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C. G. SMITH

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ELECTRICAL DISCHARGE LAMP

Filed April 24, 1931

Fig. 1.

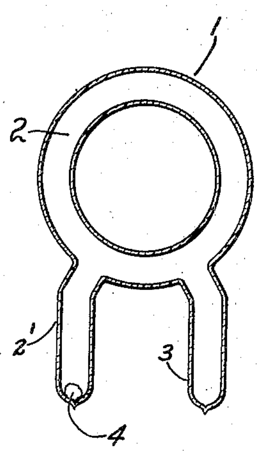
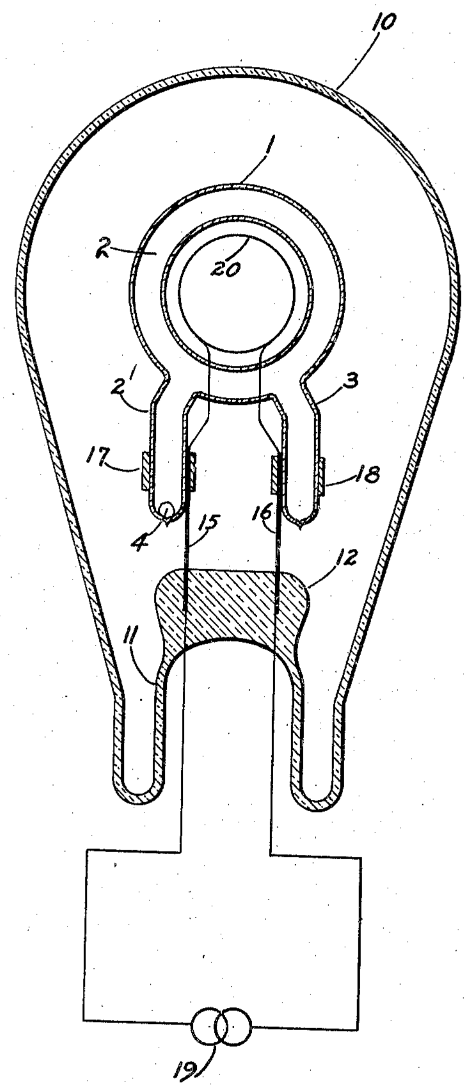


Fig. 2.



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UNITED STATES PATENT OFFICE

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ELECTRICAL DISCHARGE LAMP

Application filed April 24, 1931. Serial No. 532,464.

This invention relates to electrical discharge lamps. Among the objects of this invention is to produce such a lamp which may be operated at a high current density.

The foregoing and other objects will be best understood from the following description of an exemplification of my invention, reference being had to the accompanying drawing wherein—

Fig. 1 is a cross-sectional view of the light-generating element of my novel lamp; and

Fig. 2 is a cross-sectional view of the completed lamp.

In lamps which generate light by producing a luminous discharge in gaseous or vaporous atmosphere, I have found that the proportion of input energy which is manifested in desirable light radiations increases with an increase of current density within the discharge. Thus the efficiency at high current densities is much improved.

The density of the discharge can be increased by increasing the power input, by decreasing the volume of the discharge space, by decreasing the cross-sectional area of the discharge space or by a combination of these three factors.

However, an increase in current density or intensity of the discharge causes a larger amount of heat to be liberated in the discharge space. This heat tends to raise the temperature both of the atmosphere in which the discharge takes place and the walls of the container which enclose the discharge. Since the walls of the container must be transparent to light radiations, glass or quartz containers are used. These materials cannot be used above certain temperatures. Quartz, for example, becomes devitrified above approximately 900° C. and also becomes a fairly good conductor at that temperature. Pyrex glass has a tendency to soften above approximately 500° C., and other kinds of glass soften at temperatures considerably below 500°. Thus the intensity of the discharge is limited by the temperatures at which the containers may be operated.

In accordance with my invention I enable a discharge to be maintained at a high current density by preventing the temperature of the container from rising to excessively high points. In the embodiment shown, for example, I place the container enclosing the discharge in an atmosphere having a high thermal conductivity and surround this atmosphere with a hermetically sealed transparent member having a large area, from which heat can be dissipated, with respect to the area of the container.

The lamp which I have shown consists of a container 1 which is preferably constructed of quartz, although various kinds of glass could be used. This container comprises a toroidal member 2 having legs 2′ and 3 sealed thereon. By making the container in the form of a torus the cross-sectional area of the discharge path for a given volume of discharge space is decreased. Therefore I can obtain a greater density of current per unit of cross-sectional area with the same power input than if a container made in the form of a globe were used. Moreover, the total surface of the container from which heat can be dissipated is greater than with a globe of like volume. However, in certain cases it may be desirable to have the container in the form of a globe. The walls of the container 1 are made quite thin in order to allow the heat generated within said container to pass readily through said walls. This container is thoroughly evacuated and the walls thereof are freed of all occluded gases in accordance with the usual practice.

Some material having the desired spectral properties is then introduced into the container 1. This material may be gases, for example, neon, helium or argon, or some easily vaporizable material, for example, mercury, zinc or cadmium. When the easily vaporizable materials are used, it is desirable, though not absolutely necessary, to also introduce into the container a rare gas, such as argon, or a mixture of rare gases at a pressure of about one to two millimeters of mercury.

The container 1 is disposed within the glass envelope 10, having a re-entrant portion 11 and a press 12 of the usual construction. Supporting wires 15 and 16 are sealed in the press 12. These wires are engaged by metal bands 17 and 18 which encircle legs 2' and 3 of the container. These bands 17 and 18 are fitted tightly around the legs 2' and 3 and wires 15 and 16 so that the container is supported firmly in position. Wires 15 and 16 also serve as leads for high frequency currents from an oscillator 19 to a coil 20 concentric with the toroidal member 2. This coil is preferably placed inside the torus in order to minimize its interference with the radiation of light from the container 1. The coil 20, however, may be disposed in any manner with relation to the container 1 as long as the toroidal member 2 is in inductive relation to the coil. The coil 20 comprises a few turns of wire which is highly polished in order to produce a reflecting surface thereon. Such reflecting surface cuts down the loss of light which falls upon the coil.

In order to conduct heat rapidly away from the walls of the container 1, the envelope 10 is filled with some material having a very high thermal conductivity. This material is preferably a gas and may consist of hydrogen, helium or the like, or a mixture of such gases. Preferably I use a mixture of helium and hydrogen, the hydrogen being not more than about 25%. The pressure of the gas within the envelope 10 is sufficiently high so that an electrical discharge will not be induced therein by the coil 20.

When the coil 20 is furnished with high frequency currents from the source 19, an electrical discharge will be induced in the atmosphere within the container.

The full voltage of the source 19 which is impressed on the bands 17 and 18 is sufficient to start a glow discharge in the container. This glow discharge ionizes the gases in the torus and increases the conductivity so that the coil 20 can induce a ring discharge within the torus. Thus the bands 17 and 18 also serve as starting electrodes. Upon the discharge occurring within the container 1 light having the characteristic spectral properties of the particular atmosphere used will be emitted. The voltage of the source 19 together with the relative dimensions and constants of the coil 20 and container 1 are so chosen that the discharge within the container 1 is maintained at a very high current density and consequently a very high efficiency. I have found it advisable at the pressure mentioned not to have the diameter of the bore of the toroid shown less than about 1/4". However it is possible to use smaller bores by using higher pressures of the gas within the container and inducing higher voltages therein. Of course larger sizes of bore may also be used.

When an easily vaporizable material and a rare gas is used in the container 1, the discharge initially starts in the rare gas. The heat liberated by this discharge causes the vaporizable material to be vaporized whereupon the discharge is carried by the vapor due to the fact that it has a lower ionization voltage than that of the rare gas. In such case, the light emitted will have predominantly the spectral properties of the vapor.

The heat which is liberated by this intense discharge passes readily through the thin walls of the container 1. Due to the high thermal conductivity of the atmosphere surrounding the container 1, this heat is rapidly transmitted through this atmosphere to the outer container 10. This container having a relatively large area with respect to the area of the container 1 can dissipate to the outer atmosphere the total amount of heat transmitted to it without becoming unduly hot.

When vapors are used as the source of light, the vapor pressure varies in accordance with the temperature of the coolest portion of the vapor. It is advisable to keep the vapor pressure from rising to too high a value. Since the legs 2' and 3 are cooler than the other portions of the tube the vapor pressure will be determined by the temperature of the coolest portion of these legs. The temperature of these legs is determined by the temperature of the gases around them. Since the heat from these gases is rapidly dissipated from the comparatively large area of the container 1 these gases will be kept relatively cool. Thus even at the high intensity at which I operate my lamp the vapor pressure will not rise to excessive values. Since the atmosphere in the envelope 10 is non-oxidizing, the finish of coil 20 may be of any kind which will not tarnish in such an atmosphere. This finish may be, for example, highly polished silver or chromium.

The discharge will remain within the toroidal member 2 and will not occur within the atmosphere of the envelope 10 if certain conditions exist. For example, if helium alone is used, the walls of the envelope 10 may be placed close to the walls of the lamp 1, and the helium in the restricted space so formed will not allow a discharge to be initiated or maintained therein. However, since it is usually advisable to have a rather large surface for the envelope 10 in order to increase the radiating surface, the pressure at which the helium is maintained is kept fairly high and is preferably in the neighborhood of one atmosphere. The addition of some hydrogen to the helium will enable the pressure within the envelope 10 to be maintained at a much lower value. I have found that a mixture of helium and hydrogen, the hydrogen being not more than about 25%, enables the pressure within the envelope 10 to be kept quite low and yet prevent a discharge from occurring with the envelope. It will also be noted that such a mixture is not readily inflammable if released into the air so that any danger of explosion due to the use of hydrogen, is avoided. However, I do not wish to be limited to the use of hydrogen in this specific amount inasmuch as it is clear that hydrogen alone could be used for the atmosphere within the envelope 10, and prevent a discharge from taking place at low pressures.

The invention is not limited to the particular details of construction, materials, or processes described above, as many equivalents will suggest themselves to those skilled in the art.

It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. In an electrical discharge device comprising a container, an atmosphere within said container in which an electrical discharge of high current density is adapted to be maintained, an envelope enclosing said container, said envelope being filled with a gas of high heat conductivity and having a heat dissipating outer surface substantially in excess of the heat dissipating surface of said container.

2. An electrical discharge lamp comprising a transparent vessel filled with a radiating gas, a transparent envelope enclosing said vessel, said envelope being filled with a gas of high heat conductivity and having a dissipating outer surface substantially in excess of the heat dissipating surface of said vessel.

3. An electrical discharge lamp comprising a transparent vessel filled with a radiating gas, a transparent envelope enclosing said vessel, said envelope being filled with a gas of high heat conductivity and having a heat dissipating outer surface substantially in excess of the heat dissipating surface of said vessel, and high frequency inducing means for inducing a discharge in the gas in said inner vessel.

4. An electrical discharge lamp comprising a transparent vessel filled with a radiating gas, a transparent envelope enclosing said vessel, said envelope being filled with a gas of high heat conductivity and having a heat dissipating outer surface substantially in excess of the heat dissipating surface of said vessel, and high frequency inducing means for inducing a discharge in the gas in said inner vessel, the pressure of the gas within said envelope being of such a value that no discharge is induced therein.

5. An electrical discharge lamp comprising a vapor-filled transparent vessel, a transparent envelope enclosing said vessel and filled with a gas of high heat conductivity, said vessel having a discharge path in which an intense current flow is maintained developing substantial heat, said vessel also having a pocket disposed outside the path of the discharge and immersed in a relative cool section of the envelope to limit the pressure in said vessel.

6. An electrical discharge lamp comprising a toroidal transparent vessel filled with a radiating gas, a transparent envelope enclosing said vessel and filled with a gas of high heat conductivity, and high frequency inducing means for inducing a discharge in the gas in said inner vessel.

7. An electrical discharge lamp comprising a thin-walled quartz vessel filled with radiating gas, a transparent envelope enclosing said vessel, said envelope being filled with a gas of high heat conductivity, and having a heat dissipating outer surface substantially in excess of the heat dissipating surface of said inner vessel.

8. An electrical discharge lamp comprising a transparent vessel filled with a radiating gas, a transparent envelope enclosing said vessel, said envelope being filled with helium and having a heat dissipating outer surface substantially in excess of the heat dissipating surface of said vessel.

9. An electrical discharge lamp comprising a transparent vessel filled with a radiating gas, a transparent envelope enclosing said vessel, said envelope containing a mixture of helium and hydrogen, and having a heat dissipating outer surface substantially in excess of the heat dissipating surface of said vessel.

10. An electrical discharge lamp comprising a transparent vessel filled with a radiating gas, high frequency inducing means for inducing a discharge in said gas, said means including a coil having a polished light-reflecting surface, a transparent envelope enclosing said vessel and filled with a gas inert with respect to the surface of said coil, said coil being placed outside of said vessel within said transparent envelope.

11. An electrical discharge lamp comprising a hermetically sealed vessel filled with a gas in which an electrical discharge is adapted to be maintained, means for rapidly conducting away the heat generated in said vessel, comprising a gas of high heat conductivity in which outer surfaces of said vessel are placed, and a hermetically sealed envelope enclosing said gas of high heat conductivity.

12. An electrical discharge lamp comprising a transparent vessel filled with a radiating gas, a transparent envelope enclosing said vessel, said envelope being filled with a gas of high heat conductivity and having a heat dissipating outer surface substantially in excess of the heat dissipating surface of said vessel, high frequency inducing means for inducing a discharge in the gas in said inner vessel, the pressure of the gas within said envelope being of such a value that no discharge is induced therein, and means for increasing the permissible pressure of said latter gas comprising a quantity of hydrogen mixed therewith.

13. An electrical discharge lamp comprising a transparent vessel filled with a radiating gas, a transparent envelope enclosing said vessel, said envelope being filled with a gas of high heat conductivity and having a heat dissipating outer surface substantially in excess of the heat dissipating surface of said vessel, high frequency inducing means for inducing a discharge in the gas in said inner vessel, the pressure of the gas within said envelope being of such a value that no discharge is induced therein, and means for increasing the permissible pressure of said latter gas comprising a quantity of hydrogen mixed therewith, the proportion of hydrogen being not in excess of twenty-five per cent.

14. A space discharge device comprising a hermetically sealed envelope, a gas in which an electrical discharge is adapted to take place within said envelope, a coil adapted to be supplied with high frequency currents for inducing currents in said gas and disposed in inductive relationship to said gas, two electrodes supported at points spaced apart on said container, and two leads for said coil, said leads being connected to said electrodes and being adapted to be electrically connected to a source of high frequency current.

15. A space discharge device comprising a hermetically sealed envelope, a gas in which an electrical discharge is adapted to take place within said envelope, means for initiating a discharge in said gas comprising two electrodes supported at points spaced apart on said container, means for maintaining a discharge in said gas comprising a coil adapted to be supplied with high frequency currents for inducing currents in said gas and disposed in inductive relationship to said gas, and two leads for said coil, said leads being connected to said electrodes and being adapted to be electrically connected to a source of high frequency current.

16. A space discharge device comprising a hermetically sealed envelope, a gas in which an electrical discharge is adapted to take place within said envelope, a coil adapted to be supplied with high frequency currents for inducing currents in said gas and disposed in inductive relationship to said gas, two electrodes supported at points spaced apart on said container and external to said container, and two leads for said coil, said electrodes and said leads being electrically connected and clamped to said container at said spaced points.

17. An induction lamp comprising a transparent container, a coil adapted to be supplied with high frequency currents for exciting said lamp and disposed adjacent said lamp, two electrodes supported by said container at points spaced apart from each other, a pair of leads for said coil, said leads being clamped to said container by said electrodes, and a source of high frequency current connected to said leads.

18. An electrical discharge lamp comprising a sealed vessel filled with a gas in which an electrical discharge is adapted to be maintained, means for rapidly conducting away the heat generated in said vessel, comprising a gas of high heat conductivity in which the outer surfaces of said vessel are placed, and an envelope enclosing said gas of high heat conductivity.

19. An electrical discharge lamp comprising a sealed vessel filled with a gas in which an electrical discharge is adapted to be maintained, means for rapidly conducting away the heat generated in said vessel, comprising a gas of high heat conductivity in which the outer surfaces of said vessel are placed, an envelope enclosing said gas of high heat conductivity, means for producing a discharge in the gas in said inner vessel, conducting leads extending through said gas of high heat conductivity to said last-named means, and means for preventing a discharge through said gas of high heat conductivity between said conducting leads.

20. An electrical discharge lamp comprising a transparent vessel filled with a radiating gas, and inductive means for inducing a discharge in said gas, said means including a coil having a polished light-reflecting surface, said coil being placed in inductive relationship with respect to said radiating gas.

In testimony whereof, I have signed my name to this specification, this 23rd day of April, 1931.

CHARLES G. SMITH.