May 2, 1939. Z. BAY 2,156,369

HIGH PRESSURE ARC LAMP

Filed Feb. 11, 1938 2 Sheets-Sheet 1

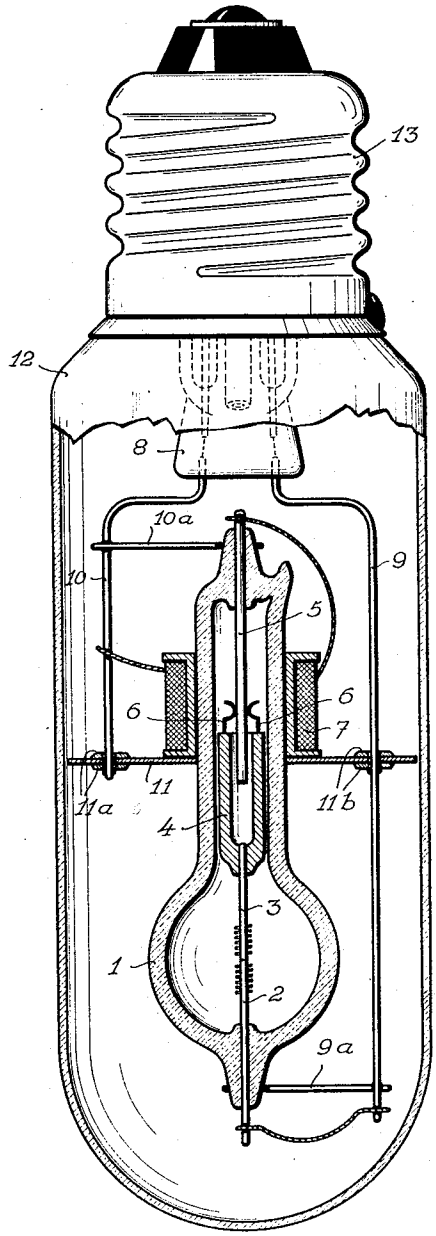

Fig. 1.

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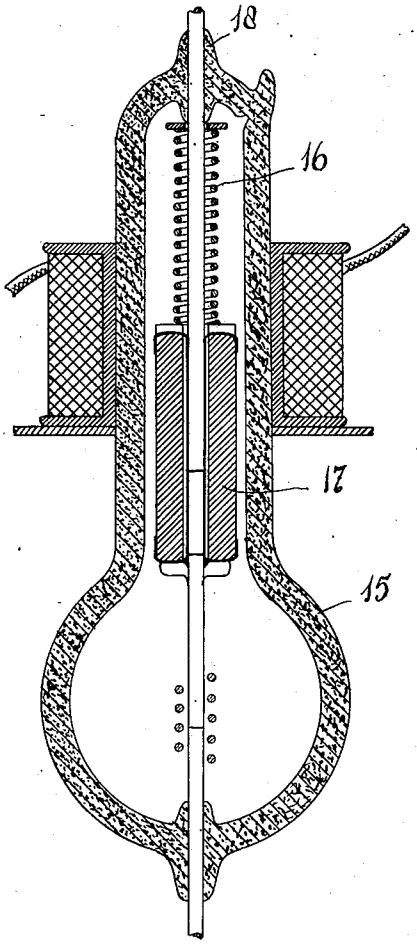

Fig. 2.

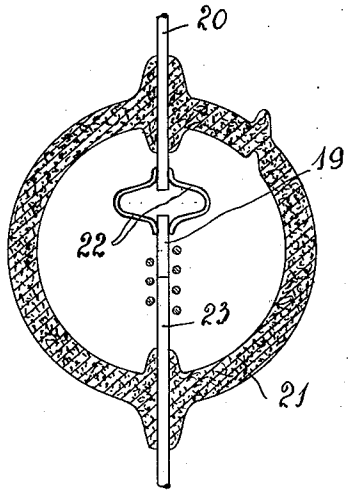

Fig. 3.

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UNITED STATES PATENT OFFICE

2,156,369

HIGH PRESSURE ARC LAMP

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Application February 11, 1938, Serial No. 189,998
In Germany December 2, 1936

5 Claims. (Cl. 176—122)

My invention relates to electric lamps and more especially to gas-filled arc lamps of the type, in which the arc forms between solid electrodes in an hermetically closed gas-filled bulb under considerable pressure above normal, the light emitted by the lamp being mainly the light of the discharge at the positive electrode, since the radiation of light of the solid electrodes is small in proportion to the light radiation of the discharge, amounting only to a small fraction of this latter.

In the lamp according to this invention the bulb is filled with a gas or gas mixture acted upon by a pressure which at room temperature, i. e., at a temperature below 50°, must not amount to less than 2 atmospheres, but is preferably much higher, amounting for instance to 5 or 8 or 15 or 25 or 50 or more atmospheres. The pressure acting on the gas in a predetermined lamp will depend on the particular use, to which the lamp is put, on the size of the lamp and also on the kind of gas in the lamp and the material of the bulb. Generally speaking the light intensity will be the greater, the higher the pressure acting on the gas.

Arc lamps with an hermetically sealed bulb containing a metal vapor, preferably mercury vapor, in which the arc is formed in a high pressure chamber, in which the operating pressure is of a similar order as mentioned above, have been put to use for different purposes in view of their high intensity of light. These lamps however involve the great drawback that owing to the unfavorable spectral composition of the light emitted by them they are not fit for general illumination purposes, for instance in buildings, unless combined with fluorescent screens, ordinary incandescent lamps and the like. These high pressure metal vapor arc lamps further involve the drawback that they operate at full intensity of light only some time after they have been cut in, for instance after about 5 to 30 minutes. The reason for this disadvantageous property of the known lamps is that they produce their full intensity of light only after having reached their normal high operating pressure. However, this operating pressure is formed for the greater part by the pressure of the mercury vapor, the pressure of the gas-filling of these lamps amounting at room temperature at the most to a few hundredths or a tenth of an atmosphere. However, at room temperature the vapor pressure of mercury ranges only at about 0.001 mm. mercury column and in order to attain the high operating pressure of several atmospheres, the entire lamp must first be heated by the discharge to the corresponding high temperature at which the high mercury vapor pressure is generated. Obviously the heating of the lamp requires some time.

It is an object of my invention to avoid these drawbacks of the high pressure metal vapor arc lamps, while retaining their high light intensity. I have found that also arc discharges in an atmosphere of permanent gases can produce high intensities of light provided that the discharge occurs under sufficiently high pressure. I have found that if the pressure acting on the permanent gas in the lamp is high, the light intensity of the discharge is high in proportion.

Now if the gas filling the bulb of the lamp is acted upon by a high pressure already at room temperature, the lamp will burn with a high intensity of light directly it has been cut in.

The gas-filled high pressure arc lamps according to this invention also involve the great advantage that the bulb is blackened far less than the bulb of a high pressure metal vapor lamp. For in lamps of this latter type, whenever they are cut in, the arc burns some time under low pressure, since, as already explained above, the inner pressure in these lamps rises only slowly. Obviously during this period of time the electrode material is disintegrated to a high extent, causing a rapid blackening of the bulb, which is known to be prevented only by high pressure, which is however not present in these lamps from the beginning. Therefore in high pressure metal vapor arc lamps the extent of blackening of the bulb depends not only from the hours of burning, but also from the number of connections. This drawback is also avoided in the lamp according to this invention, which also involves the very important advantage that by correspondingly choosing the composition and pressure of the gas-filling the spectral quality of the light emitted by the lamp can be varied within wide limits so that it is possible to produce lamps of this kind which are well-suited for general illumination purposes.

The ignition of the lamps can either be effected in a manner known per se by means of a high frequency current impulse or by interrupting the contact between the electrodes, i. e. by separating the electrodes which in the inoperative position are in contact with each other. In the latter case at least one of the electrodes must be movable and in that case is preferably coupled with a device which serves to remove the electrode from the other electrode whenever the

lamp is cut in. This removal may for instance be brought about by means of changes of form occasioned by heat expansion. The magnet field of a solenoid may for instance be excited by the lamp current itself; a bimetal strip traversed and heated by the lamp current may change its form by expansion. These two methods of moving an electrode may also be combined with each other and other means may be used for the same purpose.

I prefer filling the lamp with a rare gas or with a mixture of rare gases, but I may also fill in other gases, for instance hydrogen or a mixture of such other gases with rare gases, for instance for the purpose of influencing the spectral composition of the light. If the lamp contains other than rare gases or a mixture of such other gases with a rare gas, the electrodes must consist of a material which does not enter into a chemical reaction with the gas filling the bulb, when the lamp is under operation, since otherwise the gas or the electrode material or both would be consumed. Thus for instance, if the bulb contains hydrogen, tungsten electrodes may be used. However, as stated above, rare gases and mixtures containing nothing but rare gases have been found to be most suitable. In order to render the manufacture of these lamps easier, I prefer filling in rare gases, such as for instance argon, krypton and xenon, which can comparatively readily be liquefied.

For, if the lamp is filled with such rare gases, which are liable to be readily liquefied, I simply submerge the bulb, while its opening is not yet sealed, in liquid air, so as to cool it. While the bulb is still submerged in the liquid air, the required quantity of liquefied rare gas is filled in and the bulb, the bottom part of which is still surrounded by liquid air, is now sealed by melting. If the bulb thus prepared is then withdrawn from the liquid air, it soon assumes room temperature, whereby the liquid gas volatilizes, at the same time generating the required high inner pressure above normal.

I may however also fill the bulb with the rare gas as such under the high pressure required, and then seal the bulb extension according to some well known process, for instance as disclosed in United States Patent 1,977,671 or 2,014,471, notwithstanding the fact that at that moment the bulb is already placed under a high inner pressure.

The material constituting the bulb must be chosen in accordance with the conditions of operation of the lamp such as the consumption of energy, the pressure of the gas filling the bulb, the operating temperature, size of the bulb, etc. I prefer using bulbs made from a special glass, for instance hard glass or quartz glass. I further prefer enclosing the gas-filled bulb within an outer glass bulb, preferably of matt glass or opal glass, which is preferably also filled with a gas, for instance air or hydrogen. While it is not absolutely necessary to fill the outer bulb with a gas, its presence in the outer bulb, for instance under atmospheric pressure, is advantageous for the purpose of controlling the temperature in the inner bulb.

The electrodes preferably consist of a refractory metal, for instance tungsten, molybdenum or the like and preferably belong to the self-heating type, the electrodes as such or at least those parts of the electrodes which emit electrons being coated with or containing active material, are preferably heated directly by the heat of the discharge to that temperature which is required to obtain the electron emission.

In the drawings affixed to this specification and forming part thereof several embodiments of my invention are illustrated diagrammatically by way of example.

In the drawings:

Fig. 1 is an elevation, partly in axial section, of the first embodiment.

Fig. 2 is an axial section of a modified form of the inner bulb and

Fig. 3 is a similar view of a third form of this bulb.

Referring to the drawings and first to Fig. 1, the lamp is here shown with the socket on top and the electrodes in the inoperative position. 1 is the inner bulb, consisting of quartz glass and 2 and 3 are the two electrodes, which in the inoperative position are in contact with each other. The lower electrode 2 extends across the bulb wall. The upper electrode 3 is fixed to an iron core 4 and is movable relative to the lower electrode.

On the lamp being cut in, current will flow between the contacting electrodes, but even at the moment of cutting in the current cannot attain an injurious value, since the lamp is supplied in the usual manner by way of a stray field transformer or is connected in series with a choke coil, being of course fed with alternating current in both cases. Into the iron core 4 extends the current lead 5 having the form of a tungsten wire on which the core is arranged to slide with the aid of two contact springs 6 made of molybdenum sheet metal, which establish a good contact between the core and the tungsten lead in any relative position of the parts. To the lead 5 is connected the magnet coil 7, the other end of which is connected with the current lead 10 of the outer bulb 12. The other current lead 9 of this bulb is connected with the stationary electrode 2. The two wires 9 and 10, which also act as supports for other parts of the lamp, are fixed by melting in the glass body 8 forming part of the outer bulb and connected in the usual manner with the screw 13 and the central contact.

The bulb 1 is filled with krypton or with a mixture of krypton, xenon and argon placed under a pressure ranging between 20 and 50 atmospheres. The outer bulb is filled with air or hydrogen under atmospheric pressure.

The inner bulb 1 is held in position by wires 9*a* and 10*a*, which are connected by welding to the wires 9 and 10, respectively. The magnet coil 7 is fixed on the mica plate 11 which is mounted on the wires 9 and 10 by means of metal fixtures 11*a* and 11*b*, respectively, and also contacts with the inner wall of the outer bulb 13, thereby securing the lamp system against lateral displacement.

As shown in the drawings, all the parts are mounted on the socket of the outer bulb, so that this bulb and the socket can be assembled in the manner usual in the manufacture of incandescent lamps.

The electrodes 2 and 3 consist of comparatively thick tungsten wires, on which spirals of thinner tungsten wire are wound as usual, these spirals being coated in a well known manner with an active layer, consisting for instance of an alkaline earth compound, which is preferably deposited thereon by cataphoresis.

In the modified form of the lamp illustrated in Fig. 2 a coil spring 16 is inserted between the iron core 17 and the top end of the inner bulb

15, this spring surrounding the current lead 18. This lamp may be operated in any position.

In the inner bulb illustrated in Fig. 3 the shifting of the movable electrode is effected by the change of form, caused by heat expansion, of bi-metal strips or wires 22, which when heated by the current will suffer a change of form whereby the movable electrode 19 is lifted off the stationary electrode 23. When the lamp shown in Fig. 1 is cut in, the current flowing through the contacting electrodes 2 and 3 will be such that the magnet field generated by it in the coil 7 will immediately lift the comparatively lightweight iron core 4 so that the lamp will instantaneously be ignited. The operating current suffices to always hold the iron core 4 in the operative position, in which the end of the current lead 5 contacts with the top end of the electrode 3. As shown in the drawings the bulb wall is sufficiently spaced from the region of discharge. On the other hand the upper tubular part, surrounding and guiding the iron core 4, of the bulb exerts an excellent cooling effect, whereby in spite of the very high temperature of the discharge the operating temperature in the bulb 1 may be kept comparatively low, for instance at about 200–600° C., since in this type of lamps as contrasted with metal vapor arc lamps the high inner pressure is not based on a high temperature of the bulb. The drawings show that such a lamp, which is built up from the same parts, can also be operated in inverse position, with the socket pointing downwardly, without a spring acting on the iron core 4. To this end the unit consisting of the parts 1, 7 and 11 need only be arranged in the inverse position relative to the current leads 9 and 10, so that the spherical part of the inner bulb adjoins the part 8 of the outer bulb.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

I claim:

1. A high pressure arc lamp comprising in combination, a hermetically closed bulb, two solid refractory electrodes in said bulb and a gas filling said bulb under a pressure, measured at a temperature below 50° C. of more than 2 atmospheres.

2. The lamp of claim 1, in which the gas filling the bulb is a rare gas.

3. The lamp of claim 1 in which the gas filling the bulb is a mixture of rare gases.

4. The lamp of claim 1, in which the gas filling the bulb is a mixture of a rare gas and a gas of a different kind.

5. The lamp of claim 1, in which one electrode is movable relative to the other and able to make contact with it, when the lamp is out of operation.

ZOLTAN BAY.