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LOW-PRESSURE DISCHARGE LAMP CONTAINING MERCURY AMALGAM

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Fig. 1.

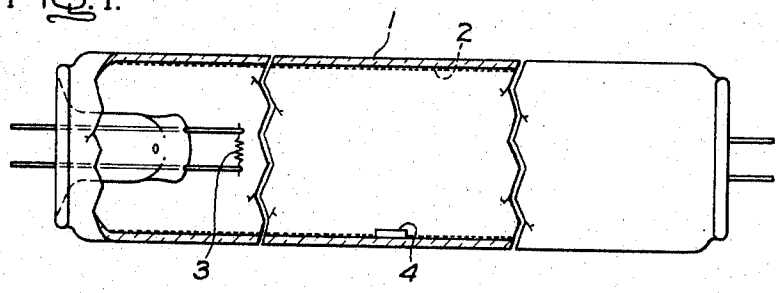
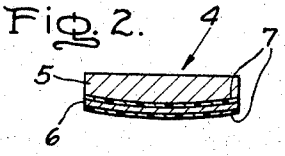


Fig. 2.



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LOW-PRESSURE DISCHARGE LAMP CONTAINING MERCURY AMALGAM

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The present invention relates to low-pressure mercury vapor discharge lamps, more particularly fluorescent lamps, which are electrically or thermally more highly loaded than was usual hitherto and which contain, beside some millimeters of mercury of an inert gas such as argon, also at least one amalgam for the purpose of achieving higher loading.

It is well known that in a low-pressure mercury discharge lamp the luminescent layer applied to the inner wall of the envelope is excited to light emission by resonance radiation produced in the mercury vapor and that this mercury resonance radiation is maximum at a definite relatively low mercury vapor pressure (about 5×10^{-3} mm. Hg). With increased thermal or electrical loading of the lamp, its temperature increases and simultaneously the mercury vapor pressure in the lamp rises causing a decrease in the output of resonance radiation. The excitation of the luminescent material is lessened thereby, more than would be expected merely from the higher loading, and the efficiency of the lamp is correspondingly lower. As is well known, the provision of an amalgam in the lamp counteracts the temperature increase brought about through the higher thermal and electrical loading by reducing the vapor pressure in the lamp so that light output is increased and the efficiency of the lamp is improved. The extent of the vapor pressure decrease depends on the composition of the amalgam.

Amalgams can, however, produce their effect of decreasing the vapor pressure only if they are present at definite places within the lamp envelope, places of not too high temperature. A place may be used provided it has a temperature where the mercury vapor pressure above the amalgam is lower than it would be above mercury alone at the coolest place in the lamp. In the technique of manufacturing such highly loaded lamps, good adhesion of the amalgams is very important. In order to achieve good adherence of the amalgam at the desired place, it is also well known to provide it in the lamp as a body of small surface relative to its volume, preferably as a tablet or pill. The amalgam body may consist of an intimate mixture of mercury and one or several metals of low melting point. It is fastened to the inner envelope wall by heating it in such manner that at least for some part of the body the softening point is reached, and by pressing it, for instance by compressed air, at the desired place from which luminescent material has been removed. Attempts have been made to fasten amalgam bodies or pills in the lamp by means of high-vacuum adhesives. There have also become known good-adhering amalgam bodies consisting of a three-component system such as indium-cadmium-mercury, having a melting point not below 90° C. It is also well-known to provide amalgams in the lamp of a composition having a pasty consistency at room temperature as well as at the operating temperature of the lamp. This permits rolling the amalgam down to a thin layer extending over a small part of the envelope wall or applying it to a carrier provided in the lamp.

By contrast, in accordance with the invention, the low-pressure mercury discharge lamp, more particularly fluorescent lamps, having increased electrical or thermal loading, in the discharge envelope of which there is contained an amalgam as a body of relatively small surface

in relation to its volume, preferably in the form of a tablet at one or several places having temperatures not much higher than those parts of the envelope exposed to the discharge, is characterized in that the body consists of a layer of pressed or molten amalgam facing the discharge and of a layer of a metallic foil coated with synthetic adhesive facing the envelope wall.

The layer facing the discharge may consist of well-known amalgams, preferably of cadmium or of indium amalgam; for the metallic foil, aluminum may be used and has proven very advantageous; tin is also quite suitable. The layer consisting of amalgam should be thicker than the layer of foil coated on both its surfaces with the synthetic adhesive. The proportion of the layer thickness of amalgam to foil should preferably be not less than 20 to 1.

The synthetic adhesive utilized for affixing the amalgam pellet to the envelope wall should have the following properties: thermal stability with a softening point in the approximate range of 110 to 130° C.; low gas emission in vacuum; resistance to irradiation; little shrinkage during tempering or setting; and solubility in highly volatile solvents. The foregoing requirements are met by synthetic adhesives of the group of condensation resins and poly-addition resins, especially polyamides and epoxy resins. Particularly suitable polyamides are those which are prepared by condensation of dimerized and trimerized fatty acids (chiefly linoleic acid) with low molecular polyamines, said polyamides, well-known under the trade name "Versamid" have a molecular weight from 1000 to 8000 and an amine factor (which states the milligrams of potassium hydroxide corresponding to the equivalent of amine in one gram of substance) smaller than three. Particularly suitable epoxy resins are those obtained by condensation of epichlorhydrin with phenolic compounds, such as are marketed under the trade name "Araldit."

A great advantage of the two-layer amalgam body according to the invention is that, if metal foil is used, only two completely smooth surfaces, viz. foil and glass, must be brought to adhesion by means of the adhesive. If the amalgam is applied directly to the glass wall by means of the adhesive, then the adherence is often defective because of the rough surface of the pressed amalgam which reduces the surface for adhesion. In this latter case there is also required a larger quantity of adhesive which may diffuse into the amalgam when heated later-on, resulting in impairment of the amalgam. Another advantage results from the fact that the adhesive attachment of the metal foil to the amalgam may be made before it is put into the lamp envelope as described in greater detail below.

A further contribution to good adherence of the amalgam body to the inner envelope wall results from the fact that, as disclosed in the present invention, the surface of the body has identically the same radius of curvature on the foil side as the lamp envelope. Thus the amalgam body has one of its surfaces adapted from the beginning to the curvature of the lamp envelope.

In FIGS. 1 ad 2 there is shown an embodiment of the invention. FIG. 1 shows a fluorescent lamp provided with the amalgam body, FIG. 2 shows the amalgam body. The fluorescent lamp shown in FIG. 1 has an envelope 1 of glass to the inner wall of which the luminescent material 2 is applied. The envelope has a diameter of about 37 mm. and a length of 1.2 m., and the lamp operates on a line voltage of 220 volts like the usual 40 watt lamp. Well-known oxide-paste coated coils are used as the electrodes 3. As shown in FIG. 2, the amalgam tablet or pill-like body 4 consists of the layer 5 of amalgam facing the discharge, for instance a composition by weight of 45% cadmium and 55% mercury, and of the

aluminum foil 6. Foil 6 has a thickness of 0.015 mm. and is coated on both surfaces with layers 7, each about 0.01 mm. thick, of a suitable synthetic adhesive. Those marketed under the trade names "Versamid" and "Araldit" are suitable. The total height of the tablet amounts to about 1.4 mm.; the diameter of the tablet is about 6 mm. and its radius on the foil side is about 17 mm. The tablet has a weight of 180 mg., the quantity of synthetic adhesive on the foil weighing about 1 mg. The lamp contains a rare gas filling of 1.7 mm. Hg of argon for starting purposes. The lamp has a wattage input of 120 watts and operates with a current of 1.5 amps.

The amalgam body itself consisting of the amalgam and the coated foil, is prepared in the following manner. The required quantity of mercury with the pulverized amalgam-forming metal, e.g., cadmium, is stirred mechanically into a dry amalgam powder. The band of metallic foil, e.g., aluminum foil, is degreased before further processing, for instance by passing it at a given speed through a degreasing bath maintained at a definite temperature. After a subsequent purification bath and following drying, the foil is coated with the synthetic adhesive, suitably in a dipping device, and is dried again. Shaping and formation of the amalgam body is made in a preforming press. For this latter purpose, the amalgam powder is poured into side-by-side arranged deepenings or die cavities of a matrix on the press plate of the machine. The foil coated with the synthetic adhesive is arranged above the die cavities in such manner that the press pin, on the stroke where it presses the amalgam powder, cuts out of the foil a little plate which it presses simultaneously onto the amalgam tablet. The press pin has a concave form on its front side with a radius of curvature corresponding to the inner radius of the lamp envelope.

In manufacture of the lamp, first luminescent material is removed, for instance by means of a suction device, from a circular place on the wall of the coated and baked envelope, however this is not absolutely necessary. Luminescent material is removed from this place, which should be remote from the electrodes, to an extent corresponding to the size of the amalgam body to be subsequently applied. Thereupon, the amalgam body is put into the lamp in such a manner that its convex surface lies on the predetermined place of the inner envelope wall. The envelope is then heated at this place, as by hot air, until the synthetic adhesive layer on the surface of the amalgam body becomes plastic which is known by a change in the appearance of the tablet surface. When the adhesive layer has become plastic, the amalgam body conforms to the inner envelope surface and adheres to it tightly. After having sealed-in the lamp stems, the place on the envelope wall carrying the amalgam pill is cooled during exhaust, suitably to a temperature below 80° C., e.g., by cooling air, and the lamp envelope is then sealed-off. The amalgam body adheres tightly to the envelope wall and no separation takes place, even in drop tests made with the lamp.

The structure of the amalgam body and the method of applying it according to the invention represent significant improvements in the area of highly loaded amalgam lamps where hitherto considerable difficulty in manufacture had been encountered. The present invention provides a solution distinguished by technological simplicity and cheapness and permits mass manufacture of the lamps in a manner which scarcely differs from the usual fluorescent lamp manufacturing processes heretofore used.

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

1. A highly loaded low-pressure mercury vapor discharge lamp comprising a vitreous envelope having electrodes sealed into its ends and containing an amalgam in the form of a body of relatively small surface area in relation to its volume, said body being located at a place having a temperature not appreciably higher than the portions of the envelope exposed to discharge, characterized in that the body consists of a layer of amalgam facing the discharge and a layer of a metallic foil coated with a synthetic adhesive facing the envelope wall and attached thereto.

2. A discharge lamp as defined in claim 1 characterized in that the layer facing the discharge consists of pressed cadmium amalgam.

3. A discharge lamp as defined in claim 1 characterized in that the layer facing the discharge consists of pressed indium amalgam.

4. A discharge lamps as defined in claim 1 characterized in that the metallic foil consists of aluminum.

5. A discharge lamp as defined in claim 1 characterized in that the metallic foil is coated on both its surfaces with a synthetic adhesive.

6. A discharge lamp as defined in claim 1 characterized in that the metallic foil is coated on both its surfaces with a synthetic adhesive consisting of an adhesive from the group of condensation resins and polyaddition resins known as polyamides and epoxy resins.

7. A discharge lamp as defined in claim 1 characterized in that the layer consisting of amalgam is thicker than the coated metallic foil.

8. A discharge lamp as defined in claim 1 characterized in that the body has on its foil side a convex surface corresponding to the curvature of the lamp envelope.

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