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(56) Documents cited
GB 1294022 **GB 0543791** **GB 0502603**
GB 1071103

(58) Field of search
H1D

(54) **High pressure sodium-vapour or metal halide lamp for direct current operation**

(57) A DC-fed high-pressure sodium vapour or metal halide lamp (1) has its internal components positioned and arranged and/or is provided with additional means so that the operational temperature at the cathode-side cold spot exceeds that at the anode-side cold spot whereby colour separation is prevented or reduced. The effect may be achieved by a suitable choice of the ratio of the distance between the cathode (6,) and the anode (7,) to the internal diameter of the discharge vessel (1) and/or by the appropriate shaping of the vessel (1) adjacent the cathode and/or by placing an appropriate heating element near the cathode and/or by heat-reflecting elements (10,) near the cathode (6,).

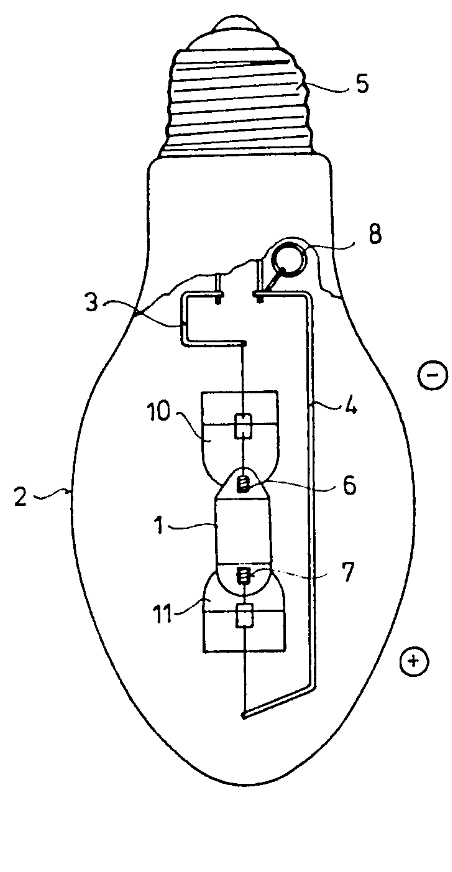

Fig. 1

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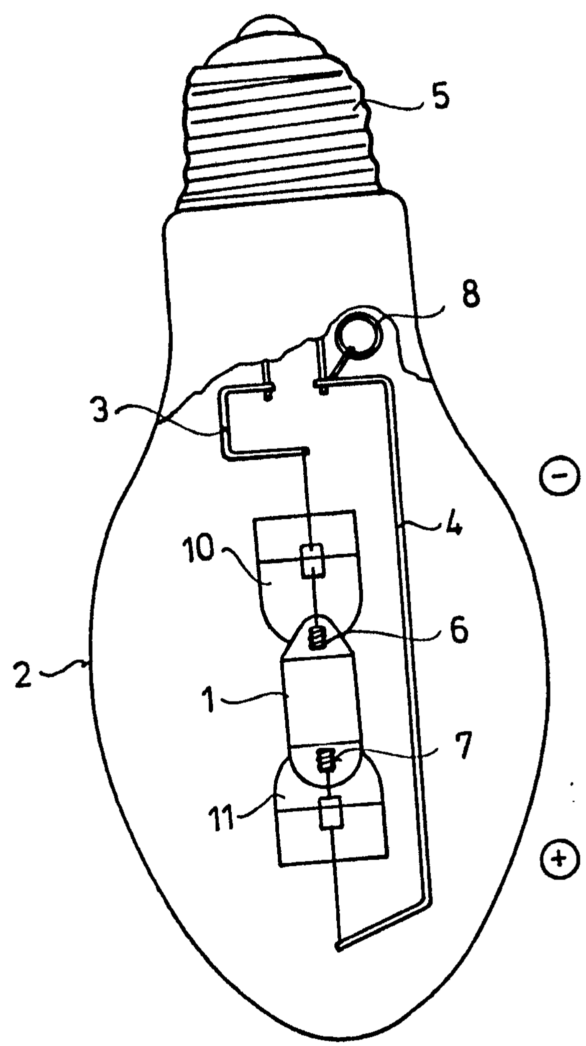

Fig. 1

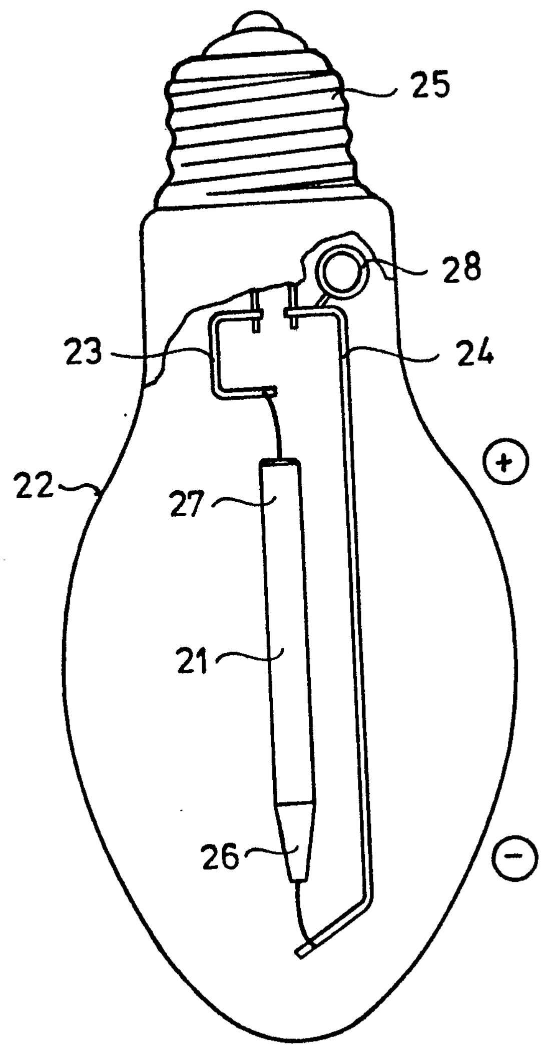

Fig. 2

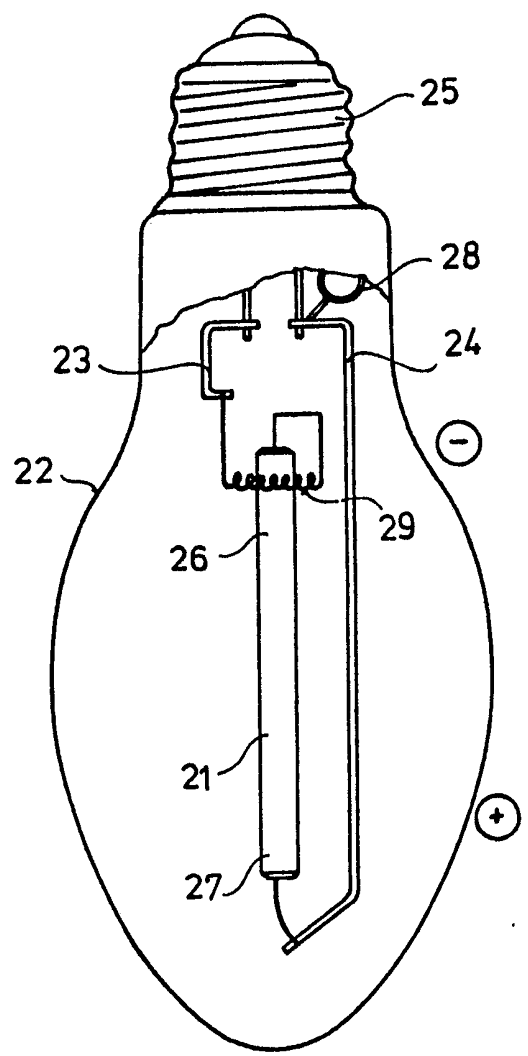

Fig. 3

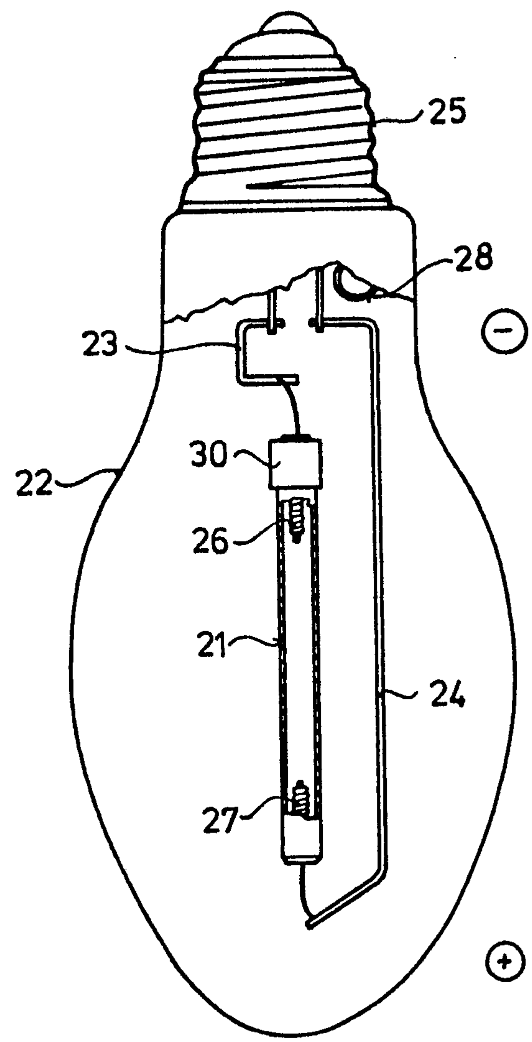

Fig. 4

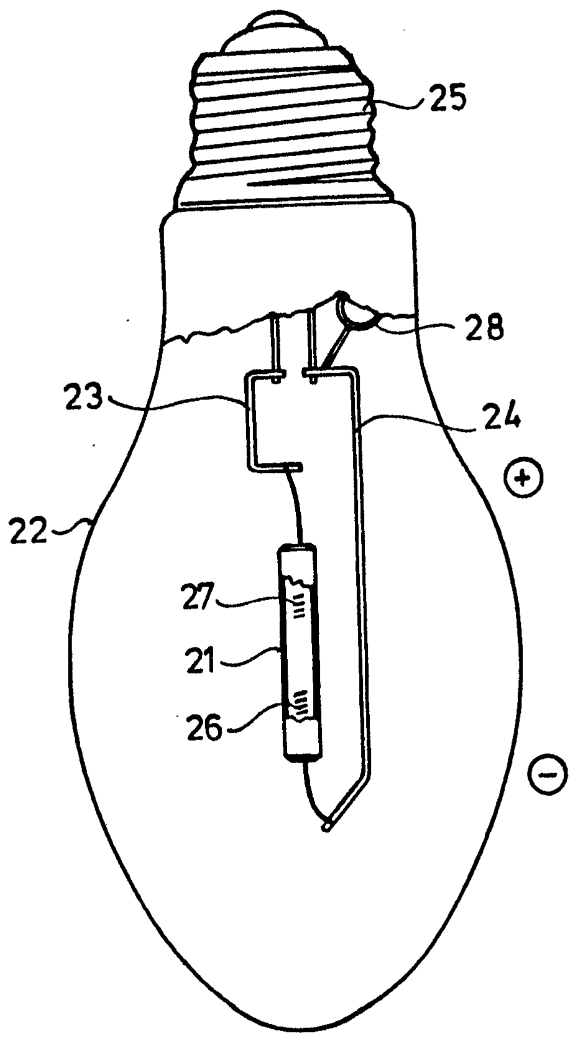

Fig. 5

SPECIFICATION

High-pressure sodium-vapour or metal halide lamp for direct current operation

The invention relates to a direct current operated high-pressure sodium-vapour or metal halide lamp provided with two main electrodes/anode, cathode/mounted into a light-transmitting discharge vessel made of translucent material, each electrode being arranged adjacent to either end of the discharge vessel, and having at least two gas or vapour components suitable for being excited to emit light during operation.

By high pressure metal halide lamp a high-pressure discharge lamp is meant, containing some kind of noble gas as starting gas and mercury, and in said gas also the halide(s) of at least the metal is present. Such a lamp may be one containing sodium iodide, thallium iodide and indium iodide, or one containing sodium iodide and scandium iodide or one containing dysprosium iodide and thallium iodide.

With direct current supply, and with the usual symmetrical constructions, i.e. where cathode and anode are of identical design, a substantial proportion of halides migrate to the cathode-side end of the discharge vessel resulting in colour separation, i.e. the colour of the light emitted from one end of the discharge tube differs from the colour emitted from the other end. This phenomenon is especially interesting with the lamp operated in vertical position. In lamps of symmetrical design comprising sodium iodide, thallium iodide and indium iodide, operated from an alternating current source, sodium iodide tends to migrate into the bottom section of the discharge tube, thus the light emitted from the lower end of the discharge becomes richer in yellow colour—characteristic of sodium—than the colour of the upper end. If the same lamp is operated from a direct current source, two different situations will be observable. With the cathode in lower position, the phenomenon of colour separation will become stronger, whereas with the cathode in upper position, colour separation will be less conspicuous.

By high-pressure sodium-vapour lamp, according to the invention, a high-pressure lamp is meant, incorporating a discharge tube generally made of ceramic material having a high melting point, in which, during operation, the pressure of sodium vapour is in the range of 20 to 1000 mbar, that of mercury vapour is between 0 to 5 bar and that of xenon is between 50 to 3000 mbar. In some types of these lamps, mercury is replaced by a metal of high molecular mass and high vapour pressure, such as cadmium and, instead of xenon, occasionally some other noble gas is used, e.g. argon or a neon-argon mixture.

From the point of view of the invention, the mentioned types should also be regarded as high-pressure sodium-vapour lamps.

In the case of high-pressure sodium-vapour lamps and metal halide lamps supplied from direct current most of the usual colour homogeneity associated with an alternating current supply is lost and, with the dispersion of individual components, due to the phenomenon of electrophoresis or cataphoresis, colour separation takes place. E.g., with high-pressure sodium-vapour lamps, the component ionizing more readily, i.e. the sodium, migrates to the cathode-side end bringing about migration of all other components as well. On the cathode-side end, the discharge will become richer in sodium lights. This is the phenomenon termed colour separation, the unfavourableness of which is one of the reasons why the system with the high-pressure sodium-vapour or metal halide lamps of direct current supply has failed to gain ground in this field. One exception is the case when colour separation is utilized for the purpose of exciting components that emit the case of a high-pressure sodium-vapour lamp, to produce light excitation, in addition to sodium, also in mercury, cadmium, thallium and/or zinc, etc. In such a case, although colour separation offers the possibility of raising the colour temperature but at the same time, the luminous efficiency will become lower.

To reduce the effects of colour unbalance due to the separation of components measures may be taken, e.g. by frosting the outer glass bulb or applying a fluorescent powder coating. In the case of high-pressure sodium-vapour or metal halide lamps supplied from an alternating current souce no such colour separation takes place, because of the frequent reversal of polarity.

The purpose of the present invention is to provide for a solution by which the phenomenon of colour separation taking place in direct current fed high-pressure sodium-vapour or metal halide lamps, due to the presence of several kinds of light emitting components and to the component dispersing effect of direct current can be avoided or minimized.

The present invention is based on the recognition that, by maintaining—during operation—the temperature of the cathode-side cold spot of a high-pressure sodium-vapour or metal halide lamp at a level exceeding the temperature of the anode-side cold spot of said lamp, and in the case of high-pressure sodium-vapour lamps, maintaining below a certain value the ratio of the distance between main electrodes to the internal diameter of the discharge vessel, it is possible to comply with the requirement of avoiding or limiting to an acceptably low level the undesirable colour separation. /It should be noted that by "cold-spot temperature" the temperature prevailing at the coldest part within the discharge vessel during operations is meant./

Thus, the object of the invention is to create on the basis of the above recognition a high-pressure sodium-vapour or metal halide lamp wherein the effect of colour separation can be avoided or minimized to a very low, acceptable level, in case of direct current supply, too.

Correspondingly, the proposed invention relates to a direct current supplied high-pressure sodium-vapour or metal halide lamp comprising a discharge vessel made of translucent or transparent material, respective main electrodes/anode, cathode/adjacent to each of the two ends of the discharge vessel, where the latter is preferably enclosed in an outer bulb, the discharge vessel further comprising a filling with at least two gaseous or vapour phase components suitable for being excited to emit light during operation, wherein according to the invention there is a suitable construction by which the cathode-side cold-spot temperture of the discharge vessel is maintained—during operation—at a level exceeding the anode-side cold-spot temperature.

Further, the proposed invention relates to a high-pressure sodium-vapour lamp for direct-current supply, comprising a tubular discharge vessel made of translucent or transparent material, respective main electrodes/anode, cathode/arranged adjacent to each of the two ends discharge vessel and a filling including in the discharge vessel at least two gaseous or vapour phase components suitable for being excited to emit light during operation, wherein according to the invention the ratio of the distance between the main electrodes to the internal diameter of the discharge vessel is less than 7, and preferably less than 5. By achieving the ratio of 7, colour separation may be reduced, while by a ratio below 5 it may be in most cases fully eliminated.

In a favourable embodiment of the lamp according to the invention the desired higher cathode-side cold-spot temperature is acheived by making the distance between the end of the discharge vessel and the end of the main electrode adjacent to the former/i.e. the base point of the arc/shorter on the cathode side than on the anode side.

In a further advantageous embodiment of the lamp according to the invention the higher cold-spot temperature on the cathode side is achieved by making the part of the discharge vessel adjacent to the cathode narrower than that adjacent to the anode.

Instead of mechanical features drawn above it can be proposed to use a solution based on electric current. Thus, in another further favourable embodiment a separate heating element is accommodated outside the discharge vessel on the cathode side of the latter.

Again, in a further advantageous embodiment of the lamp according to the invention a heat reflecting surface is placed adjacent to the discharge vessel on its side facing the cathode, ensuring thereby the required higher temperature. It can be of advantage to apply heat reflecting surfaces both on the anode side and cathode side or on the parts of the discharge vessel facing the cathode and the anode, wherein it is appropriate to use on the cathode-side a heat reflecting surface of higher heat reflection capability than that used on the anode side. This aim can be achieved, e.g. by selecting, for the cathode side, a thicker heat reflecting layer, or providing a better heat insulation on that side. Another way of improving thermal conditions is to use a body carrying the heat reflecting surface and to make the geometrical dimensions thereof at the cathode-side of the discharge vessel in longitudinal direction larger than at the anode side.

With the help of the arrangement complying with our invention it can be ensured with high-pressure sodium-vapour lamps and metal halide lamps that, with direct current supply, no colour separation along the longitudinal axis of the discharge vessel or colour separation of very low level takes place, and uniform colour distribution is obtained with lamps operated in this manner. Assurance against colour separation can be further enhanced by adopting constructions where the specific features of at least two of the listed embodiments are employed simultaneously, i.e. by combining various arrangements.

In the following, the invention will be presented in more detail on the basis of embodiments described as examples, with reference to the attached drawing. The drawings show in

Figure 1 the cross-sectional view of an embodiment of the invention, representing a high-pressure metal halide lamp, as an example thereof, in

Figure 2 the cross-sectional view of an embodiment of the invention, showing a high-pressure sodium-vapour lamp provided with a tubular discharge vessel, in

Figure 3 the cross-sectional view of an embodiment of the invention, showing a high-pressure lamp provided with a heating element, in

Figure 4 the cross-sectional view of an embodiment of the invention, showing a high-pressure sodium-vapour lamp provided with a light reflecting surface, and in

Figure 5 the cross-sectional view of an embodiment of the invention, showing a high-pressure sodium-vapour lamp designed with the dimensions proposed.

The high-pressure metal halide lamp for direct current supply, shown in Fig. 1, is of a construction ensuring best results when operated in vertical position, with the cathode situated at a higher level than the anode. In the lamp a discharge vessel 1 is enclosed in an outer bulb 2 and is supported by brackets 3 and 4, the latter serving as current conductors for feeding main electrodes as a cathode 6 and an anode 7 through a lamp cap 5. The cathode 6 is arranged in a cathode part of the discharge vessel 1 and the anode 7 in the anode part thereof. High-pressure metal halide lamp is operated in the position shown, wherein the cathode 6 assumes a higher position than the anode 7, since this arrangement itself will ensure a higher temperature in surroundings of the cathode 6, whereby also the temperature of the cathode side cold spot will be higher than that of the cold spot on the side of the anode 7. The required effect has been enhanced further also by mounting the cathode 6 closer to the end of the discharge vessel than the anode 7 on the opposite side. Gas purity within outer bulb 2 is ensured by getter 8. The desired effect can be increased further by making light reflecting surface 10 to have better reflecting properties than surface 11. Such a surface of good light reflecting capability can be obtained, e.g. by applying a zirconium-oxide coating.

In Fig. 2 a direct current operated high-pressure sodium-vapour discharge lamp is shown, where a discharge vessel 21 is mounted in an outer bulb 22 the section of which adjacent to a cathode 26 is narrower than the section adjacent to an anode 27, eliminating thereby the phenomenon of colour separation by increasing the cathode-side cold-spot temperature. Brackets 23 and 24 serve as mechanical supports, and as current leads to the cathode 26 and the anode 27 as main electrodes through a cap 25. A getter 28 provides for degassing or clean-up of the space within the outer bulb 22.

In the embodiment represented in Fig. 3, a heating element 29 accommodated at the cathode end 26 of the discharge vessel 21 in a high-pressure sodium-vapour lamp keeps the cold spot adjacent to the cathode 26 at a higher temperature than that of the cold spot at the anode 27. To the outer bulb 22 the cap is attached providing for current feed through brackets 23 and 24. The getter 28 serves for the known purpose.

In Fig. 4 a high-pressure sodium-vapour lamp similar to that to Fig. 3 is illustrated, with the difference that here, instead of the heating element 29, a heat reflecting surface 30 consisting of a niobium ring is accommodated at the cathode 26 of the discharge vessel 21. The input power rating of the high-pressure sodium vapour lamp is 35 watt. The discharge vessel 21 is a ceramic tube of 3.3 mm inside diameter, the distance /arc length/ between the cathode 26 and the anode 27 is 40 mm, and the width of the niobium ring is 6 mm. In this example, the ratio of the distance between main electrodes to the inside diameter is about 12.1. In such cases, strong colour separation is experienced, unless, as presented above, specific countermeasures are taken. Scarcely more than half of the discharge vessel 21 lights as a sodium-vapour lamp, in the light emitted by the remaining part of the vessel the spectrum of a mercury arc appears. With the use of the mentioned heating element 29 or heat reflecting surface 30, the phenomenon of colour separation can almost entirely be eliminated.

The high-pressure sodium-vapour lamp shown in Fig. 5 is dimensioned with a distance of 10 mm between the cathode 26 and the anode 27 and with an internal diameter of 3.3. mm adopted for the discharge vessel 21. Thus, the ratio of the distance between main electrodes to the internal tube diameter is about 3, at which no colour separation can be found to appear, so that for its prevention no further measures are required beyond the adoption of proper dimensions given in the description of the invention. In other respects the lamp construction dealt with here is similar to the sodium-vapour lamps described in the former examples.

The various embodiments shown above may also be applied together, singly or in any operative combination.

CLAIMS

1. A high pressure sodium-vapour or metal halide light source (lamp) for direct current operation, comprising a translucent or transparent discharge vessel preferably enclosed in an outer bulb, an anode and a cathode as main electrodes arranged respectively adjacent to each of the two ends of the discharge vessel and a filling of the discharge vessel including at least two gaseous or vapour phase components excitable to emit light, wherein the arrangement of the components of the light-source is such, and/or the light source includes means effective to achieve, that in operation, the cold-spaot temperature at the end of the discharge vessel adjacent to the cathode is maintained at a higher level than that of the cold-spot temperature at the end adjacent to the anode.

2. A light-source as claimed in claim 1, wherein the distance between the end of the discharge vesel and the end of the adjacent main electrode (i.e. the base point of the arc) is shorter at the cathode than at the anode.

3. A light source as claimed in claim 1 or 2, wherein the cathode side cold-spot temperature is maintained at a higher temperature than that at the anode side by making the distance between the end of the discharge vessel and the end of the main electrode adjacent to the former (i.e. the base point of the arc) shorter on the cathode side than on the anode side.

4. A light source as claimed in any preceding claim, wherein an additional heating element is accommodated at the cathode-side end for heating the discharge vessel from the

outside.

5. A high-pressure sodium-vapour or metal halide lamp characterized by comprising a heat reflecting surface arranged at the end of the discharge vessel surrounding the cathode.

6. A high-pressure sodium-vapour or metal halide lamp as claimed in any of claims 1 to 5, characterized by comprising a heat reflecting surface at the end facing the cathode and end facing the anode of the discharge vessel where the heat reflecting surface accommodated at the end facing the cathode has a higher heat reflecting capability than that located at the end facing the anode.

7. A high-pressure sodium-vapour or metal halide lamp as claimed in any of claims 1 to 6, characterized by comprising a layer effective to form a heat reflecting surface at the end facing the cathode and the end facing the anode of the discharge vessel the layer constituting the heat reflecting surface at the end facing the cathode being thicker than the layer of the heat reflecting surface at the end facing the anode.

8. A high-pressure sodium-vapour or metal halide lamp as claimed in any of claims 1 to 7 characterized by comprising a layer effective to form a heat reflecting surface accomodated at the end facing the cathode and at the end facing the anode of the discharge vessel the thermal insulating capability of the layer constituting the heat reflecting surface at the end facing the cathode being higher than that of the layer constituting the heat reflecting surface at the end facing the anode.

9. High-pressure sodium vapour or metal halide lamp as claimed in any of claims 1 to 8, characterised by a respective body with a heat-reflecting surface accommodated adjacent the end facing the cathode and adjacent the end facing the anode of the discharge vessel, the geometrical dimensions of the heat-reflecting surface at the end facing the cathode in the longitudinal direction of the heat-reflecting surface being larger than the respective dimensions of the heat reflecting layer at the end facing the anode.

10. High-pressure sodium vapour lamp for direct current operation, comprising an anode and a cathode as main electrodes arranged in the vicinity of the to ends of a translucent or transsparent tubular discharge vessel, and a filling with at least two gaseous or vapour phase components excitable to emit light during operation, wherein the ratio of the distance between the cathode and the anode to the internal diameter of the discharge vessel does not exceed 7.

11. A lamp according to claim 10, wherein the said ratio does not exceed 5.

12. A light source or lamp according to claim 1 or claim 10 substantially as herein described with reference to and as shown in any one of the Figs. of the accompanying drawings.

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