

[54] TUNGSTEN-BROMINE CYCLE
INCANDESCENT LAMP CONTAINING
BORON

[75] Inventors: **Germain Remi T'Jampens; Gerrit
Prakken**, both of Emmasingel,
Eindhoven, Netherlands

[73] Assignee: **U.S. Philips Corporation**, New
York, N.Y.

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[56]

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Primary Examiner—James W. Lawrence

Assistant Examiner—Wm. H. Punter

Attorney, Agent, or Firm—Frank R. Trifari

[57]

ABSTRACT

A tungsten bromine cycle lamp comprising boron in a solid state or as a gaseous or volatile compound. The boron serves to keep the lamp wall clear for the lifetime of the bulb.

4 Claims, No Drawings

TUNGSTEN-BROMINE CYCLE INCANDESCENT LAMP CONTAINING BORON

The invention relates to an electric incandescent lamp having an incandescent body of tungsten and a gas filling comprising bromine and hydrogen introduced into the lamp in a ratio between hydrogen and bromine of 1 or more, the lamp being proportioned in such a manner that the wall of the envelope during operation of the lamp everywhere assumes a temperature at which tungsten-bromine compounds formed in the lamp are volatile: which lamp will hereinafter be referred to as "tungsten-bromine cycle lamp."

Lamps of this type are known and are especially used under those circumstances where for relatively small dimensions a high light output is required throughout the lifetime of the lamp. Due to the presence of bromine and by choosing the dimensions in such a manner that the wall of the envelope during operation of the lamp everywhere assumes a temperature at which tungsten-bromine compounds formed in the lamp are volatile, it is achieved that the wall of the envelope remains clear until the end of the lifetime.

In accordance with the invention, hydrogen is provided in the lamp to suppress the direct reaction between bromine and the ends of the filament body and tungsten supports, if any, by formation of hydrobromic acid at those areas. The required bromine and hydrogen are generally introduced into the lamp as hydrobromic acid or in the form of an alkylbromide compound such as CH_3Br .

Furthermore the lamp comprises an inert gas or a mixture of such gases such as argon, krypton, xenon, nitrogen.

The total pressure of the gas atmosphere in the lamp at room temperature is approximately 1 atmosphere or more. For a given inert gas filling and filling pressure the lifetime is shortened and the light output in lumens per watt is increased with higher filament body operating temperature.

In practice it is found that incandescent lamps of the type described do not always reach the lifetime which might be expected on the ground of the filament temperature and gas filling. This was found to be particularly the case in those lamps in which during the lifetime an unpredictable quantity of molecular oxygen or oxygen compounds such as water or volatile metal oxides is released from the lamp parts.

An object of the invention is to obviate these drawbacks. To this end the incandescent lamp according to the invention is characterized in that the lamp comprises boron in the gas atmosphere in a quantity of gram atoms which is smaller than 10 percent of the quantity of bromine in gram atoms present in the lamp and which is at least equal to the quantity which corresponds to the vapour pressure above solid boron at a temperature of 200°C . It was found that in a tungsten-bromine cycle lamp the presence of boron in the given quantity is not disturbing. In the lamps according to the invention an extension of the average lifetime could be found. This indicates that under the circumstances prevailing during operation in the lamp according to the invention the oxygen pressure is stabilised by boron at a value below the value which is harmful for the lifetime of the lamp, while hydrogen and bromine are not prevented from performing their function in the tungsten-bromine cycle.

The lamp according to the invention may be manufactured in the manner conventional for tungsten-bromine cycle lamps. A very practical manner of introducing boron before gettering oxygen in the lamp is to provide boron in the solid state on the wall of the envelope at an area where boron assumes at least a temperature of 200°C . Below this temperature the reaction rate of solid boron with oxygen is found to be extremely small and the vapour pressure is too low anyway to react in the gas phase sufficiently quickly with oxygen. Boron may be introduced into the lamp, for example, in the form of a piece of wire obtained by depositing boron on a tungsten wire in a quantity of, for example, 10 to 1,000 micrograms. It is recommended to provide boron at such an area in the envelope of the lamp that the temperature of boron cannot increase to more than approximately 500°C . It may be assumed that at areas having a temperature of less than 500°C in the lamp according to the invention no or substantially no free bromine occurs but exclusively hydrogen bromide so that substantially no volatile boron bromides are formed. If it is not possible to locate the boron at such a place which may be the case, for example, in lamps having a slight volume in which the distance between the filament and the wall is short and consequently the temperature of the wall of the envelope may increase to values of more than 500°C , boron may alternatively be brought in the lamp in the form of a gaseous or volatile compound. Suitable volatile compounds are, for example, compounds of boron and hydrogen or boron, hydrogen and nitrogen.

It has been proposed to use borontribromide (BBr_3) in a tungsten-bromine cycle lamp instead of hydrogen and bromine in a ratio of 1 or more. Practice has proved that in such borontribromide containing lamps blackening may occur especially at the initial phase of the lifetime.

However, in said prior art lamps the quantity of borontribromide to be introduced into the lamp for maintaining the cycle produces so much boron upon dissociation that the vapour pressure of boron is exceeded at the temperatures prevailing in the lamp. This gives rise to local deposition of boron on the filament while forming tungsten borides. These borides have a lower melting point than tungsten, cause brittleness of the filament and have a higher electrical resistance. Generally the lifetime of the filament body is affected thereby.

When using borontribromide according to a further proposal blackening may be prevented by using borontribromide together with hydrogen. The quantity of hydrogen to be used at total pressures of more than 1 atmosphere as generally occur in these types of lamps is found to be very critical. The quantity of hydrogen in gram atoms is then much smaller than the quantity of bromine in gram atoms. It is true that the use of this step prevents blackening at the initial phase of the lifetime because probably the decomposition of borontribromide in the presence of hydrogen proceeds at a faster rate than that of borontribromide alone. The other drawbacks of the use of borontribromide, namely the fixed ratio of 1 to 3 between boron and bromine in which boron is introduced into the lamp, the attack of the filament by released boron and the difficult handling of borontribromide in connection with its corrosive behaviour are, however, not obviated by the use of hydrogen.

Gaseous or volatile compounds of boron and hydrogen and of boron, nitrogen and hydrogen decompose already at relatively low temperatures so that the formation of tungsten borides need not be feared.

Suitable gaseous and volatile non-corrosive boron compounds are, for example, boranes, such as diborothane (B_2H_6), dihydrotetraborane (B_4H_{10}), pentaborane (B_5H_9), hexaborane (B_6H_{10}), borazine ($B_3N_3H_6$).

These compounds can be introduced into the lamp by mixing them in the desired ratio with the filler gas.

The gram atoms of boron which are introduced into the lamp in this manner in the form of a gaseous or volatile compound is preferably 1/10 to 1/1,000 the gram atoms in gram atoms of bromine in gram atoms present in the lamp.

Bromine and hydrogen may be introduced into the lamp suitably in the form of hydrobromic acid (HBr) or an alkylbromide possibly mixed with extra hydrogen. Examples are CH_2Br_2 , $CHBr_3$ and CH_3Br . The filler gas furthermore comprises an inert gas such as nitrogen, argon, krypton or xenon or a mixture of these gases.

The invention particularly provides the advantage that due to a simple step it may be prevented that some tungsten-bromine cycle lamps do not reach the calculated lifetime while it is additionally achieved that the average lifetime of the tungsten-bromine cycle lamps is extended and the spread in the lifetime is reduced.

The invention will now be described in greater detail with reference to the following examples.

Example I

A gas mixture was composed of argon, hydrobromic acid and oxygen for which the partial pressures were 679 Torr, 20 Torr and 1 Torr, respectively, and it was used in a 24 Volt, 100 Watt lamp having a light output of 22 lumens per Watt. This was a one-pin lamp having an envelope of quartz with a content of 1.13 cubic cm. After an average 15 hours of operation strong whisker formation occurred in these lamps due to the unfavourable composition of the gas mixture which quickly caused the end of the lifetime. A number of lamps is provided with a quantity of solid boron in the form of a boron wire (total diameter approximately 100 micrometres) deposited on a tungsten wire (diameter approximately 12 micrometres) and having a weight of approximately 100 micrograms. (Temperature during operation of the lamp between 200° and 500°C). The lifetimes of these lamps were between 400 and 1,300 hours, while generally the end of the lifetime was reached by burning-through of the filament and not by excessive whisker formation.

Example II

In a 30 Volt, 375 Watt lamp (19 lum/W) having an envelope content of 3 cubic cm and a gas filling of 700 Torr argon and 5 Torr CH_2Br_2 strong whisker formation on the filament was found to occur after 24 hours of operation which indicating an extra tungsten transport as a result of the occurrence of a water cycle.

These whiskers may cause short circuit of filament parts and hence shorten the lifetime. Lifetimes of 1,000 hours or more were obtained when 100 micrograms of solid boron in a wire shape as described in the previous example were introduced into this lamp and such that its temperature did not exceed 500° C during operation.

Example III

In a high-pressure halogen lamp comprising hydrogen bromide a quantity of borazine was provided such that the gram atoms of boron was between 1/10 and 1/1,000 of that of bromine in gram atoms. In all cases a clear extension of the lifetime was found.

What is claimed is:

1. An electric incandescent lamp having a filament body of tungsten an envelope having a wall contoured with respect to said filament body to maintain said wall at a temperature at which tungsten-bromine compounds are volatile a gas for said envelope comprising bromine and hydrogen which are introduced into the lamp in proportions between hydrogen and bromine of 1 or more, and a quantity of gram atoms of boron in the gas atmosphere in the envelope, said quantity being less than 10 percent of the gram atoms of bromine in the lamp and at least equal to the quantity which corresponds to the vapour pressure above solid boron at a temperature of 200° C.

2. An electric incandescent lamp having a filament body of tungsten an envelope having a wall contoured with respect to said filament body to maintain said wall at a temperature at which tungsten-bromine compounds are volatile, and a filling for said envelope comprising bromine and hydrogen which are introduced into the lamp in proportions between hydrogen and bromine of 1 or more and a quantity of solid boron disposed within said envelope at an area where the temperature of boron during continuous operation of the lamp is between 200° and 500° C.

3. An electric incandescent lamp having a filament body of tungsten an envelope having a wall contoured with respect to said filament body to maintain said wall at a temperature at which tungsten-bromine compounds are volatile, and a filling for said envelope comprising bromine and hydrogen which are introduced into the lamp in proportions between hydrogen and bromine of 1 or more, and between 10 and 100 micrograms of solid boron.

4. An electric incandescent lamp having a filament body of tungsten and envelope having a wall contoured with respect to said filament body to maintain said wall at a temperature at which tungsten-bromine compounds are volatile, and a filling for said envelope comprising bromine and hydrogen which are introduced into the lamp in proportions between hydrogen and bromine of 1 or more and a gram atom quantity of boron in the form of a gaseous compound is greater than 0.1 percent of the gram atoms of bromine in the lamp.

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