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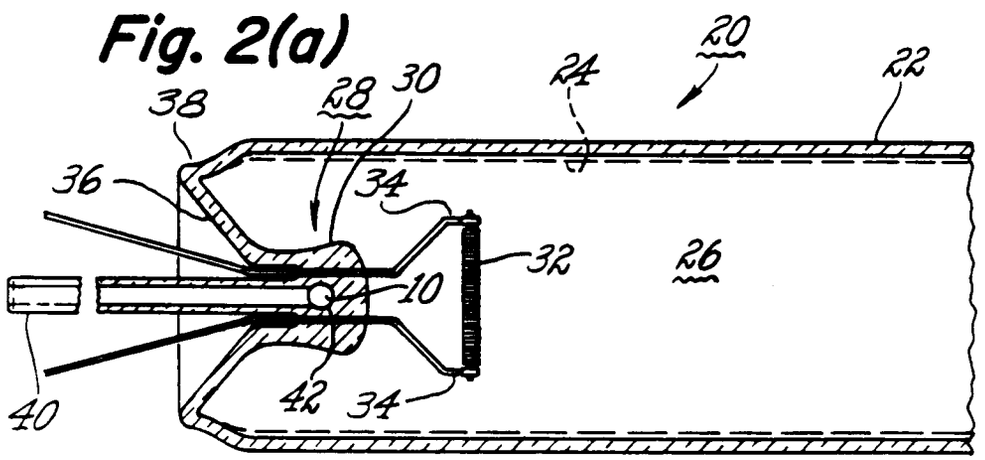
(54) Introducing a liquid into an article.

(57) An alumina sphere (10) having a porous wall structure and a cavity within is employed to introduce mercury into an arc discharge lamp, such as a fluorescent lamp (20). Mercury is introduced into the ceramic sphere by subjecting the sphere to reduced pressure, surrounding it with liquid mercury and increasing the pressure to force the mercury inside. The mercury-containing sphere is then introduced into the exhaust tube of the lamp before it is sealed. Heat or a combination of heat and reduced pressure is used to drive the mercury out of the sphere and into the interior of the lamp.



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This invention relates to a method and apparatus for dosing liquids. More particularly, this invention relates to a process for introducing mercury into a porous, hollow ceramic article, followed by introducing the mercury-containing article into an arc discharge lamp, such as a fluorescent lamp, and then discharging the mercury from the article inside the lamp and to a lamp containing the mercury and the article.

Most electric arc discharge lamps employ mercury as at least one of the ionizable components required to initiate or sustain the arc discharge and it is therefore necessary to introduce the proper amount of mercury into the lamp during the manufacturing process. The lamp industry is constantly looking for ways to introduce mercury into such lamps in a facile, inexpensive and reproducible manner. In the past, various machines and devices have been employed to introduce the mercury into the lamp in a liquid form; as an amalgam; in the interstices of a sintered metal or composite, and in mercury-containing metal or glass capsules which must be ruptured after lamp manufacture in order to release the mercury.

In accordance with illustrative embodiments of invention, it has now been discovered that a porous, hollow ceramic article, such as a sphere having porous walls, can be filled with a liquid such as mercury, the mercury-containing article then introduced into a lamp and the mercury discharged out of the ceramic article inside the lamp. The liquid or mercury is introduced into the porous, hollow ceramic article by placing the article in a subatmospheric environment to reduce the pressure inside the hollow portion or cavity of the article and then introducing the desired liquid or mercury into the reduced pressure cavity through the porous wall. The mercury-containing ceramic article is then introduced into a lamp and the mercury discharged out of the article inside the lamp by reducing the pressure in the lamp, heating the lamp and/or the article or a combination of heat and reduced pressure. This invention has been found to be particularly useful in dosing mercury into low pressure arc discharge lamps such as the well known fluorescent lamps.

Figure 1 schematically illustrates a porous, hollow ceramic microsphere made of alumina useful in the practice of the invention.

Figure 2(a) is a partial sectional view of a fluorescent lamp assembly having a porous, hollow mercury-containing ceramic sphere lodged inside the mount stem at one end of the lamp prior to sealing the exhaust tube and Figure 2(b) illustrates the lamp after sealing the exhaust tube and completing the lamp.

Referring to Figure 1, a cross section of a porous, hollow ceramic sphere useful in the practice of the invention is shown in schematic form. Thus, hollow sphere 10 is shown as comprising cavity 12 surrounded by outer wall 14. Wall 14 is sufficiently porous to allow mercury to be introduced into the interior hollow portion or inner cavity 12 of the sphere under the proper conditions. Hollow ceramic spheres having porous walls useful in the practice of the invention may be obtained from Microcel Technology, Inc., of Edison, New Jersey. These are hollow, thin-shell spheres having strength, low density and extreme resistance to thermal shock and have been made of more than twenty different ceramics including alumina, zirconia, mullite and kaolin They are available in sizes ranging from 1 to 7 mm in diameter with wall thicknesses of from 12-150 microns. Although these hollow, porous microspheres are made primarily for low mass kiln furniture, radiant burners, high-temperature low-bearing insulation and filters for molten metal, they have been found useful in the practice of the present invention.

These hollow ceramic spheres have been filled with mercury by first placing the spheres in a vacuum chamber and subjecting the spheres to vacuum or subatmospheric pressure in order to insure the desired vacuum throughout the hollow pore structure of the wall and inside the hollow cavity 12 of the spheres. After the desired vacuum or subatmospheric pressure has been reached inside the cavity, the spheres are surrounded by liquid mercury either by placing them in a pool of liquid mercury within the vacuum chamber or introducing liquid mercury into the vacuum chamber until it completely surrounds and covers all the spheres, after which time the ambient surrounding the sphere-containing pool of mercury is increased to the desired pressure. Hollow microspheres made. of alumina have been filled with mercury by placing the spheres in a vacuum chamber and reducing the pressure to a vacuum, introducing mercury into the chamber to form a pool of liquid mercury containing the spheres and then increasing the pressure over the mercury to a value ranging from atmospheric to, i.e., 200 psi. This causes the liquid mercury to penetrate through the porous walls 14 of the spheres 10 into the cavity 12. The rate of penetration of the mercury into the interior hollow cavity 12 of a sphere is dependent upon the pressure differential across the porous wall, the porosity and the temperature, it being well known and understood to those skilled in the art that increased temperature, porosity and pressure will increase the rate of penetration of mercury into the hollow sphere portion 12. On the other hand, if the porosity is too great mercury loss or leakage during storage or the lamp manufacturing process will be a problem. If the porosity is too little, release of the mercury from the sphere into the lamp may take too long. After the mercury has penetrated and filled the hollow interior cavity 12 of the microspheres in the mercury pool, the mercury is drained from the pool, or the spheres removed from the pool, and the mercury-filled spheres placed in storage under suitable conditions until they are used in the lamp making process. Storage of the mercury filled micro-

spheres is done without the need for any special precautions or handling. The vapor pressure of mercury is sufficiently low at ambient conditions and its surface tension sufficiently high to prevent the mercury from leaking or vaporizing out through the porous wall of the spheres. The amount of mercury that a hollow ceramic sphere according to the invention can contain is, of course, dependent on the size of the sphere and the cavity contained within. For example, a 3 mm diameter alumina sphere having a 0.1 mm wall thickness will hold about 80 mg of mercury and a 1.5 mm diameter sphere of the same wall thickness will hold about 20 mg of mercury.

Turning to Figure 2(a) there is shown, in schematic form, a partial section of one end of a fluorescent lamp construction prior to being sealed. Thus, fluorescent lamp preassembly 20 comprises glass envelope 22 having a coating of one or more phosphors 24 on the interior surface thereof and enclosing cavity 26. Filament mount structure 28 is shown at one end of lamp 20 as comprising glass mount stem 30 which terminates at one end in flare portion 36 fused to envelope 22 at 38. Mount stem 30 contains a pair of electrically conductive leads 34 hermetically sealed within and extending therethrough to one end of each of which is attached electrode 32 inside the lamp and the other end extends exterior of the lamp for subsequent connection to electrically conductive pins 54. The interior of electrode mount structure 28 contains exhaust tube 40 which terminates inside the mount stem at exhaust hole 42. Prior to final sealing the lamp, the assembly 20 is heated to about 300°C, exhausted, filled with argon at a pressure of about 2 torr and exhaust tube 40 is then tipped-off by heating to seal the lamp. The low pressure in the lamp assists in collapsing the exhaust tube and sealing it at the point where it is heated by a torch (not shown) to achieve sealing and removal of the excess portion of the exhaust tube after sealing. Heating the lamp assembly prior to exhausting or to applying a vacuum to the interior of the lamp envelope aids in outgassing the interior of the lamp. A mercury-containing ceramic sphere 10 is inserted into the lamp exhaust tube 40. In one embodiment the sphere passes through exhaust hole 42 and into interior cavity 26 wherein the mercury is released into the lamp due to the combination of heat and reduced pressure in the lamp. In another embodiment hole 42 is sufficiently small compared to the diameter of the sphere so as not to permit sphere 10 to pass therethrough into the interior cavity 26 of lamp envelope 22. The lamp assembly 20 is then exhausted through tube 40 and a suitable inert gas, such as argon at a pressure of about 4 torr, is filled into the lamp through exhaust tube 40 and hole 42 either before of after the mercury-containing sphere 10 is inserted into the exhaust tube, after which tube 40 is sealed as shown in Figure 2(b) containing ceramic sphere 10 enclosed either within it inside the interior of mount stem 30 or in the interior cavity 26 of the lamp. It is preferred to retain sphere 10 in the sealed and tipped-off remainder of the exhaust tube 40 within mount stem 30 so that the sphere cannot abrade or scratch the phosphor coating 24 in the lamp. After the sealed lamp assembly 20 has cooled, end caps 52 and electrical connection pins 54 are assembled onto the lamp structure to produce the completed fluorescent lamp 50.

A number of 40 watt fluorescent lamps having a coating of a calcium halophosphate phosphor 24 disposed on the inside surface of lamp envelope 22 were made in four foot lengths, being typical F40T12 cool white fluorescent lamps common in both the home and in industry. About ten lamps were made wherein the mercury-containing ceramic sphere was introduced into the interior cavity 26 of the lamp through the exhaust tube 40 and exhaust hole 42. The sphere was 3 mm in diameter, contained 80 mg of mercury and was introduced into the lamp when the lamp had cooled to about 200°C, after which 4 torr of argon was introduced into the lamp and the exhaust tube tipped-off and sealed. Another batch of ten were prepared in a similar manner, but using a 1.5 mm diameter ceramic sphere 10 containing about 20 mg of mercury which was introduced into the lamp cavity 26 after exhaustion and back filling with 4 torr of argon. The lamp was at a temperature of 200°C. Both batches of lamps were assembled with end caps and pins. These lamps were all energized and started immediately and found to be operating satisfactorily with no loss in maintenance or performance after a period of 6000 hours, at which time the lamps were turned off and the test was completed. This thus demonstrates a reduction to practice of the invention and the fact that the practice of the invention produces satisfactory fluorescent lamps.

Claims

1. A ceramic article having a porous wall structure and a hollow or cavity within wherein said cavity contains a liquid.

2. The article of Claim 1 being a sphere.

3. The article of Claim 1 or 2 being alumina.

4. A method for introducing a liquid into a ceramic article having a porous wall structure and containing a hollow or cavity within, which comprises the steps of (i) subjecting said ceramic to reduced pressure of a value and for a time sufficient to achieve the desired reduced pressure in said cavity, (ii) surrounding said ceramic with a liquid with which it is desired to introduce into said cavity and then (iii) increasing the pressure on said

liquid surrounding said ceramic to force said liquid through said porous walls into said cavity.

5. The method or article of Claim 1, 2, 3 or 4 wherein said liquid comprises mercury.

6. An arc discharge lamp containing mercury and a ceramic article having a hollow cavity within said article, wherein at least a portion of said mercury in said lamp comes from within said ceramic article.

7. The lamp of Claim 6 being a fluorescent lamp and wherein said ceramic article is present within a mount stem structure contained within said lamp.

8. A method of introducing mercury into a fluorescent lamp having an exhaust tube wherein the interior of said exhaust tube communicates with the interior of said lamp, said method comprising introducing a porous, mercury-containing ceramic article into said exhaust tube, subjecting said ceramic article to heat or heat and reduced pressure to release at least a portion of said mercury into said lamp interior and sealing said exhaust tube.

9. The method or lamp of Claim 4, 5, 6, 7 or 8 wherein said ceramic is a sphere.

10. The method or lamp of Claim 9 wherein said ceramic is alumina.

Fig. 1

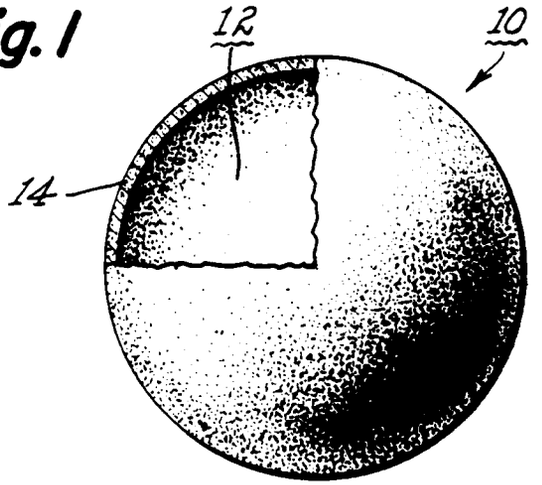


Fig. 2(a)

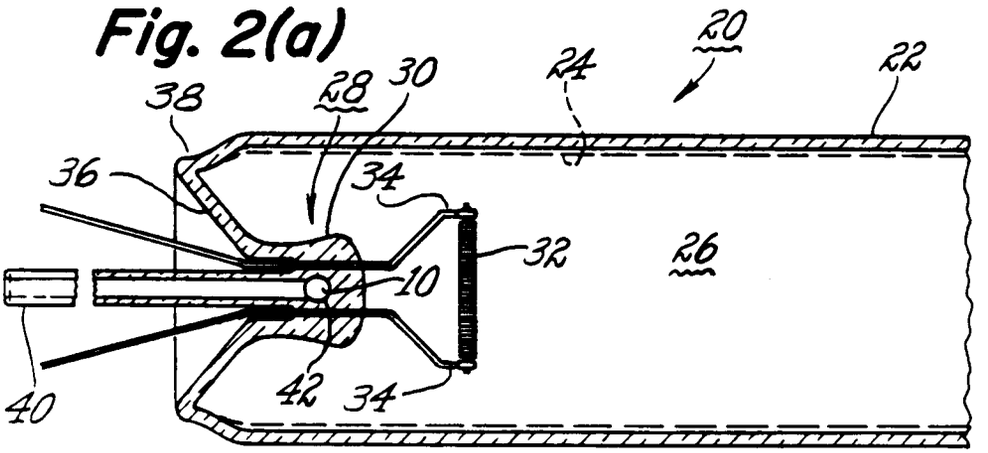
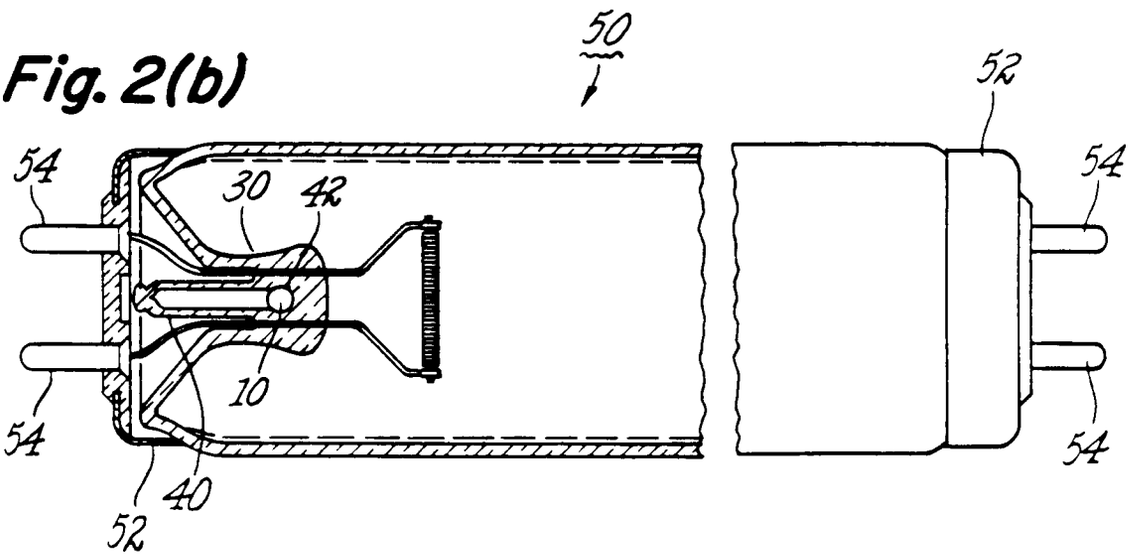


Fig. 2(b)



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EUROPEAN SEARCH REPORT

Application Number
EP 93 30 3280

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X A	US-A-4 793 980 (TOROBIN) * abstract * * column 13, line 15 - line 23 * * column 18, line 7 - line 28 * * claim 1 *	1-3 9,10	H01J61/28 H01J9/395
X A	EP-A-0 479 259 (TOSHIBA) * column 1, paragraph 1 * * claims 7,8 * * column 5, paragraph 3 -paragraph 4 * * column 6, line 21 - line 42; figures 3,8,9 *	8 1-7	
A	DE-U-8 535 777 (PATENT-TREUHAND-GESELLSCHAFT) * page 3, paragraph 1; claim 1 *	1,6	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H01J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09 AUGUST 1993	GREISER N.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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