

[54] **STABLE GLOW DISCHARGE LIGHT
SOURCE WITH CLOSE
TEMPERATURE CONTROL FOR
SHARP RESONANCE LINES**

[72] Inventor: **Steven H. Boland**, Temple City,
Calif.

[73] Assignee: **Ultra-Violet Products Inc.**, San
Gabriel, Calif.

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313/47, 313/180, 313/225, 313/228,
315/277, 315/282

[51] Int. Cl. **H01j 61/18**, H01j 61/52, H05b 41/23

[58] Field of Search. 315/50, 115, 116, 277, 282,
315/358; 313/15, 47, 180, 225, 227, 228;
240/51.11 R

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Primary Examiner—Roy Lake

Assistant Examiner—Siegfried H. Grimm

Attorney—Harris, Kiech, Russell & Kern

[57] **ABSTRACT**

A stable source for a light producing sharp resonance lines. A glow discharge lamp with a solid metal or metallic halide charge and operated at a controlled elevated temperature to provide the desired controlled output. Separate power supplies for the lamp current and the lamp heat so that the operating temperature is independent of the operating current.

7 Claims, 9 Drawing Figures

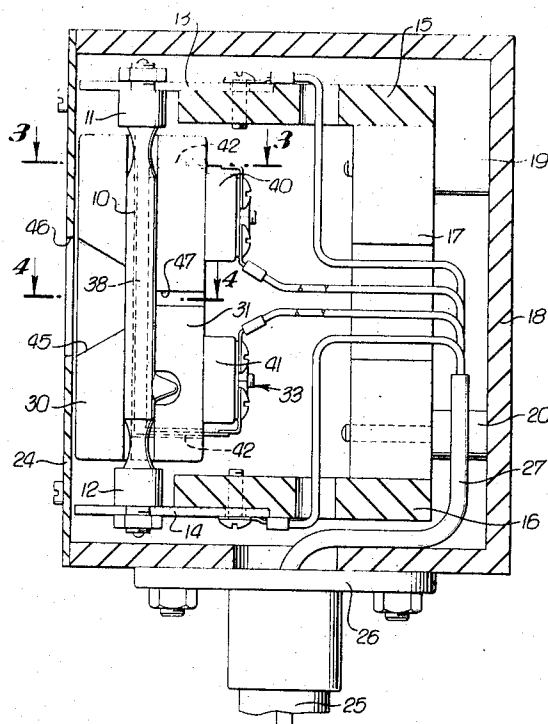


FIG. 2.

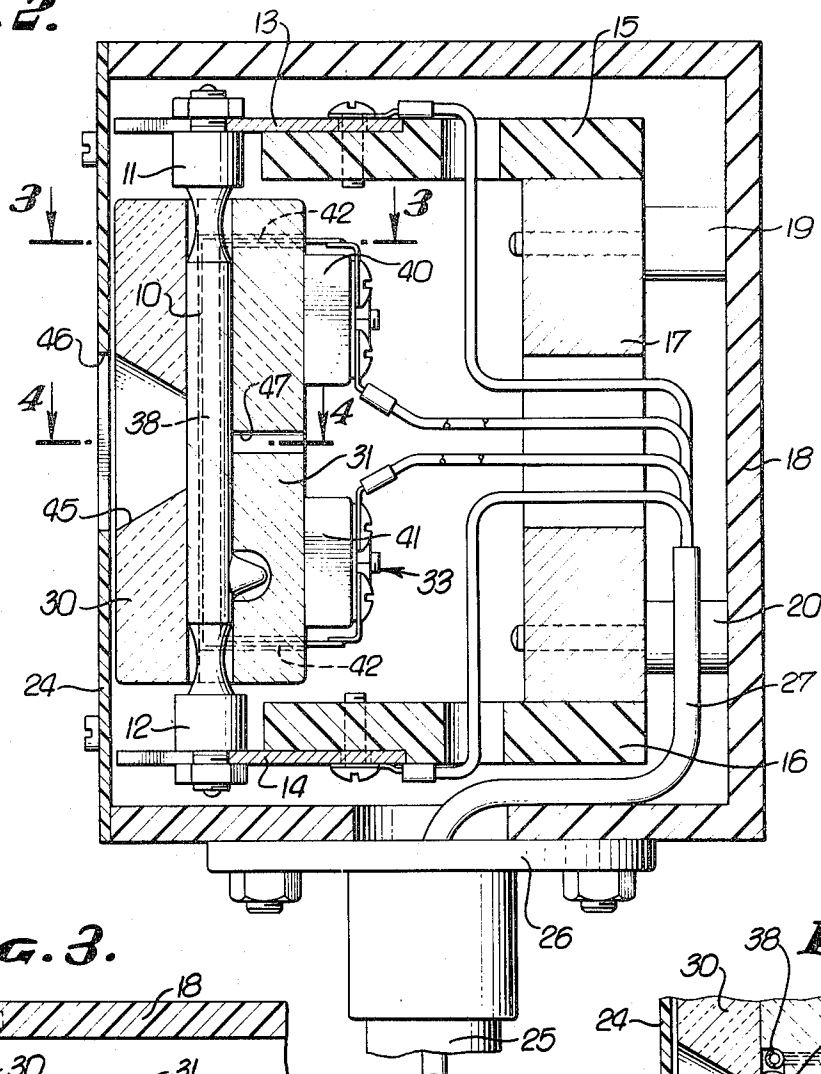


FIG. 3.

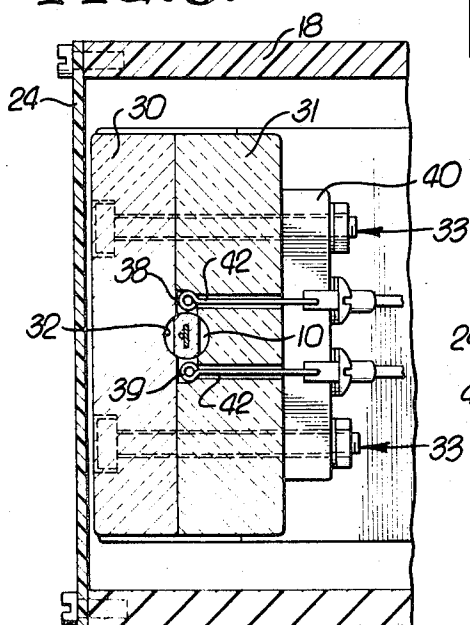


FIG. 4.

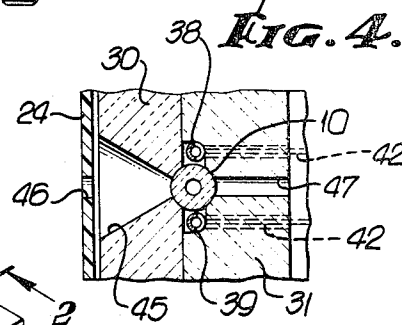
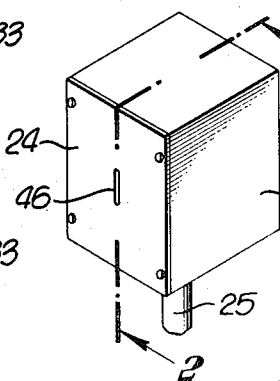


FIG. 1.



INVENTOR.
STEVEN H. BOLAND
By His Attorneys

HARRIS, KIECH, RUSSELL & KERN

FIG. 5.

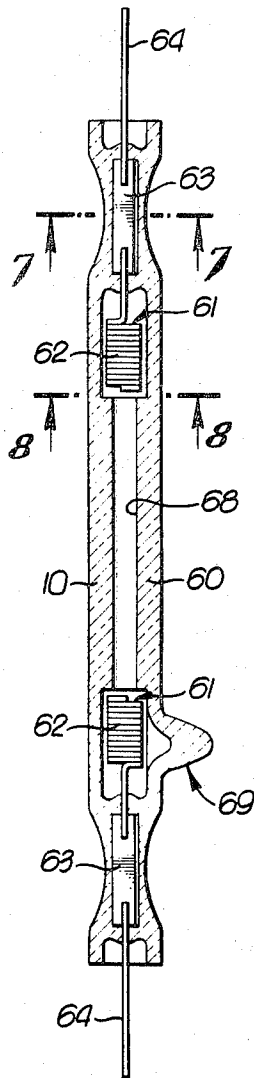


FIG. 6.

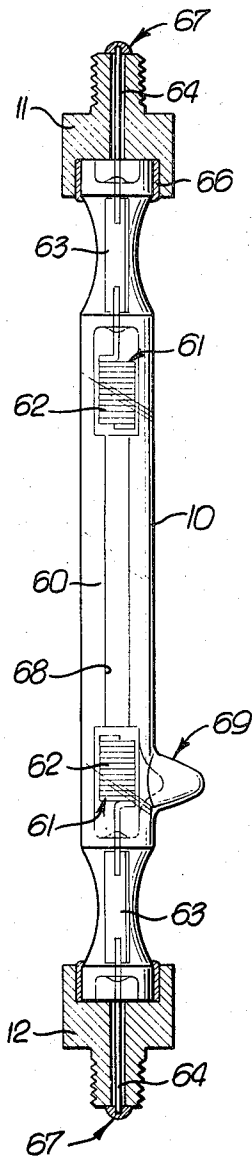


FIG. 9.

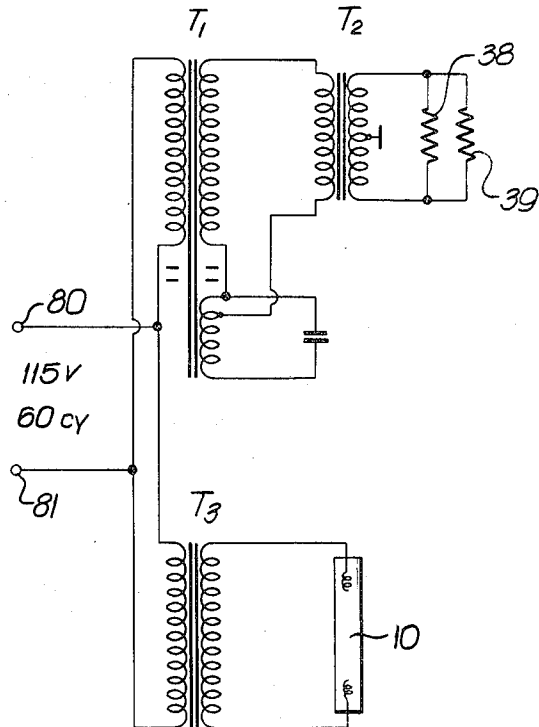


FIG. 7.

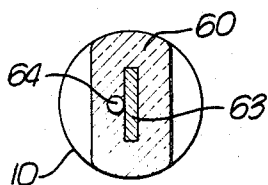
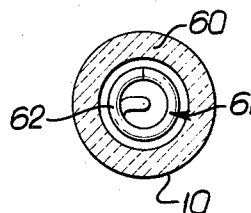


FIG. 8.



INVENTOR.
STEVEN H. BOLAND

By His Attorneys

HARRIS, KIECH, RUSSELL & KERN

STABLE GLOW DISCHARGE LIGHT SOURCE WITH CLOSE TEMPERATURE CONTROL FOR SHARP RESONANCE LINES

This invention relates to light sources and in particular to a source providing an output in a defined spectral range with sharp resonance lines. It is highly desirable that the source produce a predetermined radiation and that it be highly stable and reproducible, i.e., the output wavelength should be constant during operation and should be the same each time the light is turned on.

Electric arc lamps have been used as light sources in the past, however the stability and reproduceability of the output of the arc lamps has not been satisfactory for many applications. The electric arc lamp operates at low voltage and high current, typically less than 100 volts and greater than one ampere, with the temperature of the lamp and therefore the vapor pressure of the charge material being directly related to the current which is highly variable and difficult to control.

The present invention contemplates the use of a glow discharge lamp operating with a high voltage and a low current, in contrast to the electric arc lamp with its low operating voltage and high current. A power supply is used to provide the electric power for the lamp to produce the glow discharge. A separate power supply is used to energize a heater for the lamp to produce the metal vapor in the lamp which produces the desired light output. This arrangement provides separate control of the lamp current and lamp temperature, with the vapor pressure being a function of the temperature. The lamp may be operated at the optimum vapor pressure to produce the optimum output, normally the sharp resonance line or lines.

Other objects, advantages, features and results will more fully occur in the course of the following description. The drawings merely show and the description merely describes preferred embodiments of the present invention which are given by way of illustration or example.

In the drawings:

FIG. 1 is an isometric view of a light source incorporating a preferred embodiment of the present invention;

FIG. 2 is an enlarged sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a partial sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is a partial sectional view taken along the line 4—4 of FIG. 2;

FIG. 5 is an enlarged longitudinal sectional view of the lamp of FIG. 2;

FIG. 6 is a side view of the lamp of FIG. 5;

FIGS. 7 and 8 are enlarged sectional views taken along the lines 7—7 and 8—8 respectively of FIG. 5; and

FIG. 9 is a schematic diagram illustrating the electrical circuitry of the light source of FIG. 2.

Referring to FIG. 6, a lamp 10 has threaded terminals 11, 12 at the ends thereof for mounting in plates 13, 14 with appropriate nuts (FIG. 2). The conducting plates 13, 14 are carried on insulating blocks 15, 16 which are joined by another block 17 supported from the inner wall of a case 18 on posts 19, 20.

The case 18 has five sides with an opening closed by a cover plate 24 attached by suitable screws. The case

may be supported on a post or shaft 25 with flange 26, with an electrical cable 27 leading from the interior of the case 18 through the post 25 to the remainder of the circuitry of the light source.

The lamp 10 is preferably enclosed in a housing of low thermal conductivity, such as blocks 30, 31 formed of an asbestos and resin mixture. A variety of thermal insulating materials are available and one suitable material is Maranite, a product of Johns-Manville.

Aligned channels may be provided in the blocks 30, 31 to form an opening 32 for the lamp 10, with the blocks being clamped together on the lamp by bolts and nuts indicated at 33. Maximum thermal insulation is obtained for the lamp by carrying the housing blocks 30, 31 on the lamp rather than by supporting them from some other portion of the structure.

An electric resistance heater is positioned adjacent the lamp and in the embodiment illustrated, comprises resistance heating wires 38, 39 positioned on opposing sides of the lamp 10 in cavities provided in the block 31. Terminal blocks 40, 41 for electrical connections between conductors of the cable 27 and the heaters 38, 39 are mounted on the housing block 31 by the bolts and nuts 33. Passages are provided in the block 31 for leads 42 between the terminal blocks and the heaters.

A slot 45 in the housing block 30 and another slot 46 in the cover plate 24 provide a light output path from the lamp 10. A passage 47 may be provided in the housing block 31 for installation of a thermocouple for measuring the temperature of the lamp.

In the preferred form of the lamp illustrated in FIGS. 5—8, a sleeve or tube 60 is provided with electrodes 61 at each end. The sleeve is formed of a material having low absorption of the desired output and which is non-reacting with the charge material. Quartz is usually selected, but other materials are also used. The preferred form of electrode comprises a coil of wire 62 welded to a metal strip 63 with a conductor 64 also welded to the strip 63 and projecting from the sleeve. A press seal is formed in the sleeve 60 at the metal strip 63 to close the end of the sleeve. The coil 62 should be made of a material which does not react with the charge in the lamp, and tantalum is a preferred material. The terminals 11, 12 are affixed to the ends of the sleeve, as by bonding at 66. The conductor 64 projects through a central opening of the terminal 11 and is joined to the terminal at 67 by soldering or welding. The cavity 68 within the sleeve 60 between the sealed ends is charged and is then sealed as at 69.

In the preferred embodiment of the lamp, the lamp is charged with an inert gas and with a solid metal or metallic halide. The inert gas, typically krypton, is used to improve the starting of the glow discharge, but the inert gas can be omitted from the charge if desired. Other suitable inert gases include neon and argon.

The electrical circuitry for the light source as illustrated in FIG. 9 includes an electric power source for the lamp 10 and another electric power source for the heater elements 38, 39. Both power sources may be energized from a conventional 115 volt 60 cycle per second line at terminals 80, 81. A transformer T3 has its primary connected across terminals 80, 81 and its secondary connected across the lamp 10, supplying the starting voltage and operating current for the lamp. A preferred transformer is a neon sign type transformer

supplying about 1800 volts no load and about 30 milliamperes current.

The power source for the heaters 38, 39 preferably is a regulated source to provide a substantially constant voltage for the heaters. A preferred source includes a ferro-resonant voltage regulator transformer T1 of conventional design with the primary connected to the terminals 80, 81 and with the secondary connected to the primary of a stepdown transformer T2. In a typical embodiment, each of the heaters 38, 39 has a resistance of 27 ohms, with the regulator transformer T1 having a 30 volt ampere capacity and with the stepdown transformer T2 providing 26.8 volts at one ampere at the secondary with 115 volts at the primary.

The lamp operates as a glow discharge lamp with the output characterized by the particular metal or metals present in the lamp. The lamp is operated at an elevated temperature so that the metal is in the vapor state, with the specific output being a function of the vapor pressure of the metal and hence the function of the temperature of the lamp, since the vapor pressure varies with the temperature. The lamp is charged with a solid metal or metallic halide, preferably in combination with an inert gas, as discussed above. The vapor pressure of the solid metal or metallic halide in the charge at room temperature, i.e., 20° C, is substantially less than the vapor pressure of mercury, i.e., less by at least a factor of 10. The particular material selected for the charge depends upon the particular spectral output desired, on the operating temperature required, and on the reactivity of the material. Examples of the spectral output of various metals in the vapor state are given in Table I. Metallic halides are sometimes used for the charge instead of the metal itself because the halide will vaporize at a lower temperature than the pure metal, however, there is no spectral output from the vaporized halogen so that the light output will be the same whether the charge is a metal or a metallic halide. An iodide usually is the preferred halide because it is less reactive than the other halides.

Optimum output is obtained by operating the lamp at a specific elevated temperature and stability is obtained by maintaining this temperature as nearly constant as possible. The thermal insulating blocks 30, 31 disposed about the lamp 10 serve to substantially reduce heat loss from the lamp to the surrounding atmosphere thereby reducing the amount of heat input required and making the maintenance of the constant temperature simpler. The temperature of the lamp at the outer surface has been measured by means of a thermocouple in the passage 47 and examples of lamp charge material, primary or resonance spectral output, and optimum operating temperature of lamps are set out in Table I.

TABLE I

Charge Material	Primary or Resonance Spectral Output	Optimum Operating Temperature
Lead iodide	2802A	280° C
Zinc iodide	2138A	150° C
Iron iodide	3719A	—
Arsenic iodide	1972A	—
Zinc	2138A	220° C
Cadmium	2288A	150° C

When in operation, the voltage drop across the glow discharge lamp is substantially constant, this being an inherent characteristic of the glow discharge. In a typical situation a 50 percent change in lamp current will result in only a 5 percent change in voltage drop.

Conventional techniques may be followed for charging the lamp with solid and gaseous material. The amount of charge will vary with the size of the lamp and is readily determined by trial. Typically a milligram of metal may be used in a lamp 3 inches long overall and one eighth inch inside diameter. It is desirable to have an excess of free metal when using a halide to insure the absence of free halogen because of the reactivity of the gaseous halogen.

Although exemplary embodiments of the invention have been disclosed and discussed, it will be understood that other applications of the invention are possible and that the embodiment disclosed may be subjected to various changes, modifications and substitutions without necessarily departing from the spirit of the invention. By way of example, while the insulator blocks 30, 31 are desirable in maintaining the lamp temperature substantially constant, they are not necessary to the practice of the invention. Further, in the embodiment illustrated, a voltage regulator is utilized for maintaining substantially constant voltage for the electrical heaters. In one alternative arrangement, a feedback temperature control circuit could be utilized. While straight electrical resistance heater elements 38, 39 are illustrated positioned on opposing sides of the lamp, other heating arrangements can be used. For example, a thin film of electrical resistance material could be coated on the sleeve itself or a length of electrical resistance wire could be wound about the sleeve or a metal sleeve could be positioned over the lamp sleeve and heated by electric current or other means.

I claim:

1. In a stable light source providing an output in a predetermined spectral range, the combination of:
 - a lamp housing of low thermal conductivity comprising first and second blocks joined at inner faces thereof and including a passage along said inner faces with a larger central section and smaller sections on opposite sides of said central section;
 - a glow discharge tube lamp charged with a solid metal or metallic halide having a vapor pressure at 20° C. substantially less than that of mercury and positioned in said central section of said passage;
 - means clamping said blocks together on said lamp with said lamp supporting said blocks, one of said blocks including an output slot therethrough for radiation from said lamp;
 - an electrical resistance heater having two heating elements mounted respectively on each side of and parallel with said lamp in said smaller sections of said passage;
 - a first electric power source for said lamp providing a relatively high voltage and a relatively low current with respect to the voltage and current of an electric arc lamp;
 - first circuit means for connecting said first power source to said lamp for producing a glow discharge in said lamp;
 - a second electrical power source for said heater; and

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second circuit means for connecting said second power source to said heater to heat said lamp for increasing the vapor pressure of the charge material and producing a glow discharge in the metal vapor;

with the lamp current being a function of the output of said first power source with the voltage drop across the lamp being substantially constant, and with the lamp temperature and therefore the vapor pressure in the lamp being a function of the output of said second power source.

2. A light source as defined in claim 1 in which the charge of said glow discharge lamp includes an inert gas.

3. A light source as defined in claim 1 in which the charge of said glow discharge lamp includes a material

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selected from the group consisting of lead iodide, zinc iodide, iron iodide, arsenic iodide, zinc and cadmium.

4. A light source as defined in claim 1 in which the charge of said glow discharge lamp includes an inert gas and a material selected from the group consisting of lead iodide, zinc iodide, iron iodide, arsenic iodide, zinc and cadmium.

5. A light source as defined in claim 1 in which the charge of said glow discharge lamp includes a metallic iodide.

6. A light source as defined in claim 1 in which the charge of said glow discharge lamp includes lead iodide.

7. A light source as defined in claim 1 in which the charge of said glow discharge lamp includes cadmium.

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