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MERCURY SWITCH

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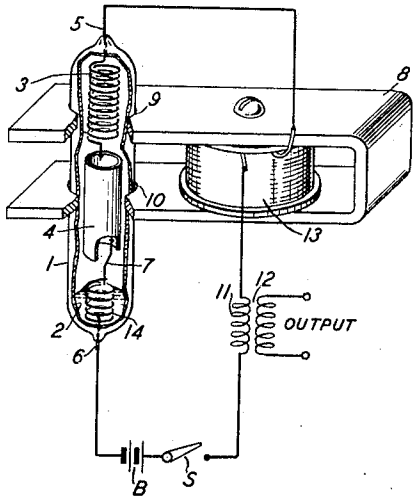

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MERCURY SWITCH

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This invention relates to so-called mercury switches and more particularly to magnetically operated mercury contact interrupters.

An object of the invention is to provide an interrupter of the mercury contact type to periodically open and close a circuit at a predetermined frequency rate.

The above object is obtained, in one embodiment of the invention, by the provision of a closed glass vessel containing a pool of mercury in the bottom thereof, a first terminal sealed into the vessel and making permanent contact with the mercury, a cylindrical armature of magnetic material slidably positioned within said vessel above the mercury and flexibly supported from the top of the vessel, a contact element carried by the armature and normally dipping into the mercury and a second sealed-in terminal electrically connected with said contact element. To prevent deterioration of the contact element and contamination of the mercury, the envelope is first evacuated and then filled to a substantial pressure with some inert gas, as for example hydrogen.

To actuate the armature and break the mercury contact, the vessel may be placed in the field of an electromagnet, the energizing circuit of which includes a source of direct current and said first and second terminals whereby a buzzer action takes place, i. e., when the circuit is completed, the electromagnetic field raises the armature thereby breaking the mercury contact and deenergizing the electromagnet whereupon the armature drops to its original position thereby again making the mercury contact and reenergizing the electromagnet to repeat the operation which continues as long as the external circuit is closed.

To cause the mercury contact to be interrupted at a desired frequency rate, the armature and its flexible support, which in practice may consist of a light coil spring, may be mechanically tuned, i. e., given a natural period of vibration by properly choosing the mass of the armature and stiffness of the spring.

This same device can be operated by an alternating current field whereby the armature will vibrate at the frequency of the varying flux.

Due to rapid vibration of the armature, a pumping action on the mercury results whereby a certain amount thereof is spattered over the inner surface of the vessel thereby lowering the level of the pool at the bottom and as it may be desirable that the contact element only dip into the pool sufficiently to make a satisfactory contact, some means is necessary to maintain the level of the mercury constant at the point touched by the contact element.

In accordance with another feature of the invention, this is accomplished by vertically positioning an open end capillary tube in the mercury pool and in so positioning the contact element that it makes contact with the mercury column within this tube, the level of which remains substantially constant regardless of the level of the surrounding main body of mercury.

Still further, due to the spattering action above mentioned, certain of the globules of mercury which collect on the walls of the vessel and on the adjacent surface of the armature may cause so-called "wetting" whereby certain globules may adhere to both the armature and wall of the vessel, thereby retarding free movement of the armature due to surface tension of the mercury. This "wetting" and consequent interference with the movement of the armature is prevented in accordance with another feature by the addition, within the vessel, of a small quantity of finely divided inorganic refractory oxide having a so-called contact angle with respect to the mercury which is greater than 90 degrees, of which the oxide silicon (i. e., quartz dust) is an example.

A more complete understanding of the invention will be had from the following description and accompanying drawing which shows a mercury interrupter switch embodying the invention.

The switch consists essentially of a glass tube 1 containing a pool of mercury 2 in the bottom thereof and having suspended from the top, by means of a flexible spring 3, a cylindrical armature 4 of magnetic material which is slightly less in diameter than the inside wall of the tube 1, the spacing betwen the armature and tube wall, however, being sufficient to permit the armature to move freely therein. A lead-in wire 5 is sealed into the top of the tube 1 and is connected to the upper end of the spring 3, the bottom end of the spring being secured in some convenient manner to the armature 4. A second lead-in wire 6 is sealed into the bottom of the tube and extends into the mercury pool 6 where it terminates in several helical turns, the convolutions of which are closely spaced with respect to each other, thereby forming a so-called capillary well 14 for a purpose to be hereinafter described.

Connected to the lower end of the armature 4 is a contact member or wire 7 of such length that when the armature 4 is in its normal (resting) position, the lower end of the contact member 7 dips into the mercury pool 2 a short distance. It will therefore be observed that when the contact member 7 is in contact with the mercury, a circuit connection exists between the upper lead-in wire 5 to the lower lead-in wire 6. In order to raise the armature 4 sufficiently to break contact between the contact member 7 and the mercury pool 2 an electromagnet 8 is provided the two polar extensions of which have openings 9, 10 in which the tube 1 is so positioned that when the electromagnet is deenergized the

armature 4 is in its normal (resting) position within the tube, it is below the center of the electromagnet. The means for operating the interrupter consists of a source of direct current B, the circuit for which includes the winding 11 of transformer 12, winding 13 of the electromagnet, lead-in wire 5, spring 3, armature 4, contact member 7, mercury pool 2, and lead-in wire 6.

The operation of the interrupter is as follows: When the switch S is closed current flows from the source B through the previously traced circuit, thereby energizing the electromagnet 8 and causing the armature 4 to be raised, thereby withdrawing the contact member 7 from the mercury and opening the circuit, thus deenergizing electromagnet 8 and permitting the armature to restore to its normal position, whereupon contact with the mercury pool is reestablished and the foregoing cycle of operation is repeated, which continues, as long as switch S is closed, at a rate determined by the mass of the armature 4 and the stiffness of spring 3.

By means of transformer 12 the periodic current impulses flowing in the winding 11 induce alternating current in the right-hand (output) winding which can be employed for any desired purpose where a substantially constant frequency is desired.

As previously mentioned, the pumping action of the contact member 7 on the mercury pool results in spattering a certain amount of the mercury over the inside of the tube, thereby lowering the level of the pool to some extent and as it is desirable that the contact member 7 only dip into the pool sufficiently to make satisfactory contact therewith some means is necessary to maintain the level of the mercury substantially constant in order that proper contact with member 7 is made during the interval the electromagnet is deenergized. This result is obtained by the previously mentioned capillary well 14 formed by the closely spaced convolutions of the lead-in wire 6, which well remains filled and maintains a constant level, due to capillary action, regardless of variations in the level of the surrounding mercury pool.

The foregoing spattering action also causes globules of mercury to collect between the armature and the opposing wall of the tube and due to the well-known characteristic of mercury to tend to adhere to glass or other ceramic materials, and to the fact that clean spots on the armature tend to become wetted by mercury, such globules have a tendency to wet and adhere to the armature and to a somewhat less degree, to the glass, thereby retarding the free vibration of the armature.

To overcome the foregoing effects it has been discovered that certain inorganic refractory substances, which are not wetted by mercury, i. e., which have a contact angle greater than 90 degrees with respect thereto, of which certain oxides, for example, the oxides of thorium, zirconium, beryllium, aluminum, silicon, etc., are examples, if introduced into the switches, according to the invention, in a finely divided form, tend to lubricate the mercury and materially reduce its tendency to adhere. Therefore, before the switches are sealed a small quantity of silicon oxide (quartz dust) is introduced therein, after which the tubes are evacuated and filled with an inert gas, as is well known in the art.

What is claimed is:

1. A mercury contact interrupter, comprising a sealed vertical tube, a pool of mercury in the bottom thereof, a first terminal extending into said tube and a permanent contact for said mercury, a mechanically tuned member flexibly supported from the top of the tube above said mercury, said member comprising a hollow cylinder of magnetic material of slightly smaller outside diameter than the inside diameter of said tube and having free vertical movements within said tube and so constructed and arranged as to vibrate vertically at a predetermined rate when moved from its natural state of equilibrium, a contact element carried by said vibrating members and normally in engagement with said mercury, a second terminal electrically connected to said contact element, and means including a capillary well vertically disposed in said mercury pool for maintaining said mercury, at its point of contact with the contact element, at a constant level.

2. In a mercury contact interrupter, a closed vessel, a pool of mercury in the bottom thereof, a capillary tube vertically disposed in said pool of mercury and so proportioned and positioned that a constant level of mercury will be maintained therein as long as the lower end of the tube is below the level of the pool, an armature of magnetic material suspended by a spring member from the top of the vessel and vertically movable therein, a first terminal extending into said vessel and in permanent contact with said mercury pool, a contact element carried by said armature, vertically movable therewith and normally engaging the mercury in said capillary well, and a second terminal extending into said vessel and electrically connected with said contact element, said spring and armature being so proportioned and constructed as to stiffness and mass respectively as to have a predetermined natural period of vertical vibration.

3. In an electric interrupter a closed vertical tube having a pool of mercury in the lower end thereof, a small diameter vessel open at its top and vertically disposed in said pool, also containing mercury which, by capillary action, is maintained at a substantially uniform level independent of variations in the level of the outer pool, an armature of magnetic material suspended by a helical spring member from the top of the tube and vertically movable therein, and a contact element secured to and movable with said armature, normally in contact with the mercury in said capillary tube and adapted to break contact therewith when said armature is raised by an external force.

4. A mercury contact interrupter comprising a sealed vessel, a pool of mercury in the bottom of said vessel, a first terminal permanently in contact with said mercury, a mechanically tuned vibrating member flexibly supported within said vessel above said pool, a contact element carried by said vibrating member and normally in contact with said mercury, a second terminal electrically connected with said contact element and means for maintaining the mercury at the point of contact with said element at a constant level regardless of the level of the surrounding pool.

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