Dec. 31, 1963 W. D. O'BRIEN ET AL 3,116,384

METHOD OF CONDITIONING AN ALL-POSITION MERCURY SWITCH

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FIG. 1

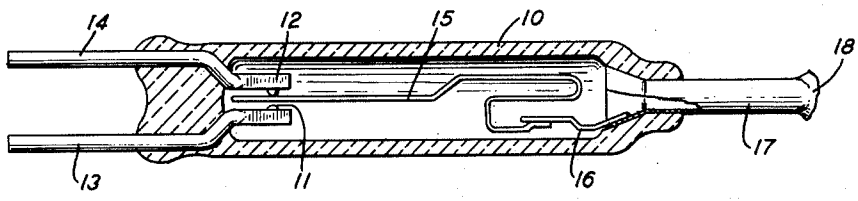


FIG. 2

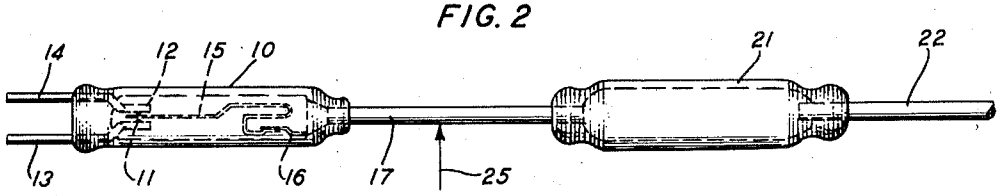
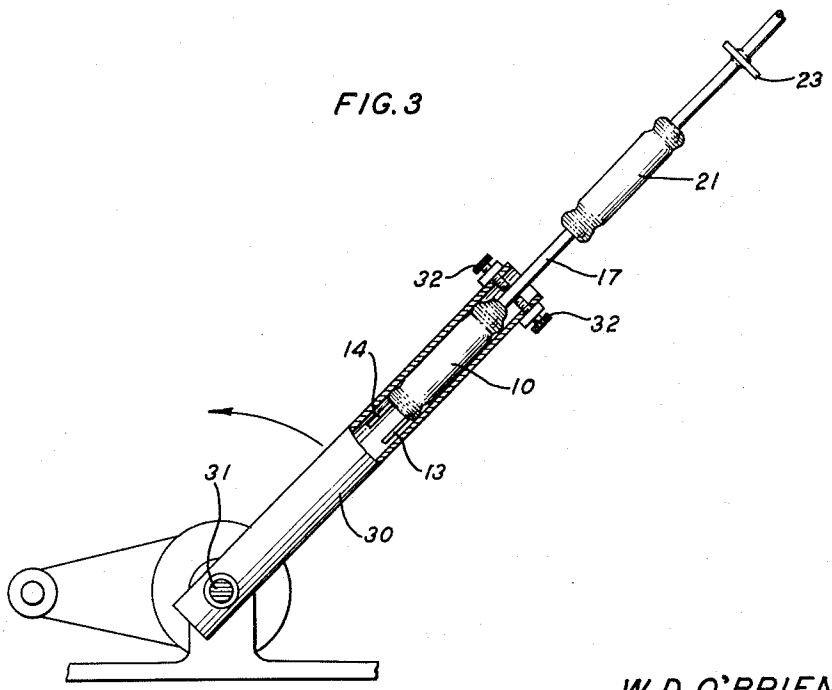


FIG. 3



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METHOD OF CONDITIONING AN ALL-POSITION MERCURY SWITCH

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This invention relates to sealed reed switches having wetted contacts and to methods of making them. More particularly, it is concerned with sealed reed, mercury switches that may be operated in any attitude, that is, all-position switches.

Mercury switches, in general, have enough mercury in them to make the attitude of the switch housing significant; for example, in the tilting type switch, the attitude determines whether the switch is on or off. In the sealed reed, mercury-wetted-contact type, as disclosed in Patent 2,868,926 to C. E. Pollard, Jr., issued January 13, 1959, the switch must be used in a vertical, or nearly vertical, position so that the free mercury will not cause a short circuit by flowing between the contacts.

The present invention involves a sealed, mercury-wetted-contact reed switch with no excess mercury to flow around, whereby it may be used in any attitude or position.

In the usual mercury, reed type switch, as disclosed in the noted Pollard patent, there is mercury in the reservoir or cup and also on the contacts and on the swinger which projects from the cup. The swinger is usually provided with a plurality of longitudinal grooves to aid in conducting mercury from the cup to the contacts and for presenting a greater storage surface than a smooth swinger.

The mercury which adheres to or wets the contacts and the swinger by surface tension is gradually dissipated at the contacts, minute droplets being lost during switch operation. Thus, the reservoir is used so that replacement mercury is available. However, such a switch, as has been noted, is limited as to the position in which it may be properly used.

Applicants have solved the problem of making a sealed reed switch with mercury-wetted contacts and operable in any position by having in the switch envelope or housing only sufficient mercury to wet the swinger and the contacts.

Such a switch might be made by sealing within the envelope more than enough mercury to wet the switch parts, "activating" the switch, and thereafter unsealing the envelope, removing the excess mercury, and then resealing the envelope. The operation called "activating" comprises heating the assembly and agitating it to suitably coat the contacts and the swinger with mercury. This way of making a switch appears to be simple, but carrying it out properly is the first concern of the present invention.

If too much mercury is removed from the switch parts, the life of the assembly is reduced more than can be tolerated for many uses. A switch in accordance with this invention, properly made, may be good for about one million operations, but this would be drastically reduced if too much mercury were removed. Moreover, once the right amount has been determined, the question of reproducibility arises; that is, will each switch be the same as every other switch? There also arises the question of contamination during mercury removal.

One of the usual ways of making a mercury switch is to introduce mercury into the envelope in which the reeds are mounted, to evacuate and fill the envelope with a suitable gas, say hydrogen, and then to seal the envelope. It has been found, as set forth in Patent 2,732,459 to C. E. Pollard, Jr., that the addition of a small amount of copper to the mercury avoids contact sticking under certain circumstances. Tin, as well as copper, may be added with benefit, in accordance with Pollard Patent 3,018,354, issued January 23, 1962, on application Serial No. 848,028, filed October 22, 1959. The added metals may be put into the switch envelope prior to the introduction of the mercury.

In order to make a good switch, all of the internal parts and the introduced materials must be cleaned and be kept clean. This is no continuing problem with the usual switch after it has been sealed, but to make the present switch, unsealing with its attendant chances of contamination appears necessary. One source of contamination that is particularly troublesome is tin that has oxidized due to contact with the atmosphere.

An object then of this invention is to take advantage of some of the properties of sealed reed, mercury switches, namely, mercury wetting of contacts, and, at the same time, eliminate one of its undesirable characteristics, namely, limited position of use. In other words, an object is to make a sealed reed switch having mercury-wetted contacts but which is usable in any attitude, namely, an all-position switch.

One of the features of this invention resides in the means for and method of making a sealed reed mercury switch having therein only sufficient mercury to properly wet the contacts and the contact swinger.

Other and further objects and features of this invention will appear more fully and clearly from the following description of an exemplary embodiment of the switch and of the method of making it, as illustrated in the appended drawings, in which:

FIG. 1 shows a longitudinal section of a switch in accordance with this invention;

FIG. 2 shows the switch of FIG. 1 with attachments used during its manufacture; and

FIG. 3 shows diagrammatically a centrifuge for performing one of the process steps on the FIG. 2 assembly.

As shown in FIG. 1, the switch comprises a housing 10 which may be a section of glass tubing. A pair of fixed contacts 11 and 12 are secured in spaced relation by means of the terminals 13 and 14, respectively. These terminals are sealed through one end of the housing 10.

A movable contact carrier or swinger 15 projects between the fixed contacts 11 and 12 and may be biased against either of them or neither, as required, by the way the swinger is initially fixed in the housing. The swinger is attached to a tab 16 which, in turn, is secured to and projects from the tubulation 17. Besides mounting the swinger, the tabulation 17 is, as is well known, in communication with the interior of the housing. The tube or tubulation 17 may be made of a suitable metal or alloy, such as nickel-iron. This tube is flared at its inner end, and its lip and the glass of the housing are faired so that there is no pocket to interfere with egress of mercury.

As may be noted in FIG. 1, the tube 17 is sealed at 18. It will be noted, however, by reference to FIG. 2 that during the making of the switch the tubulation 17 extends to and is sealed into an auxiliary housing 21 which may also be of glass. The auxiliary housing also has a tubulation 22 at its outer end.

The switches are made up with their attachments, as in FIG. 2. Small bits or slugs of copper, and of tin, if used, are introduced into the housing. A quantity of mercury greater than that need for the finished switch is then added. The assembly is then evacuated and filled with a suitable gas, such as hydrogen, by way of the tube 22, the housing 21, and the tube 17. The tube 22 is then closed as by welding at 23 (see FIG. 3).

The next step is to activate the switch which, as previously noted, comprises the application of heat to and agitation of the housing. A suitable temperature is 320 degrees centigrade. The activation may be a vibration of small amplitude, for example, 1/32 of an inch, at about 60 vibrations per second in a longitudinal direction. The switch is held in a vertical position with the contacts down, and the mercury in which the free end of the swinger and the fixed contacts are immersed travels up the swinger to coat it completely. This small amplitude vibration avoids splashing of mercury with its attendant difficulties. One result of splashing might be to wet the inside of the connecting tube with the mercury-tin-copper solution. The tin and copper, which could not be easily removed later, would interfere with later welding of the tube to seal the switch.

The manufacturing assembly is clamped in a centrifuge, as in FIG. 3, for the removal of excess mercury. The centrifuge may be a tube 30 secured to a rotatable shaft 31 and having a pin, screw, or other means for retaining the switch during rotation. For example, the screws 32 may be used. It has been found that rotation for about 30 seconds at a speed corresponding to a centrifugal acceleration about 30 times that of gravity serves the purpose. For the noted switch, about 750 revolutions per minute is suitable, with the switch contacts at about two inches from the center of rotation. This speed and radius amounts to an acceleration of about 32.5 *g*'s; up to about 35 *g*'s appears to be reasonable. In other words, the range is about 30 to 35 *g*'s for satisfactory manufacture.

After removal of the excess mercury to the auxiliary housing 21, the tubulation 17 is sealed at an intermediate point, as indicated by the arrow 25 in FIG. 2. This is the seal 18 shown in FIG. 1.

The sealing may be, and advantageously is, by welding. In order to be sure that there is no condensed mercury vapor in the tube 17 at the sealing zone, heat is applied to the tube before welding to evaporate this mercury; otherwise, the weld might not be good.

As previously indicated, the switch made in accordance with this invention appears to be capable of about one million operations before the mercury wetting becomes ineffective. The mercury that is on the contacts and the swinger will remain there unless subjected to an acceleration greater than the 30 to 35 *g*'s used during its manufacture.

What is claimed is:

1. The method of conditioning an all-position sealed reed, mercury switch by storing mercury on the contacts and the swinger only, that comprises including a reservoir in the tubulation that normally extends from the switch envelope during manufacture, injecting into the envelope an excess of mercury, evacuating and sealing the tubulation at a point to include the reservoir, activating the switch by agitating and heating it to cause mercury to adhere to the contacts and the swinger, transferring the remaining mercury to the reservoir by centrifuging at a speed to attain a radial acceleration 30 to 35 times the acceleration of gravity, sealing the tubulation between the envelope and the reservoir, and severing the tubulation to remove the reservoir.

2. The method of conditioning all-position sealed reed, mercury switch by storing mercury on the contacts and the swinger only, that comprises including a reservoir in the tubulation that normally extends from the switch envelope during manufacture, injecting into the switch envelope an excess of mercury, evacuating and sealing the tubulation at a point to include the reservoir, activating the switch by agitating and heating it to cause mercury to adhere to the contacts and the swinger, transferring the remaining mercury to the reservoir by centrifuging at a speed to attain a radial acceleration 32.5 times the acceleration of gravity, sealing the tubulation between the envelope and the reservoir, and severing the tubulation to remove the reservoir.

3. The method of conditioning an all-position sealed reed, mercury switch by storing mercury on the contacts and the swinger only, that comprises including a reservoir in the tubulation that normally extends from the switch envelope during manufacture, injecting into the envelope by way of the reservoir an excess of mercury, evacuating and sealing the tubulation at a point to include the reservoir, activating the switch to cause mercury to adhere to the contacts and the swinger, transferring the remaining mercury to the reservoir by centrifuging at a speed to attain a radial acceleration 30 to 35 times the acceleration of gravity, sealing the tubulation between the envelope and the reservoir, and severing the tubulation to remove the reservoir.

4. The method of conditioning an all-position sealed reed, mercury switch that includes an envelope, fixed contacts, a contact swinger, and a tubulation, by storing mercury on the contacts and the swinger only, that comprises temporarily including a reservoir in the tubulation, injecting into the envelope an excess of mercury, evacuating and sealing the tubulation at a point to include the reservoir, activating the switch by agitating the heating it to cause mercury to adhere to the contacts and the swinger, transferring the remaining mercury to the reservoir by centrifuging at a speed to attain a radial acceleration 30 to 35 times the acceleration of gravity, sealing the tubulation between the envelope and the reservoir, and severing the tubulation to remove the reservoir.

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