June 27, 1939. J. A. M. VAN LIEMPT ET AL 2,164,183

ELECTRIC LAMP

Filed Feb. 5, 1938

Fig. 1.

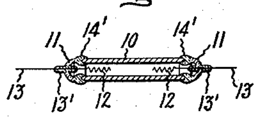


Fig. 2.

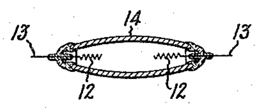


Fig. 3.

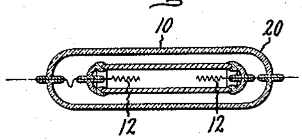


Fig. 4.

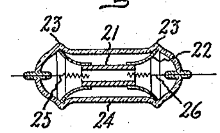
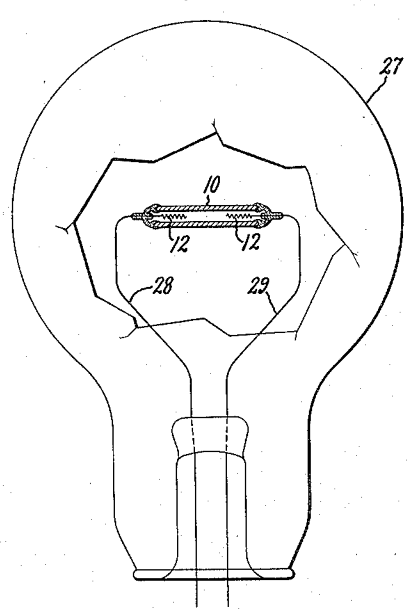


Fig. 5.



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2,164,183

ELECTRIC LAMP

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In the Netherlands February 25, 1937

4 Claims. (Cl. 176—122)

Our invention relates to electric lamps generally and more particularly to electric lamps comprising a body of refractory material which is heated to incandescence by a discharge between a pair of electrodes and has for one of its objects the provision of a lamp of this type having a high efficiency and a long useful life.

The life of an incandescent lamp with a heat resistant filament is mainly determined, for a certain load, by the evaporation velocity of the material from which the filament is made.

In the ordinary incandescent lamp, the filament is heated by a current passing through the filament. Due to the fact that the wire is not exactly cylindrical, thicker and thinner portions will be present. The thinner portions will glow at a higher temperature than the heavier ones and will consequently evaporate more rapidly. Since the evaporation velocity is approximately proportional to the 40^{th} power of the absolute temperature, it will be obvious that the evaporation of the thinner portion will be so rapid that the heavier parts will have been reduced in diameter very slightly, in practice, at the end of the life of the lamp. The evaporation coefficient (the percentage by weight of the filament which has been evaporated at the end of the life of the lamp), is only two to four per cent in the case of a standard gas-filled lamp, and consequently a relatively small value. If it should be possible to heat the filament more uniformly, for instance indirectly, then it would be possible to attain much higher evaporation coefficients so that the load of the lamp and consequently the economic features could be raised considerably.

The electric lamp according to the invention is provided with a filament of a material having a melting point preferably above 3000° K. and consists of a hollow body which forms an opaque envelope of a discharge space with such a large discharge capacity that the indirectly heated body, at least at the hottest part, radiates a total energy of a least 80 watts per square cm.

The use of the hollow, indirectly heated filament has the advantage that the temperature of the body is independent of the cross section. The body will evaporate much more uniformly over the entire surface, so that theoretically an evaporation coefficient of 100 per cent can be attained. Practically, such an evaporation coefficient cannot be realized since it will always be necessary to figure on an irregular wall thickness which will be shown by the fact that the wall will rupture locally. By means of the high evaporation coefficient it is possible to obtain a much longer life for the same load of the lamp, as compared to standard lamps, or vice-versa, it will be possible in the case of an equal life to raise the load of the lamp, that is the temperature of the filament, and consequently the economic features. The light emitted by the lamp will show a continuous spectrum.

Constructions are already known in which a discharge tube is placed in a metal body. This body is transparent or is provided with openings and its purpose is to supplement the line spectrum of the light produced by the discharge with a continuous spectrum. The metal body consequently does not form an opaque envelope of the discharge path, but rather it has the function of improving the light emitted by the discharge by means of its own glowing effect. In the present invention, the discharge serves exclusively for heating the glowing body. The light of the discharge remains entirely or almost entirely invisible.

The hollow incandescible body may have the shape of a tube, a sphere, an ellipsoid of revolution, or the like. The body may be made of tungsten or rhenium or of a carbide or nitride with a high melting point, or the like. When the body is made of tungsten, the tungsten may be deposited on a heat-proof core, of molybdenum for instance, in the gaseous phase. This can be carried out in an atmosphere of WCl_6, or WCl_6+H_2. If a core which consists of one crystal, for instance unicrystalline molybdenum, is used then the glow body provided on the core will also consist of only one crystal. Such a body will be more gas tight and will offer a higher resistance to pressures than a tube which consists of many crystals. For rhenium, methods apply which are analogous to those described for tungsten. If the glow body is to be made of tantalum carbide, then it can be made in an analogous manner by applying, in a gaseous phase, a preparation consisting of tantalum chloride, methane and hydrogen. If the body is to be made of boron nitride, then it must be pressed.

The discharge can take place in an inert gas such as argon, neon or helium or in a vapor of a metal such as mercury, thallium, lead or cadmium, or in a gas-vapor mixture.

Since the glow body during the operation of the lamp glows at a high temperature, it will be necessary to arrange it in an inert atmosphere. It is possible to use for this purpose the usual gases such as nitrogen, argon, krypton or xenon or mixtures thereof, at a filling pressure above or below one atmosphere. However, it is also possible to place the tungsten tube in a glass or a quartz vessel in which a drop or piece of a metal such as mercury or cadmium is arranged in addition to an inert gas such as argon. Upon the evaporation of the metal, an atmosphere of a high pressure will be formed in this space which greatly retards the evaporation of the tungsten.

In order to simplify the last construction, it is also possible to arrange the glow body in a discharge tube in such a way that it completely surrounds the discharge as a shield without preventing free communication between the hollow part of the glow body and the inside of the discharge tube. The use of tantalum carbide as the material for the glow body is particularly recommended in this case. If the glow body is arranged in a bulb filled with a gas or vapor having a high pressure, then it is preferable to place a second bulb around the first one. Further features and advantages of our invention will appear from the following detailed description of species thereof and from the drawing.

In thee drawing, Fig. 1 is a sectional view of a glow body according to the invention with a tubular tungsten wall; Fig. 2 is a sectional view of a glow body according to the invention which has the shape of an ellipsoid; Fig. 3 is a sectional view of a lamp according to the invention with two completely separated closed spaces; Fig. 4 is a sectional view of a lamp according to the invention which contains only one sealed space; and Fig. 5 is an elevation, partly in section, of a lamp according to the invention which is provided with the glow body shown in Fig. 1.

The glow body shown in Fig. 1 consists of a cylindrical tungsten tube 10 which at its end is sealed in a glass which is practically free from alkalies. The electrodes 12—12, which are carried by the lead-in wires 13—13, can be covered in the customary manner with a material of high electron emissivity.

Fig. 2 shows a similar glow body with the difference that the hollow body 14 has the shape of an ellipsoid of revolution. This body is also sealed in glass of a high heat resistance at its end, the leads 13—13 carrying the electrodes 12—12 extending through the glass.

The tungsten body serves as an envelope for the discharge which occurs between the electrodes and it is to be heated by this discharge so that it will glow and emit light. The light of the discharge is to be invisible or just barely visible in view of the fact that the tungsten body is entirely opaque. The discharge in this case has the function of heating the hollow tungsten body in such a way that at the hottest portions it will radiate a total energy of at least 80 watts per square cm.

If the lamp is designed for low voltages, then it is possible to fill the space enclosed by the glow body with a rare gas of a high pressure, for instance neon, argon, krypton or xenon. It is also possible to produce in this space a drop or a piece of a metal such as mercury, cadmium, thallium or lead, which vaporizes during the operation of the lamp. The main thing is that in addition to this metal a gas of a low pressure, such as argon, shall be present.

In a specific embodiment, the tungsten tube 10 in Fig. 1 has an internal diameter of 2 mm. and an external diameter of 3 mm. The length of the tube is 14 mm.; the electrodes 12—12 located therein are spaced apart 8 mm. In the glow body a drop of mercury is present as well as argon at a low pressure. In the case of an arc voltage of 30 volts and a current of 5 amperes, a vapor pressure will be formed of approximately 1 atmosphere. In the capacity of the discharge developed in that manner, a tungsten tube will radiate a mean total energy of 100 watts per square cm. over its entire area. If it is desired to obtain still higher energy radiations, it is possible to use as the heating source a mercury-vapor discharge of high pressure (for instance pressures above 10 atmospheres).

As a glass for the sealing of the tungsten electrode it is possible to use a glass that is practically free of alkalies and which has a linear coefficient of expansion lying between 10×10^{-7} and 30×10^{-7}. This glass may have the following composition:

	Per cent
SiO_2	83.1
B_2O_3	6.1
Al_2O_3	7.1
CaO	3.7

This glass is to serve for enclosing the lead-in wires 13—13 of the electrodes as indicated at 13′ (Fig. 1). It adheres very well to tungsten and is intended to assure a hermetic passage of the leads. The tungsten tube is also provided at its ends with an edge 14′ of the above-indicated glass to which the quartz 11 is then sealed.

In the lamp shown in Fig. 3, the glow body shown in Fig. 1 is sealed in the bulb 20 made of quartz or hard glass. In this case again, the above-indicated glass is used for the sealing of the lead-in wires. The space between the quartz bulb 20 and the tungsten glow body 10 may be filled with a gas that is inert to tungsten, such as nitrogen, argon, krypton or xenon, or mixtures of these gases. It is also possible to provide in this space in addition to the rare gas, a drop or piece of a metal such as mercury or cadmium. During operation, the metal will vaporize and create an atmosphere which is inert as far as tungsten is concerned.

Fig. 4 shows a lamp of a design which differs from that in Fig. 3. The glow body in this case is designed as a cylinder 21 made of tantalum carbide which is supported by means of tungsten fingers 22 in grooves 23—23 of a quartz bulb 24. At the ends of this quartz bulb tungsten electrodes 25 and 26 are introduced by means of the above-indicated special glass and are arranged in such a way that the light of the discharge toward the outside is screened practically completely by the opaque cylinder 21. The latter is to be lighted up intensively by the heating of the discharge. The space in the bulb 24 can be filled with a rare gas; it is also possible to provide in addition a drop of a metal such as mercury or one of the other above-mentioned metals.

Fig. 5 shows a lamp with a bulb 27 of standard design. Within the bulb there is provided a glow body 10 of the type shown in Fig. 1 which is supported by means of the wires 28 and 29. The bulb 27 may be filled with an inert gas such as nitrogen, argon, krypton, xenon or a mixture of these gases. In place of the glow body shown in Fig. 1 it is also possible to place in the bulb a lamp like those indicated in Figs. 3 and 4.

When the lamp is placed in operation, the danger exists that the discharge will take place partly between the electrodes and the wall of the glow body. In order to avoid this, different methods can be utilized. It is possible to cover the inside of the glow body with a refractory material such as an oxide having a high melting point, for instance thorium oxide or tantalum carbide, which has insulating properties. It is also possible to give the body the shape of an element which is convex to the outside, such as a sphere or an ellipsoid of revolution, whereby the flashover of the arc to the wall will take place less rapidly. Finally, the glow body can be made of a material which has poor electrically conducting properties, such as tantalum carbide or boron nitride.

In order to be able to connect lamps of the above-indicated design to the network or to another current source, they must be connected in the known manner in series with an impedance such as a choke coil.

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

1. An electric lamp comprising an incandescible opaque tubular envelope of highly refractory material, a thermionic electrode located at each end of said envelope, lead-in conductors connected to said electrodes and extending outwardly from the ends of said envelope, a vitreous insulating material sealing each end of said envelope and the lead-in conductor extending therethrough, an ionizable medium in said envelope, a sealed outer light-transmitting container surrounding said envelope and containing a gaseous atmosphere which is inert with respect to the material of said envelope, and means for applying a potential difference between said electrodes whereby a discharge therebetween causes said opaque envelope to be heated to a high degree of incandescence.

2. A lamp as set forth in claim 1 in which the opaque envelope consists of a highly refractory metallic material.

3. An electric lamp comprising a sealed outer light-transmitting bulb containing a light source comprising a pair of spaced electrodes and an incandescible completely opaque outwardly convex tubular body of highly refractory material surrounding the entire length of the discharge path between said electrodes, and means for applying a potential difference between said electrodes whereby a discharge therebetween causes said opaque body to radiate a total energy of at least 80 watts per square centimeter.

4. An electric lamp comprising a sealed outer light-transmitting bulb containing a light source comprising a pair of spaced electrodes and an incandescible completely opaque tubular body of highly refractory metal of a single crystal surrounding the entire length of the discharge path between said electrodes, and means for applying a potential difference between said electrodes whereby a discharge therebetween causes said opaque body to radiate a total energy of at least 80 watts per square centimeter.

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