

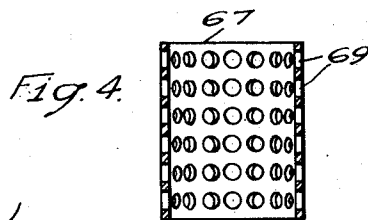
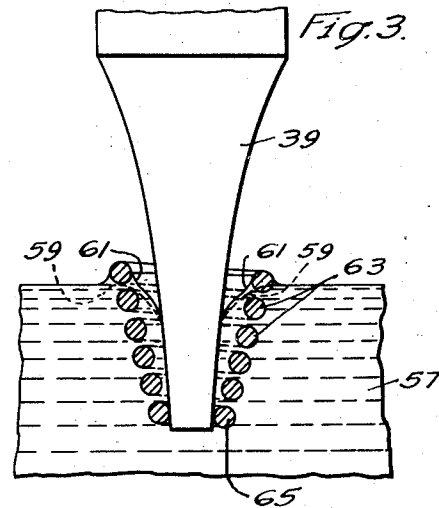
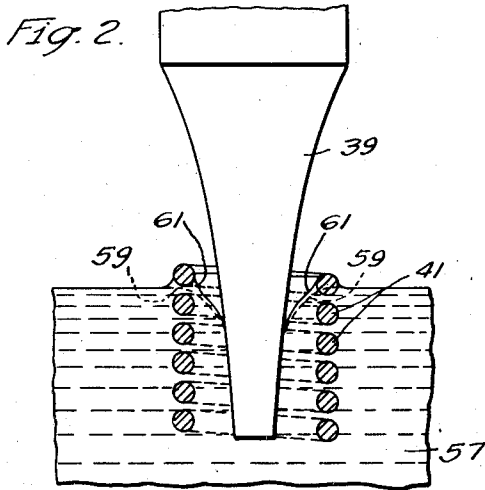
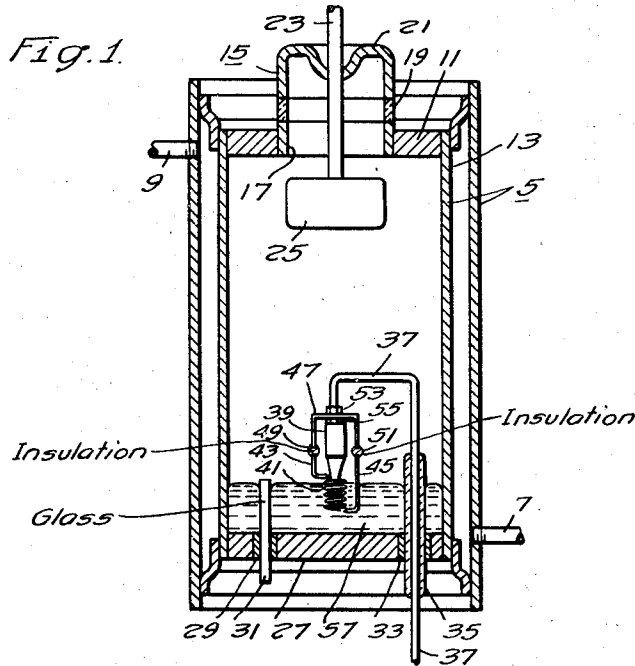
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A. H. TOEPFER

2,325,718

LOW CURRENT IGNITER

Filed July 15, 1941



WITNESSES:

E. A. McLaughlin
John R. Shipman

INVENTOR
Adolph H. Toepfer
BY
Kenneth K. Leonard
ATTORNEY

UNITED STATES PATENT OFFICE

2,325,718

LOW CURRENT IGNITER

Adolph H. Toepfer, Wilkinsburg, Pa., assignor to
Westinghouse Electric & Manufacturing Com-
pany, East Pittsburgh, Pa., a corporation of
Pennsylvania

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18 Claims. (Cl. 250-27.5)

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

In an ignitron constructed in accordance with the teachings of the prior art, ignition is effected by passing current through an ignition electrode in permanent contact with a cathode pool. The pool is customarily composed of mercury and the ignition electrode has a resistance which is high compared to that of the pool. The current flow through the ignition electrode causes an arc discharge in the boundary region between the electrode and the pool. The discharge creates a cathode spot and produces the ionization necessary to render the ignitron conductive. The usefulness of such 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 ignition is cumbersome and costly.

An ignitron in which the current and potential required for ignition is considerably reduced is disclosed in an application Serial No. 293,663, filed by John E. White on September 7, 1939. The reduction in the required current and voltage is accomplished by encircling the ignition electrode with a ring of a material which is wetted by the pool, the spacing between the electrode and the ring being so small that the meniscus of the pool between the electrode and the ring is substantially altered. The ignition electrode is composed of a material which is not wetted by mercury. Therefore, without the ring, the surface of the mercury is depressed near the electrode forming a convex meniscus. To effect ignition a certain number of the ions produced by the arc discharge must escape to the region above the main surface of the pool through the narrow annular space formed between the electrode and the depressed surface of the mercury immediately adjacent thereto. In the aforesaid White application the theory is advanced that in the absence of the ring many 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. Consequently, the initial ionization required is high and the current and voltage producing the ionization is correspondingly high. When a ring is employed, it is believed that the meniscus is changed to give the ions more room to escape because of the capillary action in the space between the ring and the electrode. Thus, the

current and potential required for ignition are reduced for less ionization is necessary.

As pointed out in the White application, the detailed effect of the ring upon the meniscus of the pool is not known, and the description given is largely theory. The theory may or may not be correct, but, in any event, it is an experimental fact that the presence of the ring reduces the required ignition current and voltage to a great extent. However, it has been found that an ignitron having an ignition electrode encircled by a ring of a material wetted by the pool in the manner described, occasionally fails to become conductive when the current impulse flows through the ignition electrode. Although such occasional failures are permissible in some operations, they are obviously undesirable. Many circuits which include ignitrons require a high degree of reliability in ignition. In these circuits, the advantages of low ignition current cannot be enjoyed unless the possibility of ignition failure is very small.

It is, accordingly, an object of my invention to provide an ignitron with improved facilities for reliable ignition which requires ignition current and potential of relatively small magnitudes.

A more general object of my invention is to provide an improved ignitron which requires current and potential of relatively small magnitudes for ignition.

Another object of my invention is to provide a novel ignition electrode which requires current and potential of relatively small magnitudes for ignition.

More specifically, it is an object of my invention to provide an ignitron requiring a relatively small current for ignition in which the possibility of ignition failure is considerably reduced.

My invention arises from the realization that the cathode spot created by the ignition arc occasionally does not transfer to the region outside of the ring. Consequently, when the anode-cathode arc begins, it is concentrated at the cathode in the small portion of the mercury pool between the ring and the electrode. As the large anode-cathode current begins to flow through this small quantity of mercury, heat is created which develops a vapor pressure sufficient to force the mercury out the bottom of the ring. As a result, the anode-cathode arc is interrupted shortly after it begins. The heat created by the anode-cathode current has increased the temperature of the ring and the electrode, which tends to prevent the mercury from returning to the space between the ring and the electrode.

If the ignitron is connected to an alternating current source and receives an ignition impulse in each alternate half period, as is the usual arrangement, the next ignition impulse occurs before the mercury returns to its original position and either the mercury is again blown out the bottom of the ring or the impulse fails even to start an arc.

In accordance with my invention, I provide an ignitron having an ignition electrode whose tip is encircled by a coil. The coil is formed of a plurality of spaced turns of a wire of a material which is wetted by the pool. The distance between the coil and the electrode and the spacing between successive turns of the coil is such that the meniscus of the mercury between the coil and the electrode is substantially changed by capillary action. As a result of the change in the surface of the mercury, the current required for ignition is substantially smaller than in the absence of the ring. If the mercury vapor pressure begins to force the mercury between the coil and the electrode downward, the space between the turns permits the vapor pressure to clear a path therethrough whereby the cathode spot may escape to the space above the surface of the pool to effect ignition.

The use of the coil instead of a solid ring has the additional advantage of reducing the care necessary in positioning the encircling member with respect to the level of the pool. When a solid ring is used, the top of the ring must be low enough to permit the ions to escape readily. When a coil is used, the ions may escape through the first space between turns which is above the mercury.

Although I prefer to use a coil, a ring having a plurality of openings therethrough may be employed. The size, shape, and disposition of the openings must be such that the ring may effect a substantial change in the meniscus of the pool whereby the required ignition current is substantially lower than in the absence of the ring.

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 specific embodiments when read in connection with the accompanying drawing, in which:

Figure 1 is a view in section showing an ignitron in accordance with the preferred embodiment of my invention;

Fig. 2 is an enlarged view of the tip of the ignition electrode illustrating a preferred embodiment of my invention;

Fig. 3 is an enlarged view illustrating a modification of my invention; and

Fig. 4 is an enlarged view illustrating a perforated ring which may be substituted for the coil in Fig. 1.

The apparatus shown in Fig. 1 comprises a hollow double walled cylindrical shell 5 provided with the usual inlet and outlet tubes 7 and 9 through which a cooling fluid, such as water, is supplied. The shell 5 may be composed of a suitable metallic substance such as steel. Near its upper end a metallic ring 11 is welded to the inner wall 13 of the shell 5, and a composite cap 15 is welded to the inner surface of the ring 11. The rim 17 of the cap 15 where it is joined to the ring 11 is an alloy which may be machined with facility and still seals to an insulating ma-

terial 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 19 of glass such as Corning G-705-AJ is sealed to the alloy rim 17, and a cup-shaped shell 21 of the alloy is sealed to the upper rim of the glass 19. A rod 23 of a suitable conducting material extends through the center of the cup 21 into the shell 5 and carries at the end within the shell a block 25 of the material, such as nickel or carbon, which functions as the anode. Near the lower end of the cylinder 5 a disk 27 is welded to the inner wall 13. On one side of its center the disk 27 is provided with an eyelet 29 of the alloy through which a glass exhausting tube 31 is sealed. On the other side of the center of the disk another alloy eyelet 33 is provided and through it a glass sleeve 35 extends. Through the sleeve 35 an alloy rod 37 bent at right angles at the end within the shell 5 is sealed. At its horizontal end the rod 37 is bent again at right angles, and an ignition electrode 39 formed of a rod of a material such as boron carbide or silicon carbide, is secured thereto.

A coil 41, formed of a plurality of spaced turns of a wire, encircles the tip of the electrode rod 39. The wire is made of a material which is wetted by mercury, such as tungsten, molybdenum or other metals having a high melting point. The ends 43 and 45 of the wire extend on each side of the coil 41 and are secured to a supporting member 47 by a pair of insulators 49 and 51. The supporting member 47, in turn, is secured to the rod 37 by a pair of nuts 53 and 55.

A suitable cathode material 57, such as mercury, is disposed on the disk 27 at such a height that the coil 41 and the tip of the rod 39 extend into it. Satisfactory operation has been obtained by employing a coil which is spaced from the electrode a distance of the order of .3 to 3 mm., and in which the spacing between successive turns is of the order of .2 to 1 mm. Although I have illustrated the coil as formed of wire having a circular cross-section, it is to be understood that a coil formed of a wire or strip having a different cross-section may be used. Hereinafter, the word strip is used to designate a suitable elongated member such as a wire.

The exact effect of the coil 41 on the meniscus of the mercury 57 is not known. The ignition electrode 39 is of a material which is not wetted by mercury. Therefore, in the absence of the coil the mercury is depressed near the electrode, as shown by the dotted-line 59 in Fig. 2. Since the coil 41 is wetted by mercury, the surface of the cathode mercury 57 tends to rise on each side of the coil. It is my theory that the surface of the mercury between the coil 41 and the electrode 39 assumes the shape shown by the solid lines 61 in Fig. 2. A greater area of the surface of the mercury is then located within the boundary region in which the arc discharge takes place. Consequently, a lower current causes an arc discharge which produces the required degree of ionization.

In Fig. 3 is shown coil 63 having a slightly different form which may be used in place of the coil 41 in Figs. 1 and 2. One of the turns 65 of the coil 63 fits tightly about the lower end of the electrode 39, and each of the remaining turns has an inner diameter greater than the diameter of the portion of the electrode encircled thereby. The tight-fitting turn 65 of the coil 63 then supports the coil in position about the electrode 39. Satisfactory operation has been obtained when

the space between the electrode 39 and any of the turns of the coil 63 is no greater than 3 mm. By use of the coil 63 shown in Fig. 3 the supporting member and insulators of Fig. 1 may be eliminated. Since the coil 63 contacts the electrode 39 only at its lower tip, current of an appreciable value does not flow through the coil.

In Fig. 4 is shown a ring-like member 67 composed of a material wetted by mercury, preferably of molybdenum, which may be used in place of the coil 41 shown in Figs. 1 and 2. The ring 67 has a plurality of openings 69 extending from its inner surface to its outer surface. The size, shape, and disposition of these openings must be such that a substantial change is made in the meniscus of the mercury between the ring and the electrode whereby the ignition current required is considerably reduced. The openings enable the ring 67 to avoid ignition failures in the manner described with respect to the coil 41 of Figs. 1 and 2.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications are possible. In explaining my invention, certain theories have been advanced. It is not my intention to be bound by these theories. Whatever theories may be used to explain the advantages achieved with my invention, the fact is that experimentally they have been shown to exist. 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 coil, formed of a plurality of spaced turns of a strip of a material which is wetted by said cathode, encircling said electrode and at least partially immersed in said cathode.

2. In an electric discharge valve of the pool type, an ignition electrode disposed in said pool, and a coil, comprising a plurality of spaced turns of a strip of a material which is wetted by said pool, encircling said electrode at a distance such that a space exists therebetween which produces by capillarity a substantial change in the surface of said pool, a main arc being ignited in said valve by the action only of said ignition electrode.

3. An electric discharge device comprising a cathode of the pool type, an igniter electrode in contact with said cathode, and a coil, comprising a plurality of spaced turns of a strip of a material substance which is wetted by said cathode, encircling said electrode and spaced therefrom a distance such that the ignition current required to render said device conductive is substantially smaller than in the absence of said coil.

4. An electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode, and a coil, comprising a plurality of spaced turns of a strip 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 coil and said electrode is modified by capillary action whereby the ignition current required to render said device conductive is substantially smaller than in the absence of said body.

5. An electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode, and a coil, formed of a plurality of spaced turns of a sub-

stance which is wetted by said cathode, encircling said electrode 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 contact with said cathode, and a coil, formed of a plurality of spaced turns of a molybdenum strip, encircling said electrode and spaced therefrom a distance of the order of .3 to 3 millimeters.

7. An electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode, and a coil, formed of a plurality of spaced turns of a tungsten strip, encircling said electrode and spaced therefrom a distance of the order of .3 to 3 millimeters.

8. An electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode, said electrode being of the type that produces ignition by reason of ionization caused by an arc discharge in the boundary region between said electrode and said cathode, and a coil, formed of a plurality of spaced turns of a strip which is wetted by said cathode, encircling said electrode and spaced therefrom a distance such that the surface of said cathode between said coil and electrode is substantially modified by capillary action, the spacing between said turns being such as to permit a cathode spot produced by said arc discharge to pass therethrough before a cathode vapor pressure sufficient to blow the spot out the bottom of said coil can be built up and still enable the coil to effect a substantial modification of the surface of the cathode, whereby the ignition current required to render the device conductive is substantially smaller than in the absence of said coil.

9. An electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode, and a member of a material which is wetted by said cathode encircling said electrode and having one or more openings from its inner surface to its outer surface, said member being spaced from said electrode a distance of the order of .3 to 3 millimeters.

10. In an electric discharge valve comprising a cathode of the pool type, an ignition electrode of the igniter type in contact with said cathode, and a member of a material which is wetted by said cathode encircling said electrode and having a plurality of openings extending from the inner surface to its outer surface, said openings being of a size, shape and disposition and said member being spaced from said electrode a distance such that the surface of said cathode between said member and said electrode is modified by capillary action whereby the ignition current required to render said device conductive is substantially smaller than in the absence of said body.

11. An electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode, said electrode being of the type that produces ignition by reason of ionization caused by an arc discharge in the boundary region between said electrode and said cathode, and a ring of a material which is wetted by said cathode encircling said electrode and having a plurality of openings extending from its inner surface to its outer surface, said openings being of a size, shape and disposition to permit a cathode spot produced by said arc discharge to pass therethrough before a cathode vapor pressure sufficient to blow the spot out the

bottom of said ring can be built up, said openings also being of such size, shape and disposition and said ring being spaced from said electrode such a distance that the ignition current required to render said device conductive is substantially smaller than in the absence of said member.

12. An electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode, said electrode being of the type that produces ignition by reason of ionization caused by an arc discharge in the boundary region between said electrode and said cathode, and a ring of a material which is wetted by said cathode encircling said electrode and having a plurality of openings extending from its inner surface to its outer surface said openings being of a size, shape and disposition to permit some of the ions produced by said arc discharge to pass therethrough before a cathode vapor pressure sufficient to blow the spot out the bottom of said ring can be built up, said openings also being of such size, shape and disposition and said ring being spaced from said electrode such a distance that the surface of said cathode between said member and said electrode is modified by capillary action whereby the ignition current required to render said device conductive is substantially smaller than in the absence of said member.

13. An electric discharge device comprising a cathode of the pool type, an ignition electrode in contact with said cathode, said electrode being of the type that produces ignition by reason of ionization caused by an arc discharge in the boundary region between said electrode and said cathode, and a member of a material which is wetted by said cathode encircling said electrode and having a plurality of openings extending from its inner surface to its outer surface, said member being spaced from said electrode a distance of the order of .3 to 3 millimeters, said openings being of such size, shape and disposition to permit some of the ions produced by said arc discharge to pass therethrough before said arc discharge can build up a cathode vapor pressure sufficient to blow the arc out the bottom of said encircling member and still enable said member to effect a substantial modification of the surface of said cathode by capillary action, whereby the ignition current required to render the device conductive is substantially smaller than in the absence of said member.

14. In combination, an ignition electrode for

a discharge device of the pool type comprising a rod of a substance suitable for ignition purposes, said rod having a tip adapted for immersion in a pool, and a coil encircling said tip and formed of a plurality of spaced turns of a strip of material which is wetted by the material of which a pool is composed.

15. In combination, an ignition electrode for a discharge device of the pool type comprising a rod of a substance suitable for ignition purposes and a coil encircling said rod and formed of a plurality of spaced turns of a strip which is wetted by the material of which a pool is composed, one of said turns fitting tightly about the end of said rod and each of the remaining turns having an inner diameter greater than the diameter of the portion of the rod encircled thereby, said tightly fitting turn supporting said coil in position with the space between the rod and the encircling turns being no greater than 3 millimeters.

16. In combination, an ignition electrode for a discharge device of the pool type comprising a rod of a substance suitable for ignition purposes, and a member of a substance which is wetted by the material of which a pool is composed, encircling said rod and spaced therefrom a distance of the order of .3 to 3 millimeters, said member having one or more openings extending from its inner surface to its outer surface.

17. An electric discharge device comprising a cathode of the pool type, an ignition electrode having a tip immersed in said cathode, and a member encircling said electrode and formed of a material which is wetted by said cathode with one or more openings from its inner surface to its outer surface, said member having an end portion with an inner surface fitting tightly about the tip of said electrode to support the member thereon with the remainder of the inner surface of said member spaced from said electrode.

18. An electric discharge device comprising a cathode of the pool type, an ignition rod having an end immersed in said cathode, and a coil encircling said rod end and formed of a plurality of turns of a strip which is wetted by said cathode, one of said turns fitting tightly about said end and supporting the coil in position with each of the remaining turns having an inner diameter greater than the diameter of the portion of the rod encircled thereby.

ADOLPH H. TOEPFER.