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Miller

[11] **3,769,544**

[45] **Oct. 30, 1973**

[54] **PURGING MEANS AND METHOD FOR XENON ARC LAMPS**

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[21] Appl. No.: **264,268**

[52] **U.S. Cl.**..... **313/175**, 313/176, 313/180, 313/184, 313/224

[51] **Int. Cl.**..... **H01j 61/26**, H01j 61/28

[58] **Field of Search**..... 313/180, 175, 176, 313/224, 184; 315/108, 110

[56] **References Cited**

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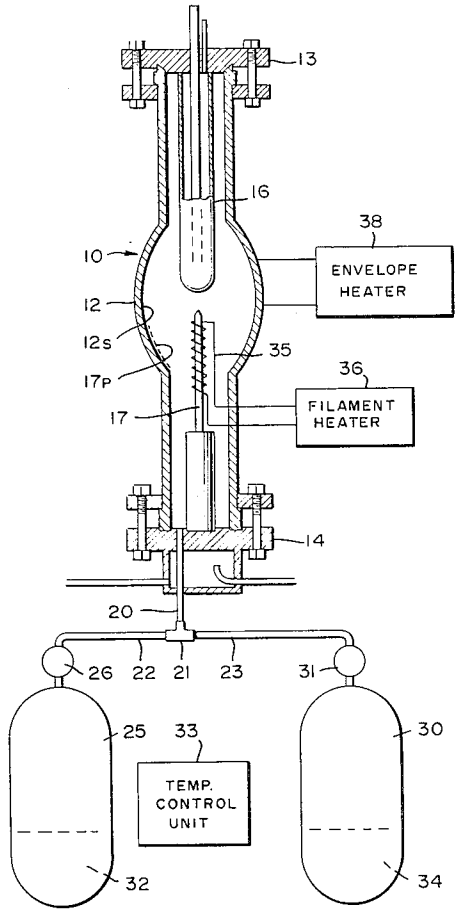
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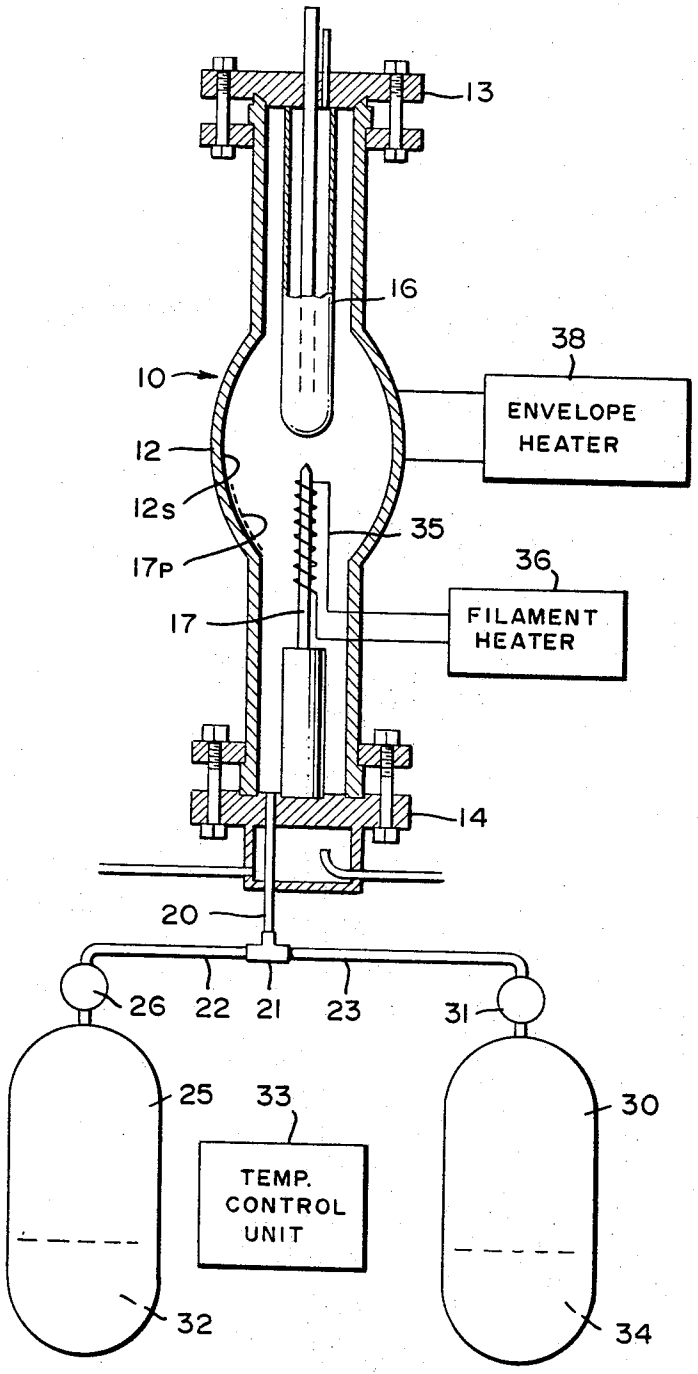
Primary Examiner—Palmer C. Demeo
Attorney—Samuel Lindenberg et al.

[57] **ABSTRACT**

A high pressure Xenon short-arc lamp with two reservoirs which are selectively connectable to the lamp's envelope is disclosed. One reservoir contains an absorbent which will absorb both Xenon and contaminant gases such as CO_2 and O_2. The absorbent temperature is controlled to evacuate the envelope of both the Xenon and the contaminant gases. Thereafter, the temperature of the absorbent is raised to desorb only clean Xenon while retaining the contaminant gases, thereby clearing the envelope of the contaminant gases. The second reservoir contains a gas whose specific purpose it is, by means of steps described in the disclosure, to remove the objectional metal film which deposits gradually on the interior surface of the lamp envelope during normal arc operation. The origin of this film is metal transferred from the cathode of the arc lamp by sputtering or other gas transfer processes. Since the cathodes in different lamps may, for particular purposes, be made of various metals, e.g. Tungsten, Nickel, Rhodium, Molybdenum, it is necessary to use a cleanup gas, and cleanup procedures, that are appropriate to the metal constituting the cathode surface, since it is the cathode surface material, which, transferred to the interior wall of the lamp envelope, constitutes the objectional metal film. Suitable gases and processing methods are described in the disclosure for a variety of cathode metals.

13 Claims, 1 Drawing Figure




13
16
38
10
ENVELOPE HEATER
12
12s
35
17P
36
17
FILAMENT HEATER
14
20
26
22
21
23
31
25
33
30
TEMP. CONTROL UNIT
32
34

PURGING MEANS AND METHOD FOR XENON ARC LAMPS

ORIGIN OF INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 USC 2457).

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to improvements in high pressure compact arc lamps, and more particularly, to a pressurized gas arc-lamp with means for purging and cleaning the lamp envelope's inside surface, and to a method for purging and cleaning the inside of the lamp envelope of tungsten deposits from the cathode and anode of the lamp, in order to extend the useful life thereof.

2. Description of the Prior Art

The use of high pressure compact arc-lamps such as xenon arc-lamps is well known. Such lamps find wide applications, ranging from the motion picture industry, police helicopter lighting, color-fast testing of fabrics, to the simulation of solar light for testing equipment destined for space exploration. Even though the price of compact gas arc-lamps is quite high, until recently, the useful life of such lamps, in terms of hours of satisfactory operation, was relatively short, due to various inherent limitations in the conventional lamps. In recent years, several improvements were made in the construction and mode of operation of these lamps to extend their useful life. Among these improvements is the depressurization of the lamp, during non-operative periods to reduce the gas pressure in the lamp envelope, and thereby reduce the danger of fracturing of the envelope. This improvement is described in U. S. Pat. No. 3,621,330, issued Nov. 16, 1971. Another improvement which relates to multiple anodes in such lamps is described in U. S. Pat. No. 3,635,531, issued Jan. 15, 1972.

Although these improvements represent an advance over the previously existing state of the art, there are still several factors which unnecessarily limit lamp life and operating efficiency which the prior developed improvements did not solve.

Among these factors are the generation of objectionable gases, such as CO, CO_2 and O_2 after relatively long operation, and the darkening of the lamp envelope by deposition from the electrode metals, typically tungsten, which are carried from the electrodes to the inner surface of the envelope by sputtering or reactive gas transfer processes. The life of, and operating efficiency of a high pressure gas arc-lamp can be greatly increased by eliminating, or at least greatly reducing the presence of generated, objectionable gases, and/or the darkening of the envelope by metal deposits.

OBJECTS AND SUMMARY OF THE INVENTION

It is a primary object of the present invention to provide an improved compact arc, high pressure gas arc-lamp.

Another object of the invention is to provide an arc-lamp with means for purging it from objectionable generated gases.

Yet another object of the invention is to provide means for reducing lamp envelope darkening, in a high pressure gas arc-lamp.

A further object of the invention is to provide a method of purging objectionable gases from the gas content of a gas arc-lamp, and for reducing the darkening of the lamp envelope by deposited metal.

These, and other objects of the present invention are achieved by providing a high pressure, compact arc-lamp containing an appropriate gas, e.g., xenon, in connection with which the invention will be described, with a first storage chamber which contains a suitable adsorbent of xenon, and the objectionable gases which are generated in the lamp envelope during operation. Suitable examples of adsorbents of xenon and objectionable gases such as CO_2 and O_2 are metal-loaded zeolite, sodium metal and activated charcoal. The chamber is in communication with the lamp envelope through a control valve. During non-operative periods, the valve is opened and the chamber temperature is controlled to cause both the xenon and the objectionable gases to be adsorbed by the adsorbent. The adsorbent temperature may be controlled so as to completely evacuate the envelope by adsorbing all the xenon, and the objectionable gases in the envelope. The adsorbent is of the type which desorbs xenon at a lower temperature than that at which the objectionable gases are desorbed. Thus, after the envelope is evacuated of all gases, the adsorbent temperature is raised to desorb only xenon until the xenon pressure in the envelope reaches a desired non-operation pressure value. Thereafter, the valve is closed. As a result, only xenon is returned to the envelope for a subsequent operation and substantially all the objectionable gases are in the adsorbents in the storage chamber.

To reduce envelope darkening in a lamp with a tungsten cathode, a second chamber which is connectable to the envelope through a second control valve is included. The second chamber contains a halogen gas such as bromine (Br_2) or iodine (I_2), or a halogen compound. A heatable auxiliary tungsten filament is also included in the envelope. During non-operation, when the envelope is evacuated of all gases, including xenon, the second control valve is opened, and the halogen gas or halogen compound allowed to fill the envelope to a selected pressure of the order of 1 torr. The second chamber may be heated, if necessary. Thereafter, the envelope is heated to above a minimum temperature required to cause the halogen gas to react with tungsten metal which, during previous operations, adhered to the inner surface of the envelope. The reaction forms a tungsten halide gas, thereby removing the tungsten film from the envelope's inner surface. The heatable, auxiliary filament is heated to a much higher temperature, causing it to glow. At the glowing temperature, the tungsten halide gas is decomposed, depositing the tungsten onto the filament. After cleaning the tungsten film from the envelope wall, the halogen gas or halogen compound is returned to the second chamber by cooling the chamber. The second valve is then closed, and the lamp is in condition to be repressurized with clean xenon, for subsequent operation.

The novel features of the invention are set forth, with particularity in the appended claims. The invention will best be understood from the following description when read in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

THe drawing is a combination block and cross-section view of a high pressure gas arc-lamp with the improvements, in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described in conjunction with a high pressure compact xenon arc-lamp. However, as will become apparent, the invention is not limited thereto, and it may be employed with any high pressure arc-lamp using other gases, such as neon, argon, krypton or mixtures thereof.

The teachings of the invention are used in connection with a xenon arc-lamp, designated in the drawing by numeral **10.** The lamp includes an envelope **12,** sealed at its ends to plates **13** and **14** to form a gas-tight envelope. Supported in the envelope are an anode **16** and a cathode **17,** which as is appreciated by those familiar with the art are connected to an appropriate power source, and are often water-cooled. The water cooling arrangement and power source are deleted from the drawing, since they do not form a part of the present invention.

A fill tube **20** extends through plate **14,** and communicates at one end with the envelope **12.** The other end of the tube **20** is attached to a tee connection **21** through which the tube is connected to branches **22** and **23.** Branch **22** is connected to a first storage container or reservoir **25** through a control valve **26,** while branch **23** is connected to a second storage container or reservoir **30** through control valve **31.** In accordance with the teachings of the present invention, reservoir **25** contains an adsorbent material, or simply an adsorbent **32,** which is capable of adsorbing xenon, as well as the objectionable gases, such as CO_2 and O_2, hereafter referred to as the contaminants, depending on the adsorbent's temperature.

As shown in the aforementioned patent number 3,621,330, the temperature of the adsorbent in reservoir 25, which is analogous to containers **66** or **80** in said patent may be controlled by controlling the reservoir temperature to vary between liquid nitrogen temperature and room temperature, or between room temperature and a higher temperature produced by a heating arrangement.

In practice, a small reservoir is required if its temperature is varied between liquid nitrogen temperature and room temperature. However, a source of liquid nitrogen is needed. On the other hand, a larger reservoir must be employed if the desired temperature range is from room temperature and above, together with an appropriate heating arrangement. In the drawing, Reference **33** designates a temperature control unit used to control the temperature of either reservoir **25** or **30.**

In accordance with the teachings of the present invention, during non-operative periods, both the pressurization of the envelope and the removal of contaminants therefrom are achieved by opening valve **26** and controlling the temperature of reservoir **25,** so that all the gases in the envelope, including xenon and the contaminants, are adsorbed by the adsorbent **32.** As is known, the desorption temperature of xenon, a noble gas, from an adsorbent is lower than the desorption temperatures of active gases which comprise the contaminants. Thus, in accordance with the present invention, after the envelope is completely evacuated of all gases, the adsorbent's temperature is raised above the desorption temperature of the xenon, and below the desorption temperature of the contaminants. Consequently, only xenon is desorbed from the adsorbent. The desorbed xenon refills the envelope **12.** When the envelope is repressurized with xenon to the desired non-operative value, as taught in said Patent, valve **26** is closed. Thus, the envelope contains only clean xenon, and the contaminants remain adsorbed by adsorbent **32.**

From the foregoing, it is seen that the reservoir **25,** with the adsorbent **32,** enable the depressurization of the envelope, as taught in said Patent. However, in addition, by providing a contaminant adsorbent, the latter also enables contaminants to be removed from the envelope, thereby increasing the lamp life and operating efficiency. It should be pointed out that in the present invention, unlike the teachings of said Patent in which the xenon pressure is only lowered to a desired value without completely evacuating the envelope, the envelope is first completely evacuated, thereby removing all the xenon and the contaminants therefrom. Only thereafter is xenon returned to the desired non-operative pressure.

If desired, substantially all the contaminants may be removed from the envelope without having to complete the evacuation of the latter as taught herebefore. During non-operation after opening valve **26,** the adsorbent temperature may be lowered far enough, so that most of the contaminants and enough of the xenon are removed until the envelope is depressurized to the desired value. While not all of the contaminants are removed at one step by this process, in a typical lamp, there will be about 80% removed, and kept sequestered on the adsorbent in one pass. Only a few passes are enough for virtually complete cleanup, even if they are done at different times. Such a technique for removing contaminants is lengthier timewise than the one in which the envelope is evacuated completely. However, it may be used successfully, particularly with lamps in which complete evacuation of the envelope is not desirable or feasible.

From the foregoing, it is thus seen that the present invention provides a means for, and a method of removing contaminants from the lamp's envelope, thereby increasing its useful life and operating efficiency.

A further factor which would contribute to extended lamp life and operating efficiency is the elimination, or at least substantial reduction of envelope darkening caused by the deposition of metal particles, or a metal film on the envelope's interior surface or wall, since such deposits both lower light transmission through the envelope, and cause the wall temperature to rise to undesirably high temperatures, due to light energy absorbed by the metal film. Such high temperatures can cause devitrification and mechanical failures.

In the drawing, the interior surface or wall of the envelope is designated by **12***s* and the particles by **17***p.*

It is appreciated by those familiar with the art that during operation, particles of the electrode metal, typically tungsten, tend to be separated from the electrodes. These particles are carried, and get deposited on the interior surface of the envelope by sputtering or reactive gas transfer processes, thereby reducing the

envelope transparency. In addition, the presence of any particles on the envelope's interior surface is very undesirable, since the envelope temperature during operation is close to the devitrification temperature of the envelope material. The presence of any metal film thereon which can become hotter than the envelope, because of light absorption, often causes envelope rupturing. Therefore, it would be most desirable to be able to remove any metal particles or light-absorbing film from the envelope's surface.

In accordance with the present invention, such removal is achieved by having in container **30** a material capable of reacting with the tungsten particles **17***p* or tungsten film on the envelope surface **12***s* at a sufficient temperature to form a gas and free the wall of the tungsten deposit. The resulting gas is capable of dissociation at a higher temperature. If the cathode **17**, and wall-covering film and particles **17***p* are tungsten, a halogen such as bromine (Br_2), or iodine (I_2) or halogen compound is contained in the container **30**. Such halogen compound is designated by the numeral **34**. In addition, a tungsten filament **35** is included in the envelope. With the envelope completely evacuated, valve **31** is opened, and container **30** is heated, thereby filling envelope **12** with the halogen gas, e.g., Br_2 to a desired pressure, between 0.1 and 10 torr. Thereafter the filament **35** is heated by power from an appropriate source designated by numeral **36** to a glowing temperature. The envelope is simultaneously heated by heating unit **38** to a temperature of several hundred degrees C, e.g., 300°C. At this temperature, the halogen reacts with the tungsten film **17***p* to form gaseous tungsten halide. Thus, the tungsten deposit is removed from surface **12***s*. The tungsten bromide circulating around the glowing filament **35** is decomposed, with the tungsten being redeposited on the tungsten filament itself.

After the removal of substantially all of the particles from surface **12***s*, the heating of the envelope and the filament is terminated, and the envelope is evacuated by cooling container **30**, so that all the halide or halide compound returns to it. Thereafter valve **31** is closed, and valve **26** is opened to repressurize the envelope with clean xenon.

It should be stressed that in the present invention the halogen **30** is not present in the envelope during normal lamp operation. Rather it is introduced into the envelope during non-operation for envelope clean-up purposes and is returned to reservoir **30** after the envelope surface is cleaned and before normal operation is resumed.

Herebefore it was assumed that the envelope **12** is completely evacuated before the halogen gas **34** is introduced. If desired a small amount of xenon up to a desired pressure e.g. one atmosphere pressure gauge may be present in the envelope when the halogen gas is introduced. The presence of the xenon would eliminate the need to evacuate the envelope completely. Also in some cases, the presence of the xenon may provide better transport because of convection currents in the gases.

As is appreciated in the type of lamps with which the invention is concerned, the cathode is usually made of tungsten. Thus, a halogen gas is useful to form a tungsten halogen gas, and thereby remove the tungsten from the interior wall. Clearly, if the cathode is made of a metal other than tungsten, another gas may be stored in reservoir **30** for subsequent reaction with the metal particles, so as to remove them from the envelope wall, and thereby eliminate, or at least greatly reduce envelope darkening.

For example, particles or film of nickel, iron, molybdenum, cobalt or rhodium may be removed from surface **12***s* by the action of carbon monoxide gas at suitable temperatures which may be introduced into envelope **12**. In these cases the film reacting with the carbon monoxide will form metal-carbonyl which together with the excess carbon monoxide may be removed onto a liquid nitrogen-cooled charcoal or molecular sieve trap.

Although particular embodiments of the invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art, and consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.

What is claimed is:

1. In a high pressure gas discharge arc lamp of the type including a gas-tight envelope containing a selected gas, dischargeable during operation between anode means and cathode means in said envelope, an arrangement comprising:

storage means coupled to said envelope and forming a gas-tight system therewith, whereby gases are transferable between said envelope and said storage means;

a selected adsorbent material in said storage means, for adsorbing said selected gas and contaminant gases, formed in said envelope during operation, when the adsorbent material temperature is below a first level to thereby substantially evacuate said envelope from said selected gas, and said contaminant gases, with said adsorbent material desorbing only said selected gas when the temperature thereof is above the desorption temperature of said selected gas, and below the desorption temperatures of said contaminant gases;

first valve means for controlling the flow of gases between said envelope and said storage means during non-operative periods of said lamp; and

temperature control means for controlling temperature of said adsorbent material in said storage means during a non-operative period of said lamp, whereby when the adsorbent material temperature is not above said first level, said selected gas and said contaminant gases are adsorbed by said adsorbent material, thereby substantially evacuating said envelope of said selected gas and said contaminent gases, said temperature control means further control the temperature of said storage means and said adsorbent material, after said envelope is substantially evacuated to rise above the desorption temperature of said selected gas and below the desorption temperatures of said contaminent gases, whereby only said selected gas is desorbed and refills said envelope to a preselected pressure.

2. In a high pressure gas discharge arc lamp, as recited in claim **1** wherein said cathode means is of a selected metal, particles of which are depositable on the interior wall of said envelope during operation, thereby reducing the transparency of said envelope, and said arrangement further includes means for reacting with said particles, so as to remove them from said envelope interior wall.

3. In a high pressure gas discharge arc lamp, as recited in claim 2, wherein said metal particles on wall are tungsten and said means for reacting form a tungsten-containing gas with said tungsten particles when said envelope is heated to at least several hundred degrees centigrade, said envelope further containing a filament means heatable to a glow, for dissociating said tungsten containing gas, whereby said tungsten particles are deposited on, and adhere to said glowing filament.

4. In a high pressure gas dischargeable arc lamp of the type including a gas-tight envelope for containing a selected gas dischargeable during operation between a metal anode means and a metal cathode means in said envelope, with metal of said cathode becoming separated from said cathode, and depositable as a metal film on the interior surface of said envelope, an arrangement for removing the metal film from the envelope's interior surface during non-operative periods of said lamp, comprising:

first storage means coupled to said envelope to form a gas-tight system therewith, whereby gas is transferable between said envelope and said storage means;

a first selected material in said first storage means of a type which reacts in gas form with said metal film above a preselected temperature to form a gas containing said metal, so as to remove said metal film from said envelope surface;

temperature control means for controlling the temperature of said first storage means and the first selected material therein, whereby when said temperature is above the first value, said first selected material in a gas form exits said first storage means into said envelope; and

when the temperature is below a second value, said first material in gas form in said envelope returns to said first storage means;

means for heating said envelope to above said preselected value, whereby said first material in gas form in said envelope reacts with the metal film on the interior surface of said envelope to form a particular gas therewith;

means for separating said particular gas, and for adsorbing the metal content therefrom; and

first valve means for controlling the flow of said first material in gas form between said envelope and said first storage means.

5. In a high pressure gas discharge arc lamp, as recited in claim 4, wherein said means for separating comprises a filament, heatable to a temperature range at which said particular gas dissociates into said metal film and said first material in gas form.

6. In a high pressure gas discharge arc lamp, as described in claim 5, wherein said filament is of the same metal as said metal film.

7. In a high pressure, gas discharge arc lamp, as described in claim 6, wherein said cathode and said filament are of tungsten, and said filament is heatable to a glow.

8. In a high pressure, gas discharge arc lamp, as recited in claim 7, wherein said first material is a halogen or halogen-containing compound.

9. A method of removing metal film from the interior surface of the invelope of a high pressure gas dischargeable arc lamp during non-operation of said lamp which is of the type including a gas-tight envelope which contains a selected gas dischargeable during operation between a metal anode and a metal cathode, said film comprising particles of said cathode which are removed therefrom during maintenance periods of lamp non-operation, the steps comprising:

reducing the pressure in said envelope from said dischargeable gas to a preselected value;

introducing into said envelope a preselected gas which at a selected temperature range reacts with said metal film to form a metal-containing gas by heating said envelope to said selected temperature range; and

removing from said envelope the preselected gas together with the newly-formed metal-containing gas.

10. A method as described in claim 9 further including the step of dissociating said metal-containing gas prior to removing said preselected gas from said envelope.

11. A method as described in claim 10 wherein said envelope includes a heatable filament adjacent said cathode and said metal-containing gas is dissociated by heating said filament to a glow, whereby the metal in said metal-containing gas is dissociated from said preselected gas and adheres to said filament.

12. A method of removing from the envelope of a high pressure gas dischargeable arc lamp during non-operation periods gas contaminants which are formed during lamp operation the steps comprising:

providing in storage means an adsorbent material capable of adsorbing and desorbing said dischargeable gas and said gas contaminants as a function of the temperature thereof;

providing a gas-tight connection between said envelope and said storage means including a valve for controlling the flow of gases between said storage means and said envelope;

controlling the temperature of said adsorbent material to adsorb said dischargeable gas and said gas contaminants to thereby reduce the pressure in said envelope to a first preselected value;

controlling the temperature of said adsorbent material by raising it above the desorption temperature of said dischargeable gas to cause said adsorbent material to desorb only said dischargeable gas while adsorbing said gas contaminants, until the pressure in said envelope reaches a second preselected non-operating pressure; and

inhibiting by means of said valve gas flow between said envelope and said storage means.

13. A method as described in claim 12 wherein said envelope is first evacuated of substantially all of said dischargeable gas and said gas contaminants before said dischargeable gas is desorbed from said adsorbent material by controlling the latter's temperature.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,769,544 Dated October 30, 1973

Inventor(s) Charles G. Miller

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Abstract

Line 2, "absorbent" should read -- adsorbent --.

Line 3, "absorb" should read -- adsorb --.

Line 4, "absorbent" should read -- adsorbent --.

Line 7, "absorbent" should read -- adsorbent --.

Column 3, line 3, "THe" should read -- The --.

Column 8, line 3, (Claim 9), "invelope" should read -- envelope --.

Signed and sealed this 2nd day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

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