United States Patent [19]

Taxil et al.

[11] **3,848,150**

[45] **Nov. 12, 1974**

[54] **DISCHARGE LAMP WITH BAFFLE PLATES**

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[22] Filed: **Mar. 14, 1973**

[21] Appl. No.: **341,004**

[52] **U.S. Cl.** **313/204,** 313/492

[51] **Int. Cl.** **H01j 61/10**

[58] **Field of Search** 313/204, 109, 193, 195

[56] **References Cited**

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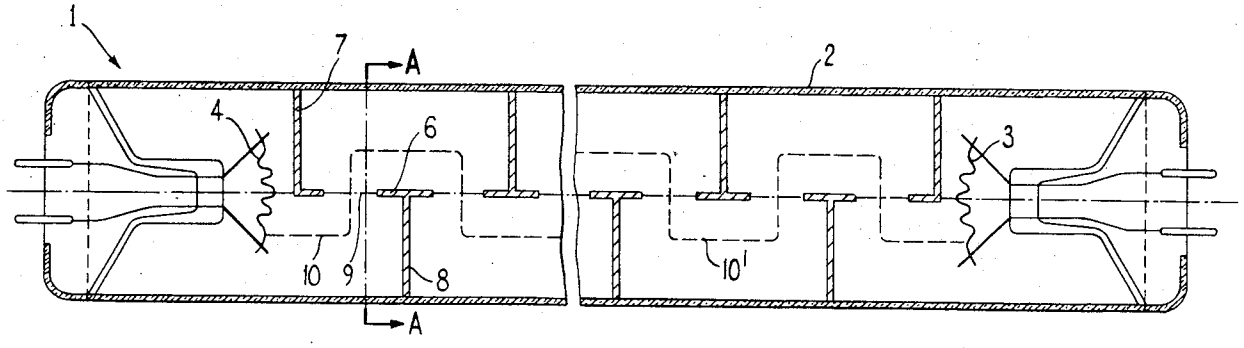
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[57] **ABSTRACT**

A low pressure metal vapor discharge lamp, such as of mercury vapor, is provided with internal interdigitated apertured baffle plates. This lengthens the discharge path and reduces temperature to provide increased efficiency and improved operation at higher intensities. The baffles may be of insulation or conductor materials and may be coated with a protective layer, fluorescent material or ultra-violet reflective layer.

8 Claims, 4 Drawing Figures



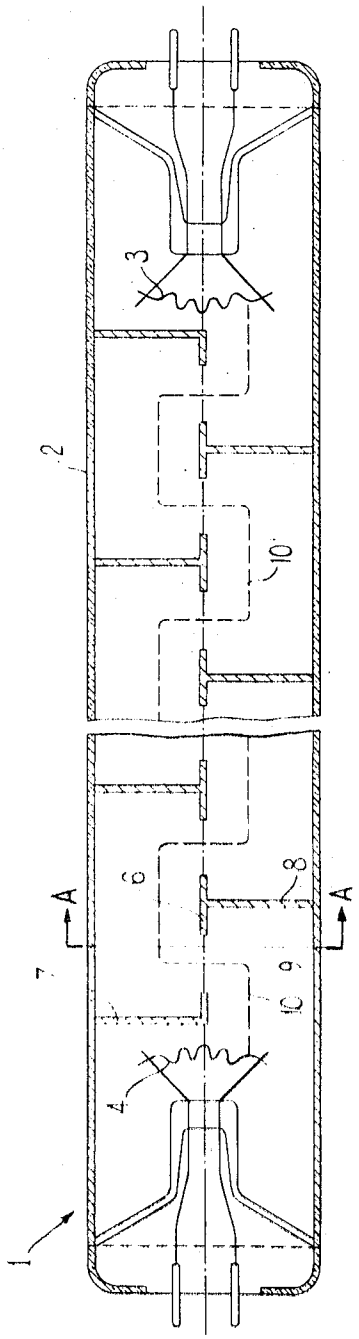


FIG. 1a

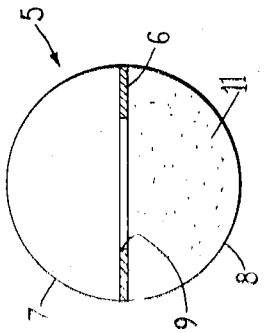


FIG. 1b

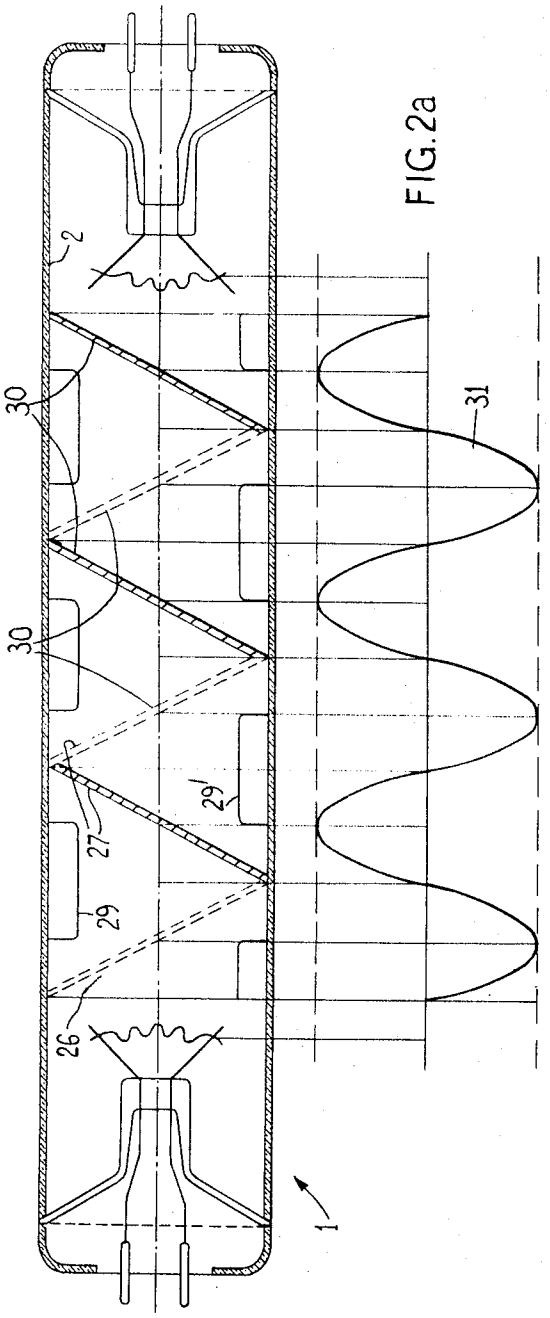


FIG.2a

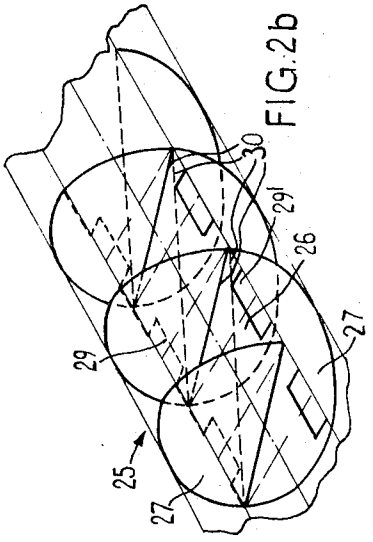


FIG.2b

DISCHARGE LAMP WITH BAFFLE PLATES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to electric illumination sources such as metal-vapor discharge lamps of low-pressure mercury-vapor and, in particular, those lamps which have a plurality of baffle plates between discharge electrodes for optimizing tube efficiency.

2. Description of the Prior Art

In the illumination field, low-pressure mercury-vapor discharge lamps are used as efficient high intensity sources capable of supporting high electric or thermal loads. For these lamps, light efficiency depends not only on the quantity of electrical energy received, but also on the efficiency of resonant radiation excited in the metal vapor. This last factor is preponderant as far as the source excitation is concerned. The most advantageous value for resonant radiation with mercury vapor corresponds to a rather low constant mercury vapor pressure, as is well known to those skilled in the art. This results in a number of drawbacks when energy received by the source is increased so as to increase illumination thereof. In particular, temperature increases as well as vapor pressure, and resonant radiation efficiency decreases. The increase in illumination is no longer proportional to the quantity of electrical energy supplied which limits the output for such lamps.

Various remedies have been attemped. Thermal dissipation has been increased by enlarging the envelope surface with the same length by providing sinuous-shaped glass lamps with baffles. Several types of baffled glass envelopes have produced improved efficiency. In particular, envelope shapes presenting a cross-section with reentrant or grooved portions are of advantage in increasing illumination efficiency, lamps utilizing mercury vapor having a resonant radiation of 2,537 A. to excite the luminescent material coating the internal mercury-vapor lamp glass-envelope wall. As a result, higher light emissions per unit length have been produced with a given illumination efficiency for larger electrical loads.

These results may be explained by considering an example of a lowpressure mercury-vapor discharge lamp having such a baffle structure which provides an electron velocity increase, a reduction of energy losses caused by elastic collisions, and an electron and mercury ion diffusion improvement resulting in an improved radiation emission rate at the wave length of 2,537 A. at the internal envelope walls. For a given length and electrical power per unit length, the lamp utilizes a relatively low current and a voltage which is higher than corresponding values for same circumference circular-cross-section lamps which results in a reduction of losses in the cathode and ballast. In addition, it is easier to hold the mercury vapor pressure at the optimum value to enhance emission efficiency at the particular radiation of 2,537 A. The angles joining the envelope wall on both sides of the baffle region reentrant portions are colder than the rest of the tube. Their temperature increases as the load increases, but not as rapidly as the rest of the cross-section. This is due to plasma or discharge constriction which directs the discharge away from the joining angles when current increases to reduce the local heating effect.

However, such arrangements do not permit satisfactory adjustment of the mercury vapor pressure which is naturally determined by the coldest point of the envelope. To overcome this and to produce illumination radiation of high stability, it has been suggested that shields be placed behind the cathodes to provide a cold point at each discharge end of the lamp. This solution has the drawback of requiring additional space in the lamp that does not provide illumination radiation and a symmetrical structure at each end which results in a substantial loss of useful length.

Special glass envelope designs have been used wherein a specific contour permits substantial cancellation of the discharge within a given region so as to provide a cold point for adjusting pressure in the useful portion. This has the advantage of not lengthening the lamp while improving the adjustment, but the amount of control is still not sufficient. Other complex shapes of glass envelopes with baffles or reentrant portions and folds in the reentrant portions for cancelling the discharge result in a more sophisticated and costly product. Accordingly, such solutions have not been utilized. For the purposes of controlling mercury vapor pressure in these lamps, another satisfactory solution has been found by inserting a movable amalgam in the glass envelope, particularly an indium amalgam such as described in French Pat. No. 1,583,078 in name of the present applicant.

SUMMARY OF THE INVENTION

It is therefore the primary object of the present invention to provide an improved discharge lamp which utilizes baffles inside the envelope between electrodes to lengthen the discharge path. The baffles cooperate with the internal envelope wall to provide greater illumination flux per unit length of the lamp. The glass envelope may have a conventional shape such as cylindrical.

According to another feature of this invention, the lengthened discharge path is accomplished by a plurality of serially-associated interdigitated baffles, which may be prefabricated independently from the envelope itself. This avoids the drawbacks of sophisticated as well as costly glass envelope shapes. The plurality of baffles are associated with the internal glass envelope wall and may be made of one or several insulator materials which include amorphous silicates of the glass family, such a fiberglass or crystallized silicates such as mica.

According to another feature of this invention, the material of the plurality of baffles enclosed inside the glass envelope may be of an electrical conductor material, such as aluminum, nickel, iron, etc. In some embodiments, the material of the baffles may have a protective coating and in one specific embodiment, the said coating is of a material reflecting ultra-violet radiations. In another case, the coating is fluorescent. In a further embodiment, the discharge tube includes an indium amalgam which may be mobile within the tube.

In addition, the invention includes a process for manufacturing such discharge lamps which comprises the following steps:

a. forming a plurality of baffles having an external pattern of identical shape but slightly smaller than the internal pattern of the envelope cross-section,

b. inserting and mounting the interdigitated baffles in the envelope,

c. evacuating and degassing the lamp, and

d. filling the lamp with a metal vapor and closing and sealing the lamp.

Other features of this invention will become apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1*a* is a schematic axial cross-sectional view of a mercury-vapor discharge lamp according to a first embodiment of this invention,

FIG. 1*b* is a transverse cross-sectional view of the baffle arrangement inside the lamp shown in FIG. la,

FIG. 2*a* is a schematic axial cross-sectional view of a second embodiment of a mercury-vapor discharge lamp wherein the baffle arrangement provides a sinusoidal path for the discharge through the tube, and

FIG. 2*b* is a schematic perspective view of the baffle arrangement shown in FIG. 2*a*.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the first embodiment illustrated in FIGS. 1*a* and 1*b*, the metal vapor discharge lamp **1** comprises a cylindrical glass envelope **2**, wherein discharge occurs between internal electrodes **3** and **4** at opposite ends. According to this invention, a set of interdigitated baffles **5** is positioned between electrodes **3** and **4**. FIG. 1*b* shows this arrangement in a cross-sectional view taken along line AA' of FIG. 1*a* normal to the tube axis. The assembly of baffles **5** includes an axially extending plate **6** having a full length slightly shorter than the distance between the end electrodes and a laterally extending width slightly shorter than or at most equal to the internal tube diameter. When the plate **6** is mounted inside the tube, it divides the interelectrode space into two regions, an upper region and a lower region, connected by apertures **9** in the plate **6**. Plate **6** is secured on a series of interdigitated half-circular-shaped baffle-plates **7, 8** extending from opposite sides of the envelope normal to plate **6**. The baffle plates have radius slightly shorter than internal radius of envelope **2**. Along a direction normal to the plane of plate **6**, an upper baffle-plate **7** is followed by a lower baffle-plate **8** which is in turn followed by another baffle-plate **7**, and so on. Each aperture **9** in plate **6** is positioned between each pair of successive adjacent baffle plates **7, 8**.

The entire assembly of baffles **5** is prefabricated in a simple manner completely independently of the discharge lamp envelope. For example, the assembly has been made of a suitable metal such as nickel or aluminum. Plate **6** is a sheet of small thickness and apertures such as **9** are easily produced by piercing, for example. Baffle-plates **7** and **8** are fastened to plate **6** either by direct welding or by any other suitable method. Since overall sizes are slightly smaller than the internal glass envelope, it is simple to position such a baffle assembly inside the envelope by threading and sliding it along the walls during the manufacturing step when only one tube end is closed. The lamp assembly is then completed, dried and evacuated, filled with gas and sealed at the end in the usual manner.

Operation is illustrated in FIG. 1a which shows a dashed line path **10–10'** for the discharge between electrodes **3** and **4**. Since the discharge is forced to follow the predetermined path due to the interdigitated baffles and apertures, the discharge path is lengthened geometrically for a particular direct distance between electrodes. Such an arrangement makes it possible to substantially increase power per unit of length without degrading the electrical characteristics of the lamp power supply as in previous designs.

The baffle arrangement may be embodied either in a metal sheet as in the above described example or in an insulating material such as fiberglass. In both cases, the material is so selected that it supports drying and vacuum degassing, which are basic for proper assembly of the lamp.

Various other materials which support drying and vacuum degassing have been tried in manufacturing these lamps and very good results have been obtained independent of the electric conduction quality of the material. This permits a much larger selection of materials than if use was limited to insulator materials. In addition, various coating material layers have been successfully applied. For example, the baffle plate **8** has been coated with an inactive protective-type layer **11** such as cadmium and anodized aluminum.

A baffle arrangement has also been made of a material coated with an active fluorescent-type layer by applying a fluorescent powder similar to that coating the internal glass wall. This resulted in substantial improvement in illumination efficiency since the excited fluorescent surface is substantially increased. Lastly, an active ultra-violet reflecting layer, such as titanium oxide, has also been tried. A substantial increase of the discharge lamp illumination efficiency was obtained since the absorbed radiation portion is reduced to a minimum.

In a further embodiment, a certain amount of indium was introduced in addition to the usual mercury dose. The same controlled mercury pressure was obtained as when the tube did not include the baffle assembly. The indium may be held on a resilient support as described in the above mentioned French Pat. No. 1,583,078. The position of the amalgam during lamp operation is a function of temperature. In this manner, cumulative advantages are obtained from both the use of amalgam for controlling pressure and the use of baffles for lengthening the discharge path.

In all the above mentioned examples, the power supply is provided in a conventional manner by a self-inductance, a leakage autotransformer, or a current limiting device. In all these cases the discharge is established in a satisfactory manner using the baffles. The electrical characteristics are very different from those provided by a lamp having the same length, but without baffles. Voltage per unit length (volt/cm) for the same current intensity, depends primarily on the geometric arrangement of the baffles. The greater the number of baffles, the higher the lamp performance, since the baffles further lengthen the discharge path.

In this respect, various other geometric baffle arrangements may be used to obtain longer and more complex meander paths. The improvement is directly proportional to the lengthening of the geometric path. FIGS. 2*a* and 2*b* illustrate a more sophisticated geometric baffle arrangement than those of FIGS. 1*a* and 1*b*. In such an arrangement, the assembly **25** includes oblique baffle-plates such as **27** associated with base plate **26** provided with apertures **29, 29'** symmetrically located with respect to the opposite outer sides of plate

26 within the boundaries 30 provided by upper and lower oppositely angled baffle plates.

Assembly 25 is positioned within the lamp as in the first embodiment by sliding it along the inner wall of envelope 2. The line 31 of FIG. 2*a* illustrates the pattern of the discharge path resulting from baffle assembly 25. The discharge path is substantially lengthened. The path 31 has a sinusoidal shape. Elementary geometric considerations show that the discharge path is approximately four times longer than the distance between electrodes. Electrical measurements also show that voltage gradients, in voltage per unit length (volt/cm), are multiplied by four. The actual improvement is proportional to the lengthening of the discharge path. These embodiments are not limited to the use of mercury vapor lamps, the same advantages being obtained with sodium, cadmium and other discharge lamps.

While the principles of the present invention have been described in relation to specific embodiments, it will be clearly understood that this description has been made only by way of example and does not limit the scope of this invention.

What is claimed is:

1. A metal-vapor discharge lamp comprising a longitudinal envelope having a metal-vapor therein, electrodes at opposite ends of said envelope, a longitudinal baffle plate dividing said envelope into upper and lower spaces connected through apertures in said plate, and a plurality of lateral baffle plates supported in said envelope between said electrodes forming a lengthened meandering discharge path through said vapor.

2. The metal vapor lamp of claim 1 wherein successive lateral baffle plates are secured alternately on opposite upper and lower sides of said longitudinal plate, respective apertures being positioned between pairs of adjacent alternate plates.

3. The metal-vapor lamp of claim 2 wherein said lateral baffle plates are at oblique angles with respect to the longitudinal axis of said lamp forming a sinusoidal discharge path.

4. The metal-vapor discharge lamp of claim 2, wherein said baffle plates are of an insulator material.

5. The metal-vapor discharge lamp of claim 2, wherein said baffle plates are of an electrical conductor material.

6. The metal-vapor discharge lamp of claim 2, wherein said baffle plates include a protective coating layer.

7. The metal-vapor discharge lamp of claim 2, wherein said baffle plates include an ultra-violet reflecting layer.

8. The metal-vapor discharge lamp of claim 2 wherein said baffle plates include a fluorescent layer.

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