opposed spaced relationship within said housing; a spherical weight disposed and laterally closely confined in said housing intermediate said contacts; tension spring means connected with said weight and adjustably connected said one of said closure members for biasing said weight into normal contact with contacts carried by one of said structures, inertia forces being adapted longitudinally to move said weight into contact with contacts carried by said other of said structures, said spherical weight contacting said contacts with a wiping action; and means for providing independent electrical connection with said contact structures and said weight, said connection with said weight including said tension spring means.

4. An inertia electrical switch apparatus comprising, in combination: an elongated tubular housing; closure members threadably engaging each longitudinal end of said housing; a pair of contact carrying structures, one of said structures comprising a tubular portion having means for retaining said portion in association with one of said closure members and in one end of said housing, the other of said structures comprising a tubular portion; means for longitudinally adjustably connecting said other of said structures to another of said closure members; a plurality of resilient contacts carried by each of said structures and disposed in opposed spaced relationship within said housing, said contacts being disposed at an acute angle relative to an axis of said housing and kinematically arranged in spaced circumferential relationships to each other on each of said structures; a spherical weight disposed and laterally closely confined in said housing intermediate said contacts; tension spring means connected with said weight and adjustably connected to said one of said closure members for biasing said weight into normal contact with contacts carried by one of said structures, inertia forces being adapted longitudinally to move said weight into contact with contacts carried by said other of said structures, said spherical weight contacting said contacts with a wiping action; and means for providing independent electrical connection with said contact structures and said weight, said connection with said weight including said tension spring means.

5. An inertia electrical switch apparatus comprising, in combination: an elongated tubular housing; an insert in one end of said housing; a closure member threadably engaging the other end of said housing; a pair of contact carrying structures, one of said structures having a tubular portion disposed about said insert and tab means disposed over an end of said housing; a threaded retainer carried by said one end of said housing for securing said insert and said one of said structures in position; shank means for longitudinally adjustably connecting the other of said structures to said closure member; a plurality of resilient contacts carried by each of said contact carrying structures and disposed within said housing in opposed spaced relationships, said contacts being arranged in groups of three, disposed at equal acute angles relative to an axis of said housing and kinematically arranged in spaced circumferential relationships in each group thereof; a spherical weight disposed and laterally closely confined in said housing intermediate said contacts; a tension spring disposed in a recess in said insert having one end secured to said weight and the other end adjustably connected with said insert whereby to bias said weight into normal contact with one of said groups of contacts as carried by said one of said structures, inertia forces being adapted longitudinally to move said weight into contact with the group of contacts carried by said other of said structures, said spherical weight deflecting said contacts upon engagement therewith to provide a wiping action therebe-

tween; and means providing independent electrical connection with said contact carrying structures and said weight, said electrical connection with said weight including said tension spring.

6. An inertia electrical switch apparatus comprising, in combination: an elongated tubular housing; an insert in one end of said housing; a closure member threadably engaging the other end of said housing; a pair of contact carrying structures, one of said structures having a tubular portion disposed about said insert and tab means disposed over an end of said housing; a threaded retainer carried by said one end of said housing for securing said insert and said one of said structures in position; shank means for longitudinally adjustably connecting the other of said structures to said closure member; a plurality of resilient contacts carried by each of said contact carrying structures and disposed within said housing in opposed spaced relationships, said contacts being arranged in groups of three, disposed at equal acute angles relative to an axis of said housing and kinematically arranged in spaced circumferential relationships in each group thereof; a spherical weight disposed and laterally closely confined in said housing intermediate said contacts; a tension spring disposed in a recess in said insert having one end secured to said weight and the other end adjustably

connected with said insert whereby to bias said weight into normal contact with one of said groups of contacts as carried by said one of said structures, inertia forces being adapted longitudinally to move said weight into contact with the group of contacts carried by said other of said structures, said spherical weight deflecting said contacts upon engagement therewith to provide a wiping action therebetween; leaf spring means disposed in said insert recess; an enlargement carried by and disposed from said weight, said enlargement being adapted for cooperation with said leaf spring means to release said weight with a snap action upon inertia induced or spring biased movement thereof; and means providing independent electrical connection with said contact carrying structures and said weight, said electrical connection with said weight including said tension spring.

References Cited in the file of this patent

UNITED STATES PATENTS

2,431,027	Busacker et al.	Nov. 18, 1947
2,475,728	Smith	July 12, 1949
2,552,969	Holman	May 15, 1951
2,787,678	Burggren	Apr. 2, 1957
2,835,759	Waldow	May 20, 1958