Sept. 28, 1943. J. E. WHITE 2,330,768

IGNITER

Filed Sept. 7, 1939

Fig. 1.

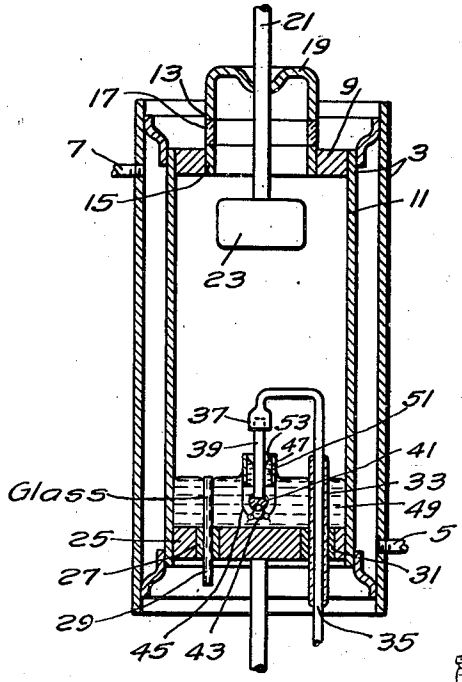


Fig. 3.

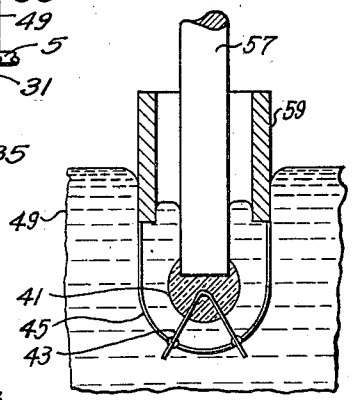
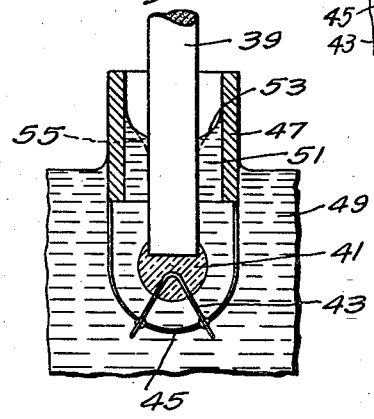


Fig. 2.



WITNESSES:

E. A. McCloskey.

Hyman Diamond.

INVENTOR

John E. White.

BY

F. W. Lyle

ATTORNEY

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2,330,768

IGNITER

John E. White, Lilly, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 7, 1939, Serial No. 293,663

18 Claims. (Cl. 250—27.5)

My invention relates to electric discharge apparatus and has particular relation to ignitrons.

In ignitrons constructed in accordance with the teachings of the prior art of which I am aware, firing is effected by passing current through a rod which is in contact with a pool. The pool is customarily composed of mercury and the rod has a resistance which is high compared to that of the pool. The current flow through the rod produces the ionization necessary for firing in the boundary region between the rod and the pool. Hereinafter, I shall designate a rod which is in contact with a pool cathode and through which current flows to produce ionization for firing an arc as an ignition electrode of the igniter type. The usefulness of the prior art ignitrons is severely limited because the potential and current required for ignition purposes is relatively high. This condition is objectionable not only by reason of the power loss which it involves but also because the auxiliary equipment required for firing is cumbersome and costly.

It is an object of my invention to provide an ignitron which shall require current and potential of relatively small magnitude for firing.

Another object of my invention is to provide an ignition electrode for an ignitron which shall require current and potential of relatively small magnitude.

More concisely stated, it is an object of my invention to reduce the current required for firing an ignitron and thus to correspondingly reduce the auxiliary equipment needed in the ignition circuit.

My invention arises from the realization that current and potential of substantial magnitude are required for firing because of the geometry of the region in which the firing ionization is produced. The ignition rod in the prior art apparatus is not wetted by the pool. The meniscus of the pool in the region of the igniter is, therefore, depressed to a depth of the order of 1 to 3 millimeters below the pool surface. The ions are produced in the annular meniscus region and must pass through the annular space before reaching the space above the surface of the pool where they are effective to produce firing. A number of the ions are rendered ineffective in passing to the surface by reason of neutralization as a result of collision with the mercury or the igniter, and the initial ionization required is high. The current and potential which produce the initial ionization must, therefore, be correspondingly high.

In many cases the igniters which are used have a negative temperature coefficient of resistance. Since the igniter is cooled when in contact with the mercury, the cooling is effective below the contact point of the meniscus. In the region of the meniscus the igniter is uncooled and the heat developed therein is not effectively transferred to the surrounding region. As a result the temperature of the igniter in the region of the contact with the pool is raised and its electrical resistivity is reduced. There is, therefore, a substantial increase in the current required for ignition and substantial power loss.

In accordance with my invention, the depth of the meniscus between the ignition rod and the pool is substantially reduced. This object may be accomplished by encircling the ignition rod with a body of a material which is wetted by the pool. The spacing between the ignition rod and the encircling body is so small that there is a substantial capillary effect and the surface of the meniscus in the region of the rod is substantially raised. In accordance with the preferred practice of my invention, the ignition rod is encircled by a molybdenum ring. My invention may, of course, be practiced, in its broader aspects, with bodies or rings of other materials wetted by the pool. In certain cases the encircling need not, moreover, be complete; there may be a substantial gap in the body.

Finally, I have found that a body of a material which is not wetted by the pool, to a certain extent, improves the firing conditions, and, therefore, in its broadest aspects my invention may be practiced with an ignition rod encircled by a body which is not wetted by the pool.

The improvement in the firing properties is in this case achieved in the so-called "light-contact" igniters. Such an igniter is immersed in the pool only a short distance, of the order of 1 millimeter or less, and requires a small starting current because the surface of engagement of the electrode and the pool is small. Ordinarily difficulties are encountered in using a light contact electrode because the waves in the pool surface or depression of the surface by evaporation have a tendency to break the contact between the pool and the igniter entirely. When a non-wetted body forming a capillary space around the igniter is used, the surface outside of the body may be at a substantial height, say 3 or 4 mm. above the top of the igniter while the surface in the capillary space extends only 1 mm. or less above the tip. As the outside surface drops, the surface in the capillary space

drops slightly but the contact remains because the mercury cannot entirely recede from the capillary space as long as the rod and its encircling body are at a lower level than the surface of the mercury outside.

It is to be noted that in this case the distance through which the ions produced by the igniter move to produce firing is small because of the light contact. The increase in temperature by reason of the reduced cooling may be somewhat greater but this is of no consequence as a low resistivity material may be used with a light contact starter. For a light contact starter boron carbide and silicon carbide may be used. However, materials of lower resistivity such as tungsten also function properly.

The novel features that I consider characteristic of my invention are set forth with particularity in the claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawing, in which:

Figure 1 is a view in section showing an ignitron in accordance with my invention,

Fig. 2 is an enlarged view of the region of the igniter which illustrates the theoretical basis of my invention, and

Fig. 3 is an enlarged view illustrating the theoretical basis of my invention as applied to a "light-contact" igniter.

The apparatus shown in the drawing comprises a hollow double-walled cylindrical shell 3 provided with the usual inlet and outlet tubes 5 and 7 through which a cooling fluid such as water is supplied. The shell may be composed of a suitable metallic substance such as steel. Near its upper end a metallic ring 9 is welded to the inner wall 11 of the shell, and a composite cap 13 is welded to the inner surface of the ring. The rim of the cap, where it is joined to the ring 9, is a shell 15 of an alloy which may be machined with facility and still seals to an insulating material such as glass. A cobalt-nickel-iron alloy sold under the trade name of "Kovar" may be used to advantage for this purpose. A ring 17 of glass, such as Corning G–705–AJ, is sealed to the alloy shell and a cup-shaped shell 19 of the alloy is sealed to the upper rim of the glass. A rod 21 of a suitable conducting material extends through the center of the cup 19 into the shell 3 and carries at the end within the shell a block 23 of a material such as nickel or carbon which functions as the anode.

Near the lower end of the cylinder 3 a disc 25 is welded to the inner wall 11. On one side the disc is provided with an eyelet 27 of the alloy through which a glass exhausting tube 29 is sealed. On the other side another alloy eyelet 31 is provided and through it a glass sleeve 33 extends. Through the sleeve an alloy rod 35, bent at right angles at the end within the shell 3, is sealed. At its horizontal end the rod 35 is bent again at right angles and provided with a cup-shaped tip 37 to which a bar 39 of a material such as boron carbide or silicon carbide is secured.

The rod 39 is beaded at its lower end with glass 41 or any other suitable material. A wire 43 bent into the form of a hairpin is sealed to the bead at its axis and near its extending ends is welded to a U-shaped wire 45. A molybdenum ring 47 is welded to the upper ends of the U-shaped wire 45. The U-shaped wire 45 and the hairpin 43 are so dimensioned that the distance between the inner surface of the molybdenum ring 47 and the rod 39 is of the order of .3 to 3 millimeters.

A suitable cathode material 49 such as mercury, is disposed on the disc 25. The height of the mercury is such that the lower rim of the molybdenum ring 47 extends into it. Because of the surface tension of the mercury a capillary column 51 rises within the molybdenum ring above the surface of the mercury outside of the ring. By reason of the relationship which exists between the pressure above the mercury surface within the ring and the pressure above the mercury surface outside, the meniscus 53 of the mercury in the contact region with the rod is substantially higher than it would be in the absence of the ring. So that the active portion of the pool surface may be as unobstructed as possible, it is preferable that the height of the ring 47 above the mercury surface shall be no greater than the height of the capillary column corresponding to the spacing between the rod 39 and the ring.

This situation is illustrated in Fig. 2. Since the mercury 51 within the ring 47 is at a substantially higher level than the mercury 49 outside, the internal pressure within the mercury just below the surface 53 within the ring is lower than the pressure in the vapor which exists just above the surface of the mercury within the ring. Under such circumstances the surface 53 of the liquid towards the vapor must be everywhere concave. The meniscus 53, therefore, has the form represented by the full lines 53 in Fig. 2 rather than the slightly convex form represented by the broken lines 55.

Fig. 3 illustrates my invention as applied to a "light-contact" igniter 57. A ring 59 of material which is not wetted by the mercury 49 is mounted on the igniter rod 57 by a glass bead 61 and wires 63 and 65. It is to be noted that the igniter rod is immersed in the mercury but a short distance. However, because of the capillary space existing between the rod and the ring, the surface of the mercury in the capillary space is lower than the surface of the mercury outside of the ring. If the outside surface drops, the surface in the capillary space drops slightly, but the contact with the rod remains as previously set forth.

In explaining my invention I have here to a certain extent theorized. It is, of course, not my intention to be bound by the theory advanced here. Whatever theory may be used to explain the advantages achieved with my invention the fact is that experimentally they have been shown to exist.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. An electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode and a body of a substance which is wetted by said cathode encircling said electrode and spaced therefrom a distance of the order of .3 to 3 millimeters.

2. A electric discharge device comprising a cathode of the pool type, an ignition electrode in

contact with said cathode and a body composed of molybdenum encircling said electrode and spaced therefrom a distance of the order of .3 to 3 millimeters.

3. A electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode and a ring composed of molybdenum encircling said electrode and spaced therefrom a distance of the order of .3 to 3 millimeters.

4. An electric discharge device comprising a cathode of the pool type, an ignition electrode having a resistance which is high compared to said cathode in contact with said cathode and a body of a substance which is wetted by said cathode encircling said electrode and spaced therefrom a distance of the order of .3 to 3 millimeters.

5. An ignition electrode for a discharge device of the pool type comprising a bar of a material suitable for ignition purposes beaded near one end with vitreous material and a ring of molybdenum secured to said vitreous material and encircling said bar near said end and spaced therefrom a distance of the order of .3 to 3 millimeters.

6. An electric discharge device comprising a cathode of the pool type, an ignition electrode in permanent metallic contact with said cathode, said ignition electrode being of the type that produces ignition when current is transmitted through it to the cathode by reason of ionization in the boundary region between said ignition electrode and said cathode and a body disposed within said cathode and encircling said electrode and spaced therefrom a distance of the order of .3 to 3 millimeters, said body and said ignition electrode bounding a space within which a portion of said cathode is present.

7. In an electric discharge valve of the pool type, an ignition rod disposed in said pool in permanent metallic contact therewith and capable of producing ignition when current is transmitted through it to said pool by reason of ionization in the boundary region between said pool and said rod and a body disposed adjacent to said rod at a distance such that a capillary space exists between said rod and body, said body and said rod bounding a space within which a portion of said pool is present.

8. An electric discharge device comprising a cathode of the pool type, an ignition electrode in permanent metallic contact with said cathode and a body of a substance which is not wetted by said cathode encircling said electrode and spaced therefrom a distance such that a capillary space exists between said body and said electrode.

9. An electric discharge device comprising a cathode of the pool type, an ignition electrode in permanent metallic contact with said cathode and a body of a substance which is not wetted by said cathode disposed adjacent to said electrode and spaced therefrom a distance such that a capillary space exists between said body and said cathode.

10. An electric discharge device comprising a cathode of the pool type, an ignition electrode of the "light contact" type in permanent metallic contact with said cathode and a body of a substance which is not wetted by said cathode disposed adjacent to said electrode and spaced therefrom a distance such that a capillary space exists between said body and said cathode.

11. In an electric discharge valve of the pool type, an ignition rod disposed in said pool and a body of a material which is wetted by said pool disposed adjacent to said rod at a distance such that a space producing by capillarity a substantial change in the surface of said pool exists between said rod and body, a main arc being ignited in said valve by the action only of said ignition rod.

12. An electric discharge device device comprising a cathode of the pool type, an ignition electrode in contact with said cathode and a body of a substance which is wetted by said cathode disposed adjacent to said electrode and spaced therefrom a distance such that the surface of said cathode between said body and said electrode is modified by capillary action between said electrode and said body whereby the ignition current required to render said device conductive is substantially smaller than in the absence of said body.

13. An electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode and a body of a substance which is wetted by said cathode encircling said electrode and spaced therefrom a distance such that the surface of said cathode between said body and said electrode is modified by capillary action between said electrode and said body whereby the ignition current required to render said device conductive is substantially smaller than in the absence of said body.

14. An ignition electrode for a discharge device of the pool type comprising a bar of a material suitable for ignition purposes beaded in one region thereof with an insulating material and a body encircling said bar out of contact therewith suspended from said insulating material.

15. An ignition electrode for a discharge device of the pool type comprising a bar of a material suitable for ignition purposes beaded near one end with vitreous material and a body encircling said bar near said end out of contact with said bar and spaced therefrom a distance of the order of .3 to 3 millimeters suspended from said vitreous material.

16. In an electric discharge valve of the pool type, an ignition rod of the igniter type disposed in said pool in permanent metallic contact with said pool and a body disposed adjacent to said rod at a distance such that a space capable of producing by capillarity a substantial change in the surface of said pool exists between said rod and body, a portion of said pool being present within said capillary space.

17. An electric discharge device comprising a pool, an igniter in permanent contact with said pool, said igniter being beaded with insulating material at the end thereof that is in contact with said pool and a body encircling said igniter out of contact therewith suspended from said insulating material.

18. An electric discharge device comprising a cathode of the pool type, an ignition electrode in permanent contact with said cathode and a body wetted by said cathode disposed adjacent said electrode at a distance no greater than 3 millimeters therefrom.

JOHN E. WHITE.