

Nov. 18, 1969

K. FRÖHNER ETAL

3,479,550

DEVICE AND METHOD FOR REDUCING BLACKENING IN A LAMP

Filed June 20, 1966

3 Sheets-Sheet 1

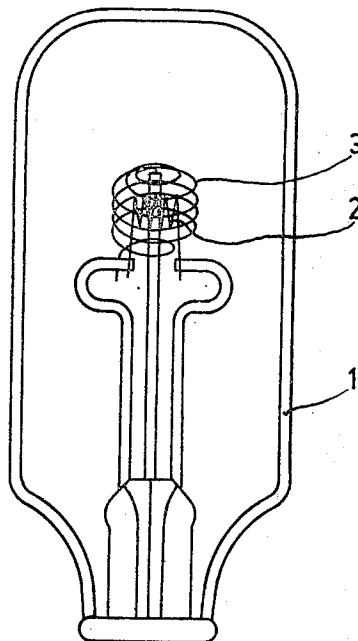


FIG. 1

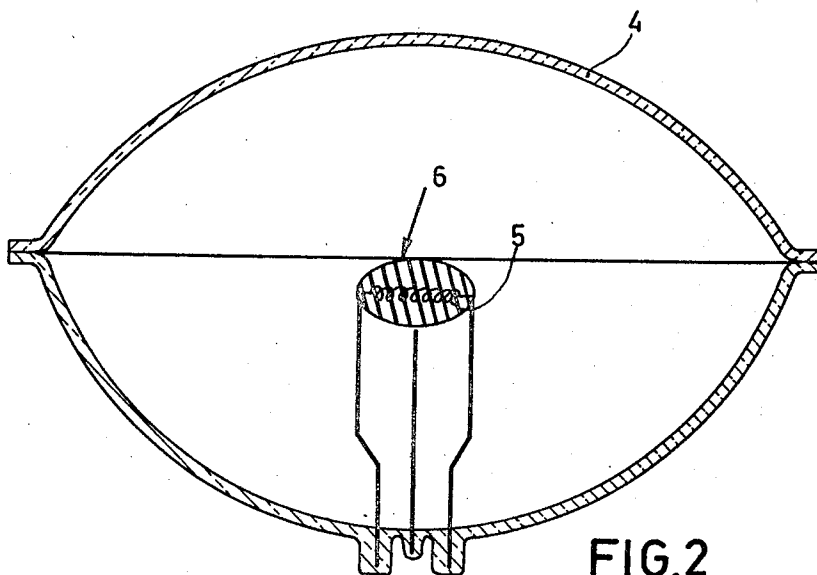


FIG. 2

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3 Sheets-Sheet 2

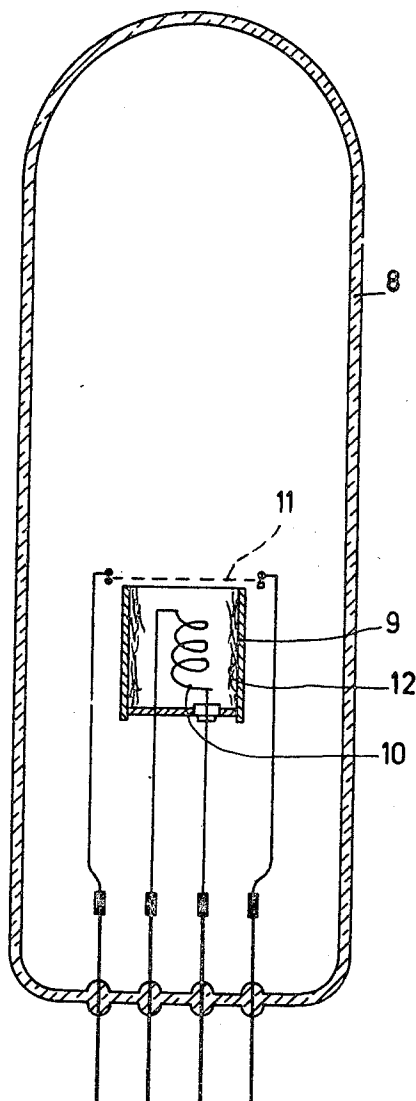


FIG. 3

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3 Sheets-Sheet 3

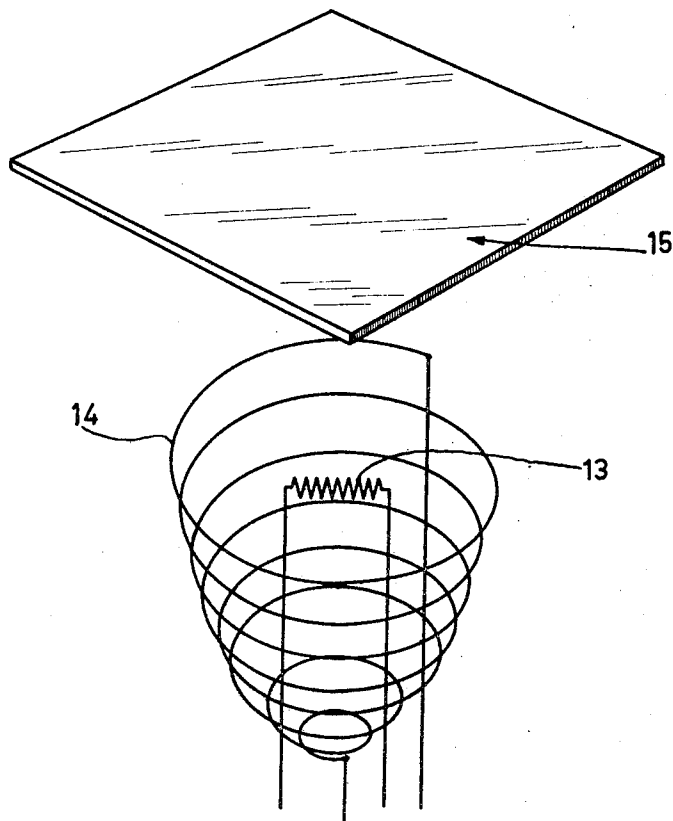


FIG. 4

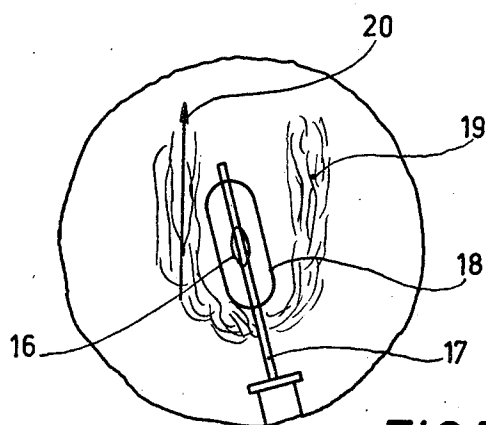


FIG. 5

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DEVICE AND METHOD FOR REDUCING
BLACKENING IN A LAMP

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Filed June 20, 1966, Ser. No. 558,824

Claims priority, application Germany, June 29, 1965,
N 26,964

Int. Cl. H01j 17/04, 61/04

U.S. Cl. 313—205

13 Claims

ABSTRACT OF THE DISCLOSURE

A sealed, gas-filled device such as an incandescent lamp, has therein a heated filament which partially vaporizes, thus blackening the interior of the bulb, and a grid surrounding the filament and electrically heated to establish a radiometric force that will impede the flow of vaporized metal to the bulb walls.

The invention relates to a gas-filled device such as an incandescent lamp, in which a member to prevent blackening surrounds a filament body and which consists at least partially of a grid. The grid is at a higher temperature than the bulb wall.

The vaporization of the filaments in gas-filled incandescent lamps, not only has an adverse influence on the life of the lamp but also causes blackening of the bulb and consequently a considerable reduction of the luminous efficiency. Moreover, in heavily loaded lamps, high temperatures may occur as a result of absorption of radiation at places with a strong blackening. Therefore, the bulb becomes soft and blistered in a comparatively short period of time.

In this connection, numerous attempts have been made to prevent said phenomena. It is known, for example, in gas-filled incandescent lamps to provide a screen or raster above the filament construction, so as to filter the metal, assisted by the convection current. In this case, the screen or raster is heated by the convection current and by irradiation. However, blackening of the bulb is not completely prevented.

A known arrangement has for its object to decrease the vaporization of filaments in gas-filled filament lamps and the associated blackening of the bulb by arranging in the proximity of the filaments, namely outside the filament construction or between the filaments, an electrode which consists, for example, of thin wires extending parallel to the filaments. The object of the said electrode is to return the vaporized tungsten which is assumed to be charged electrically to the filament or to collect it on the electrode by suitably applied voltages. In the case of negative polarity of the electrode with respect to the filament, the electrode must be heated at a high temperature to obtain emission of electrons to cause the charging of the vaporized tungsten. However, none of these proposals has proved to be useful for practical purposes. In other technical fields, the problem of preventing blackening also occurs. For example, a hydrogen isotope replenisher for low pressure ranges can readily be obtained by evaporating a suitable metal in a rare gas atmosphere at a pressure of approximately 1 to 100 torr. A precipitation of metal soot is formed, which after pumping away the rare gas, is charged with deuterium/tritium mixtures at a pressure of approximately 40 torr. In this case so much gas is admitted that the atomic ratio between hydrogen isotope atoms and metal atoms is from 0.5 to 0. With such a

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replenisher the gas pressure in a vacuum system may be adjusted at a given value of for example 10^{-4} to 10^{-2} mm. by choice of the temperature, in which in the vacuum system gas consumed at another place is replenished by the metal soot or gas released at another place is absorbed by the metal soot. During the vaporization of the metal, it should be noted that the soot deposits at undesired places, on the contrary it is the very invention that the soot is maintained in a small gas-permeable vessel, the member for preventing vaporization being required to prevent emergence of the soot during vaporization without forming a resistance to flow for the mixture of hydrogen isotopes.

In an absorption pump, it may be required to deposit finely divided metal on a given surface and to keep the remainder of the surface of the pumping vessel free from deposits. If metal sheets are used as members for preventing the vaporization which sheets terminate in the proximity of the desired place of deposition, they may constitute a considerable resistance to flow for the gases to be absorbed and as a result prevent the gases from being absorbed rapidly by the absorption layer consisting of finely divided metal.

It is the object of the invention to provide a device which overcomes the drawbacks of the known devices and moreover has advantages over the prior art constructions.

In a gas-filled device, in which a member to prevent vaporization surrounds a filament and consists at least partially of a grid which is at a higher temperature than the wall of the device, according to the invention, the temperature of the grid is so high and consequently the temperature gradient between the filament and the grid is so low and the grid has such a mesh size with respect to its distance to the filament that at a short distance from the filament nuclei formed by supersaturation in the metal vapour formed by atomic vaporization and the conglomerates grown therefrom are hampered in their movement by radiometer force, the difference in voltage between the grid and the filament being either zero or so small that the electric field has no noticeable influence on the movements of the conglomerates.

The invention is based on the recognition of the fact that, the vaporization of the filament in a gas not attacking the filament body, for example, the vaporization of a filament in a gas-filled incandescent lamp taking place atomically on the surface of the filament, at a short distance thereof (less than 2 mm.) nuclei formation occurs on the bases of high super-saturations. These nuclei grow into metal drops having diameters of from 30 to 200 Å. The presence of such metal drops could be proved with electron-optical records of metal deposited in lamps. By reducing the temperature gradient between the filament and the grid which is at a high temperature, the movement of the material particles and consequently also the mass transport are hampered. The forces, which in a gas act upon particles suspended in the gas under the influence of temperature differences are known as the radiometer effect. The radiometer forces are proportional to the temperature gradient. According to the invention, the temperature gradient is reduced and thus the material transport decreased by the conglomerates formed. Since it can be demonstrated that under the conditions occurring in incandescent lamps diffusion by concentration differences is negligible with respect to material transport by conglomerates under the influence of radiometer forces, the device according to the invention provides a considerable reduction of the material transport and consequently of the blackening of the bulb.

Calculations also prove that very high field strength of a few thousand v./cm. would have to be used to obtain

a noticeable influence of the material transport by electrostatic forces on possibly charged metal drops.

Temperature gradients of more than 10,000° K./cm. can occur in incandescent lamps in the proximity of the filament. According to the invention, the temperature gradient is preferably chosen to be lower than 500° K./cm. by providing a grid. In this case, the mutual distances between the grid wires preferably do not exceed the distance of the grid wires to the filament. The wires may be very thin so that the loss of light as a result of the presence of the grid is small and in the direction of use, is less than 10%, preferably less than 5%.

As a result of the presence of the grid around the filaments only a strongly reduced laminar flow occurs inside the grid in an incandescent lamp which promotes the decrease of the temperature gradient and the reduction of the material transport. The decrease of the temperature gradient can be made visible with a "Schlieren"-device in that the principal "Schlier" occurs outside the grid.

In an incandescent lamp according to the invention, the grid may be connected in parallel with the filament to raise its temperature. However, according to the invention, it is also possible to heat the thin wires of the grid by radiation from the filament at such a high temperature that the conditions are satisfied. In this case, it should be ensured in particular that heavy supporting wires do not dissipate too much heat.

A gas replenisher according to the invention comprises a metal vaporizer in a metal beaker, which comprises on its open side a metal net which can be heated.

According to the invention, a device, for example an absorption pump for depositing a finely divided metal at restricted places comprises a vaporizer surrounded by a grid which can be heated and which has a comparatively large aperture only in the direction of the metal deposit but otherwise meets the conditions of the invention and thus is gas-permeable.

In order that the invention may readily be carried into effect, it will now be described, in greater detail, by way of example, with reference to the accompanying drawing in which,

FIG. 1 is a diagrammatic view of a projection lamp,

FIG. 2 is a sectional view of an automobile headlight lamp,

FIG. 3 is a sectional view of a gas replenisher, for a nuclear physical apparatus,

FIG. 4 is a diagrammatic illustration of a vaporizing device for directed vaporization, and

FIG. 5 is a diagrammatical representation of a "Schlieren"-photograph.

In FIG. 1, a glass bulb 30 mm. in cross-section 80 mm. in length is denoted by 1. The tungsten filament 2 for 12 volt and 100 watt is surrounded at a distance of approximately 7 mm. by a tantalum wire 3, diameter 0.1 mm. and the turns spaced 2 mm. apart. The tantalum wire 3 is connected parallel to the filament 2 and is heated at a temperature of approximately 1800° C. The filament 2 has a temperature of 3000° C. The total energy consumption of filament and grid is not larger than for a filament without grid. Whereas a very strong blackening of the bulb occurred within a period of 10 hours when no grid was used, blackening was no longer observable when a grid was used.

In FIG. 2 reference numeral 4 denotes a headlight with a filament 5 of 6 volts and 150 watt. The filament is surrounded by a helically wound tantalum wire 6 of 1/40 mm. thickness and the turn spaced 2.5 mms. apart. By absorption of radiation, the tantalum wire reaches a temperature of 1500° C. The filament and the tantalum wire are supported by three supporting wires 7. No blackening was observed in the lamp after prolonged burning.

FIG. 3 shows a part of a bulb 8 of a physical apparatus which during operation is filled with a mixture of the hydrogen isotopes, deuterium and tritium under a pressure

of 10⁻³ torr. In the bulb is arranged a nickel cylindrical receptacle 9, which comprises a vaporization spiral 10. The vaporization spiral 10 consists of a tungsten wire, on which titanium wire is wound. Closely above the upper openside of the receptacle 9, a gauze 11 is arranged manufactured from molybdenum wire, 25 microns thickness with apertures of 200 microns.

In the receptacle 9 titanium soot is to be prepared by vaporization of the spiral 10, the bulb 8 being filled with argon gas at a pressure of 20 mm. mercury column. During the vaporization of the spiral 10, the gauze 11 is heated at a temperature of approximately 1500° C. while the spiral has a temperature of approximately 2000° C. As a result of the heating of the gauze, no noticeable vaporization through the gauze takes place in contrast with the case in which the gauze is not heated. After filling the bulb with the desired pressure of the hydrogen isotopes, it is ensured by the presence of the gauze that the gas has ready access to the titanium soot 12 on the inside of the receptacle 9, which would not be the case if, instead of the gauze, a flat plate were arranged close above the nickel receptacle 9.

FIG. 4 shows a vaporization device which may be used, for example, in absorption pumps. A filament 13 coated with a layer of titanium is arranged in a conical grid 14. During the vaporization of the titanium from the spiral 13, said grid is heated to such a high temperature that the titanium deposits only on the surface 15 and is not scattered in other directions.

FIG. 5 is a Schlieren-photograph of a projection lamp with flat spiral 16, which in the photograph is substantially entirely hidden behind the supporting pole 17. The flat spiral 16 is surrounded by a wide spiral 18 consisting of thin wire and also heated only to a somewhat lower temperature. The principal "Schlieren" occurring in this lamp according to the invention is denoted by 19, the arrow 20 indicating the direction of the vertical.

What we claim is:

1. A gas filled device including a sealed housing for use in conjunction with a source of electric current, comprising: (a) a filament disposed within the sealed housing, (b) circuit means for conducting electric current from the source to the filament for heating the filament from which particulate matter is emittable as partial vaporization thereof, (c) a grid means disposed between at least a part of filament and the housing wall, and (d) circuit means for conducting electric current from the source to the grid for heating the grid to a temperature higher than that of the housing wall and lower than that of the filament with a smaller temperature gradient between the filament and grid, than between the grid and the wall, whereby radiometric forces from the heated grid inhibit the outward movement of said particulate matter emitted from the filament toward the grid.

2. A device as defined in claim 1 wherein the grid surrounds the filament and has one relatively large aperture, the emitted particulate matter (inhibited from flowing toward the grid) is permitted to flow from the filament outward through the aperture.

3. A device as defined in claim 2, further comprising a plate disposed adjacent said aperture in the grid, whereby particulate matter flowing through the aperture becomes deposited on the plate.

4. A device as defined in claim 1 for use as a gas replenisher, further comprising a metal receptacle generally surrounding the filament and having one open side, the grid being disposed adjacent said open side, whereby said emitted particulate matter (inhibited from flowing out of the receptacle toward the grid) is permitted to flow toward and become deposited on the inner walls of the receptacle.

5. A device as defined in claim 1 wherein said device is an incandescent lamp and the temperature gradient between the filament and the grid is smaller than 5000° K./cm.

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6. A device as defined in claim 1 wherein said grid is connected parallel to said filament with respect to said source of current.

7. A device as defined in claim 1 further comprising means for maintaining the voltage differential between the filament and the grid sufficiently small that movement of said particles is substantially unaffected by the electric field.

8. A gas filled device including a sealed housing for use in conjunction with a source of electric current, comprising: (1) a filament disposed within the sealed housing, (2) circuit means for conducting electric current from the source to the filament for heating the filament from which particulate matter is emittable as partial vaporization thereof, (3) a grid disposed between the filament and the housing wall and substantially surrounding the filament on all sides, and (4) circuit means for conducting electric current from the source to the grid for heating the grid to a temperature higher than that of the housing wall and lower than that of the filament, whereby radiometric forces from the heated grid inhibit the outward movement of said particulate matter emitted from the filament, and reduces blackening of the bulb walls by said matter.

9. A device as defined in claim 8 used as a lamp wherein the grid comprises wires and the distances between the grid wires are at least as small as the distance between the grid and the filament, and the loss of light in the direction of use is smaller than 10%.

10. A method for use with a gas-filled device including a sealed housing and an electrically-heated filament therein, for controlling the movement of particular matter emittable as partial vaporization of the filament, comprising the steps:

- (a) at least partially surrounding the filament with a grid, and
- (b) heating the grid to a temperature lower than that of the filament and higher than that of the housing walls, and thereby maintaining a temperature gradient between the grid and filament substantially smaller than the gradient between the grid and the housing walls for inhibiting the flow of particulate matter from the filament toward the grid.

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11. A method as defined in claim 10, comprising the further steps:

- (a) surrounding the filament with a metal receptacle having an aperture, and
- (b) disposing said grid adjacent said aperture, whereby the emitted particulate matter flows to and is deposited on the inner walls of the receptacle.

12. A method as defined in claim 10 comprising the further step of maintaining a voltage difference between the grid and the filament sufficiently small such that the electric field has no noticeable influence on the movement of the conglomerates.

13. A method for reducing the deposition onto the interior walls of a sealed, gas-filled device of metal particulate vaporized from the filament therein, comprising the steps:

- (a) heating the filament by flowing a current there-through,
- (b) substantially surrounding the filament with a grid,
- (c) heating the grid by flowing current therethrough,
- (d) maintaining the temperature of the grid lower than that of the filament, but high enough to establish a radiometric force for opposing the movement of vaporized particles from the filament toward the grid.

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U.S. Cl. X.R.

313—217, 222, 240, 348