

Nov. 16, 1937.

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2,099,111

GASEOUS DISCHARGE DEVICE

Filed March 9, 1935

2 Sheets-Sheet 1

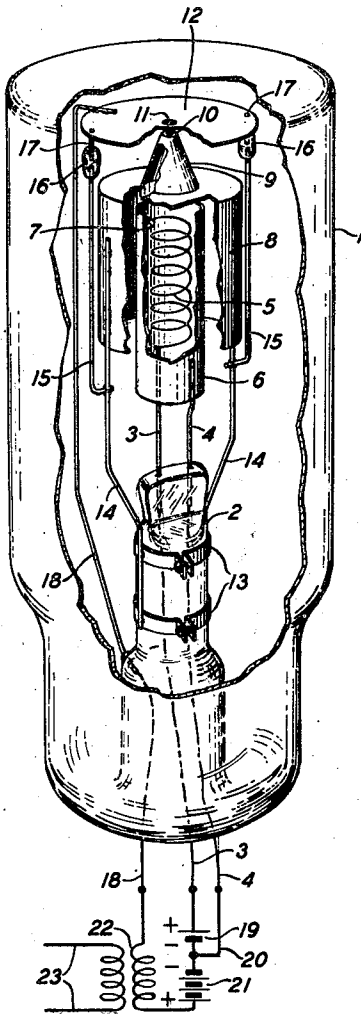


FIG. 1

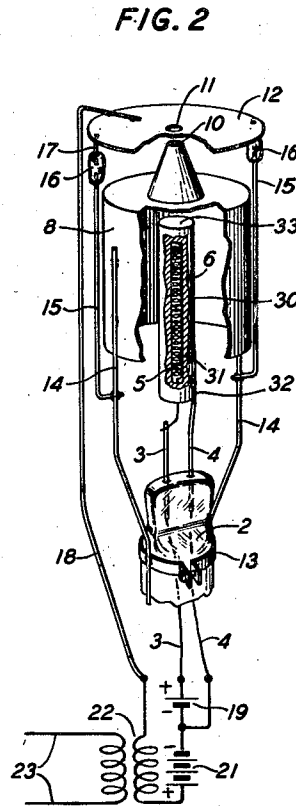


FIG. 2

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FIG. 3

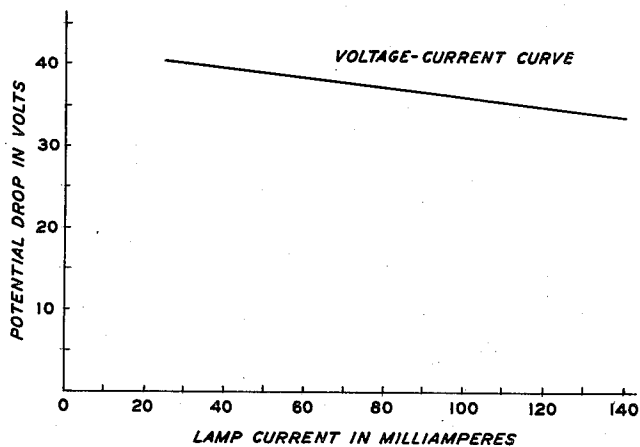
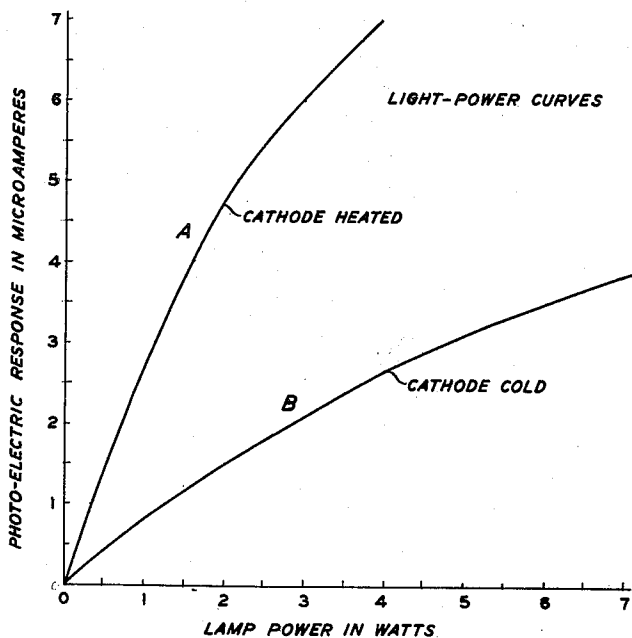


FIG. 4



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2,099,111

GASEOUS DISCHARGE DEVICE

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Application March 9, 1935, Serial No. 10,239

10 Claims. (Cl. 176-124)

This invention relates to a gaseous discharge device and more particularly to a device having a heated cathode.

The prior art contains a disclosure of a discharge lamp including a cathode adapted to be heated to electron emitting temperature, in which the cathode is directly and continuously heated by electric current supplied by the source which supplies energizing potential to the discharge path or indirectly heated by supplying current from that source to a heating unit associated with a cathode either during the starting period alone, i. e., for a short time preceding the initiation of the discharge across the path between the electrodes when the heating unit is disconnected from the supply source, or during a starting period and throughout the operating period.

While such a lamp is satisfactory for lighting purposes, it is not adapted for use in signaling systems wherein the energy supplied to the discharge path varies between wide limits of current and voltage, for the reason that at low values of current and voltage the lamp becomes inoperative, because the current supplied to the heater is insufficient to maintain the cathode heated to electron emitting temperatures, with the result that certain signals may be lost or so mutilated that they are unintelligible. Again, since the heat supplied by the heater unit varies with the square of the current, the temperature of the cathode and hence its electron emissivity will vary therewith and, as a result, the signal produced will be distorted.

In certain types of signaling, such as in picture transmission and television systems and in sound recording, it is essential that the light source be maintained in a continuously operative condition in order that the light supplied by it may faithfully follow variations of the signal current and potential, which fluctuate from substantially zero amplitude, representing a dark condition or a minimum intensity, to a large amplitude corresponding to white or maximum intensity. In other words, the operation of the heating unit must be independent of the potential producing the discharge between the electrodes.

An object of this invention is to provide a gaseous discharge lamp adapted to be supplied with variable energizing potential and having a heated cathode, the temperature of which is independent of the potential producing the discharge.

Another object is to provide a gaseous discharge lamp adapted to be supplied with variable energizing potential and having a cathode continu-

ously maintained at electron emitting temperature.

An important feature of this invention relates to a gaseous discharge device having a heating unit exposed to the discharge but protected from bombardment by such discharge.

According to one embodiment of this invention, a gas-filled container or bulb encloses electrodes between which is applied a signal or variable potential for controlling a luminous discharge between them. The electrodes comprise an anode having a small aperture, and either a tubular cathode surrounding, or a cylindrical cathode having a closed end adapted to completely enclose, a heating unit that is supplied with constant current for maintaining the cathode at all times heated to an electron emitting temperature. There is also a discharge directing member provided with a capillary opening, this capillary opening and the aperture in the anode being in line with the longitudinal axis of the cathode, whereby there is provided a low voltage positive column gaseous discharge device which operates to produce light which varies in intensity with the fluctuating signal potentials applied to its electrodes and hence operates to faithfully reproduce the signals without introducing distortion.

A detailed description of the invention follows which is illustrated in the attached drawings, in which

Fig. 1 illustrates a glow lamp, partly in section, having a tubular cathode surrounding a heating unit;

Fig. 2 shows a glow lamp, also partly in section, in which the heating unit is completely enclosed by a cathode;

Fig. 3 is a graphical representation of the relation between the voltage and the current applied to the lamp; and

Fig. 4 is a graphical representation of the relation between the light emitted and the power taken by the luminous discharge of the heated cathode type lamp as compared with a cold cathode lamp of otherwise similar construction.

Referring more particularly to the drawings, Fig. 1 shows a glow discharge lamp comprising a bulb 1 provided with a press 2. Lead-in conductors 3 and 4 extend through this press 2, conductor 3 connecting to one terminal of a heating unit or coil 5 while conductor 4 is connected to cathode 6, to which the other terminal 7 of the heating coil 5 is attached for a purpose which will be more fully explained as the description proceeds. The cathode 6 in Fig. 1 comprises an

open cylinder surrounding the heating coil 5 and is formed of or externally coated with a material which is adapted to be heated to electron emitting temperature by that coil.

5 Surrounding the cathode 6 is a cylindrical member 8 provided with a conical extension 9 which terminates in a capillary opening 10 adjacent an aperture 11 in the anode 12. Aperture 11 in the anode 12 and the capillary opening 10 are in line with the longitudinal axis of the cylindrical cathode 6.

Clamped on the press 2 are a pair of split sleeves 13 from which rods 14 extend into the lamp away from the base. These rods support 15 the member 8 which surrounds the cathode 6. Secured to the rods 14 are a pair of rods 15 provided at their upper ends with insulators 16 from which extend short projections 17. These short projections 17 are secured to the anode 12. 20 The elements 16 serve to electrically insulate the rods 15 from the projections 17 and these three sets of elements combined with the rods 14 serve as supports for the anode 12. A lead-in wire 18 extends through the base of the lamp 25 and is connected to the anode 12.

The bulb 1 contains a charge of a rare gas, such as neon, helium, or argon, at a pressure of a few millimeters of mercury. It may be advantageous also to have a charge consisting of a mixture of one of these gases and either nitrogen, hydrogen or mercury. The pressure of the gas charge may be between 5 and 10 millimeters of mercury and, in the case where nitrogen or hydrogen is used, the nitrogen or hydrogen may constitute from 2 to 5 per cent by volume of the charge. When mercury is used a smaller amount would be sufficient.

The coil 5 is supplied with heating current from any constant current source, such as, for 40 example, the battery 19. The negative terminal 20 of the source 19 is connected to the cathode 6 by means of the lead-in wire 4 and the positive terminal is connected via the lead-in wire 3 to the coil 5. The coil 5 is thus supplied with constant current of sufficient value to maintain the cathode 6 heated at all times to electron emitting temperature. This is an important feature of this invention.

The negative terminal of the battery 19 is also connected to the negative terminal of a battery 50 21, which has its positive terminal connected through the secondary winding of a transformer 22 and lead 18 to the anode 12. The primary winding of the transformer 22 is supplied with variable signal current transmitted over the circuit 23, for example, with current varying as the tone values of a picture or object scanned at a transmitting station of a picture transmitting or television system. Battery 21 supplies a steady 55 potential of sufficient value to cause a luminous positive column discharge of constant light intensity to occur across the space between the surface of the cathode 6 and the anode 12. This positive ionic discharge occurs between the anode 12 and both surfaces, inside and outside, 60 of the cathode 6. For this reason, the discharge is distributed over a greater area than if the closed end cathode is used. The concentrated beam is consequently more intense. As the heating coil 5 is in the path of the discharge, means which will now be described are provided to prevent the positive ions from causing destructive bombardment of this coil.

The drop across the heating coil 5 is such that 75 the potential difference between the lower end

of the coil 5 and the anode 12 is less than that across the battery 21 which produces the luminous discharge. This coil, therefore, is not subject to the highly destructive ionic bombardment due to the luminous discharge which would materially reduce the useful life of the lamp as all portions of the coil except the end connected to the cathode are positively polarized with respect to the cathode. If the battery 19 were reversed in polarity, the potential difference between the 10 lower end of the coil 5 and the anode 12 would then be greater than that between the anode 12 and the cathode 6 and most of the discharge would occur between the coil 5 and the anode 12, thus materially reducing the life of the coil 5. 15 By utilizing an electron emitting surface of extended area, a large current carrying capacity is assured, and by concentrating the discharge into the capillary opening 10, a positive column of great brightness and constant intensity is 20 produced.

By properly selecting the potential of the battery 21, signals varying over an extremely wide range of values may be supplied by the transformer 22 for superposition on that supplied by 25 the battery without causing the effective potential applied to the lamp to be reduced below its extinction voltage. However, even if the signals are of such magnitude as to reduce the voltage applied to the electrodes to a value below the extinction voltage of the lamp, the luminous discharge will be immediately restarted upon restoration of the breakdown voltage of the lamp, due to the fact that the cathode is maintained uniformly heated to electron emitting temperature by current from the constant current source 30 19.

As shown in Fig. 3, the relation between the voltage and current supplied to the lamp is linear, and the line representing this relation has a negative slope. For an otherwise similar cold cathode lamp the slope would be positive. 40

Fig. 4 shows light versus power curves A and B, which respectively relate to a heated cathode lamp of the type described herein and to a cold cathode lamp of otherwise similar construction. It will be observed that the shape of curve A for the heated cathode lamp is somewhat similar to curve B for the cold cathode lamp. However, the amount of light produced by a glow discharge lamp having a heated cathode is several times that produced by a lamp of this type provided with a cold cathode, which is identical in design and is operated under exactly the same conditions, and this result is attained with an expenditure of only a fraction of the electrical power used in a cold cathode lamp. Curve A shows only the power taken by the luminous discharge, but the total power curve (taking into account the power extended by the heater coil) would be 60 parallel to and slightly to the right of A.

The design of lamp shown in Fig. 2 differs from that of Fig. 1 solely in the feature that the cathode 6, instead of being an open cylinder surrounding the heating coil, consists of a solid cylindrical body 30 having a central bore 31 which extends from one end 32 thereof to a point intermediate its length, so as to provide an electron emitting element having closed upper end 33. The heating coil 5 is secured in this opening so that it is completely enclosed by the cylindrical body 30, and since the ionic discharge is directed toward the outer surface of the cathode 6 including the closed end 33 thereof from the anode 12, the heating coil 5 is not exposed to this ionic discharge. 75

charge. In this case, the battery 19 may be connected in either direction with respect to the heating coil. As shown, the heating coil 5 is connected between the lead-in wire 3 and the cathode 6, but it may be connected between the two lead-in wires 3 and 4 or directly to the terminals of battery 19.

From the preceding description, it will be apparent that this invention provides a low voltage, positive column discharge lamp, designed to have a long useful life, operable with low power input to provide a discharge having high current density to produce illumination of great intensity and controllable by signal potentials which vary over an extremely wide range of values, such as, for example, those used in sound recording and at the receiving station of a picture transmission or television system to control the production of a picture or image, without causing the positive column discharge to be interrupted in such manner that distortion would be introduced.

What is claimed is:

1. A gaseous discharge device comprising electrodes determining a discharge path between said electrodes, a discharge directing member between said electrodes, means for heating one of said electrodes to electron emission temperature, and means for supplying to said heating means constant current, one terminal of said heating means being connected to the heated electrode and the other terminal being positively polarized with respect thereto.

2. A gaseous discharge device comprising electrodes, a discharge directing member between said electrodes, a unit exposed to the discharge between said electrodes for heating one of said electrodes to electron emission temperature, and means for supplying to said unit constant current, one terminal of said unit being connected to the heated electrode and the other terminal being positively polarized with respect thereto.

3. In combination, a transformer, connections from a source of signal potential to the primary of said transformer, a glow lamp comprising an anode, a cathode, and a heating unit for said cathode, a source of direct current in series with the secondary of said transformer and the discharge space between said anode and cathode, and a source of constant current for said cathode heating unit, one terminal of said heating unit being connected to the cathode and the other terminal being positively polarized with respect thereto.

4. A positive column gaseous discharge device comprising an anode, a cathode having an open end adjacent said anode, a member surrounding said cathode provided with a capillary opening, an aperture in said anode, said aperture and capillary opening being in line with the longitudinal axis of the cathode, a unit exposed to the discharge between said anode and cathode for heating said cathode to electron emission temperature, and means for supplying to said unit constant current, one terminal of said unit being at cathode potential and the other terminal being positively polarized with respect thereto.

5. A positive column gaseous discharge device comprising an anode, a cylindrical cathode, a member surrounding said cathode provided with a capillary opening to direct the discharge between said anode and cathode, means within said cathode for heating it to electron emission

temperature, a source supplying signal potential between said anode and cathode, and a source supplying constant current to said heating means, one terminal of said heating means being at cathode potential.

6. A positive column gaseous discharge lamp comprising an anode, a cathode, a cylindrical member surrounding said cathode, a conical cap for said cylindrical member, a capillary opening at the apex of said conical cap, an aperture in said anode, said aperture and capillary opening being in line with the longitudinal axis of the cathode, and means exposed to the discharge between said anode and cathode for heating said cathode to electron emission temperature, said heating means having one terminal thereof connected to said cathode and its other terminal positively polarized with respect thereto to prevent ionic bombardment of said unit.

7. A positive column gaseous discharge device comprising an anode, a cathode, a cylindrical member surrounding said cathode, a conical cap for said cylindrical member, a capillary opening at the apex of said conical cap, an aperture in said anode, said aperture and capillary opening being in line with the longitudinal axis of the cathode, means combined with said cathode for heating it to electron emission temperature, a source supplying signal potential between said anode and cathode, and a source supplying constant current to said heating means.

8. A gaseous discharge lamp comprising a glass bulb, a press in said bulb, a plurality of split sleeves clamped on said press, an anode, a cathode, a heating unit for said cathode, an aperture in said anode, a cylindrical member having a conical cap and a capillary opening at the apex of said cap surrounding said cathode, said aperture and capillary opening being in line with the longitudinal axis of the cathode, rods fastened to said split sleeves for supporting said cylindrical member and said anode, leads through said press to said cathode and heating unit, and a lead to said anode.

9. A positive column gaseous discharge device comprising a glass enclosure, a press in said enclosure, an anode having an aperture therein, a cathode, a heating unit for said cathode, a cylindrical member having a conical cap and a capillary opening at the apex of said cap surrounding said cathode, said aperture and capillary opening being in line with the longitudinal axis of the cathode, means on said press for supporting said anode, cathode, heating unit, and cylindrical member, a source supplying constant current to said heating unit, and a source supplying signal potential between said anode and cathode.

10. An electric discharge device comprising a gas-tight receptacle containing a gas filling, an anode, a cathode, and electrical means adjacent said cathode for heating it to cause it to emit electrons, said anode, cathode and heating element being so disposed that when an electric discharge occurs between said anode and cathode said heating means is exposed to bombardment by positive ions, and means for limiting said bombardment of said heating means comprising means for maintaining the potential of at least the major portion of said heating means more positive than said cathode.

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