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GASEOUS DISCHARGE DEVICE

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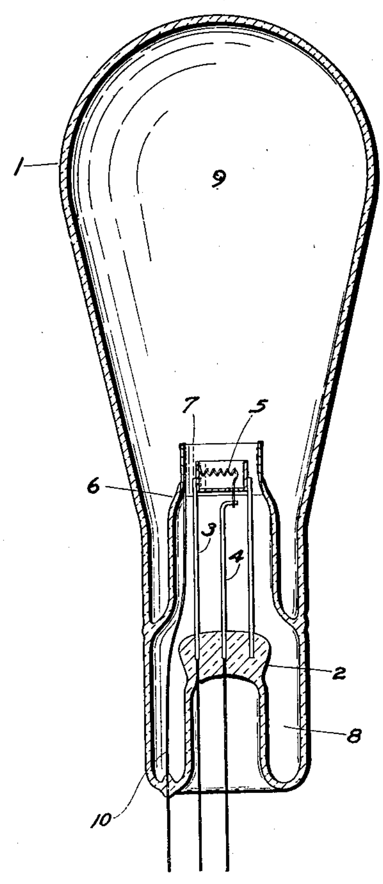

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GASEOUS DISCHARGE DEVICE

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14 Claims. (Cl. 176—122)

This invention relates to gaseous discharge devices and especially to a device for producing light of a desirable color at high efficiency. Glow lamps in which a gaseous discharge occurs producing light, are old. The color of the light depends upon the gas or vapor used in the glow lamp, different gases and vapors radiating light of different frequency and color.

While it is desirable to mix the colors in order to obtain a certain resultant color, this can not be done by the simple expedient of mixing the gases. The reason for this is that the gas or vapor having the lower ionization potential is the one which carries practically the entire current. In other words, the gas or vapor having the lowest ionization potential is the only one which is ionized to any extent. This will be evident from the following considerations. With a mixture of gases or vapors or both, the various particles will be uniformly distributed among each other. An electron falling down the potential gradient between the cathode to the anode, will be accelerated to a certain velocity, assuming this velocity corresponds to the lowest ionization potential of the gases or vapors. Under these conditions, the electrons in striking a particle having the lowest ionization potential will have an inelastic collision resulting in the ionizaton of such particle. With such a collision, substantially all of the entire energy of the electron prior to the impact, is absorbed, the electron starting out again from a position of rest.

If the electron collides with a gas particle before it has had an opportunity to get up to an exciting or ionizing speed, its collision will be harmless and in most cases leave the gas particle as it was before. Due to the comparatively large number of gas particles in the space between electrodes, and due to the enormous velocity of the electrons, equivalent to sweeping through a very large number of gas particles, very few, if any electrons, will ever be able to get up to a speed which is higher than the ionizing speed corresponding to the lowest ionization potential of the mixture.

It is true, of course, that there may be random collisions between gas particles having a higher ionization potential and electrons travelling at a speed sufficient to ionize them. It is equally true that there may be random collisions between gas particles having higher ionization potential than the lowest of the mixture of electrons travelling at a sufficiently great speed to excite the particles. In both of these last two cases upon the resumption of the normal state by the gas particles, light will be emitted having a frequency different from the light emitted in general. However, in actual practice, such different colored light is negligible in amount and can hardly be detected.

In my prior application, Serial No. 706,658, I disclosed a lamp filled with a mixture of gases of different ionizing potential with a special arrangement for producing high velocity electrons inside the gas filled lamp so as to produce luminous radiation by all the gases in the lamp. The high velocity of the electrons in the tube is produced by means of an incandescent cathode and an anode placed in the gas filled lamp close to each other at a distance less than the mean free path of the gas molecules in the tube. The anode is perforated and under the action of a high potential, the electrons are accelerated to a velocity above the ionization voltage of all the gases in the tube and after passing through the anode perforations they enter the main gas space and ionize both the gas of low ionizing potential as well as the gas of high ionizing potential, causing both gases to radiate.

This invention while following the same general lines as the other one, embodies improvements therein allowing of the more effective bombardment of the mixed gas particles by high speed electrons. In general, I accomplish this by having a thermionic cathode emit electrons to an anode at a high positive potential with respect to the cathode. The space between the cathode and anode is preferably exhausted to a high vacuum. The anode is of some thin metal such as nickel, beryllium or the like, and is preferably though not necessarily, the dividing wall between the highly evacuated region in which the cathode lies and a space containing a mixture of gases or vapors or both. By impressing a sufficiently high potential at the anode with respect to the cathode, electrons are drawn to the anode with such great force that they strike and penetrate it to travel some distance beyond. In traveling beyond the anode, the electrons have their speed greatly reduced by the attraction of the anode on them tending to reduce the speed of the latter to zero and causing them to return to the anode ultimately. In this way, however, the behavior of the electrons is very much similar to the swinging of a pendulum in which the latter overshoots the position of equilibrium.

After penetrating the anode and going into the gaseous region, the electrons are traveling at a velocity corresponding to a potential in excess of that required to ionize any of the gas particles in the region. The speed may correspond to a potential of 10,000 volts or more. Hence, practically all collisions between electrons and gas particles results in ionizing or exciting the latter and ultimately causing the emission of light. Because of the high speed at which electrons are traveling when they enter the gaseous region, rays of very short wave length such as X-rays are produced in addition to the ionization. Hence, in another aspect this device may be considered as a generator of X-rays having as a target a gaseous region.

Referring to the drawing, the single figure shows a lamp embodying my invention. An envelope 1 of glass or similar material has a reentrant press 2. Sealed in this press are wires 3 and 4 supporting a filamentary cathode 5. Sealed around press 2 to the glass wall of container 1 is a glass circular member 6. This member may if desired be of metal instead of glass. Sealed over the top of member 6 is a cup-shaped metal member 7 preferably of thin metal such as nickel or beryllium. Members 6 and 7 separate the space within container 1 into two chambers 8 and 9. These chambers are distinct from each other. Chamber 8 is exhausted to a high vacuum by usual methods. Chamber 9 has therein a mixture of gases or vapors or both at any desired pressure. Thus mercury and neon may be used. As is well known, the spectrum of mercury is deficient in red, while neon is rich in that color. A lamp having this mixture may thus be made to furnish a very desirable light as a substitute for daylight. However, any other gas or vapor may be used. More than two may also be used, and in fact any desired number of gases or vapors may be used.

In order to impress a positive potential upon member 7, lead wire 10 is connected thereto. Electrons emitted by thermionic filament 5 are attracted to anode 7 by the very great potential gradient. The electrons are accelerated so much that when they arrive at anode 7 they tend to penetrate through the metal and go into the gaseous region 9 for a certain distance before returning. In going into gaseous region 9, many of them have ionizing collisions with the gas particles.

It is well known that the voltage at the anode to cause electrons to go through the anode into the gas region depends upon the thickness of the material. The thicker the material, the higher the voltage. In order therefore to reduce the voltage, member 7 may be made entirely of or have one wall of very thin metal of a thickness of .0005 of an inch. If any extensive area of metal is used, the pressure in 9 may be kept low in order that the thin metal member will not be broken down. This pressure may be of the order of ten mm. of mercury. At this pressure there will be ample particles of gas or vapor for intense ionization. If desired, member 7 may be made in the form of a grille or mesh of heavy wire upon which is supported a very thin metal wall.

Due to the fact that there is no cathode in the gaseous region, it is evident that there will be no bombardment of any electrodes by positive ions. Hence, however intense the ionization may be, no clean up of any of the gases will occur as is so frequently the case in ordinary gaseous discharge devices. Thus there are no restrictions as to the nature of the gases which may be used in combination with each other in such a lamp. In ordinary glow lamps one or more of the gases as a rule are cleaned up by being driven into the cathode. This results in the gaseous content of the tube being gradually changed from what it was originally. Such a change is impossible in applicant's device.

I claim:

1. An electron discharge device comprising the combination with an envelope, of two compartments within the envelope, a cathode and an anode in one of the said compartments, and a mixture of gases in the other compartment, the said anode being of such thinness that electrons emitted from the cathode will pass through the anode at a velocity sufficient to ionize gas particles in the gas containing compartment to produce a glow.

2. An electron discharge device comprising the combination with an envelope divided into adjacent compartments, of a hollow cup-shaped anode forming a part of the boundary of the adjacent compartments, and a cup-shaped cathode containing an auxiliary filament enclosed by the said anode and spaced apart therefrom at such a distance that electrons emitted from the cathode will reach the anode at a velocity in substantial excess of that required to ionize any gas particles in the space between the electrodes, and to penetrate the anode with a residual velocity sufficient to ionize gas particles in the adjacent compartment to produce a glow.

3. An electron discharge device comprising the combination with an envelope, means for dividing the said envelope into adjacent gas and electrode compartments, a cup-shaped anode comprising at least a portion of the dividing means, and a cathode symmetrically disposed to and spaced from the anode and located in the electrode compartment, the said compartment being exhausted, the distance between the cathode and anode being such that electrons emitted from the cathode will reach the anode at a velocity in substantial excess of that required to ionize any gas particles in the space between the electrodes, and to penetrate the anode with a residual velocity sufficient to ionize gas particles in the gas compartment to produce a glow.

4. An electron discharge device comprising the combination with an envelope, of a gas chamber and an electrode chamber within the envelope, the said gas chamber containing a gaseous material under reduced pressure, and the electrode chamber being evacuated to a high vacuum, a cup-shaped anode in the electrode chamber adjacent the gas chamber, and a cathode symmetrically positioned to and spaced apart from the said anode and adapted to emit electrons upon energization thereof, the said anode being of such thinness as to be penetrated by electrons emitted from the cathode, the distance between the cathode and anode being such that electrons emitted from the cathode will reach the anode at a velocity in substantial excess of that required to ionize any gas particles in the space between the electrons, and will penetrate the anode with a residual velocity sufficient to ionize gas particles in the adjacent compartment to produce a glow.

5. An electron discharge device comprising the combination with an envelope divided into adjacent compartments, one of the said compartments being a gas compartment, and the other being an electrode compartment, the electrode compartment being highly evacuated, of a hollow cup-shaped anode positioned in the electrode chamber adjacent to the gas chamber, and a cathode enclosed by the anode and spaced apart therefrom at such a distance that electrons emit-

ted from the cathode will penetrate the anode and will have a residual velocity after penetration sufficient to ionize gas particles in the gas compartment to produce a glow.

6. An electron discharge device comprising the combination with an envelope, divided into adjacent compartments, one of said compartments containing gas, and the other of the said compartments being an electrode compartment and being highly evacuated, of a hollow cup-shaped anode positioned in the electrode compartment adjacent to the gas compartment, and a cup-shaped cathode containing an auxiliary filament enclosed by the said anode and spaced apart therefrom at such a distance that electrons emitted from the cathode will reach and penetrate the anode, and will have a residual velocity after penetration sufficient to ionize gas particles in the gas compartment to produce a glow.

7. A gaseous electric lamp comprising, a gas tight vessel having a transparent wall for passing luminous radiation therethrough, an ionizable gas in said vessel at a pressure at which on excitation by sufficiently accelerated electrons the gas molecules radiate light, and means for driving a stream of electrons in form of cathode rays from a space outside said gas tight vessel into said vessel at a velocity at which said electrons will excite said gas to luminous radiation, said means being the sole means for producing a discharge in said gas-tight vessel.

8. A gaseous electric lamp comprising, a gas tight vessel having a transparent wall for passing luminous radiation therethrough, a gas of low ionizing potential and a gas of high ionizing potential in said vessel, each of said gases being at a pressure at which on excitation by sufficiently accelerated electrons the gas molecules radiate light, and means for driving electrons from a space outside said gas tight vessel through the gas in said vessel at a velocity higher than that corresponding to the ionization voltage of the gas having the higher ionization voltage to cause said electrons to excite both of said gases to luminous radiation.

9. A gaseous electric lamp comprising, a gas tight vessel having a transparent wall for passing luminous radiation therethrough, an ionizable gas in said vessel at a pressure at which on excitation by sufficiently accelerated electrons the gas molecules radiate light, said vessel having a window for passing cathode rays into its interior, and means for driving the stream of electrons in the form of cathode rays from a space outside said gas tight vessel into said vessel at a velocity at which said electrons will pass through said window and continue to move through the gas in said vessel at a velocity of the order of the ionization voltage of the gas in said vessel, said means being the sole means for producing a discharge in said gas-tight vessel.

10. A gaseous electric lamp comprising, a gas tight vessel having a transparent wall for passing luminous radiation therethrough, a gas of low ionizing potential and a gas of high ionizing potential in said vessel, each of said gases being at a pressure at which on excitation by sufficiently accelerated electrons the gas molecules radiate light, said vessel having a window for passing cathode rays into its interior, and means for driving a stream of electrons in the form of cathode rays from a space outside said vessel through the window into said vessel at a velocity at which said electrons will penetrate said window and continue to move through the gas in said vessel at a velocity of the order of the ionization voltage of the gas having the higher ionization potential.

11. A gaseous electric lamp comprising, a gas tight vessel having a transparent wall for passing luminous radiation therethrough, an ionizable gas in said vessel at a pressure at which on excitation by sufficiently accelerated electrons the gas molecules radiate light, a second gas tight vessel adjoining said first vessel but evacuated to a high degree to practically eliminate ionization by collision therein, a window separating said vessels from each other and adapted to pass high velocity cathode rays from said evacuated vessel into said gas filled vessel, and a pair of electrodes in said evacuated vessel for producing a stream of electrons in the form of cathode rays passing from said evacuated vessel through said window and continuing to move thereafter through the gas in said gas filled vessel at a velocity sufficient to produce luminous radiation in the gas therein, the arrangement whereby said stream of electrons is passed into said gas-filled vessel constituting the sole means for producing a discharge in said gas-filled vessel.

12. A gaseous electric lamp comprising, a gas tight vessel having a transparent wall for passing luminous radiation therethrough, a gas of low ionizing potential and a gas of high ionizing potential in said vessel, each of said gases being at a pressure at which on excitation by sufficiently accelerated electrons the gas molecules radiate light, a second gas tight vessel adjoining said first vessel but evacuated to a high degree to practically eliminate ionization by collision therein, a window separating said vessels from each other and adapted to pass high velocity cathode rays from said evacuated vessel into said gas filled vessel, and a pair of electrodes in said evacuated vessel for producing a stream of electrons in the form of cathode rays passing from said evacuated vessel through said window and continuing to move thereafter through the gas in said gas filled vessel at a velocity of the order of the velocity corresponding to the ionization voltage of the gas having the higher ionization voltage.

13. A gaseous electric lamp comprising, a gas tight vessel having a transparent wall for passing luminous radiation therethrough, an ionizable gas in said vessel at a pressure at which on excitation by sufficiently accelerated electrons the gas molecules radiate light, an additional gas tight vessel adjoining said first gas tight vessel and evacuated to a degree at which gaseous ionization is substantially eliminated, an anode and a cathode in said highly evacuated vessel, said anode constituting a window separating said two vessels from each other and adapted to pass cathode rays from said high vacuum vessel into said gas filled vessel, and means for producing a flow of electrons from said cathode to said anode at a velocity sufficient to cause said electrode to penetrate through said anode into said gas filled vessel and then continue to move with a velocity sufficient to excite the gas in said gas filled vessel to luminous radiation, the arrangement whereby said stream of electrons is passed into said gas-filled vessel constituting the sole means for producing a discharge in said gas-filled vessel.

14. A gaseous electric lamp comprising, a gas tight vessel having a transparent wall for passing luminous radiation therethrough, a gas of low ionizing potential and a gas of high ionizing potential in said vessel, each of said gases being at a pressure at which on excitation by sufficiently ac-

celerated electrons the gas molecules radiate light, an additional gas tight vessel adjoining said first gas tight vessel and evacuated to a degree at which gaseous ionization is substantially eliminated, an anode and a cathode in said highly evacuated vessel, said anode constituting a window separating said two vessels from each other and adapted to pass cathode rays from said high vacuum vessel into said gas filled vessel, and means for producing a flow of electrons from said cathode to said anode at a velocity sufficient to cause said electrode to penetrate through said anode into said gas filled vessel and then continue to move at a velocity of the order corresponding to the ionization voltage of the gas in said vessel having a higher ionization voltage.

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