(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 085 969**
B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **16.09.87**

(51) Int. Cl.[4]: **H 01 J 9/395,** H 01 J 61/02

(21) Application number: **83101082.2**

(22) Date of filing: **04.02.83**

(54) Method of releasing mercury into an arc discharge lamp.

(30) Priority: **10.02.82 US 347605**

(43) Date of publication of application:
17.08.83 Bulletin 83/33

(45) Publication of the grant of the patent:
16.09.87 Bulletin 87/38

(84) Designated Contracting States:
BE DE FR GB NL

(56) References cited:
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DE-A-2 927 350
GB-A-2 063 556
GB-A-2 081 503

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EP 0 085 969 B1

Courier Press, Leamington Spa, England.

Description

This invention relates to a method of releasing mercury into an arc discharge lamp and has particular application to fluorescent lamps.

In the past, it has been common to dispense liquid mercury into a lamp through an exhaust tubulation. Since this procedure has on occasion been considered an environmental hazard, as well as being wasteful, other techniques, involving the release of mercury from a solid after the lamp has been evacuated and sealed, have been employed.

These other techniques have involved the use of radio frequency (RF) induced currents in order to heat the mercury target. This has required the use of a metal antenna loop in order to intercept and convert the RF energy into an RF heating current. (See f.i. GB—A—2,063,556).

In one such method the antenna took the form of a disintegration shield encircling the lamp coil. This shield contained an intermetallic Ti_3 Hg alloy applied to one side of an oval-shaped ribbon loop made of a base metal such as nickel or stainless steel. The metal ribbon had a width of about 6.35 mm (0.25 inches).

Another method of mercury dispensing employing the disintegration shield RF antenna principle was to position the mercury target across a gap in the ribbon shield. The mercury was contained in either a glass or metal capsule. In the case of the glass capsule a fine wire was either wrapped around the capsule or passed through it. The ends of the wire were then welded to each side of the shield gap to complete the loop current path. In the case of the metal capsule, the capsule itself is welded across the gap to complete the loop current path.

Previous dispensing techniques involving metal ribbon shields have relied on the heat generated by the RF current to raise the temperature of the metal loop or the wire or capsule across the shield gap to the level required for mercury release. The required temperature varied depending on the type of mercury target. The Ti_3 Hg alloy releases mercury by thermal decomposition within a temperature range of 600°C to 1000°C. The release time will be lower at the higher temperature. A release time of 25 seconds is achieved for a temperature of 900°C. In the case of the glass capsule, the wire temperature required to crack the glass is about 1000°C, and Hg release times are between 5 and 10 seconds. For the metal capsules, the mercury release is obtained when the vapor pressure within the capsule increases to the bursting point of the capsule design. This can vary considerably depending on the capsule material as well as the wall thickness. Release times of about 5 seconds have been reported using stainless steel capsule of 2—3 mil wall thickness.

All of the methods as mentioned above require the use of a closed loop metal antenna to convert the RF energy to RF heating current. This adds to the expense of the lamp and limits the minimum release time since a two-stage energy conversion process is required.

Further, a method of releasing mercury into an arc discharge lamp is known, said discharge lamp having a tubular glass envelope with two ends, a mount sealed into each of said ends, each of said mounts including a glass stem having a pair of lead-in conductors sealed therein, and an electrode supported between each of said pairs of said lead-in conductors, and a mercury target, more specifically, prior application EP—A—0,081,263 (a document according to Art 54(3) Epc) relates to a method of producing a low-pressure mercury vapour discharge lamp in which a container holding a quantity of mercury is positioned at one end of a supporting element. Such supporting element is electrically connected to one of the electrode lead-in-wires by means of a nickel connecting wire. The container is heated by electron bombardment to release the mercury by applying a direct current voltage between two connecting pins. Thereafter, an additional manufacturing step is required to break the nickel wire before the lamp is ready for use.

It is an object of the invention to obviate the disadvantages of the prior art and to enhance mercury release within an arc discharge lamp, more specifically, to achieve faster mercury release times at the expenditure of less energy while using an arc discharge lamp having a tubular glass envelope with two ends, a mount sealed into each of said ends, each of said mounts including a glass stem having a pair of lead-in conductors sealed therein, and an electrode supported between each of said pairs of said lead-in conductors, and a mercury target adjacent one of the electrodes.

This object is accomplished in that one of said mounts is provided with a third lead-in conductor and that said method comprises the steps of positioning the mercury containing target on said third lead-in conductor within said lamp, connecting this third lead-in conductor to the positive side of a d.c. power supply and one of the electrodes forming a source of electrons to the negative side of the d.c. power supply, and bombarding said target with a directed stream of electrons of sufficient energy to heat said target and release said mercury.

With the invention all the current will be drawn to the mercury target and the collector surface area will be limited to that of the target itself; electrons arriving at the target end of the lamp will not be divided by the electrode, lead-in wires and mercury target. This will result in solving the object as stated above. The mercury release is accomplished after the exhaust, fill, and tip-off operations have been performed.

The invention and preferred embodiments thereof will be described in more detail hereinafter in connection with the accompanying drawings.

Fig. 1 is a diagrammatic view of an electrical circuit employable with the invention;

Fig. 2 is a diagrammatic view of one form of fluorescent lamp utilizing a particular electrical connection to release mercury in accordance with the invention;

Fig. 3 is a diagrammatic view of an alternate lamp configuration with a different electrical connection in accordance with the invention.

Referring now to the drawings with greater particularity, there is shown in Fig. 1 a fluorescent lamp 10 formed of a tubular glass envelope 11 and having ends 12 and 14.

Lamp 10 (see Fig. 2) has mounts 16 and 18a sealed within ends 12 and 14. Mount 16 comprises a glass stem 20, lead-in conductors 22 and 24 and an electrode 26 connected to the lead-ins and supported thereby. Mount 18a comprises a glass stem 28, lead-in conductors 30 and 32 and an electrode 34.

As shown in Figs. 2 and 3, one of the mounts, for example, 18a, includes a third lead-in 40 which mounts the target 36. The target 36 such as a disc of Ti_3 Hg, is positioned between electrode 34 and stem 28.

The basic circuit arrangement for utilizing electron current to release the mercury is shown in Fig. 1 as comprising a d.c power supply 42 and a variable resistor 44. The end of the lamp 10 containing the mount to which the mercury target is attached is connected to the positive side of the power supply 42 while the other end of the lamp 10 is connected to the negative side of the power supply 42.

The current drawn through fluorescent lamp 10 is essentially electron current. The primary source of electron current in the lamp 10 is the lamp cathode which in the d.c. circuit shown is the electrode 26 connected to the negative side of the power supply 42. The primary electron current generates secondary electrons through an ionization process in the positive column of the evacuated, filled and sealed lamp. These electrons have a random thermal velocity as well as a drift velocity established by the lamp field in the direction from cathode-to-anode. Electrons arriving at the positive end of the lamp will be collected by the electrode 34, the lead-in wires, and the mercury target 36. The electron collection process converts the kinetic energy of the electron current into heat energy. The quantity of heat energy produced will depend on the kinetic energy of the electrons which is directly relatable to the anode sheath voltage. The anode sheath voltage is related to the lamp current and the electron collector surface area by equation (1).

$$V_s = \frac{KT_e}{q} \ln \frac{I_L}{J_r \cdot A_c} \qquad (1)$$

where:

V_s=Anode sheath voltage
K=Boltzman gas constant
T_e=Electron gas temperature
q=Electron charge
ln=Natural logarithmic function
I_L=Lamp current
J_r=The random thermal electron current density
A_c=The electron collector surface area.

By increasing the lamp current and reducing the size of the collector surface, the value of the sheath voltage is increased.

The power dissipated in the anode will be equal to the product of the sheath voltage and the lamp current.

$$P = V_s I_L = \frac{KT_e}{q} I_L \ln \frac{I_L}{J_r \cdot A_c} \qquad (2)$$

In using the anode heating process for mercury release, it is important that the mercury target 36 be positioned on the mount structure 18a in a manner which will maximize the value of heating power. This will minimize the required release time which is of critical importance in high speed lamp making equipment.

The mercury target 36 is attached to the isolated third lead-in wire 40 which is then connected to the positive side of the d.c. power supply. This configuration assures that the entire electron current will be collected by the mercury target. This method will result in the fastest mercury release time for a specified activation current since all the current will be drawn to mercury target 36, and the collector surface area A_c will be limited to that of the target 36 itself. Both these factors can be seen to increase the heating power in equation (2).

Two variations of the three-lead-wire circuit are shown in Figs. 2 and 3. In Fig. 3 the cathode of the discharge (the electrode 26) is located at the lamp end opposite to the mercury target 36. In Fig. 2 the cathode is the electrode 34 which is at the same end of the lamp 10 as the mercury target 36.

Activation of the mercury target 36 requires a current of between 500 to 1000 mA, depending on the size of the target 36 and the mercury release time desired. In one test of the procedure cylindrical stainless steel capsules were utilized having a wall thickness of 3 mils, a length of 160 mils, and a diameter of 22 mils. The capsules were flat on the bottom and filled with 20 mg of liquid mercury and then hermetically welded at the top end. At an activation current of 1000 mA, mercury release was accomplished in 3.5 seconds.

The target 36 also may consist of a metal capsule containing either liquid mercury, a powdered intermetallic mercury alloy, or a solid form of the mercury alloy. Alternately, the target 36 might consist of a glass ampule containing either the liquid mercury, or a powdered or solid form of a mercury alloy. The glass ampule would be contained within a cylindrical metal holder loosely crimped at the ends or a wire-type mesh holder fashioned to hold the ampule in place. In yet another embodiment, the mercury target 36 might comprise a piece of metal ribbon onto which a mercury alloy has been applied.

Claims

1. The method of releasing mercury into an arc discharge lamp (10) having a tubular glass envelope (11) with two ends (12, 14), a mount (16, 18a) sealed into each of said ends, each of said mounts including a glass stem (20, 28) having a pair of lead-in conductors (22, 24; 30, 32) sealed therein, and an electrode (26, 34) supported between each of said pairs of said lead-in conductors, and a mercury target (36) adjacent one of the electrodes, characterized in that one of said mounts (18a) is provided with a third lead-in conductor (40) and that said method comprises the steps of positioning the mercury containing target (36) on said third lead-in conductor (40) within said lamp (10), connecting this third lead-in conductor (40) to the positive side of a d.c. power supply and one of the electrodes forming a source of electrons to the negative side of the d.c. power supply, and bombarding said target (36) with a directed stream of electrons of sufficient energy to heat said target and release said mercury.

2. The method of claim 1 wherein said mercury target (36) is adjacent one (34) of said electrodes; and the other of said electrodes is the source of said electrons.

3. The method of claim 1 wherein said mercury target is adjacent one (34) of said electrodes; said adjacent electrode (34) being the source of said electrons.

Patentansprüche

1. Verfahren zur Abgabe von Quecksilber in eine Bogenentladungslampe (10) mit einer rohrförmigen Glashülle (11) mit zwei Enden (12, 14) und jeweils einer in jedes der beiden Enden eingesiegelten Halterung (16, 18a), die einen Glasschaft (20, 28) mit einem Paar darin eingesiegelter Zuführungsleiter (22, 24; 30, 32) aufweist, wobei zwischen jedem Paar Zuführungsleitern jeweils eine Elektrode (26, 34) gehalten und wobei eine Quecksilber-Fangelektrode (36) einer der Elektroden benachbart angeordnet ist, dadurch gekennzeichnet, daß eine der Halterungen (18a) mit einem dritten Zuführungsleiter (40) versehen ist und das verfahren die Schritte des Positionierens der Quecksilber enthaltenden Fangelektrode (36) auf dem dritten Zuführungsleiter (40) innerhalb der Lampe (10), das Verbinden dieses dritten Zuführungsleiters (40) mit der positiven Seite einer Gleichstromquelle einerseits und einer der eine Elektronenquelle bildenden Elektroden mit der negativen Seite der Gleichstromquelle andererseits, und schließlich das Bombardieren der Fangelektrode (36) mit einem gerichteten Elektronenstrom von ausreichender Energie umfaßt, um die Fangelektrode aufzuheizen und das Quecksilber abzugeben.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Quecksilber-Fangelektrode (36) nahe einer (34) der Elektroden angeordnet wird und die andere Elektrode die Elektronenquelle darstellt.

3. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Quecksilber-Fangelektrode nahe einer (34) der Elektroden angeordnet wird und diese benachbarte Elektrode (34) die Elektronenquelle darstellt.

Revendications

1. Procédé de libération du mercure à l'intérieur d'une lampe à décharge en arc (10) ayant une ampoule tubulaire en verre (11) présentant deux extrémités (12, 14), une monture (16, 18a) scellée à l'intérieur de chacune des extrémités, chaque monture incluant un pied de verre (20, 28) dans lequel deux entrées de courant conductrices (22, 24; 30, 32) sont scellées, et une électrode (26, 34) disposée entre les dites deux entrées de courant de chaque pied, et une capsule-cible enfermant du mercure (36) à proximité immédiate de l'une des électrodes, caractérisé en ce que l'une des dites montures (18a) comporte une troisième entrée de courant conductrice (40), et que le dit procédé comporte une étape au cours de laquelle on positionne la capsule-cible enfermant le mercure (36) sur la dite troisième entrée de courant (40) à l'intérieur de la lampe (10), on relie cette troisième entrée de courant (40) à la borne positive d'une source de puissance en courant continu, et une des électrodes constituant une source d'électrons à la borne négative de la dite source, et on bombarde la dite capsule-cible (36) avec un faisceau dirigé d'électrons présentant une énergie suffisante pour chauffer la dite cible et libérer le mercure.

2. Procédé selon la revendication 1 caractérisé en ce que la dite capsule-cible enferment du mercure (36) est à proximité immédiate de l'une (34) des dites électrodes, l'autre électrode constituant la source des dits électrons.

3. Procédé selon la revendication 1 caractérisé en ce que la dite capsule-cible enfermant du mercure (36) est à proximité immédiate de l'une (34) des dites électrodes, cette électrode (34) constituant la source des dits électrons.

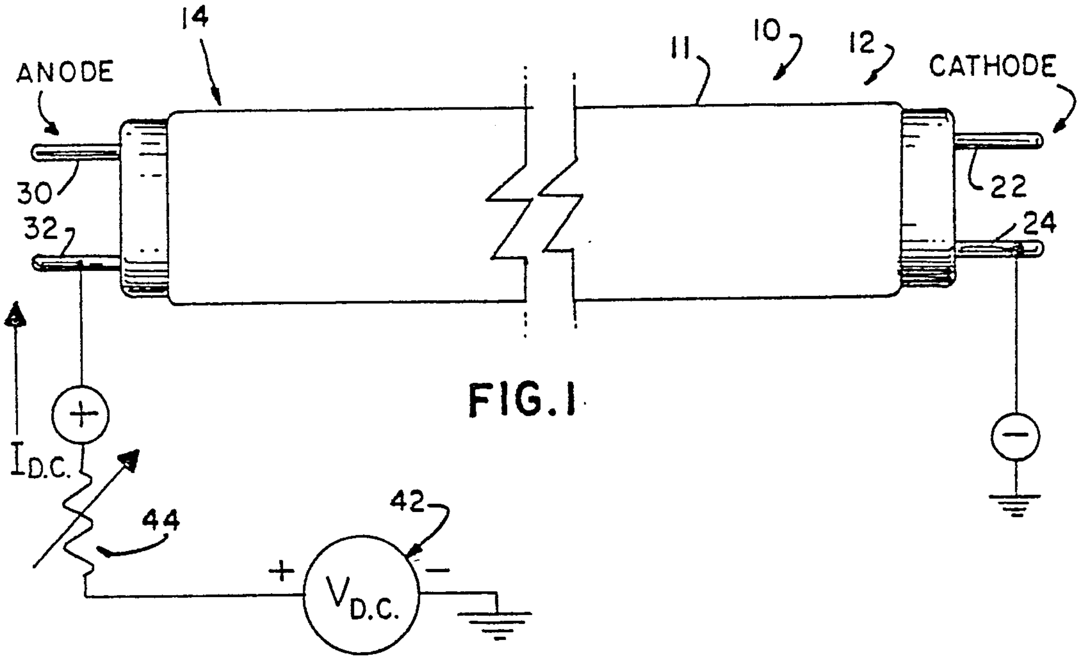


FIG.1

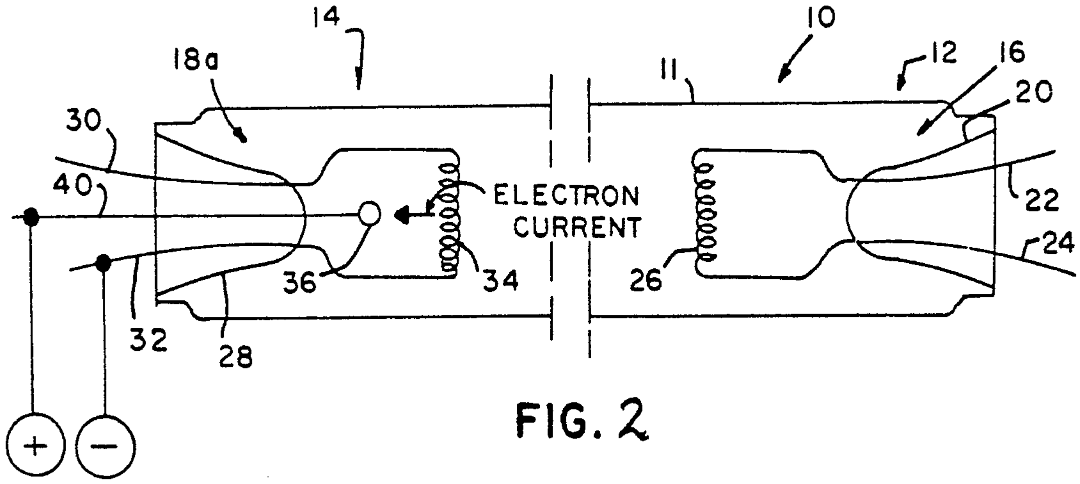
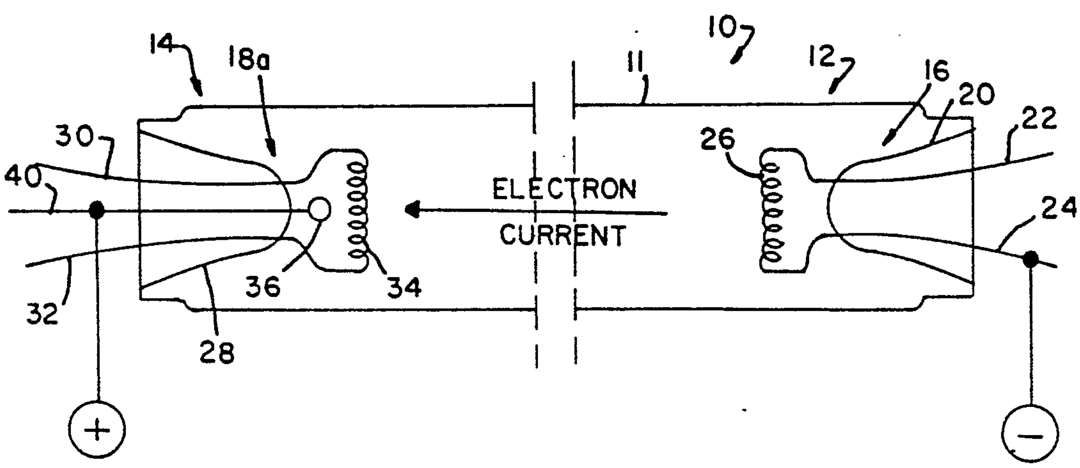

14
10
18a
11
12
16
20
30
40
ELECTRON
CURRENT
22
24
36
34
26
32
28
+
−

FIG. 2


10
14
18a
11
12
16
20
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ELECTRON
CURRENT
24
36
34
32
28
+
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FIG. 3