Feb. 14, 1933. W. R. WALKER ET AL 1,897,454

LOW RESISTANCE FLUID FLOW SWITCH

Filed March 3, 1931

Fig. 1

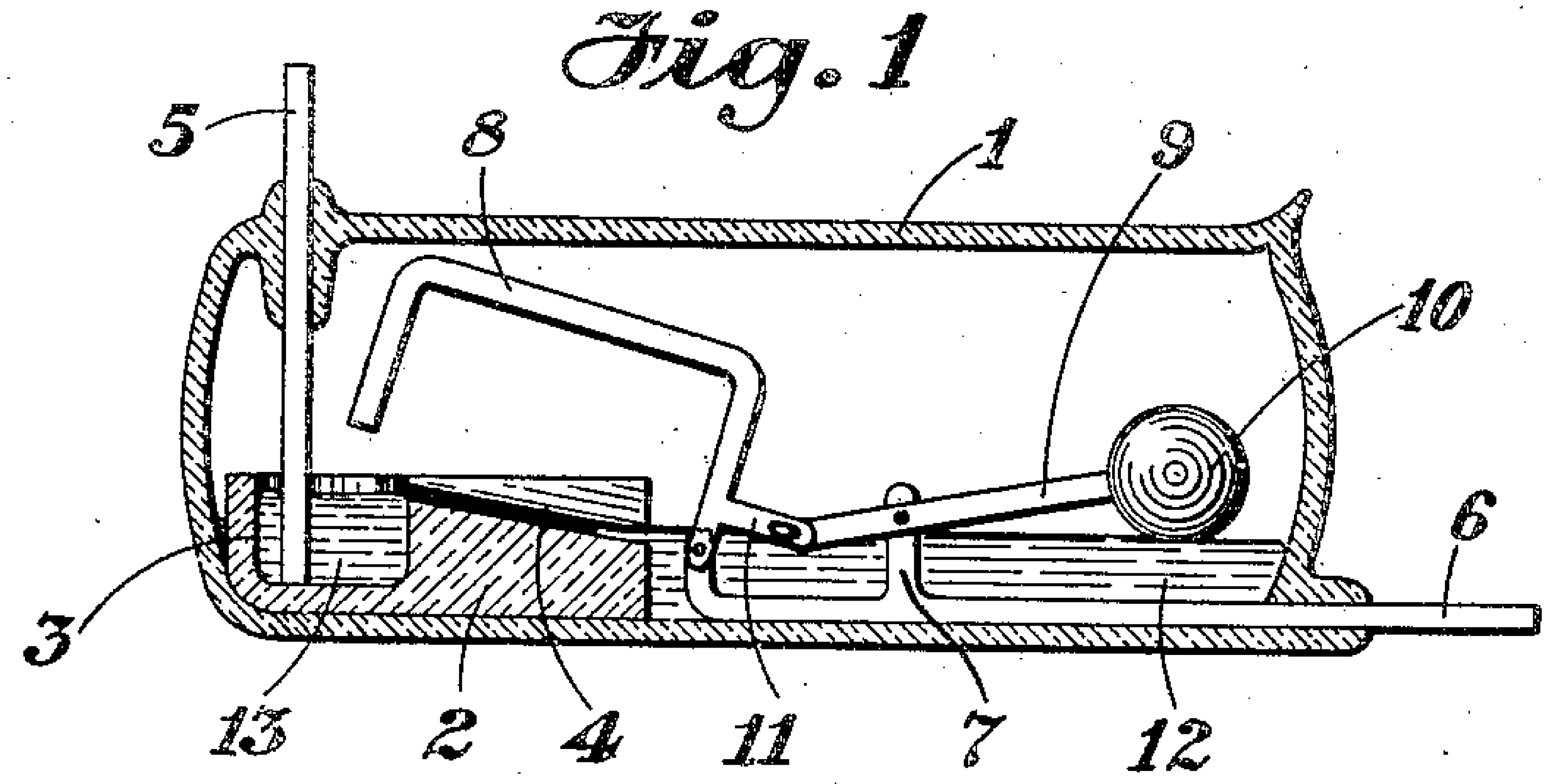
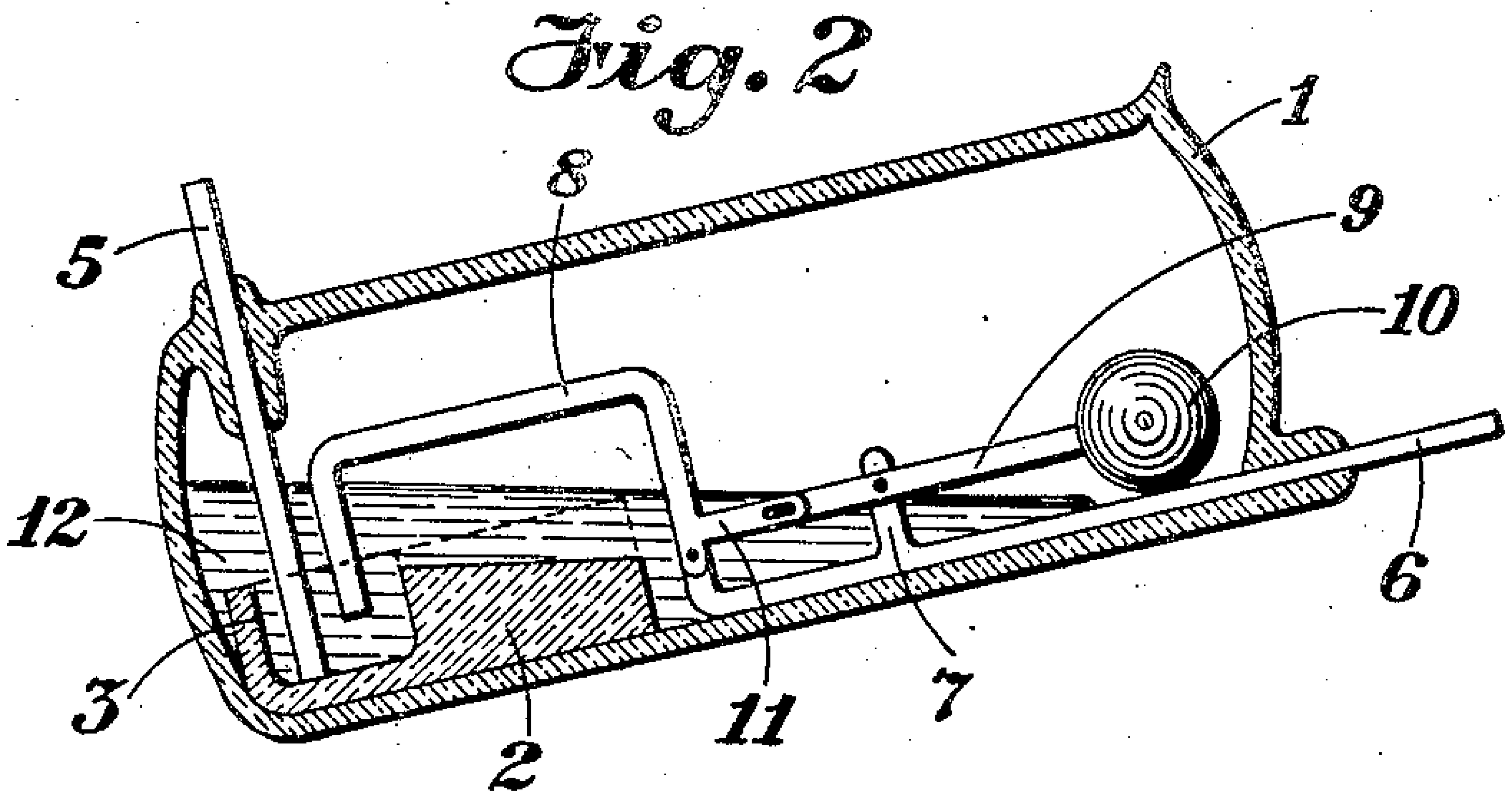


Fig. 2



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LOW RESISTANCE FLUID FLOW SWITCH

Application filed March 3, 1931. Serial No. 519,833.

The present invention relates to fluid flow switches, and especially to switches which are adapted for use in circuits carrying relatively large currents.

The invention consists in a fluid flow switch of novel construction, and in a novel method of operating fluid flow switches, as hereinafter set forth and claimed.

A particular object of the invention is to provide a fluid flow switch having a relatively large current capacity. Another object of the invention is to provide a switch having a low internal resistance. Still another object of the invention is to provide a novel method of operating a fluid flow switch. Other objects and advantages of the invention will appear from the following detailed specification, or from an inspection of the accompanying drawing.

The current rating of electrical switches is determined, as is well known, by two factors; the current which they can safely interrupt, and the current which they can continuously carry without undue heating due to the internal resistance thereof. In switches of the fluid flow type the emphasis has been on the first of these factors, hence in this type of switch the metallic inleads have invariably been spaced a considerable distance apart, in order to permit the arc of rupture to be drawn out sufficiently to extinguish it. This construction obviously necessitates the use of a relatively long fluid path to complete the circuit through the switch when it is in a closed circuit position. A long fluid path is, however, highly undesirable from the standpoint of the second factor mentioned above, due to the fact that any of the fluids which are ordinarily used have a relatively high specific resistance. For example, mercury, the fluid almost universally used, has a specific resistance which is approximately twenty times that of tungsten, and sixty times that of copper. Hence from the standpoint of minimum internal resistance, and thus of minimum heating, it is obvious that the fluid path between the inleads should be as short as possible, especially since the effective conducting area of the fluid path is limited by practical considerations, such as maximum dimensions for the switch, weight, cost, and the like. It would thus appear that additional current carrying capacity could be obtained in a practical switch only by a sacrifice of the rupturing capacity, with the result that there has been heretofore a more or less definite limit to the capacity of commercially practical switches.

We have now discovered that this limitation can be overcome by means of a novel construction of our invention, which operates in a unique manner to give a minimum fluid path when the switch is in the closed circuit position without necessitating any corresponding reduction of the path of the arc of rupture. According to our new invention the circuit is opened or closed by fluid flow in a conventional manner between widely separated fluid pools. The fluid movement is availed of, however, to move a solid metallic conductor which is located within the switch envelope in such a manner that the length of the fluid path which must be traversed by the current is materially reduced after the circuit through the switch has been closed, and increased again before the circuit through the switch is opened. Consequently our new construction permits the carrying of very large currents in a switch in which the arc of rupture occurs between two fluid pools spaced at any desired distance—a result which has heretofore been deemed impossible.

For the purpose of illustrating our invention we have shown a preferred embodiment thereof in the accompanying drawing, in which

Fig. 1 is a sectional view of a mercury switch having a bridging conductor operated by a float, said switch being shown in an open circuit position, and

Fig. 2 is a sectional view of the same switch in a closed circuit position.

In the drawing the tubular sealed envelope 1 may consist of any suitable vitreous material, such as glass, fused silica, or the like, but I prefer to use a borosilicate glass, due both to the refractory nature of this glass and the ease with which inleads are sealed therein. At one end of said envelope there is a refractory body 2 of porcelain, lavite, or the like, said body having a cup 3 formed therein at the end which is nearer the adjacent end of the envelope 1. A channel 4 in the top of said refractory body 2 extends from said cup 3 to the other end of said body, the bottom thereof sloping away from said cup. An inlead 5 is sealed through the top of the envelope 1 at a point directly above the cup 3, said inlead extending to the bottom of said cup at a point as near the end of the refractory body 2 as is convenient, whereby said refractory body is maintained in a fixed position within the envelope 1. A second inlead 6 is sealed into the opposite end of said envelope 1 and extends longitudinally along the bottom thereof to a point near the refractory body 2, at which point it extends upwardly a short distance. At an intermediate point on said inlead 6 there is also another upward extension 7. A conductor 8 in the form of an inverted U has one end thereof pivotally mounted on the upturned end of the inlead 6, said conductor having such dimensions that the other end thereof can be inserted in the cup 3 and removed therefrom at will by pivotal movement on said inlead. A lever 9 is pivotally mounted at the upper end of the extension 7 of the inlead 6. One end of said lever 9 carries a suitable float 10, which is preferably a hollow metal sphere, while the other end of said lever engages an arm 11 on the conductor 8 by means of a suitable pin and slot connection therebetween. A quantity of mercury 12 is provided within the envelope 1 which is sufficient to so elevate the float 10 that the free end of the conductor 8 is raised an appreciable distance above the level thereof before said mercury 12 separates from the mercury pool 13 which is retained in the cup 3 when said switch envelope is tilted. When the envelope 1 is made of a borosilicate glass I can conveniently use tungsten for the inleads 5 and 6, since tungsten can be fused directly thereto. In order to reduce the internal resistance of my switch, however, especially when very large currents are to be carried, I prefer to make that portion of the inlead 6 which extends within the envelope 1, as well as the conductor 8, of a better electrical conductor such as copper. Since the latter metal rapidly contaminates the mercury I find it advisable to electroplate these parts with nickel, chromium, or other metal which resists amalgamation. The remaining metal parts, which are not called upon to carry current, may be made of any metal which will not deleteriously affect the mercury, such as iron, nickel or various alloys thereof, or which is plated with nickel, chromium, or the like. A hydrogen or other arc suppressing atmosphere is preferably sealed within the envelope 1.

In the use and operation of this switch, assuming it to be in an open circuit position, as shown in Fig. 1, as the envelope 1 is tilted in a counter-clockwise direction the level of the mercury 12 rises in the channel 4 until said mercury merges with the mercury pool 13. A circuit is thereupon closed from the inlead 5 through a relatively long path in the mercury 12 to the end of the inlead 6. This circuit, which is typical of the switches of the prior art, has a relatively high resistance due to the long constricted mercury path with the result that the switch would be excessively heated if large currents were continuously carried thereby. But during this tilting of the envelope 1 the mercury level below the float 10 has necessarily fallen, with the result that the free end of the conductor 8 has been moved downwardly toward the cup 3. Upon further tilting of the switch envelope this downward movement of the free end of the conductor 8 is continued until it becomes immersed in the mercury 12 at a point very close to the inlead 5, as shown in Fig. 2. Due to the extremely low resistance of the conductor 8 the larger part of the current will thereupon flow from the inlead 5 through an extremely short path of large area in the mercury 12 to the conductor 8, and thence through said conductor to the inlead 6. Since the pivotal connection between the conductor 8 and the inlead 6 is immersed in the mercury 12 it is obvious that a good electrical connection will always exist therebetween. Hence the internal resistance of the switch is very materially reduced, to say a small fraction of its original value, once the conductor 8 has become effective, with the result that exceptionally large currents can be continuously carried thereby. Upon tilting the switch envelope in the reverse direction the mercury 12 flows toward the float 10, causing it to rise. The free end of the conductor, being linked to said float, necessarily rises therewith, and soon moves out of contact with the mercury 12. No arc of rupture ensues, however, since a circuit is still closed between the inleads 5 and 6 through a longer mercury path, with the result that said mercury 12 is maintained at substantially the same potential as the conductor 8. Further tilting of the envelope 1 in a clockwise direction causes the mercury 12 to flow away from the cup 3, until it eventually separates from the mercury pool 13 therein, whereupon the circuit through the switch is interrupted. The arc of rupture which thereupon occurs is drawn out by the flow of the mercury 12 into the channel 4, where it is soon suppressed by the hydrogen atmosphere. The conductor 8 having been elevated to a considerable height above the level of the mercury 12 before this arc of rupture occurs there is no likelihood of the arc striking thereto. With this construction it is obvious that the rupturing capacity of the switch is not in any way impaired, despite the provision of the short fluid path during the time that the switch is closed. As a result currents well in excess of 100 amperes may be successfully handled by a switch of our novel construction, and operated in the manner of our invention, of a size commensurate with 25 ampere switches of the type heretofore in use.

While we have described our invention by reference to a specific construction it is obvious that our invention is not limited thereto, but that various changes, omissions and substitutions, within the scope of the appended claims, may be made therein without departing from the spirit thereof.

We claim as our invention:

1. A fluid flow switch comprising a sealed envelope, two inleads sealed therein, a fluid conductor in said envelope, a movable solid conductor within said envelope, and means responsive to movement of said fluid conductor to move said movable conductor.

2. A fluid flow switch comprising a sealed envelope, two inleads sealed therein, a fluid conductor in said envelope, a movable solid conductor within said envelope, and means responsive to movement of said fluid conductor to move said movable conductor to change the length of the fluid path between said inleads.

3. A fluid flow switch comprising a sealed envelope, two inleads sealed therein, a fluid conductor in said envelope, a movable solid conductor within said envelope, and means responsive to movement of said fluid conductor to move said movable conductor into a bridging position between said inleads after the circuit has been closed therebetween by said fluid conductor, and out of said bridging position before the circuit is opened therebetween.

4. A fluid flow switch comprising a sealed envelope, two inleads sealed therein, a fluid conductor in said envelope, a bridging member pivotally mounted on one of said inleads, and means responsive to movement of said fluid conductor to move the free end of said bridging member into contact with said fluid at a point in juxtaposition to the other of said inleads.

5. A mercury switch comprising a sealed envelope, mercury in said envelope, two inleads sealed into said envelope, each of said inleads terminating in a pool of said mercury, a bridging member pivotally supported by one of said inleads, and means responsive to movement of said mercury to move the free end of said bridging member into contact with said mercury at a point in juxtaposition to the other of said inleads after said pools have been merged by mercury flow and to remove said free end from contact with said mercury before said pools separate.

6. A mercury switch comprising a sealed envelope, mercury in said envelope, two inleads sealed into said envelope, each of said inleads terminating in a pool of said mercury, a bridging member pivotally supported by one of said inleads and a float actuated lever pivotally mounted on said inlead, said lever being linked to said bridging member, whereby the free end of said bridging member is caused to move in accordance with changes in the level of said mercury.

7. A mercury switch comprising a sealed envelope, mercury in said envelope, two inleads sealed into said envelope, each of said inleads terminating in a pool of said mercury, a bridging member pivotally supported by one of said inleads and a float operated lever supported by said inlead and linked with said bridging member in such a manner that the free end of said bridging member is moved into contact with said mercury at a point in juxtaposition to the other inlead whenever said mercury rises above the level at which said pools are merged, and out of contact with said mercury whenever said mercury falls toward the level at which said pools separate, the point of support of said bridging member being located at a point which is below the level of the mercury whenever the free end thereof is in contact with said mercury.

Signed at Hoboken in the county of Hudson and State of New Jersey this 2nd day of March A. D. 1931.

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FRANK MOOS.