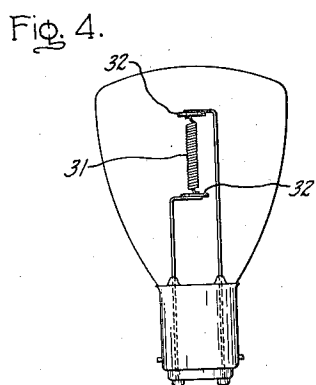
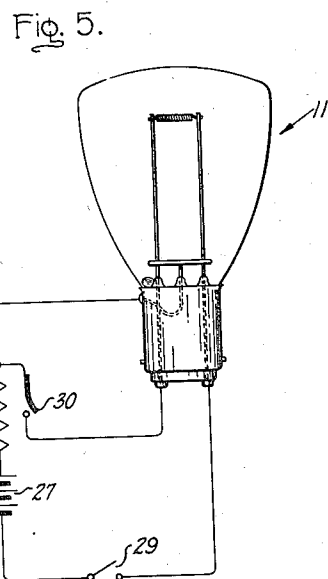
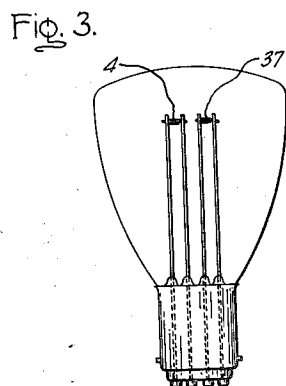
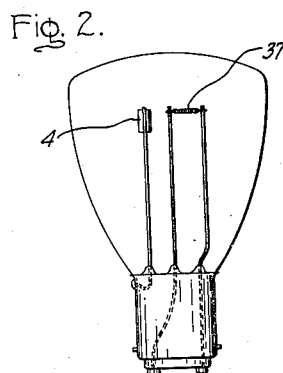
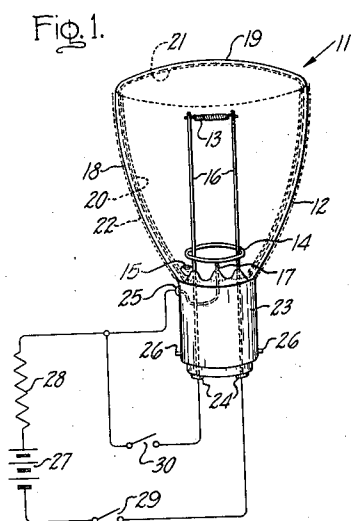


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ELECTRIC DISCHARGE DEVICE

2,341,990

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ELECTRIC DISCHARGE DEVICE

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5 Claims. (Cl. 176-122)

Our invention relates to gaseous electric discharge devices in general, and more particularly to discharge lamps of the cathodic glow type comprising more or less globular bulbs.

It is an object of our invention to provide cathodic glow lamps of small size and capable of operation from a low voltage source of direct or alternating current. Our lamps may be designated as miniature lamps in contrast to large lamps now on the market employing bulbs having spherical portions of about three to five inches diameter. The lamp may contain an atmosphere capable of producing ultraviolet radiation and it may be provided with an internal coating of fluorescent material capable of being excited by the said ultraviolet radiation to emit either visible radiation or ultraviolet radiation of longer wavelengths than the exciting radiation.

One feature of our invention is the provision of an internal coating of fluorescent material of different thicknesses, or a single heavy coating on only a portion of the bulb, such that the thicker coating will serve to cause substantially all the fluorescent radiation emitted thereby to be projected within the bulb through the thinner coating or through an uncoated portion of the bulb.

Another feature is the provision of a lamp in which the necessary ballast is provided solely by the resistance of the heater coil of a bimetallic switch connected to the lamp.

One particular use for a lamp of the type comprising our invention is for producing ultraviolet radiation for such fields of application as airplane instrument panel lighting, wherein it is necessary to dispense with cumbersome auxiliary equipment and wherein the available sources of power are generally of low voltage. Although our invention is not in any way limited to this field of application, it will be described herein with particular reference thereto.

The recent development of fluorescent materials as sources of illumination for such applications as airplane instrument panel illumination has given rise to the need for a relatively light weight and compact source of ultraviolet radiation which may be operated on the available relatively low voltage sources of power without the use of voltage step-up devices. Generally, these power sources are of the direct current type such as a storage battery, although the lamp of the invention may be used in either alternating current or direct current circuits. The source of ultraviolet radiation for these particular uses should also be such that little, if any, visible light is produced. Hitherto mercury arc discharges of the positive

column type have been used, but these have not been entirely satisfactory because their otherwise advantageous characteristics are generally impaired by attempts to operate them in envelopes of the small size required. Further, they will not operate with the stability and efficiency desired on the low voltages which are available.

Further objects and advantages of our invention will be apparent from the following detailed description and from the accompanying drawing, in which Fig. 1 shows a lamp constructed in accordance with the invention along with a circuit for operating the same; Figs. 2 through 4 show alternative constructions of the lamp shown in Fig. 1; and Fig. 5 shows a modification of the circuit of Fig. 1.

In accordance with one object of our invention, we may provide a cathodic discharge within an envelope, the inner surface of which is coated with a fluorescent material capable of fluorescing in the long ultraviolet spectral region. The envelope is preferably shaped as a reflector in order that the radiation developed both by the cathode glow and by the fluorescent material will emerge from the lamp in a directed beam. The dimensions will also preferably be of approximately the same extent as those of the cathode glow surrounding the electrodes. It will be understood that what is meant by a cathodic discharge lamp, as distinguished from a positive column lamp, is one in which the anode is positioned so that no appreciable positive column is developed within the discharge.

Referring now to Fig. 1, the lamp 11 comprises generally a pear-shaped envelope 12 containing the cathode 13, the anode 14, and a gaseous atmosphere comprising mercury vapor from the mercury droplet 15, as well as an auxiliary or starting gas such as argon at pressure of about 4 mm. The cathode 13 is preferably formed as a coiled coil tungsten filament of the type now common in the art of incandescent lamps. It will be supported by any convenient means, such as its own leads 16. The anode 14 may take the form of the ring or plate shown and it will be supported by any suitable means such as the lead 17. We have found that the auxiliary gas pressure should be of at least the order of 4 mm. if the coiled coil of the cathode 13 is to stand up under the deteriorating effect of the arc. We have also found that for the optimum efficiency for the lamp shown, the cathode and anode should be spaced from each other by about 15 mm. If the distance is smaller, the efficiency falls off, while if it is greater, the discharge will

tend to develop a positive column. The introduction of a small amount of positive column into the discharge will cause the cathode glow to contract. If this occurs, the loss in light output due to the contraction of the cathode glow may be greater than the increase obtained by the addition of the small amount of positive column. Further, a certain amount of instability in the operation of the discharge will result. It will be understood, of course, that the dimensions here given will vary somewhat with the pressure of the contained gases, particularly that of the mercury vapor.

The envelope 12 is preferably of such size and shape that the ratio of the volume of the discharge to the area of the envelope is small, since the efficiency of the discharge is roughly inversely proportional to that ratio. Further, it will be very desirable that the dimensions have the same extent as those of the cathode glow in order that all of the available cathode glow be utilized. For the lamp dimensions noted above we have found that an envelope having a maximum diameter of about an inch and one-half gives very good results. It will be observed that the envelope is formed in the shape of a reflector having a pear-shaped portion 18 and a convex portion 19 through which the radiation will be directed to the object to be illuminated. The portion 18 will be given a heavy coating of fluorescent material 20 on the inside of the envelope, while the portion 19 will be given a light coating of the same or similar fluorescent material 21. The coating 20 is made heavy in order that substantially all fluorescence from it will radiate on the inside of the envelope and thus be reflected out through the portion 19. The coating of fluorescent material 21 on the portion 19, however, is light in order that it interfere as little as possible with the direct passage of the radiation. The coating 20 may, for example, be three or four times as thick as that of the coating 21. The fluorescent material of both of these coatings will preferably be of any material which fluoresces in the long ultraviolet, such as the cerium-activated calcium phosphate disclosed in application Serial No. 374,738 of W. A. Roberts, filed January 16, 1941, or the aluminum silicate disclosed in application Serial No. 366,434 of said Roberts, filed November 20, 1940.

The coating 21 on the portion 19 may be omitted entirely if desired. In this case, the radiation from the coating 20 will pass directly through the portion 19. The envelope 12 will preferably be formed of glass which transmits substantially only the ultraviolet rays and excludes the major portion of the visible radiation. Alternatively, the whole envelope may be constructed of ordinary glass and the portion 19 coated with a glaze of material which absorbs the visible radiation and passes the ultraviolet. The outer surface of the portion 18 may be coated with a surface of black paint 22 for the purpose of completely absorbing any stray radiation which may find its way through the coating 20 and the side walls of the portion 18. The lower portion of the envelope will be provided with a suitable base 23 having a pair of contacts 24 to which the cathode leads 16 are connected and a shell 25 to which the anode lead 17 is connected. The prongs 26 are provided for directing the insertion of the base into a suitable socket (not shown).

The lamp 11 will be energized by any source

of direct current voltage such as the battery 27 which may, for example, have a voltage of about 24 volts. The battery 27 may be connected to the electrodes of the lamp through the ballast resistor 28 and the switch 29. The resistor 28 may, for example, take the form of a 12-volt incandescent lamp which may also be advantageously used for illumination purposes when desired. For the purpose of preheating the cathode 13, the terminals 24 may be arranged to be momentarily connected across the battery 27 and the resistor 28 through the manually operated switch 30 and the leads shown. In one case, we have found that with a 24-volt source of power and a 12-volt incandescent lamp the current through the ultraviolet producing lamp was about 0.35 ampere. The mercury vapor pressure, under these conditions, is a small fraction of a millimeter and the discharge is rich in ultraviolet radiations of 2537 Å. wave length. It will be understood, of course, that the lamp may be operated from an alternating current source of voltage. In this case, however, the voltage required to operate the lamp will generally be higher. Further, it will be necessary to construct the lamp in such a manner that both of the electrodes have activated surfaces. Such a lamp is shown, for example, in Fig. 3.

In operation the switch 29 is first closed and then, after the cathode 13 has been preheated by the momentary closing of the switch 30, an arc discharge is started between the cathode 13 and the anode 14. The mercury arc discharge created thereby will produce a certain amount of ultraviolet radiation in the usual manner and this radiation will excite the fluorescent layers 20 and 21 to produce ultraviolet radiation of longer wave length. Due to the relatively large thickness of the coating 20, almost all of the radiation therefrom will be directed toward the inside of the lamp and then reflected out through the portion 19 along with the radiation from the thin coating 21 itself and a certain amount of the ultraviolet radiation coming directly from the arc. Because the coating 21 is relatively thin, the fluorescence developed in it will be radiated to the outside with a minimum loss.

The Figs. 2, 3 and 4 each show alternative modifications of the lamp in Fig. 1. In Fig. 2, the anode takes the form of the plate 4 positioned adjacent the cathode 3, as shown. In Fig. 3, both anode and cathode are formed of coiled coil wire activated with suitable electron emissive materials in order that the lamp may be made to operate on alternating current. Fig. 4 shows a simplified arrangement which requires but two leads through the stem press of the envelope. It will be observed that these two leads are connected to an activated filament 31, each end of which may be provided with anode discs 32. In operation, after preheating, a discharge will be passed between the various portions of the filament and the anode discs 32. This modification may also be operated on either alternating or direct current.

The Fig. 5 shows a modification of the circuit of Fig. 1. Here the switch 30 takes the form of a bimetallic element which is opened by heat produced by resistor 28. With this arrangement, the closure of switch 29 causes heating current to flow in the cathode preheating circuit and at the same time applies potential between anode and cathode. After a short preheating time the bimetallic switch 30 is opened and the preheating discontinued. In this circuit, the resistor 28,

which is a part of the automatic bimetallic switch, may alone provide the ballast required for the lamp, or additional ballast may be provided if necessary.

From what has already been said, it will be observed that we have provided an ultraviolet lamp of relatively simple construction which can be built into a relatively light weight unit. By the use of ultraviolet transmitting glass in the envelope, we have been able to eliminate a separate filter which would ordinarily add to the complexity and weight of the unit. It will be further observed that, aside from the small ballast resistor 28, no auxiliary equipment is needed.

It will be understood that the foregoing described lamps represent but several of the many possible embodiments of our invention, and that many modifications in the structural features, in the magnitudes of the voltages and currents employed, and in other details, may occur to those skilled in the art to which it appertains. All such modifications we aim to include within the scope of the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A cathodic glow lamp comprising an envelope, at least a portion of which is pervious to ultraviolet radiation but largely impervious to visible radiation, a gaseous atmosphere comprising mercury vapor and an auxiliary gas within said envelope, an anode and an activated cathode therein, a portion of said envelope having on the inside thereof a coating of fluorescent material capable of fluorescing in the long ultraviolet spectral range, said coating being sufficiently thick to insure that substantially all of the fluorescence therefrom will radiate to the inside of said envelope, a second portion having a sufficiently thin coating of said material to insure that the fluorescence will pass therethrough with a minimum of loss.

2. A cathodic glow lamp comprising an envelope, at least a portion of which is pervious to ultraviolet radiation but largely impervious to visible radiation, a gaseous atmosphere comprising mercury vapor and an auxiliary gas within said envelope, an anode and an activated cathode therein, a portion of said envelope having on the inside thereof a coating of fluorescent material capable of fluorescing in the long ultraviolet spectral range, said coating being sufficiently thick to insure that substantially all of the fluorescence therefrom will radiate to the inside of said envelope, a second portion having a sufficiently thin coating of said material to insure that the fluorescence will pass therethrough with a minimum of loss, and a coating of opaque material on the outside surface of said first portion.

3. A cathodic glow lamp comprising an approx-

imately pear-shaped bulb having a maximum diameter of approximately one and one-half inches, a gaseous ionizable medium in said bulb comprising a rare gas at a pressure of a few millimeters of mercury and also a quantity of mercury, a cathode and an anode spaced apart longitudinally of the bulb a distance of the order of 15 mm., said cathode comprising a wire coil coated with electron emissive material and extending laterally across the bulb axis adjacent the front end of the bulb, said anode being a ring-shaped wire member disposed rearwardly of the bulb in a plane extending laterally of the bulb axis, and means for supplying to said lamp an energy loading of approximately four watts so that the lamp operates with a mercury pressure of a small fraction of a millimeter and the discharge between said cathode and anode is a cathodic glow substantially filling the bulb and including no appreciable positive column.

4. A cathodic glow lamp comprising an approximately pear-shaped bulb having a maximum diameter of approximately one and one-half inches, a gaseous ionizable medium in said bulb, a cathode and an anode spaced apart longitudinally of the bulb a distance of the order of 15 mm., said cathode comprising a wire coil coated with electron emissive material and extending laterally across the bulb axis adjacent the front end of the bulb, said anode being a ring-shaped wire member disposed rearwardly of the bulb in a plane extending laterally of the bulb axis, radiation-concentrating means comprising fluorescent material coated on the inner surface of the sides of said bulb, said coating of fluorescent material being sufficiently thick that substantially all the fluorescence therefrom is radiated to the inside and through the front of the bulb, and means for supplying to said lamp an energy loading of approximately four watts.

5. A miniature cathodic glow lamp comprising a sealed bulbous envelope having a diameter of the order of an inch and a half, a gaseous atmosphere in said envelope comprising a rare gas at a pressure of the order of a few millimeters of mercury and also a quantity of mercury, an activated filamentary cathode and an anode spaced apart in said envelope, and means for supplying to said lamp an energy loading of the order of four watts, the discharge between said cathode and anode being a cathodic glow substantially filling the envelope and including no appreciable positive column, the mercury vapor pressure, during operation, being a small fraction of a millimeter of mercury.

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