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STARTER ELECTRODE

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Fig. 1.

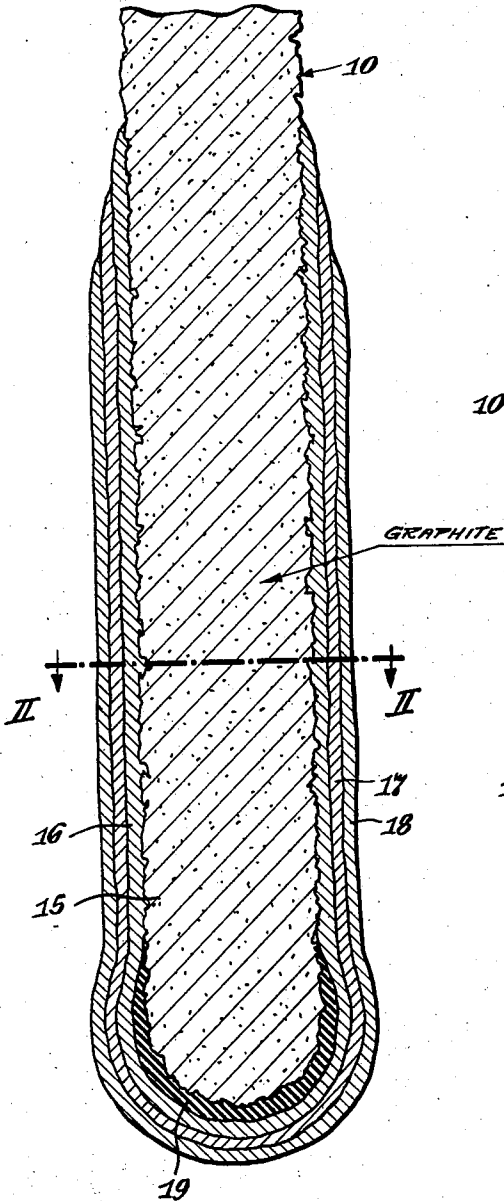


Fig. 2.

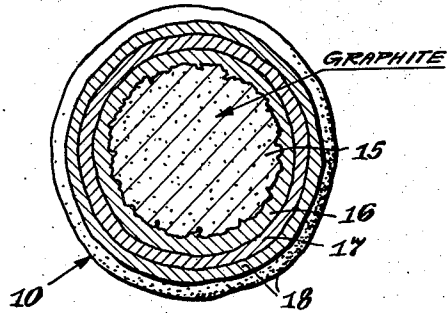
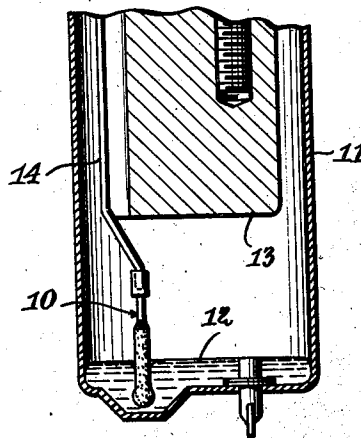


Fig. 3.



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STARTER ELECTRODE

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Application October 22, 1941, Serial No. 416,041

7 Claims. (Cl. 250—27.5)

This invention relates to an improved starter electrode and specifically to an electrode such as employed as an immersion starter for pool-type discharge devices. The invention is more particularly an improvement upon the construction of starter electrode described in co-pending application, Serial No. 387,838, of April 10, 1941, assigned to the same assignee as the present application.

Difficulties encountered in manufacture, and imperfections developed by use of the present-day electrodes have presented problems to be solved, and considerable activity has taken place directed to the improvement of such devices. Notwithstanding the concentrated effort in this field of endeavor, starter electrodes have still proven unsatisfactory in various respects. Inequality of electrode characteristics of different electrodes presumably made to be identical has been a most serious handicap in quantity production. It has also been found, in the effort to overcome this handicap by turning to coating a core with a resistive material, that while duplication characteristics are improved, failures in use have occurred resultant from the insecure bond between or other imperfections of the core and coating.

It is an object of the present invention to overcome the drawbacks heretofore encountered in manufacture and use of starter electrodes.

Another object of the invention is to provide an immersion electrode which may be duplicated in its characteristics in manufacture under conditions of quantity production.

A further object of the invention is to provide an electrode of more permanent character and less likely to become defective by use.

A still further object of the invention is to provide an immersion electrode requiring a lower starting voltage and current than those previously employed, and characterized by greater freedom from starting variations.

Yet another object of the invention is to reduce the voltage drop between the core and coating.

Still further objects of the invention will appear to those skilled in the art as the description progresses, both by direct statement thereof and by implication from the context.

In the accompanying drawing, wherein like numerals of reference indicate similar parts throughout the several views;

Figure 1 is a longitudinal and greatly enlarged sectional view of the coated end of a starting electrode constructed in accordance with my invention;

Figure 2 is a cross section on line II, II of Fig. 1; and

Figure 3 is a sectional view of a device identified as an ignitron, showing my improved starting electrode in place therein.

In the specific embodiment of the invention illustrated in said drawing, a starting electrode 10 is shown, and in Figure 3 is depicted within and forming part of an ignitron as indicative of one use to which the invention is applicable. The ignitron illustrated provides a sealed envelope 11 within which is a mercury pool cathode 12 at the bottom of the envelope and an anode 13 above the pool cathode suitably spaced and insulated from the envelope as well as from the cathode. It will be understood that the cathode and anode are to be externally connected in series relation with a load circuit and a suitable source of potential. In order to initiate a discharge between the cathode and anode, which constitute the main electrodes, an immersion starting electrode 10 is provided having a tip thereof projecting below the surface of the mercury or otherwise situated so as to create a cathode spot. The immersion starting electrode is also intended to be externally connected through a metallic conductor 14 to a regulatable source of exciting potential adapted to cause passage of current from the starter into the mercury pool at a predetermined time with respect to positive and negative variations of the main electrode voltage. The character and operation of the starter electrode is of utmost importance to the proper operation of the ignitron or other device wherein a starter electrode is required.

According to the present invention the starter electrode comprises a conductive core 15 upon which is applied a resistive coating 16. A feature of the present invention is to increase and improve the intimacy of bond between the core and coating. In forming the electrode, I prefer to select a porous or other rough surfaced material as a base and to fabricate it to the desired shape to constitute the core. The fabrication is of a character which does not destroy the rough or porous character of the outer surface of the finished core, the porosity or other roughness being maintained as an inherent feature of the invention. The material which I have found especially desirable to comprise the said core is carbonaceous in character and preferably in the form of graphite. The said core may be of any desired shape, and for purposes of illustration is here shown of rod shape, that is to say, is an elongated member of relatively small diameter.

Inasmuch as the drawing illustrates the invention as greatly exaggerated it may be stated that for ordinary usage in an ignitron the graphite core may well have a diameter approximating one-tenth of an inch or perhaps slightly greater. The lower end of the core is preferably rounded to avoid any sharp corners. The showing of Figures 1 and 2, by being greatly exaggerated, represents the outer surface of the core as rough or porous, thereby providing natural or other minute cavities throughout the surface area.

This core 15 has coating 16 intimately associated therewith, the coating obtaining a strong bond with respect to the core by imbedding in said cavities or pores of the graphite constituting said core. By virtue of this tenacious bond between core and coating, I am enabled to apply a much heavier coating on a single application thereof to the core than is possible when applying a coating to a non-porous core such as shown in co-pending application, Serial No. 387,838, supra, and in view of this fact, a reasonably satisfactory electrode can be made wherein the coating upon the graphite core is constituted by a single thick layer. However, advantages are gained by utilization of more than a single layer, and for illustrative purposes I have shown two other layers 17 and 18 of which the layer 17 is disposed intermediate of inner layer 16 and outer layer 18. While the first layer may be directly applied to the core throughout the coated area, I preferably coat the rounded end or tip of the core with insulating cement 19 as shown in Figure 1. This insulating cement is preferably silicon carbide. If preferred, as disclosed in said co-pending application and where the core is by way of example of tungsten, a cement sold under trade designation of "Sauereisen No. 78" is satisfactory and may be used. The purpose of this cement is to reduce the current flow from the end of the core, which current does not help in the creation of the cathode spot.

The character of the coating 16 applied to the core 15 is of such nature that it will readily wet the core when applied and will flow into the pores or other cavities and will harden therein as well as over the entire surface of the core to which it is applied. The coating accordingly has a covering characteristic and a bond characteristic in its relationship to the core. The coating is furthermore of a resistive material and of a character enabling it to function with respect to the mercury pool as will be understood by those skilled in the art.

As explained in the aforementioned co-pending application, the said layer 16 next core 15 is preferably formed of equal parts of boron-carbide powder of 320 mesh and silicon-carbide of 500 mesh mixed with a few percents of silicon powder. The preferred composition is 10 grams of boron-carbide, 10 grams of silicon-carbide and ½ gram of silicon. This powder is mixed with a binder and preferably with approximately 10½ cubic centimeters of a binder consisting of nitrocellulose mixed with a solvent such as amyl-acetate or diethyl-carbonate. The core 15 is immersed in this mixture to the desired depth and withdrawn at a rate depending upon the thickness of the coating desired. In practice, core 15, which may preferably have an outside diameter of .097 inch, is withdrawn slowly from the mixture in 5 to 45 seconds and will then have a coating formed thereon of approximately .002 inch to .005 inch in thickness. More precisely, I prefer to withdraw the core in 15 seconds and produce

a coated core or electrode of a diameter of substantially .104 inch. The coating may be thickened by withdrawing the core more slowly or may be made thinner by a quicker withdrawal. The dipping may be repeated if necessary.

This first coating may be dried naturally in air or it may be fired in hydrogen at 1100° C. for ten minutes such as described in Patent 2,235,504, p. 2, lines 45 to 55, issued to R. Rennie, March 18, 1941, and assigned to the same assignee as the present invention. The electrode, as thus made, may be used without further treatment, if desired.

In order to increase the resistivity of the second or intermediate coating 17 I preferably increase the percentage of silicon-carbide therein. My preferred coating is that of 5 grams of boron-carbide to 15 grams of silicon-carbide with ½ gram of silicon mixed in the solution previously described. The core is inserted and then withdrawn gradually in 15 to 30 seconds to provide a second coat thereon. Further layers may be added if desired in order to gradually increase the resistivity of the layer from the inner core or conductor to the outside surface of the electrode. In the preferred embodiment, however, I do not immediately dry or heat the second or intermediate coating but while the coating is still moist I roll the core in silicon-carbide which will pass a mesh within the range of 60 to 200, and preferably approximately 180 mesh silicon-carbide to form a hard rough crystalline layer 18 over the outside surface of the previously applied coating. A rough surface reduces the total current. Boron-carbide may be used instead of silicon-carbide. The complete electrode is then preferably fired again in hydrogen for ten minutes at 1100° C. and after being cleaned with a soft brush is fired in air up to 960° C. and cooled rapidly.

Prior art coated cores used in ignitrons have presented unreasonably high percentage of failures due to a puncture through the coating caused by the high voltage gradient developed by inadequate bond between coating and core. If this gradient anywhere exceeds the dielectric strength of the material, a puncture will occur. In my ignitor electrode the voltage gradient near the surface of the core is reduced below the dielectric strength of the material by virtue of the improved bond effected between coating and core.

It is particularly pointed out that utilization of the graphite core has the advantages of being less expensive, of having advantageous intimacy of engagement by the coating, of forming a better bond between itself and the coating than possible with a metal or relatively smooth and non-porous core, of reducing the voltage drop at the inner surface of the coating by virtue of the improved bond and intimacy thereat, of obtaining a starting electrode functioning at lower voltage and with less current than heretofore necessary, and of increasing efficiency and rapidity of response of the ignitron or other device with which employed. The graphite, with its surface pores well filled with the coating, provides a structure wherein the coating will not easily chip or flake off during operation and which presents a resistance gradient increasing in a direction through the coating but substantially uniform throughout the area of the coated core and with the resistance gradient adequately preventing puncture during use.

I claim:

1. An electrode for a discharge device com-

prising a graphite base having a rough surface thereby providing irregular cavities in said surface, and a coating of boron-carbide on said graphite base with the portion of said coating contiguous to the base imbedded in said irregular cavities in the surface thereof.

2. An electrode for a discharge device comprising a graphite base having a rough surface thereby providing irregular cavities in said surface, and a coating of silicon-carbide on said graphite base with the portion of said coating contiguous to the base imbedded in said irregular cavities in the surface thereof.

3. An electrode for a discharge device comprising a graphite base having a rough surface thereby providing irregular cavities in said surface, and a coating of boron-carbide and silicon-carbide on said graphite base with the portion of said coating contiguous to the base imbedded in said irregular cavities in the surface thereof.

4. An electrode for a discharge device comprising a base having a rough surface and a coating having intimate bonding engagement with said rough surface of the base, said coating comprising plurality of layers successively of increasing resistivity.

5. An electrode for a discharge device comprising a base having a rough surface and a coating having intimate bonding engagement with said rough surface of the base, said coating comprising plurality of layers successively of increasing resistivity, and the outer coating consisting of a rough material.

6. An electrode for a discharge device comprising a graphite base having a rough surface and a coating having intimate bonding engagement with said rough surface of the base, said coating comprising plurality of layers successively of increasing resistivity and the outer coating consisting of a rough material in part embedded in the layer next thereto.

7. An electrode for a discharge device comprising a graphite base, a coating of boron-carbide and silicon-carbide on said graphite base with the portion of said coating contiguous to the base imbedded in the pores thereof, and a layer of insulating cement interposed between the base and coating throughout a limited area next one end of the electrode.

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