Dec. 15, 1959 D. E. MARSHALL 2,917,649

IGNITRON

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Fig. 1.

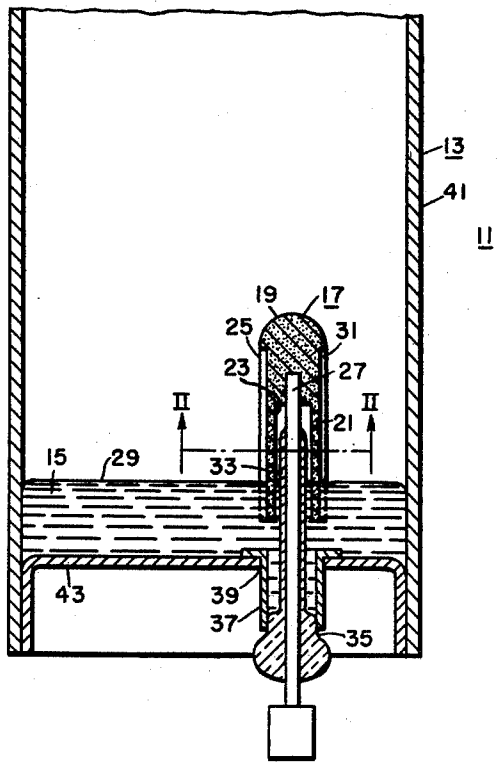
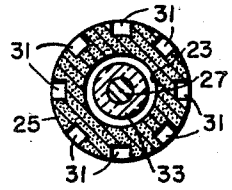


Fig. 2.



WITNESSES

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IGNITRON

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This invention relates to ignitrons and, more particularly, to ignitrons having ignitors which make contact with a liquid cathode.

Basically, ignitrons are rectifiers usually including three electrodes. First, there is a liquid cathode which is usually made of a conductive material such as mercury. Spaced from the cathode is an anode which frequently is made of a block of graphite and, in addition, there is a special electrode called an ignitor, portions of which project into the liquid cathode. The ignitor is usually made of a highly resistant or semiconductive material such as boron carbide, silicon carbide, graphite or other similar materials. The ignitor performs the function of a make-alive electrode which will initiate the formation of an arc between the cathode and the anode under proper conditions.

It is frequently desirable to use an ignitron for very high current pulse applications such as capacitor discharge, short circuit at power supplies to protect delicate apparatus, etc. These high current pulse applications require that the lead and support assembly to which the ignitor is attached must be adequately shielded from the eroding effects of the arc plasma between the cathode and the anode. Certain structures have been proposed in which the ignitor lead and support assembly have been shielded but they have the disadvantage that they require a very high firing current because of the use of a comparatively large contact area between the ignitor and the liquid cathode. My invention provides an ignitor having an adequately shielded lead and support assembly in combination with a reasonable firing current.

Therefore, it is an object of this invention to provide an improved ignitron.

It is another object to provide an improved ignitron having an improved ignitor.

It is a further object of this invention to provide an improved ignitor for liquid cathode ignitron.

It is an additional object to provide an improved ignitor for liquid cathode ignitron in which the ignitor lead and ignitor support assembly are adequately shielded.

It is an auxiliary object to provide an ignitor for liquid cathode ignitron which requires only a moderate firing current.

These and other objects of this invention will be apparent from the following description, taken in accordance with the accompanying drawing, throughout which like reference characters indicate like parts, which drawing forms a part of this application, and in which:

Figure 1 is a partial sectional view of an ignitron in accordance with one embodiment of this invention; and

Fig. 2 is a sectional view taken along the lines II—II of the ignitor and ignitor support assembly shown in Fig. 1.

In Figs. 1 and 2, there is shown an ignitron 11, the upper portion of which is omitted for reasons of simplicity. The ignitron 11 includes an envelope 13 having envelope side portions 41 and an envelope bottom portion 43. This envelope may be made of a metallic material such as steel, or in some cases an insulative material such as glass or ceramic may be used. In the bottom of the envelope

13 is positioned a liquid cathode 15 which usually is made of a liquid metal such as mercury. Positioned in contact with the liquid cathode 15 is an ignitor 17. In the particular embodiment shown in Figs. 1 and 2, the ignitor 17 has a solid upper portion 19 and a lower portion 21 which has a tubular configuration and which is the portion of the ignitor 17 which is in actual contact with the liquid cathode 15. In this particular embodiment, the tubular lower portion has a cylindrical configuration but of course, other variations may be used if desired. The tubular lower portion 21 includes a reentrant inner surface 23 and an outer surface 25. The ignitor 17 is supported by a conductive support member 27 which may be made of a material such as the iron, nickel, cobalt alloy known as "Kovar" described in U.S. Patent 2,062,335 by Howard Scott and assigned to the same assignee as the subject application. Said conductive support member 27 passes through an opening 39 in the bottom portion 43 of the envelope 13. The conductive support member 27 also passes through the liquid cathode 15, passes within the interior of the lower portion 21 and is attached to the solid upper portion 19 of the ignitor 17. The conductive support member 27 is insulated from the liquid cathode 15 by a suitable support member insulator 33 which in this particular embodiment, is shown as a sleeve of glass.

A suitable seal 35 is formed between the conductive support member 27 and a metal eyelet 37 which extends from the opening 37 in the bottom portion 43 of the envelope 13. This seal 35 may be made of a suitable insulating material such as glass or porcelain. If desired, the seal 35 may be made of the same material as the support member insulator 33.

As can be seen, the electroconductive support member is electrically insulated from the liquid cathode 15 and is also spaced from the inner surface 23 of the tubular lower portion 21 to allow proper mechanical clearance. As the tubular lower portion 21 extends below the top surface 29 of the liquid cathode 15, the conductive support member 27 and other portions of the support assembly are shielded from the arc plasma which is generated between the cathode 15 and the anode (not shown) and from any erosion due to bombardment by positive ions or mercury drops. However, it is found that if the tubular lower portion has merely a smooth cylindrical configuration, extremely high firing currents are necessary to fire the ignitor, because of the large contact area between the ignitor 17 and the liquid cathode 15. These firing currents may be on the order of 40 amperes which, practically speaking, is an unmanageable value for many commercial ignitrons.

I have found that this high firing current may be reduced to a reasonable and manageable value by reducing the contact area between the ignitor 17 and the liquid cathode 15. This may be accomplished by providing a number of indentations in the outer surface 25 of the tubular lower portion 21 of the ignitor 17. In the particular embodiment shown, these indentations are in the form of grooves 31. As mercury is a heavy metal having a high surface tension, as evidenced by the meniscus shown on the top surface 29 of the liquid cathode 15, it is found that with indentations or grooves 31 of the proper configuration that the surface tension of the mercury will prevent the mercury from contacting the sides and bottom of the grooves and thus only the areas of the outer surface 25 between the grooves 31 will be in contact with the mercury of the liquid cathode 15. I have found that by the use of an ignitor having a diameter of ¼ inch and made of a material such as a mixture of boron carbide, boron nitride and aluminum oxide, grooves having a length of approximately ⅜ inch, a width of $\frac{3}{64}$ inch and a depth of $\frac{1}{32}$ inch reduce the firing current to 20 amperes

which is a readily manageable value and is suitable for commercial use. I have found that, with a mercury cathode, suitable results may be obtained with grooves or indentations having a width between about 1/32 inch and 1/16 inch and a depth from 1/2 to 1 times the width.

As shown in Fig. 1, the indentations or grooves 31 must of course extend below the top surface 29 of the liquid cathode 15 which is the portion of the ignitor 17 which makes contact with the liquid cathode 15. Also, indentations having other configurations than the grooves shown may be used as long as they are at least partially below the top surface 29 of the liquid cathode 15.

One particular method I have used for forming the grooves 31 in the ignitor 17 is to cut them with a diamond cutting wheel.

Thus, it can be seen that I have disclosed a novel ignitor suitable for use in a liquid cathode ignitron which provides the necessary shielding for use with very high current pulse applications yet requiring only moderate firing currents.

While the present invention has been shown in one form only, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit and scope thereof.

I claim as my invention:

1. An ignitron including a liquid cathode and an ignitor having a solid upper portion and a tubular lower portion, said tubular lower portion having a reentrant inner surface and an outer surface, said tubular lower portion extending below the surface of said liquid cathode, said outer surface having a plurality of indentations therein.

2. An ignitron including a liquid cathode and an ignitor having a solid upper portion and a tubular lower portion, said tubular lower portion having a reentrant inner surface and an outer surface, said tubular lower portion extending below the surface of said liquid cathode, said outer surface having a plurality of grooves extending below the surface of said liquid cathode.

3. An ignitron including a mercury cathode and an ignitor having a solid upper portion and a tubular lower portion, said tubular lower portion having a reentrant inner surface and an outer surface, said tubular lower portion extending below the surface of said mercury cathode, said outer surface having a plurality of grooves extending below the surface of said mercury cathode, said grooves having a width between 1/32 inch and 1/16 inch and a depth from 1/2 to 1 times said width.

4. An ignitron including a liquid cathode, an ignitor and an ignitor support assembly, said ignitor having a solid upper portion and a tubular lower portion having a reentrant inner surface and an outer surface, said tubular lower portion extending below the surface of said liquid cathode, said ignitor supoprt assembly including a conductive support member extending upwards through said liquid cathode and within said tubular lower portion, said support member being attached to said upper portion thereby supporting said ignitor, said support member being insulated from said liquid cathode and being spaced from said inner surface of said lower portion of said ignitor, said outer surface of said lower portion having a plurality of indentations therein, at least portions of said indentations being located below the surface of said liquid cathode.

5. An ignitron including a liquid cathode, an ignitor and an ignitor support assembly, said ignitor having a solid upper portion and a tubular lower portion having a reentrant inner surface and an outer surface, said tubular lower portion extending below the surface of said liquid cathode, said ignitor support assembly including a conductive support member extending upwards through said liquid cathode and within said tubular lower portion, said support member being attached to said upper portion thereby supporting said ignitor, said support member being insulated from said liquid cathode and being spaced from said inner surface of said lower portion of said ignitor, said outer surface of said lower portion having a plurality of grooves extending below the surface of said liquid cathode.

6. An ignitron including a mercury cathode, an ignitor and an ignitor support assembly, said ignitor having a solid upper portion and a tubular lower portion having a reentrant inner surface and an outer surface, said tubular lower portion extending below the surface of said mercury cathode, said ignitor support assembly including a conductive support member extending upwards through said mercury cathode and within said tubular lower portion, said support member being attached to said upper portion thereby supporting said ignitor, said support member being insulated from said mercury cathode and being spaced from said inner surface of said lower portion of said ignitor, said outer surface of said lower portion having a plurality of grooves extending below the surface of said mercury cathode, said grooves having a width between 1/32 inch and 1/16 inch and a depth from 1/2 to 1 times said width.

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