Feb. 23, 1960 K. M. KIEL 2,926,226

MERCURY SWITCH

Filed Jan. 10, 1946

FIG. 1

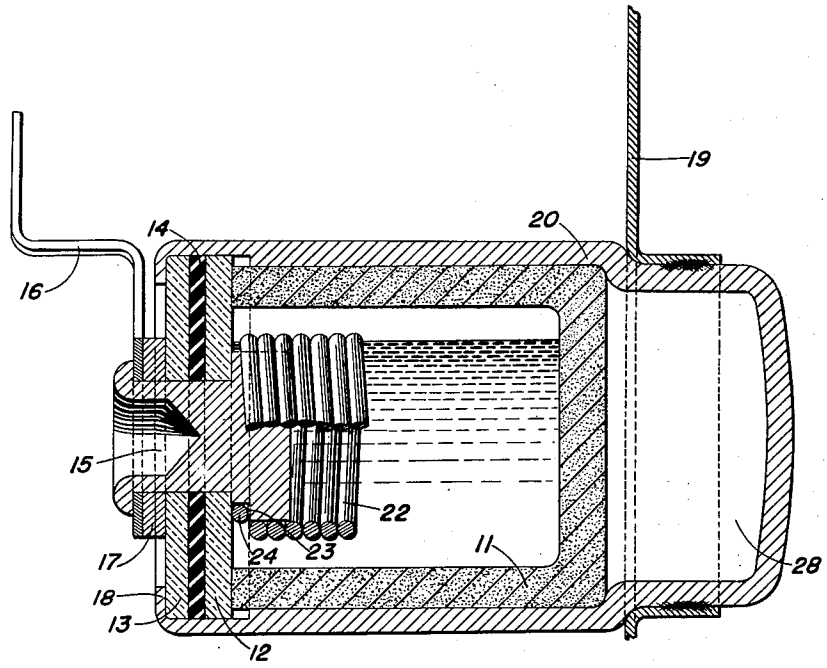


FIG. 2

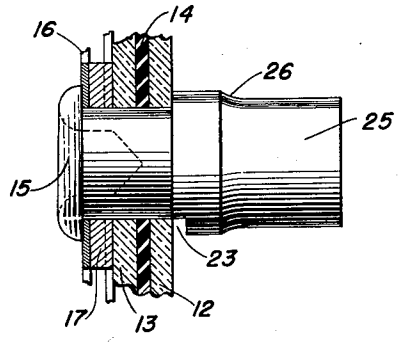
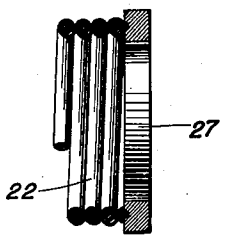


FIG. 3



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United States Patent Office 2,926,226 Patented Feb. 23, 1960

2,926,226

MERCURY SWITCH

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Application January 10, 1946, Serial No. 640,281

4 Claims. (Cl. 200—80)

The present invention relates to mercury switches of the type described in the copending patent application of Samuel M. Darr, Serial No. 617,366, filed in the United States Patent Office on September 19, 1945, entitled "Centrifugal Switch," now Patent #2,901,569, and assigned to the same assignee as the present invention. More specifically, it relates to a switching device having normally short circuited electrical contacts adapted to be opened when the device is subjected to centrifugal force. The two contact elements are normally placed in circuit with each other by a mass of electrically conductive liquid such as mercury. Conventionally, one of the contact elements is a metallic container and the other is a metallic post or lug disposed within the container and held spaced therefrom by solid insulation. The container is made of conducting material of sufficient porosity to permit the mercury to flow therethrough under the high pressures produced by centrifugal force. Sintered nickel powder is a preferred material. However, since centrifugal force varies as the square of angular velocity, the pressure, and hence the rate of mercury flow increase rapidly with increasing speed of rotation. This has an undesirable effect on the operation of such switching devices in one application in which they are of particular utility. In this application a switching device of the character indicated is installed in a projectile, the longitudinal axis of the switch being normal to the projectile spin axis. It is desirable to render the time of opening of the metallic contacts dependent on the existence of centrifugal force during spin and on the porosity of the container, but to decrease the dependence of this time on the magnitude of centrifugal force and on projectile rate of spin. For example, if a given projectile spins with extreme rapidity it is desirable to compensate for the rapid mercury flow by requiring the mercury to flow a greater distance before breaking contact. Conversely, if the spin rate is lesser, the mercury should flow a lesser distance.

In order to offset the above-mentioned undesired action, the inner contact element is, in accordance with the invention, made extensible by shaping it as a helix or the like, with its longitudinal axis in the direction of the centrifugal force. The helix elongates when subjected to centrifugal force and maintains contact with the escaping mercury for a longer time than would be a rigid post. The greater the centrifugal force, the greater the elongation of the helix.

A specific purpose served by such a switching device is to act as a safety means in a projectile, by short-circuiting the electrical leads of a firing squib until the projectile has reached a safe distance from the gun. A firing squib or electrically operable primer is a prior-art igniting device for detonating the projectile and is actuated by electrical currents generated in a fuze by a target influence.

The invention will be clearly understood by referring to the accompanying drawing in which:

Fig. 1 is a longitudinal sectional view of a switch embodying the invention in a preferred form;

Fig. 2 is a fragmentary detail view showing a modified stud suitable for incorporation in the Fig. 1 embodiment;

Fig. 3 is a fragmentary detail view of a modified construction showing a weight added to the spring of Fig. 1 and the spring extended as in operation.

The switch illustrated in Fig. 1 comprises a cup or container **11** made of porous conducting material, preferably sintered nickel powder. This cup is sealed at one end by a subassembly comprising discs **12** and **13** of rigid insulating material and an interposed soft rubber disc **14** of yieldable material. This subassembly is pierced by a conducting stud **15**. This stud is one contact of the switch. Conductor **16** is electrically attached to the stud, a washer **17** serving to space said conductor away from the disc **13**, so as to clear flange **18**. The other conductor **19** makes contact with the can **11**, through a metal casing **20**. To ensure mechanical strength as well as electrically good contact, it may be spot welded to said casing **20** at two opposite points as shown.

The stud carriers a spring **22**, preferably pre-tensioned and made of steel, which is secured to the stud, as by deforming its inner end and securing said end in a slot **23** in said stud. The spring has its inner end **24** formed as a chord, which slips into the chordal notch **23** in stud **15**. Alternatively, the inner end of the spring may be be spot welded to the stud, or both the chordal construction and the welding may be used together. The spring optionally may carry a weight **27** at its outer end, which may be secured by spot welding as indicated in Fig. 3.

While the stud illustrated in Fig. 1 is relatively short it may be made longer at its inner end, as shown in Fig. 2. Here the stud has an extension **25** of somewhat reduced diameter, that will clear the inside of spring **22**. A curved portion or fillet **26** connects these two portions, to make it easier to put the spring into place in manufacturing the device. The extension serves the purpose of keeping the spring from flexing into contact with cup **11**.

Casing **20** has a closed end **28** which defines a sump, adapted to receive the mercury which has penetrated through the pores in the end of container **11**. Air pressure in the sump may equalize with that in the cup **11** by a return flow of air through the cylindrical wall of the cup, thus preventing the mercury flow from being impeded by the compression of air in the sump that would otherwise occur.

In operation, it will be understood that the switch device is installed in the body of a projectile, with the longitudinal axis of the device perpendicular to the longitudinal axis of the shell, and with the stud end radially inward. Thus the spin of the shell in flight produces centrifugal force tending to cause mercury flow. As a result, two things happen: The mercury, which normally nearly fills container **11** and short-circuits spring **22** thereto, is thrown against the end of the container and flows through the pores therein at a rate determined by the velocity of spin of the projectile. Eventually, enough of the mercury will pass into the sump **28** to break contact between spring **22** and container **11**.

The spring **22**, however, stretches, due to centrifugal force, by an amount also depending on angular velocity, and thus delays the instant at which the breaking of contact occurs. Thus the safety interval during which the switch device remains in a short-circuit condition may be controlled and made uniform despite great differences in the rate of spin of various shells.

While a specific embodiment of the invention has been disclosed, it will be obvious that the same is merely

illustrative and that many details may be changed without departing from the scope of the invention.

It should also be understood particularly that while mercury has certain advantages as the conductive liquid, such as high specific gravity and ready availability, and is therefore at present preferred, other liquid conductors may be substituted, for example, a liquid alloy containing potassium and sodium, or even a solution acting as an electrolyte.

I claim:

1. In a centrifugally operable electrical switch, a deformable contact member adapted to be strained by centrifugal force a conductive liquid which is in electrical contact with said member when the switch is at rest, the liquid being thrown radially outward by the centrifugal force when rotation occurs, and means providing delayed outward escape of the liquid, whereby the time the liquid remains in contact with the contact member depends inversely on the escape rate and also directly on the extent to which said contact member is strained.

2. An electrical switch comprising a container having one end closed, said container being made of electrically conductive material having fine pores therein, an insulating closure at the other end of the container, an electrical contact supported by said closure in spaced relation to said container, a mass of conductive liquid in said container sufficient to short-circuit said contact and said container, said container being adapted to be supported for rotation about an axis substantially transverse to its own axis so that centrifugal force due to the said rotation forces the liquid toward the said closed end of the container and out through the pores thereof, and means comprising a resilient member carried by and electrically connected to said contact and forming a continuation thereof to maintain the short circuit between said container and said contact for a time dependent upon the degree of extension of said resilient member due to the action of centrifugal force on its own mass.

3. A switch comprising a container having one end closed, said container being made of electrically conductive material having fine pores therein, an insulating closure at the other end of the container, an electrical contact supported by said closure in spaced relation from said container, said contact comprising a stud and a helical metallic spring secured to the stud near its insulated end, a mass of mercury in said container sufficient to short circuit said contact and said container said container being adapted to be supported for rotation about an axis substantially transverse to its own axis so that centrifugal force due to said rotation strains said spring and simultaneously forces the mercury toward the closed end of the container and out through the pores thereof, and an enclosure for said container having a sump to receive said mercury.

4. A switch comprising a container having one end closed, said container and end being made of electrically conductive material having fine pores therein, an insulating closure at the other end of the container, an electrical contact supported by said closure in spaced relation to said container, a mass of mercury in said container sufficient to short circuit said contact and said container, said container being adapted to be supported for rotation about an axis substantially transverse to its own axis so that centrifugal force due to said rotation forces the mercury toward said closed end of said container and out through the pores thereof, and extensible conductive means secured to said contact and responsive to centrifugal force to suffer a strain corresponding to the rate of said rotation, thus delaying the breaking of the short circuit in accordance with said rate of rotation.

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