United States Patent

[11] 3,629,641

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[21] Appl. No. **55,396**
[22] Filed **July 16, 1970**
[45] Patented **Dec. 21, 1971**

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[32] Priority **July 25, 1969**
[33] **Germany**
[31] **P 19 378.5**

[54] **LOW-PRESSURE MERCURY VAPOR DISCHARGE LAMP CONTAINING AMALGAM**
7 Claims, 3 Drawing Figs.

[52] U.S. Cl. **313/229,** 313/227
[51] Int. Cl. **H01j 61/20**
[50] Field of Search 313/227, 228, 229

[56] **References Cited**

UNITED STATES PATENTS

3,227,907	1/1966	Bernier et al.	313/207
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FOREIGN PATENTS

1,005,446	9/1965	Great Britain	313/229

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ABSTRACT: A low-pressure mercury vapor fluorescent lamp containing amalgams at three different locations in order to extend the temperature range of maximum light output. The main amalgam is indium with a weight ratio of indium to mercury from 12:1 to 3:1 located at places within the lamp having temperatures from 80° to 110° C. The two additional or runup amalgams are located at places within the lamp envelope which are much hotter than the main amalgam and which attain their operating temperature successively and earlier than the main amalgam, for instance on the electrode cap and on the stem press.

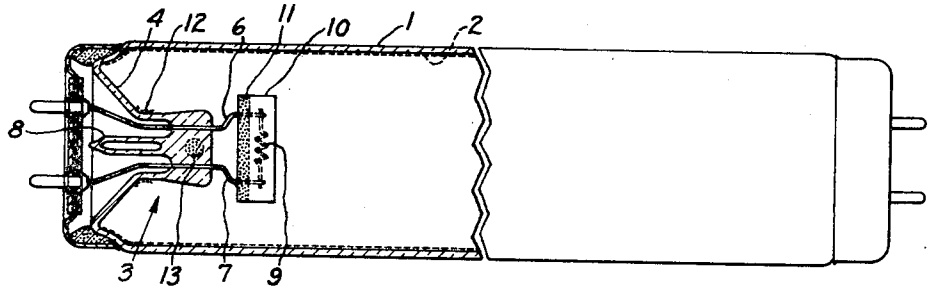


Fig. 1.

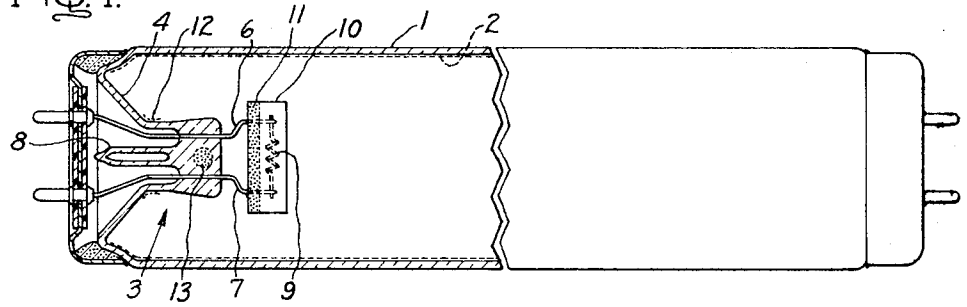
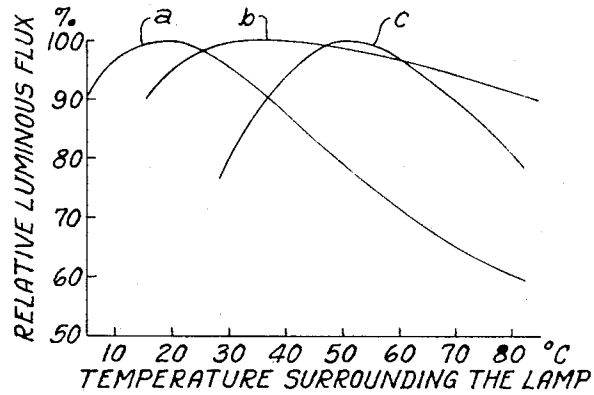
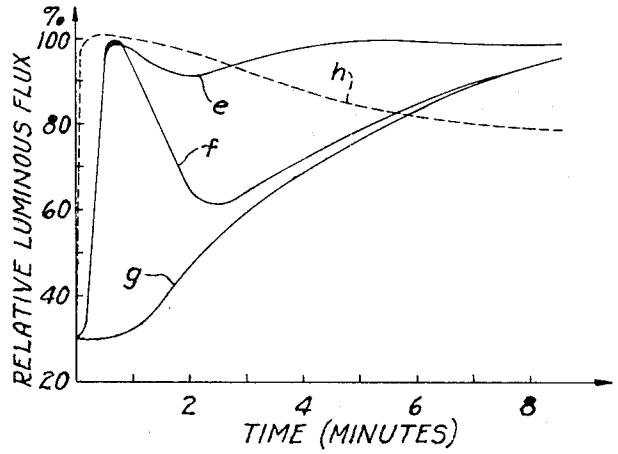


Fig. 2.



TEMPERATURE RANGES FOR:	TEMPERATURE IN LUMINAIRE (AT 28°C, AMBIENT)
OPEN LIGHT STRIPS.	I
DOWNWARDLY OPEN REFLECTORS.	I—I
LOUVERED LUMINAIRES.	I—I
CLOSED LUMINAIRES.	I——I
TOTALLY ENCLOSED LUMINAIRES.	I——I

Fig. 3.



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LOW-PRESSURE MERCURY VAPOR DISCHARGE LAMP CONTAINING AMALGAM

BACKGROUND OF THE INVENTION

This invention relates to low-pressure mercury vapor discharge lamps, more particularly to fluorescent lamps containing amalgam. In these lamps the amalgam causes the mercury to have a vapor pressure which, at the same temperature, is lower than that of free mercury.

As is well known, the location of the amalgam-forming metal or of the amalgam, respectively, is of importance for the action of the amalgam within the lamp both in respect of the chosen amalgam-forming metal, and, additionally, in respect of its quantitative proportion in the alloy; even the choice of the amalgam-forming metal(s) and the composition of the amalgam(s) to be utilized is influenced by the place of location (German Federal Republic Pat. No. 1,086,804). The temperature prevailing in this place during operation of the lamp is decisive as regards the choice of the place of location within the lamp.

Particularly suitable for application within the lamp proved the amalgam-forming metals cadmium and/or indium, and/or tin, the geometrical structure within the lamp and the type of application of the amalgam-forming metals or of the amalgams being quite different depending upon the choice. For example, it is already well known to incorporate amalgams in already specified composition into the lamp and to either paste or roll them onto the inner wall of the discharge envelope in the form of a strip, a film or a pellet (German Federal Republic Pat. Nos. 1,104,060; 1,140,286; 1,149,818; and 1,196,292). It is however likewise well known to incorporate only the amalgam-forming metal into the lamps initially so that the amalgam forms subsequently when the lamp is dosed with mercury. For example, there is disclosed (in Japanese Pat. application No. 40-8518) the application of indium in the form of a strip covering the inner circumference of the bulb wall in the middle of the lamp; or, a strip of indium was attached to the stem presses (German Gebrauchsmuster Pat. No. 1,934,678) or housed in a sievelike container (German GM Pat. No. 1,937,402). or, a wire-mesh of nickel placed around the lamp stem was utilized which had been impregnated with indium to which in most cases tin is added because of the difficult handling of the indium which during lamp operation is in liquid state. With this type of application of the amalgam-forming metal, however, the length of the stem tube has to be increased in order to observe the distance from the filament of from at least 20 to 60 mm. necessary for the operating temperature of the amalgam provided in this form (Dutch Pat. application No. 65,07,948). If indium alone was incorporated into the lamp as the amalgam-forming metal, the ratio of indium to mercury in the amalgam formed after initiation of lamp operation was in most cases 3:1. Moreover, it was found that when utilizing indium-amalgam, especially with an addition of tin, the temperature dependence of the luminous flux is reduced, i.e., the curve of luminous efficiency plotted versus vapor pressure is flatter than, for example, with cadmium-amalgam; the luminous efficiency drops within a temperature range of 30° C. not more than about 5 percent, and within a temperature range of 45° C. not more than about 10 percent (Dutch Pat. application No. 65,07,948, Dutch Pat. application No. 68,15,202).

Furthermore, the interaction of two amalgams of different individual actions is well known, for example, a main amalgam by means of which the mercury vapor pressure during lamp operation is determined, and another amalgam effecting a reduction of the runup period. When utilizing either cadmium or indium as the main amalgam it is well known to incorporate into the lamp indium or an alloy of indium to form the starting or runup amalgam (German Federal Republic Pat. No. 1,274,228, Dutch Pat. application No. 65,12,256, U.S. Pat. No. 3,227,907).

Though progress has already been achieved in the manufacture of lamps containing amalgam, it has been still necessary

up to now, however, to provide a type of lamp of specified dimensioning of the amalgam filling for each thermal load region such as results, for example, when operating lamps in the various types of lighting fittings; suitably, the amalgam-forming metal and the composition ratio of the amalgam are so chosen that the maximum of luminous flux of the lamp is reached approximately in the middle of the intended region. For operation in rooms having a temperature of 25° C. and when utilizing open batten type fittings, conventional fluorescent lamps without amalgam were heretofore used.

It is now the principal object of the invention to reduce the number of different lamp types. Another object of the invention is to provide an optimum lamp as regards dimensioning, filling, runup characteristics and simple manufacturing methods.

SUMMARY OF THE INVENTION

In accordance with our invention, a low-pressure mercury vapor discharge lamp, preferably a fluorescent lamp, containing amalgam is characterized in that the main amalgam determining the condition of equilibrium of the operating vapor pressure is indium-amalgam with a weight ratio of indium to mercury of from 3:1 to 12:1, the main amalgam or the respective amalgam-forming metal is located in places within the lamp which have an operating temperature of from 80° to 110° C., and the lamp contains at least two additional amalgams or amalgam-forming metals accelerating the runup of the lamp located in places which are much hotter than the place of the main amalgam. The additional amalgams are desirably located in places of low-heat capacity closer to the electrodes and which attain their operating temperatures successively and earlier than the place of the main amalgam. The invention is particularly useful in lamps having power inputs from 0.3 to 0.6 watts per centimeter of discharge path length, (0.75 to 1.5 w/in).

It is advantageous if the place of location of the main amalgam or of the respective amalgam-forming metal has a temperature of 95° C. during lamp operation, and that the weight ratio of indium to mercury in the amalgam is 6:1.

When observing the aforesaid conditions, most surprisingly a substantial broadening of the temperature curve of luminous flux is obtained. While previously with an indium component of 88 percent by weight in the amalgam the luminous flux dropped already about 10 percent from its maximum value, within a temperature range of approximately 45° C., with the lamp according to the invention within a temperature range of 70° the luminous flux does not drop below 90 percent of its maximum which is reached at 37° C. Within a temperature interval of 45° C. the luminous flux of the lamps according to the invention is even above 95 percent of the maximum value, whereas with the well known former lamps only a temperature interval of approximately 30° C. is covered. A broadening of the curve of luminous flux versus temperature by more than 50 percent offers obvious advantages both in respect of the utilization of the lamp in different ambient temperature ranges, and in respect of the utilization in lighting fittings as well. Since temperature occurring in commercially available lighting fittings such as, for example, open batten-type fittings, louvered fittings, trough-shaped, coffered, moistureproof fittings, are assuming values of between 30° and 75° C. with a constant room temperature, the lamp according to the invention is most prefectly suited for all lighting fittings applicable in interior lighting and is therefor a replacement for both the standard fluorescent lamp provided for open fittings, and for the various well-known former amalgam lamps adapted to the respective enclosed fittings. For in a lamp with cadmium-amalgam and a luminous flux maximum of 50° C., as well as in a standard fluorescent lamp with a luminous flux maximum of 18° C., the luminous flux decreases already within a temperature interval of 30° C. about 10 percent.

Since a low mercury content of the indium-amalgam in the lamps according to the invention has to be chosen in order to

obtain the favorable temperature-dependence characteristic, it is suitable to provide an additive amalgam in a similar manner as with cadium-amalgam lamps in order to reduce the runup period of the lamp. This runup amalgam preferably an indium alloy, is applied in a place which is quickly heated up after ignition of the lamp, for example, on the electrode cap. It proved however that the luminous flux of these lamps after rapid initial rise drops temporarily for a predetermined time because the still cold main indium-amalgam having a high affinity for mercury, absorbs the mercury and gives off defined amounts thereof only after a longer runup period. In further development of the invention there are now provided further runup amalgams within the lamp which are rated so, and the places of their location are chosen so that said amalgams are counterbalancing the temporary decrease of luminous flux. As place of location only a place of low heat capacity is suitable which is closer to the electrode than that of the main amalgam, for example, a place on the stem press, and the amalgam-forming metal is suitably a spray-deposited spot of indium. The stem press is heated up after energization of the lamp more slowly than the electrode cap, but more rapidly than the place of the main amalgam so that the second runup amalgam delivers mercury just during that period in which the first runup amalgam on the electrode cap has already completely given off its mercury, the main amalgam on the other hand is still too cold for the evaporation of a sufficient amount of mercury.

As is well known, difficulties arise when depositing larger quantities of indium-amalgam within the lamp. Due to the low-melting temperature of indium and its low adhesive strength, it proved preferable not to introduce the indium-mercury-alloy as the main amalgam into the lamp but the indium alone. The advantage is that during exhaust when no mercury is present in the lamp, there is no need of cooling any lamp parts, In an already proposed very suitable mode of application, the indium is sprayed in liquid state finely dispersed onto at least one electrode stem in such manner that the stem flare is covered by an annular film of specified thickness and specified annular diameter.

DESCRIPTION OF DRAWINGS

In the drawings:

FIG. 1 is a side view, partly sectioned, of a fluorescent lamp embodying the invention with portions cut away to shorten the figure.

FIG. 2 shows curves of relative luminous flux plotted against ambient temperatures for various fluorescent lamps. Below the temperature scale, ranges are marked which are covered by the commercially available lighting fittings or fixtures, resulting from the type of fitting and the number of lamps operated within the fitting.

FIG. 3 shows the runup characteristic, that is luminous flux versus time, of 65 W. fluorescent lamps in a commercially available fitting having an internal temperature of 50° C. in an ambient temperature of 25° C.

DESCRIPTION OF PREFERRED EMBODIMENT

In FIG. 1, electrode stems 3 are sealed to the end portions of lamp envelope 1 internally provided with a phosphor coating 2, said stems comprising stem flare 4, press 5 through which the lead-in wires 6 and 7 are passed, and exhaust tube 8. The electrode coil 9 pasted with oxide is attached to the inner ends of lead-in wires 6 and 7 and surrounded by annular metal cap or shield 10 of sheet iron. The cap 10 is carrying a first runup amalgam in the form of a strip 11 composed of an indium alloy, preferably with an indium-tin-lead ratio of 2:6:2. The total amount of amalgam-forming metals in the strip-shaped coating 11 is approximately 5 to 10 mg. On the stem flare 4 indium metal 12 is spray-deposited in a quantity of 60 mg. as the amalgam-forming metal for the main amalgam, the indium component of the amalgam amounting to 6:1. An indium spot 13 of from 5 to 10 mg. is spray-deposited on press 5 for the second runup amalgam.

In FIG. 2, curve *a* shows the luminous flux of a standard fluorescent lamp without amalgam (maximum luminous flux at 18° C.), curve *b* that of an indium-amalgam lamp according to the invention (maximum at 37° C.), and curve *c* that of a cadmium-amalgam lamp (maximum at 50° C.). Considering the operating temperatures indicated for the various lighting fittings, the advantage of the lamp according to the invention is unequivocally recognizable.

FIG. 3 shows in curve *e* the runup characteristic of a 65 W. fluorescent lamp with indium as the main amalgam and with two runup amalgams, by comparison with one runup amalgam in curve *f*, and without runup amalgam in curve *g*. Curve *h* shows by comparison a 65 W. fluorescent lamp without amalgam. The relative luminous flux is plotted versus minutes of time elapsed since the lamp has been started, up to 8 minutes. The curves show clearly that by means of the second runup amalgam in indium-amalgam lamps, the runup period is considerably reduced and the temporary decrease of luminous flux seen in curve *f* is almost fully compensated as seen in curve *e*.

The lamp according to the invention makes it possible to enlarge considerably the range of utilization of standard fluorescent lamps operated on a normal power input without need to effect structural modifications. In all temperature ranges occurring in interior lighting, the lamp according to the invention supplies a high luminous flux which drops in no case below 95 percent of the value obtained at optimum temperature. While optimum operation in respect of luminous flux of fluorescent lamps without amalgam can only be achieved in open fittings, and in respect of luminous flux of the former amalgam lamps rated for different temperature ranges can only be achieved in enclosed fittings, the operating ranges of all these lamps are united in the optimum range of operation of the indium-amalgam lamp so that the lamp according to the invention represents a universal lamp for interior lighting.

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

1. A low-pressure mercury vapor discharge lamp comprising an elongated vitreous envelope having electrodes sealed into its ends, said envelope containing indium-mercury amalgam as the main amalgam determining the condition of equilibrium of the operating vapor pressure, said main amalgam having a weight ratio of indium to mercury from 3:1 to 12:1, said main amalgam being located in places within the lamp having an operating temperature from 80° to 110° C., said lamp containing at least two additional amalgams accelerating the runup of the lamp and located in places which are hotter than the place of the main amalgam, said additional amalgams attaining their operating temperatures successively and earlier than the main amalgam after the lamp is turned on.

2. A lamp as in claim 1 wherein the weight ratio of indium to mercury is 6:1.

3. A lamp as in claim 1 wherein the main amalgam or amalgam-forming metal is located in places within the lamp which during lamp operation attains a temperature of about 95° C.

4. A lamp as in claim 1 wherein the additional amalgams or the amalgam-forming metals are located closer to the electrodes than the main amalgam determining the operating vapor pressure.

5. A lamp as in claim 4, wherein the additional amalgams or amalgam-forming metals are attached to parts of low heat capacity within the lamp.

6. A lamp as in claim 1 wherein the main amalgam is located around the stem flare and the additional amalgams are located on a cap surrounding the electrodes and on the press of the stem.

7. A lamp as in claim 6 wherein the power input is in the range of 0.3 to 0.6 watts per centimeter of discharge path length.

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