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PROCESS AND MEANS FOR PREVENTING FILM DEPOSITS IN LAMPS

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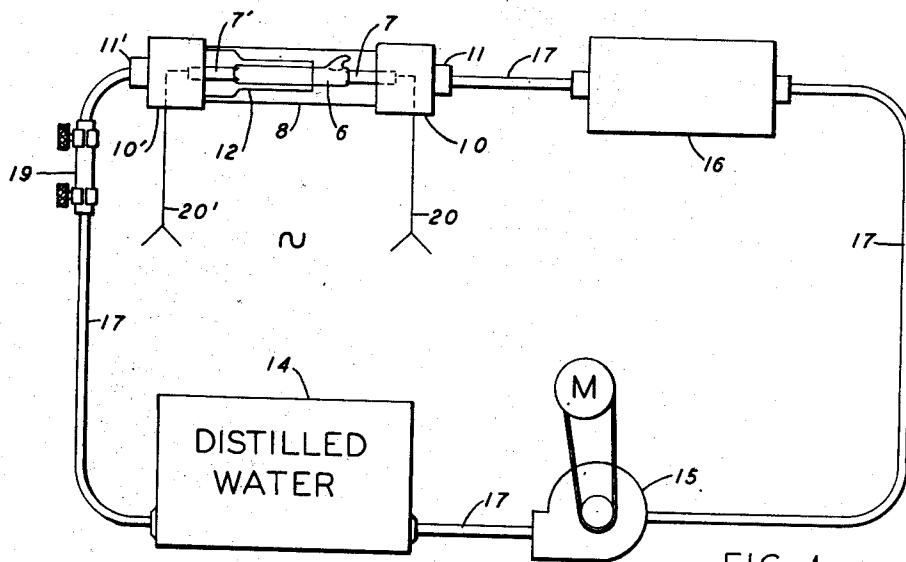


FIG. 1

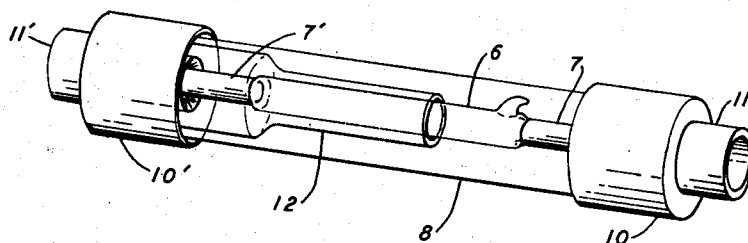


FIG. 2

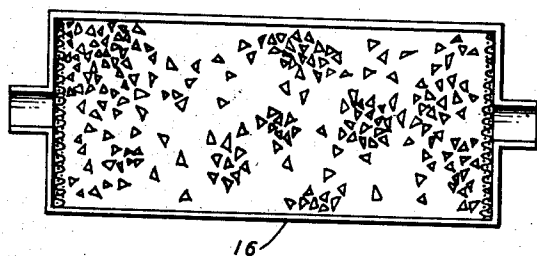


FIG. 3

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PROCESS AND MEANS FOR PREVENTING
FILM DEPOSITS IN LAMPS

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2 Claims. (Cl. 313-23)

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This invention relates to cooling high intensity gaseous discharge lamps, and more particularly to an arrangement for cooling mercury vapor capillary arc lamps.

High intensity light sources of the type known as mercury vapor capillary arc lamps develop an intense heat which, if not absorbed by cooling, will destroy the lamp. Therefore, it is necessary to cool these lamps either by an air blast, or, preferably, by flow of cooling liquid. To this end, the lamp is enclosed in a transparent jacket through which the cooling liquid, in intimate contact with the lamp surface, is passed.

Capillary arc lamps are only a few inches in size, but develop close to 200,000 candle power per square inch (approaching the brightness of high intensity carbon arcs). The physical construction necessitates large electrodes in proportion to the overall size of the lamp. These electrodes cannot be isolated from the cooling system, but must be immersed in the cooling liquid to be also cooled thereby. The terminal voltage between electrodes is high, approximately 1200 volts at the start, and, under normal operation, between 800 to 900 volts.

In open flow cooling systems, where a continuous supply of well or city water is available, it has been observed that a dark deposit is formed upon the outer wall of the lamp and on the inner wall of the jacket. This deposit forms a film which not only strongly absorbs the actinic light radiated from the lamp and thereby impairs the efficiency, but also shortens its life, since the cooling becomes less effective, resulting in a temperature increase beyond the safe limit which rapidly destroys the lamp. Moreover, when metallic ions collect on the outer wall of the lamp, a current conductive path of relatively low resistance is produced in shunt with the terminal electrodes. The localized heating effect of the current flowing in the shunt path will crack the glass envelope of the lamp. This film forms after a few hours of operation, and can only be removed by cleaning of the lamp assembly. This deposit is attributed to dissolved impurities in the water, and subsequent oxidation of metallic ions.

In a closed circuit cooling system, where the water from a storage tank is recirculated through the jacket of the tube, distilled water, free from impurities, proves no more effective in eliminating the above-mentioned disadvantages. Formation of a light-absorbing deposit at a fairly rapid rate is not eliminated by the use of distilled water, so that frequent disassembly and cleaning of the tube and the jacket are required. Chemical

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inhibitors have been tried, such as trisodium phosphate, with little benefit except that it slowed down the formation of deposit extending the effective use of the lamp to a period of a few hours longer.

It is a primary object of this invention to prevent, substantially completely, the formation of light-absorbing deposits in water cooled mercury arc lamps, and to this end means are provided, in a closed circulatory cooling system, to restrain a build-up of metallic ions.

A particular feature of this invention is that by inclusion in the cooling system of simple apparatus, the above-mentioned disadvantages are entirely eliminated resulting in a continuous and substantially indefinite operation of such lamps, limited only by their normal life period.

Other objects and features will be apparent from the following description of the invention, pointed out in particularity in the appended claims and taken in connection with the accompanying drawings, in which:

Figure 1 is a schematic representation of the closed circulatory cooling system;

Figure 2 is a perspective view of the capillary arc lamp placed in the jacket; and

Figure 3 is an enlarged cross-sectional view of the container which is a component element of the cooling system shown in Figure 1.

Referring to the figures, the mercury arc lamp 6 is of tubular construction having terminal electrodes 7 and 7'. A transparent jacket 8 surrounds the lamp 6 forming a cylindrical housing with suitable metal fittings 10 and 10' at each end, having fittings 11 and 11' to which suitable pipe or hose connections may be made. The jacket 8 has an inner tubular portion 12 of narrower diameter which will be described in greater detail in connection with Figure 2.

The cooling system consists essentially of the cooling liquid storage tank 14, the pump 15 driven by a suitable motor M for propelling the liquid at a given rate of flow, a container 16 through which the liquid must pass which is the essential element in applying the invention, and pipes 17 interconnecting these components into a closed recirculating system.

Only as much of the component elements of the cooling system are shown here, for the sake of simplicity, which are necessary for the understanding of the application and operation of the invention. Such systems generally also include some form of a heat exchanger, various valves, thermostatic controls, and safety interlock switches.

The construction of the jacket 8 can better be seen in the perspective view of Figure 2, where similar reference characters denote identical component elements. The cylindrical jacket 8 has an inwardly extending inner tube portion at one end thereof which forms a velocity tube around the lamp 6, constraining the cooling liquid to flow past the lamp 6 at increased velocity, due to the restriction of the cross-section of the water passage.

The cross-sectional view of Figure 3 indicates that the container 16 is filled with a chemical composition for the purpose described below.

The closed circulating cooling system, shown in Figure 1, represents, by way of example, a simple arrangement whereby distilled water placed in the storage tank 14 may be recirculated by means of the pump 15 and forced to flow through the cooling jacket 8 and through the container 16. In view of the fact that the electrodes 7 and 7' are immersed in the cooling water, and one of these terminals is generally placed at ground potential, it is necessary to insulate the other terminal from the conductive portions of the system. For this purpose, a flexible hose 19, preferably of rubber or other suitable electrical insulating material, is inserted into the metal conduit at one point of the system. The terminals of the lamp 6 may be brought out through the fittings 10 and 10'. Since this invention is not concerned with the electrical portion of the system, the electrical connection to the lamp is merely indicated by leads 20 and 20' between which the electrical potential applied is shown by a conventional sign for alternating current.

It was mentioned before that the use of distilled water, free from impurities, has not lessened the formation of a light absorbing deposit on the lamp 6 or on the inner wall of the jacket 8, and, particularly, on the velocity tube 12. That this deposit formation was due to electrolysis of the metal electrodes, when ordinary water of even very low conductivity was used, has been recognized, and chemical inhibitors advocated for repressing the formation of simple metallic ions. With pure, distilled water as the cooling liquid, the discoloration of the water and the formation of deposit has been a puzzling phenomenon, and only temporary remedy effected by the use of such inhibitors. Trisodium phosphate in any concentration did not prevent the oxidation of ferrous or manganous ions, permitting more of the phosphate-complexed ions to dissociate and be deposited on the lamp and jacket.

I have considered this, and come to the conclusion that although pure distilled water is used, which has an extremely high specific resistance, as soon as a potential difference exists between the electrodes, a few free ions present will produce an infinitesimal current conductivity which will bring additional metal ions into solution. These ions in turn produce a greater increase of current and electrolysis becomes more rapid. This reaction is, in effect, autocatalytic, since once electrolysis has started, the solution deteriorates at an ever increasing rate. Another possible source of soluble metallic ions is from the gal-

vanic effects produced in the system because of the presence of impure and of dissimilar electrode metals producing electrolytic couples or "miniature batteries." Small electric current leakages will, of course, enhance such effects.

To overcome this undesired reaction, in accordance with this invention, an ion exchange medium is placed in the circulating system. This ion exchanger medium is held in the container 16 and may comprise a cationic exchange resin consisting of polynaphthalene sulfonic acid formaldehyde derivatives. It is preferred to include also an anionic exchange resin, for example, a resinous condensation product of urea ethylenediamine and formaldehyde. Therefore, this resin bed is made up of the mixture of cation and anion active resins, and all ions, whether metallic or non-metallic, are captured as the given portion of the water passes through the bed. Consequently, there is never an opportunity for the ion concentration to rise sufficiently to support electrolysis.

Resins of the type mentioned are readily available and are being used as water softeners in the industry. In their above-described use, in connection with distilled water, they perform a different function, namely to prevent electrolysis by retaining any free ions. Just as the formation of ions producing electrolysis is normally autocatalytic in rate, the action of the anionic and cationic exchange resin bed is a negative counterpart in that the capture of free ions progressively decreases, resulting in a state of complete deionization, which is then maintained substantially indefinitely. For this reason, in practice, such resin beds need be replaced very infrequently, if at all.

This is in part a continuation of my copending application Serial No. 695,333, filed September 6, 1946, now abandoned.

I claim:

1. The combination with a water-cooled electric lamp wherein the lamp is mounted between electric-supply terminals, in a jacket in a system through which the cooling water circulates in contact with said terminals, of ion-exchange means comprising a mixture of anion and cation exchange resins for treating said water during the circulation thereof in said system to prevent the deposition of a coating on the exterior of said lamp.

2. A process of minimizing the formation of a coating on the quartz tube of a water-cooled electric lamp in which cooling water is circulated through the lamp to cool the quartz tube thereof and in which the lamp terminals are immersed in the cooling water, which process comprises passing the circulating stream of cooling water through a bed composed of a mixture of anion and cation exchange resins.

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