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(54) **High-pressure sodium discharge lamp**

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Lampe à décharge dans le sodium à haute pression

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- **JJ. DE GROOT ET AL:'The High Pressure Sodium Lamp' 1986, KLUWER TECHNISCHE BOEKEN BV, DEVENTER, NL; "Lamp Design" - Chapter 10**

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Description

FIELD AND BACKGROUND OF THE INVENTION

This invention relates to high-pressure sodium discharge lamps for operation at low frequency, in particular for higher arc brightness at a color temperature between 1800 and 2250 K. The lamp is provided with a sealed elongated light-transmitting discharge tube placed within an evacuated vitreous outer envelope, which surrounds the discharge tube and has electrical inleads and support members for supporting and making electrical connections from the base of the lamp to the discharge tube. In the discharge tube there are electrodes arranged opposite to each other, and feedthroughs, which extend through the seal of the discharge tube, making electrical connections to the electrodes. The discharge tube has fill materials comprising sodium in a quantity so as to achieve partial pressure at the operating temperature between 4 and 40 kPa in the inside of the discharge tube, and also comprising noble gas.

High-pressure sodium discharge lamps with higher brightness are valuable for improved beam performance in reflector lamp applications.

Low frequency operation means that the power supply of the lamp has components below 1 kHz in frequency.

In general, the wall loading of a high-pressure sodium discharge tube in an evacuated outer envelope is limited to a value below 20 W/cm^2 in the case of the so-called "standard" or "delux" operation which denominations cover a color temperature between 1800 and 2250 K and a color rendition index from 10 to 70.

Lamps of the standard kind are mentioned in the US Pat. No. 3,906,272. In such lamps the brightness is significantly limited by the permissible maximum wall loading since it is known that the increase of the wall loading, in general, raises the wall temperature of the discharge tube, and exceeding the maximum tube wall temperature results in shortened lamp life.

Efforts have been made by lighting manufacturers to maintain typical wall temperature values and at the same time to achieve higher wall loading in high-pressure sodium discharge tubes by means of filling the outer envelope with inert gases instead of the usual vacuum.

While filling the outer envelope with an inert gas is effective in permitting higher wall loading, it complicates the lamp construction because the gas is susceptible to electrical breakdown and arcing when the usual starting pulses are applied to the lamp. For this reason it would be more advantageous to use an evacuated outer envelope also in the case of higher wall loading.

It is known from J.J. de Groot and J.A.J.M. von Vliet: "The High-Pressure Sodium Lamp" (Deventer 1986), p. 286, that the wall loading should not exceed 20 W/cm^2. However, for shorter discharge tubes larger loadings may the tolerated, if a substantial part of the dissipated power is transported through the alumina from the middle of the discharge tube to the ends by thermal conduction. For very short discharge tubes the wall temperature and not the wall loading should be chosen as design parameter.

OBJECT AND SUMMARY OF THE INVENTION

The object of the invention is to provide a high-pressure sodium discharge lamp of the kind mentioned in the field of the invention, the discharge tube of which can be operated with a wall loading higher than 24 W/cm^2 in order to achieve higher brightness without taking any extra measures for the maintenance of the wall temperature below a permissible value.

The invention is based on the recognition that a higher wall loading can be used in case of the above lamp, if its discharge tube has a value for the ratio of the discharge gap (i.e. distance between the top of the electrodes) to the discharge tube inner diameter (D/d) lower than 5.0. It was found, that the heat conduction to the ends of the discharge tube significantly drops the center wall temperature, if the ratio D/d is less than 5.0, which recognition means that usual wall temperatures can be maintained also at higher values of wall loading.

It was also found that when the wall of the discharge tube is thicker, the above effect is more pronounced, and the most preferred values for the wall thickness of the discharge tube are more than 0.6 mm. It is to be mentioned that a discharge tube of polycrystalline alumina having a wall thickness of more than 3.0 mm is difficult to manufacture, and has relatively poor light transmission.

It was also found, that for a given ratio of D/d, smaller discharge tube inner diameters are more effective at lowering the maximum wall temperature, which occurs at the center of the discharge tube. However, the most preferred range of the discharge tube inner diameter is between 3.5 and 7.0 mm, because it must be taken into account as well, that the efficiency of the discharge tube severely decreases if the inner diameter is smaller than 3.5 mm.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be further described in more detail by way of example and with reference to a preferred embodiment.. Furthermore some experimental data will be shown illustrated in the accompanying drawings, wherein:

FIG. 1 shows a high-pressure sodium discharge lamp constructed in accordance with the present invention.

FIG. 2 shows the discharge tube of the lamp according to FIG. 1 partly in sectional view,

FIG. 3 shows some experimental data on the rela-

tionship between the wall loading and the discharge tube inner diameter at various ratios of D/d.

DETAILED DESCRIPTION OF THE INVENTION

A high-pressure sodium discharge lamp 1 embodying the invention in preferred form is illustrated in FIG. 1 and a discharge tube of this lamp in FIG. 2.

The high-pressure sodium discharge lamp 1 for operating at 90 Watts and 60 Hz frequency comprises a discharge tube 2 surrounded by a vitreous outer envelope 3, that ends in a standard screw base 10 for insertion into a socket by which the lamp 1 can be energized, and comprises furthermore a stem 15, which is sealed to the envelope 3. Electrical inleads 8, 9 extend through the stem 15, from the base 10 into the inside of the outer envelope 3, and are connected to support members 19, 20 that supply current to the discharge tube 2 and provide for its fixed position within the lamp 1. The outer envelope 3 is evacuated by pumping and flashing getter rings 11, 12, 13, 14.

The discharge tube 2 has a cylindrical wall 18 made of sintered aluminum oxide which has a thickness, w, of 0.76 mm, a length, L, of 35 mm and an inner diameter, d, of 4.0 mm. In the discharge tube 2 there are two electrodes 6, 7, opposite to each other. The distance D between the tips of the electrodes 6, 7, i.e. the discharge gap is 16 mm. The cylindrical wall 18 is closed at its two ends by means of sintered aluminum oxide plugs 16, 17. Additionally, feedthroughs 4, 5 extend through the plugs 16, 17 and make electrical connection to the electrodes 6, 7. The feedthrough 5 is a niobium wire, while the feedthrough 4 is a niobium tube through which the discharge tube 2 is exhausted during manufacturing. The plugs 16, 17 are sealed to the cylindrical wall 18 and the feedthroughs 4, 5 to the plugs 16, 17 by means of seal glass.

The described discharge tube 2 has fill materials comprising sodium, furthermore xenon gas. The partial pressure of the sodium is between 4 and 40 kPa at the operating temperature of the discharge tube. The sodium can be dosed into the discharge tube 2 in form of sodium-mercury amalgam, in a quantity of 17 mg. The ratio of the sodium in the amalgam is 17 % by weight. The pressure of the xenon gas is 2.5 kPa at 300 K.

In the case of the above described discharge tube 2, the ratio D/d of the discharge gap to the discharge tube inner diameter is 4.0. FIG. 3 shows some experimental data on the discharge tube wall loading for a maximum wall temperature 1200 C at various discharge tube inner diameter values. The data relates to the case of 0.76 mm wall thickness. The diagrams show that a higher value for the wall loading can be achieved at smaller values of the ratio D/d, and furthermore that this trend increases in the case of smaller discharge tube inner diameter.

The above described lamp construction and operation results in the following:

The color temperature of the lamp is 2000 K, the color rendition index is 20. The achieved wall loading is 40 W/cm^2 at a wall temperature of 1200 C.

The example described above proves that the invention provides a solution for a high-pressure sodium discharge lamp of low color temperature having an evacuated outer envelope in order to achieve higher brightness without the increase of the wall temperature over conventional discharge tube designs with values of the ratio D/d more than 5.

While a preferred embodiment of the present invention has been shown and described herein, this embodiment provides an example, only. Numerous variations, changes and substitutions relating to the disclosed dimensions and operating power characteristics for instance can be made without departing from this invention as defined in the appended claims.

Claims

1. A high-pressure sodium discharge lamp for operation at low frequency comprising:

   an elongated light-transmitting discharge tube (2) having sealed ends (16,17),
   electrodes (6,7) arranged in said discharge tube opposite to each other,
   feedthroughs (4,5) for making electrical connections to said electrodes and which extend out of the seal of the discharge tube,
   fill materials within said discharge tube comprising sodium in a quantity achieving partial pressure at the operating temperature of said discharge tube between 4 and 40 kPa, further comprising a noble gas,
   an evacuated vitreous outer envelope (3) surrounding said discharge tube and having electrical inleads (8,9) and support members (19,20) for supporting and making electrical connections to said electrodes of said discharge tube,
   said discharge tube emitting light during operation having a color temperature between 1800 and 2250 K and a wall loading of at least 24 W/cm^2 and having a value for the ratio of discharge gap to discharge tube inner diameter lower than 5.0.

2. A high-pressure sodium discharge lamp as in claim 1 wherein said discharge tube has a wall thickness more than 0.6 mm.

3. A high-pressure sodium discharge lamp as in claim 1 wherein the inner diameter of said discharge tube is between 3.5 and 7.0 mm.

Patentansprüche

1. Hochdruck-Natriumentladungslampe zum Betrieb bei geringer Frequenz, umfassend:

   ein langgestrecktes, lichtdurchlässiges Entladungsrohr (2) mit abgedichteten Enden (16,17),
   einander gegenüberliegend angeordnete Elektroden (6,7) in dem Entladungsrohr,
   Durchführungen (4,5) zur Herstellung elektrischer Verbindungen mit den Elektroden, die sich aus der Dichtung des Entladungsrohres heraus erstrecken,
   Füllmaterialien innerhalb des Entladungsrohres, umfassend Natrium in einer Menge, um bei der Betriebstemperatur des Entladungsrohres einen Partialdruck zwischen 4 und 40 kPa zu erzielen, und weiter ein Edelgas,
   einen evakuierten, glasartigen Außenkolben (3), der das Entladungsrohr umgibt und elektrische Zuleitungen (8,9) und Trägerteile (19,20) zum Abstützen und Herstellen elektrischer Verbindungen mit den Elektroden des Entladungsrohres aufweist,
   wobei das Entladungsrohr während des Betriebes Licht einer Farbtemperatur zwischen 1.800 und 2.250 K emittiert, eine Wandbelastung von mindestens 24 W/cm^2 und einen Wert des Verhältnisses des Entladungsspaltes zum Innendurchmesser des Entladungsrohres von weniger als 5,0 aufweist.

2. Hochdruck-Natriumentladungslampe nach Anspruch 1, worin das Entladungsrohr eine Wandstärke von mehr als 0,6 mm aufweist.

3. Hochdruck-Natriumentladungslampe nach Anspruch 1, worin der Innendurchmesser des Entladungsrohres zwischen 3,5 und 7,0 mm liegt.

Revendications

1. Lampe à décharge dans le sodium à haute pression destinée à fonctionner à basse fréquence, comprenant :

   - un tube à décharge (2), allongé et transmettant la lumière, comportant des extrémités scellées (16, 17),
   - des électrodes (6, 7) placées dans ledit tube à décharge en vis-à-vis l'une de l'autre,
   - des traversées (4, 5) servant à réaliser des connexions électriques avec lesdites électrodes et s'étendant à l'extérieur du scellement du tube à décharge,
   - des matériaux de remplissage placés à l'intérieur du tube à décharge, comprenant du sodium en une quantité qui donne, à la température de fonctionnement dudit tube à décharge, une pression partielle comprise entre 4 et 40 kPa, et comprenant en outre un gaz rare,
   - une ampoule extérieure (3) en verre, dans laquelle on a fait le vide, qui entoure ledit tube à décharge et comporte des conducteurs électriques d'entrée (8, 9) et des éléments de support (19, 20) pour soutenir lesdites électrodes dudit tube à décharge et réaliser des connexions électriques avec elles,

   ledit tube à décharge émettant en fonctionnement une lumière avec une température de couleur comprise entre 1800 et 2250 K, une charge de paroi d'au moins 24 W/cm^2 et une valeur du rapport entre l'intervalle de décharge et le diamètre intérieur du tube à décharge inférieure à 5,0.

2. Lampe à décharge dans le sodium à haute pression selon la revendication 1, dans laquelle ledit tube à décharge a une épaisseur de paroi supérieure à 0,6 mm.

3. Lampe à décharge dans le sodium à haute pression selon la revendication 1, dans laquelle le diamètre intérieur dudit tube à décharge est compris entre 3,5 et 7,0 mm.

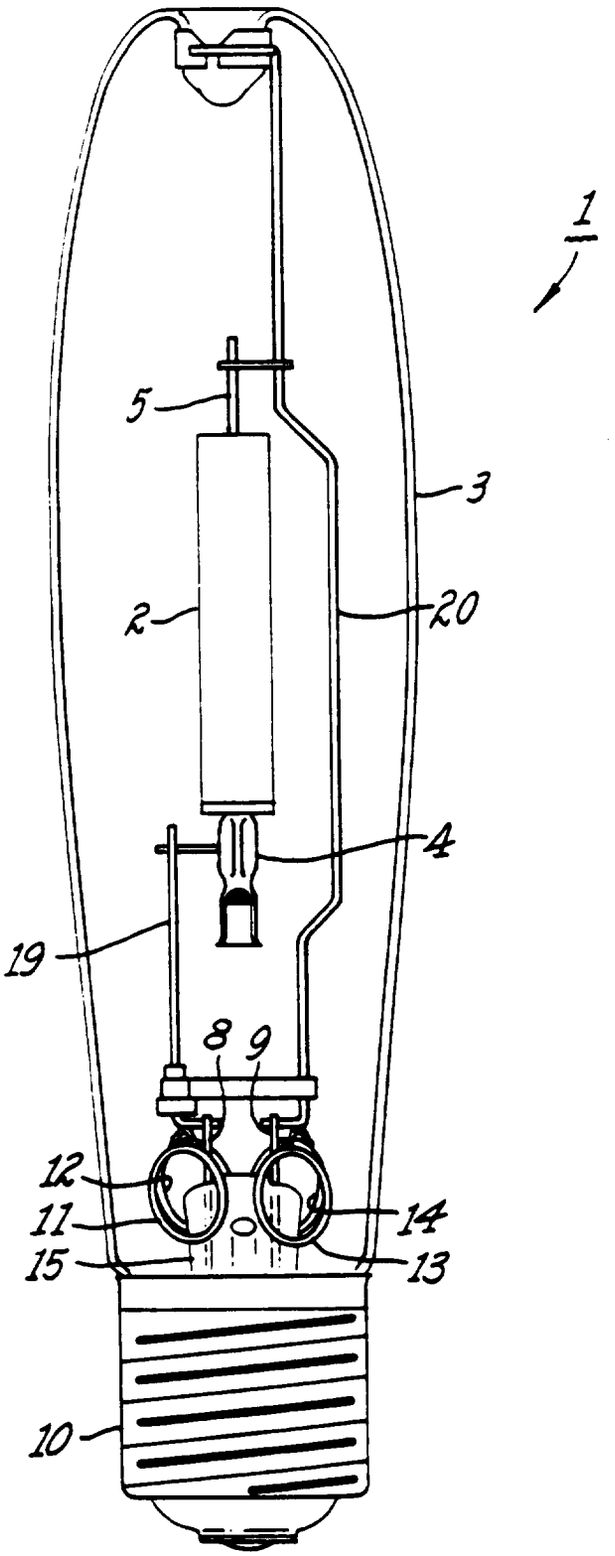


Fig. 1

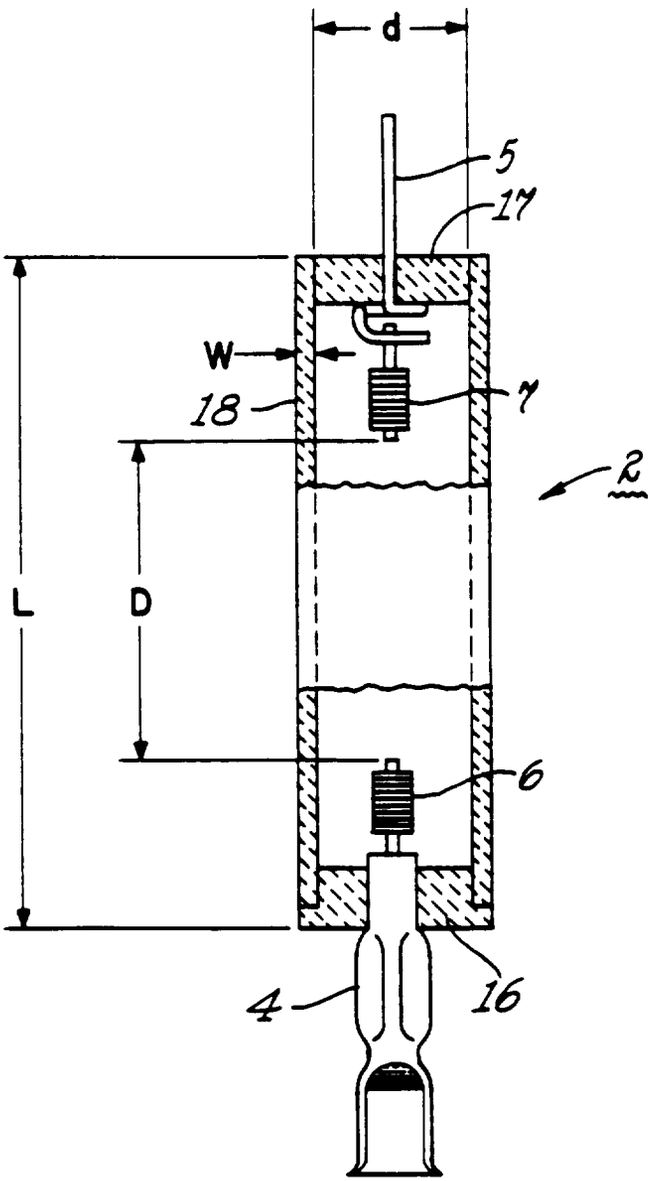
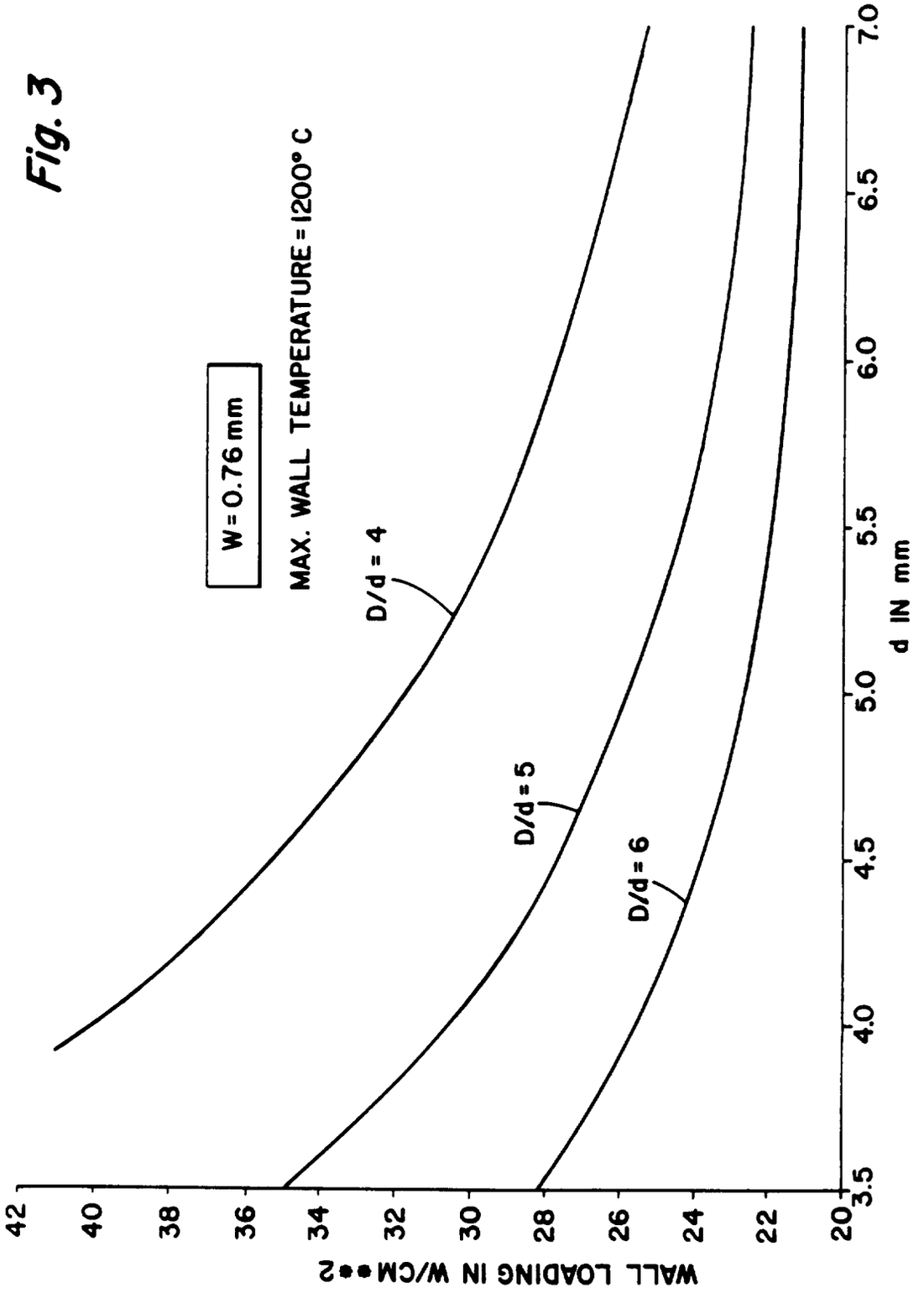


Fig. 2

Fig. 3


W = 0.76 mm
MAX. WALL TEMPERATURE = 1200° C
D/d = 4
D/d = 5
D/d = 6
WALL LOADING IN W/CM**2
d IN mm
42
40
38
36
34
32
30
28
26
24
22
20
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0