July 7, 1970 V. HOROWITZ 3,519,965

ROTATING PLUNGER FOR MERCURY DISPLACEMENT RELAY

Filed Nov. 17, 1967

FIG.1

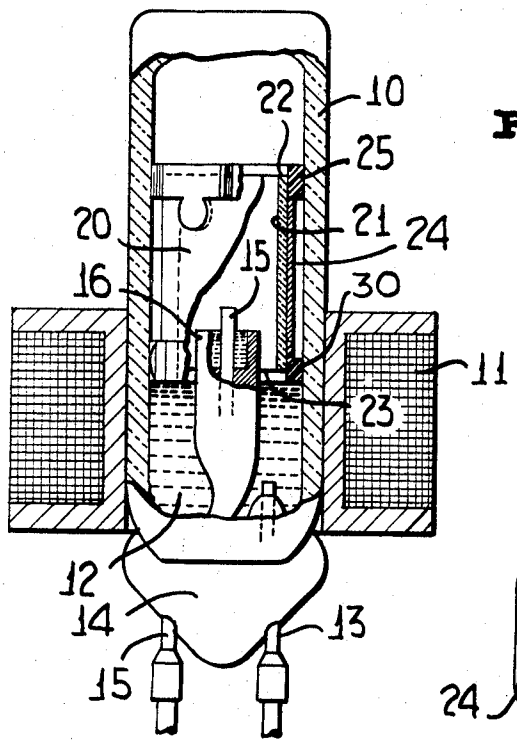


FIG.2

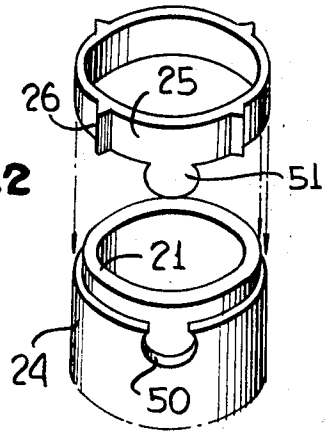


FIG.3

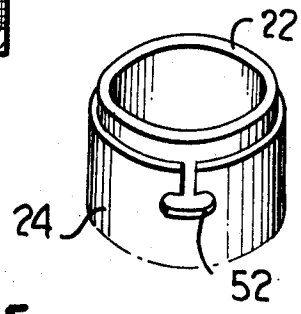


FIG.4

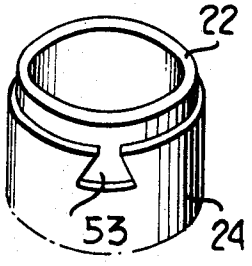


FIG.5

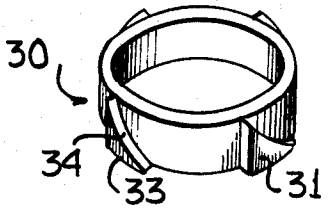


FIG.9

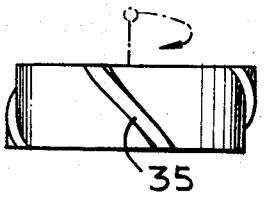


FIG.6

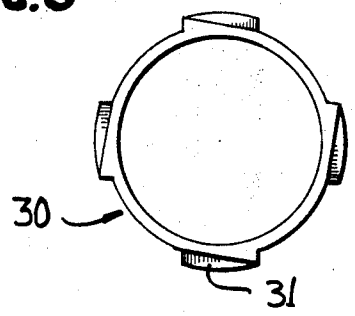


FIG.8

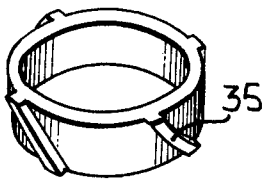


FIG.10

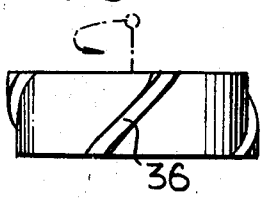
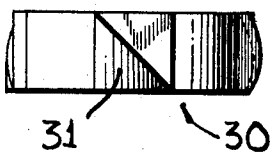


FIG.7



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ROTATING PLUNGER FOR MERCURY DISPLACEMENT RELAY

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Int. Cl. H01h 29/02
U.S. Cl. 335—52 10 Claims

ABSTRACT OF THE DISCLOSURE

A plunger type mercury switch is provided with a ring of Kel-F or Teflon or other low friction plastic, extending about and protruding above the plunger, and a further ring of the same material extending about and protruding below the plunger. The upper ring contains protrusions which serve to guide the plunger in its envelope. The lower ring includes protrusions so shaped that each cycle of energization and de-energization of the switch causes a slight net rotation of the plunger, and the rings provide cushioning of the plunger at the ends of its travel.

BACKGROUND OF THE INVENTION

The envelope of a plunger type mercury switch may be glass or metal, or the like. The plunger, in translating lengthwise of the envelope during operation of the switch develops friction with the envelope, the plunger wears, and the life of the switch is reduced. In switches of this type small stand-off bearing surfaces are employed, which space the plunger from the envelope. The bearing surfaces may be of various shapes, usually being knobs, or hemispheres, and may be made of plastic material which is virtually frictionless. Typical of such substances are Kel-F, which is the trade name for chlorotrifluoroethylene sold by Minnesota Mining & Manufacturing Company, or Teflon, which is the trade name for polytetrafluoroethylene sold by Du Pont. Prolonged life tests indicate that a plunger tends to assume one angular position with respect to its envelope, so that wear takes place always identically, and life is reduced. The present invention employs stand-offs which cause a slight rotation of the plunger with each operation, the net rotation being in one sense. The offsets extend beyond the normal confines of the plunger, so that they act in substitution of the cushioning springs which are normally employed.

The concept of providing a rotatory plunger is provided in the U.S. patent to McKinney, No. 2,973,417, but this is accomplished by a helicl coil wound around the plunger. No cushioning action is provided.

SUMMARY OF THE INVENTION

Two rings are secured about the two ends of a plunger of a mercury displacement type relay, which are shaped to provide low friction stand-offs and also to effect turning of the plunger with each actuation as well as to provide cushioning at each termination of plunger travel.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in front elevation of a mercury relay switch according to the invention;

FIG. 2 is an exploded view in perspective of a portion of a plunger employed in the system of FIG. 1;

FIGS. 3 and 4 are views in perspective of alternative designs for a tab receiving recess shown in FIG. 2;

FIG. 5 is a view in perspective of a rotatory annulus employed in the relay switch of FIG. 1;

FIG. 6 is a top view of the structure of FIG. 5;

FIG. 7 is a side view of the structure of FIG. 5;

FIG. 8 is a view in perspective of a modification of the annulus of FIG. 5;

FIG. 9 is a side view of FIG. 8; and

FIG. 10 is a view in perspective of a modification of the structure of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 is the sealed envelope of a solenoid operated switch, and may be fabricated of glass or metal, or the like. The operation solenoid is **11**. The envelope **10** contains a quantity of mercury **12** in its lower end. A first lead **13** extends into the envelope **10** through its bottom pinch seal **14**, to a level which assures that it will always contact the mercury **12**. A second lead **15** extends through pinch seal **14** and in insulated relation to the mercury **12**, being exposed only above the level which the mercury attains when the switch is not energized. An insulating cup **16** surrounds the exposed end of the lead **15**, and normally contains a small quantity of mercury. The electrodes **13**, **15** are then unbridged by mercury **12** when the level of the mercury is low, and is bridged when that level is high.

A plunger **20** rides internally of the envelope **10**. When undepressed and floating, as illustrated, the level of mercury **12** is low, and when pulled down, the level of mercury **12** is high and the switch is closed.

Plunger **20** includes an internal ceramic liner **21**, surrounded except near its top and bottom edges, **22**, **23**, by a ferromagnetic sleeve **24**, preferably of stainless steel. Extending about the top of the liner **21** and beyond it and abutting against the upper edge of sleeve **24**, is an annulus **25** preferably fabricated of moldable plastic composed of 80% of nylon and 20% of Teflon. Teflon or nylon or Kel-F alone may be used, or these may be impregnated, as with glass fibers, etc.

Protruding radially from the annulus **25** are preferably for equally spaced spacers **26**, preferably of triangular configuration so that the only line contact is made between the annulus **25** and the envelope **10**.

Secured about the bottom end of the ceramic liner **21** is a further annulus **30**, which protrudes beyond liner **21** and abuts against the lower edge of sleeve **24**. Spaced about the outer diameter of annulus **30** are preferably four spacers or stand offs **31**. These may have various shapes. In FIGS. 5–7, inclusive, each stand off **31** has a horizontal bottom wall **33** and a slanted top wall **34** which may make an angle of about 45° with the bottom wall. In consequence, when the plunger is pulled down there is no turning movement exerted on the plunger, but when the plunger rises, the plunger tends to turn counterclockwise, as seen from below, as mercury flows along slanted top wall **34**.

Variants of the shape of stand-off protrusions may be resorted to. In FIGS. 8 and 9, ribs **35** making an angle of 135° with the horizontal may be employed, and in FIG. 10, ribs **36** making an angle of 45° with the horizontal may be employed. The precise angle employed is not critical; it being essentially necessary only that there be sufficient asymmetry of vertical pressures on the ribs, on upward and downward movements of the plunger, respectively. This asymmetry is achieved, in FIGS. 8–10, by the differences in force required to pull down the plunger and that which occurs on release of the plunger due to its buoyancy. In models of the system tested by us rotation occurred on both downward and upward motions of the plunger, but the latter was greater. So in FIG. 9 there is a net rotation clockwise, and in FIG. 10 a net rotation counterclockwise, as seen from above.

The plastic rings **25**, **30**, molded directly to ceramic liner **21**, provide rotation of the plunger and thereby eliminate wear of the envelope at any one location, i.e.,

wear is uniform over the inner surface of the envelope. In addition, smooth damping action occurs, which insures smooth silent operation, i.e., without chattering due to oscillation of the plunger. The usual springs are dispensed with, which enables the plunger to proceed more deeply into the mercury pool, increasing the buoyancy of the plunger while decreasing the quantity of mercury required.

In FIG. 2 is illustrated a recess **50** pre-formed in ferro-magnetic sleeve **24**, into which is filled a tab **51** extending from annulus **25**. A similar expedient may be adopted in respect to each of the annuli, **25** and **30**, to assure that these remain fixed with respect to the plunger **20**. Alternative shapes for recess **50** are illustrated at **52** and **53** of FIGS. 3 and 4.

While I have described and illustrated one specific embodiment of my invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be restorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. In a mercury switch having a cylindrical envelope containing at least two contacts extending internally thereof, and having a pool of mercury and a magnetic cylindrical plunger buoyant in the pool, the combination of a resilient annulus secured about said plunger and axially extending beyond one of its ends and located only adjacent said one of its ends, said annulus having outward discrete protrusions at a greater diameter than the outer diameter of said plunger but smaller than the inner diameter of said envelope and being fabricated of low friction plastic non-metallic material.

2. The combination according to claim **1** wherein said protrusions are shaped to provide asymmetrical rotary forces on movement of said plunger in opposite directions longitudinally of said envelope.

3. The combination according to claim **2** wherein said protrusions are ribs making an acute angle with respect to the longituidnal axis of said plunger of about 45°.

4. The combination according to claim **1** wherein said plunger includes a ceramic liner and a surrounding magnetic shell, the ends of said shell being spaced from an end of said liner to expose an area of liner, said annulus being mounted on said area.

5. In a mercury switch having a cylindrical envelope containing at least two contacts extending internally thereof, and having a pool of mercury and a magnetic cylindrical plunger buoyant in the pool, the combination of a resilient annulus secured about said plunger and extending beyond one of its ends and located only adjacent said one of its ends, said annulus supporting means including outward discrete protrusions at a greater diameter than the outer diameter of said plunger but smaller than the inner diameter of said envelope, which extend at an angle to the axis of said cylindrical envelope selected to provide asymmetrical rotary forces on movement of said plunger in opposite directions longitudinally of said envelope.

6. A plunger for a mercury relay switch of the type including an envelope containing a plunger immersed in a pool of mercury, wherein said plunger includes a ceramic liner, a ferromagnetic sleeve secured on said liner, said sleeve leaving exposed areas of said liner adjacent the ends of said liner, and plastic annuli secured about said exposed areas and extending longitudinally beyond the liner in one direction and into abutting relation with an edge of said sleeve in an opposite direction, whereby said sleeve provides a buffer for said ceramic liner and is located by said edge of said sleeve.

7. The combination according to claim **6**, wherein each of said annuli includes discrete protrusions providing bearing surfaces between said plunger and said envelope.

8. The combination according to claim **7** wherein said annuli are fabricated at least in part of a fluoroethylene.

9. The combination according to claim **8** wherein the protrusions of one of said annuli are shaped to provide surfaces oriented to generate forces tending to generate net rotation of said plunger in one sense in reseponse to longitudinal flows of said mercury longitudinally of said one of said annuli alternately in opposite directions.

10. A plunger for a mercury relay switch of the type including an envelope containing a plunger floating in and partially immersed in a pool of mercury and constrained to be further immersed in said pool of mercury in response to energization of a relay coil, said plunger being ferromagnetic and including an annulus, said annulus being normally at least partially immersed in said mercury and including a configuration arranged to rotate said plunger differentially in response to reciprocating axial movements of said plunger.

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U.S. Cl. X.R.

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