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RADIO-INTERFERENCE-FREE LOW-PRESSURE MERCURY-VAPOR LAMP

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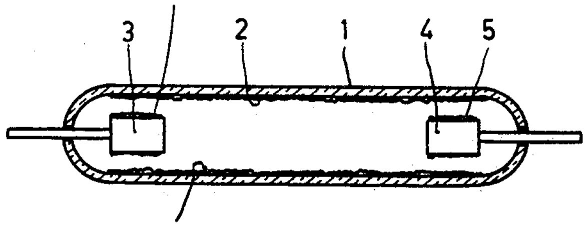


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# RADIO-INTERFERENCE-FREE LOW-PRESSURE MERCURY-VAPOR LAMP

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## ABSTRACT OF THE DISCLOSURE

A low-pressure mercury-vapor discharge lamp employing cathodes having an emissive material containing boron and/or certain borides to reduce radio interference, i.e., to suppress emission of electromagnetic radiations which would interfere with other telecommunication signals.

This invention relates to low-pressure mercury-vapor discharge lamps having a discharge space containing two thermionic cathodes each comprising a carrier coated with electron-emissive material.

Lamps of the above mentioned kind intended for illumination purposes are usually formed by rectilinear or circular glass tubes having the inner side coated with a luminescent material which converts the ultra-violet radiation produced in the discharge into light. Such lamps have been found to be very important, inter alia because of their capacity to provide a considerable amount of lumens per watt of energy supplied. Furthermore, by using different luminescent substances, the color of the light radiated by the lamps may be varied within very wide limits and thus matched to any purpose desired.

A disadvantage of these low-pressure mercury-vapor discharge lamps which has been known for a long time is that, in addition to emitting light, they also produce and emit electromagnetic oscillations having a wavelength such as to cause interference with electromagnetic telecommunication signals, for example, radio signals. Although the level of the interference signals produced by the lamp is not high in an absolute sense, the interference may be very troublesome with weak signals. Experiments have revealed that electromagnetic oscillations produced in the lamps may exert their interfering influence along two paths. One of these paths is the direct radiation. This may be decreased, for example, by electrically shielding the lamps, i.e., by arranging them in a grounded metal cage. As a matter of fact, this cage will usually be made of a material, for example, metal gauze, which is permeable to the desired radiation of light. The second path along which the interfering oscillations may exert their influence on apparatus for producing or observing telecommunication signals extends through the supply leads. If both the lamp and the apparatus are connected to the same source of supply, for example the current supply mains, the connection is electrically conductive or capacitive and hence the transfer of interference is considerable. Apart from this direct transfer there is a transfer of interference due to the current-supply wires of the lamp connected to the mains emitting interference radiation. In order to inhibit the two last-mentioned interference influences, it has been suggested to employ electrical filters between the lamp and the current supply mains. Such filters may be combined, for example, with the current-stabilizing elements, such as choke coils, which are required anyway for feeding low-pressure mercury vapor discharge lamps. It will be evident that such filter elements render the whole installation more complicated and hence more expensive. Furthermore, such steps do not remove the cause of the



interference and can therefore yield a given result only under certain conditions. If the telecommunication signals to be observed are very weak, it is necessary either to use very complicated filters or accept a low, though certain, interference level. Such filters are naturally no remedy against the interference resulting from the above-mentioned direct radiation by the lamp itself.

While investigations have been made concerning the causes of the interference oscillation produced in the lamps, no clear picture has been obtained as to their cause. Two phenomena seem to play a main part:

(a) The occurrence of a negative space charge in the area of the discharge space directly in front of the electrode serving as the cathode.

With the conventional supply with alternative voltage, this negative space charge arises due to the fact that, during the passage of current in the discharge space the highly concentrated emission spot of high temperature which exists on the cathode remains so hot as the alternating voltage passes through zero that more electrons are emitted than is necessary at this moment for maintaining the discharge. Consequently, irregular oscillations of charge carriers are produced in the said area. The resulting variations in the electromagnetic field give rise to part of the above-mentioned interference, which will be referred to hereinafter as "re-ignition interference." The frequencies of this interference lie in the range between 550 kc./sec. and 1400 kc./sec.

(b) The occurrence of anode oscillations.

These oscillations occur when an electrode acts as an anode. They will be referred to hereinafter as "anode interference." The frequencies of this interference lie in the range between 160 kc./sec. and 240 kc./sec.

Steps have previously been suggested for decreasing the above-mentioned interference. Thus, for example, it has been proposed to bring about an improvement by modifying the structure of the cathode, for example, by varying the dimensions of the carrier for the emissive material which is usually a heating coil.

Further, it has previously been suggested to cover or mix the emissive material with an amount of finely-divided material, for example carbon, iron, platinum, tungsten, palladium, molybdenum, tantalum or compounds thereof which are electrically conductive. These are added in comparatively large amounts, in certain cases even from 50 to 75% by weight of the amount of emissive material.

The use of such high percentages entails several drawbacks. Thus, inter alia, strong blackening of the ends of the lamp occurs, and the light efficiency of the lamp, that is to say the number of lumens emitted per watt of energy supplied is decreased strongly. The ignition voltage is also increased to impracticable values.

A principal object of the invention is to reduce the intensity of the interference oscillations produced by a low-pressure mercury-vapor discharge lamp, especially of the re-ignition interference, but while avoiding the above-mentioned drawbacks.

A low-pressure mercury vapor discharge lamp according to the invention has a discharge space containing two thermionic electrodes each consisting of a support which is coated with a thin layer of electron-emitting material containing one or more alkaline-earth oxides mixed with boron and/or at least one metallic boride which is capable of reducing the emission of unwanted electromagnetic radiations in a quantity which is from 0.1% to 15% of the quantity by weight of alkaline-earth oxide. Such borides are those of elements in the second, fourth, fifth, sixth and seventh columns of the Periodic Table of the Elements, and those of lanthanide and actinide series.

The borides of chromium, molybdenum, uranium, tungsten, tantalum, and manganese are especially suitable for the above mentioned purpose. When added in comparatively small percentages, these borides cause a strong decrease in interference level and small decrease in the specific light flux. Tantalum boride is preferred but tungsten monoboride gives in addition a very small reduction in the specific light flux.

Since it is necessary for the added materials to be intimately mixed with the particles of emissive material, the grain size of the particles of the added materials is preferably chosen to be not greater than 30 times the mean grain size of the particles of emissive material. Very satisfactory results are obtained with a grain size which is smaller than 15 times the mean grain size of the emissive particles.

From the experiments which have resulted in the invention it has been found that the quantity of added material must preferably be from 0.1% to 10% of the amount by weight of the emissive material. In fact, a satisfactory compromise is then reached between the decrease in interference oscillations and the decline in specific light efficiency.

The electrodes in a low-pressure mercury-vapor discharge lamp according to the invention preferably also contain a quantity of zirconium mixed with the emissive material. Such an addition is known per se to reduce the blackening of the ends of the lamp as the result of disintegration of the electrodes. There are indications that in lamps according to the invention the reduced occurrence of interference signals is improved further by the use of zirconium on the electrodes. The quantity of zirconium is preferably from 1% to 5% of the amount by weight of emissive material.

The invention will be described with reference to the accompanying drawing, the sole figure of which shows a lamp according to the invention. The lamp, as shown in the drawing, comprises an envelope **1** filled with mercury vapor and a noble gas such as neon. The inner wall of the envelope is coated with a luminescent material **2** which converts the radiation produced by an electrical discharge through the mercury vapor to a more pleasing visible



radiation. Cathodes **3** and **4**, connected to a power source (not shown), provide an electrical discharge since they are covered with an electron emissive material **5** which consists of alkaline earth oxides mixed with a metallic boride which suppresses the emission of unwanted electromagnetic radiations. For example, in an ordinary 40 watt low-pressure mercury-vapor discharge lamp these cathodes consisted of a coiled tungsten wire coated with a mixture of barium carbonate, calcium carbonate, strontium carbonate, zirconium and tungsten monoboride. The quantities of the carbonates of this mixture were chosen to be such that the weight ratio $BaCo_3$:$CaCO_3$:$SrCO_3$ was equal to 8:5:7. The quantity of zirconium was 3% by weight of the quantity of carbonates. The amount of tungsten monobride was varied. In the table given below, three percentages are specified with respect to the total quantities by weight of the carbonates and the zirconium.

The lamps according to the example were completed in quite the normal manner, the cathodes, inter alia, being heated, as a result of which the carbonates decomposed into oxides. The lamps were then set into operation in an experimental set-up and the level of interference signals transmitted by the lamps at various frequencies, which are specified in the table, was measured. The intensity of these interference levels was compared with the intensity of the interference level of a lamp which differed from the lamps according to the example only in that no tungsten monoboride was present on the electrodes. The table shows the differences with respect to these reference lamps in db.

In the last column of the table the reduction in the specific light efficiency of the lamps according to the example with respect to the reference lamp is stated in percent. The decline in light and the level of the interference were measured after the lamps had been in operation 100 hours.

The table also gives measured results of lamps which were manufactured exactly in accordance with the above example but in which other borides or the element boron itself was used in the specified amounts.

TABLE

| Addition Used | Percent by Weight | Difference Interference Level in db — 550 kc./sec. | 1,000 kc./sec. | 1,400 kc./sec. | Decrease Specific Light output in percent |
|---|---|---|---|---|---|
| Boron | 0.3 | −8 | −7 | −7.5 | 1 |
| Boron oxide | 0.3 | −8 | −7.5 | −8 | 0.8 |
| | 2.5 | −11 | −9.5 | −12 | 2.5 |
| Chromium diboride | 0.3 | −8 | −14.5 | −15 | 1 |
| | 2.5 | −15.5 | −19.5 | −18.5 | 2.9 |
| | 4.0 | −16 | −20.5 | −19.5 | 4.1 |
| Tungsten monoboride | 0.3 | −8.5 | −12.5 | −14.0 | 0.4 |
| | 2.5 | −8.5 | −17 | −18.5 | 0.7 |
| | 5.5 | −8.5 | −15.5 | −17.5 | 1.4 |
| Molybdenum diboride | 0.3 | −1.5 | −7.5 | −14 | 0.4 |
| | 2.5 | −9 | −17 | −19 | 3.6 |
| | 4.0 | −10.5 | −17 | −19.5 | 4.1 |
| Calcium boride $CaB_6$ | 0.3 | −15 | −15 | −13 | 1.6 |
| | 2.5 | −5 | −5 | −5 | 4.5 |
| | 5.5 | −14 | −11 | −4 | 11.6 |
| Lanthanum hexaboride $LaB_6$ | 0.3 | −6.5 | −14.5 | −17 | 2.2 |
| | 2.5 | −14 | −17 | −16 | 5.8 |
| | 5.5 | −13.5 | −14.5 | −13 | 7.6 |
| Cerium hexaboride $CeB_6$ | 0.3 | −15 | −16 | −15 | 2 |
| | 2.5 | −17 | −17 | −15 | 5.1 |
| | 5.5 | −18 | −17 | −15 | 7.7 |
| Praseodymium boride $PrB_6$ | 0.3 | −10 | −14 | −13 | 3.1 |
| | 2.5 | −14 | −16 | −14 | 5.4 |
| Samarium boride $SmB_6$ | 0.3 | −6 | −14 | −13 | 2.9 |
| | 2.5 | −14 | −16 | −14 | 5.8 |
| Mixture of borides of rare earths | 0.3 | −13 | −16 | −14 | 2.9 |
| | 2.5 | −12 | −16 | −15 | 5.1 |
| Uranium boride $UB_2$ | 0.3 | −10 | −8 | −8 | 0 |
| | 2.5 | −18 | −17 | −16 | 3.3 |
| Zirconium boride $ZrB_2$ | 0.3 | −3.5 | −5.5 | −7 | 0.8 |
| | 2.5 | −8.5 | −12 | −12 | 3.8 |
| | 5.5 | −9 | −9 | −8 | 6.2 |
| Vanadium diboride $VB_2$ | 0.3 | −8 | −16 | −15 | 3.9 |
| | 2.5 | −12 | −10 | −8 | 7.6 |
| | 5.5 | −11 | −11 | −8 | 8.9 |
| Tantalum monoboride TaB | 0.3 | −12 | −13 | −13 | 0 |
| | 2.5 | −14 | −16 | −15 | 1.4 |
| | 5.5 | −17 | −16 | −14 | 3 |
| Manganese diboride $MnB_2$ | 0.3 | −11 | −13 | −13 | 0.4 |
| | 2.5 | −17 | −17 | −15 | 2.6 |
| | 5.5 | −13 | −14 | −12 | 4.6 |

What is claimed is:

**1.** A low-pressure mercury-vapor discharge lamp comprising an envelope filled with an ionizable medium defining a discharge space, a pair of spaced thermionic electrodes within said discharge space, each of said electrodes comprising a support which is coated with a thin layer of electron-emissive material containing at least one alkaline-earth oxide, said emissive material being mixed with, from 0.1% to 15% of the amount by weight of alkaline-earth oxide, a boron-containing material capable of suppressing unwanted electromagnetic radiations during operation.

**2.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1** in which the boron-containing material is boron.

**3.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1** in which the boron-containing material is a metal boride.

**4.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1** in which the boron-containing material is a boride of a metal selected from the group consisting of a metal in second, fourth, fifth, sixth and seventh groups of the periodic table, a metal selected in the lanthanum series, and a metal in the actinide series.

**5.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1** in which the boron-containing material is a boride of a metal selected from the group consisting of chromium, molybdenum, and tungsten.

**6.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1** in which the boron-containing material is a boride of a metal selected from the group consisting of uranium and manganese.

**7.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1** in which the boron-containing material is tungsten monoboride.

**8.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1** in which the boron-containing material is tantalum boride.

**9.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1**, in which the grain size of the boron-containing material mixed with the emissive material is smaller than 30 times the average grain size of the particles of emissive material.

**10.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1**, in which the total quantity of the boron-containing material is from 0.1% to 10% of the quantity by weight of the emissive material.

**11.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1**, in which the grain size of the boron-containing material mixed with the emissive material is smaller than 15 times the average grain size of the particles of the emissive material.

**12.** A low-pressure mercury-vapor discharge lamp as claimed in claim **1** in which the emissive layer in addition to the boron-containing material contains from 1% to 5% of zirconium of the quantity by weight of emissive material.


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