Jan. 13, 1942. R. F. RENNIE 2,269,861

IGNITRON STARTER

Original Filed April 19, 1939

Fig. 1.

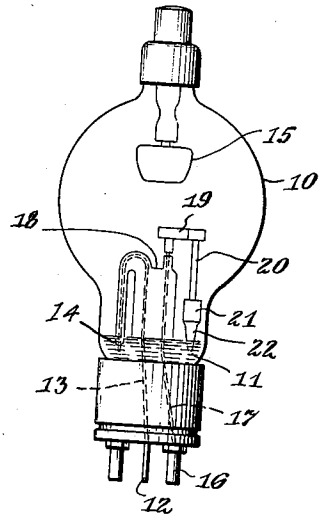


Fig. 2.

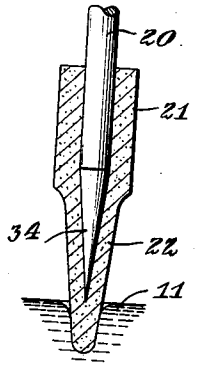


Fig. 3.

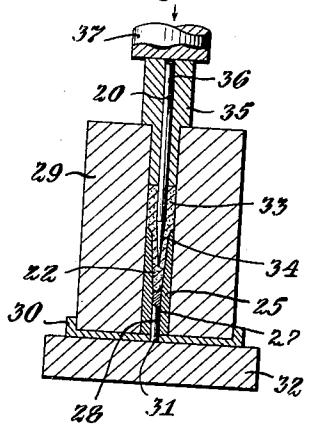


Fig. 4.

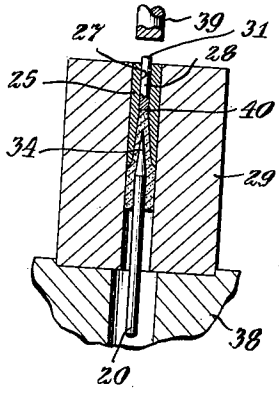


Fig. 5.

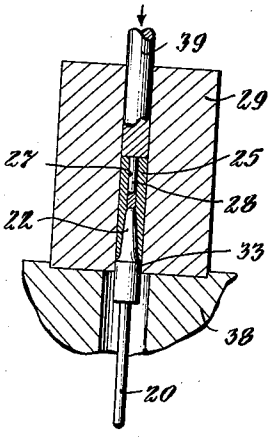


Fig. 6.

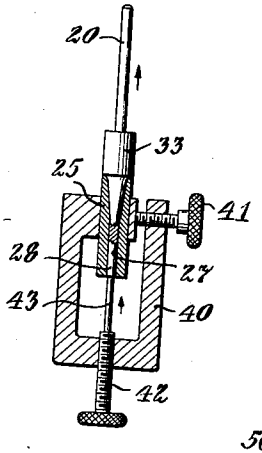
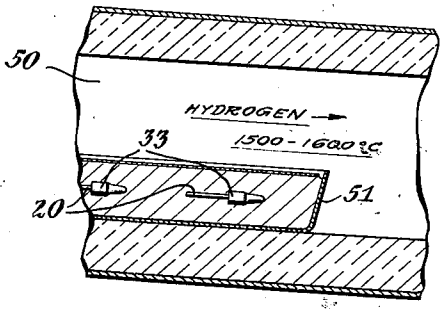


Fig. 7.



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UNITED STATES PATENT OFFICE

2,269,861

IGNITRON STARTER

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Original application April 19, 1939, Serial No. 268,661. Divided and this application March 29, 1940, Serial No. 326,582

6 Claims. (Cl. 250—27.5)

This application is a division of my parent application, Serial No. 268,661, filed April 19, 1939, for Ignitron starters.

My invention relates to starting electrodes, and especially to the make-alive type of starting electrode utilized with mercury pool devices.

An object of my invention is to provide a make-alive electrode that will accomplish an easier starting of the discharge than that possible with the make-alive electrodes now utilized.

Another object of my invention is to reduce the voltage required for starting the discharge in a mercury pool device by as much as 50%.

Other objects and advantages of the invention will be apparent from the following description and drawing, in which:

Fig. 1 is a view in front elevation of a discharge tube having a make-alive therein.

Fig. 2 is a view mainly in cross-section illustrating a make-alive electrode with the metal core extending the major portion therethrough.

Figs. 3, 4, 5, 6, and 7 are views mainly in cross-section illustrating various steps in the formation of the electrode.

The make-alive electrode described in my parent case Serial No. 268,661, filed April 19, 1939, for Ignitron starters, has the special advantage that only approximately 50% of the usual voltage applied to the make-alive electrode need be applied to my starting electrode to initiate the discharge. In the make-alive electrodes of the prior art, the starting current had to pass through a considerable length of high resistance material, such as boron carbide or silicon carbide, before reaching the mercury pool to create sparks that would initiate the discharge. My make-alive electrode, as is apparent from the enlarged Fig. 2 on the drawing, has a metal core extending through the major portion of the make-alive. This metal core has an extension practically to the level of the mercury, with the result that the current passing down this metal core has a very short path through the high resistance material in comparison with corresponding paths through the high resistance material in make-alives of the prior art. Because of this short high resistance path, the starting voltage applied to the make-alive of my invention is only approximately 50% of that which is necessary to apply to the make-alives of the prior art. Where these make-alives of the prior art required approximately 150 volts for the starting current, my make-alive will only require approximately 75 volts. The preferred method of starting my make-alive, as well as a description of a typical installation thereof is as follows:

The invention relates to the formation of a make-alive and in Fig. 1 is illustrated a typical discharge tube which utilizes such a make-alive. The tube illustrated in Fig. 1 has a glass envelope 10 with a mercury pool 11 in the lower portion thereof. A contact pin 12 has a connection 13 to the mercury at 14. At the upper end of the tube is an anode 15. A connecting pin 16 at the base of the tube has a connection 17, and this connection passes through the press 18 to an arbor 19 that makes a supporting contact with the shaft or connecting pin 20 upon the lower end of which is the make-alive 21.

As is well known, this make-alive 21 consists of a high resistance material and in operation a voltage is applied to this make-alive, and a series of tiny sparks or discharges will be created along the lower surface of the make-alive at the surface of the mercury. These discharges will ionize the mercury vapor and make the tube break down if a suitable voltage is applied across the anode 15 and the mercury pool 11.

It is necessary, of course, that the make-alive 21 be of such composition as to be able to withstand the corrosive action of these tiny discharges for initiating the current. The make-alives heretofore constructed have been very expensive to manufacture. My invention provides a cheaper method suitable for quantity production and at the same time provides for uniform shape and consistent characteristics of the make-alive.

The material from which I prefer to construct the make-alive is from 40% to 60% silicon and the rest principally silicon carbide or boron carbide or a mixture of both. In place of 60% silicon, ferro-silicon may be utilized, or a combination of ferro-silicon and silicon. Small amounts of iron oxide such as 1 to 10% may be used. Other silicides, carbides, nitrides, or borides may also be used. I prefer, however, to use ferro-silicon of the 85% grade which consists of $FeSi_2$ and free Si. The 50% grade consisting of $FeSi_2$ and FeSi could be used. The 40% boron carbide (B_4C) is preferably of the 320 grain. These percentages may, of course, be varied.

My tests have especially covered silicon carbide with the remainder of varying percentages of 10 to 60% silicon; 10 to 60% ferro-silicon of the 85% silicon grade; 10 to 60% ferro-silicon of the 50% silicon grade; 10 to 60% ferro-silicon of the 25% silicon grade and 10% cobalt. They have also covered boron carbide with 10 to 60% silicon, 10 to 60% ferro-silicon of the 85% grade; 30 to

60% ferro-silicon of the 50% grade; 30 to 60% ferro-silicon of the 25% grade, and 10% cobalt. Other proportions included 40% boron carbide, 20% silicon carbide, 40% silicon; 45% boron carbide, 45% silicon carbide, 10% silicon; 40% boron carbide, 50% silicon, 10% ferro-silicon (85% grade); 45% boron carbide, 45% silicon carbon, 10% ferro-silicon (85% grade); 40% boron carbide, 55% silicon, 5% iron and 40% boron carbide, 52% silicon, 8% iron oxide.

The mixture of silico nor ferro-silicon and boron carbide is well mixed by ball milling. The mixture is then ready to be placed in the die. Fig. 3 illustrates a preferred form of apparatus for forming the make-alive. This consists of a die 25 formed as a cylinder with a conical shape desired for the pointed end 22 of the make-alive illustrated in Fig. 1. The conical opening of the die continues into a cylindrical opening 27 extending through the remaining portion of the die. In this opening is located a rod 28. The die and rod are placed in the die block 29 which has a cylindrical opening therethrough corresponding with the outer diameter of the die 25 and the desired cylindrical diameter of the make-alive.

For the purpose of compressing the conical point of the make-alive as hereinafter described, it is desired that the rod 28 in the die project a little from the die and accordingly the die and die block are placed on a supporting plate 30 perforated to accommodate the projecting portion 31 of the rod. The whole assembly rests upon a suitable support 32. The desired quantity of the boron carbide, silicon, or ferro-silicon or other mixture, is then placed in the die and die block, as illustrated at 33. The connecting rod 20 for the make-alive is then inserted in this mixture. This connecting rod 20 is preferably of molybdenum, and at its lower end is pointed or tapered at 34 to correspond somewhat with the conical taper of the make-alive.

A plunger 35, having a central opening 36 to accommodate the molybdenum rod 20, compresses the mixture 33 as illustrated in Fig. 3. At the same time a press 37 is applied to the upper end of the molybdenum rod 20 to press its lower pointed end down to the desired location very deep within the mixture 33 as illustrated. The rod thus forms a core extending through the major portion of the length of the make-alive. The press and plunger are then removed, and I prefer to turn the die block 29 upside down upon a lower die block 38, as illustrated in Fig. 4. The rod 28 has its projection 31 extending above the surface of the die block 29.

A plunger 39, having the diameter of the central opening through the die block, is then applied to the assembly in this central opening of the die block. The first contact of this plunger 39 is upon the extension 31 of the rod 28. The first action will be to compress the tip 40 of the boron carbide, silicon, or ferro-silicon mixture, as illustrated in dotted lines in Fig. 4. The plunger 39 will then enter the central opening of the die block and push out the die 25, rod 28, pressed make-alive mixture 33 and connecting rod 20 from the die block 29.

The pressed make-alive can then be removed from the die in any convenient manner. I have found it convenient to use the apparatus in Fig. 6 for this purpose. This apparatus comprises a vise 40 for holding the die 25 by means of a screw 41. The vise is also screw threaded to receive a turn screw 42 that has a shaft 43 applied against the end of the rod 28 and of somewhat smaller diameter. By turning the screw 42 with a gentle pressure, the rod 28 will gently force the compressed make-alive 33 out of the die.

To obtain a uniform sintering temperature, the starters are buried in a powdery medium that will not sinter together too hard at the temperature employed. Silica has been found to answer the purpose. It has been found desirable to mix some graphite with the silica to furnish a suitable firing atmosphere. Fifteen to seventeen per cent. graphite has been found to be especially suitable, although this percentage may be varied.

I have also found it advisable to give this mixture a pre-firing at 1500° C. in hydrogen and then to regrind it before utilizing it to surround the compressed make-alives. In Fig. 7 I have illustrated the combination of the starters and the mixtures in a portion of one type of furnace. The furnace, which may be electrical, is illustrated by the walls 50 and upon the lower wall is resting the so-called furnace boat 51 having the mixture of silica and carbon therein. The compressed make-alives 33 with their connecting molybdenum rods 20 are illustrated buried in the mixture.

The first step is pre-firing with air flowing through the furnace at anywhere from 200° to 600° C. I prefer to pre-heat at approximately 570° to 580° C. If it is desired to reduce the resistance of the finished starter, the pre-firing should be at higher temperatures than 580° C.

In Fig. 7, I have illustrated the second step in which hydrogen is applied through the furnace and this hydrogen is preferably at a temperature between 1500° and 1600° C. The hydrogen is preferably dried over P_2O_5 and the gas flow is kept preferably as low as possible, about 1½ cubic feet per hour. The firing is preferably of the order of eight minutes.

The boat is then removed from the furnace and the uniformly sintered make-alive removed from the silica carbon mixture. After the silica carbon mixture is removed, the make-alive is then ready for insertion in a discharge device, such as that illustrated in Fig. 1, which, of course, is for purposes of illustration and not to limit the invention.

When the make-alive is thus inserted in such a device, the metal core 20 with its point 34 will be practically at the surface of the liquid cathode and the starting current will have a very short high resistance path to travel from the core to the surface of the make-alive at the level of the mercury. Only approximately 50% of the usual starting voltage need be applied to my make-alive.

It is apparent that many modifications may be made in the order of the steps and the particular shape of the apparatus utilized and also the composition of the materials specified without departing from the spirit and scope of the appended claims.

I claim:

1. A make-alive electrode for mercury pool devices comprising a high resistance conductive material having a metal core throughout the major portion of the length of said high resistance material and with its end extending within the high resistance material to substantially coincide with the immersion level of the electrode in use.

2. A make-alive electrode for mercury pool devices comprising a high resistance material from the group of boron carbide, silicon carbide, silicon

and ferro-silicon alloys and a metal core throughout the major portion of the length of and terminating within said high resistance material a distance from the end thereof within the range of the maximum transverse sectional dimension of said material.

3. A make-alive electrode for mercury pool devices comprising a metal core tapering to a point and a sintered mixture of high resistance material on said pointed metal core.

4. A make-alive electrode for mercury pool devices comprising a body of high resistance material having a tapered end portion and a metal core extending within said tapered end portion a distance from the end thereof within the range of the maximum transverse sectional dimension of said tapered portion.

5. A discharge device comprising an anode, a mercury pool cathode and a make-alive of high resistance material partially immersed in said mercury pool, said make-alive having a metal core extending within said high resistance material substantially to the level of the surface of the mercury pool cathode.

6. A make-alive electrode for mercury pool devices, comprising a body of high resistance material having a tapered end portion and a metal core tapering to a point extending within said tapered end portion.

ROBERT F. RENNIE.