May 12, 1964 E. H. REID 3,133,224

ELECTRIC DISCHARGE DEVICE

Filed Nov. 25, 1960

FIG.1.

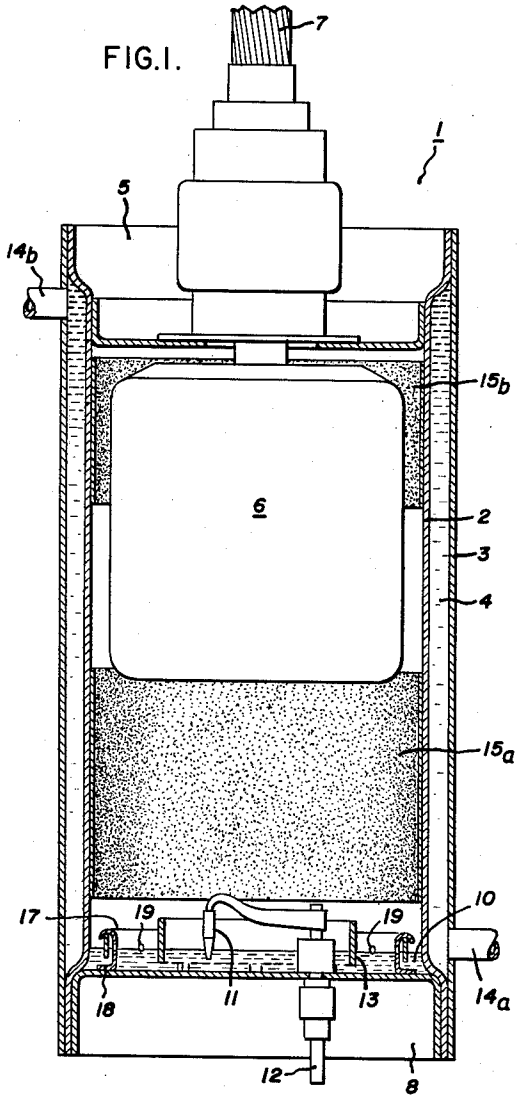


FIG.2.

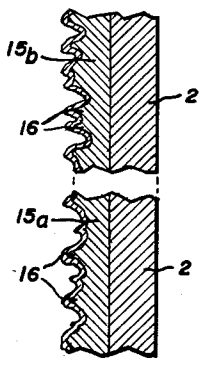


FIG.3.

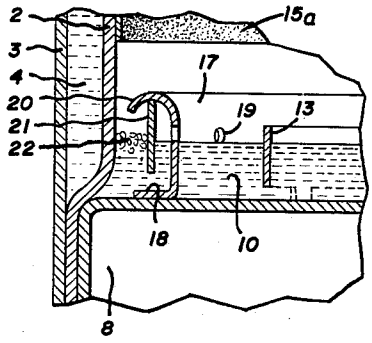


FIG.4.

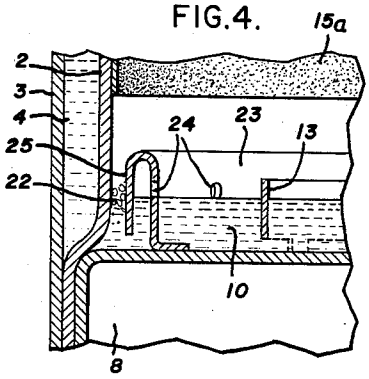
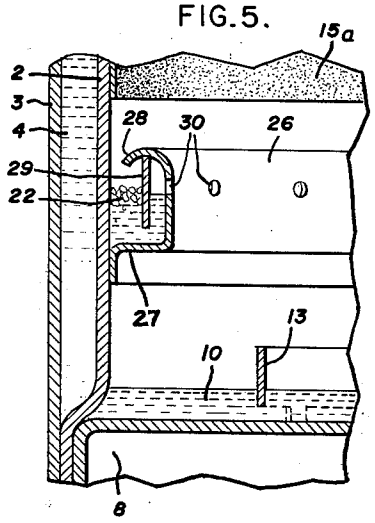


FIG.5.



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ELECTRIC DISCHARGE DEVICE

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My invention relates to electric discharge devices and pertains more particularly to arc discharge devices incorporating liquid-pool cathodes containing mercury.

Ignitrons are exemplary of arc discharge devices employing liquid-pool cathodes containing mercury; and in the manufacture thereof it is customary to "de-gas" or remove approximately 60% to 70% of undesired occluded gases from the materials of the device by heating the device during exhaust of the envelope thereof. Removal of this amount of undesired gases by the "de-gassing" operation has been generally sufficient to enable operation of a tube; and, subsequently during operation gas cleanup by the arc, or sorption of undesirable gases by the materials of certain parts in the tube during operation has heretofore been relied upon to lower the pressure of unwanted gases to a desired further reduced amount. Expressed in another manner, the "de-gassing" operation, because of cost considerations, is generally carried out only so far as it is necessary to reduce the rate of gas evolution during operation of the tube to a point where gas cleanup by the arc can be effectively relied upon for lowering to a desired amount the pressure of such evolved gases.

However, the above-discussed method of reducing the pressure of undesired gases has not been found uniformly reliable. Additionally, when the arc is relied upon for gas cleanup there is usually an initial "aging" period, following starting of a tube in operation and lasting until the arc is effective for cleanup, during which time the pressure of the undesired gases can be relatively high. The "aging" time required in some cases, and especially after a prolonged idle period, such as the usual storage period before shipment to users, can be objectionably long. Also, the pressure of undesired gases can be sufficient after such an idle period as to cause arc-back substantially immediately after starting and until gas cleanup by the arc is effective in reducing the pressure. Further, it has been found that in some ignition structures the described method of reducing the pressure of undesired gases has not been effective for reducing to an acceptable minimum all of the hydrogen and hydrocarbon gases that may be present in the materials employed in the manufacture of the tube. These particular gases have been found to comprise the major portion of gases tending to evolve from the tube materials and to accumulate in the device during idle periods. Also, it has been found that these particular gases are generally the worst offenders in causing undesirable high arc drops and arc backs during operation.

Thus, there is a tendency for some newly manufactured mercury arc tubes which have been processed in the above-described manner to fail certain operating tests usually required before shipment or to require substantial aging by operation to reduce the pressure of undesired gases. My invention contemplates the provision of means effective for removing the hydrogen and hydrocarbon gases from the internal atmosphere of mercury arc tubes without reliance upon the arc for gas cleanup and in a manner to insure against the accumulation of such undesired gases during idle periods.

It has also been recognized that arc back and slow deionization is often attributable to excess mercury vapor density and that the ratings of mercury vapor tubes are often limited by the efficiency with which mercury vapor in the tubes is condensed. My invention also contemplates the provision of improved means for increasing the efficiency of the mercury condensation effected in the tubes.

Additionally, in the operation of mercury pool tubes the formation of a floating sludge has been encountered on the cathode pool. This sludge has been found to be an effective hydrogen getter or sorber. However it is a fact that the floating sludge is easily splashed into the hot cathode spot where it vaporizes and releases previously sorbed hydrogen, causing a vapor pressure surge and resultant arc back. Vaporization of the sludge also enables metal constituents of the sludge to condense and become deposited on the nearest relatively cold surface which generally is the ignitor projecting into the mercury cathode pool. In this manner a metal ring or deposit can be formed on and about the ignitor at the mercury surface level with the result that a relatively low resistance conduction path may be formed to the cathode pool, whereby the ignitor can be rendered ineffective for its intended purpose of ionizing mercury to initiate an arc. This undesirable effect can also result from vaporization of other metal particles which may find their way into the pool. The present invention contemplates the provision of means effective for maximizing the utility of the sludge for gettering undesired gases in the tube and for avoiding subsequent release of such gases or vaporization of metal constituents in the sludge. Additionally, it contemplates avoiding the movement of other metal particles toward the active portions of the pool.

Accordingly, a primary object of the present invention is to provide a new and improved mercury arc electric discharge device including improved means for controlling the internal vapor pressure thereof.

Another object of my invention is to provide a new and improved liquid-pool cathode device including improved means for reducing arc drop and minimizing arc back.

Another object of my invention is to provide new and improved means for permanently removing undesired gases from the internal atmosphere of a mercury arc electric discharge device.

Another object of my invention is to provide a new and improved mercury pool electric discharge device including new and improved means for increasing the mercury condensation efficiency therein.

Another object of my invention is to provide a new and improved mercury pool electric discharge device including new and improved means for avoiding accumulation therein of undesired gases during the idle periods of operation and for avoiding reliance upon gas cleanup or by aging by the mercury arc to lower the pressure of undesired gases therein.

Another object of my invention is to provide in a mercury pool electric discharge device, including an ignitor, new and improved means for protecting the ignitor against condensation thereon of metallic impurities occurring in the pool.

Another object of my invention is to provide a new and improved mercury pool electric discharge device including new and improved means for maximizing utility of sludge occurring in the pool for gettering of undesirable gases.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In carrying out the objects of my invention, I provide a mercury pool electric discharge device including an envelope having spaced inner and outer walls forming a chamber for having a coolant circulated therethrough. Provided in the bottom of the envelope is a mercury pool cathode and associated therewith is an ignitor element for initiating starting of the device. Lo-

cated in the opposite end of the envelope is an anode and disposed on the internal surface of the inner wall member is a layer of getter material preferably selected from the group consisting of titanium, zirconium and alloys thereof. The internal surface of the mentioned layer is highly porous and rough textured or irregular and the layer is preferably restricted to a predetermined region of the inner wall. Associated with the liquid cathode is a sludge trap including improved means for avoiding association of the sludge and other metallic impurities with the arc while insuring rapid return to the pool of liquid mercury condensing on the envelope wall and flowing toward the pool. The sludge trap is preferably located in a relatively cool location and can be either disposed in the pool or mounted on the side wall above the pool.

For a better understanding of my invention reference may be had to the accompanying drawing in which:

FIGURE 1 is a sectionalized elevational view of an electric discharge device incorporating an embodiment of my invention;

FIGURE 2 is an enlarged fragmentary sectionalized illustration of one feature of my invention;

FIGURE 3 is an enlarged fragmentary sectionalized view of one form of the sludge-entrapping feature of my invention;

FIGURE 4 is an enlarged fragmentary sectionalized view of another form of the sludge-entrapping feature of my invention; and

FIGURE 5 is an enlarged fragmentary sectionalized view of still another form of the sludge-entrapping feature of my invention.

Referring to the drawing, I have shown in FIGURE 1 my invention as applied to a mercury pool power conversion tube or an electric discharge device of the ignitron type including an elongated cylindrical envelope 1. The envelope 1 can be advantageously formed of stainless steel and includes spaced inner and outer walls 2 and 3, respectively, defining a coolant chamber 4.

The envelope 1 is closed at its upper end by a header assembly generally designated 5 which includes a customary anode seal construction. The header assembly 5 supports a generally cylindrical positive electrode or anode 6 centrally within the upper end of the envelope. As is well understood, the mentioned anode seal construction supports the anode in insulated spaced relation with respect to the envelope and provides an externally accessible anode terminal indicated by the numeral 7. The anode, in accordance with common practice in electric discharge devices, can be formed of graphite.

The opposite end of the cylindrical envelope is closed by an inverted cup-shaped header 8 which is welded to the lower end of the inner cylinder 2 to form a hermetic seal. The negative electrode or cathode of the device is contained in an envelope and is provided by a pool of vaporizable liquid, indicated by the number 10 which, to advantage may be mercury or a mixture or amalgam of materials including mercury.

In the operation of power conversion tubes, or arc discharge devices, of the described character some of the cathode material 10 is vaporized initially, for example, by a starter electrode or ignitor 11 which is suitably supported on and electrically connected with a conductive lead 12 sealed suitably through the header 8 and thereby made accessible for external electrical connection thereto of a starter circuit. Upon energization of the mentioned starter circuit the ignitor is effective for ionizing a small quantity of the mercury pool into which the ignitor 11 protrudes and, thus, an arc discharge is established between the surface of the cathode and the anode. Provided for retaining the arc in a substantially central position in the pool is a refractory metal ring 13. The ring can be advantageously formed of molybdenum and is supported in any suitable manner in the pool 10 with the lower edge spaced slightly above the header 8.

The mentioned arc discharge results in substantial mercury vaporization which, in turn, provides for a substantially increased arc cross section and increased current conduction. In order to maintain satisfactory operation of the device it is necessary that the mercury vapor pressure be maintained within a predetermined desired operating range. Otherwise, arc back, or reversal of current flow, and the destruction of certain tube elements can result.

In order to maintain the mercury vapor within the desired predetermined operating range, and, in accordance with customary practice, a coolant, such as water, is admitted into the chamber 4 through an inlet 14*a* at the lower end of the chamber, circulated through the chamber and discharged through an outlet 14*b* at the upper end of the chamber. By means of suitable temperature-responsive means (not shown) the cooling effect is controlled, thus to control condensation of mercury on the inner wall of the envelope and thereby control the internal mercury vapor pressure. The effectiveness of this arrangement in controlling the mercury vapor pressure is dependent upon the efficiency with which the mercury is condensed; and, as will be brought out in greater detail hereinafter, one advantage of my invention is its capability of increasing the efficiency with which the mercury is condensed.

Directly bonded to the inner surface of the inner wall 2 of the envelope is a metallic coating in two annular longitudinally spaced sections designated 15*a* and 15*b*. Both sections of the metallic coating constitute highly porous rough textured layers of getter material selected preferably from the group consisting of titanium, zirconium and alloys thereof, such for example, as titanium-zirconium alloy of the type disclosed and claimed in U.S. Patent No. 2,926,981 of V. L. Stout et al. assigned to the same assignee as the present invention.

The materials of which the layers 15*a* and 15*b* are formed are well known for their capacity to sorb large quantities of hydrogen and hydrogen-containing gases at temperatures between approximately 0° C. and 400° C. Also, such materials are known to react reversibly with hydrogen and hydrogen-containing gases and will desorb such gases at temperatures above the mentioned range. Still further, these materials are known for being irreversibly reactive with active gases other than hydrogen and can be relied upon for permanently gettering such other active gases at temperatures above approximately 700° C.

Thus, during the "de-gassing" operation which is usually carried out at a temperature range of between approximately 700° C. and 800° C. desorption of hydrogen and hydrogen-containing gases from the layers 15*a* and 15*b* results and these gases are exhausted from the envelope before seal-off. Therefore, following envelope seal-off the layers 15*a* and 15*b* stand ready, or are activated, for sorbing upon cooling any hydrogen and hydrogen-containing gases that may be evolved from the tube materials during idle periods or during tube operation. Also, at the elevated temperature of the de-gassing operation, the getter material is effective for taking other active gases, such as oxygen and nitrogen, permanently into solution.

In order to increase the gas-sorbing capacity of the layers 15*a* and 15*b*, and as seen in FIGURE 2, the layers are formed to be highly porous and with exposed surfaces thereof rough and irregular to the extent of providing myriads of peaks or protrusions 16. In this manner, the exposed surfaces of the layers 15*a* and 15*b* are each substantially increased to an area approximately 10 to 20 times greater than the area of a plane surface of getter material having the same length and width dimensions as the mentioned layers. This greatly increased exposed area of the getter material has the desirable effect of increasing greatly the gas sorbing capacity of the layers 15*a* and 15*b* and, thus, is effective for increasing

greatly the amount of evolved undesired gases than can be sorbed by the layers **15***a* and **15***b* during the idle periods of the device.

The desired roughened or irregular texture of the layers **15***a* and **15***b* can be obtained, for example, by spraying molten metal on the inner wall of the envelope. However, other means and methods for providing a metallic layer of the prescribed metal and texture can be employed. For example, a relatively smooth coating can be provided and then machine knurled to provide the desired myriad of peaks or protrusions to increase the exposed surface area of the getter material.

Thus, after cooling of the device following the degassing operation the layers **15***a* and **15***b* are effective in sorbing any hydrogen or hydrogen-containing gases that may still be present in the tube or that may evolve during any idle period. As a result, immediately upon starting the internal atmosphere of the device can be substantially free of evolved undesired gases, reducing substantially the reliance upon arc clean up. Additionally, the resultant reduced pressure of undesired gases prevents sufficient gas from getting into the arc stream to cause arc back.

As pointed out above, the reaction between the getter material of which the layers **15***a* and **15***b* can be advantageously formed ordinarily reacts reversibly with hydrogen, therefore, in order to avoid undesired re-evolution therefrom of effective amounts of previously sorbed gases during tube operation I have so predeterminedly located the getter material in the envelope as to insure against effective desorption therefrom of such previously sorbed hydrogen.

Specifically, both layers **15***a* and **15***b* are directly bonded to the water cooled inner wall **2** of the envelope which serves to control the temperature of the getter material. The getter material covers less than all of the internal exposed surface of the envelope so that most of the exposed surface subject to elevated temperatures above the desorption range of said getter material is free from getter material. More particularly, the lower coating **15***a* is restricted or limited to a relatively cool region extending between a point inwardly of the inner or lower end of the anode and a point longitudinally spaced above the cathode. The upper layer **15***b* is restricted to another relatively cool area extending between the upper header **5** and a point longitudinally spaced from the inner end of the anode and preferably located approximately midway along the length of the anode. In this arrangement there is no layer of getter material on the portion of the envelope wall corresponding to the region extending between approximately the midpoint of the anode side wall and the anode tip. This intermediate region is a relatively large portion or part of the wall, i.e., a limited but significant area, and has been found to run substantially hotter during a normal operation than the regions on which the layers of getter material are provided and, thus, would be more likely to cause desorption of the gettered gases during the loading or operation of the tube if the layer of getter material were to extend over the intermediate region.

It will be understood from the foregoing that if desired either of the layers **15***a* or **15***b* may be employed alone. Concurrent use of both is preferable because of the large gas-sorbing capacity afforded thereby.

Additionally, the layers **15***a* and **15***b*, by being roughened to increase the exposed surface areas thereof and by being metallic and directly bonded to the water-cooled inner wall, are effective for increasing the efficiency with which the mercury is condensed in the device. This results in improved control of the mercury vapor atmosphere which, in turn, insures against arc backs and resultant erratic tube operation and damage.

As pointed out above, during normal operation of a device of the type described a sludge usually occurs on the surface of the cathode mercury pool **10**. The sludge includes a substantial quantity of amorphous carbon and has a tendency to sorb hydrogen and hydrocarbon gases, which is desirable. However, if permitted to associate with the hot cathode spot, the sludge ordinarily re-evolves the hydrogen and hydrocarbon gases and thus can cause pressure surges and increased tendency toward arc back. My invention is effective for minimizing this re-evolution of the undesired gases in several manners.

First, due to the effectiveness of the metallic coatings **15***a* and **15***b* in sorbing the undesired hydrogen and hydrocarbon gases, less quantities of such gases are available for being sorbed by the sludge and, therefore, less hydrogen and hydrocarbon gases could possibly be re-evolved upon association of any sludge with the hot spot. Additionally, my invention involves the provision of means for avoiding the mentioned association of the sludge with the hot spot. Specifically, my invention in various forms, is effective for maintaining any sludge forming in the tube in an area remote from the center of the mercury pool cathode and from the hot spots therein. Additionally, the remote location of entrapment is against or immediately adjacent the cooled wall which assists in insuring against evolution of gettered gases from the sludge.

Illustrated in FIGURES 1 and 3 of the drawing is one form of my invention effective for maintaining the sludge remote from the arc-forming portion of the cathode. This form of my invention involves the employment of an annulus or ring wall **17** formed preferably of metal such as iron, steel or stainless steel and including a lower flange **18** suitably secured by welding concentrically to the bottom of the header **8**. The ring **17** includes a plurality of circumferentially spaced apertures **19** preferably located in a common plane at approximately the upper level of the pool and permitting flow through of the cathode pool material. Additionally, the ring **17** is dimensioned for being located outward of the center of the pool and for defining a substantially large central active pool surface. The ring **13** defines a still smaller central active area. However, the ring **13** is not effective for avoiding association of the sludge with the arc. The ring **17** also includes an outwardly extending and downwardly depending rim **20**. The rim **20** cooperates with a cylindrical outer barrier ring **21** which can be formed of the same material as the ring **17**. The outer ring **21** is adapted for floating in the mercury and for being restrained in its buoyancy by the rim **20**. Additionally, the ring is dimensioned to extend below the level of the apertures **19**. Upon condensation of mercury on the inner wall **2** the liquid mercury, under the influence of gravity, returns to the cathode pool at the outer edge thereof. The condensed mercury sometimes includes a quantity of sludge indicated at **22** which can contain sorbed hydrogen and hydrocarbon gases as well as various other active gases the presence of which would be undesirable in the tube. The sludge **22** is also buoyant in the mercury and tends to accumulate on the surface of the portion of the pool between the ring **21** and the inner wall **2**. The ring **21** is effective for preventing the sludge **22** from floating toward and through the apertures **19** in the inner ring **17**. These apertures **19** in ring or wall **17** are positioned substantially above the lower or immersed end of ring **21**. Thus, my described sludge-entrapping arrangement permits the condensed mercury returning to the pool to flow through the apertures **19** into the central active portion of the cathode but prevents the sludge from entering the central portion. The central portion of the cathode, or that portion defined by the ring **17**, is maintained substantially free of sludge which avoids the above-discussed undesirable effects of sludge coming into association with the hot cathode spot and, specifically, the re-evolution of the hydrogen and hydrocarbon gases previously sorbed by the sludge.

Illustrated in FIGURE 4 is a modified form of my invention. In this form a ring **23**, which can be formed of the same size and material as the ring **17** in FIGURES 1 and 3, is provided which is suitably secured concen-

trically on the header 8 in the bottom of the device. The ring 23 includes a plurality of apertures 24 located on a common plane corresponding generally to the upper level of the mercury pool. The apertures 24 are adapted for permitting mercury condensing on the outer wall 2 to flow therethrough for readmission into the central portion of the mercury pool defined by the ring 23. Additionally, the ring 23 includes an outer rim 25 which extends downwardly below the apertures 24 and serves as a barrier to prevent passage of floating sludge 22 through the apertures 24. Expressed in another manner, the rim 25 permits passage through the apertures 24 of only liquid mercury which is free of the floating sludge 22.

Illustrated in FIGURE 5 is a modified form of my invention wherein a sludge-entrapping structure is mounted on the inner wall of the device at a point located above the pool 10. This embodiment includes a metal ring 26 having a lower rim 27 extending radially outwardly and suitably secured, as by welding, to the inner wall 2 of the device at a point spaced above the cathode pool 10.

In all other respects the structure including the ring 26 can be similar to the ring 17 and can include an upper outwardly and downwardly projecting rim 28 and an outer cylindrical floating ring 29. In this arrangement the mercury draining down the side walls is intercepted by the ring 26 and the ring 29 is effective for preventing the sludge 22 from passing through apertures 30 provided in the ring 26. Liquid mercury, however, would be free to flow through the apertures 30 for draining into and replenishing the mercury cathode pool 10. It will be understood that, if desired, a fixed rim such as the rim 25 in FIGURE 4 could be substituted for the floating ring 29 in FIGURE 5.

In addition to preventing re-evolution of undesired gases from the sludge and thus avoiding pressure surges and enabling full advantage to be taken of the gettering properties of the sludge, the above-described forms of my invention which are adapted for avoiding association of the sludge with the arc is effective also for preventing vaporization of metallic ingredients included in the sludge and any metallic particles, such, for example, as particles from the coatings 15*a* and 15*b* and which may find their way into the cathode pool. It has been found that when such vaporization is permitted the metallic ingredients often condense and deposit on the relatively cool ignitor 11 and cover same with a conductive coating. When so coated, the ignitor 11 can be rendered inoperative for its intended purpose of providing a high-resistance starting element.

It will be appreciated from the foregoing that my improved device is adapted for operating with a desired greatly reduced internal atmosphere immediately upon starting and even after a prolonged idle period. My device does not require aging to achieve the desired internal atmospheric condition. Also, my invention enables continued use of the cost-reducing practice of removing through a degassing operation only approximately 60–70% of the available gas and, in fact, opens the way to extending a further cost reduction as by enabling removal of still less gas through the degassing step.

While I have shown and described specific embodiments in my invention I do not desire my invention to be limited to the particular forms shown and described, and I intend by the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An arc discharge device comprising an envelope, an anode in said envelope, a liquid pool cathode in said envelope, means for vaporizing the material of said cathode to effect an arc discharge between said anode and cathode, means for cooling said envelope to condense the vaporized cathode material, and a quantity of getter material adapted for reversibly sorbing hydrogen and hydrogen-containing gases in a predetermined temperature range supported on the inner surface of said envelope, said envelope having a relatively large portion of the internal surface thereof operable during operation of said device at an elevated temperature in the effective gas desorption range of said getter material, said getter material covering substantially less than all of said inner surface of said envelope, and most of said portion of said internal surface being free of getter material.

2. An arc discharge device comprising an envelope, a liquid-pool cathode in said envelope, means for vaporizing and condensing the material of said cathode, the internal surface of the wall of said envelope having bonded thereto a layer of metal selected from the group consisting of titanium, zirconium and alloys thereof, said envelope having a relatively large portion of the internal surface thereof exposed during operation of said device to elevated temperatures above the effective gas desorption temperature for the said getter metal, said getter metal covering less than all of said internal surface of said envelope which is exposed to hydrogen containing gas, and most of said portion of said internal surface being free of getter metal, said metal layer being further characterized by having a porous exposed surface of an increased irregular surface texture which substantially increases the ordinary surface area thereof exposed to the internal atmosphere of said device.

3. An arc discharge device comprising an envelope, an anode and a liquid-pool cathode arranged in insulated spaced relation in said envelope, means for vaporizing and condensing the material of said cathode, said envelope having a region of its inner wall surface operable at a higher temperature and a further region operable at a lower temperature, the internal surface of the wall of said envelope having bonded thereto a layer of getter metal selected from the group consisting of titanium, zirconium and alloys thereof, said layer of material being confined to a limited region of said envelope wall extending only between about the lower end of said anode and said cathode, said limited region being a region operating at said lower temperature, said lower temperature being below the effective gas desorbing temperature of said getter metal.

4. An arc discharge device comprising an elongated metal envelope, means for cooling the walls of said envelope, an anode mounted from one end of said envelope and extending therein in insulated spaced relation to a liquid-pool cathode disposed in the opposite end of said envelope, means for vaporizing and condensing the material of said cathode, the operation of said device causing an intermediate region of the inner surface thereof to be at a higher temperature, a pair of longitudinally spaced annular layers of metal selected from the group consisting of titanium, zirconium and alloys thereof, directly bonded to the inner surface of said envelope, one of said layers being restricted to a region extending only between approximately the lower end of said anode and a point spaced from said cathode, and the other of said layers being restricted to a region extending only between approximately the said one end of said envelope and a point located approximately midway the length of said anode, said annular layers occupying regions of said envelope inner surface operable at a temperature lower than the effective gas evolving temperature of said metals.

5. The invention as recited in claim 4 wherein said layers are of rough textured titanium.

6. The invention as recited in claim 4 wherein said layers are rough textured titanium-zirconium alloy.

7. An arc discharge device comprising an envelope on the inner surface of which liquid is condensed during operation, means for cooling said surface to facilitate condensation of said liquid, an anode and a liquid-pool cathode arranged in mutually insulated cooperating relation in said envelope, means for vaporizing the material of said cathode and establishing an arc between said anode and an active portion of said cathode, wall means

in said envelope intercepting condensate draining from the inner surface of said envelope and any other material carried thereby and maintaining said intercepted condensate separate from said liquid-pool cathode, said wall means having barrier means associated therewith to provide additional separation of said intercepted condensate into two portions so that flow of said condensate from one portion to the other must take place below said barrier in said condensate, said barrier means confining said other material to one of said portions, said wall means having opening means therein spaced above the lower end of said barrier to provide flow of condensate from the other of said portions into said liquid-pool cathode, said barrier means confining said other material adjacent said cooled wall and remote from said active cathode.

8. The invention as recited in claim 7 wherein an inner peripheral member is concentrically positioned within said wall means and immersed in said liquid to define said arc.

9. An electric discharge device comprising an envelope on the inner surface of which liquid is condensed during operation, an anode and a liquid-pool cathode comprising mercury arranged in mutually insulated cooperating relation in said envelope, means for cooling said wall to facilitate said condensation of said liquid, means for vaporizing the material of said cathode and establishing an arc between said anode and an active portion of said cathode including an ignitor element protruding into said active portion of said cathode, and a rough textured coating of a metal taken from the class consisting of zirconium, titanium, and their alloys covering less than all of the internal surface of said envelope and being positioned on at least that portion of said internal wall surrounding said arc and a sludge entrapping structure comprising an annular refractory metal member mounted concentrically in said envelope adjacent the wall thereof and disposed in the path of condensate draining from the wall of said envelope towards the active portion of said cathode, said member including an outwardly extending and depending upper rim and a plurality of circumferentially spaced apertures for admitting condensate liquid to drain into said active portion of said cathode, a second annular refractory metal member encircling said first member floating in said liquid and restrained in upward movement by said rim, said second member extending between said rim of said first member to a point below said apertures and effective for preventing sludge carried by said condensate from draining through said apertures into said active portion of said cathode and for confining said sludge adjacent said wall.

10. An arc discharge device according to claim 9, wherein said sludge entrapping structure is disposed in said cathode.

11. An arc discharge device according to claim 9, wherein said sludge entrapping structure is mounted on the sidewalls of the envelope at a higher elevation than said liquid-pool cathode with the level of the surface of the condensate therein at a substantially higher elevation than the level of the liquid in said pool cathode.

12. An arc discharge device comprising an envelope on the inner wall of which liquid is condensed during operation, an anode and a liquid-pool cathode comprising mercury arranged in mutually insulated cooperating relation in said envelope, means for cooling said wall to facilitate condensation of said liquid, means for vaporizing the materials of said cathode and establishing an arc between said anode and an active portion of said cathode including an ignitor element protruding into said active portion of said cathode, and a coating of a metal taken from the class consisting of titanium, zirconium, and their alloys, covering less than all of the internal wall of said envelope and at least covering the portion of said wall surrounding said arc, and a sludge entrapping structure comprising an annular member mounted concentrically in said envelope adjacent the cooled wall thereof and disposed in the path of condensate draining from the walls of said envelope toward a said active portion of said cathode, said member including an inner cylindrical wall containing a plurality of apertures in the upper region thereof at approximately the surface level of said liquid for admitting condensate liquid to drain into said active portion of said cathode, and an outwardly and downwardly depending rim portion extending to a point below said apertures and effective for preventing sludge carried by said condensate from draining through said apertures into said active portion of said cathode and for confining said sludge adjacent said wall.

13. An arc discharge device comprising an envelope on the inner surface of which a liquid is condensed during operation, an anode and a liquid-pool cathode in said envelope, means for vaporizing the material of said cathode and establishing an arc between said anode and an active portion of said cathode, said inner surfaces of the envelope having bonded thereto a layer of metal selected from the group consisting of titanium, zirconium and alloys thereof, said layer of metal covering less than all of said inner surfaces of said envelope and covering at least that portion of said wall surrounding said arc, means intercepting condensate draining from said wall and any other material carried thereby and maintaining said condensate separate from liquid cathode, means permitting return of liquid material to said active portion of said cathode and confining said other material at a location remote from said active portion of said cathode, said means including a barrier immersed in said condensate and permitting flow of said condensate thereunder, said means also including apertures in a region elevated from the lower portion of said barrier to provide flow of condensate to said active portion of said cathode and the location at which said other material is confined being at least immediately adjacent said wall.

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