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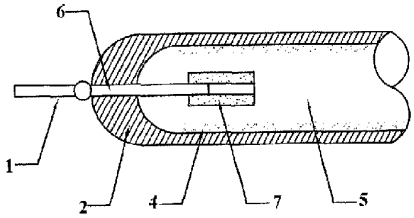
(54) Title: A MERCURY GAS DISCHARGE DEVICE



(57) Abstract: A mercury gas discharge device comprises an envelope with inert gas and mercury vapour contained within it. The mercury gas discharge device further comprises a pair of electrodes. One or more sintered metal portions are also located inside the envelope. The sintered metal portions have high gettering characteristics with respect to waste gases, but low gettering characteristics with respect to the mercury vapour.

A MERCURY GAS DISCHARGE DEVICE

Field of the Invention

This invention relates to mercury gas discharge devices, in particular mercury vapour fluorescent lamps including hot cathode and cold cathode fluorescent lamps (CCFLs).

Background to the Invention

Nowadays, cold cathode fluorescent lamps (CCFLs) are often used as miniature high luminous intensity light sources. They feature simple construction, are miniature in size, have high luminous intensity, exhibit small increases in lamp temperature during operation, and have a relatively long operating life. Because of these characteristics, CCFLs have been widely used as a light source in various backlit light units and scanners.

In recent years, rapid developments in information technology, communication equipment and office and consumer products have necessitated development of CCFLs with better performance, increased functionality and smaller size. Meanwhile, LCD backlit sources have been developed with the aim of increasing the area of coverage, reducing power consumption and extending operational lifetime. Currently, CCFLs are mass produced and have great difficulty meeting these ever increasing demands.

An example of a current CCFL is shown in Figure 1. Figure 1 shows a glass envelope 2 with a fluorescent powder film 4 coated onto its interior wall. Gas 5 such as a neon and argon mixture with a source of mercury vapour are confined in glass envelope 2. Electrodes 1 are disposed at opposing ends of glass envelope 2.

Electrodes 1 are a key component of the CCFL. They are responsible for conducting electricity, emitting electrons, forming a magnetic field, and for other lamp and heating functions. To a large extent, lamp performance depends upon the choice of the electrode material.

Electrodes commonly used in CCFLs include an electrode wire 6 formed of tungsten, dumet or kovar and a cathode in the form of a nickel tube or nickel bucket 3 welded onto the part of electrode wire 6 which is inside glass envelope

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2. Conventional nickel tubes or nickel buckets are made using high-ratio compression.

In conventional CCFL construction, the operating surface area of the nickel tube or nickel bucket 3 is limited by the inner diameter of glass envelope 2 and the length of the electrode. Accordingly, any increase in the lamp's luminous intensity during operation is limited by the surface area of the nickel tube or nickel bucket and the melting point of nickel which is approximately 1453°C. As a result of these limitations, current CCFL's are not able to withstand a large lamp electric current and the impact of a strong electron stream. The limited surface area of the nickel tube or nickel bucket also limits the amount of active alkaline metals such as barium, calcium, strontium and cesium that can be added. These metals can be added to the cathode to enhance electron emission efficiency.

During long term operation, the glass and fluorescent powder used in fluorescent lamps or current CCFLs continually discharge and deposit waste materials inside the glass tube. Waste gases, such as water, oxygen, nitrogen, carbon monoxide and carbon dioxide, develop and proliferate from the materials used. These waste gases enter into the interior of the lamp. They result in an increase in resistance to electrical conductivity within the lamp, and cause damage to the cathode by reacting with the active alkaline metals that can be added to the cathode. This reduces the functioning of the lamp and is known to present difficulties when attempting to produce high quality, small sized, high luminous intensity and high performance fluorescent lamps and CCFLs.

The aforementioned problems do not only exist in CCFLs, but are also found in any other mercury gas discharge device, including but not limited to mercury vapour sunlamp and germ-killing ultraviolet light tube utilizing mercury vapour.

A reference herein to a patent document or other matter which is given as prior art is not to be taken as an admission that that document or matter was, in Australia, known or that the information it contains was part of the common general knowledge as at the priority date of any of the claims.

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Summary of the Invention

According to an aspect of the present invention, there is provided a mercury gas discharge device including:

(a) an envelope;

(b) inert gas and mercury vapour confined within the envelope;

(c) a pair of electrodes; and

(d) one or more sintered metal portions located inside the envelope;

wherein the one or more sintered metal portions consist of or include iron, nickel and/or cobalt having high gettering characteristics with respect to waste gases, but low gettering characteristics with respect to the mercury vapour.

According to another aspect of the present invention, there is provided a fluorescent lamp including:

(a) a tube with an interior wall and an exterior wall and a fluorescent powder film coating on the interior wall;

(b) inert gas and mercury vapour confined within the tube;

(c) a pair of electrodes; and

(d) one or more sintered metal portions located inside the tube;

wherein the one or more sintered metal portions consist of or include iron, nickel and/or cobalt having high gettering characteristics with respect to waste gases, but low gettering characteristics with respect to the mercury vapour.

The present invention provides a mercury gas discharge device such as a cold cathode fluorescent lamp (CCFL) with a construction that overcomes or at least ameliorates the problems of prior art mercury gas discharge devices. The invention provides a mercury gas discharge device such as a CCFL that operates under a larger operating electric current without affecting the device's operational lifetime. The present invention provides a mercury gas discharge device such as a CCFL that provides greater intensity and longer operational lifetime when compared with current mercury gas discharge devices. These and further objects and advantages of the present invention will be discussed in more detail throughout the description of the invention.

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Brief Description of the drawings

Figure 1 is a schematic diagram illustrating the construction of known CCFLs.

Figure 2 is a schematic diagram illustrating a CCFL constructed in accordance with an embodiment of the present invention.

Figure 3 is a graph showing the typical life span of a CCFL constructed in accordance with an embodiment of the present invention.

Figure 4 is a schematic diagram illustrating a CCFL constructed in accordance with another embodiment of the present invention.

Figure 5 is a schematic diagram illustrating a CCFL constructed in accordance with a further embodiment of the present invention.

Figure 6 is a schematic diagram illustrating an external electrode fluorescent lamp according to another embodiment of the invention.

Detailed Description of Preferred Embodiments

Referring firstly to Figure 2, there is provided a fluorescent lamp 10 comprising a tube 2 with an interior wall and an exterior wall and a fluorescent

powder film coating 4 on the interior wall. Inert gas and mercury vapour 5 are confined within the tube and the lamp includes a pair of electrodes 1. One or more sintered metal portions 11 are also located in tube 2. Sintered metal portions 11 have high gettering characteristics with respect to waste gases such as water, oxygen, nitrogen, carbon monoxide and carbon dioxide, but low gettering characteristics with respect to the mercury vapour.

One or more sintered metal portions 11 may be placed anywhere within tube 2. It is preferred that sintered metal portions 11 are welded in the tube, preferably welded to one or more of electrodes 1, although welding to electrodes is not essential. In an embodiment where one or more sintered metal portions 11 are welded to an electrode, they may be welded to any part of the electrode which is inside tube 2.

There may be any number of sintered metal portions 11 within tube 2. The number of sintered metal portions 11 included is preferably determined by the size of tube 2. When tube 2 is small, only one sintered metal portion 11 may be required to achieve the advantages of the invention.

Now referring to Figures 4 and 5, schematic diagrams are shown which illustrate two particular embodiments of the invention. In these embodiments, tube 2 may be any appropriate type of tube and is preferably a glass tube. It is preferred that the sintered metal portion is a sintered metal tube (or bucket) 7 or plate 8 (which can be in a pair as shown in Figure 5) which is welded on to the part of each electrode wire 6 which extends inside the tube. The sintered metal tube (or bucket) 7 or plate 8 may be manufactured using typical metal powder metallurgy techniques or ultrasonic moulding press or any other appropriate methodology.

During the sintering process, very small particles of the chemical element are strongly bonded together under high temperature without melting the elements. Bonding without melting results in a large number of internal pores within the sintered article. These pores increase the physical gettering characteristics of the metal portion by enhancing its porosity, and, when the sintered portion is used as a cathode, increase the surface area for electron emission and for adding active alkaline metals (such as barium, calcium, strontium and cesium) for enhancing electron emission efficiency.

The sintered metal tube 7 or plate 8 (which may also be provided in the form of a bucket, not shown) includes at least one metal element which is selected from a first group of metal elements which have high gettering characteristics with respect to waste gases and low gettering characteristics with respect to the mercury vapour within tube 2. Such metal elements have very low gettering characteristics with respect to mercury vapour. Accordingly the first group of metal elements includes but is not limited to ferrous family metals such as iron, nickel and cobalt. These metal elements react chemically with waste gases such as water, oxygen, nitrogen, carbon monoxide and carbon dioxide under operating temperatures of the lamp 10 but not with the mercury vapour. Therefore, the gettering characteristics of the sintered metal tube 7 or plate 8 is enhanced by the inclusion of one or more of the metal elements included in the first group.

When the lamp 10 operates, high temperatures are generated inside tube 2, particularly in the vicinity of electrode wires 6 (and sintered metal tube 7 or plate 8 when used as a cathode or when welded to an electrode). As these high temperatures develop, it is possible for sintered metal tube 7 or plate 8 to break or sputter. Accordingly, it is preferred that sintered metal tube 7 or plate 8 is a combination of metal elements which also includes one or more metals from a second group that exhibit high temperature resistance in combination with low or very low gettering characteristics with respect to the mercury vapour, thereby reducing the possibility of sputtering. Metals such as molybdenum, tungsten, tantalum and niobium are appropriate for inclusion in the second group of metals.

Figure 6 illustrates a further arrangement in which the electrodes 12 are entirely outside of tube 2. This type of arrangement is known as an external electrode fluorescent lamp (EEFL). In this particular arrangement, each end of tube 2 is capped with an electrode 12, each of which has an electrical connector 13. As is the case with each of the other embodiments, tube 2 has a powder film coating 4 on the interior wall, and inert gas and mercury vapour 5 are confined within the tube 2. One or more sintered metal portions may be located anywhere within the tube. In the particular arrangement illustrated, a sintered metal portion in the form of sintered tube 7 is located at one end of the EEFL tube 2, held in place by a neck portion of EEFL tube 2.

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In a preferred embodiment, sintered metal tube 7 or plate 8 is a metallic combination comprising between 2 and 5 metal elements with at least one of the metal elements being selected from the first group (high gettering characteristics with respect to waste gases but not mercury vapour) and at least one of the metal elements being selected from the second group (resistant to high temperatures with low or very low gettering characteristics with respect to mercury vapour). It is preferred that the sintered metallic combination is porous with a porosity of 50% to 4% and a relative density of 50% to 96%.

In another embodiment, where the sintered metal portion is used as a cathode, the metal portion further includes one or more active alkaline metals for enhancing the efficiency with which electrons are emitted from the cathode. The active alkaline metals may include but are not limited to barium, calcium, strontium, and cesium.

Referring to Figure 3, a graph shows brightness or luminous intensity versus life span for a CCFL constructed with a sintered porous metal tube or plate according to the present invention. In the primary stage of operation (i.e. during approximately the first 200 hours of operation), the graph of Figure 3 shows a distinct drop in luminous intensity of around 3 to 5%. This is due to the proliferation of waste gases derived from the glass, fluorescent powder and the electrodes. The proliferation of these waste gases results in contamination and sputtering inside the lamp. Meanwhile, during operation the sintered porous metal tube or plate continues to attempt to increase absorption of the waste gases.

After around 400 hours of operation, the proliferation of waste gases stabilizes and the sintered metal tube or plate begins to function as a gettering device, absorbing large quantities of the waste gases. As the waste gas content in the glass tube decreases, the luminous intensity of the lamp increases, and the CCFL regains its former luminosity as evidenced by the rapid increase in luminous intensity in Figure 3. This advantage can not be achieved by conventional mercury vapour fluorescent lamps.

During aging, luminosity drops due to the generation of the waste gases. Mercury vapour is also slowly and gradually absorbed by the fluorescent powder contributing further to the drop in luminosity, but such drop is of a lesser extent because the chemical affinity between fluorescent powder and mercury

vapour is weak. Figure 3 shows a gradual linear decline in luminosity or brightness which corresponds to this aging process. However, the decrease in luminous intensity is slower and steadier than that of conventional CCFLs. Since the decrease occurs over a longer time, the aging period of the lamp of the present invention is much longer than that of conventional lamps. After approximately 15000 hours of operation, the fall in luminous intensity of a fluorescent lamp constructed according to the present invention is around 10% less than the fall in brightness which occurs in conventional fluorescent lamps after the same lifetime. This is achieved in part by the continuous gettering function provided by the sintered metal portion which maintains a very low level of waste gases in the glass tube during lamp operation.

This is complemented by the fact that the sintered metal selected does not react with or absorb mercury vapour during operation. As a result, the content of the mercury vapour within the tube is maintained at a higher level for longer, thereby reducing the rate at which the lamp's luminous intensity decreases when compared with conventional lamps.

According to the luminous intensity vs lifespan graph of Figure 3, it is anticipated that the fluorescent lamp of the present invention is capable of withstanding twice the operational electric current of conventional fluorescent lamps. For example, the operational electric current of a conventional CCFL with an outer diameter of 2.6mm is 5mA. However, a CCFL constructed in accordance with the present invention with the same outer diameter and with a sintered porous metallic combination tube can withstand an operational electric current of up to 10mA, achieving an increased luminous intensity of 8,000 to 10,000cd/m^2 whilst maintaining comparable lamp life (approximately 15,000 to 20,000 hours). Further, if the CCFL of the present invention and the conventional CCFL operate using the same current, the operational life of the inventive CCFL may exceed 50,000 hours. This is an improvement of 100 to 150% when compared with conventional CCFLs.

Figure 4 shows a schematic illustration of a CCFL constructed according to an embodiment of the present invention. It comprises glass envelope 2, fluorescent powder film 4 coated onto the interior wall of glass envelope 2 and inert gas and mercury vapour 5 confined inside glass envelope 2. Electrodes 1 are located at the ends of the lamp (only one shown). Electrodes 1 include

electrode wire 6 sealed at the end of envelope 2 and extending from the interior to the exterior of envelope 2. In contrast to the CCFL of Figure 1, the inventive CCFL has a sintered metal tube 7 composed of a combination of 2 to 5 metal elements welded onto electrode wires 6 and used as a cathode, although sintered metal tube 7 may be welded anywhere in glass envelope 2. This replaces the conventional nickel tube 3 illustrated in Figure 1.

The inventive sintered metal tube 7 is produced by metallic powder processes using typical powder metallurgy and is, therefore, a porous product. As a result, its surface area is 2 to 20 times greater than that of the high density compacted nickel tube of conventional lamps. The sintered metal tube 7 can therefore absorb or accommodate more of active alkaline metals such as barium, calcium, strontium and cesium etc. which act as activating elements for electron emission, thereby reducing the resistance to electron emission at cathode.

The inventive sintered metal portion composition is preferably chosen from the following group of compositions:

1.	tungsten or molybdenum or tantalum or niobium OR tungsten + molybdenum OR tungsten + niobium OR tungsten + tantalum OR molybdenum + niobium OR molybdenum + tantalum OR tantalum + niobium OR tungsten + molybdenum + tantalum + niobium OR tungsten + molybdenum + tantalum OR tungsten + molybdenum + niobium OR tungsten + tantalum + niobium OR molybdenum + tantalum + niobium	70% to 90%	TO	10% to 30%	iron or nickel or cobalt OR iron + nickel + cobalt OR iron +nickel OR iron + cobalt OR nickel + cobalt
2.	tungsten or molybdenum or tantalum or niobium OR tungsten + molybdenum OR	40% to 70%	TO	30% to 60%	iron or nickel or cobalt OR iron + nickel OR iron + cobalt OR nickel + cobalt OR iron + nickel +cobalt

tungsten + niobium

OR

tungsten + tantalum

OR

molybdenum + niobium

OR

molybdenum + tantalum

OR

tantalum + niobium

OR

tungsten + molybdenum + tantalum + niobium

OR

tungsten + molybdenum + tantalum

OR

tungsten + molybdenum + niobium

OR

tungsten + tantalum + niobium

OR

molybdenum + tantalum + niobium

3. tungsten or molybdenum or tantalum or niobium OR tungsten + molybdenum (10% to 40%) TO (60% to 90%) iron or nickel or cobalt OR iron + nickel OR iron + cobalt OR nickel + cobalt OR iron + nickel +cobalt

OR

tungsten + niobium

OR

tungsten + tantalum

OR

molybdenum + niobium

OR
molybdenum + tantalum
OR
tantalum + niobium
OR
tungsten + molybdenum + tantalum + niobium
OR
tungsten + molybdenum + tantalum
OR
tungsten + molybdenum + niobium
OR
tungsten + tantalum + niobium
OR
molybdenum + tantalum + niobium

It is not necessary for the inventive sintered metal portion to be composed only of elements in the aforementioned first and second groups of metal elements. However, it is preferred that the proportion of metal elements selected from the first group in combination with the proportion of metal elements selected from the second group comprises between 50% and 100% of the total sintered metal composition.

CASE STUDY 1

A linear CCFL is produced with an outer diameter of 2.6mm, an inner diameter of 2.0mm, a lamp length of 243mm and uses a sintered porous metal tube composed of tungsten, molybdenum, iron and cobalt and welded onto a tungsten electrode. The composition is:

tungsten + molybdenum: 10 to 40%

iron + cobalt: 90 to 60%

The electrode tube is sealed in a borosilicate (hard glass) tube, the interior wall of which is coated with fluorescent powder film with a color

temperature of 5800°K. The borosilicate tube is filled with an appropriate neon/argon gas combination and a mercury vapour source, and is ignited with circuitry known in the art. In operation at 7.5mA and 15mA, the CCFL of Case Study 1 has performance characteristics as shown in Table 1 below.

Operating Current	7.5mA	15mA	Performance Change
Luminous Intensity	44000cd/m^2	55000 cd/m^2	+25%
Luminous Flux	176 lumen	212 lumen	+20.5%
After intensive aging test, equivalent to 4,000 hours of normal operation:			
Luminous Intensity	42030 cd/m^2	52030 cd/m^2	+23.8%
Luminous Flux	151 lumen	189 lumen	+25%
Decrease in Luminous Intensity	4.5%	5.4%	
	Conventional average drop is 8.5-10%		

Table 1

Extrapolating the data obtained from Case Study 1, it is estimated that a CCFL constructed using the described porous sintered metal combination will achieve a lamp life of 25,000 to 30,000 hours of continuous operation at 7.5mA, and a lamp life of 10,000 to 15,000 hours of continuous operation at 15mA. This performance exceeds the capabilities of conventional CCFLs.

CASE STUDY 2

A linear cold cathode fluorescent lamp (CCFL) is produced with an outer diameter of 1.8mm, an inner diameter of 1.2mm and lamp length of 72.5mm as illustrated in Figure 5. The feature distinguishing the CCFL of Figure 5 from that of Figure 4 is the use of porous sintered metal plate 8 in place of tube 7. The sintered porous metal plate is composed of tungsten, molybdenum, iron, nickel and cobalt and is welded onto a tungsten electrode. The composition is:

tungsten + molybdenum: 10 to 40%

iron + nickel + cobalt: 90 to 60%

The electrode plate is sealed in a borosilicate (hard glass) tube, the interior wall of which is coated with fluorescent powder film with a color temperature of 6500°K. The borosilicate tube is filled with an appropriate

neon/argon gas combination and a mercury vapour source, and is ignited with circuitry, as known in the art. In operation at 2mA and 3mA, the CCFL of Case Study 2 has performance characteristics as shown in Table 2 below.

Operating Current	2mA	3mA	Performance Change
Luminous Intensity	28930 cd/m^2	40070 cd/m^2	+38.5%

After intensive aging test, equivalent to 6,250 hours of normal operation:

Luminous Intensity	26520 cd/m^2	34150 cd/m^2	+28.7%
Decrease in Luminous Intensity	8.3%	14.8%	-

Table 2

It is to be noted that conventional lamps are not capable of operating for extended periods at an operational current of 2mA.

CASE STUDY 3

A linear cold cathode fluorescent lamp (CCFL) is produced with an outer diameter of 2.6mm, an inner diameter of 2.0mm and a lamp length of 243mm. It uses a sintered porous metal tube composed of tungsten, molybdenum, iron and cobalt and welded onto a tungsten electrode. The composition is:

tungsten + molybdenum: 70 to 90%

iron + cobalt: 30 to 10%

The electrode tube is sealed in a borosilicate (hard glass) tube, the interior wall of which is coated with fluorescent powder film with a color temperature of 5800°K. The borosilicate tube is filled with an appropriate neon/argon gas combination and a mercury vapour source, and is ignited with circuitry, as known in the art. In operation at 7.5mA, the CCFL of Case Study 3 has performance characteristics as shown in Table 3 below.

Operating Current	7.5mA
Luminous Intensity	44000 cd/m^2

After intensive aging test, equivalent to 15,000 hours of normal operation:

Luminous Intensity	39020 cd/m^2
Decrease in Luminous Intensity	11.3% (conventional average drop: 29%)

Table 3

Extrapolating the data obtained from Case Study 3, it is estimated that a CCFL constructed using the described porous sintered metal tube will achieve a life of approximately 40,000 hours of continuous operation.

CASE STUDY 4

A linear CCFL is produced with an outer diameter of 4.0mm, an inner diameter of 2.9mm, a lamp length of 264mm and uses a sintered porous metal tube composed of niobium, molybdenum, iron, nickel and cobalt and welded onto a tungsten electrode. The composition is:

niobium + molybdenum: 30%

iron + nickel + cobalt: 70%

The electrode tube is sealed in a borosilicate (hard glass) tube, the interior wall of which is coated with fluorescent powder film with a color temperature of 5200°K. The borosilicate tube is filled with an appropriate neon/argon gas combination and a mercury vapour source, and is ignited with circuitry known in the art. In operation at 8.2mA and 6.4mA, the CCFL of Case Study 4 has performance characteristics as shown in Table 4 below.

Operating Current	8.2mA	16.4mA	Performance Change
Luminous Intensity	26900cd/m^2	42800 cd/m^2	+59%
Luminous Flux	176 lumen	248 lumen	+40.9%

After intensive aging test, equivalent to 15,000 hours of normal operation:

Luminous Intensity	23700 cd/m^2	36670 cd/m^2	+49.0%
Luminous Flux	156 lumen	218 lumen	+39.7%
Decrease in Luminous Intensity	11.9%	14.3%	
Decrease in Luminous Flux	11.4%	12.1%	

Table 4

Extrapolating the data obtained from Case Study 4, it is estimated that a CCFL constructed using the described porous sintered metal combination will achieve a lamp life of 50,000 or more hours of continuous operation at 8.2mA, and a lamp life of 10,000 to 15,000 hours of continuous operation at 16.4mA. This performance exceeds the capabilities of conventional CCFLs.

CASE STUDY 5

A linear CCFL is produced with an outer diameter of 1.8mm, an inner diameter of 1.4mm, a lamp length of 38.5mm and uses a sintered porous metal tube composed of tungsten, tantalum, iron and cobalt and welded onto a tungsten electrode. The composition is:

tungsten + tantalum: 80%

iron + cobalt: 20%

The electrode tube is sealed in a borosilicate (hard glass) tube, the interior wall of which is coated with fluorescent powder film with a color temperature of 12000°K. The borosilicate tube is filled with an appropriate neon/argon gas combination and a mercury vapour source, and is ignited with circuitry known in the art. In operation at 3mA and 6mA, the CCFL of Case Study 5 has performance characteristics as shown in Table 5 below.

Operating Current	3mA	6mA	Performance Change
Luminous Intensity	30600cd/m^2	45000 cd/m^2	+47.1%
Luminous Flux	10 lumen	13.5 lumen	+35%

After intensive aging test, equivalent to 4,000 hours of normal operation:

Luminous Intensity	27600 cd/m^2	37710 cd/m^2	
Luminous Flux	8.5 lumen	11 lumen	
Decrease in Luminous Intensity	9.6%	16.2%	
Decrease in Luminous Flux	15%	18.5%	

Table 5

Extrapolating the data obtained from Case Study 5, it is estimated that a CCFL constructed using the described porous sintered metal combination will achieve a lamp life of about 50,000 hours of continuous operation at 3mA.

The mercury gas discharge device (such as a CCFL) constructed according to the present invention uses sintered metal portions (such as tubes, buckets or plates) to improve gettering with respect to waste gases within the device envelope, thus increasing intensity, extending lifetime of the device and significantly improving performance. In one embodiment, the inventive sintered metal portion is porous. Therefore, it has an increased operational surface area when compared with the getters of conventional mercury gas discharge devices or CCFLs. Accordingly, the device is able to withstand higher operating currents whilst maintaining steady operating conditions and intensity; when the operating current increases, so too does the intensity or luminous intensity. In particular, a CCFL with a porous sintered portion, when used as the cathode and constructed according to an embodiment of the present invention, exhibits a significantly higher luminous intensity index than conventional fluorescent lamps.

It is to be noted that a mercury gas discharge device (such as a CCFL) constructed according to an embodiment of the present invention would also exhibit an increase in temperature during operation. The increase in temperature will release any mercury vapour which has become physically trapped within the sintered metal portion, but will not release waste gases as they will be chemically bound to the "gettering" metal.

A sintered metal portion according to an embodiment of the present invention forms compounds with waste gases in the device envelope and absorbs them. These sintered metal portions become more active when protected in a vacuum or inert gas environment. Accordingly, they exhibit a stronger binding force to waste gases such as oxygen, nitrogen, carbon monoxide and carbon dioxide as well as water, thereby providing significantly improved gettering characteristics as well as serving as "conventional" cathode when welded to the end of an electrode inside the device envelope.

The inventive sintered metal portion is ideal for use in multi-functional, high efficiency and long life CCFLs. A CCFL according to the present invention exhibits a life span which is among the longest of all CCFLs.

Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by the specific disclosure herein, but only by the appended claims.

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The claims defining the invention are as follows:

1. A mercury gas discharge device including:

(a) an envelope;

(b) inert gas and mercury vapour confined within the envelope;

(c) a pair of electrodes; and

(d) one or more sintered metal portions located inside the envelope;

wherein the one or more sintered metal portions consist of or include iron, nickel and/or cobalt having high gettering characteristics with respect to waste gases, but low gettering characteristics with respect to the mercury vapour.

2. A mercury gas discharge device according to claim 1 wherein the one or more sintered metal portions include a combination of:

(a) one or more metal elements selected from a first group having high gettering characteristics with respect to waste gasses but low gettering characteristics with respect to the mercury vapour, such as iron, nickel and/or cobalt; and

(b) one or more metal elements selected from a second group being resistant to high temperatures within the mercury gas discharge device and having low gettering characteristics with respect to the mercury vapour, such as molybdenum and/or tungsten and/or tantalum and/or niobium.

3. A mercury gas discharge device according to claim 2 wherein the proportion of metal elements selected from the first group in combination with the proportion of metal elements selected from the second group includes between 50% and 100% of the total sintered metal composition.

4. A mercury gas discharge device according to any one of claims 1 to 3 wherein at least one of the sintered metal portions is used as a cathode.

5. A mercury gas discharge device according to any one of claims 1 to 4 wherein one or more of the sintered metal portions is a porous sintered metal.

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6. A mercury gas discharge device according to claim 5 wherein the porous sintered metal has a porosity of 50% to 4% and of relative density of 50% to 96%.

7. A mercury gas discharge device according to any one of claims 4 to 6 wherein one or more of the sintered metal portions further includes one or more active alkaline metals, enhancing the efficiency with which electrons are emitted from the cathode, the active alkaline metals including but not limited to one or more of the following:

(a) barium;

(b) calcium;

(c) strontium; and

(d) cesium.

8. A fluorescent lamp including:

(a) a tube with an interior wall and an exterior wall and a fluorescent powder film coating on the interior wall;

(b) inert gas and mercury vapour confined within the tube;

(c) a pair of electrodes; and

(d) one or more sintered metal portions located inside the tube;

wherein the one or more sintered metal portions consist of or include iron, nickel and/or cobalt having high gettering characteristics with respect to waste gases, but low gettering characteristics with respect to the mercury vapour.

9. A fluorescent lamp according to claim 8 wherein the one or more sintered metal portions include a combination of:

(a) one or more metal elements selected from a first group having high gettering characteristics with respect to waste gasses but low gettering characteristics with respect to the mercury vapour, such as iron, nickel and/or cobalt; and

(b) one or more metal elements selected from a second group being resistant to high temperatures within the fluorescent tube and having low

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gettering characteristics with respect to the mercury vapour, such as molybdenum and/or tungsten and/or tantalum and/or niobium.

10. A fluorescent lamp according to claim 9 wherein the proportion of metal elements selected from the first group in combination with the proportion of metal elements selected from the second group includes between 50% and 100% of the total sintered metal composition.

11. A fluorescent lamp according to any one of claims 8 to 10 wherein at least one of the sintered metal portions is used as a cathode.

12. A fluorescent lamp according to any one of claims 8 to 11 wherein one or more of the sintered metal portions is a porous sintered metal.

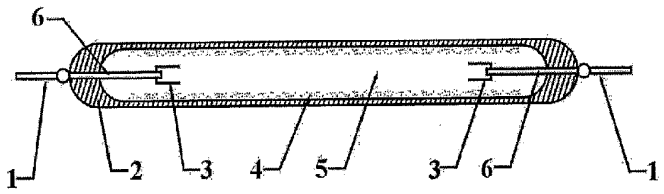
13. A fluorescent lamp according to claim 12 wherein the porous sintered metal has a porosity of 50% to 4% and a relative density of 50% to 96%.

14. A fluorescent lamp according to any one of claims 11 to 13 wherein one or more of the sintered metal portions further includes one or more active alkaline metals, enhancing the efficiency with which electrons are emitted from the cathode, the active alkaline metals including but not limited to one or more of the following:

(a) barium;
(b) calcium;
(c) strontium; and
(d) cesium.

15. A mercury discharge device substantially as hereinbefore described with reference to any one of the embodiments shown in Figures 4 to 6.

16. A fluorescent lamp substantially as hereinbefore described with reference to any one of the embodiments shown in Figures 4 to 6.


6
1
2
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3
6
1

FIG. 1

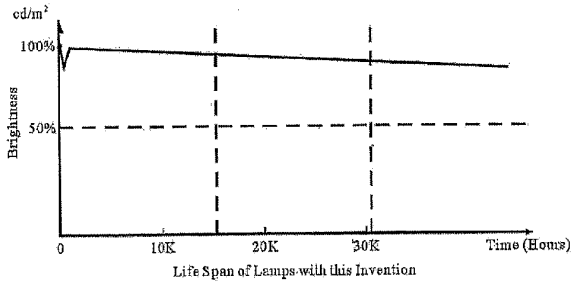
cd/m²
100%
50%
Brightness
0
10K
20K
30K
Time (Hours)
Life Span of Lamps with this Invention

FIG. 3

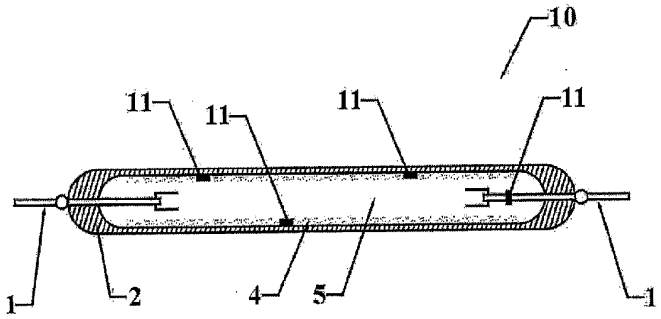

FIG. 2

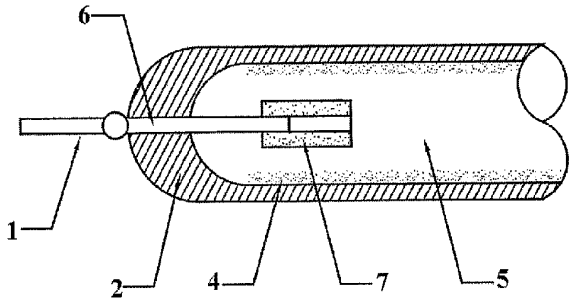

FIG. 4

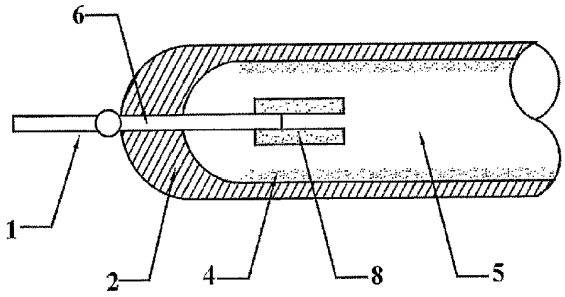

FIG. 5

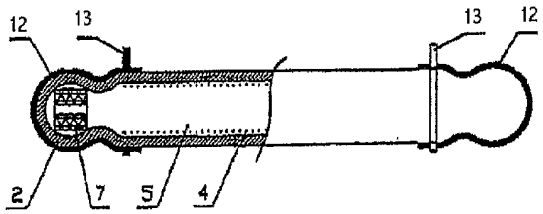

FIG. 6