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(12) # EUROPEAN PATENT APPLICATION

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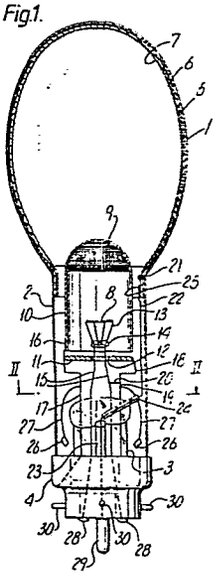
(54) **Cathodoluminescent light sources and electric lighting arrangements including such sources.**

(57) A cathodoluminescent lamp includes an anode constituted by an electrically conducting coating on the interior surface of the bulb wall, a phosphor coating over the whole of the bulb wall interior, a dome-shaped grid located near the junction of the bulb with the envelope neck and supported on a hollow metal cylinder, and an electron emissive cathode mounted within the grid/cylinder assembly. The cathode may be effectively circular and located near the grid, or may be a linear filament located near the open end of the cylinder remote from the grid. In the latter case a metal disc, connected to the negative lead to the cathode, is located near the open end of the cylinder, to repel electrons emerging therefrom. The leads to the anode, cathode and grid lie within the neck and pinched foot tube closing the neck, and are connected to contacts carried by the lamp cap, the anode lead passing through the exhaust tube in the foot tube.

Fig.1.

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This invention relates to cathodoluminescent light sources in the form of lamps which are suitable for use for general lighting purposes, and to electric lighting arrangements including such lamps.

In the specification of our co-pending European Patent Application No. 81300387.8 there is described a cathodoluminescent lamp which includes an evacuated bulbous glass envelope with an integral glass neck portion terminated by a cap, an anode constituted by an electrically conductive coating on at least part of the interior surface of the bulb wall, such that at least part of the bulb wall is light transmissive, a layer of phosphor on the whole of the interior of the bulb wall and overlying the said anode coating, which phosphor is excitable to luminescence by electron bombardment, a dome-shaped grid located within the bulb adjacent to the junction between the bulb and neck of the envelope and supported by a hollow metal cyclinder disposed coaxially within the envelope neck, an electron emissive cathode mounted within the assembly of the grid and its supporting cylinder, which cathode is so shaped, and/or so located within the said grid assembly, that the electrons emitted from the cathode in operation of the lamp are substantially uniformly distributed over the whole of the surface of the grid on which they impinge, and electrically conducting leads connecting the said anode, grid and cathode to respective contacts, the grid and cathode contacts being constituted by or carried by the said cap and the anode contact being located on the exterior of the envelope neck, which contacts are adapted to be connected to a circuit arrangement for operation of the lamp from a source of electric current supply.

In a first form of lamp described in the aforesaid specification, the cathode is of effectively circular form and is located coaxially within the grid

assembly so that the electron emissive part thereof lies in the region of the junction between the grid and its supporting cylinder. In a second form of lamp described in the aforesaid specification, the cathode consists of a linear wire coil filament incorporating electron emissive material and disposed orthogonally to the longitudinal axis of the assembly of the grid and its supporting cylinder, and is located within the said cylinder in a position nearer to the open end of the cylinder remote from the grid than to the end thereof on which the grid is supported.

In each of the forms of lamp described in the aforesaid specification, the leads to the cathode and grid are sealed into the closure of the neck of the envelope and extend to contacts on the lamp cap, and the lead to the anode is located along the exterior of the neck, being sealed through the envelope wall for connection to the anode coating, and extending to a contact provided on the exterior of the neck.

It is an object of the present invention to provide an improvement in lamps of the forms described in the above-mentioned specification, in respect of the location of the lead to the anode.

According to the invention, a cathodoluminescent lamp includes an evacuated bulbous glass envelope with an integral glass neck closed by a pinched glass foot tube incorporating an exhaust tube extending parallel to the longitudinal axis of the foot tube, the neck closure terminating in a cap, an anode constituted by an electrically conductive coating on at least part of the interior surface of the bulb wall, such that at least part of the bulb wall is light transmissive, a layer of phosphor on the whole of the interior of the bulb wall and overlying the said anode coating, which phosphor is excitable to luminescence by electron bombardment, a dome-shaped grid located within

the bulb adjacent to the junction between the bulb and neck of the envelope and supported by a hollow metal cylinder disposed coaxially within the envelope neck, an electron emissive cathode mounted within the assembly of the grid and its supporting cylinder, and electrically conducting leads, all located wholly within the envelope neck and neck closure, connecting said anode, grid and cathode to respective contacts carried by the said cap for connection to a circuit arrangement for operation of the lamp from a source of electric current supply, the leads to the grid and cathode being sealed through the glass of the pinched foot tube, and the lead to the anode passing through the said exhaust tube.

The location of the anode lead within the envelope neck, instead of on the outside thereof, is advantageous from the point of view of safety, in view of the high potential, of the order of 5 to 15 kilovolts, which is required to be applied to the anode for operation of the lamp. The portion of the anode lead which passes through the exhaust tube is isolated from the portions of the cathode and grid leads which are sealed through the glass of the foot tube. The portion of the anode lead extending within the envelope neck, from the anode coating on the bulb to the exhaust tube entry, should be located so that the distances between the anode lead and the other electrically conducting members within the neck, including the leads to the cathode and grid and the grid supporting cylinder, are maintained as large as possible. Thus the anode lead is preferably laid along, or close to, the interior surface of the envelope neck to a level approaching that of the exhaust tube opening, and then bent to enter the exhaust tube; at least the portion of the anode lead extending from the neck wall to the exhaust tube is preferably insulated by a surrounding glass sleeve.

The cathode, in respect of its shape and location, may be of any of the forms described in the above-mentioned specification.

The anode coating preferably covers the whole of the interior surface of the bulb wall and may consist of a known type of light transmissive electrically conducting coating formed, for example, of tin oxide and/or indium oxide. Alternatively, part of the bulb may be provided with an internal reflective metal coating which also serves as at least part of the anode, the remainder of the bulb either being free from any conductive coating or, preferably, having a light transmissive coating to provide continuity of the anode over the whole of the bulb wall.

In a lamp in which the anode consists of a light transmissive conducting coating covering the whole of the interior surface of the bulb wall, the phosphor layer overlying the anode coating is preferably covered with a white particulate reflecting coating, which may consist of any highly reflective white substance which can be produced in the form of a smoke and deposited as very fine particles on the phosphor layer, for example titanium dioxide or magnesium oxide. Such a coating, which does not impede the bombardment of the phosphor layer by electrons in operation of the lamp, reflects any of the light emitted by the phosphor which would otherwise be directed into the bulb, thus ensuring that all the light emitted by the phosphor is transmitted through the bulb wall, and hence improving the light output of the lamp.

The invention further provides an electric lighting arrangement consisting of a lamp of the form described above, and a circuit arrangement for operating said lamp from a source of electric current supply, which circuit arrangement includes means for converting

the supply voltage to unidirectional operating potentials of required magnitudes for application respectively to the anode, cathode and grid of the lamp. Suitable operating potentials are 5 to 15 kilovolts applied to the anode, 40 to 250 volts applied to the grid, and a cathode potential lower than that applied to the grid.

The circuit arrangement may be contained within a housing which is detachably mounted on the lamp cap and is insertable into a lampholder, or may be incorporated in a lampholder, the housing or lampholder being provided with contacts arranged to co-operate with the contacts on the lamp cap.

A specific form of lamp in accordance with the invention will now be described by way of example with reference to the accompanying diagrammatic drawings, in which

Figure 1 shows the lamp in part-sectional elevation, and

Figure 2 is a plan view drawn partially on the line II-II in Figure 1.

The lamp shown in Figure 1, which is designed for general lighting service, comprises an evacuated envelope formed of lead glass, or any other suitable glass which will inhibit the transmission of X-rays generated by the electron bombardment of the envelope, and consisting of a bulb 1 and an integral neck 2 in which an electron gun assembly is mounted, and which is closed by a pinched glass foot tube 3 and surmounted by a brass cap 4. The whole of the interior surface of the bulb 1 is coated with a film 5 of transparent conducting material, suitably tin oxide and/or indium oxide, which constitutes the anode, and this film is overlaid by a layer of electron-responsive phosphor 6. The phosphor layer is coated with a thin layer 7 of fine particulate titanium dioxide,

deposited from a titanium oxide smoke produced, in known manner, by hydrolysis of titanium tetrachloride vapour by bubbling the vapour through water.

The electron gun assembly includes a cathode 8 in the form of a straight single coil of tungsten wire incorporating electron emissive material, for example one or more of the oxides of barium, strontium and calcium, a dome-shaped grid 9 formed of nickel wire mesh, supported on a titanium cylinder 10 in the lower part of which the cathode is located, and a titanium disc 11 of substantially the same diameter as the cylinder 10, which disc has a central aperture 12 and is located immediately below the open lower end of the cylinder 10.

The cathode coil is mounted on four support wires 13 sealed into a glass bead 14, the wires to which the ends of the coil are attached being extended through the aperture 12 in the disc 11 and joined to nickel wires 15 which are sealed through the foot tube 3 and which constitute supports for, and conducting leads to, the cathode. The grid support cylinder 10 is carried by a nickel bracket 16 which is attached to a nickel wire 17 sealed through the foot tube and constituting the support and lead for the grid. The disc 11 is supported by a nickel bracket 18 and nickel wire 19, also sealed into the foot tube; the wire 19 is connected to the negative lead to the cathode, as shown at 20.

For connection of the anode coating 5 to a current supply, a coating of carbon 21 is applied to the interior surface of the neck-bulb junction region, covering the edge region of the anode coating, and a nickel-iron alloy lead wire 22 is attached to the carbon coating and is laid close to the interior surface of the envelope neck to a point approaching the level of the opening of the exhaust tube 23 in the foot tube, then bent to pass through the exhaust tube; the portion of the lead

extending from the vicinity of the neck to the exhaust tube is covered by a glass sleeve 24. A plan view showing the arrangement of the leads in the foot tube and exhaust tube, and including the portion of the anode lead passing from the neck wall to the exhaust tube, is shown in Figure 2. The anode lead is suitably attached to the carbon coating 21 by a silver contact 25, formed by applying a drop of silver paint over the end of the lead in contact with the carbon, the paint being hardened by heating during subsequent processing of the lamp. In the manufacture of the lamp, the anode lead wire may or may not be sealed through a glass bead before it is inserted into the exhaust tube, and the bead or wire is subsequently sealed into the exhaust tube by heating, after evacuation of the lamp. The glass seal is not seen in Figure 1, since it lies within the cap 4.

Barium/aluminium getter rings 26, of known form, are supported by wires 27 attached to the lead wires to the cathode and grid.

The lamp cap carries a pair of contacts 28, to which the cathode leads are connected, and a pin contact 29 to which the anode lead is connected, these contacts being insulated from each other and from the brass cap in the usual manner. The grid lead 17 is connected to the brass cap itself, which thus constitutes the grid contact. The cap is provided with locating pins 30, preferably three in number to ensure correct orientation of the lamp in a lampholder or circuit housing for connection of the respective contacts to the operating circuit.

The function of the disc 11, connected to the negative lead to the cathode, is to repel any electrons, emitted by the cathode in operation, which escape through the lower open end of the cylinder 10 and which would, in the absence of the disc, be attracted to the interior surface of the neck, which is positively charged in

operation, thus heating the neck and possibly causing it to crack.

As a result of the positioning of the linear cathode within the grid support cylinder, a large proportion of the electrons emitted by the linear activated filament in operation of the lamp are initially attracted to the cylinder, which is maintained at a positive potential with respect to the cathode. The electrons are thus diffused in all directions around the filament and therefore, on impinging on the grid, are distributed substantially uniformly over the interior surface thereof. This effect, combined with the effect of the dome shape of the grid, promotes substantially uniform distribution of the bombarding electrons over the whole of the phosphor-coated bulb surface, thus ensuring substantially uniform light output from the whole of the light transmissive surface area of the bulb.

For operation, the lamp of the example is inserted into a lampholder, or a housing insertable into a lampholder, in which lampholder or housing a circuit arrangement for operating the lamp from an electric current supply is mounted, the lampholder or housing carrying internal contacts arranged to co-operate with the contacts 28 and 29 and the cap 4, for connection of the cathode, anode and grid respectively to the operating circuit. The circuit arrangement employed may be of the form described in the specification of Application No. 81300387.8 with reference to Figure 4 of the drawings accompanying that specification.

Claims

1. A cathodoluminescent lamp in the form of an evacuated bulbous glass envelope (1) with an integral glass neck (2) closed by a pinched glass foot tube (3) incorporating an exhaust tube (23) extending parallel to the longitudinal axis of the foot tube, the neck closure terminating in a cap (4), characterised in that the lamp includes an anode constituted by an electrically conductive coating (5) on at least part of the interior surface of the bulb wall, such that at least part of the bulb wall is light transmissive, a layer of phosphor (6) on the whole of the interior of the bulb wall and overlying the said anode coating, which phosphor is excitable to luminescence by electron bombardment, a dome-shaped grid (9) located within the bulb adjacent to the junction between the bulb and neck of the envelope and supported by a hollow metal cylinder (10) disposed coaxially within the envelope neck, an electron emissive cathode (8) mounted within the assembly of the grid and its supporting cylinder, and electrically conducting leads (22, 17, 15), all located wholly within the envelope neck and neck closure, connecting said anode, grid and cathode to respective contacts (29, 4, 28) carried by the said cap for connection to a circuit arrangement for operation of the lamp from a source of electric current supply, the leads to the grid and cathode being sealed through the glass of the pinched foot tube, and the lead to the anode passing through the said exhaust tube.

2. A lamp according to Claim 1, characterised in that the portion of the anode lead (22) extending within the envelope neck, from the anode coating on the bulb wall to the exhaust tube entry, is located so that the distances between the said lead portion and other electrically conducting members within the neck are

maintained as large as possible.

3. A lamp according to Claim 1 or 2, characterised in that at least part of the portion of the anode lead located within the envelope neck is insulated by a surrounding glass sleeve (24).

4. A lamp according to Claim 1, 2 or 3, characterised in that the anode consists of a light transmissive conducting coating (5) covering the whole of the interior surface of the bulb wall, and in that the phosphor layer (6) overlying the said coating is covered with a white particulate reflective coating (7).

5. A cathodoluminescent lamp according to Claim 1, characterised in that the anode consists of a film (5) of transparent conducting material covering the whole of the interior surface of the bulb wall (1), the phosphor layer (6) overlying the said film is coated with a thin layer (7) of fine particulate titanium dioxide, the grid(9) is formed of metal wire mesh, the cathode consists of a straight single coil (8) of tungsten wire incorporating electron emissive material and is located within the grid-supporting cylinder (10), a metal disc (11) of substantially the same diameter as the said cylinder is located immediately outside the open end of said cylinder remote from the grid, and the anode lead wire (22) is connected to the anode film by means of a silver contact (25) formed on a coating of carbon (21) which is applied to the interior surface of the neck-bulb junction region of the lamp so as to cover the edge region of the anode film.

6. An electric lighting arrangement consisting of, in combination, a lamp according to any preceding Claim and a circuit arrangement for operating said lamp from a source of electric current supply, which circuit arrangement includes means for converting the supply voltage to unidirectional operating potentials of required magnitudes for application respectively to the anode,

cathode and grid of the lamp.

7. An electric lighting arrangement according to Claim 6, wherein the said circuit arrangement is designed to apply operating potentials of, respectively, 5 to 15 kilovolts to the anode, 40 to 250 volts to the grid, and, to the cathode, a potential lower than that applied to the grid.

Fig.1.

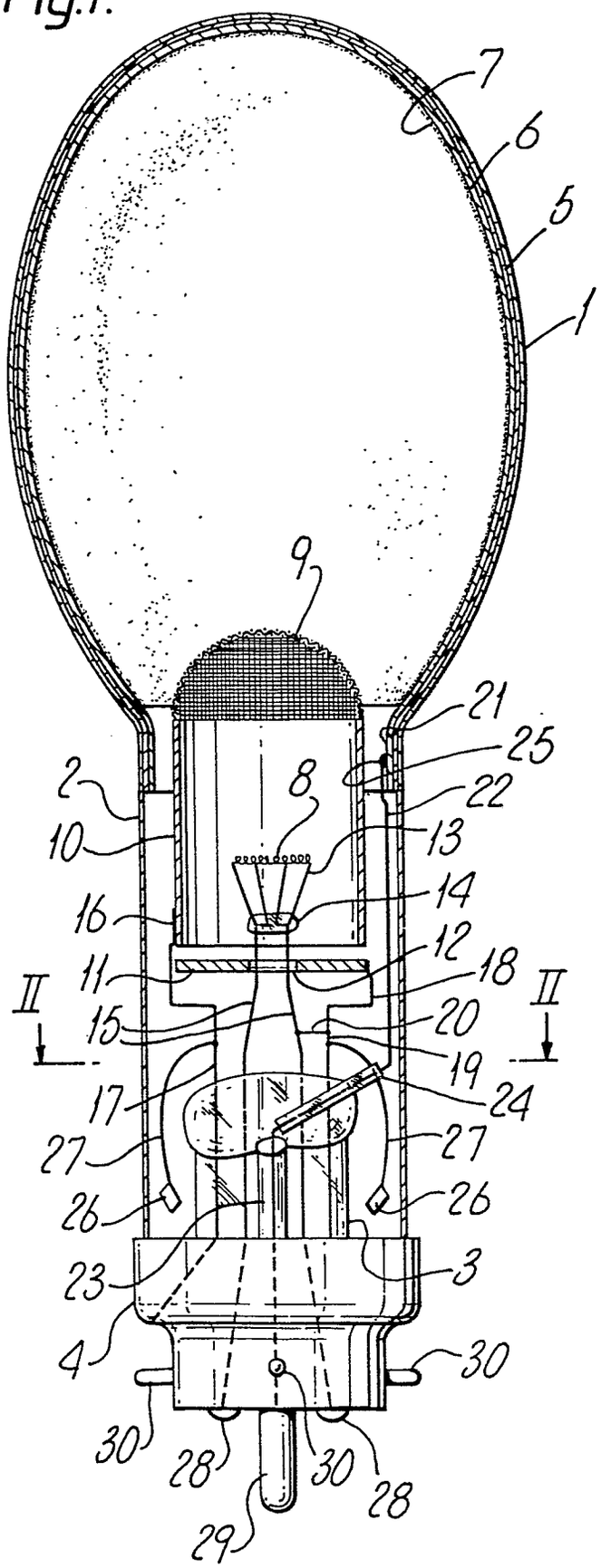
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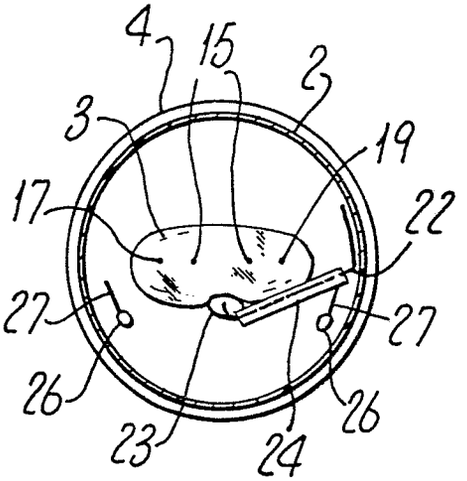
Fig.2.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EP 81305389.9

# EUROPEAN SEARCH REPORT

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim |
|---|---|---|
| D,P,X | EP - A3 - 0 035 828 (G.E.C) (16-09-1981)<br>* Fig. 1-4; abstract; claims 1-10 *<br>& GB-A - 2 070 849 (09-09-1981)<br>& JP-A2-56 136 452 (24-10-1981) | 1-7 |
| A | GB - A - 749 448 (SEBEL)<br>* Page 2, lines 5-93; fig. 1,2 * | 1 |
| A | US - A - 2 907 909 (KAZUK)<br>* Column 2, lines 33-72; column 3, lines 1-27 * | 1 |

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

H 01 J 63/06

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

H 01 J 63/00
H 01 J 31/00

CATEGORY OF CITED DOCUMENTS

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X The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| VIENNA | 08-03-1982 | VAKIL |