

UNITED STATES PATENT OFFICE

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VAPOR ARC APPARATUS

No Drawing.

Application filed July 20, 1925. Serial No. 44,934.

My present invention relates to vapor arc apparatus and particularly to a source in such apparatus of a vapor material for starting the electric arc. It relates more particularly to mercury which has amalgamated therewith or dissolved therein or another material such as a metal or metalloid, such additional material being supplied for the purpose of decreasing the surface tension of the resultant vapor source below that of mercury alone, for increasing the emissivity of the electrons therefrom under electrostatic pressures or differences of potential of low value or for both these purposes.

I have discovered that the starting characteristics of a mercury vapor lamp can be materially bettered by amalgamating with or dissolving in the mercury material of a nature and in amounts that will be held in its association with the liquid mercury during the continued operation of the lamp and which will affect the mercury in the cold or non-operating state to reduce its surface tension whereby the characteristic convex meniscus is replaced by a substantially flat surface or preferably concave meniscus. I find still further that the advantageous effects of such an association are still further increased when the mercury or the mercury association is brought to the state in which a thin film of it will rise to an appreciable distance up the sides of the containing vessel or envelope as through capillary attraction. This "appreciable distance" may be imperceptible to the eye but I find it to be effective in favorably changing the starting characteristics of a lamp if the mercury or the mercury association is made to present an upward extension of such small cross section that it will have a comparatively very high surface density of static charge when standard starting voltages are impressed across the terminals of the lamp. In other words I find that by causing the mercury or the mercury association to wet the wall of the enclosing envelope that the starting characteristics of the lamp are materially improved. This can be done while keeping the association material in the mercury at all times during the normal operation of the lamp when certain materials are used for ex-

ample, copper, nickel, chromium, aluminum or mixtures of these and in amounts herein-after set forth.

I have discovered that metals can be successfully used in an association with mercury for the starting of an arc in a vapor arc device when such metals are used as will give an association which under operating conditions of the device have a lower vapor pressure than that of the mercury alone. That is, I have discovered that certain such metals can be successfully used for the above purpose and also for the purpose of reducing the surface tension of the mercury itself to make the mercury wet the walls of the container without using such metals actively or to a substantial degree in the production of the vapor path itself. In other words, according to my invention, I employ such metals for the purpose of activating the mercury as will remain in the mercury under the operating conditions of the lamp. Of course, a material which would return to the mercury after passing from the main body thereof in the arc stream or otherwise and without accumulating outside or blackening the container wall would be practical but heretofore no such substance has been used of such kind and in such quantity as will remain in the mercury. In fact such materials as have been tried heretofore have been abandoned as being inoperative or impractical due to their leaving the mercury and depositing themselves outside the mercury and thereby losing their function in the device, or by blackening the walls of the envelope of the device to such an extent as to render it useless for practical purposes, or by resulting in both of these defects.

One of the materials which I have discovered to be useful for activating the mercury and in amounts such as will either not leave the mercury, or will leave it in such quantities as are readily carried back to the mercury, is copper. For example, in a mercury vapor arc lamp having an envelope of vitreous material fifty inches in length and one inch in diameter, containing six ounces of mercury, and operable on substantially 110 volt service I use in such mercury copper in amount from about 0.003% to 0.03% of the mercury, pref-

erably about 0.01%, the copper being placed in the mercury at the time of the assembling of the parts. As a result of using this copper in the mercury I have been able to start mercury vapor lamps under much more severe conditions than it has been possible heretofore and this in the practical production for the trade of practically the entire output of the largest maker of mercury vapor lamps in the country. These lamps made with copper in the mercury in substantially the amounts above stated have withstood and continued to withstand operating conditions under rigid and extended laboratory tests and further, and which is more significant, in practical use in factories in all parts of the country.

It is to be understood that metals other than copper can be used in the mercury for the purposes above set forth such other metals being, for example, nickel or chromium. Such metals are used in the mercury in substantially the same molecular proportions as is the copper.

It is to be further understood that as I am not limited to copper as the addition material I also am not limited to the amounts stated of copper used. The lower limit of the addition material used varies under different conditions of temperature and pressure and can best be stated as "effective amounts"; and the maximum amounts of copper are such as sufficiently produce the surface tension changes desired, the difficulty with larger amounts being that a piece of the metal floating on the mercury surface and lodging against the side of the envelope may draw the cathode hot spot thereto with the result that the envelope is burned at this point and also the disadvantage of darkening of the tube due to the action of excessive amounts of the added material.

Another element which I find desirable to use is aluminum. In the case of aluminum in a commercial mercury vapor lamp of the type and dimensions hereinbefore referred to I use .001 grams of aluminum per ounce of mercury. In the production of lamps of the types herein disclosed it is noticed that visual inspection of these lamps can be made after the lamp has been sealed off at the exhaust pump and the fact determined instantly whether or not the factory has produced a perfect lamp for if the lamp is a "leaker", the fact becomes known immediately as the gases of the air will have reacted with the dissolved substance in the mercury forming a tell-tale scum on the surface of the electrode which is readily visible, and this is particularly evident in the case where aluminum is the dissolved metal. This results in a saving in the cost of production of mercury vapor lamps in that the results are now attained immediately by visual inspection alone, whereas heretofore the results could not be observed until after each lamp had been put through an ex-

pensive inspection test of several hours burning.

The term "association" as used in the claims forming part of this application is intended to mean a solution or an amalgamation of the mercury of the cathode and the material used for modifying the mercury for affecting the starting characteristic of the cathode and of the lamp. The term "associated", likewise, is intended to have a co-relative meaning.

It is to be understood that the advantageous effect of the association material on the mercury may be explained in terms of increases of electron emissivity of the association over mercury alone and in the claims the invention has been specifically set forth in terms of association material amounts sufficient to produce emissivity effects on the cathode without sensibly affecting the volt-ampere operating characteristics of the vapor arc device in which the association is used.

It is to be further understood that when desired the association material is added to the mercury before the mercury is added to the envelope of the device.

It is to be further understood that the effect of the association material on the mercury is explainable in terms of electrostatic charge densities of certain parts of the liquid electrode at the time of starting. That is to say, by causing the liquid electrode to wet the glass of the envelope portions of the electrode liquid are obtained which have small or minute thickness of cross-section and at these points comparatively high charge densities are obtained as a result of which the electron emissivity of the electrode is greatly increased and starting of the device is greatly facilitated. A modification of the qualifying material, used in association with the mercury of the cathode, is claimed in application Serial No. 163,560, filed January 25, 1927, allowed May 11, 1931, vapor arc apparatus.

I claim:

1. An electrode for mercury vapor apparatus comprising mercury qualified by an amount of a material capable of reversing the meniscus of mercury while maintaining the characteristic color of light emitted by a mercury arc, said material containing copper.
2. A cathode material for vapor electric apparatus comprising mercury qualified by copper in an amount capable of reducing the starting voltage characteristics of the electrode and simultaneously maintaining the electrode volt-ampere operating characteristics.
3. A cathode material for vapor electric apparatus comprising mercury and a quantity of copper completely dissolved therein, said material having a lower starting voltage characteristic than mercury and also having the characteristic color of the light emitted by a mercury arc.
4. A mercury cathode and copper qualifier

therefor in amounts varying between 0.003 and 0.03 per cent of the weight of the mixture.

5 5. An electrode for mercury vapor apparatus comprising mercury qualified by copper in an amount capable of being completely dissolved by the mercury and of reversing the meniscus of mercury, while simultaneously
10 maintaining the color of the light of a mercury arc, as emitted by said electrode.

6. An electrode for mercury vapor devices comprising mercury and a maximum quantity of copper which is substantially all dissolved in the mercury.

15 Signed at Hoboken, in the county of Hudson and State of New Jersey.

WILFORD J. WINNINGHOFF.

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