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P. P. SCHWAB

3,527,906

CENTRIFUGAL SWITCH

Filed June 6, 1969

FIG. 1

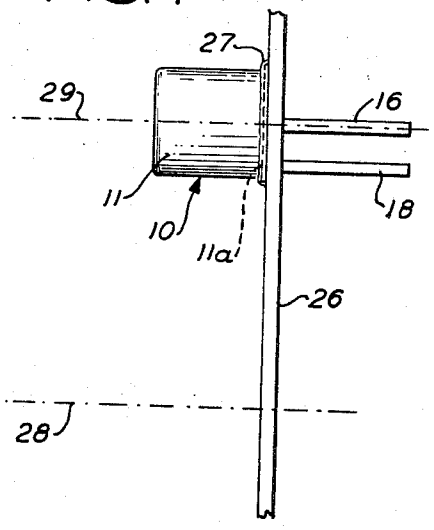


FIG. 2

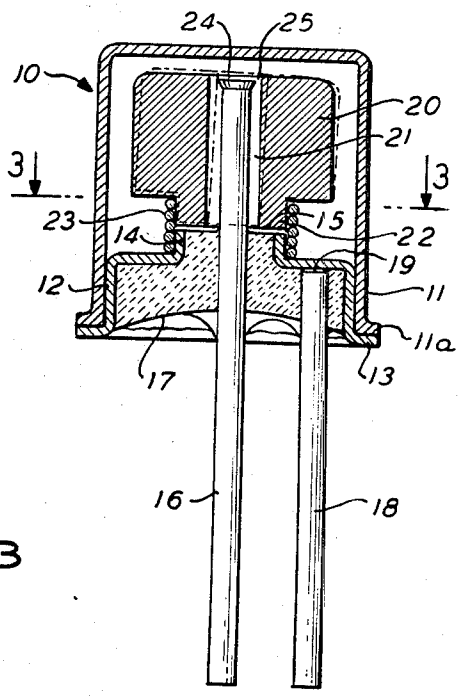
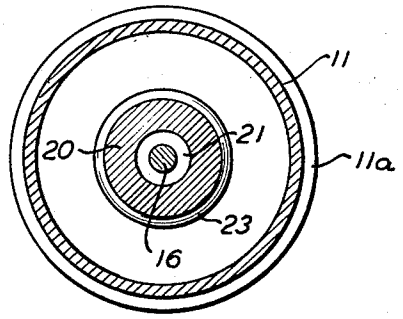


FIG. 3



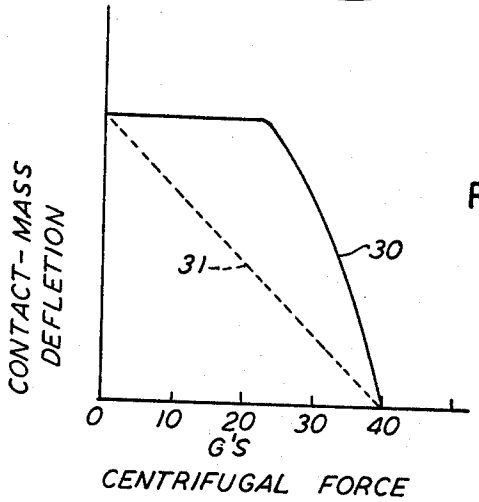


FIG. 4

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CENTRIFUGAL SWITCH

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U.S. Cl. 200—80 6 Claims

ABSTRACT OF THE DISCLOSURE

A miniature centrifugal switch of a rugged shockproof construction is provided for triggering ballistic fuses of projectiles. The switch comprises a metal cylindrical case mounted for revolving movement about an axis parallel to its longitudinal axis. A movable conductive mass serving also as a switch contact is mounted on an end wall of the case through a helical spring to permit the mass to be deflected sidewise by centrifugal force. However, the spring is pretensioned—i.e., wound tightly on itself—so that the mass is not deflected by increasing centrifugal force until a predetermined rotational speed is reached about an axis parallel with the central longitudinal axis through the helical spring and mass.

The design requirements for ballistic switches are extremely rigid in that the switches must be of miniature size, must meet rigid shockproof and vibration proof requirements, must experience no physical change after years of storage under wide temperature and humidity conditions, and must operate dependably within close limits of a specified rotational speed.

An object of the present invention is to provide a novel and economical design of a centrifugal switch which meets these rigid requirements.

Other objects and features of the invention will be apparent from the following description and the appended claims.

In the description of my invention reference is had to the accompanying drawings, of which:

FIG. 1 is a view showing the mounting of the present centrifugal switch device relative to its rotational axis;

FIG. 2 is a diametrical sectional view of the switch device taken along its longitudinal axis;

FIG. 3 is a cross sectional view taken on the line 3—3 of FIG. 2; and

FIG. 4 is a plot of contact-mass deflection versus centrifugal force during the revolving of the switch.

The present centrifugal switch device has a cylindrical case **10** comprising a cylindrical cup **11** formed by deep drawing as of nickel-plated copper. The cup is formed during the drawing operation with flanged edge **11***a* at its open end. Typically, the size of the case is approximately .2" long and .21" in diameter. The case has a shallow cup-shaped header **12** of Kovar metal (nickel-iron alloy) fitted into the open end of the cup **11**. The header has a peripheral radially extending rim **13** which is seated against the rim **11***a* of the cup **11** and is welded or braised thereto. The central portion of the header is formed with an annular inwardly extending flange **14** forming a central cylindrical opening **15**. A first terminal pin **16** extends centrally through the opening **15** and is sealed to the header by a glass medium **17**. A second terminal pin **18** is braised at **19** to the header **12** and encased at its tip also by the glass medium **17**.

The header **12** constitutes a supporting base for the internal parts of the switch, permitting the switch therefore to be fully assembled on the header before the latter is mounted on and braised to the cup **11**. The switch comprises a cylindrical mass **20** having an axial opening **21** extending therethrough and having a cylindrical extension **22** at its outer end, which is of reduced diameter equal to that of the flange **14** on the header. The mass **20** has a clearance spacing on all sides from the case **10** and occupies about 50% of the internal space in the case. The mass is made of any suitable material having the desired specific gravity, and is nickel and gold plated to provide it with good surface conductivity, since it serves also as a contact of the switch, as will appear.

A helical spring **23** is pressed at one end onto the flange **14** and at the other end onto the extension **22** of the mass **20**, and may be braised at both ends to these parts. This spring provides a yieldable support on the case for the contact mass **20**. The spring convolutions are wound tightly onto each other to pretension the spring so that it tends to hold the mass rigidly in centered relation to the case. However, as will appear, a sidewise force on the mass lateral of the case may bend the spring sidewise allowing a sidewise deflection of the mass when the force exceeds a critical value.

The central pin **16** extends longitudinally through the mass **20** with a clearance spacing from the wall of the axial opening **21**. This pin has a frustoconical tip **24** at its end which is at a uniform spacing from the surrounding wall **25** of the opening **21**. The terminal pin **16** is preferably made of Kovar and the tip **24** thereof is nickel and gold plated since it serves as a contact of the switch. When the switch is closed electrical connection is made between the terminal pins **16** and **18** via the header **12**, spring **23** and contact mass **20**. The use of nickel and gold plating of the portions forming the switch contacts assures very low resistance between the contacts under light pressure and protects the contact areas from film formations which would increase the contact resistance. Further, to this same end, the case **10** is evacuated of air and is then filled with inert nitrogen preferably also with some helium for leak detection purposes. Low electrical resistance from the contact mass **20** to the terminal pin **18** is achieved by using a stainless steel spring **23** which is copper flashed and also nickel and gold plated and by both nickel and gold plating the flange **14** on the header **12**.

As is shown diagrammatically in FIG. 1, the present switch device is mounted with its base end flat against a support **26**. The terminal pins **16** and **18** extend through the support—which may be a printed circuit board—and are secured thereto as by soldering. Additionally, the case may be secured to the board as by an epoxy resin **27**. The support **26** is considered as having a rotational freedom of movement about an axis **28** parallel to the longitudinal axis **29** through the switch device. The spacing of the rotational axis **28** from the longitudinal axis **29** is approximately .5".

The switch contacts are to remain open during revolving movement of the switch device about the axis **28** until the speed reaches 1800 r.p.m. and the contacts are to reopen when the rotational speed falls about 100 r.p.m. below this value. The switch is to be capable of repeating this operation after being subjected to a mechanical shock of 13,000 G's; also, the switch must be capable of withstanding storage up to ten years duration under all environments of temperatures from .80° F. to 170° F. and of humidity from .5% to 95%. The stringent requirements of avoiding any switch misoperation under heavy conditions of shock and vibration, and of then operating dependably under the above-specified rotational conditions have been met reliably by securing the contact mass to the case through a helical spring wound tightly on itself so that it is pretensioned and serves as a rigid column until a specified centrifugal force is applied to the mass. For example, the pretensioning of the spring **23**

enables it to support the mass **20** as a rigid column without any sidewise deflection from centrifugal force until the specified rotational speed is reached causing a sudden opening of the *s* spring convolutions. This is illustrated by the plot in FIG. 4 showing that the mass **20** is held stationary with respect to the case as the centrifugal force builds up to about 25 G's, and that with increasing centrifugal force there is a rapid, sharp flexure of the spring indicated by the curved line **30**. Without the pretensioning of the spring the mass would be moved gradually with increasing centrifugal force indicated by the straight line **31** with a resultant indefinite contact closure.

I claim:

1. A centrifugal switch comprising a metal case mounted for revolving movement about a given rotational axis, a mass in said case spaced from the walls thereof, a yieldable support in said case for said mass comprising a pretensioned helical spring secured at one end to said case and at the other end to said mass on a medial axis through said case parallel to said given rotational axis whereby said mass is deflected with sidewise beinding of said helical spring when the centrifugal force of the mass reaches a critical value determined by the pretensioning of said spring, a first terminal pin insulatedly mounted in a wall of said case and having an end contact at said medial plane coacting wiith a contact area on said mass forming an electric switch operable by said deflection of the mass, and a second terminal pin on said case for said switch connected to said contact area via said case, helical spring and conductive surface of said mass.

2. The centrifugal switch set forth in claim **1** wherein said case comprises a cylindrical cup and a header fitted in the open end of said cup and welded thereto, and wherein said helical spring iis secured to said header.

3. The centrifugal switch set forth in claim **2** wherein said mass is a conductive body of cylindrical shape supported with clearance on all sides from said case, said mass having a reduced diameter portion on one end wall extending toward said header and said header having an opening surrounded by a rim flange of te diameter of said reduced portion of said mass, and said helical spring being fitted onto and secured to said reduced diameter portion at one end of said rim flange at the other end.

4. The centrifugal switch set forth in claim **2** wherein said case is evacuated of air and filled with an inert gas, and wherein the surfaces in said case completing the circuit of said switch are plated with a noble metal.

5. A centrifugal switch having a metal cylindrical case mounted for revolving movement about a given rotational axis parallel to the longitudinal axis of the case, said case comprising a cylindrical cup provided with a rim flange and a metal header fitted into the open end of said cup against said rim flange and joined in sealed relation thereto, said header having a central opening, a cylindrical conductive mass in said case having an axial opening, a helical spring mounted at one end on an end wall of said case and secured at the other end to said mass for supporting said mass in a centered position in said case spaced from the walls thereof, said spring being pretensioned to constitute a rigid column for holding said mass fixed in said case until the centrifugal force on the mass reaches a critical value, a first terminal pin extending through said opening of said header and into said axial opening of said mass in spaced relation thereto, said pin being hermetically sealed to said header and having an end portion forming a switch contact coacting with the surrounding contact wall of said axial opening, and a second terminal electrically connected to said case.

6. The centrifugal switch set forth in claim **5** wherein the opening in said header is surrounded by an inwardly extending rim flange, said axial opening in said mass is extended throughout the length thereof, said helical spring is fitted at one end onto said rim flange of said header, and said first terminal pin is extended substantially through the full length of the axial opening of said mass and is flanged at the end thereof forming a circular switch contact coacting with the sourrounding wall of said axial opening forming a set of normally open switch contacts closed by sidewise deflection of said mass when the centrifugal force on said mass reaches said critical value causing said helical spring to be bent sidewise.

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H. J. HOHAUSER, Assistant Examiner

U.S. Cl. X.R.

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