Aug. 29, 1939. G. A. FREEMAN 2,171,234

DISCHARGE DEVICE AND ELECTRODE

Filed Aug. 12, 1937

Fig. 2.

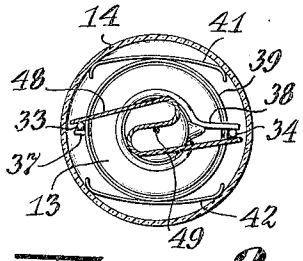


Fig. 5.

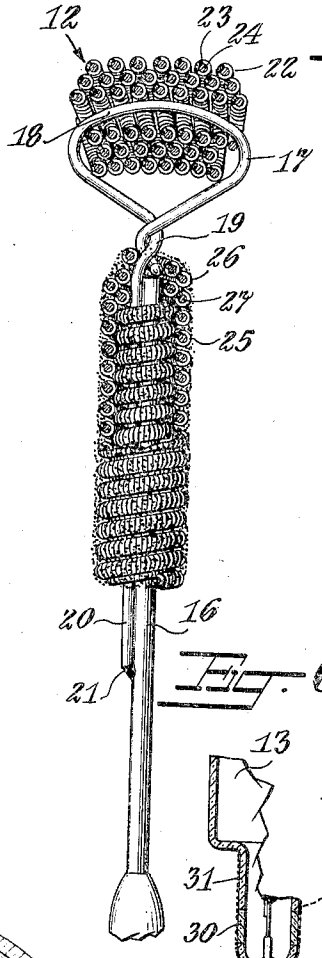


Fig. 1.

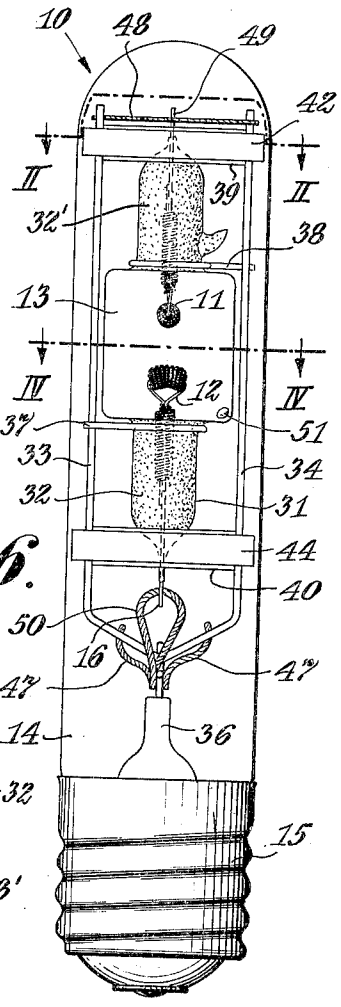


Fig. 3.

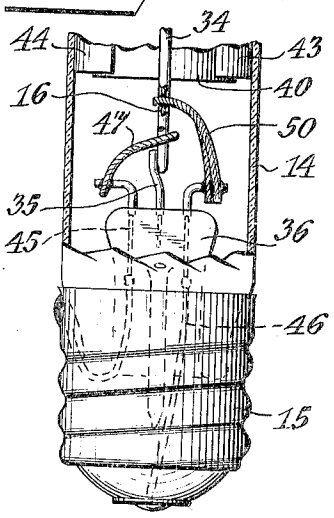


Fig. 6.

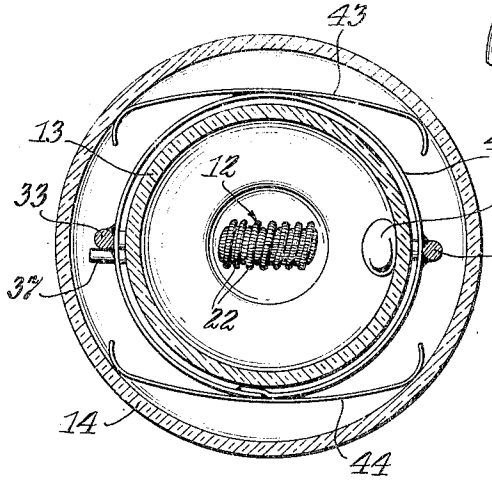


Fig. 4.

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2,171,234

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DISCHARGE DEVICE AND ELECTRODE

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Application August 12, 1937, Serial No. 158,678

20 Claims. (Cl. 176—122)

This invention relates to discharge devices and, more particularly, to electrodes therefor that will not disintegrate under the extreme conditions of heat and bombardment imposed by very short high-wattage mercury arcs.

The principal object of my invention, generally considered, is the provision of an improved form of high-powered mercury arc lamp and electrodes therefor, in which the wattage per unit arc length is increased by shortening said arc length and increasing the current flow.

An object of my invention is to provide a novel form of what might be called a duplex electrode, or one comprising a main portion, having no electron emitting oxide, and thus adapted to withstand high temperatures, and a starting portion spaced outwardly therefrom and coated with electron emission material to supply a copious flow of electrons for initially ionizing the normally-contained rare gaseous medium at reduced or normally low pressure within the enclosing envelope.

Another object of my invention is the provision of a new design of electrode for high-powered short-arc mercury vapor lamps, in which the store of electron-emission material, which makes the device start easily, is separated from the main arc stream during normal operation.

A further object of my invention is to provide an electrode having a tip formed as a coil large enough to allow a considerable surface for the arc to strike, and at the same time radiate most of the heat generated.

A still further object of my invention is the provision of a novel form of electrode comprising a supporting wire carrying a tip or main electrode coil on an end loop, and a starting coil spaced outwardly from said loop, said starting coil carrying electron emission material and the tip coil supporting wire normally conducting only enough heat to warm said electron-emission material to the desired temperature.

An additional object of my invention is the provision of a mercury arc lamp containing electrodes, each of which comprises tip coils which take the main discharge, and coils spaced outwardly therefrom which act in starting when the ionizable material in the envelope is at low pressure, the arc jumping from the starting coils to the tip coils as the pressure and wattage rise.

Another object of my invention is the provision of a mercury arc lamp in which a quartz envelope enclosing the electrodes is provided with end portions decreased in section and coated with a heat-conserving film, said envelope being mounted in an outer envelope to maintain the desired operating temperatures.

Other objects and advantages of the invention relating to the particular arrangement and construction of the various parts will become apparent as the description proceeds.

Referring to the drawing illustrating my invention,

Fig. 1 is a side elevational view of a mercury arc lamp embodying my invention.

Fig. 2 is a transverse sectional view on the line II—II of Fig. 1, in the direction of the arrows.

Fig. 3 is a fragmentary elevational view, partly in vertical or axial section, of the lamp shown in Fig. 1, but looking in a direction at right angles to the direction of view of Fig. 1.

Fig. 4 is an enlarged transverse sectional view, on the line IV—IV of Fig. 1, in the direction of the arrows.

Fig. 5 is an enlarged elevational view, partly in longitudinal section, of one of the electrodes.

Fig. 6 is a fragmentary longitudinal sectional view of one end portion of the inner envelope illustrated in Fig. 1.

In designing mercury arcs for projection purposes, the wattage per unit of arc length is increased by shortening the arc length and increasing the current flow. The heat of the arc is then concentrated close to the electrodes and brings them to such a high temperature that oxide emission material, usually employed, is volatilized so that the emission must then come from the tungsten itself, or other refractory carrying material. This requires more energy and the electrodes become hotter, causing the refractory metal to vaporize and blacken the bulb wall.

In lieu of large electrodes, which might be the remedy if it were convenient to employ a large enough quartz bulb, I provide a new form of electrode in which the storage of emission material is separated from the arc. An electrode tip, or main electrode portion, is formed as a coil large enough to provide a considerable surface for the arc to strike and at the same time radiate most of the heat generated. No emission material, or material having a high vaporization point, is put on the tip coil. Small wires are employed connecting the tip coil to another coil of similar design so that only enough heat is conducted therebetween to warm the outer or starting coil. The outer coil takes the arc at low pressure in starting and, as the pressure and wattage rise, the arc jumps over to the tip coils.

Referring to the drawing, there is shown as one embodiment of my invention, a mercury arc pro-

jection lamp 10 comprising a pair of electrodes, generally designated by the reference characters 11 and 12, mounted in an inner envelope 13, which desirably contains a quantity of mercury which may completely vaporize during operation, and a rare gaseous filling at low pressure to facilitate starting, in turn positioned in an outer envelope 14, shown formed with a screw base 15, and desirably containing nitrogen or other inert gas at a pressure sufficient to prevent a glow discharge between the conductive parts therein. The electrode spacing is illustrated as about one-quarter inch, in the disclosed embodiment, one electrode being desirably arranged with the plane of its tip loop disposed at an angle of 90° with respect to that of the other. Inasmuch as the electrodes 11 and 12 are of identical construction, only one, such as 12, will be described.

From Fig. 5, where I show the electrode 12 enlarged, it will be apparent that it comprises a supporting lead-in wire 16, of tungsten or other refractory metal, which extends through one end of the quartz envelope 13. Associated with this is a wire loop 17 to provide a transversely extending slightly curved tip-coil-carrying portion 18. The loop wire 17 comprises portions desirably bent or helically twisted together, as indicated at 19, an end portion being extended along the lead-in wire 16, as indicated at 20, the extreme end of said portion 20 being desirably welded to the supporting portion 16, as indicated at 21. The lead-in wire 16 is larger than the loop wire 17 in order to carry the current without excessive local heating. As an example, the wire 16 may be 40 mil and the wire 17, 20 mil.

The tip or main portion of the electrode 12 is formed by winding, on the transverse portion 18, a secondary coil 22 from a primary coil 23 wound on a mandrel 24. A desirable tip coil may be formed from .0025 inch tungsten primary wire wound on a .018 inch tungsten mandrel with 200 turns per inch. In order to provide the desired area, the mandrel-wound primary wire 23 and mandrel 24 are, in the present embodiment, shown as formed into a secondary 22 comprising three coaxially-wound coils or layers. The secondary may be wound on a .035 inch mandrel, which is then removed and the formed tip coil applied to the supporting wire 17 prior to shaping.

The starting secondary coils 25 may be formed of similar tungsten primary wire 26 wound on a similar tungsten mandrel 27 and formed into two coaxially-wound secondary coils or layers disposed around the straight axially extending lead wire 16 and the straight portion 20 of the loop wire 17 in series with the coil 22. These starting coils 25 are what carry the electron emission material, such as a barium and strontium carbonate mixture, which is subsequently decomposed to the oxides during the process of manufacture. The coils 25 may be initially applied to the straight portion 20 and screwed onto the twisted portion 19, the lead 16 being sharpened and subsequently pushed in the coils along the straight portion 20, to provide a snug fit.

If desired, strontium carbonate may be applied to the tip coil, instead of nothing at all, with barium and strontium carbonates on the starting coil. The strontium oxide, which is subsequently formed, can withstand a much higher temperature than barium oxide, but is not quite as good as an emitter; therefore, starting will still take place on the outwardly spaced coils 25 and jump-over to the tip coils 22 when the temperature and pressure rise. The emission from the strontium oxide will be better than from tungsten alone, thus reducing the temperature where the arc strikes.

In order to facilitate the sealing of the leading-in conductor 16 into the quartz envelope 13, said conductor is desirably first covered with a thin glaze, skin or film 28 of sealing glass, having the proper characteristics, which extends for a considerable distance, as for example about one-half inch. In the center of the glazed section a short bead 28' is made. The joint between the bead and the glaze is always free from crevices since they are of the same material, that is, of glass of the same or substantially the same composition, and adhere without coaxing. This seal can stand such shocks as immersion in water while at a yellow heat and not crack. The physical shape is the unique feature responsible for the strength of the seal. The bead 28' is joined, preferably by a plurality of sleeves 29 and 30, also having the desired graded characteristics, to the reduced end portion 31 of the quartz envelope 13. Said reduced portion and connecting sleeves are desirably coated with platinum 32, or other refractory metallic reflecting material, to conserve the heat of the restricted portion of the envelope 13 and prevent undesired condensation of mercury vapor therein during operation of the lamp. The leading-in conductor 49 of the electrode 11 is desirably sealed to the restricted end portion at the other end of the envelope 13, in a similar manner, and a similar metallic coating 32' applied.

The envelope and contained electrodes are shown supported in the outer bulb 14 by longitudinally extending support portions or members 33 and 34, which are desirably formed of nickel and supportingly connected to a spud 35 extending from the press 36 of the envelope 14. These supporting members 33 and 34 respectively carry wires 37 and 38 which are bent around the restricted end portions of the envelope 13 for holding it in place, as shown most clearly in Figs. 1 and 2.

Centering of the envelope 13 and the supporting wires 33, 34, 37 and 38 is, in the present embodiment, obtained by cylindrical bands 39 and 40, desirably formed of nickel, which respectively connect the upper and lower, or free and united, portions of said supporting wires 33 and 34. Intermediate the points of connection with the wires 33 and 34, said bands 39 and 40 carry spring elements 41, 42, 43, and 44, the generally central portions of which are desirably spot-welded to the respective band 39 or 40, and the outer ends of which are curved and resiliently engage the inner surface of the glass envelope 14, at points spaced approximately uniformly around the circumference, as shown most clearly in Figs. 2 and 4.

Leading-in conductors 45 and 46 extend through the press 36 on either side of the spud 35, one of said conductors, such as 45, being desirably connected by a doubled-over or pair of flexible copper wires 47 to the supporting members 33 and 34, the outer ends of which are in turn connected, in a similar manner, by flexible copper wire means 48 to the outer end of the leading-in conductor 49 for the electrode 11. The other leading-in conductor, such as 46, is connected to the outer end of the leading-in conductor 16, preferably by means of a pair of wires, or a doubled-over flexible copper wire 50.

From the foregoing disclosure, it will be seen that I have provided electrodes particularly

adapted for discharge devices of the metallic vapor type, wherein a portion of each electrode serves to initiate a discharge at a low temperature and pressure, and upon increase of temperature and pressure during operation of the lamp, another portion of each electrode takes the discharge. Inasmuch as that portion of the electrode which initiates the discharge is maintained comparatively cool during normal operation of the lamp, it may carry efficient electron emission material which cannot stand the high temperature of the tips or main electrode portions. Inasmuch as I have illustrated a mercury vapor lamp, a small globule of mercury is indicated by the reference character 51.

I have also provided lead-in wires brought into the quartz or inner envelope through graded seals, in which ordinary practice, using long bulky beads liable to crack and leak, is avoided, by thinly glazing a considerable length of the wire and applying a short bead to said glazed portion.

Although a preferred embodiment of my invention has been disclosed, it is understood that modifications may be made within the spirit and scope of the appended claims.

It will also be understood that although I have shown the wire 17 as smaller and separate from the wire 16, yet, if desired, the same may be formed as a continuation of said wire 16.

I claim:

1. An electric discharge device comprising a sealed envelope, a leading-in conductor extending into each end of said envelope, a looped-over wire associated with each conductor, leaving a laterally elongated eye, and extending back along the leading-in conductor toward its point of entry into said envelope, a coil of refractory wire wound around the inner arm of said looped-over wire to form a main electrode surface of relatively large area, and another coil of wire disposed around the extended portion of said looped-over wire and conductor, outwardly of said loop, and coated with electron-emission material to form a starting electrode surface.

2. An electric discharge device comprising a sealed envelope, a leading-in conductor extending into each end of said envelope, each conductor having a laterally extending coil wound around a portion thereof disposed close to the other conductor, said coils being closely spaced with respect to one another in order to provide a very short arc therebetween when the device is operated, and a coil disposed outwardly from the laterally extending coil and arranged coaxially with respect to said envelope, said outer coils carrying electron-emissive material to provide starting electrode surfaces.

3. An electric discharge device comprising a sealed envelope, a leading-in conductor extending into each end of said envelope, each conductor provided, adjacent the portion positioned nearest to the other conductor, with a wire looped-over to provide a laterally elongated eye, and extending back along said conductor, a mandrel-wound primary coil, formed into a secondary coil of several layers, mounted on the innermost element of each eye-forming loop to provide a main electrode surface of relatively large area and heat-dissipating capacity, and a coil formed of similar mandrel-wound wire, disposed on each conductor, outwardly of the loop-carried coil, with its axis substantially perpendicular to said coil and carrying electron-emitting oxide-material to provide a starting surface.

4. An electric discharge device comprising a sealed envelope containing a rare gas at reduced pressure admixed with mercury vapor, an electrode extending into said envelope from each end, said electrodes being designed to carry electron-emission material separated from the arc when the device is actuated, and for that purpose each electrode having a bare coil formed of refractory metal and providing relatively large discharge and heat-radiating surfaces, and a similar coil in series therewith, outwardly disposed with respect thereto, and impregnated with electron-emission material, whereby the arc starts between the impregnated coils and jumps to the bare coils when the temperature and pressure rise to the desired extent in the envelope.

5. An electric discharge device comprising a sealed envelope, a leading-in conductor extending into each end of said envelope, each conductor having an inner portion looped over, passing through a tip portion formed of a number of mandrel-wound primary coils of refractory metal, coiled again into a secondary of several layers, that portion of each conductor outwardly of said coil-carrying portion serving to support a longitudinally extending secondary coil formed of similar material and impregnated with electron-emission material, whereby each electrode has a starting portion comprising a coil large enough to provide a considerable surface for an arc to strike and at the same time radiate a sufficient amount of heat to prevent undesired high temperatures and loss of material due to vaporization.

6. An electric discharge device comprising a sealed envelope, a leading-in conductor extending into each end of said envelope, each conductor having a laterally extending coil wound around a portion thereof, and a coil disposed outwardly from the laterally extending coil and arranged coaxially with respect to said envelope, said outer coils carrying electron-emissive material.

7. An electrode for discharge device comprising a refractory wire having a curved portion, providing a laterally elongated loop wound around itself and extended back away from said loop, a coil of refractory wire wound around the extreme portion of said loop to form a main electrode surface of relatively large area, and another coil of wire wound around the extended portion, spaced from said loop, and coated with electron-emission material to form a starting electrode portion.

8. An electrode for a discharge device comprising conductor means having a laterally extending coil wound around an end portion thereof, and another coil spaced from said laterally extending coil, arranged coaxially with respect to said wire, and carrying electron-emission material.

9. An electrode for a discharge device comprising a conductor looped over, to provide a laterally elongated eye, and extending back upon a supporting conductor portion, a mandrel-wound primary coil formed into a secondary coil of several layers and mounted on said looped-over portion to provide a main electrode portion of relatively large area, and a coil formed of similar mandrel-wound wire disposed on said conductor portion, spaced from said loop-carried coil, disposed with its axis substantially perpendicular to the axis of said coil, and carrying electron-emitting material to provide a starting electrode portion.

10. An electrode for a discharge device comprising a bare coil formed of refractory metal

providing a relatively large main discharge and heat-radiating surface and mounted on an end portion of a conductor, and a similar coil in series therewith, mounted on another portion of said conductor, and impregnated with electron-emission material to provide a starting surface.

11. An electrode for a discharge device comprising a conductor with a portion looped-over and passing through a tip portion formed of a number of mandrel-wound primary turns of refractory material, coiled again into a laterally extending secondary coil of several layers, and a longitudinally extending secondary coil formed of similar material, impregnated with electron-emission material, and mounted on another portion of said conductor.

12. An electric discharge device comprising a sealed envelope having an intermediate discharge chamber, relatively large in cross section, and end chambers reduced in cross section and extending longitudinally therefrom, a leading-in conductor extending through each end chamber and terminating in the intermediate chamber, inner conductor portions being looped over and extended back along the leading-in conductors toward their points of entry, a coil of refractory wire wound around each looped-over portion, and another coil wound around a portion of each conductor in the corresponding restricted end chamber, each end chamber being coated with a reflecting refractory metal to conserve the heat therein.

13. An electric discharge device comprising a sealed envelope, conductor means extending into each end thereof, each conductor means having a coil wound around the innermost portion thereof, another coil disposed outwardly therefrom and carrying electron emissive material, an outer envelope enclosing said sealed envelope, and means supporting and centering the latter with respect to the former.

14. An electric discharge device comprising inner and outer envelopes, said inner envelope having a pair of electrodes between which a discharge may occur, said outer envelope having a press from which a spud extends, a pair of supporting conductors one on each side of said inner envelope and secured to said spud, and two leading-in conductors, a flexible electrical connection between each supporting conductor and one of said leading-in conductors, securing means extending from one supporting conductor and encircling a portion of said inner envelope and from said other conductor and encircling another portion of said inner envelope, electrical connections between the other leading-in conductor and the adjacent electrode of the inner envelope, and between both of said supporting conductors and the other electrode, bands disposed adjacent the ends of the inner envelope and connecting the respective portions of the supporting conductors, and spring means having intermediate portions secured to said bands and arms extending therefrom and resiliently engaging the inner surface of said outer envelope, for resiliently centering said inner envelope with respect thereto.

15. A seal comprising a lead-in conductor thinly covered with a skin of suitable glass for a considerable distance and a relatively short bead of glass of substantially the same composition applied to said covered portion.

16. A seal comprising a lead-in conductor thinly covered with a film of suitable glass for a considerable distance, a relatively short bead of the same kind of glass applied to said covered portion, said bead serving to form part of a graded seal with an associated envelope, and the inner end of said conductor supporting a duplex electrode adapted to carry a discharge.

17. An electric discharge device comprising a sealed envelope having an intermediate discharge chamber formed of quartz and relatively large in cross section, and end chambers reduced in cross section and extending longitudinally therefrom, each end chamber having a lead-in conductor sealed into the end portion thereof, each conductor being thinly covered with a suitable sealing glass for a considerable distance and a relatively short bead of similar glass applied to said covered portion, each end chamber comprising a plurality of sleeves having characteristics grading from that of the quartz chamber to that of sealing glass, in order to provide a graded seal between the quartz discharge chamber and the corresponding lead-in conductor, the end of each lead-in conductor terminating in the intermediate chamber and having an inner conductor portion looped over and extending back therealong toward the point of entry, a coil of refractory wire wound around each looped-over portion, and another coil of such wire wound around a portion of each conductor in the corresponding restricted end chamber and carrying electron-emission material for starting purposes, the outer surfaces of the sleeves forming the end chambers being coated with a reflecting metal to conserve the heat therein.

18. An electric discharge device comprising inner and outer envelopes, said inner envelope having end portions restricted in diameter and extending from a larger intermediate portion, a pair of electrodes extending from said restricted portions into said intermediate portion, and between which a discharge may occur, said outer envelope having a press, a pair of conductors supported by said press and disposed one on each side of said inner envelope, and a pair of lead-in conductors extending through said press, one of said lead-in conductors being electrically connected to said pair of conductors and the other electrically connected to the adjacent electrode of the inner envelope, the ends of said pair of conductors away from said press being electrically connected to the other electrode and carrying a pair of inner envelope supports, each of which has its outer end secured to one of said conductors and its inner portion encircling one of said restricted end portions adjacent the intermediate portion.

19. An electric discharge device comprising inner and outer envelopes, said inner envelope containing a pair of electrodes extending from end portions thereof and between which a discharge may occur, said outer envelope having a press, a pair of conductors supported by said press and disposed one on each side of said inner envelope, means supporting said inner envelope from said conductors, a pair of lead-in conductors extending through said press, one of said lead-in conductors being electrically connected to said pair of conductors and the other electrically connected to the adjacent electrode of the inner envelope, the ends of said pair of conductors away from said press being electrically connected to the other electrode, and a pair of springs carried by said pair of conductors, intermediate portions of said springs being secured thereto, and the end portions of which are bent inwardly to provide convex surfaces engaging the inner sur-

face of the envelope at places spaced approximately equi-distances around the circumference thereof, for resiliently centering the inner envelope with respect thereto.

20. An electrode for a discharge device comprising conductor means carrying a laterally extending coil, and another coil with its axis angularly disposed with respect to that of said laterally extending coil, spaced therefrom, and carried by said conductor means, at least one of said coils carrying electron-emission material.

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