

Nov. 18, 1941.

R. F. HAYS, JR., ET AL

2,263,171

GASEOUS DISCHARGE LAMP

Filed July 5, 1940

Fig. 1.

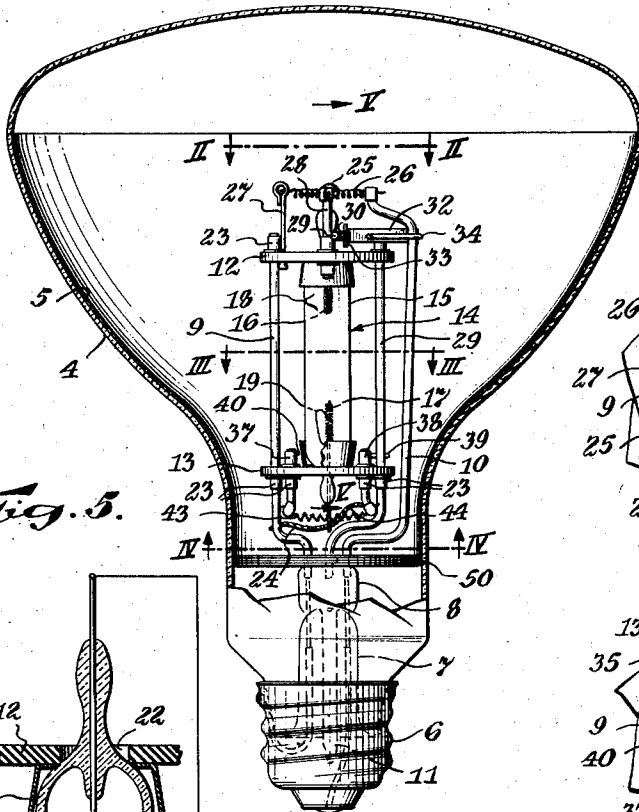


Fig. 2.

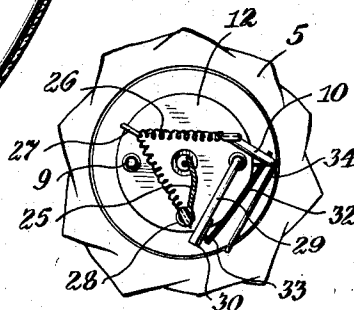


Fig. 3.

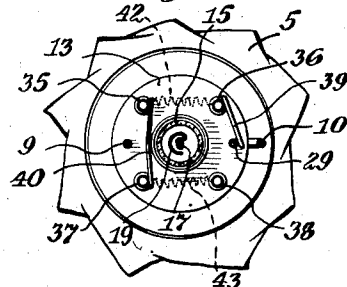


Fig. 4.

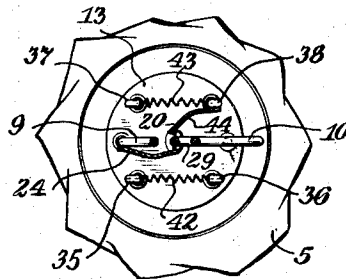
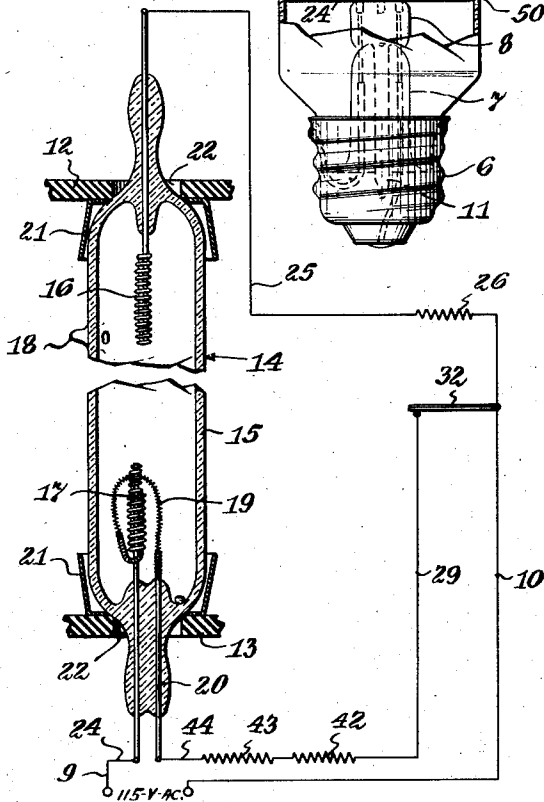


Fig. 5.



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2,263,171

GASEOUS DISCHARGE LAMP

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Application July 5, 1940, Serial No. 344,014

8 Claims. (Cl. 176—1)

The present invention relates to gaseous electric discharge lamps and more particularly to lamps of this type which require no external auxiliary starting equipment.

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 the copending application of Daniel S. Gustin and George A. Freeman, Ser. No. 215,578, filed June 24, 1938, 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 of barium, strontium, etc., if desired, although this is not essential and in our preferred embodiment an uncoated filament is employed. 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 reaching approximately one atmosphere. 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.

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. It is also significant to note that the starting electrode 19 receives no portion of the discharge during normal operation since it is entirely carried by the electrode 17, thus preventing sputtering of the electron-emissive coating if provided on the starting electrode 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 initiating an arc discharge between the main electrodes. 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. An electric lamp comprising a sealed container, a gaseous discharge lamp mounted in said container provided with a pair of main electrodes

and an auxiliary electrode adapted to be heated to an electron-emitting temperature from a source of supply of domestic voltage, a filament connected in series with said main electrodes and said source of supply to serve as a ballast resistance and to augment the visible light generated by said lamp during operation, and a second filament and a heat-responsive element connected in series with said auxiliary electrode and in parallel with said main electrodes and said first mentioned filament, to cause full line voltage to be impressed across said main electrodes and for causing heating of said auxiliary electrode to an electron-emitting temperature from said source to initiate a discharge between said auxiliary electrode and the oppositely disposed main electrode, and said heat-responsive element being operable to cause disconnection of said second mentioned filament and said auxiliary electrode from the domestic source of supply upon initiation of the discharge in said lamp.

2. An electric lamp comprising a sealed container, a gaseous electric discharge lamp mounted in said container provided with a pair of oppositely disposed non-activated electrodes and an activated filamentary electrode adapted to be heated to an electron-emitting temperature from a source of supply of domestic voltage, a filament connected in series with said non-activated electrodes and said source of supply to serve as a ballast resistance and to augment the visible light generated by said lamp during operation, a second filament and a heat-responsive element connected in series with said activated filamentary electrode and in parallel with said non-activated electrodes and said first mentioned filament, to cause full line voltage to be impressed across said non-activated electrodes and for causing heating of said activated electrode to an electron-emitting temperature from said source to initiate an arc discharge between said activated electrode and the oppositely disposed non-activated electrode, said heat-responsive element being operable to cause disconnection of said second mentioned filament and said activated electrode from said domestic source of supply with attendant transfer of the arc discharge to both of said non-activated electrodes, and said first mentioned filament being operable to heat said heat-responsive element during operation of said lamp to maintain said element in an opened position.

3. An electric lamp operable from a source of electrical energy of the customary domestic potentials comprising a sealed container, a gaseous electric discharge lamp mounted in said container provided with an envelope having an ionizable medium therein at a predetermined pressure, a pair of oppositely disposed main electrodes in said envelope having a spacing therebetween so proportioned to the pressure of the ionizable medium as to sustain an arc discharge between said main electrodes at the voltage available from said domestic source, an auxiliary electrode disposed adjacent one of said main electrodes adapted to be heated to an electron-emitting temperature from said domestic source and of sufficient area to support an arc discharge with the oppositely disposed main electrode, heat-responsive means in said container for connecting said auxiliary electrode to said domestic source, and a filament in said container for limiting the current supplied to said lamp during operation and to augment the visible light generated by the latter, said heat-responsive means

being operable upon the initiation of said discharge to cause disconnection of said auxiliary electrode from said source with transfer of said arc discharge to said main electrodes, and said filament being further operable to heat said heat-responsive means during continuance of the discharge to maintain said means in circuit-interrupting position.

4. An electric lamp operable from a source of electrical energy of the customary domestic potentials comprising a sealed container, a gaseous electric discharge lamp mounted in said container provided with an envelope containing an ionizable medium at a predetermined pressure, a pair of oppositely disposed main electrodes in said envelope having a spacing therebetween so proportioned to the pressure of the ionizable medium as to sustain an arc discharge between said electrodes at the voltage available from said domestic source, an auxiliary electrode disposed adjacent one of said main electrodes adapted to be heated to an electron-emitting temperature from said domestic source and of sufficient area to support an arc discharge between it and the oppositely disposed main electrode, a filament mounted in said container and connected in series with said main electrodes and said source of supply to serve as a ballast resistance and to augment the visible light generated by said discharge lamp during operation, and a second filament and a heat-responsive element mounted in said container and connected in series with said auxiliary electrode and in parallel with said main electrodes and first mentioned filament, to cause full voltage from said source to be impressed across said main electrodes and for heating said auxiliary electrode to an electron-emitting temperature to initiate said arc discharge, said heat-responsive element being operable upon the flow of current therethrough to cause disconnection of said second mentioned filament and said auxiliary electrode from the domestic source of supply with attendant transfer of the discharge to both said main electrodes, and said first mentioned filament being further operable to heat said heat-responsive element during operation of said lamp to maintain said element in a circuit-interrupting position.

5. An electric lamp operable from a source of electrical energy of the customary domestic potentials comprising a sealed container, a gaseous electric discharge lamp mounted in said container provided with an envelope having an ionizable medium therein at a predetermined pressure, a pair of oppositely disposed main electrodes in said envelope having a spacing therebetween so proportioned to the pressure of the ionizable medium as to sustain an arc discharge between said main electrodes at the voltage available from said domestic source, an auxiliary electrode disposed in said envelope adjacent one of said main electrodes adapted to be heated by said domestic source to an electron-emitting temperature, said auxiliary electrode being shaped to confine the space required for both main and auxiliary electrodes to a minimum to prevent the formation of cool pockets where condensation of the ionizable medium would otherwise occur and being of an area sufficient to initiate a discharge when heated to an electron emissivity between it and the oppositely disposed main electrode, heat-responsive means normally connecting said auxiliary electrode to said domestic source and operable upon the flow of current therethrough to

disconnect said auxiliary electrode from said source with attendant transfer of said arc discharge to both said main electrodes, and a filament in said container for limiting the discharge current supplied to said lamp and to augment the visible light generated by the discharge and operable to heat said heat-responsive means during operation of said lamp to prevent return of said means to its normal position.

6. An electric discharge lamp operable from a source of electrical energy of the customary domestic potentials comprising a sealed container, leading-in and supporting conductors extending into said envelope, a pair of bridges supported by said conductors, a gaseous electric discharge lamp suspended between said bridges and provided with a pair of oppositely disposed main electrodes and an auxiliary electrode adjacent one of said main electrodes and adapted to be heated to an electron-emitting temperature from said domestic source, a filament supported by one of said bridges and connected between one of said conductors and one of the main electrodes to limit the discharge current during operation of said lamp and to augment the visible light generated by the discharge, a second filament supported by the other of said bridges and connected to the auxiliary electrode and to another of said conductors to cause full line voltage from said domestic source to be impressed between said main electrodes, a bimetallic strip normally interconnecting the conductors to which the respective filaments are connected to cause said auxiliary electrode to be heated to an electron-emitting temperature and initiate an arc discharge between it and the oppositely disposed main electrode and operable upon the flow of current therethrough to interrupt the connection between the conductors to which the respective filaments are connected whereby the arc discharge is transferred to both said main electrodes, and said first mentioned filament being further operable to heat said bimetallic strip during operation of said lamp to prevent its return to its normally closed position.

7. An electric lamp comprising a sealed container, a gaseous discharge lamp mounted in said container provided with a pair of main electrodes and an auxiliary electrode adapted to be heated to an electron-emitting temperature from a source of domestic voltage, an impedance device connected in series with said main electrodes and said source of supply to serve as a ballast resistance during operation of said lamp, and a heat responsive element connected in series with said auxiliary electrode and in parallel with said main electrodes and said impedance device, to cause full line voltage to be impressed across said main electrodes and for causing heating of said auxiliary electrode to an electron-emitting temperature from said source to initiate a discharge between said auxiliary electrode and the oppositely disposed main electrode, and said heat-responsive element being operable to cause disconnection of said auxiliary electrode from the domestic source of supply upon initiation of the discharge in said lamp.

8. An electric lamp comprising a sealed container, a gaseous discharge lamp mounted in said container provided with a pair of main electrodes and an auxiliary electrode adapted to be heated to an electron-emitting temperature from a source of supply of domestic voltage, an impedance device connected in series with said main electrodes and said source of supply to serve as a

ballast resistance during operation of said lamp, and a second impedance device and a heat-responsive element connected in series with said auxiliary electrode and in parallel with said main electrodes and said first mentioned impedance device, to cause full line voltage to be impressed across said main electrodes and for causing heating of said auxiliary electrode to an electron-emitting temperature from said source to initiate

a discharge between said auxiliary electrode and the oppositely disposed main electrode, and said heat-responsive element being operable to cause disconnection of said second mentioned impedance device and said auxiliary electrode from the domestic source of supply upon initiation of the discharge in said lamp.

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