July 7, 1936. R. F. STRICKLAND 2,047,042

ENCLOSED ARC DEVICE

Filed Nov. 18, 1929

Fig. 1

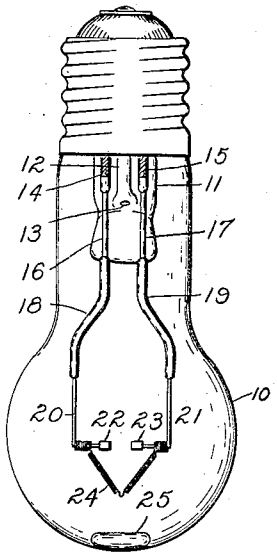


Fig. 2

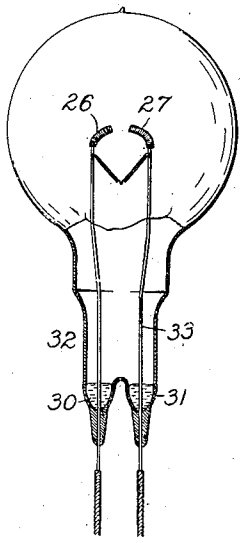


Fig. 4

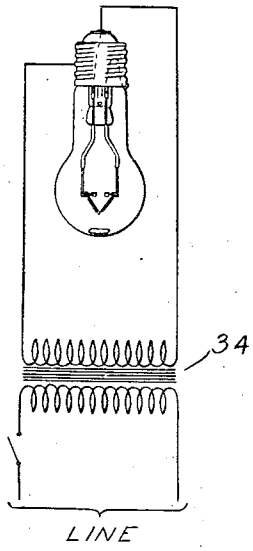
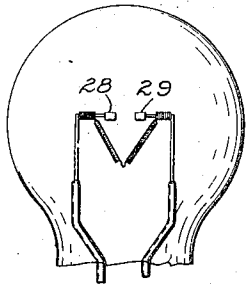


Fig. 3



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Patented July 7, 1936 2,047,042

UNITED STATES PATENT OFFICE

2,047,042

ENCLOSED ARC DEVICE

Royal F. Strickland, Cleveland Heights, Ohio, assignor to General Electric Company, a corporation of New York

Application November 18, 1929, Serial No. 407,817

12 Claims. (Cl. 176—1)

My invention relates to arc lamps of the type which comprise highly refractory electrodes sealed in a light transmitting enclosure containing an inert gas or vapor. One of the principal objects of my invention is to provide a lamp which may be started like an ordinary incandescent lamp and which does not require a complicated switch or other mechanical means for starting. Another object of my invention is to provide a lamp which will give its maximum light without substantial delay after the lamp is turned on. This application is a continuation-in-part of my application Serial No. 301,645, filed August 23, 1928, and entitled Metal electrode arc lamp.

One feature of my invention from a more specific standpoint is that there is mounted, in juxtaposition to the refractory arc electrodes, which are separated by a gap and capable of operating with a commercial length of life at a temperature of sufficiently high electron emissivity to support an arc, a filament which is connected to the inner leads of said electrodes in multiple or parallel relation to the path of the arc. The voltage should be sufficiently high to raise the filament to a temperature above 2400° K. (above 2100° C.). At that temperature the filament will emit electrons sufficiently to insure prompt starting of the arc. Moreover, the resistance of the filament should be sufficiently hign so that the voltage drop along the filament will be sufficiently above the ionizing voltage of the gas contained in the lamp to start an arc. The first arc which forms is across the filament terminals. The emission of electrons from the filament ionizes the gas and the electrodes proper are heated by bombardment until they reach incandescence and become emitters of electrons. The arc which first appeared across the filament terminals then transfers itself across the gap between the electrodes. Stated otherwise, the emission of electrons from the filament causes an ionization of gas and when alternating current is used, the electrode which happens to be an anode is heated to incandescence by electron bombardment. On the next half cycle, when the voltage is reversed, the said electrode acts as a cathode and emits electrons toward the other electrode, which is then an anode, and heats it to incandescence. Consequently two electrodes become alternately emitters of electrons and anodes and the arc consequently passes between the two electrodes instead of passing from the negative end of the filament toward each electrode. Whatever the theory, however, the fact is that the device functions as an arc lamp with no material delay after it is turned on. It is a feature of my invention that the resistance of the filament is materially greater than that of the arc during the operation of the device and the result is that only a small part of the electric energy is taken by the filament, most all of it being available for the arc.

It is preferred that the filament consist of a loop with an acute angle between the portions of the loop so that when the current is passed through the loop, the arc will strike gradually across the bight portions of the loop and travel so that it passes between the extremities and then between the electrodes.

Argon is desirable as a gas to be used as a filling in my lamp. The ionizing voltage of argon is about fifteen and the voltage drop along the filament may be as high as thirty volts, or somewhat above this, as it is desirable to have the lamp operated by a transformer which will have a comparatively high open circuit voltage. As soon as the arc starts, the ionized gas becomes such a good conductor that the arc voltage drops down below the ionizing voltage, down to eleven volts, for instance, and consequently the current is carried mostly by the arc and only to a minor extent by the filament.

It is necessary in order to obtain the best results to be careful as to the purity of materials and as to the construction and proportioning of the parts of the lamp. The metal parts should be free from oxide since oxide tends to lower the electron emission. The arc will not start unless a certain minimum electron emission is secured. The gases should also be as free as possible of oxygen and gases containing oxygen in combined form. For instance, no moisture or carbon dioxide should be present. It is also desirable that the electrodes, preferably buttons of refractory metal such as tungsten, should be placed a distance apart which is relatively small when compared with the distance between the two ends of the filament. If the electrodes are too far apart or if no buttons are used, the end of the filament which is acting as an anode is apt to rise to an excessively high temperature and melt. The preferred arrangement is with the filament below the electrodes. A loop-shaped filament is preferred in order not to have the ends separated too much from each other or the electrodes and still to have a suitable length of filament.

One of the principal uses of my invention is in the production of light containing a comparatively high proportion of ultra violet radiation. For this purpose a quantity of mercury is in-

cluded so that the mercury vapor will be formed and its radiation will be added to the light. When the enclosure, preferably a bulb, is composed of a material which will transmit a considerable portion of the ultra violet radiation below that transmitted by ordinary window glass, the radiation emitted can be made to have the characteristics of sunlight or even of the light from the quartz mercury arc lamp. Although my invention is not in any way limited to such lamps or to any particular material composing the bulb or other enclosure, I prefer to utilize glass of such a composition that it will transmit radiation in the so-called stimulating range of wave length between 3200° A. and 2900° A., but substantially no radiation below 2900° A. The light from such a lamp may have approximately the quality of sunlight which is recognized to have at least substantial disease preventing effects. Such a lamp may be operated by one of the general public with care approximating that which is taken as to sunburn. Obviously if the transmission of substantial radiation below 2900° A., which requires expert handling, is desired, a material such as quartz may be used for the enclosure.

In general, instead of mercury, other comparatively easily vaporizable materials which will not injuriously affect the lamp filament, leads or bulb may be used to obtain light of a desired quality. For instance, the alkali metals, particularly sodium or caesium, may be used with a suitable glass. In addition to the advantage in the quality of the light, the presence of these vapors, whether mercury or the others, allows the filament and electrodes, usually tungsten, to operate at a comparatively high temperature without undue vaporization.

Other features and advantages of my invention will appear from the following description of species thereof and from the accompanying drawing.

In the drawing, Fig. 1 is an elevation of a lamp embodying my invention and designed particularly for base-up operation; Fig. 2 is an elevation of a modification designed for base-down operation; Fig. 3 is a partial elevation of a lamp designed for base-down operation but with a modified electrode and filament arrangement; and Fig. 4 is a diagrammatic view showing the lamp connected in an electric circuit.

In the form shown in Fig. 1, the bulb 10 is ordinarily of glass. In order to allow transmission of light having approximately the quality of sunlight, a borosilicate glass free from lead and iron may be used. One such glass has a composition of:

	Percent
Silica	80
Boron tri-oxide	12
Alkali	6
Alumina	2

If it is desired to transmit light having a substantial radiation below 2900° A., quartz may be employed. Sealed in the bulb is a stem 11 which may be of the type disclosed in Mitchell and White Patent 1,423,956 and which comprises an exhaust tube 12 communicating with the interior of the bulb through the aperture 13. The external leads 14—15 may be of copper, nickel or other good conducting metal. They are united to the sealed-in conductor sections 16—17 which are of a material which will seal into the glass stem and therefore have a co-efficient of expansion approximating that of the glass in which they are sealed. As so-called hard glass is used, these sections are preferably composed of tungsten. The inner leads 18—19 are at least in part composed of metal such as molybdenum which will stand considerable heat. For instance, the portions 20—21 may be of molybdenum and the remaining portion of metal such as nickel. The electrodes 22—23 are preferably buttons of refractory metal such as tungsten. Connected across the inner leads 20—21 and in multiple relation to the path between the electrodes is a filament 24 of refractory metal such as tungsten. It is preferred to locate the filament below the arcing electrodes and also that the filament shall be loop-shaped and have a materially greater length than the distance between the electrode terminals. The bulb is filled with an inert gas, preferably pure argon, at a pressure of about one hundred millimeters. In order to obtain a substantial amount of ultra violet radiation, it is preferred to include a quantity of mercury 25. A getter such as cryolite may be applied to the lead tips.

In the form shown in Fig. 2, the electrodes 26—27 are of coiled refractory metal, such as tungsten, although the preferred form of electrodes is the button shown in Fig. 1. The arrangement of electrodes 28—29 shown in Fig. 3, is desirable for lamps designed for base-down operation. When the mercury or other easily vaporizable material is incorporated, the form of seal shown in Fig. 2 is preferred. In the form shown, pools of mercury are contained in depressions formed by the tubular bulb extensions 30—31. The tungsten or molybdenum leads 32—33 which are sealed in said tubular extensions serve to conduct the heat from the filament to the mercury to vaporize the same. Moreover, short circuiting is prevented by the separation of the mercury into two separate pools by the said tubular extensions.

In Fig. 4 is diagrammatically illustrated an electric circuit including the lamp of my invention. As hereinbefore stated, the starting voltage for my lamp is preferably about thirty, or somewhat above, and this falls to below fifteen volts, usually to eleven volts, when the arc is in normal operation. In order to use my lamp in the ordinary line which has a voltage in the neighborhood of 110, it is necessary to use a transformer 34. A transformer with a drooping characteristic should be used as the voltage is much higher at the start than during operation. If a suitable transformer is used, the use of energy consuming ballast resistances may be avoided. Of course where direct current is used, it will be necessary to use the ballast resistances.

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

1. An arc device comprising a container, a gas therein at substantial pressure, a pair of inner leads mounted within said container, a pair of cooperating arc electrodes separated by a gap and supported by said leads and a continuous filament connected in multiple relation with said gap and having a materially higher resistance than an arc between said electrodes across said gap, said filament being shaped in the form of a loop with an acute angle between the portions of said loop.

2. An arc device comprising a container, a gas therein at substantial pressure, a pair of inner leads mounted within said container, a pair of cooperating arc electrodes separated by a gap

and supported by said leads and a continuous filament having its extremities in line with said gap connected in multiple relation with said gap and having a materially higher resistance than an arc between said electrodes across said gap, said filament being shaped in the form of a loop with an acute angle between the portions of said loop.

3. An arc device comprising a container, a gas therein at substantial pressure, a pair of inner leads mounted within said container, a pair of cooperating arc electrodes separated by a gap and supported by said leads and a continuous filament supported entirely by said leads and having its extremities in line with said gap connected in multiple relation with said gap and having a materially higher resistance than an arc between said electrodes across said gap, said filament being shaped in the form of a loop with an acute angle between the portions of said loop.

4. An arc device comprising a container, a gas therein at substantial pressure, a quantity of vaporizable metal in said container, a pair of inner leads mounted within said container, a pair of cooperating arc electrodes separated by a gap and supported by said leads and a continuous filament connected in multiple relation with said gap and having a materially higher resistance than an arc between said electrodes across said gap, said filament being shaped in the form of a loop with an acute angle between the portions of said loop.

5. An arc device comprising a container, a gas therein at substantial pressure, a quantity of vaporizable metal in said container, a pair of inner leads mounted within said container, a pair of cooperating arc electrodes separated by a gap and supported by said leads and a continuous filament having its extremities in line with said gap connected in multiple relation with said gap and having a materially higher resistance than an arc between said electrodes across said gap, said filament being shaped in the form of a loop with an acute angle between the portions of said loop.

6. An arc device comprising a container, a gas therein at substantial pressure, a quantity of vaporizable metal in said container, a pair of inner leads mounted within said container, a pair of cooperating arc electrodes separated by a gap and supported by said leads and a continuous filament supported entirely by said leads and having its extremities in line with said gap connected in multiple relation with said gap and having a materially higher resistance than an arc between said electrodes across said gap, said filament being shaped in the form of a loop with an acute angle between the portions of said loop.

7. An arc device comprising a container, a gas therein at a pressure corresponding to about 100 mm. of mercury, a quantity of vaporizable metal in said container, a pair of inner leads mounted in said container, a pair of cooperating arc electrodes separated by a gap and supported by said leads and a filament connected in multiple relation with said gap and having a materially higher resistance than an arc between said electrodes across said gap, said filament being shaped in the form of a loop with an acute angle between the portions of said loop.

8. An arc device comprising a container, argon therein at a pressure corresponding to about 100 mm. of mercury, a quantity of vaporizable metal in said container, a pair of inner leads mounted in said container, a pair of cooperating arc electrodes separated by a gap and supported by said leads and a filament connected in multiple relation with said gap and having a materially higher resistance than an arc between said electrodes across said gap, said filament being shaped in the form of a loop with an acute angle between the portions of said loop.

9. An arc device comprising a container, a gas therein at a pressure corresponding to about 100 mm. of mercury, a quantity of mercury in said container, a pair of inner leads mounted in said container, a pair of cooperating tungsten arc electrodes separated by a gap and supported by said leads and a filament connected in multiple relation with said gap and having a materially higher resistance than an arc between said electrodes across said gap, said filament being shaped in the form of a loop with an acute angle between the portions of said loop.

10. An electric lamp comprising a closed transparent container of globular form, having therein an atmosphere of readily ionizable gases, said container having a hollow neck projecting from its top, a pair of spaced, leading-in wires depending in said neck and having their lower ends offset away from each other and having their adjacent portions insulated from each other, an incandescible filament connecting the extremities of said offset portions, and a pair of electrodes carried by said offset portions above said filament, each of said electrodes facing the other electrode and said filament having its middle portion deflected downwardly away from the arc-space between said electrodes.

11. An electric lamp comprising a glass globe containing one or more of the ionizable, chemically-inactive, atmosphere gases, a hollow integral neck projecting upwardly from the top of said globe, a glass tube sealed in the upper end of said neck and depending therein, a pair of leading-in wires sealed in the end of said tube and projecting into the interior of said globe, said wires being spaced from each other and from said walls, an incandescible filament connecting the extremities of said wires and comprising a fine refractory wire wound in a helical coil, and a pair of spaced metallic electrodes carried one by each of said leading-in wires adjacent to said filament and defining therebetween a positive-column-path, located in multiple circuit with said filament, and a small quantity of mercury inside said globe, out of contact of either said filament or said electrodes, the line joining said electrodes being substantially perpendicular to the axis of said neck, and said filament having its middle portion deflected downwardly away from said positive-column-path

12. An electric lamp comprising a closed transparent container having therein an atmosphere of readily ionizable gases, a pair of leading-in wires sealed in one wall of said container, a pair of spaced metallic electrodes inside said container and secured one to each of said leading-in wires, and a filament inside said container spaced from and connected as a shunt across said electrodes, said filament being of substantially V-shape, having one end connected permanently to each of said leading-in wires and having its apex turned away from said electrodes.

ROYAL F. STRICKLAND.

Certificate of Correction

Patent No. 2,047,042. July 7, 1936.

ROYAL F. STRICKLAND

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 15, for "3200° A." and "2900° A." read *3200 Å.* and *2900 Å.* respectively; and lines 16, 23, and 64, for 2900° A. read *2900 Å.*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 8th day of September A. D. 1936.

[SEAL]

LESLIE FRAZER,
Acting Commissioner of Patents.