Dec. 18, 1934. W. R. WALKER 1,984,505

ELECTRIC SWITCH

Filed Dec. 13, 1932

Fig. 1

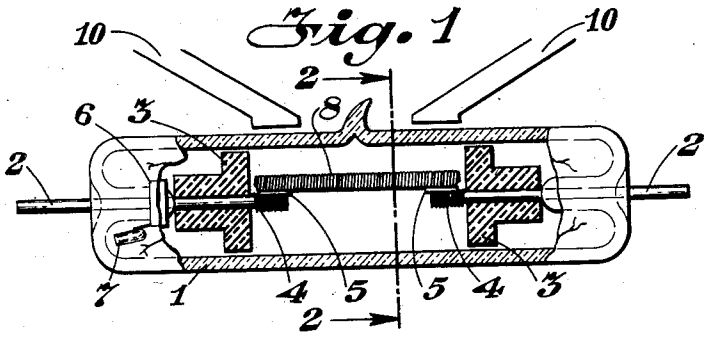


Fig. 2

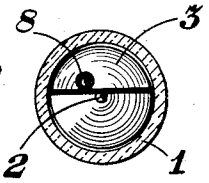


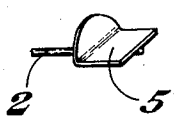
Fig. 3



Fig. 4



Fig. 5



INVENTOR
Warren R. Walker
BY
John A. Brown
ATTORNEY

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ELECTRIC SWITCH

Warren R. Walker, Short Hills, N. J., assignor to General Electric Vapor Lamp Company, Hoboken, N. J., a corporation of New Jersey

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9 Claims. (Cl. 200—87)

The present invention relates to electric circuit makers and breakers, and in particular to those operating in a vacuum.

A particular object of the invention is to provide a magnetically operated vacuum switch which will be reliable in operation. Another object is to provide a switch of this type which will be simple and inexpensive, and which will have a long useful life. Still other objects and advantages of my invention will appear from the following detailed specification, or from an inspecton of the accompanying drawing.

The invention consists in the novel device hereinafter set forth and claimed.

For many years attempts have been made to produce electric switches in which the circuit is made or broken between solid contacts within an evacuated chamber, because it was recognized that this type of switch had many advantages. Due to the difficulties which are obviously inherent in mechanical movement of the contacts within an evacuated chamber these switches were usually designed for magnetic operation. Unfortunately, however, a serious difficulty has likewise been encountered in magnetic operation of these switches, as a result of which they have never progressed beyond the experimental stage. This difficulty is caused by the fact that the contacts in any of these devices have a serious tendency to freeze together upon closure of the circuit. Since the magnetic gap is necessarily large in these devices, and since the armature must have a relatively small mass in order to prevent damage to the enclosing envelope, particularly where the latter is of glass, the magnetic force available to separate these frozen contacts is relatively small, so that it has been impossible to assure positive opening of the circuit.

I have now discovered that this difficulty can be entirely eliminated by providing a novel switch structure of my invention. According to my invention two fixed contacts are electrically connected by a freely movable bridging member of appreciable length. At least a portion of this bridging member consists of a magnetizable material which serves as an armature. With this construction it is obvious that there are two contact points. Experience has shown that the freezing of the contacts always occurs at one or the other of these points, but not at both simultaneously. Hence, even though one end of the bridging member is frozen the other end thereof is aways free, and the magnetic attraction of this free end produces an appreciabe turning movement on the frozen contacts, even in a weak field, due to the length of the lever arm. This turning moment has been found to be quite adequate to free the contact which is frozen. As a further refinement, however, I prefer to make my bridging member in the form of a tube with a rod of magnetic material freely movable therein. This offers the further advantage that the magnetic rod immediately starts to move upon application of the magnetic field, and thus strikes a hammer blow on the surrounding tube. This blow, coupled with the turning moment, is sufficient to separate the contacts even in the most aggravated cases of sticking which have been encountered.

For the purpose of illustrating my invention I have shown in the accompanying drawing a preferred form of switch embodying the foregoing features, together with a modification thereof. In the drawing

Fig. 1 is an elevational view, in part section, of my novel switch,

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

Fig. 3 is an enlarged view, in part section, of the bridging member,

Fig. 4 is an end view of said bridging member, and

Fig. 5 is a perspective view of a modification of the fixed contact structure.

As shown in Figs. 1 and 2 I preferably form my novel switch with a tubular envelope 1 of any suitable material. A pair of inleads 2 are sealed into opposite ends of this envelope through a conventional seal. These inleads may be of any suitable material, but where a boro-silicate glass is used for the envelope 1 these inleads are conveniently formed of tungsten. A hubbed disc 3 of suitable insulating material, such as porcelain, or the like, is mounted for free rotation on each of said inleads with the hub side against said seal. The diameter of said disc is only slightly less than the inner diameter of the envelope 1. A metal sleeve 4, which in practice is formed as a closely wound helix of nickel wire, is slipped over the end of each of said inleads 2 to a point adjacent to said discs 3, said sleeves thus serving as retaining means for said discs 3. A transverse metal plate 5 which extends entirely across the interior of the envelope 1 is then placed horizontally on each of the sleeves 4 near the end of the associated inlead 2. These plates, which serve as the fixed contacts, may be made of copper, nickel or the like, but tungsten or molybdenum is preferred therefor, due to the fact that these metals have a better resistance to disintegration by the arcs incidental to operation of any switch. Each plate 5 is welded

to its supporting inlead 2, the intervening sleeve 4 of nickel greatly facilitating the welding operation where a relatively refractory metal, such as tungsten, is used for either said inleads or said plates, or both. A metal band 6 which hangs over one of the inlead seals supports a pellet 7 within which there is a quantity of magnesium or other suitable getter. These parts are, of course, all assembled on the respective inleads 2 prior to sealing into the envelope 1.

A tubular bridging member 8 rests upon the contact members 5 and is slightly shorter than the distance between the discs 3, while the diameter thereof is appreciably greater than the gap between said discs 3 and the envelope 1. Thus this bridging member has considerable freedom of movement, but cannot escape from its position above the contact plates 5, nor can it become wedged between the discs 3 and the envelope. Said bridging member may be made of tubing of copper, nickel or the like, if desired, but I prefer to make it of tungsten in order to increase the useful life of my switch, in which case it is most conveniently formed of tungsten wire of, say, 10 mils. diameter in a closely wound helix, such as shown in the drawing. Due to the rigidity of tungsten this helix behaves substantially the same as a tube. Within said bridging member 8 there is a rod 9 of iron or other magnetic material. Said rod is slightly shorter than said bridging member and has a diameter appreciably less than the interior diameter of the latter, so that it is free to move therein. Said rod is retained within said bridging member by the end turns thereof, which are bent across the axis of said bridging member, as particularly shown in Fig. 4, although it is obvious that the ends of said bridging member may be plugged in various other ways, if desired, to produce the same result.

In some cases the fixed contact members may be modified, as shown in Fig. 5, where the back edge of the contact plate 5′ is turned up to form a stop for the end of the bridging member 8. In this case there is no need, of course, for the discs 3.

After the complete device has been assembled as previously described, the envelope 1 is evacuated to as good a vacuum as possible, the various elements being degassed by the application of heat during this evacuation. This heat is preferably induced in the various metal parts by a high frequency magnetic field, care being employed not to heat the pellet 6 until the evacuation is complete. Said pellet is then heated to a temperature sufficient to volatilize the magnesium therein which thereupon condenses upon the walls of the envelope 1. The residual gas is cleaned up by said magnesium, which thus not only produces but maintains an extremely good vacuum. It is to be understood, however, that in some cases it is not necessary to provide such a good vacuum, and that where desired a gas such as hydrogen or a vapor such as that of mercury, may be provided in the envelope 1. Said envelope 1 is then sealed off and the switch is complete.

In the operation of the switch shown in Figs. 1–4 the switch envelope 1 is placed below the poles of an electromagnet, the poles 10 thereof being shown conventionally in Fig. 1, said poles each terminating directly above a contact plate 5. Whenever said electromagnet is energized the rod 9 is attracted toward the top of the envelope 1. The first movement of this rod in response to this attraction is independent of the tubular member 8, until the slack has been taken up therebetween. Thus said rod 9 delivers a hammer blow to the member 8 which loosens any frozen or sticking contacts, and thereafter said rod 9 and bridging member 8 move upwardly together, the circuit through the switch being thereupon interrupted. This loosening of the frozen contacts is greatly facilitated, of course, due to the fact that one end of the member 8 is always free to exert a turning moment on the frozen contacts, thus making the hammer blow delivered by the rod 9 at this end especially effective. The circuit remains open, of course, so long as the electromagnet is energized. As soon as it is deenergized, however, the bridging member again falls back onto the contact plates 5, closing the circuit through the switch. Due to the great freedom of movement of the bridging member 8 it may happen, of course, that said member will occasionally tend to assume a sloping position against one of the discs 3, in which position the circuit would, of course, remain open. Said disc 3 is free to rotate, however, under the weight of the bridging member, and hence said bridging member immediately drops to the contact plate 5 and closes the circuit. Thus my novel switch may be absolutely relied upon to positively open and close the circuit therethrough whenever desired.

When the modified fixed contacts shown in Fig. 5 are used the operation of the switch is virtually the same as previously described. With this construction, however, the circuit is closed as soon as the bridging member 8 makes contact with both of the contact plates 5′, regardless of the angle of said bridging member. In some cases, however, the contacts may become frozen when the bridging member is at a considerable slope. While this condition has been overcome by the turning moment and hammer action previously described in all the cases observed, it is believed that the optimum conditions for the positive opening of the circuit irrespective of freezing occur when the bridging member is horizontal before the circuit is closed. Hence the structure shown in Figs. 1–4, in which this is assured, is preferred.

The low mass of the moving parts of this novel switch is an extremely desirable feature thereof, since it greatly reduces the impacts received by the envelope both in shipment and in operation, with a consequent virtual elimination of the breakage hazard. This low mass also makes possible the operation of the switch at high frequency. Another desirable feature of my novel switch is that the magnetic field is always applied from one side of the bridging member, rather than axially thereof. Hence there is no tendency for said bridging member to bind against a wall of the envelope under the influence of the magnetic field, such as tends to occur when axial movement is relied upon. Another novel feature of my structure results from the freedom of movement of the bridging member 8, which permits it to make contact with the contact plates 5 at a different point every time. Furthermore the contact is equally likely to be made to a different point on said bridging member each time, due to rotation and longitudinal movement thereof. As a result pitting is virtually eliminated, and my switch has an exceptionally long useful life.

This novel switch is especially desirable for use where an extremely rapid response is required, and especially where it is desired to abruptly open

a circuit. The switch illustrated, for example, is especially designed for use in combination with an inductance which is energized whenever said switch is closed to generate high voltage surges, such as used to start a mercury arc lamp of the Cooper Hewitt type. When so used it is found that this switch cooperates in a unique manner with the associated circuit, due to the nature of the circuit interruption, to produce a high frequency discharge of extremely high voltage which is unusually effective.

While I have described my invention by reference to certain specific structures it is to be understood that it is not limited thereto, it being obvious that various omissions, substitutions and 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. An electric circuit maker and breaker comprising a sealed envelope, two fixed contacts sealed into said envelope, and a relatively long bridging member extending between said contacts, at least a portion of said member being made of a magnetizable body, said fixed contacts being spaced apart by a distance slightly less than the length of said member, whereby each end of said member engages one of said contacts.

2. An electric circuit maker and breaker comprising an evacuated envelope, two fixed contacts of solid material sealed into said envelope, and a cylindrical bridging member extending between said contacts, at least a portion of said member consisting of a magnetizable body, said fixed contacts being spaced apart by a distance slightly less than the length of said member, whereby each end of said member engages one of said contacts.

3. An electric circuit maker and breaker comprising an evacuated envelope, two fixed contacts sealed into said envelope, a tubular bridging member extending between said contacts, and a magnetizable body within said bridging member and freely movable therein.

4. An electric circuit maker and breaker comprising an evacuated envelope, two fixed contacts sealed into said envelope, a relatively long bridging member extending between said contacts, at least a portion of said member consisting of a magnetizable body, and means to prevent axial displacement of said bridging member, said fixed contacts being spaced apart by a distance slightly less than the length of said member, whereby each end of said member engages one of said contacts.

5. An electric circuit maker and breaker comprising an evacuated envelope, two fixed contacts sealed into said envelope, a bridging member extending between said contacts, at least a portion of said member consisting of a magnetizable body, and means to prevent axial displacement of said bridging member, said means comprising a pair of members which are rotatably supported within said envelope.

6. An electric circuit maker and breaker comprising an evacuated envelope, two fixed contacts sealed into said envelope, and a relatively long resilient bridging member extending between said contacts, each end of said member being adapted to engage one of said contacts, at least a portion of said member consisting of a magnetizable body.

7. An electric circuit maker and breaker comprising an evacuated envelope, two fixed contacts sealed into said envelope, and a relatively long helically wound wire bridging member consisting in part of magnetizable material extending between said contacts, each end of said member being adapted to engage one of said contacts.

8. An electric circuit maker and breaker comprising an evacuated envelope, two fixed contacts sealed into said envelope, a relatively long bridging member of helically wound wire extending between said contacts, each end of said member being adapted to engage one of said contacts, and a magnetizable body freely movable within said bridging member.

9. An electric circuit maker and breaker comprising an evacuated envelope, two fixed contacts sealed into said envelope, and a relatively long bridging member extending between said contacts, each end of said bridging member being adapted to engage one of said contacts, at least a portion of said bridging member consisting of a magnetizable body, said bridging member being so disposed with respect to said contacts that it is out of contact therewith whenever it reaches one of its limits of movement.

WARREN R. WALKER.