June 27, 1944. P. L. SPENCER 2,352,230

ARC STARTING ELECTRODE AND METHOD OF FORMING SAME

Filed Feb. 18, 1942

FIG. 1.

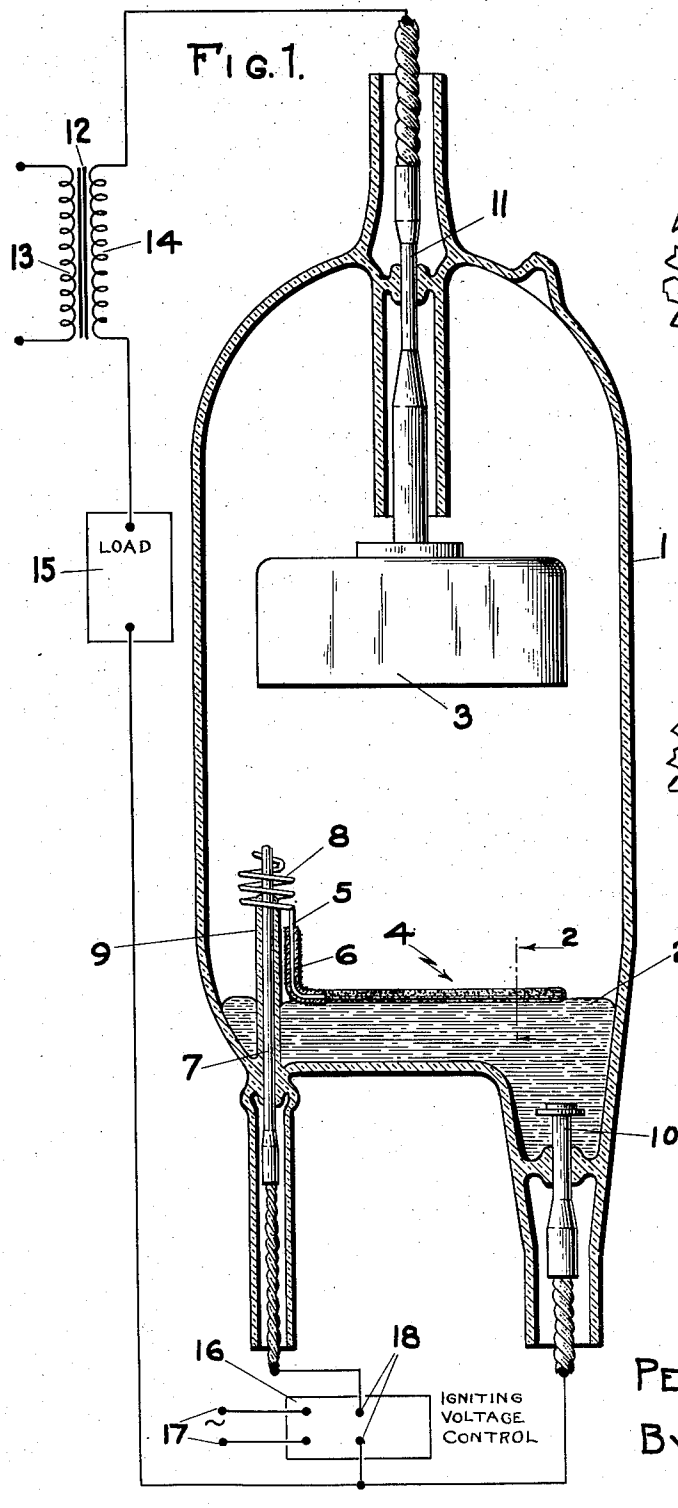
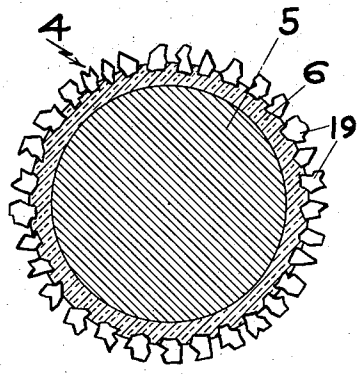


FIG. 2.



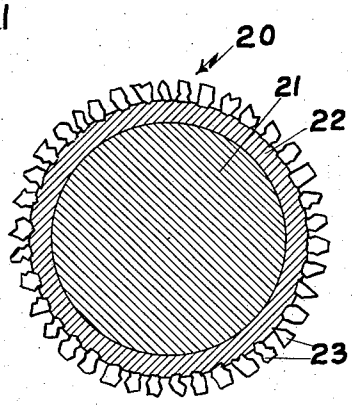


FIG. 3.

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ARC STARTING ELECTRODE AND METHOD OF FORMING SAME

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13 Claims. (Cl. 250—27.5)

This invention relates to igniters for initiating an arc spot on a pool type cathode and to methods for forming such igniters.

An object of this invention is the provision of novel igniters which will easily initiate an arc and are reliable and uniform in operation.

Another object of this invention is the provision of igniters having longer effective lives.

Wetting of the igniting electrode material generally produces undesirable operation. It is therefore a further object of this invention to provide igniters whose surfaces retain their non-wetting characteristics for long periods of time and under adverse conditions.

This invention is applicable to both the electrostatic and resistance types of igniters. By the electrostatic type of igniter I mean the type of igniters comprised of a conductor covered by a thin wall of insulating material, which insulating material is arranged in direct contact with the cathode pool. By the resistance type of igniter I refer to the type having relatively high resistance through which resistance a current is passed into the pool.

A feature of this invention is the provision of electrostatic igniters which operate on lower igniting voltages and thus without danger of rupture of their insulating walls.

With the resistance type of igniting electrode it has been found desirable to have the major portion of the resistance of said electrode confined to the area making contact with the cathode pool. Another feature of this invention therefore is the provision of an igniting electrode having its high resistance confined to the portion thereof making contact with the cathode pool.

A still further object of the present invention is the provision of methods of forming igniting electrodes of the types described herein.

Other and further objects and advantages of this invention will become apparent and the foregoing objects and features will be best understood from the following description of exemplifications thereof, reference being had to the drawing, in which

Fig. 1 is a cross-section of a tube embodying my invention, together with a diagrammatic representation of a circuit with which said tube may be used;

Fig. 2 is a cross-section taken along line 2—2 of Fig. 1; and

Fig. 3 is a cross-sectional view similar to the one shown in Fig. 2 of a modification of my novel igniting electrode.

Referring now to the drawing, the tube illustrated comprises a sealed envelope 1 containing a pool cathode 2, preferably consisting of a pool of mercury, and an anode 3. In order to provide means for initiating an arc spot on the surface of the cathode pool 2, the tube is provided with an igniter 4, consisting of an electrode comprising an elongated conductor 5 separated and insulated from the cathode pool by means of an insulating layer 6 covering the surface of said conductor. This insulating coating or layer is preferably made of glass sealed to the surface of said conductor, preferably as described and claimed in my co-pending application Serial No. 251,069, filed January 16, 1939, wherein the insulating layer is described as having a thickness of the order of 10 mils or less. The glass insulating layer is covered with an insulating material, as will be more fully described hereinafter in connection with the description of Figs. 2 and 3. The conductor 5 may be of any convenient diameter, for example between 30 and 40 mils. The igniter 4 is floated on the surface of the mercury pool 2 with a considerable length of said igniter in contact with the surface of said pool. Preferably, as illustrated, substantially the entire length of the coated conductor 5 is thus in contact with the surface of said pool. The coated conductor 5 may be of any convenient shape, as for example, a straight length.

External electrical connection is made to the conductor 5 through a lead-in conductor 7 sealed through the bottom wall of the envelope 1. A flexible lead 8 connects the upper end of the lead-in conductor 7 to one end of the conductor 5. The lead 8 is of sufficient flexibility to permit the coated electrode 5 to float freely on the surface of the pool 2 and to change its position with variations in the level of said pool. As shown, the lead 8 may consist of a light coiled spring. In order to insulate and separate the conductor 7 from the pool 2, it is covered by an insulating wall 9, also preferably of glass. Since it is desired that the ignition occur at the floating igniting structure, the thickness of the glass layer 9 is preferably made substantially greater than that of the glass layer 6. I prefer to leave the upper end of the conductor exposed as illustrated. The exposed end of the conductor 7 thus acts as an electrode which facilitates the transition of incipient arc spots formed on the surface of the pool 2 adjacent the insulating layer 6 into true arc spots. Furthermore, as soon as such an arc spot is formed, a discharge occurs between the upper end of the electrode 7 and the pool 2 which

is of relatively low voltage drop. This removes the high voltage existing between the conductor 5, and the pool 2. Thus this voltage only rises to the value necessary to initiate the arc spot whereupon it is removed.

External electrical connection may be made to the cathode 2 through a lead-in conductor 10 sealed through the lower wall of the envelope 1 and projecting into the pool 2. External electrical connection may also be made to the anode 3 through an anode lead-in conductor 11 sealed through the upper end of the envelope 1.

In tubes of the type described above, the application of a comparatively high voltage between the lead-in conductors 7 and 10 will produce an incipient cathode spot at some point along the insulating layer 6 in contact with the surface of the mercury pool 2. If the anode 3 at such time has impressed upon it a positive voltage, said incipient arc spot will be transformed into a true arc spot which will then be maintained by said anode.

The tube which I have described above may be utilized in a wide variety of circuits. In Fig. 1 I have illustrated one typical circuit which may be used. This circuit consists of an input transformer 12 having a primary winding 13 connected to a suitable source of alternating current and a secondary winding 14. One end of said secondary winding 14 is connected to the anode lead-in conductor 11. The other end of the secondary winding 14 is connected through a suitable load 15 to the cathode lead-in conductor 10. Igniting voltage is supplied by an igniting voltage control 16 having its input 17 connected to a suitable source of alternating current. One end of the output 18 of the igniting voltage control 16 is connected to conductor 7 and the other end thereof is connected to the cathode lead-in conductor 10.

The igniting impulses supplied by the igniting voltage control 18 are synchronized with the voltage supplied by the secondary winding 14 so that a positive voltage is impressed on the starting anode 3 whenever an igniting voltage impulse is supplied to the igniter.

Referring now to Fig. 2, as stated hereinbefore, the igniter 4 is comprised of an elongated conductor 5 coated with a glass insulating layer 6 and having additional insulating material 19 arranged thereon. The material 19 preferably has a high dielectric constant and should be capable of withstanding the arcing occurring within the tube. It should be a highly insulating material. Furthermore, it should be arranged in such form as to accumulate the maximum electrical charge when arranged for operation. For this purpose I prefer to use diamond particles, also known as diamond dust. Besides being an excellent insulator and being capable of withstanding arcing, diamond dust has the high dielectric constant of 16.5. The particles should be of a size small enough to pass through mesh having 500 to 900 openings per square inch. The size of the particles passing through mesh having 900 openings per square inch is approximately 1 mil in diameter or less. Those passing through the 500 mesh are of approximately 2 mils diameter or less.

The igniter 4 is preferably formed by shrinking the thin glass insulating layer 6 on to an elongated conductor 5 of a suitable material such as, for example, tungsten. The glass which is heated during the shrinking operation is covered with the diamond particles while it is still soft and tacky and these particles are embedded in the glass and adhere thereto. Minute openings, depending upon the size of the diamond particles employed, are formed between the various particles and the layer of diamond particles thus formed is foraminous. However, by selecting sufficiently small particles the core may be completely covered.

It was found that this type of igniter operates more easily than the igniters of the prior art. In addition to having a longer operative life it is more reliable and uniform in starting arcing in the tube.

Referring now to Fig. 3, a resistance type of igniter 20 is there illustrated which may be substituted for igniter 4 in the tube and circuit illustrated in Fig. 1. Igniter 20 is comprised of a core 21 of conducting material having a relatively high melting point, such as tungsten, on which a sleeve 22 of conducting material having a relatively low melting point, such as nickel, is arranged. Diamond particles 23 are embedded in the nickel sleeve 22. Diamond particles capable of passing through 200, 500, and 900 mesh were employed successfully in this type of igniter. These particles have a diameter of the order of magnitude of 5 mils, 2 mils and 1 mil respectively. By selecting the size of the particles employed the contact resistance of the igniter can be determined. The resistance of the igniter if desired can be made of the same order as the resistance of the usual type of resistance igniter. The layer of particles thus formed is also foraminous. Igniter 20 like igniter 4 is adapted to be partly immersed in the cathode pool 2 with the layer of diamond particles which is embedded in the core portion of said igniter arranged between said core and the pool.

Igniter 20 is formed by arranging a thin nickel sleeve 22 over the tungsten core 21. Diamond dust particles of the desired size are packed in a crucible and the tungsten core together with the nickel sleeve arranged thereon is inserted into the crucible with the diamond dust particles tightly packed thereabout. The crucible is then heated until the nickel sleeve is fused, the nickel sleeve thereby wetting the tungsten and upon cooling adhering thereto. When the nickel sleeve is in softened condition the dust particles are embedded therein and adhere thereto.

The following is my present understanding of the theory of operation of this resistance type of igniter. The mercury of the pool cathode projects sufficiently into the openings formed between the particles to make at least a point contact with the underlying core. Due to the small size of such openings the area of such contact is small and thereby presents a path of relatively high resistance to the current flow. The result is therefore an igniter which has operating characteristics analogous to those of the usual type of resistance igniter.

It was found that resistance igniters of the type hereinbefore described possess a longer operative life and are more uniform and reliable in operation. Because of the concentration of the high resistance of said igniters at the surface of the electrode, such igniters are more efficient in operation.

Figs. 2 and 3 are schematic and are distorted in order to more clearly show applicant's structure. They are not intended to show the dimensions of the various parts relative to each other.

While I have shown and described specific embodiments of my invention it is apparent that

various modifications may be made without departing from the teachings thereof. For example, the type of core employed might be changed, and the form of the igniter or the glass insulating layer might be altered without departing from the teachings of this invention. Modifications in the steps of the methods of forming these igniters will readily suggest themselves. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. An igniter for starting an arc spot on a cathode pool comprising a core and a layer of discrete particles of insulating material arranged on said core between said core and the cathode pool and forming restricted interstices therebetween.

2. An igniter for starting an arc spot on a cathode pool comprising a core and a layer of discrete particles of insulating material having a high dielectric constant arranged on said core between said core and the cathode pool and forming restricted interstices therebetween.

3. An igniter for starting an arc spot on a cathode pool comprising a core and a layer of discrete particles of insulating material having a high dielectric constant and capable of withstanding arcing arranged on said core and forming restricted interstices therebetween.

4. An igniter for starting an arc spot on a cathode pool comprising a core and a diamond layer arranged on said core.

5. An igniter for starting an arc spot on a cathode pool comprising a core and a foraminous layer of discrete particles of insulating material arranged on said core between said core and the cathode pool.

6. An igniter for starting an arc spot on a cathode pool comprising a core and a foraminous diamond layer arranged on said core between said core and the cathode pool.

7. An igniter for starting an arc spot on a cathode pool comprising a core and a layer of discrete particles of insulating material having a diameter of an order of magnitude of 5 mils or less arranged on said core between said core and the cathode pool.

8. An igniter for starting an arc spot on a cathode pool comprising a core and a diamond layer, said last-mentioned layer being comprised of particles having a diameter of an order of magnitude of 5 mils or less arranged on said core between said core and the cathode pool.

9. An igniter for starting an arc spot on a cathode pool comprising a core and a layer of discrete particles of insulating material embedded in said core and forming restricted interstices therebetween.

10. An igniter for starting an arc spot on a cathode pool comprising a conducting core, an insulating layer arranged on said core, and a layer of particles of insulating material arranged on said insulating layer between said core and the cathode pool.

11. An igniter for starting an arc spot on a cathode pool comprising a conducting core, a glass insulating layer arranged on said core, and a layer of particles of insulating material arranged on said insulating layer.

12. An igniter for starting an arc spot on a cathode pool comprising a conducting core having a high melting point, a layer of conducting material having a relatively lower melting point arranged thereon, and a layer of particles of insulating material arranged on said conducting layer.

13. An igniter for starting an arc spot on a cathode pool comprising a core, an insulating layer arranged on said core, and a diamond layer arranged on said conducting layer.

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