March 30, 1943. R. F. HAYS, JR., ET AL 2,315,286

GASEOUS DISCHARGE LAMP

Filed Jan. 11, 1941

Fig. 1.

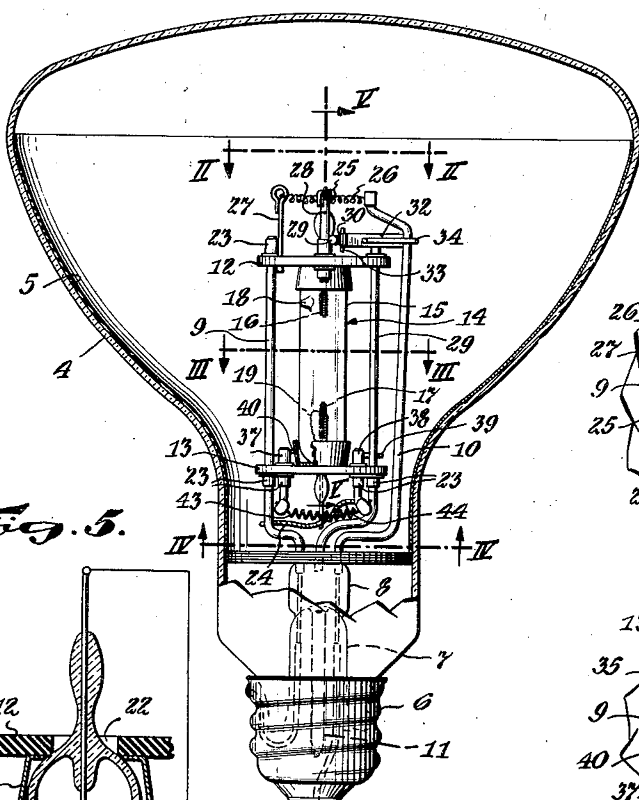


Fig. 2.

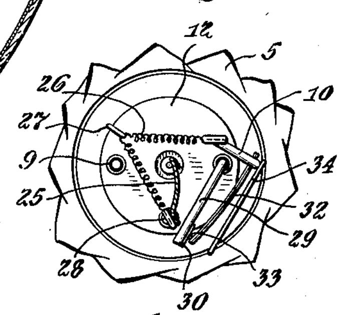


Fig. 3.

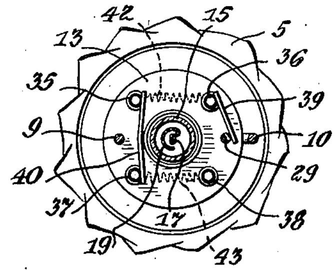


Fig. 4.

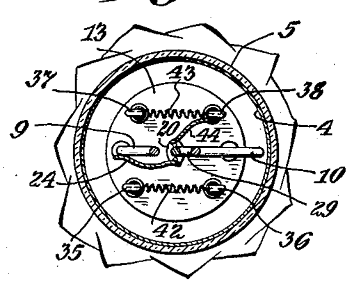
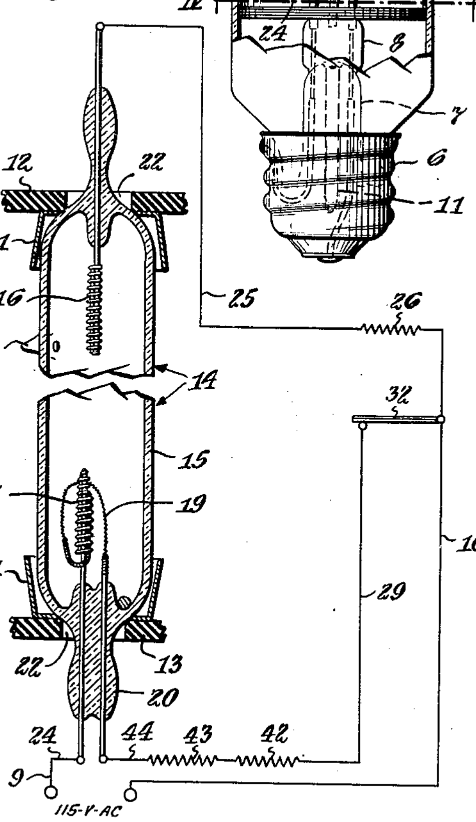


Fig. 5.



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GASEOUS DISCHARGE LAMP

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Application January 11, 1941, Serial No. 374,074

6 Claims. (Cl. 176—122)

The present invention relates to gaseous electric discharge lamps and more particularly to lamps of this type which require no external auxiliary starting equipment and the instant application is a continuation-in-part of our Patent No. 2,263,171, issued November 18, 1941, and assigned to the same assignee as the present invention.

Lamps of the mercury vapor type are now well known in the art, but have heretofore been limited in their use because of the necessity for auxiliary starting equipment. This is due to the fact that a transient voltage higher than that of the source of supply has heretofore been necessary to initiate a discharge, and the current must be limited during operation of the lamp. To this end it has been suggested to employ a series resistance in the form of an incandescent filament surrounding the lamp, but enclosed with the latter in a surrounding container so as to augment the visible light from the discharge.

Although such construction has decreased the starting voltage of the lamp, nevertheless such lamps have not heretofore been operable without auxiliary equipment, at the usual domestic voltage of 115 to 130 volts, so they can be inserted in sockets within homes. Moreover, when a filament is used as a ballast resistance and designed so as to become incandescent during the starting period, it is not heated sufficiently during the operating period to become incandescent; and when designed to become incandescent during the latter period, it is overloaded during the starting period when the discharge voltage is low.

It is accordingly an object of the present invention to provide a highly efficient light source comprising a gaseous electric discharge lamp and an incandescent filament which is operable from the usual domestic voltage source.

Another object of the present invention is the provision of a gaseous electric discharge lamp employing an incandescent filament to augment the visible light generated by the discharge and wherein no starting electrode is required to first form a glow discharge in order to initiate an arc discharge between the electrodes.

Another object of the present invention is the provision of a gaseous electric discharge lamp utilizing a filament as a series impedance and as a heater for maintaining an operating condition of the lamp, and wherein no auxiliary starting equipment externally of the lamp itself is required to initiate a discharge.

A further object of the present invention is the provision of a gaseous electric discharge lamp which is operable from the usual source of domestic potential, and wherein no starting electrode is required to first form a glow discharge in order to initiate an arc discharge between the electrodes.

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

Fig. 1 is an elevational view of a lamp constructed in accordance with the present invention;

Fig. 2 is a cross-sectional view taken on the line II—II of Fig. 1, and looking in the direction indicated by the arrows;

Fig. 3 is a cross-sectional view taken on the line III—III of Fig. 1, and looking in the direction indicated by the arrows;

Fig. 4 is a cross-sectional view taken on the line IV—IV of Fig. 1, looking in the direction indicated by the arrows, and

Fig. 5 is a cross-sectional view taken on the line V—V of Fig. 1, looking in the direction of the arrows, and showing schematically the electrical circuit arrangement within the lamp itself.

Referring now to the drawing in detail, the lamp shown in Fig. 1 comprises an enclosing container 4 of suitable vitreous material, such as glass or an ultra-violet pervious material if emission of ultra-violet radiations is desired, and which may also have a reflecting or a fluorescent coating 5 on the interior surface thereof. A base 6 is cemented or otherwise secured to the container 4 to enable the lamp to be screwed into the usual socket carrying the customary domestic potential of 115–130 volts.

A mount comprising a reentrant stem 7 having the usual press portion 8 is sealed to the container, as is common in the incandescent lamp art. A pair of leading-in conductors 9 and 10 of suitable metal, such as magno, nickel, or the like, and provided with a seal-forming portion having a coefficient of expansion approximating that of the vitreous container, are sealed to the press and connected to the center contact and shell of the base 6. Prior to affixing the base to the container, the latter is exhausted through an exhaust stem 11 and filled with an inert gas, such as nitrogen, to prevent arcing. As will be noted, the leading-in conductors are of rod-like form and widen out immediately above the press portion and extend in parallel relation longitudinally of the enclosing container 4.

A pair of bridges 12 and 13 of a suitable material, which may be of metal or an insulating material, tie the leading-in rods together for the purpose of forming a rigid mount for a discharge lamp 14. This lamp, as shown, is of the high pressure mercury type and comprises an envelope 15 of vitreous material capable of withstanding the high temperature of operation, such as quartz or the like, and provided with a pair of electrodes 16 and 17 between which a discharge occurs, as hereinafter more fully described. After evacuation of the envelope 15 through an exhaust tip 18, it is filled with an ionizable medium, such as mercury together with an inert gas such as argon, neon, or the like, at a predetermined pressure, to facilitate starting.

The electrode 16, as can be more readily seen in Fig. 5, is preferably in the form of a tungsten helix surrounding a bar of metal having high electron-emissive properties, such as thorium, which emits a copious flow of electrons when heated, as more fully shown and described in Patent 2,241,345, issued May 6, 1941, to Daniel S. Gustin and George A. Freeman, and assigned to the same assignee as the present invention. The electrode 17 is similar to the electrode 16 except that it is provided with a filament 19 thus constituting an auxiliary starting electrode which may be provided with a thermionic emissive coating, such as an oxide or barium, strontium, etc., if desired, although this is not essential and we prefer to use merely a coiled tungsten filament. One end of this starting electrode 19 is connected to the electrode 17 and the other end is connected to a leading-in conductor 20, so that the filament can be heated to an electron-emitting temperature, as hereinafter more fully explained.

The lamp 14 is provided with the customary elongated tapering seal at each end to which the leading-in wire for each electrode and the wire 20 for the filament 19 are sealed. This elongated end passes through heat shields 21 and openings 22 (Fig. 5) provided in the bridges 12 and 13, which thus suspends the lamp 14 between the latter in firm engagement therewith. Each bridge is in turn provided with eyelets 23 secured thereto which are of insulating material if the bridges are metal, or of metal if the bridges are formed of insulating material, and which are secured in any suitable manner to the rod-like leading-in conductors 9 and 10.

As can best be seen from Fig. 4, the electrode 17 is connected to the leading-in conductor 9 by a flexible conductor 24, and the electrode 16 is connected by a flexible conductor 25 to one end of a refractory metal filament 26 secured to a pair of supports 27 and 28 extending upwardly from the bridge 12 and by the end of the leading-in conductor 10, as can be readily seen from Fig. 2. A rod-like conductor 29 is sealed into the press 8 and extends upwardly through the bridges 12 and 13 with its upper extremity bent substantially normal to its major axis and provided with a terminal 30 at its end. Secured to the leading-in conductor 10 is a heat-responsive element, such as a bimetallic strip 32, the free end of which is provided with a terminal 33 normally engaging the terminal 30, and a rigid guide rod 34 is secured to the conductor 10 and parallels the bimetallic strip to limit deflection thereof upon heating, and which at the same time places a strain on the bimetallic strip, assuring its return to the normal circuit closing position.

The bridge 13 is also provided with four spaced depending supports 35, 36, 37, and 38 which project completely through the bridge. As can be seen from Fig. 3, the support 36 is connected by a bar or the like 39 to the conductor 29, and in a similar manner the supports 35 and 37 are electrically tied together by a similar rod 40. Beneath the bridge 13 a filament is supported, which for the conservation of space is divided, so that a portion 42 is suspended between the supports 35 and 36, the remaining portion 43 being suspended between the supports 37 and 38. As shown more clearly in Fig. 4, a flexible conductor 44 connects the support 38 and accordingly one end of the filament 43, to the leading-in conductor 20 (Fig. 5) and through the latter to the filamentary electrode 19.

The various parts of the lamp as above described accordingly form a circuit shown schematically in Fig. 5. By reference now more particularly to this latter figure, it will be observed that upon insertion of the lamp in a socket carrying the usual domestic potential of 115 to 130 volts, full line voltage will thus be impressed between the electrodes 16 and 17; but since there is an open circuit across the lamp 14, no current flows through the filament 26. At the same time, current from the source flows through a parallel circuit including the bimetallic strip 32, the filament formed by the portions 42 and 43, and the lamp filament or starting electrode 19 back to the other side of the source. The filament 42—43 will thus become incandescent and the starting electrode 19 will be heated to an electron-emitting temperature.

The lamp 14 is designed so that the maximum arc length, commensurate with gas pressure and the starting voltage of 115–130 volts, is obtained. In other words, the arc length or electrode spacing and gas pressure is the optimum for a starting voltage of 115 to 130 volts; and in the lamps we have constructed, it has been found that an electrode spacing of approximately 25 mm. and a pressure of the filling gas of approximately 25 mm. of mercury, operates very satisfactorily with the pressure of the mercury vapor during operation ranging from approximately one atmosphere to one and one-half atmospheres. On the other hand, if the gas pressure is too low, sputtering of the filament 19 and blackening of the envelope 15 results; and if the pressure is too high, the discharge will not be initiated at the available voltage of 115–130 volts.

Also, the amount of mercury in the lamp is critical to operation at the voltage of the domestic source, since the mercury pressure and the ballast filament 26 control the arc voltage during operation. For example, the value of the ballast filament 26 is such that it takes only a portion of the line voltage, allowing sufficient voltage to sustain a stable arc at the pressure of the mercury vapor; and if the latter is too high, the arc voltage will take too great a portion of the line voltage, thus making the arc unstable and resulting in its extinguishment. Moreover, the input wattage of the present lamp is necessarily limited by the maximum allowable current of the customary domestic circuit as well as the voltage but by confining the pressure of the mercury vapor during operation to the range of from approximately one to one and one half atmospheres, as above noted, substantially maximum ultra-violet radiations in the spectral range of from 2537 to 2800 A. U. are produced at the optimum allowable input wattage for the lamp.

The starting electrode 19 is designed so as to support the arc discharge only during the starting period and at the same time enable it to be heated to an electron-emitting temperature sufficient to cause a copious flow of electrons. Moreover, this starting electrode is so shaped as to require a minimum space around the base of the adjacent main electrode 17 so that a maximum amount of mercury will be vaporized during operation of the lamp, which thus minimizes fluctuations in the arc voltage and insures a more stable arc despite any line voltage fluctuations.

Upon heating of the starting filamentary electrode 19, as above mentioned, a discharge occurs between this heated electrode 19 and the electrode 16 since full line voltage is impressed between the electrodes 16 and 17 due to the filaments 42—43 limiting the voltage of the parallel circuit including the starting electrode 19. Inasmuch as the heated filamentary electrode 19 momentarily functions as cathode, current is accordingly passed through the lamp in only one direction. This "direct current" operation makes the current abnormally high with the result that the electrode 16, functioning momentarily as anode, is quickly heated to an electron-emitting temperature by the discharge, after which the heated filamentary electrode 19 and the electrode 16 alternately operate as anode and cathode, as is customary on alternating current.

By this time, the flow of current through the bimetallic strip 32 heats the same, causing it to deflect against the stop bar 34, thereby interrupting the heating circuit for the starting filamentary electrode 19 and extinguishing the incandescent filament 42—43. However, since the electrode 16 is now heated to an electron-emitting temperature and full line voltage exists between it and the electrode 17, the electrode 16 will momentarily function as cathode and the electrode 17 as anode. The lamp thus rectifies the alternating current, and during the forward half cycle the current is again abnormally high which rapidly heats the electrode 17 to an electron-emitting temperature, after which the electrodes 16 and 17 alternately function as anode and cathode at normal current flow.

Although in starting the lamp 14 it goes through the above described cycle of operation, nevertheless the total time required, from initiation of the discharge until it operates at normal current flow, is only approximately of three seconds duration. During continued normal operation of the lamp, the incandescent ballasting filament 26 not only limits the discharge current and augments the visible light generated by the ensuing discharge, but also heats the bimetallic strip 32 so as to maintain the heating circuit for the starting electrode 19 and the filament 42—43 interrupted. Moreover, the starting electrode 19 receives substantially no portion of the discharge during normal operation since it is carried practically entirely by the electrode 17, due to the high resistance of the filament 19. In addition, a heat insulating shield 50 may be employed to prevent undue heating of the seal-forming portion of the container.

It thus becomes obvious to those skilled in the art that a gaseous electric discharge lamp is herein provided which does not require a starting electrode to cause a glow discharge for ionizing the gas prior to initiation of an arc discharge between the main electrodes as has heretofore been the case. Moreover, an arc discharge is formed upon connection of the lamp to a source of electrical energy of the customary domestic potential of 115 to 130 volts without the necessity of cumbersome and expensive auxiliary equipment. By confining all elements necessary to start and operate the tube within the tube itself and employing some of these elements for the production of visible light as well as other functions, which thus augments the light generated by the discharge, a highly efficient lamp is produced.

Although one embodiment of the present invention has been herein shown and described, it is to be understood that still further modifications thereof may be made without departing from the spirit and scope of the appended claims.

We claim:

1. A high pressure gaseous electric discharge lamp comprising an envelope, a pair of oppositely disposed main electrodes in said envelope and spaced apart the optimum distance to sustain a stable arc discharge therebetween at the voltage of the customary domestic source of supply, an ionizable medium in said envelope for supporting the discharge including a vaporizable material at a pressure between one and one and one-half atmospheres during operation of said lamp, and a filamentary auxiliary electrode in said envelope connected to one of said main electrodes and to the same domestic source of supply as said main electrodes and adapted to be heated to an electron-emitting temperature from said domestic source to initiate an arc discharge between it and the most distant main electrode, and said auxiliary electrode being positioned in juxtaposition to said adjacent main electrode out of the discharge path between said main electrodes to confine the space required by both said electrodes to a minimum to conserve heat and prevent condensation of the vaporizable material and said auxiliary electrode taking no part in sustaining the discharge during operation of said lamp.

2. A high pressure gaseous electric discharge lamp comprising an envelope, a pair of oppositely disposed main electrodes in said envelope having a spacing therebetween of approximately 25 millimeters to sustain a stable arc discharge therebetween at the voltage of the customary domestic source of supply, an ionizable medium in said envelope at a pressure of approximately 25 millimeters of mercury and including a vaporizable material for supporting said arc discharge during operation of said lamp, and a filamentary auxiliary electrode connected to one of said main electrodes and to the same domestic source of supply as said main electrodes and adapted to be heated to an electron-emitting temperature from said domestic source of supply to initiate an arc discharge between it and the most distant main electrode, and said auxiliary electrode being disposed out of the discharge path between said main electrodes and taking no part in sustaining the discharge during operation of said lamp.

3. A high pressure gaseous electric discharge lamp comprising an envelope, a pair of oppositely disposed main electrodes in said envelope and spaced apart the optimum distance to sustain a stable arc discharge therebetween at the voltage of the customary domestic source of supply, an ionizable medium in said envelope for supporting said arc discharge including a vaporizable material at a pressure of approximately one atmosphere during operation of said lamp, a filamentary auxiliary electrode in said envelope adapted to be heated to an electron-emitting temperature from the same domestic source of supply as said main electrodes to initiate an arc discharge between it and the most distant main electrode, and means operable to cause optimum input wattage allowable by the limitations of said source to be supplied to said lamp to produce maximum radiations within the spectral region of 2537 to 2800 Angstrom units, and said auxiliary electrode

being disposed out of the discharge path between said main electrodes and taking no part in sustaining the discharge during operation of said lamp.

4. A high pressure gaseous electric discharge lamp comprising an envelope, a pair of oppositely disposed main electrodes in said envelope adapted to sustain an arc discharge at the voltage of the customary domestic source of supply, an ionizable medium in said envelope for supporting the discharge including a vaporizable material, a coiled filamentary auxiliary electrode in said envelope adapted to be heated to an electron-emitting temperature from said domestic source to initiate an arc discharge between it and the most distant main electrode, and said auxiliary electrode being connected to one of said main electrodes and to the same domestic source of supply as said main electrodes and disposed adjacent to the main electrode to which it is connected but out of the discharge path between said main electrodes with the major axis of its convolutions disposed substantially parallel to said adjacent main electrode to confine the space required by both said main and auxiliary electrodes to a minimum to prevent formation of a cool area otherwise causing condensation of said ionizable medium during operation of said lamp, and said auxiliary electrode taking no part in sustaining the discharge during operation of said lamp.

5. An electrode for a gaseous discharge lamp comprising a leading-in conductor, a material having high electron emissivity when heated in contact with said leading-in conductor, a refractory metal surrounding said leading-in conductor and electron-emissive material to form a main discharge electrode, and a coiled refractory metal filament connected to said electrode and disposed in the form of a loop adjacent thereto with the major axis of its convolutions disposed substantially parallel to said electrode on each side of the longitudinal axis thereof to form an auxiliary electrode having high resistance.

6. An electrode for a gaseous discharge lamp comprising a leading-in conductor, metallic thorium having high electron emissivity when heated in contact with said leading-in conductor, a refractory metal helix surrounding said leading-in conductor and said thorium to form a main discharge electrode, and a coiled coil filament connected to said electrode and disposed adjacent thereto in the form of a loop with the major axis of its convolutions disposed substantially parallel to said electrode on each side of the longitudinal axis thereof to form an auxiliary electrode having high resistance.

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