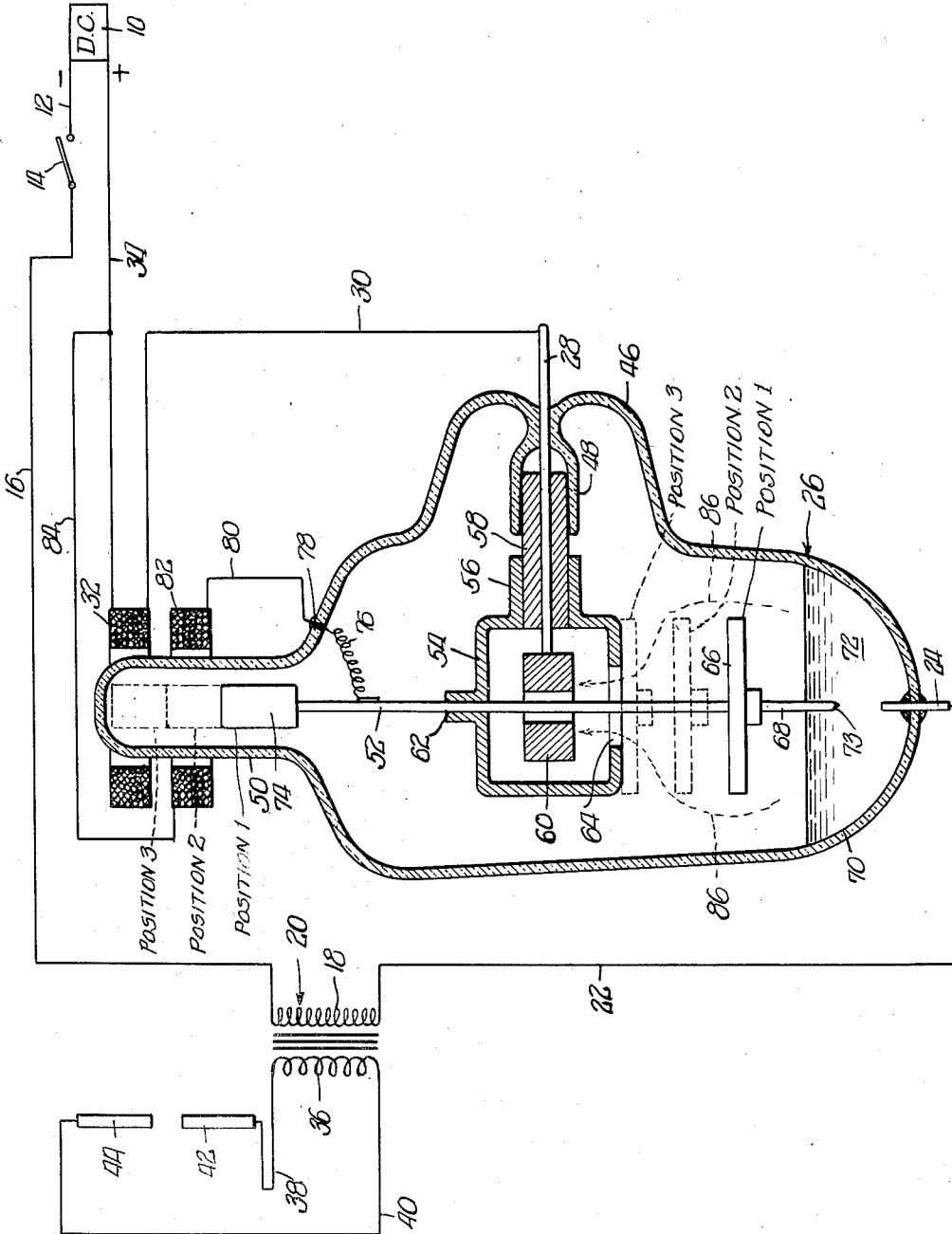


Dec. 27, 1949

W. G. TAYLOR
MERCURY VAPOR SWITCH
Filed July 1, 1944

2,492,669



INVENTOR.
Warren G. Taylor,
BY
Stone, Artman & Bisson.

Attis

UNITED STATES PATENT OFFICE

2,492,669

MERCURY VAPOR SWITCH

Warren G. Taylor, Chicago, Ill.

Application July 1, 1944, Serial No. 543,189

9 Claims. (Cl. 315—331)

1

This invention relates to a mercury arc switch. It was designed for a particular application, namely to break the primary circuit in welding apparatus. It should be of use wherever it is desired to break a direct circuit cleanly.

In concurrently filed application, Serial No. 543,190, filed July 1, 1944, the applicant described the reasons for such a switch and disclosed a vacuum tube switch wherein two graphite electrodes are separated inside a vacuum so as to break the primary circuit of welding apparatus. The present invention has the same general objective, but accomplishes its end by forming a mercury vapor arc as part of the conductive primary circuit of the welding apparatus and then snuffing out this arc so as to collapse the circuit suddenly. The particular embodiment by which applicant accomplishes this end is shown in a single figure in the drawings wherein Figure 1 shows a schematic welding circuit with a cross section of applicant's mercury arc switch tube.

Continuing to refer to the drawings, the numeral 10 identifies a direct current source of power having its negative post connected by a conductor to a switch 14. The conductor 16 connects the switch 14 to the primary winding 18 of a transformer 20. The primary circuit is completed by a conductor 22 connected to a post 24 on an evacuated tube 26. This tube constitutes applicant's mercury arc switch. A post 28 on the tube 26 is connected by a conductor 30 to a low resistance solenoid 32. The solenoid 32 is connected to the direct current source of power by a conductor 34.

Referring to the transformer 20, its secondary winding 36 is connected by conductors 38 and 40 to electrodes 42 and 44 respectively of welding apparatus—all of which, is schematically shown.

Returning now to the mercury arc switch 26, this is composed of a glass envelope 46 which has an inwardly directed hollow post 48 and a projection forming a recess 50 directed outwardly along the long axis of the tube. Extending along the longer dimension of this tube 26 is a tungsten rod 52 whose purpose it is to act as a starter. This tungsten rod 52 is held in vertical reciprocal position by means of a hollow hard graphite casing 54 which is supported by means of a shoulder 56 mounted on a ceramic tube 58, which in turn is seated permanently in the glass hollow post 48. The lead 28 is made of tungsten and extends inwardly through the ceramic tube 58 and supports at

2

its inner end a tungsten anode 60 which is shaped like a ring or annulus. The graphite casing 54 has an opening 62 which snugly fits the tungsten rod 52 and acts as a vertical guide for up and down movement. On the side of the casing 54 opposite to the opening 62 is a larger opening 64. The rod 52 passes through the center of this and at its lower end there is placed a disc made of graphite 66. Depending to a point below the disc 66 is the lower end or conductive contact 68 having a point 73 of the graphite rod 52. The bottom 70 of the tube is filled with mercury 72, which acts as an emitting cathode when coupled to the negative side of a direct current circuit.

Positioned on the upper end of the rod 52 is an iron armature 74, of a size and shape which is adapted to move readily in and out of the glass projection 50. Tapped to the rod 52 is a flexible conductor 76 connected to a lead-in post 78. This post is connected by a conductor 80 to a second solenoid 82 positioned around the glass projection 50, and closer to the iron armature 74 than is the solenoid 32. The solenoid 82 has high resistance and is connected by a conductor 84 to the line 34.

The glass envelope 46 is evacuated.

This mercury arc switch functions as follows. When the welding apparatus operator closes the switch 14, the primary circuit is completed to the transformer 20 by the conductors 16, 18, 22, 24, mercury 72, 68, 52, 76, 78, 80, 82, 84 and 34. The high resistance solenoid 82 pulls the iron armature 74 upwardly into position 2 and in so doing the tip 73 of the lower end of the tungsten rod 68 starts an arc from the mercury pool as it leaves the pool. This arc closes the primary circuit of the transformer 20 from the mercury pool 72 to the anode 60. The primary circuit through the transformer 20 is now being completed by the mercury vapor arc which closes the circuit through the anode 60, lead 28, conductor 30 and low resistance solenoid 32. By this time the current is built up in the transformer 20 and the armature 74 now moves into position 3. In so doing, the disc 66 moves into position 3 and snuffs out the mercury vapor arc. As is well understood in the art, the mean free path required for a mercury vapor arc is about $\frac{1}{4000}$ of an inch, or at least a small part of an inch. In order to snuff out the mercury vapor arc, therefore, the disc 66 need not seat itself over the opening 64 with the greatest precision. Approximate tightness is sufficient. This also accounts for the fact that the mercury vapor arc will

3

not go around the casing 54 to go in around the rod 52 in between the rod 52 and the hole 62.

The snuffing out of the vapor arc collapses the field in the primary windings of the transformer 20 very suddenly and causes the surge of current in the secondary which is so desirable in welding.

As long as the switch 14 is in closed position, the tungsten rod 52 will remain in position 3. As soon as the switch 14 is open, the tungsten rod 52 will drop by gravity into position 1. It will be appreciated that a spring or some other device may be used to urge the tungsten rod 52 vertically.

In this switch, the poles of the source of power may not be reversibly connected to the posts of the tube. The lead 28 is an anode and must be connected to the positive side of the source of power.

In place of the mercury pool, a hot cathode, as for example an oxide coated cathode may be substituted. In such a structure, the direct contact from the hot cathode will be broken by the activity of a high resistance solenoid in much the same way shown in a mercury vapor switch. When the direct contact has been broken, the hot cathode will emit to an anode to maintain the primary circuit in operation and bring into action a low resistance solenoid which will shut off the anode and stop the admission by the cathode.

Having thus described my invention, I claim:

1. A self-opening switch for a direct current circuit comprising an evacuated envelope, an emitting cathode in the envelope conductively associated with an external post for connection to the negative side of the circuit, an anode spaced from the cathode with a passageway connecting the two, said anode being conductively associated with an external post for connection to the positive side of the circuit, a conductive contact movable into and out of engagement with the cathode, said contact being conductively associated with an external post for connection to the positive side of the circuit, electrical means in this contact circuit for moving the contact out of engagement with the cathode, and a closure member associated with this movable contact for thereafter closing the passageway.

2. A self-opening switch for a direct current circuit comprising an evacuated envelope, a mercury pool in the envelope conductively associated with an external post for connection to the negative side of the circuit, an anode spaced from the mercury pool with a passageway connecting the two, said anode being conductively associated with an external post for connection to the positive side of the circuit, a conductive contact movable into and out of engagement with the mercury pool, said contact being conductively associated with an external post for connection to the positive side of the circuit, electrical means in this contact circuit for moving the contact out of engagement with the mercury pool, and a closure member associated with this movable contact for thereafter closing the passageway.

3. A self-opening switch for a direct current circuit comprising an evacuated envelope, an emitting cathode in the envelope conductively associated with an external post for connection to the negative side of the circuit, an anode spaced from the cathode with a passageway connecting the two, said anode being conductively associated with an external post for connection to the positive side of the circuit, a conductive contact movable into and out of engagement with the cath-

4

ode, said contact being conductively associated with an external post for connection to the positive side of the circuit, a solenoid in the circuit of the movable contact, an armature actuable by the solenoid and associated with the movable contact for moving it out of engagement with the cathode, and a closure member associated with this movable contact for thereafter closing the passageway.

4. A self-opening switch for a direct current circuit comprising an evacuated envelope, an emitting cathode in the envelope conductively associated with an external post for connection to the negative side of the circuit, an anode spaced from the cathode with a passageway connecting the two and conductively associated with an external post for connection to the positive side of the circuit, a conductive contact movable into and out of engagement with the cathode, said contact being conductively associated with an external post for connection to the positive side of the circuit, a closure member movable with the contact for closing the passageway when the contact has moved a selected distance from the cathode, electrical means in the movable contact circuit for moving the contact out of engagement with the cathode, and electrical means in the anode circuit for thereafter moving the closure member across the passageway.

5. A self-opening switch for a direct current circuit comprising an evacuated envelope having a vertical axis, an axially movable conductive rod disposed along the vertical axis, an armature on the upper end of the rod, a first solenoid and a second solenoid disposed one above the other and above the armature, an emitting cathode in the bottom of the envelope and contactable by the rod when in its lower position, an anode in the envelope connected by a passageway to the emitting cathode, a closure member mounted on the rod and seatable over said passageway when the rod is in its uppermost position, a conductor connecting the rod to a lead of the first solenoid, and a conductor connecting the anode to a lead of the second solenoid, whereby when the switch is placed in a direct current circuit with the negative pole connected to the cathode and the positive pole connected to the other leads of the two solenoids, the first solenoid will raise the rod from the cathode starting an arc and a flow of current to the anode and the second solenoid will further raise the rod and thereby close the passageway and break the circuit.

6. The self-opening switch of claim 5 in which the cathode consists of a mercury pool.

7. The self-opening switch of claim 5 in which the first solenoid has a high resistance and the second solenoid a low resistance.

8. A self-opening switch for a direct current circuit comprising an evacuated envelope having a vertical axis, a ring anode supported in said envelope with its hole concentric with the envelope axis, a nonconductive casing around said anode having a comparatively large downwardly directed concentric opening therein, a mercury vapor cathode in the bottom of the tube, a rod movably disposed in the vertical axis of the tube so that it passes through the center ring in nonconductive relationship thereto and through the top and bottom opening of the housing and in its lower position contacts the cathode, an armature on the upper end of the rod, a solenoid concentric with the axis above the armature, a conductor connecting the rod to one lead of the solenoid, and a disc mounted on the bottom of the rod for

5

closing the opening in the casing, whereby when the negative side of a direct current circuit is connected to the cathode of the switch and the positive side is connected to the anode and the lead of the solenoid, the rod will first start an arc between the cathode and the anode and thereafter the closure member will snuff out the arc.

9. A self-opening switch for a direct current circuit comprising an evacuated envelope having a vertical axis, a ring anode supported in said envelope with its hole concentric with the envelope axis, a nonconductive casing around said anode having a comparatively large downwardly directed concentric opening therein, a mercury vapor cathode in the bottom of the tube, a rod movably disposed in the vertical axis of the tube so that it passes through the center ring in nonconductive relationship thereto and through the top and bottom opening of the housing and in its lower position contacts the cathode, an armature on the upper end of the rod, a solenoid concentric with the axis above the armature, a conductor connecting the rod to one lead of the solenoid, a disc mounted on the bottom of the rod for closing the opening in the casing, and a second solenoid positioned above the first solenoid and having one lead connected to the anode whereby when the negative side of a direct current circuit is con-

6

nected to the cathode and the positive side is connected to the leads of both solenoids, the rod will rise to a first position starting an arc between the cathode and the anode and will then rise to a second position whereby the closure member will snuff out the arc.

WARREN G. TAYLOR.

REFERENCES CITED

- 10 The following references are of record in the file of this patent:

UNITED STATES PATENTS

	Number	Name	Date
15	1,300,251	Davis	Apr. 15, 1919
	1,816,168	Berthold	July 28, 1931
	1,941,567	Marti	Jan. 2, 1934
	2,053,930	Winter	Sept. 8, 1936
	2,072,993	Ulrey	Mar. 9, 1937
20	2,169,818	Scott	Aug. 15, 1939
	2,203,579	Randolph	June 4, 1940
	2,221,569	Berkey	Nov. 12, 1940
	2,248,574	Knight	July 8, 1941
	2,292,137	Livingston	Aug. 4, 1942
25	2,294,388	Dawson	Sept. 1, 1942
	2,341,562	Klemperer	Feb. 15, 1944
	2,388,430	Mikhalapov	Nov. 6, 1945