Dec. 9, 1941. P. S. BEAR ET AL 2,265,681

MERCURY SWITCH

Filed Oct. 4, 1939 2 Sheets-Sheet 1

Fig. 1.

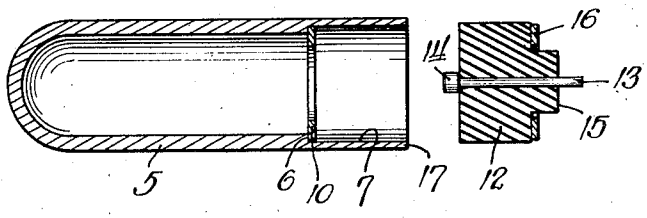


Fig. 2.

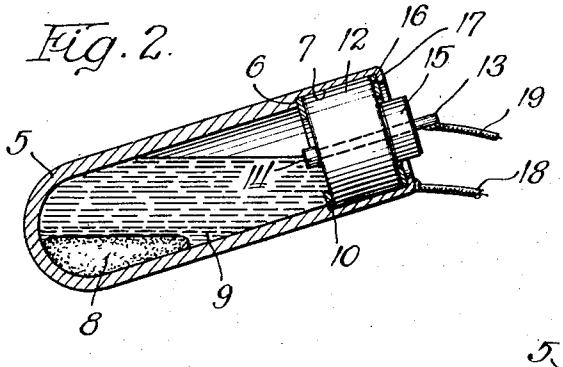


Fig. 4.

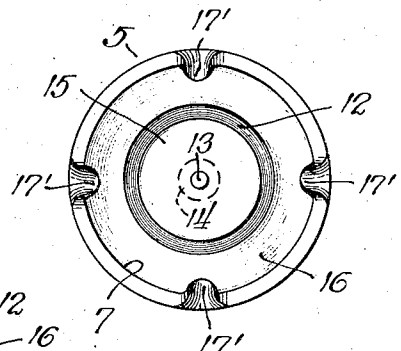
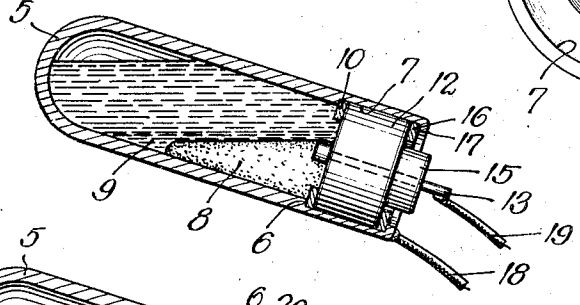


Fig. 3.



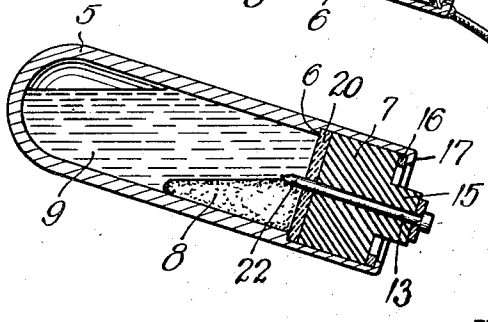


Fig. 5.

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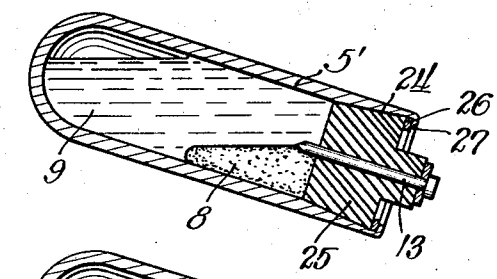


Fig. 6.

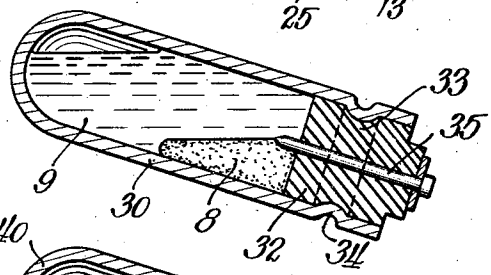


Fig. 7.

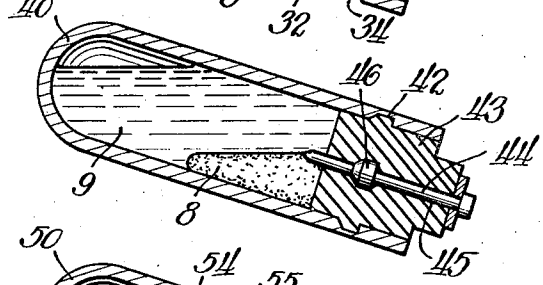


Fig. 8.

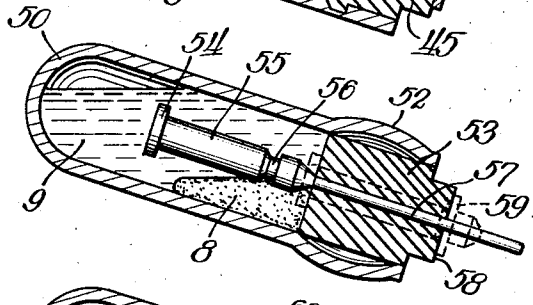


Fig. 9.

Fig. 10.



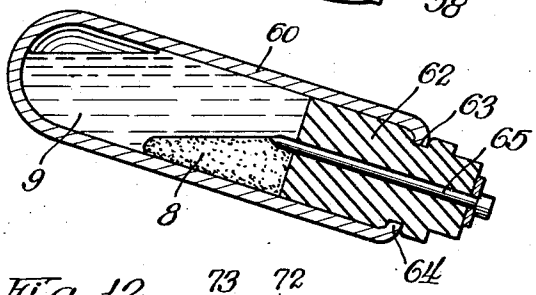
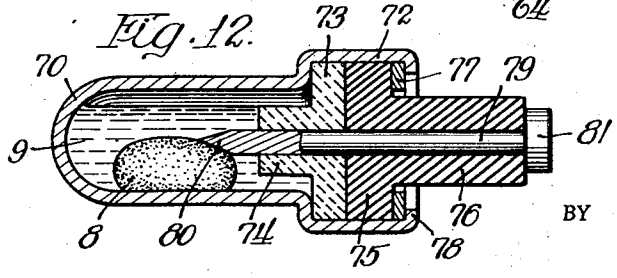


Fig. 11.

Fig. 12.



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MERCURY SWITCH

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Application October 4, 1939, Serial No. 297,806

16 Claims. (Cl. 200—152)

This invention relates to mercury switches, and more particularly is directed to mercury switches of the metal envelope type to be employed in low voltage circuits such as used in automobile light systems and the like.

More particularly, the present invention is directed to switches adapted to operate on battery currents used for lighting the interiors of compartments, such as trunk compartments, glove compartments, and engine compartments of vehicles, the switches being attached to the hinged cover closing such compartments and being tilted into switch operating position upon opening of such cover.

One of the primary objects of the present invention is to design a switch that will be extremely simple to assemble, will comprise relatively few parts, and will be capable of mass production at very small cost. In this connection we have designed a switch of the general type shown in the copending application of Paul S. Bear, Serial No. 745,842, filed September 28, 1934.

The present invention contemplates the provision of a metal envelope which is preferably cup-shaped, and at its open end is provided with a counterbored portion forming an internal radial shoulder or tapered seat. Seated in this end is an insulating plug carrying an electrode which projects outwardly of the end thereof. The plug is suitably compressed into sealing engagement with the envelope wall by spinning over the end of the envelope, or spinning the envelope into a groove in the plug, and the shank of the electrode is insulated by the plug radially with respect to the metallic envelope. Plugs of this type can be formed in multiple cavity molds and can therefore be produced very economically, while the switch envelopes can be screw machined parts which are also capable of economical production. The electrode carried by the insulating plug can comprise an ordinary nail, or a cold headed shank piece of suitable length and size with the head end thereof forming the contact surface against which the body of mercury is adapted to engage. This nail is preferably driven through the plug in such manner as to be tightly gripped therein, and preferably, the shank of the nail is of the type that is corrugated or finned to insure locking engagement of the shank within the plug. From the above it will be apparent that the production of the switch can be made very economically and that the assembly is very much simplified, as compared to the normal types of metal envelope mercury switches.

Other objects and advantages of the present invention will be more apparent from the following detailed description which, taken in conjunction with the accompanying drawings, will disclose to those skilled in the art the particular construction and operation of a preferred form of the invention.

In the drawings:

Figure 1 is an exploded view taken on the transverse section through the switch;

Figure 2 is a sectional view showing the switch in its "off" position;

Figure 3 is a corresponding view showing the switch in its "on" position;

Figure 4 is an end elevation of a slightly modified construction;

Figure 5 is a sectional view through a modified form of switch having a tapered plug seat;

Figure 6 is a similar view of a still further modified form of switch;

Figures 7 to 9, inclusive, are similar views showing different means for holding the plug in position in the envelope;

Figure 10 is an elevational view of the clamping ring employed in Figure 9;

Figure 11 is a sectional view of a still further modified form of the invention; and

Figure 12 is a corresponding view of a still further modified form of switch.

Considering now the drawings in detail, we provide a switch envelope 5 which may be formed of iron or steel, and which, at its open end is provided with a counterbored portion 7 forming the radially extending shoulder 6 with the main body portion of the switch.

In manufacturing the switch, a body of mercury 8 is first introduced therein, and over this is disposed a body of alcohol 9, it being understood that prior to this, all parts of the switch have been thoroughly washed in alcohol or any other suitable medium to remove any impurities or foreign matter therefrom. When the mercury and alcohol in the proper quantities have been introduced into the switch envelope 5, the ring 10 is pressed in position on the shoulder 6 forming a stop for limiting the inward movement of the insulating plug 12.

The plug 12 is preferably formed of rubber which has been molded into shape, and is a substantially unitary hard mass with limited elastic properties. We have found that rubber of the type used in the mallet heads of rubber mallets has the desired characteristics for the purposes

which we require, and is not affected by alcohol or other liquid fills of the type contemplated at the temperature at which these switches operate. Such rubber is molded so that its outside diameter is very slightly greater than the counterbored portion 7 of the envelope 5. By means of suitable compression members, the plug 12 is forced into the end of the switch envelope with its inner face moving into abutment against the ring 10. The electrode 13 of the plug may comprise an ordinary finish nail, or a cold headed electrode pin, which is driven through the plug, preferably, there being a slight center opening formed in the plug first so that only the head 14 thereof projects from the inner face of the plug. With the plug and electrode thus in position in the end 7 of the switch, the shank of the electrode is radially insulated from the envelope wall by means of the cylindrical extension 15 on the plug which projects outwardly a distance sufficient to insure that there can be no direct leakage path between the shank and the envelope wall.

After the electrode and plug have thus been positioned, the ring 16 is applied about the outer face of the plug 12, having an inner diameter such that it is spaced from the extension 15 and pressure is applied thereon to slightly bulge the rubber plug 12 to insure its sealing engagement with the surface 7 of the envelope. The outer edge of the envelope indicated at 17 is then spun over, thereby holding the parts in compressed sealed engagement in the end of the envelope and preventing any leakage past the rubber or electrode. The retaining rings 10 and 16 are employed for the purpose of preventing bulging of the rubber when the spinning pressure is applied, and also preventing any possible shearing of the rubber on the shoulder 6 of the envelope. When the switch has thus been sealed, it is in condition for operation, it being understood that no evacuation of the interior of the switch is provided since we have found that the alcohol, or a liquid fill such as triethanolamine, is sufficient to pick up contamination within the switch, leaving the mercury clean and allowing no deposits of mercury globules which might hold the circuit closed. Also, the alcohol and rubber are of such character that there is no inter action therebetween which might tend to destroy the switch.

With the switch in the position shown in Figure 2, it will be apparent that the body of mercury 8 is entirely out of contact with the electrode head 13, and the circuit through the switch connected thereto by the conductors 18 and 19 secured respectively to the shell 5 and to the shank of the electrode 13 is open. When the switch is tilted from the position shown in Figure 2 to that shown in Figure 3 the body of mercury 8 moves longitudinally within the envelope 5 to provide for bridging contact between the envelope 5 and the electrode head 14. This completes the circuit through the switch, and this circuit will remain closed until the envelope is again tilted in the opposite direction.

In Figure 4 we provide for retaining the plug in compressed position by staking over only certain portions 17' of the outer edge of the envelope, since little internal pressure is produced in a switch of this type. It is understood that suitable means is employed for initially producing the axial compression, and that the staking merely retains this pressure on the plug.

In Figure 5 we have disclosed a modified form of switch construction as compared with that shown in Figures 1 to 4, in which the metallic ring 10 is replaced by a ceramic or refractory washer 20 which extends entirely across the face of the plug 7 and is seated against the shoulder 6 formed in the envelope 5. The outer end of the envelope is sealed in the manner previously described to retain the plug in compressed position between the washer 20 and the washer 16.

In this form of the invention it is contemplated that the switch envelope may be evacuated, and for this purpose, the electrode 13 is disposed in inverted position, that is, it is driven through the plug 7 and through the washer 20 from the outer end of the envelope, after the envelope has been evacuated and filled through the opening in the plug 7 which the shank 13 of the electrode is adapted to close. This opening in the plug 7 is of smaller diameter than the shank 13, but is sufficiently large to allow evacuation and filling of the shell after the plug has been compressed into sealed engagement with the end of the envelope. When the nail like electrode is then driven through the plug, it expands the opening into tight sealing engagement with the lateral surface thereof and the tip end portion 22 extends inwardly of the refractory 20 to provide an electrode spaced from the shell with which the body of mercury is adapted to make contact when the switch is tilted into the position shown in Figure 5.

Considering now the form of the invention shown in Figure 6, this is similar to that described in connection with Figure 5, except that the envelope 5' is provided with a frusto-conical outer end portion 24 forming a wedge-shaped opening into which the tapered plug 25 is adapted to be pressed, the plug under such pressure forming a perfectly tight seal with the surface 24. The plug is retained in position by means of the retaining ring 27 over which the end 27 of the shell 5' is spun. It will be noted that with this construction no washer or facing is provided at the inner end of the plug 25. The electrode 13 is of the form described in connection with Figure 5, and is adapted to be driven into place after the mercury 8 and liquid fill 9 have been introduced into the envelope through the opening through which the electrode is driven.

In Figure 7 we have provided a metal envelope 30 which has inserted in the open end thereof the plug 32 provided with an annular recessed surface 33. The plug 32 which is of resilient insulating material when introduced into the envelope at a distance such that the outer face thereof is flush with the end of the envelope, is locked in position by spinning an inwardly directed bead 34 into the envelope shell about the groove 33. This effectively locks the plug against axial movement in either direction and the envelope may then be filled with mercury 8 and liquid 9 and then completely closed by means of the electrode 35 being driven through the center of the plug in the manner shown. This provides a very simple type of switch in which no counterboring in the envelope or successive drawing operations thereon are required, and the spinning operation may be readily accomplished at little or no cost.

In Figure 8 a still further modified construction is provided in which the envelope 40 is provided with an annular groove 42 formed in the internal surface thereof adjacent the open end. A substantially straight insulating plug 43 is provided which is pressed into the open end of the envelope, and which has the central opening 44 therein adapted to receive the shank of the elec-

trode 45. The shank portion of the electrode 45 is provided with an enlarged shoulder portion 46 so that when the electrode is driven into position, the shoulder portion 46 thereof will be positioned substantially in radial alinement with the groove 42. Due to this enlargement, the material comprising the plug 43 is expanded radially at this point into locking engagement in the groove 42 of the shell to thereby lock the plug against axial movement, while the inner end of the shank 45 projects beyond the inner face of the plug to form a contact terminal.

The form of the invention shown in Figures 9 and 10 comprises an electrode shell or cup 50 formed at its end with a belled portion 52 which is normally adapted to form an arcuate annular recess in the internal surface of the shell.

A substantially straight cylindrical plug 53 is introduced into the end of the shell 50 in this form of the invention, and carries therein an electrode 54 having the shank portion 55 provided with an annular groove 56 and with an extending small diameter shank 57. To lock the plug 53 in position, suitable means is engaged with the projecting end of the shank portion 57, and while the plug is held against movement, the electrode is pulled through the plug into the position shown in dotted lines, which moves the grooves 56 a short distance outwardly of the end face 58 of the plug. In this position a suitable C washer 59 is disposed in the groove and forms an abutment against the face 58, locking the electrode against axial movement relative to the plug. Due to the enlarged diameter of the portion 55 of the electrode, the plug is belled outwardly into the recess 52, thereby firmly locking it against axial movement in either direction with respect to the envelope.

In Figure 11 a still further modified form of switch is shown in which the shell 60 is provided with a substantially cylindrical open end adapted to receive the plug 62, this plug being provided with an annular groove portion 63 adjacent its outer end. The end 64 of the shell is adapted to be spun into the groove 63 after the plug has been pressed into position, thereby securely locking the plug against axial movement and at the same time compressing the resilient material forming the plug against the internal surface of the shell about the spun over edge 64 in such manner as to provide a perfect seal. A suitable electrode 65 is driven through the plug after the interior of the envelope has been filled with mercury and the liquid fill, and functions in the same manner as the electrodes previously described.

Figure 12 discloses a switch construction including a metal envelope 70 having a portion 72 of enlarged diameter adapted to receive the ceramic or refractory insert 73 having the inwardly extending nose portion 74. The envelope is sealed by a closure 75 of semi-resilient insulating material having extending reduced portion 76 about which is disposed a retaining disc 77 held in position to compress the closure 75 into sealing engagement by the spun-over end 78 of the envelope. It is to be understood, however, that any of the locking means shown in the previous embodiments of the invention may be used to hold closure 75 in position.

Driven centrally through closure 75 and a coaxial bore in the insert 73 is a metal electrode 79, which at its inner end is provided with a tip 80 of arc resisting metal that is spaced away from the nose 74, whereby arcs in the switch are spaced from any part of the sealing means. The insert 73 insures that a refractory barrier will be interposed between the point of arcing and the closure to protect it absolutely from such arcs. The extension 76 of the closure 75 radially insulates the electrode shank from the ring 77 and the end of the envelope, and also serves as a support for the terminal head 81 disposed at the outer end of this shank.

It will be apparent from the foregoing description that the plug may be locked in the end of the envelope in a number of ways, it being desirable that the electrode carried by the plug have a pressed or driven fit therein in order to insure a perfect seal between the plug and the electrode, as well as providing some explanation of the plug into sealing engagement with the internal surface of the shell.

It will therefore be apparent that we have provided a very economical form of switch which can be made very cheaply and requires little or no assembly operations.

We are aware that slight changes in the design of the constituent parts of the present construction may be made without in any way departing from the underlying principles of this invention, and we therefore do not intend to be limited except as defined by the scope and spirit of the appended claims.

We claim:

1. A mercury switch comprising a cup-shaped metallic envelope having an internal radial shoulder adjacent the open end thereof, a metal washer axially seated against said shoulder, an insulating plug axially seated against said washer, a second washer against the outer face of said plug, the outer end of said envelope being spun over to compress said plug between said washers, a headed pin extending centrally through said plug with the head end spaced radially within said first washer, said plug having a cylindrical outer projection radially insulating the pin from the outer washer, and a body of mercury in said envelope.

2. In a metal envelope mercury switch, an insert and electrode assembly for one end of the envelope comprising a cylindrical rubber plug of limited elasticity having a nail driven centrally therethrough, the head of said nail projecting from one end face of the plug and the plug having an extension surrounding the extending shank of the nail, and a pair of metallic washers on opposite end faces of said plug spaced radially from said head and said extension.

3. The combination, with a metallic cup-shaped switch envelope having an internal enlargement adjacent the open end defining a radial shoulder, of an end assembly comprising a semi-rigid insulating plug having a ceramic end washer on its inner face adapted to be inserted in said envelope end and stopped against said shoulder, the edge of the envelope being spun over the outer end of said plug, and an electrode extending through the plug and radially spaced from said washers.

4. The combination of claim 3 further characterized in the provision of a reduced cylindrical extension on the outer face of said plug radially insulating the electrode shank from the outer washer and the spun-over edge.

5. The combination of claim 3 further characterized in that said electrode has a head portion on the inner face of said plug and a shank projecting axially outwardly beyond the end of said envelope.

6. A mercury switch comprising an elongated cup-shaped shell, an insulating plug adapted to be pressed axially inwardly to seat in said shell for closing the open end thereof, a nail extending axially through said plug and having a head at one end thereof, the end of the shell being spun over intermediate the ends of said plug to retain the plug against outward movement, and a body of mercury in the shell.

7. A switch comprising a cup-shaped metal envelope adapted to contain a body of mercury and having a counterbored open end forming an internal radial shoulder, a metallic ring seated on said shoulder and projecting radially inwardly thereof, an insulating semi-elastic plug fitting tightly in said counterbored portion and abutting against said ring, a nail driven axially through said plug with the head on the inner face thereof spaced radially from said ring, a second ring on the opposite face of said plug and seated in the end of the envelope, said end being spun over said second ring to impose axial pressure thereon for radially sealing said plug against the confining surface of said envelope, and a cylindrical extension on said plug radially insulating said nail shank from said spun-over end.

8. A mercury switch comprising a cylindrical metal envelope closed at one end and having a counterbored opposite end, an insulating rubber plug adapted to be pressed into said counterbored end, metal washers on opposite ends of said plug, the inner washer seating against a radial shoulder formed by the counterbore and the outer washer fitting under the spun over end of the envelope, a nail-like electrode extending centrally through the plug and having its head spaced radially from the inner washer, and a body of mercury in the envelope adapted to make and break contact between said head and envelope upon tilting of the envelope.

9. A mercury switch comprising an elongated cup-shaped shell, a semi-resilient insulating plug closing the open end thereof, an electrode extending axially through said plug, the shell being deformed radially intermediate the ends of said plug to retain the plug against outward movement, and a body of mercury in the shell.

10. A mercury switch comprising a cup-shaped metal envelope having an open end provided with an internal annular recess, a resilient insulating plug pressed into said end, an electrode having a shank portion adapted to be forced axially through said plug, a portion of said plug being adapted to be expanded into locking engagement within said recess upon said movement of said shank portion, and a body of mercury movable into and out of bridging contact between said envelope and electrode upon tilting of said switch.

11. A mercury switch comprising a cup-shaped metal envelope having an open end, a semi-resilient insulating plug extending into said open end, an annular ring-like portion of said envelope being spun inwardly intermediate the ends of said plug to deform said plug for locking said plug and envelope against relative movement, an electrode carried in said plug and projecting inwardly of the inner face thereof, and a body of mercury in the envelope adapted to engage said electrode upon tilting of said switch.

12. In a mercury switch, a cup-shaped metal envelope having an internal radial abutment adjacent the open end thereof, a semi-rigid insulating plug seated in said open end, an electrode pin extending axially through said plug and having the ends thereof projecting from opposite ends of the plug, the peripheral edge of the envelope being spun over the outer face of said plug to maintain it in position, said plug having an integral cylindrical extension radially insulating said pin from said spun-over edge, and a body of mercury in said envelope adapted to make and break contact with the inner projecting end of said pin upon movement of said mercury axially in said envelope.

13. The switch of claim 12 further characterized in that said plug has a facing of ceramic insulating material on the inner end face thereof.

14. In combination, a cup-shaped metallic shell, an insulating plug driven into the open end of said shell into sealing engagement therewith, an electrode pin driven axially through said plug until the inner end projects beyond the inner face of said plug, said shell having a radially instruck portion intermediate the ends of said plug for interlocking the plug and shell against relative axial movement, and a body of mercury in said shell movable axially into engagement with said end of said pin.

15. The combination, with a metallic cup-shaped shell having an internal enlargement adjacent the open end defining a radial shoulder, of an end assembly comprising a semi-rigid insulating plug having end washers adapted to be inserted into said end and stopped against said shoulder, the edge of the envelope being spun over the outer washer, an electrode extending centrally through said plug and radially spaced from said washers, and a reduced cylindrical extension on the outer end of said plug radially insulating the electrode shank from the outer washer and the spun-over edge.

16. In combination, a cup-shaped tubular metal envelope having a uniform external diameter and having a counterbore in the open end thereof providing a radial shoulder internally of said end, a solid semi-resilient cylindrical plug of substantially uniform diameter seated in said counterbored portion and seating against said shoulder to limit inward movement thereof, an electrode pin extending axially through said plug and projecting from opposite ends thereof, a reduced cylindrical extension on said plug extending axially beyond the end of the envelope about said pin, a body of mercury in said envelope for making and breaking the circuit between said envelope and pin, a metal washer engaging said plug about said extension, and radially inturned means integral with the end of said envelope engaging the outer face of said washer for locking said plug and washer against outward movement.

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