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ELECTRIC LAMP FOR UNIFORMLY CHARGING THE PHOTOCONDUCTIVE INSULATING LAYER OF A XEROGRAPHIC PLATE

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FIG. 1

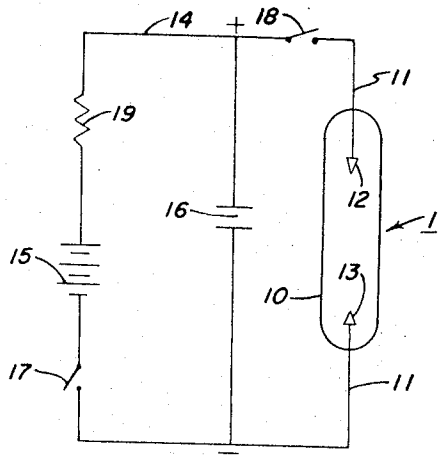


FIG. 2

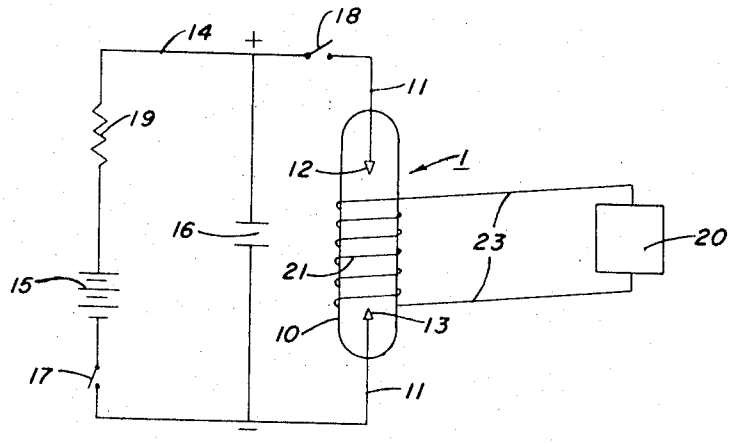
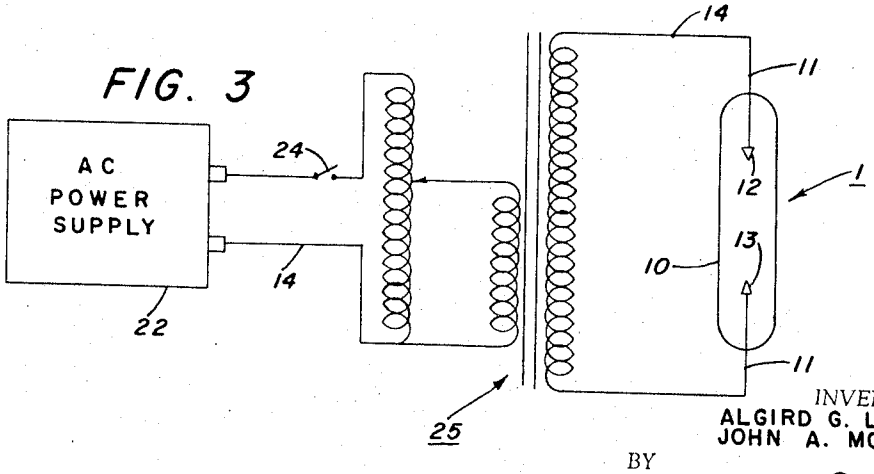


FIG. 3



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ELECTRIC LAMP FOR UNIFORMLY CHARGING THE PHOTOCONDUCTIVE INSULATING LAYER OF A XEROGRAPHIC PLATE

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11 Claims

ABSTRACT OF THE DISCLOSURE

A lamp system for emission of electromagnetic radiation by passage of electric current between two electrodes through a mixture of gaseous iodine and a gas selected from the group consisting of xenon, krypton and mixtures thereof enclosed by an envelope.

This invention relates to an electric lamp and more particularly, to an electric discharge device filled with gaseous iodine and xenon or krypton or a mixture thereof.

Many applications exist for a lamp emitting relatively intense radiation in the middle ultraviolet region and in the infrared region as well as in the visible region, of the electromagnetic spectrum.

For example, it has recently been discovered, as disclosed in co-pending application, Ser. No. 436,145, filed Mar. 1, 1965, entitled Photo-Charging of Xerographic Plates, that a xerographic plate may be left with a net charge on the surface of the plate upon exposing the plate to electromagnetic radiation of a desired short wavelength. Selenium in its amorphous form is a preferred material for a photoconductive insulating layer in a xerographic plate because of its extremely high quality image making capability and relatively high light response when positively charged. This type of photoconductive insulating material has found extensive commercial embodiment. As disclosed in said co-pending application the threshold wavelength of electromagnetic radiation to photo-charge amorphous selenium has been found to be about 2620 angstrom units. It is also disclosed therein that ultraviolet radiation of wavelength less than about 200 angstrom units is absorbed by the gases in the atmosphere thus preventing transmission of the radiation to the surface of the photoconductor. Specifically, it has been found that the oxygen in the air is an absorber of this shorter wavelength radiation which converts the oxygen to undesirable ozone. It is clear that a source of relatively intense electromagnetic radiation in the relatively narrow wavelength range between about 2620 angstrom units and about 2000 angstrom units is needed and would have great utility in the photo-charging of selenium. Prior art lamps emitting radiation in this wavelength region have suffered from a number of defects including the lack of sufficiently intense radiation or sufficient radiation intensities coupled with unsatisfactory lamp life and low efficiency.

It is also clear that there is a need for a relatively intense source of electromagnetic radiation in the middle ultraviolet region and more specifically, in the 2062 angstrom unit wavelength region as a photo-chemical light source for various photo-chemical studies. For example, as disclosed in the article entitled "The Iodine Lamp: A Light Source for Selective Excitation of CO" appearing in the Journal Z. Naturforschg. 19a, 2–6 (1964), prior art lamps emitting electromagnetic radiation in the ultraviolet range had not been entirely satisfactory as radiation sources for photo-chemical studies of certain materials and specifically for carbon monoxide. It was found

that 2062 angstrom unit radiation excited carbon monoxide for the purpose of photochemical study without interference from the other gases in the atmosphere.

An intense source of middle range ultraviolet radiation would also have great utility in the hardening of sensitized colloids such as dichromate sensitized colloids which have been found to be sensitive to radiation in the 2100 angstrom unit region and are useful as photo-resists for letterpress printing, and as a sensitizer for lithographic plates, silk screen and polyvinyl alcohols. The polyvinyl alcohols have found utility in color T.V. tube manufacture as a binder for the phosphor during deposition.

Additionally, of course, an electric lamp with relatively intense radiation in the middle ultraviolet region as well as in the visible and infrared regions might be utilized in the process of xerography as much more than a source to photocharge the photoconductive insulating layer. In the process of xerography, for example, as disclosed in Carlson Patent No. 2,297,691, a xerographic plate comprising a layer of photo-conductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate areas in accordance with the radiation intensity that reaches them and thereby creates an electrostatic latent image on or in the photo-conductive layer. Development of the latent image is effected with an electrostatically charged, finely divided material such as an electroscopic powder that is brought into surface contact with the photoconductive layer and is held thereon electrostatically in the pattern corresponding to the latent electrostatic image. Thereafter, the developed xerographic powder image is usually transferred to a support surface to which it may be affixed by any suitable means.

In the xerographic process it may be envisioned that a single radiation source emitting infrared, visible and middle ultraviolet radiation, for example, by the use of selective filters could photo-charge the photoconductive insulating material, for example, selenium, with the middle ultraviolet radiation, expose the xerographic plate to the subject matter to be reproduced with the visible radiation and fix the transferred xerographic powder image to the support surface by black body absorption of all radiation, thus melting the powder to bond it to the support surface. Heretofore, it has been customary to charge the xerographic plate by a corona charging device, for example, as disclosed in Walkup Patent No. 2,777,957, and fix the powder image by application of heat from a filament type heating means or by solvent vapor fusing. Of course there is always the need to make commercial apparatus more economical and efficient. To provide one radiation source to accomplish the three steps of charging, exposing and fixing would accomplish this desirable aim of simplicity and economy.

Prior art lamps, besides being relatively weak in the middle ultraviolet range are also often of the incandescent type and thus suffer from the defects commonly associated with such lamps.

Incandescent type lamps as sources of radiation to fill the above noted needs suffer from a large number of disadvantages including a lack of electrode materials to emit intense radiation of the desired wavelengths, deterioration and sputtering of the electrodes due to the high heat necessary to cause glow of the electrodes and the sputtering of electrode material onto the wall of the lamp envelope to inhibit transmission of radiation through the envelope.

These last two disadvantages severely limit the life of an incandescent type lamp and have to be counteracted by special measures such as the addition of special com-

pounds or gases to the gaseous mixture within the lamp to combat the effect of undesirable sputtering of the electrodes onto the envelope wall. See, for example, U.S. Patent No. 3,091,718 to J. Shurgan and U.S. Patent No. 2,697,183 to O. Neunhoffer et al. However useful the remedies of these patents are, they serve to make the construction and operation of incandescent lamps costlier and more complicated.

Accordingly, it is an object of the invention disclosed herein to provide an electric lamp that is devoid of the above noted disadvantages and has the capability of satisfying the above noted needs.

It is a further object of the invention to provide an electric discharge lamp emitting relatively intense radiation in the 2062 and 9114 angstrom unit regions.

It is a still further object of the invention to provide an electric discharge device capable of emitting greater intensity 2062 and 9114 angstrom unit region radiation while utilizing less electrical power than has heretofore been possible in the art.

It is a still further object of the invention to provide an electric discharge lamp, particularly advantageous in the photo-charging of photoconductors.

It is a still further object of the invention to provide a simply constructed electric discharge lamp of long life and simple operation.

The above and still further objectives are achieved in accordance with this invention by providing an electric discharge lamp including an envelope, a filling of a mixture of gaseous iodine and xenon or krypton or a mixture thereof and at least two spaced apart electrodes. As a result of the passage of electric current between the electrodes through the gaseous mixture, the gaseous mixture emits electromagnetic radiation surprisingly intense in the 2062 and 9114 angstrom unit wavelength regions as well as visible radiation and other radiations in the ultraviolet and infrared regions.

A better understanding of the nature and advantages of this invention as well as other objects and further features thereof will become apparent upon consideration of the following detailed disclosure of the invention to be read in connection with the accompanying drawings wherein:

FIG. 1 schematically shows a lamp of the type disclosed herein connected in operating relation to an electrical circuit with a direct current power source,

FIG. 2 schematically shows a lamp of the type disclosed herein connected in operating relation to an electrical circuit with a direct current power source in combination with an auxiliary trigger circuit,

FIG. 3 schematically shows a lamp of the type disclosed herein connected in operating relation to an electrical circuit with an alternating current power source.

Referring now to FIG. 1, there is seen an envelope **10** of a material capable of being formed into a sealed container to withstand evacuation to the partial vacuums herein described and capable of transmitting desired wavelengths of radiation generated by the gaseous mixture within the envelope. Lead-in wires **11** are embedded in the envelope, each lead-in wire bears an electrode, **12** and **13**, in spaced apart relationship.

The anode electrode **12** is connected by electrical conductor **14** to the positive terminal of a capacitor or capacitors **16** that may be charged through a charging resistance **19** from an energy source such as battery **15** when switch **17** is closed. The other or cathode electrode **13** is connected to the negative terminal of capacitor or capacitors **16**.

When the switches **17** and **18** are closed, the voltage to which capacitor or capacitors **16** is charged may, depending upon various characteristics of lamp **1**, in and of itself be sufficient to effect a discharge through the gaseous medium within envelope **10** between the anode electrode **12** and the cathode electrode **13**. This initial voltage required to operate the lamp is herein called the breakdown voltage and is usually greater than later lamp operating voltages because of increased ionization and electrical conductivity of the gaseous medium within envelope **10** after the lamp has been operated for a time.

Referring now to FIG. 2, there is seen a lamp and circuit similar to the one shown in FIG. 1 in combination with a trigger circuit **23** including, for example, a radio frequency source **20** and external winding **21**.

The trigger circuit provides for an alternative manner to ignite the lamp. For example, capacitor or capacitors **16** may be charged, as previously described, to a voltage below the breakdown voltage for the particular conditions of flash lamp **1**. The lamp may then be triggered by means of trigger circuit **23** by transmitting an impulse from radio frequency source **20** to external winding **21** to cause partial ionization of the gaseous medium within envelope **10** making the medium conductive enough to permit the voltage stored in capacitor or capacitors **16** to become discharged through the gaseous medium, from the anode **12** to cathode **13** thereby producing high intensity radiation in the regions described.

It should be appreciated that many other trigger devices are suitable for use herein. For example, a charged silver strip painted on part of the envelope or a charged metallic reflector can also serve as an external trigger electrode causing the lamp to fire. In fact since many optical applications utilize a metallic reflector anyway, the reflector's use as an external electrode is eminently practical.

Referring now to FIG. 3, there is shown lamp **1** electrically connected in operating relation to alternating current power source **22**. Upon closing switch **24** electrical power is supplied from source **22** to variable, high voltage A.C. transformer **25** which in turn supplies voltage to electrodes **12** and **13** to operate the lamp.

Envelope **10** may be a transparent quartz or any other material which permits transmission through the envelope of the radiation produced by the lamp. A preferred material for the envelope has been found to be Suprasil type, quartz glass available commercially from Amersil Quartz Div., Engelhard Industries, Inc., which is a synthetic fused silica permitting ultraviolet transmission down to 1,600 angstrom units as well as permitting transmission of visible and infrared radiation.

Electrodes **12** and **13** may be comprised of any suitable electrode material used in electric discharge devices. Typical electrode materials include most conductors including light metals such as aluminum or magnesium, and tungsten which may be surface treated with alkali metals and alkali-earth oxides to enhance their ability to impart charge. A preferred electrode material has been found to be tunsten which stands up well under use with a minimum of deterioration.

Before the introduction of the gaseous mixture to the envelope, the envelope is evacuated. Generally, it is found that an evacuation to about 10^{-5} torr or lower pressure is sufficient to remove enough air, water vapor and impurities to ensure satisfactory lamp operation without undue deterioration of the electrodes. It will be appreciated that evacuations to lower pressures, for example, to 10^{-6} torr or to 10^{-8} torr or even lower pressures are desirable insofar as lamp operating conditions are concerned but it becomes increasingly difficult to achieve these greater vacuums and some balance must be struck between the realities of lamp construction and optimum lamp operating conditions.

Iodine may conveniently be introduced into the envelope from a side tube which may then be sealed off by a stop cock or other means. Since some of the iodine from a piece of solid iodine volatilizes into a gas at room temperature, for convenience the iodine may be introduced into the envelope at its vapor pressure at room temperature, such as between about 10° C. and 30° C. There is some disagreement as to the value of the vapor pressure of iodine in this temperature range but Van Nostrand's Scientific Encyclopedia (2nd ed. 1947) reports it to be 0.030 torr at 0° C. and 0.20 torr at 20° C.

Gaseous iodine may be introduced in sufficient quantity to cause the formation of solid iodinc deposite at the coolest points within the envelope.

Another convenient means for introducing the iodine into the envelope is to place a piece of solid iodine into the envelope and allow it to vaporize therein. As the temperature of the envelope and within the lamp rise above room temperature, which may occur during a long period of operation or by an external heating means, more of any deposits of solid iodine contained within the envelope will vaporize than at room temperature to produce a higher partial pressure of iodine in the lamp. As the lamp cools after operation some of the iodine vapor is found to solidify once again in the coolest part of the envelope which in an envelope of the type configuration shown in the figures is generally found to be behind the electrodes at the extremities of the lamp. For isolated flashings of a lamp of the type described herein, at room temperatures, lamp operating temperatures will be little above room temperature and thus the partial pressure of iodine in the lamp will roughly, in the region as reported by Van Nostrand. However, synergistically enhanced radiations in the 2062 and 9114 angstrom unit regions were found to occur for a lamp of the type disclosed herein heated up to about 100° C. and a resultant partial pressure of iodine of about 45.5 torr, as reported by Van Nostrand.

The gases xenon and krypton may conveniently be introduced into the envelope from a side tube which may then be sealed off by a stop cock or other means. For the amounts of iodine in the envelope, as herein described, xenon and krypton in amounts ranging from a sum of the partial pressures of the two gases from about 2 torr to over 300 torr produced synergistically enhanced radiation in the 2062 and the 9114 angstrom unit regions as well as other wavelength radiation. Synergistically enhanced 2062 angstrom unit radiation appears to be optimized at a sum of the partial pressures of xenon and krypton between about 100 torr and 200 torr.

Envelopes may take a number of shapes. Electrodes may be variously placed. A cylindrical envelope configuration is shown in the figures. A spherical envelope or other shapes may be used depending upon the application or ease of construction. Somewhat special envelope shapes may be utilized to accommodate electrode placings that are other than in a directly opposed relation as shown in the figures. One such special electrode placing and envelope shape is disclosed in U.S. Patent No. 2,939,984 to H. E. Edgerton wherein the electrodes are offset outside the main walls of the envelope as to be external to any pressure shock wave produced during lamp operation.

Electrode spacing may be extensively varied. The closer together the electrodes, the more the radiation tends to be a point source. For larger spacings of the electrode a combination of one or more of the following will provide satisfactory lamp operation; increasing the voltage, increasing the trigger effect or increasing the temperature of the gaseous mixture so as to produce more ionization of the gaseous mixture to make it more conductive.

The electric discharge device of the type described herein is found to be an excellent source of ultraviolet radiation and an especially excellent source of synergistically enhanced ultraviolet radiation in the 2062 angstrom unit region. The lamp also emits an enhanced amount of radiation in the 9114 angstrom unit region. It is found that the total intensity of 2062 and 9114 angstrom unit region radiation is much greater for the mixture of iodine and xenon or krypton or a mixture thereof than for the sum of the radiations from an iodine filled lamp and a xeonon filled lamp or a krypton filled lamp or a lamp filled with a mixture of xenon and krypton fired under the same conditions. In short, it is noted that an extremely desirable synergistic enhancement of radiation in the 2062 angstrom unit region as well as the 9114 angstrom unit region results from the passage of current through the mixture of gaseous iodine and xenon or krypton or a mixture thereof.

This surprising synergistic effect in the 2062 and the 9114 angstrom unit regions is thought to be a result of the excitation of iodine atoms to a high energy state by means of energy exchanging collisions with metastable xenon and krypton atoms in close energy resonance with a high energy state of the iodine atoms. The iodine atoms then spontaneously decay to lower energy states ultimately emitting radiations in the 2062 and the 9114 angstrom unit regions. It is also noted that the addition of xenon or krypton or a mixture thereof stabilizes and may increase the breakdown voltage of the lamp.

The following examples further specifically define the present invention. The examples below are intended to illustrate various preferred embodiments of the electric discharge device of this invention.

All radiation intensities in the 2062 and the 9114 angstrom unit regions in the following examples are measured with a Spex Czerny-Turner recording spectrometer the signal being recorded photographically by displaying the output of the spectrometer on a Tektronix 555 oscilloscope. Radiation intensities in the 4,000 to 11,000 angstrom unit range as a measure of total visible output from the lamp are recorded in all the examples through an EG & G "Light Mike" (available from Edgerton, Germeshausen and Grier, Inc., 160 Brookline Ave., Boston, Mass.) the signals being recorded along with the voltage difference across the electrodes, on separate traces on the Tektronix 555 oscilloscope. The light mike was used to trigger the oscilloscope trace because of the rapid response and to monitor the overall behaviour of the discharge. In Examples I through VI the lamp is ignited by a trigger circuit comprising an EG & G TM–11 trigger circuit and 20 turns of copper wire wrapped around the envelope the trigger being a low current 30,000 volt pulse.

Example I

A Suprasil quartz envelope of shape as shown in FIG. 2, with tungsten electrodes spaced about 6 inches apart is evacuated by a side tube to a pressure of about 5×10^{-6} torr. Iodine is introduced into the envelope from a side tube in sufficient quantity to cause formation of solid iodine deposits within the envelope. The lamp is then closed off from the iodine supply by closing a stop cock in the side tube. The lamp is then electrically connected to a circuit as shown in FIG. 2 with a fixed capacitor of 150 microfarads and a 150 microhenry inductance. The lamp is ignited by charging the fixed capacitor to 1,000 volts and then discharging the capacitor through the lamp filling by activating the trigger circuit. The 2062 and 9114 angstrom unit region radiation, and the total visible radiation are measured. The iodine is removed, and the envelope is again evacuated to about 5×10^{-6} torr. Xenon gas is introduced into the envelope from a side tube at a partial pressure of about 20 torr and the lamp is closed off as before. The lamp is ignited under the same conditions and in the same manner as when it contained iodine. The 2062 and 9114 angstrom unit region radiation and the total visible radiation are measured. The lamp is again evacuated to about 5×10^{-6} torr and iodine and xenon are introduced into the envelope in the same manner as before to fill the envelope with a mixture of gaseous iodine and xenon at a partial pressure of xenon of about 20 torr. The lamp is ignited under the same conditions and in the same manner as before and the 2062 and 9114 angstrom unit region radiation and the total visible radiation are measured.

The 2062 angstrom unit region radiation from the mixture of gaseous iodine and xenon is indicated to be about 30 times more intense than from the sum of the 2062 radiation from the iodine filled lamp and the xenon filled lamp and the 2062 angstrom unit region radiation from the mixture of gaseous iodine and xenon minus the 2062 radiation from the xenon filled lamp is indicated to be

about 95 times more intense than the 2062 radiation from the iodine filled lamp.

The 9114 angstrom unit radiation from the mixture is indicated to be about 15 times more intense than from the sum of the 9114 radiation from the iodine filled lamp and the xenon filled lamp and the 9114 radiation from the mixture minus the 9114 radiation from the xenon filled lamp is indicated to be about 25 times more intense than the 9114 radiation from the iodine filled lamp.

Visible radiation intensities show little or no synergistic enhancement which is also the case in Examples II through X.

Example II

Example I is followed except that a potential difference of 2,000 volts is discharged across the electrodes. The 2062 radiation from the mixture is indicated to be about 9 times more intense than from the sum of the 2062 radiation from the iodine filled lamp and the xenon filled lamp and the 2062 radiation from the mixture minus the 2062 radiation from the xenon filled lamp is indicated to be about 110 times more intense than the 2062 radiation from the iodine filled lamp.

Example III

Example I is followed except that a potential difference of 3,000 volts is discharged across the electrodes. The 2062 radiation from the mixture is indicated to be about 1.2 times more intense than from the sum of the 2062 radiation from the iodine filled lamp and the xenon filled lamp and the 2062 radiation from the mixture minus the 2062 radiation from the iodine filled lamp and the xenon be about 19 times more intense than the 2062 radiation from the iodine filled lamp.

Example IV

Example I is followed except that xenon at a partial pressure of 2 torr is used instead of xenon at a partial pressure of 20 torr.

The 2062 radiation from the mixture is indicated to be about 2 times more intense than from the sum of the 2062 radiation from the iodine filled lamp and the xenon filled lamp and the 2062 radiation from the mixture minus the 2062 radiation from the xenon filled lamp is indicated to be about 3 times more intense than the 2062 radiation from the iodine filled lamp.

Example V

Example I is followed except that xenon at a partial pressure of 240 torr is used instead of xenon at a partial pressure of 20 torr.

The 2062 radiation from the mixture is indicated to be about 23 times more intense than from the sum of the 2062 radiation from the iodine filled lamp and the xenon filled lamp and the 2062 radiation from the mixture minus the 2062 radiation from the xenon filled lamp is indicated to be about 88 times more intense than the 2062 radiation from the iodine filled lamp.

Example VI

Example I is followed except that xenon at a partial pressure of 132 torr is used instead of xenon at a partial pressure of 20 torr.

The 2062 radiation from the mixture is indicated to be about 30 times more intense than from the sum of the 2062 radiation from the iodine filled lamp and the xenon filled lamp and the 2062 radiation from the mixture minus the 2062 radiation from the xenon filled lamp is indicated to be about 125 times more intense than the 2062 radiation from the iodine filled lamp.

The 9114 radiation from the mixture is indicated to be about 1.25 times more intense than from the sum of the 9114 radiation from the iodine filled lamp and the xenon filled lamp and the 9114 radiation from the mixture minus the 9114 radiation from the xenon filled lamp is indicated to be about 5 times more intense than the 9114 radiation from the iodine filled lamp.

Example VII

A Suprasil quartz envelope of shape as shown in FIG. 1 with tungsten electrodes spaced about 6 inches apart is evacuated, by a side tube, to a pressure of about 5×10^{-6} torr. Iodine is introduced into the envelope from a side tube in sufficient quantity to cause formation of solid iodine deposits within the envelope. The lamp is then closed off from the iodine supply by closing a stop cock in the side tube. The lamp is then electrically connected to a circuit as shown in FIG. 1 with a fixed capacitor of 150 microfarads and a 150 microhenry inductance. The lamp is ignited by providing a potential difference across electrodes 12 and 13 of about 1,600 volts which is equivalent to the breakdown voltage of the lamp containing only iodine and which is sufficient of itself to operate the lamp.

The 2062 and 9114 angstrom unit region and the total visible radiation are measured. The iodine is removed, and the envelope is again evacuated to about 5×10^{-6} torr. Xenon gas is introduced into the envelope from a side tube at a partial pressure of about 5 torr. The lamp is ignited by providing a potential difference across the electrodes of about 2,200 volts which is equivalent to the breakdown voltage of the lamp containing only xenon. The 2062 and 9114 angstrom unit region radiation and the total visible radiation are measured. The lamp is again evacuated to about 5×10^{-6} torr and iodine and xenon are introduced into the envelope in the same manner as before to fill the envelope with a mixture of gaseous iodine and xenon at a partial pressure of xenon of about 5 torr. The lamp is ignited by providing a potential difference across the electrodes of about 2,800 volts which is equivalent to the breakdown voltage of the lamp containing this gaseous mixture. The 2062 and 9114 angstrom unit region radiation and the total visible radiation are measured.

Synergistically enhanced 2062 and 9114 radiation from the mixture is observed.

Example VIII

A Suprasil quartz envelope of shape as shown in FIG. 3, with tungsten electrodes spaced about 6 inches apart is evacuated by a side tube to a pressure of about 5×10^{-6} torr. Iodine is introduced into the envelope from a side tube in sufficient quantity to cause formation of solid iodine deposits within the envelope. The lamp is then closed off from the iodine supply by closing a stop cock in the side tube. The lamp is then electrically connected to a circuit as shown in FIG. 3 with a 117 volt alternating current power source **22** and a variable, auto-type typical neon sign, 12,000 volt-30 milliamp transformer **25**. The lamp is started by closing switch **24**. The discharge starts initially at a voltage somewhat higher than the operating voltage of 650 volts at a current of 20 milliamps which is sufficient to operate the lamp after there has been sufficient ionization of the gaseous filling to make it conductive at the lower voltage. The 2062 and 9114 angstrom unit region radiation and the visible radiation are measured as the lamp is operated. The iodine is removed, and the envelope is again evacuated to about 5×10^{-6} torr. Xenon gas is introduced into the envelope from a side tube at a partial pressure of about 20 torr. The lamp is operated under the same conditions and in the same manner as when it contained pure iodine. The 2062 angstrom unit region radiation and the visible radiation are measured. The lamp is again evacuated to about 5×10^{-6} torr and iodine and xenon are introduced into the envelope in the same manner as before to fill the envelope with a mixture of gaseous iodine and xenon at a partial pressure of xenon of about 20 torr. The lamp is operated under the same conditions and in the same manner as before and the 2062 angstrom unit region radiation is measured.

The 2062 radiation from the mixture minus the 2062 radiation from the xenon filled lamp is indicated to be about 73 times more intense than the 2062 radiation from the iodine filled lamp. It is to be noted that at the operating voltage of 650 volts, 2062 radiation from the xenon filled lamp was essentially zero.

Example IX

Example I is followed except that krypton at a partial pressure of 130 torr is used instead of xenon at a partial pressure of 20 torr.

The 2062 radiation from the mixture is indicated to be about 48 times more intense than from the sum of the 2062 radiation from the iodine filled lamp and the krypton filled lamp. Synergistically enhanced 9114 radiation from the mixture is also observed.

Example X

Example I is followed through the ignitions and intensity measurements of the lamp containing only iodine and only xenon. The lamp is evacuated to about 5×10^{-6} torr after the filling of the xenon filled lamp and krypton is introduced into the envelope from a side tube at a partial pressure of about 20 torr and the lamp is closed off as before. The lamp is ignited under the same conditions and in the same manner as when it contained only iodine and only xenon. The 2062 and 9114 angstrom unit region radiation and the total visible radiation are measured. The lamp is again evacuated to about 5×10^{-6} torr and iodine and xenon and krypton are introduced into the envelope in the same manner as before to fill the envelope with a mixture of gaseous iodine and xenon and krypton, the partial pressure of the xenon and the krypton each being about 20 torr. The lamp is ignited under the same conditions and in the same manner as before and the 2062 and 9114 angstrom unit region radiation and the total visible radiation are measured. Synergistically enhanced 2062 and 9114 radiation from the mixture is observed.

Although specific components and proportions have been stated in the above description of preferred embodiments of the electric lamp disclosed herein other suitable materials and configurations as listed herein may be used with similar results. In addition, other materials may be placed within the lamp envelope to synergize, enhance, or otherwise modify the lamp's properties. For example, a hydrophilic material or other gettering agent may be added to the lamp to lessen the chance of serious deterioration of the electrodes due to water vapor within the envelope. Also, heavy gases such as argon and neon may be added to further stabilize or to change the value breakdown of the voltage of the lamp.

Other modifications and ramifications of the present invention will occur to those skilled in the art upon a reading of the disclosure. These are intended to be included within the scope of this invention.

What is claimed is:

1. A method for uniformly charging the photoconductive insulating layer of xerographic plate comprising:

(a) providing an electric discharge device comprising an envelope containing a gaseous mixture of iodine and a gas selected from the group consisting of xenon, krypton and mixtures thereof, and spaced electrodes;

(b) operating said discharge device adjacent to said xerographic plate, thereby exposing the photoconductive insulating layer to electromagnetic radiation from said discharge device;

(c) collecting electrons emitted from the photoconduc- insulating layer.

2. A method according to claim **1** wherein the partial pressure of the gaseous iodine within said envelope during operation is between about 0.030 torr and about 45.5 torr.

3. A method according to claim **2** wherein the partial pressure of the gas selected from the group consisting of xenon, krypton and mixtures thereof is between about 2 torr and about 300 torr.

4. An electric discharge device comprising:

(a) an envelope;

(b) a gaseous mixture in said envelope, substantially metal vapor free, and comprising iodine and a gas selected from the group consisting of xenon, krypton and mixtures thereof;

(c) spaced electrodes in said envelope; and

(d) external circuit means electrically connected to said spaced electrodes, said external circuit means controlling a gaseous discharge of the device by controlling the voltage difference across said spaced electrodes and the current through the gaseous mixture and between said spaced electrodes.

5. An electric discharge device according to claim **4** wherein the iodine is present in said envelope in sufficient quantity to provide a partial pressure of the gaseous iodine during operation between about 0.030 torr and about 45.5 torr.

6. An electric discharge device according to claim **4** wherein the partial pressure of the gas selected from the group consisting of xenon, krypton and mixtures thereof is between about 2 torr and about 300 torr.

7. An electric discharge device according to claim **5** wherein the partial pressure of the gas selected from the group consisting of xenon, krypton and mixtures thereof is between about 2 torr and about 300 torr.

8. An electric discharge device according to claim **7** wherein the partial pressure of the gas selected from the group consisting of xenon, krypton and mixtures thereof is between about 100 torr and about 200 torr.

9. An electric discharge device according to claim **8** wherein said envelope comprises a material having a high degree of transparency for 2062 angstrom unit region electromagnetic radiation.

10. An electric discharge device according to claim **9** in combination with trigger circuit means to ignite the lamp.

11. An electric discharge device according to claim **9** wherein said external circuit means causes the spaced electrodes to be operated below incandescence.

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