Feb. 14, 1933. W. R. WALKER 1,897,455

LOW RESISTANCE FLUID FLOW SWITCH

Original Filed March 3, 1931

Fig. 1

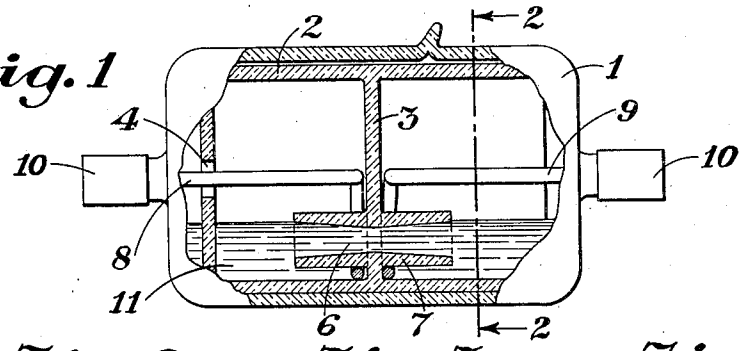


Fig. 2

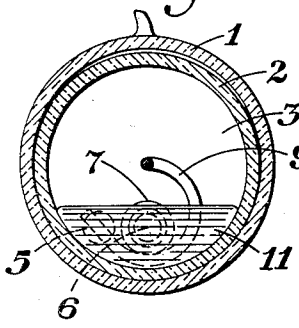


Fig. 3

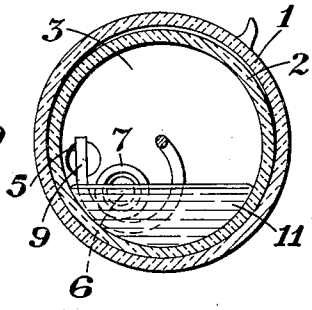
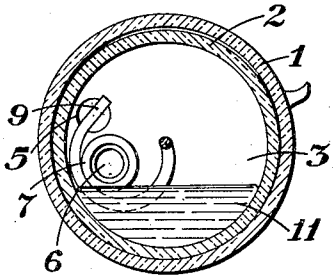


Fig. 4



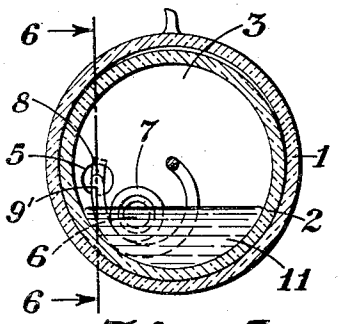


Fig. 5

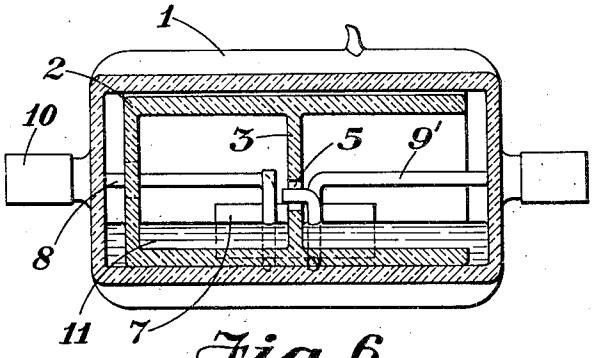


Fig. 6

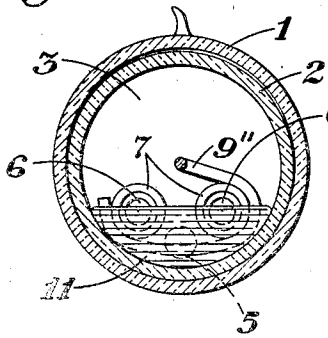


Fig. 7

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UNITED STATES PATENT OFFICE

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LOW RESISTANCE FLUID FLOW SWITCH

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

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

A particular object of the invention is to provide a fluid flow switch which will have a high current capacity. Another object of the invention is to provide a switch having a low internal resistance. A further object of my invention is to provide a switch of simple construction having the aforesaid characteristics. Still another object of my invention is to provide a switch of the rotative type having the aforesaid characteristics. Other objects and advantages of my invention will appear from the following detailed specification, or from an inspection of the accompanying drawing.

The current capacity 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 resistance thereof. In switches of the fluid flow type the emphasis has been upon 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 to a sufficient length 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 inleads should be as short as possible, especially since the effective conducting area of the fluid 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 corresponding loss in rupturning capacity, with the result that there has been heretofore a more or less definite limit to the capacity of commercially practical fluid flow switches.

I have now discovered that this limitation is overcome by a novel construction of my invention. This new construction, which is especially adapted for use in fluid flow switches of the rotating type, permits the circuit to be opened and closed through a relatively long fluid path, much longer in face, than has been used heretofore, in this type of switch—despite the fact that an unusually short fluid path of low resistance is provided during the interval that the circuit through the switch is closed. This new result is conveniently attained by the provision of two openings in a baffle by which the fluid is separated to open the circuit through the switch, one of these openings being made of great length, while the other is made as short as possible, the inleads extending to a point close to the latter opening on either side of said baffle. These openings are relatively close together, so that the fluid will extend through both at the same time, yet are so arranged that upon partial rotation of the switch the fluid will separate at the shorter opening before it separates at the longer one, so that the arc of rupture always occurs in the longer opening. By the use of a second long opening in the baffle I am also able to attain the desired result in a switch which is continuously rotated in either direction.

For the purpose of illustration I have shown several embodiments of my invention in the accompanying drawing, in which

Fig. 1 is a longitudinal elevation, in part section, of a mercury switch in which the circuit is interrupted between remote mercury pools, despite the short fluid path between inleads during the time that the circuit is closed, showing the switch in a closed circuit position,

Fig. 2 is a sectional view of the switch of Fig. 1, taken on the line 2—2 thereof,

Fig. 3 is a similar sectional view of the switch of Fig. 1, showing the switch after it has been rotated toward the open circuit position to interrupt the short fluid path,

Fig. 4 is a similar sectional view of the switch of Fig. 1, showing the switch in an open circuit position,

Fig. 5 is a similar sectional view of a modification of the switch of Fig. 1, showing the switch in an intermediate position, similar to that of Fig. 3,

Fig. 6 is a sectional view of the switch of Fig. 5 taken on the line 6—6 of Fig. 5, and

Fig. 7 is a sectional view of another modification of the switch of Fig. 1, showing the switch in a closed circuit position, this switch being adapted to continuous rotation in either direction.

In the drawing, with special reference to Figs. 1–4, there is shown a mercury switch having the tubular sealed envelope 1 of any suitable vitreous material, such as glass, fused silica or the like. Within said envelope 1 there is a lining 2 which is preferably made of a refractory vitreous material such as fused silica, porcelain or the like. Said lining, which closely fits the inside of the envelope 1, has a central transverse baffle 3, which may be integral with said lining, or fused thereto, as desired; or it may be held in place by a suitable packing material such as spun glass or asbestos. One end of said lining 2 is completely closed except for a small central opening 4 therein, while the other end of said lining is left open. Said baffle 3, which is preferably made relatively thin, has an opening 5 therein at a point near its circumference. Near said opening 5, but on a different radial line from the center of the baffle 3, is a second opening 6 which extends not only through said baffle 3 but also through the tubular extensions 7 thereof, said opening 6 being preferably tapered outwardly toward each end. An inlead 8, which is conveniently made of tungsten when the envelope 1 is of fused silica or a borosilicate glass, is sealed through one end of said envelope 1 and extends axially through the opening 4 in the lining 2 to a point adjacent to the baffle 3 and then continues parallel to said baffle under the tubular extension 7 thereof and across the end of the opening 5. A similar inlead 9 is sealed through the opposite end of the envelope 1 and extends axially through the open end of the lining 2 to a point adjacent to the baffle 3, and thence continues parallel to said baffle under the other tubular extension 7 of said baffle and across the other end of said opening 5. These inleads which are in contact with the extensions 7, as a result of their conformation serve to maintain the lining 2 in a substantially fixed position with respect to the envelope 1. The metallic ferrules 10 which are centrally mounted on the ends of the envelope 1 are electrically connected with the inleads 8 and 9 respectively. A quantity of mercury 11 which is sufficient to extend above the level of the openings 5 and 6, when the switch is in the position shown in Fig. 1, but insufficient to reach the opening 4, is enclosed within the envelope 1. A suitable arc suppressing gas, such as hydrogen, is preferably sealed within the envelope 1, according to the usual practice.

The switch of Figs. 5 and 6 is identical with that of Figs. 1–4, save that the end of the inlead 9′ extends through the opening 5 in the baffle 3, terminating a short distance from the inlead 8. In this manner the fluid path between the inleads 8 and 9′ may be made as short as desired, irrespective of the thickness of the baffle 3. The opening 5 may also be restricted, when desired, with the result that the inlead 9′ will cooperate therewith to prevent rotational movement of the lining 2 with respect to the envelope 1.

The switch of Fig. 7 is also similar to that shown in Figs. 1–4. In this switch an opening 6 through the baffle 3 is symmetrically disposed on either side of the opening 5, each of said openings extending not only through said baffle but through the tubular extensions 7 on either side thereof. The inleads 8″ and 9″ are also similar to the inleads 8 and 9, but the portions thereof which are parallel to the baffle 3 pass below each of the tubular extensions 7 and cross the face of the opening 5 therebetween. The inleads 8″ and 9″ thus serve to lock the lining 2 in a desired position within the envelope 1.

In the use and operation of the switch shown in Figs. 1–4, when the switch is in a closed circuit position, as shown in Figs. 1 and 2, substantially all of the current flows from a ferrule 10 to the inlead 8, and thence to the inlead 9 and the other ferrule 10 through the extremely short path in the mercury 11 permitted by the opening 5. Since this fluid path may be made of large area, as well as extremely short, in a switch having my novel construction, it is obvious that the resistance of the fluid path can be reduced to an extremely small value, with the result that large currents, of the order of several hundred amperes, can be carired with ease in a relatively small switch whose capacity would otherwise be limited to much smaller values. Upon rotation of this switch in a clockwise direction, from the viewpoint of Fig. 2, the opening 5 is moved above the surface of the mercury 11, thus opening the short fluid path between the inleads 8 and 9. No arc of rupture occurs, however, due to the fact that the circuit is still closed between said inleads by way of the much longer fluid path through the opening 6, as shown in Fig. 3. This longer fluid path, which is not

adapted to continuously carry large currents due to the relatively large resistance thereof, is then opened by further rotation of the switch in a clockwise direction to the position shown in Fig. 4 in order to bring the opening 6 above the level of the mercury 11. The mercury 11 is thereby separated into two bodies within the tubular opening 6, these mercury bodies rapidly receding toward opposite ends of said opening or passage due to the sloping floor thereof, with the result that the arc of rupture is rapidly drawn out to a considerable length and extinguished, this arc being substantially confined, however, within the extensions 7 of the baffle. Upon rotation of the switch in the reverse direction from this open circuit position it is obvious that the mercury 11 will first flow through the opening 6, reestablishing the long fluid path therethrough, after which further rotation will again bring the opening 5 below the level of the mercury 11, thus again establishing the desired short fluid path which is so essential where large currents are to be carried for any appreciable length of time. Thus this switch is highly suitable for use in circuits continuously carrying large currents, where the switch is to be operated by oscillation through a limited angle. Upon occasion, however, this switch may be operated to produce the same result by tilting, as will be obvious to those skilled in the art.

The operation of the switch of Figs. 5 and 6 is substantially identical with that of the switch of Figs. 1–4, described above. In this switch, however, the short fluid path is established by rotating the end of the inlead 9′ below the surface of the mercury, this construction permitting the use of an even shorter current carrying fluid path than is practical with the previously described structure.

The switch of Fig. 7 operates in a manner analogous to that of the switch of Fig. 1. Upon rotation of this switch in either direction from the closed circuit position illustrated one of the openings 6 will first be moved above the surface of the mercury 11. No appreciable change will result, however, due to the fact that the inleads 8″ and 9″ are still connected through the short fluid path and through the other opening 6. Upon further rotation of the switch the opening 5 will be moved above the surface of the mercury 11, there being no arc of rupture, however, due to the continued existence of a longer fluid path through an opening 6. Upon still further rotation of the switch the second of the openings will be moved above the level of the mercury 11, whereupon the arc of rupture will occur within said opening. Upon continued rotation of the switch the opening 6 which first rose above the level of the mercury 11 will again pass below the level thereof, thereby reestablishing the circuit through a relatively long fluid path. Still further rotation will result in the opening 5 again passing below the surface of the mercury 11, again establishing the desired short mercury path therethrough. Upon still further rotation the second opening 6 will also pass below the surface of the mercury, only slightly lowering the resistance of the switch, however, thus restoring the switch to its initial condition. Continued rotation of the switch will obviously cause a repetition of this cycle of operations. Thus this switch is especially adapted for use where a switch which is continuously rotated must handle relatively large currents.

In some cases, where it is necessary to even further decrease the resistance of the switch copper or the like may be substituted for the tungsten of the inleads 8 and 9, provided these inleads are plated or otherwise coated with nickel, chromium or other metal which does not deleteriously affect the mercury.

While I have described my invention by reference to certain preferred embodiments thereof, it is to be understood that it is not limited thereto, but that various omissions, substitutions or changes, within the scope of the appended claims, may be made therein without departing from the spirit of my invention.

I claim as my invention:

1. A fluid flow switch comprising a sealed envelope, an electrically conducting fluid therein, a transverse baffle separating said fluid into two pools, a relatively long opening through said baffle through which said pools can be united at will, inleads extending into said envelope and making contact with said fluid on opposite sides of said baffle, and means to establish a short fluid path between said inleads after said pools have been united through said long opening.

2. A mercury switch comprising a sealed envelope, mercury therein, a transverse baffle separating said mercury into two pools, a relatively long opening through said baffle through which said mercury pools can be united at will, inleads extending into said envelope and making contact with said mercury on opposite sides of said baffle, and means to establish a short fluid path between said inleads after said pools have been united through said long opening and to open said short path before said pools are again separated within said opening.

3. A mercury switch comprising a sealed tubular envelope, a tubular refractory lining therein, mercury in said envelope and in said lining, means comprising a transverse baffle to separate said mercury into two pools, two adjacent openings through said baffle, one being considerably shorter than the other, and inleads extending into said envelope and making contact with said mercury pools on

opposite sides of said baffle, each of said inleads extending to a point adjacent to the shorter of said openings.

4. A mercury switch comprising a sealed envelope, a refractory lining therein, a transverse baffle in said lining, mercury in said envelope and in said lining, two openings through said baffle, one of said openings being considerably shorter than the other, said openings being so disposed with respect to each other that in one position of said switch envelope said mercury will extend through only the longer of said openings, while in another position of said envelope said mercury will extend through both of said openings, inleads extending into said envelope and making contact with said mercury on opposite sides of said baffle, each of said inleads extending to a point close to said shorter opening, and means to prevent union of the mercury on opposite sides of said baffle save through said openings.

5. A mercury switch comprising a sealed tubular envelope, a tubular refractory lining fixed against rotation within said envelope, a transverse baffle in said lining, mercury in said envelope and in said lining, two openings through said baffle, one of said openings being considerably shorter than the other, said openings being so disposed with respect to each other that at three adjacent rotational positions of said switch envelope said mercury will extend through both of said openings, only the longer thereof, and neither, respectively, inleads extending into said envelope and making contact with said mercury on opposite sides of said baffle, each of said inleads extending to a point close to said shorter opening, and means to prevent union of the mercury on opposite sides of said baffle save through said openings.

6. A mercury switch comprising a sealed envelope, a refractory lining therein, mercury in said envelope and in said lining, a transverse baffle in said lining, a relatively long opening through said baffle, inleads extending into said envelope and into contact with said mercury on opposite sides of said baffle, one of said inleads extending through another opening in said baffle to a point in proximity to the other of said inleads, the portion of said inlead extending beyond said baffle being so disposed with respect to the aforesaid long opening therethrough that in one position of said switch envelope said mercury will not be in contact with said portion extended on that side of the baffle but will extend through said opening, while in another position of said envelope said mercury will both make contact with said portion on that side of the baffle and extend through said opening, and means to prevent union of the mercury on opposite sides of said baffle save through said openings.

7. A mercury switch of the rotating type comprising a sealed tubular envelope, a tubular refractory lining fixed against rotation within said envelope, a transverse baffle in said lining, mercury in said envelope and in said lining, a short eccentric opening in said baffle, two longer eccentric openings through said baffle, said longer openings being symmetrically disposed on opposite sides of said shorter opening, said openings being in such relative positions that upon rotation of said envelope said mercury extends through one of said longer openings before it extends through said short opening, and continues to extend through the other long opening after said short opening has moved above said mercury, inleads extending into said envelope and into contact with said mercury on opposite sides of said baffle, each of said inleads extending to a point in proximity to said shorter opening, and means to prevent union of the mercury on opposite sides of said baffle save through said openings.

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

WARREN R. WALKER.