Feb. 13, 1940. P. W. BLACKBURN 2,190,308

CRATER LAMP AS A SPOTLIGHT

Filed Oct. 27, 1937

Fig. 1.

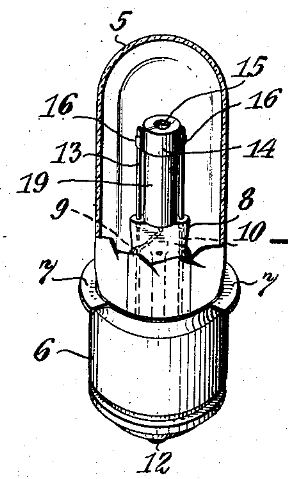


Fig. 2.

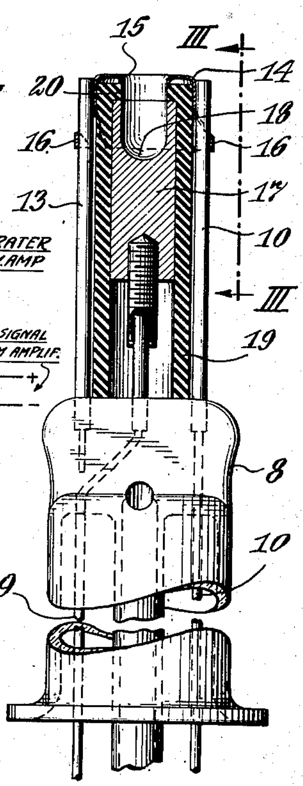


Fig. 5.

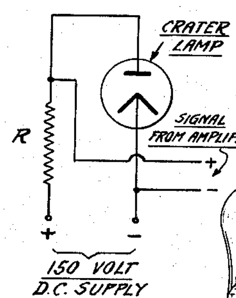


Fig. 3.

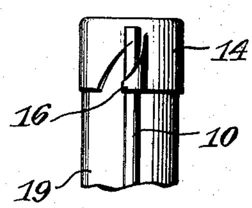


Fig. 6.

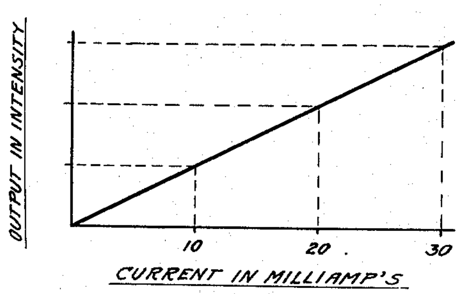
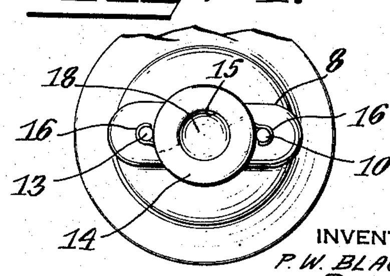


Fig. 4.



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CRATER LAMP AS A SPOTLIGHT

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5 Claims. (Cl. 176—122)

The present invention relates to electrical discharge devices and has particular relation to a glow discharge lamp employing a point source of light from a luminous discharge which renders the device readily adaptable to transferring electrical impulses to a visual record on film such as in television, picture transmission, and sound film.

Devices of this type are known to the art but have heretofore been exceedingly inefficient in operation inasmuch as they have had numerous inherent disadvantages. For example, prior art lamps employed in television, picture transmission, etc., either by wire or radio, have had a life of but a few hours and have required a comparatively high voltage and current. Also there has been an entire lack of uniformity not only between different lamps but between the spots produced by such lamps. Moreover, in these prior art lamps an increase in current does not give a proportional increase in intensity as is readily shown by plotting the modulation curve for such lamps.

It is accordingly an object of the present invention to provide a glow discharge device in which the discharge is confined to a restricted area of one of the electrodes so as to render the device readily adaptable to the transfer of electrical impulses to films such as employed in picture transmission, television and sound film.

Another object of the present invention is the provision of a glow discharge device which is readily adaptable to the transfer of electrical impulses to films such as employed in television, and sound film, wherein the device has a life of several hundred hours and is instantaneously responsive with fidelity to changes of signal current imposed between the electrodes at frequencies within the range of the human ear.

Another object of the present invention is the provision of a glow discharge lamp which generates a concentrated light spot of a wavelength lying partially within the invisible portions of the spectrum so as to readily sensitize photographic film and wherein a uniformity of modulation and other characteristics exists between the same and different lamps.

A further object of the present invention is the provision of a glow discharge lamp readily adaptable to picture transmission which is stable in operation and operable at a low voltage and current.

Still further objects of my present invention will become obvious to those skilled in the art by reference to the accompanying drawing where:

Fig. 1 is an elevational view of a glow discharge lamp constructed in accordance with the present invention with parts thereof broken away to better illustrate the device.

Fig. 2 is a cross-sectional view and on an enlarged scale of the device as shown in Fig. 1 prior to its being sealed to the enclosing envelope,

Fig. 3 is an elevational detailed view of the anode electrode support,

Fig. 4 is a top plan view of the device as shown in Fig. 2,

Fig. 5 is a schematic diagram showing a circuit arrangement utilizing the glow discharge lamp of Fig. 1, and

Fig. 6 is a graphic illustration showing the relationship of light intensity to current.

Referring now more specifically to Fig. 1, the lamp as shown may comprise a vacuum tight envelope 5 which, after complete exhaustion is provided with a suitable gaseous filling, and having any conventional type base 6 provided with contacts so that electrical connection can be made from the electrodes to a suitable socket. Extending inwardly of the envelope 5 is a reentrant press portion 8 of conventional design through which extends a pair of leading-in conductors 9 and 10 connected, respectively, to the base 6 and contact tip 12.

As shown more clearly in Fig. 2, the leading-in conductor 10, in cooperation with a rod 13 also sealed into the press portion 8 of the envelope, supports an anode electrode 14 which may take the form of an annular metallic thimble provided with a small aperture 15. This anode 14 may be of any suitable metal which can be readily cleaned and degassed, such for example as nickel, and may be secured to the leading-in conductor 10 and rod 13 by spot welding or by cutting the thimble and forming lugs 16 by winding or rolling the cut portion around the rod and leading-in conductor, as shown more clearly in Fig. 3.

A cathode 17, of a suitable metal having certain characteristics as hereinafter described, in the form of a rod is supported by the leading-in conductor 9. The upper end of the cathode 17 is spaced a definite distance of not greater than about 2 mm. from the anode 14 and is provided with a recess in the form of a uniform "crater" 18 having a small diameter which, for example, may be of approximately .1 of an inch and a depth of approximately .15 inch, depending upon maximum operating current and desired spot area.

Surrounding the cathode 17 and resting on the reentrant press is a cylindrical shield 19 of a comparatively good electrical insulating material which will prevent electrical leakage, such for example as porcelain or the like, but preferably lava, since the latter can be readily obtained in desired shapes and sizes. The upper open end of the shield 19, as shown in Fig. 2, may be provided with a small shoulder portion 20, so as to rest on the cathode and insulate the same from the anode, the outer periphery of which may surround the shield.

In a lamp of this type several characteristics are essential, among them being a life of several hundred hours, uniformity of modulation, uniformity of light spot produced, uniformity between lamps, uniformity of breakdown voltage with low current flow and high energy output in that part of the spectrum lying between 3000 and 5000 Angstrom units in order to sensitize photographic films. To insure first a life of several hundred hours it has been found necessary to employ a stable gas or mixture of gases of sufficient pressure so that clean-up of the gaseous filling will not occur. The gas most satisfactorily meeting this condition was found to be neon or preferably a mixture of gases containing a high percentage of neon at the minimum optimum pressure for cold cathode negative glow lamps of approximately 30 mm. which maintains minimum breakdown voltage.

It is known that a pure inert gas, such as neon, has a definite breakdown voltage but in most cases this voltage is comparatively high. Also since it is essential in a lamp of this type that the breakdown voltage, as well as the voltage drop of the lamp, be kept low, the addition of from .2 to .5% argon to the neon lowers the breakdown and operating voltage by 30% or more than in the case of pure neon. For example, a lamp constructed in accordance with the present invention when filled with 100% neon has a breakdown of approximately 140 volts D. C. and a voltage drop of approximately 120 volts, but when filled with a mixture of 99.5% neon and .5% argon the breakdown voltage is lowered to approximately 100 volts D. C. and the voltage drop to approximately 75 volts.

Most photographic films, as before noted, are sensitive to radiations lying within the spectrum between 3000 and 5000 Angstrom units, and consequently the lamp must have an energy output which is comparatively high in this region. However, neon alone is very poor in this output and argon also is a low producer of these wavelengths. When admixed in the proportion of approximately 99.5% neon and .5% argon the spectrum changes so that it is richer in the yellow region but no better, if as good, in the blue and ultraviolet. It is preferable to therefore add between .5% and 1% nitrogen to the above mixture while maintaining the minimum optimum pressure of approximately 30 mm. which changes the energy completely, and, as indicated by a spectrograph, the region between 3000 and 5000 Angstrom units which was very weak is now quite strong, inasmuch as the weak lines are much more pronounced and many new lines are added. Upon exposing a photographic film for a very short period of time a complete sensitizing results.

Not only does the stability of the gaseous filling constitute a major factor in the life of the lamp, but in cooperation with the cathode it determines the uniformity between lamps while the cathode material and construction, as well as its relative spacing with respect to the anode, determines the uniformity of the light spot. In order to obtain uniformity between the same and different lamps, there must be a definite breakdown voltage and voltage drop as well as a uniformity of spectral output, the latter of which is determined, as above noted, by the selection of the gas and its pressure. To obtain uniformity of breakdown and voltage drop between the same and different lamps it is essential that a cathode be employed having certain requisite characteristics as before mentioned.

For example, the cathode must have a high uniform cold emission and the material be a reservoir to renew the emissive surface, as well as having a low work function, long life and low sputter factor. Although clean nickel or other material coated with an emissive material such as barium azide will function, it has been found preferable to employ thorium, inasmuch as such material has all the above noted characteristics which give uniformity of breakdown and voltage drop, and at the same time gives a longer life since there is no coating which eventually sputters off.

Uniformity of light spot is obtained first by providing the cathode with a uniform "crater", the surface of which is smooth and clean. The "crater" is cleaned and the high points removed by running the tube at high current and low gas pressure on exhaust which sputters off any contamination and high points that would otherwise cause non-uniformity during operation. Since the cathode is surrounded by the shield 19, the procedure of cleaning the cathode naturally forms a deposit on the anode which must also be cleaned. This is accomplished by operating the device at reversed polarity until the material is again sputtered off and removed from the envelope during exhaust.

Upon initial breakdown of the tube accompanied by minimum current flow the "crater effect" causes the formation of a spot on the surface of the "crater" at the lowermost portion thereof with the radiations being projected through the anode aperture in the direction of the longitudinal axis of the lamp. The radiations thus form a projected spot of minimum intensity. When the current is increased, as hereinafter described, the discharge uniformly spreads over the smooth and clean cathode surface without the formation of any dark areas and in proportion to the increase in current which causes a similar increase in the intensity of the projected spot.

To prevent the formation of a glow around the cathode except in the "crater" the cathode is carefully insulated, as before mentioned, by the insulating shield 19 so that the "crater" is the nearest part electrically to the anode. In addition any so-called fuzziness around the anode, due to a positive column discharge, is precluded by very carefully spacing the anode from the cathode at a distance less than 2 mm.

By constructing a lamp in the manner described, with proper spacing of the electrodes, proper gas pressure and mixture and proper cathode material, the lamp will have a uniformity in light spot and of breakdown and voltage drop. Consequently, when utilized in a circuit such as shown in Fig. 5, the lamp, when impressed with a voltage from a suitable source, such as a 150 volt D. C. source which is limited by a resistance R to approximately 100 volts, breaks down since such voltage is no higher than that necessary to cause breakdown with attendant current flow of not more than 1.5 milliamperes. This accordingly forms a light spot in the "crater" of the cathode with the radiation emanating through the aperture in the anode.

When a signal is received or the current increased by any means such as increased voltage or decreased resistance, it is amplified and, as noted in Fig. 5, the resulting increased voltage from the amplifier is impressed upon the input circuit for the lamp which then passes current in proportion to the increase in signal voltage. Since the voltage, prior to the receipt of any signal voltage, is just sufficient to cause breakdown of the tube and current flow, as above mentioned, is at a minimum, the intensity of the light spot produced is likewise at a minimum. However, as the signal voltage increases the current passed by the tube likewise increases, and since the useful light output is proportional to this increase in current, the light spot increases in intensity with fidelity.

This is shown by the curve of Fig. 6 wherein the abscissa represents current in milliamperes and the ordinate, output in intensity. It will thus be seen from this figure that not only does increase of light intensity follow with fidelity increases in current but the latter is a straight ascending line. Moreover, since the cathode "crater" is uniform, the spot is confined to a fixed point within the "crater" and its increase and decrease in intensity in accordance with modulation caused by the signal voltage completely sensitizes photographic film with a high degree of reproductive accuracy, since the light spot produces both visible and invisible radiations to which the film is sensitive.

It thus becomes obvious to those skilled in the art that by employing a cathode of a material having certain desired characteristics and spacing the same a definite predetermined distance from the anode and by proper selection of the gaseous filling and its pressure, a glow discharge lamp is produced which has a definite and comparatively low breakdown voltage and low current. Moreover, a light spot is produced which is confined to a fixed area of the cathode and the intensity of which modulates with fidelity in accordance with the signal voltage and with variations in current flow. Due to the comparatively low voltage and current together with the above noted requisites, the device has a relatively long useful life of several hundred hours, modulates uniformly, produces a uniform light spot giving a uniformity between the same and different lamps and the energy output is of a wave-length lying partly within the invisible portion of the spectrum which completely sensitizes photographic films.

Although I have shown and described one specific embodiment of my invention, I do not desire to be limited thereto, as various other modifications of the same may be made without departing from the spirit and scope of the appended claims.

I claim:

1. An electric discharge device comprising an envelope containing a gaseous mixture consisting of approximately 99% neon, and the remainder argon and nitrogen of at least .2% adapted upon excitation thereof to emit radiations having its maximum intensity lying within the spectral range between 3000 and 5000 Angstrom units, an annular shaped metallic anode within said envelope provided with a reentrant portion forming a smooth surfaced aperture therein, and a cathode in axial alignment with said anode and spaced therefrom a distance no greater than 2 mm. to definitely limit the breakdown potential of said device to a preselected minimum, said cathode being of a metal having electron emissive properties commensurate with the barium group of elements and of a lower vapor pressure than such group of elements at the operating temperature of said device, and said cathode having a low work function and high cold electron emissive characteristics and provided with a crater therein having a clean, smooth surface and an arcuate end and a diameter at least no greater than the aperture in said anode.

2. An electric discharge device comprising an envelope having a gaseous atmosphere consisting of approximately 99% neon and the remainder argon and nitrogen, each of said gases argon and nitrogen being at least .2% of said gaseous atmosphere and cooperating electrodes within said envelope.

3. An electric discharge device comprising an envelope containing a gaseous mixture comprising at least 95% neon and the remainder argon and nitrogen, said argon and nitrogen being present in a percentage greater than .2%, and cooperating electrodes within said envelope, and an insulator spacing said electrodes approximately 2 millimeters apart and an opening in one of said electrodes.

4. An electric discharge device comprising an envelope having a gaseous atmosphere consisting of approximately 99% neon and the remainder argon and nitrogen, each of said gases argon and nitrogen being at least .2% of said gaseous atmosphere and cooperating electrodes within said envelope, and an insulator spacing said electrodes approximately 2 millimeters apart and an opening in one of said electrodes.

5. An electric discharge device comprising an envelope having a gaseous atmosphere consisting of approximately 99% neon and the remainder argon and nitrogen, each of said gases argon and nitrogen being at least .2% of said gaseous atmosphere, and cooperating electrodes within said envelope, one of said electrodes having an opening therethrough and the other of said electrodes having a crater aligned with said opening and closely spaced thereto.

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