July 27, 1926. 1,594,057

G. R. FONDA

ELECTRIC INCANDESCENT DEVICE

Filed August 30, 1924

Fig. 1.

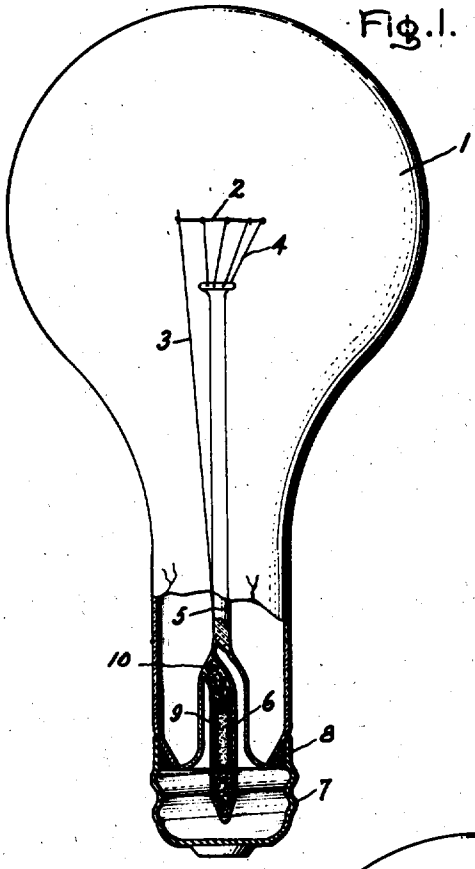


Fig. 2.

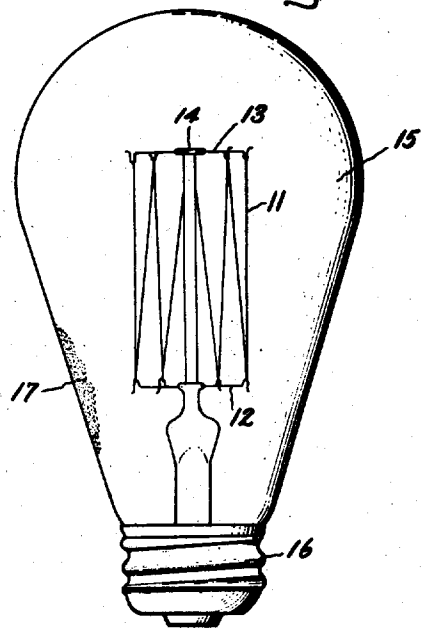
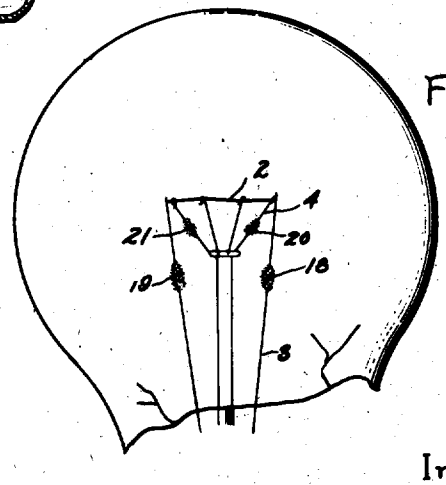


Fig. 3.



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UNITED STATES PATENT OFFICE.

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ELECTRIC INCANDESCENT DEVICE.

Application filed August 30, 1924. Serial No. 735,074.

The present invention relates to devices containing a filament or other body operating at incandescence and in particular to electric lamps containing a tungsten filament.

It is the object of my invention to increase the resistance of tungsten incandescent bodies to the disintegrating effect of high temperature operation.

In gas-filled lamps particularly, the failure of the filament is due usually to a local disintegration rather than to a uniform wasting away along its entire length. I have found upon the examination of many burned-out lamps that a displacement or slippage within the crystals of the filament had occurred, particularly near the supports. On a minute scale this displacement is analogous to the "faulting" of geological strata. This slippage of crystal planes over each other should not be confused with the "off-setting" of crystals as a whole with respect to each other. It is apparently due to this "faulting" in the crystals that in the average gas-filled lamp the lighting filament fails when its decrease of weight by volatilization is only about one-third of the average loss of weight which a filament in a vacuum lamp will withstand before failure occurs.

I have discovered that this faulting of the crystal planes in tungsten bodies at incandescence may be very substantially reduced and for a given efficiency the life of a filament will be lengthened correspondingly by introducing into the filament a small quantity of zirconium.

The zirconium alloy thus formed also has a lower vapor pressure than tungsten which does not contain zirconium. For this reason the filament can be operated with a longer average life at a given efficiency or with a higher efficiency at a given life in a vacuum lamp, as well as in a gas-filled lamp. In the latter case the improvement either in efficiency or in length of life, depending on the operating conditions, is most marked as the lower volatility of the tungsten-zirconium alloy as compared with unalloyed tungsten and the decrease in tendency to faulting in the crystal both benefit the operation of the lamp.

In my prior application Ser. No. 399,798, filed July 29, 1920, I have described the introduction of zirconium into a lighting body by a process involving the coating of a tungsten filament before its introduction into a lamp bulb with a layer of zirconium, the alloyage of diffusion of the zirconium into the interior of the filament occurring subsequently at a higher temperature. In this case the filament begins its operation in a lamp or other device with a maximum zirconium content which is gradually decreased by evaporation at incandescence.

In accordance with my present invention the zirconium as an alloying constituent is obtained from a source provided in the lamp bulb and the zirconium is introduced into the tungsten body by a different method, namely, the progressive thermal decomposition of the vapor of a zirconium compound which comes into contact with the incandescent body at low pressure, accompanied by immediate alloyage of the liberated zirconium with the tungsten. This gradual decomposition of the zirconium and the alloyage of zirconium is a process which goes on during the entire life of the lamp. The advantage of this continuous alloyage will be later explained.

The accompanying drawing shows in Fig. 1 an incandescent lamp having a hollow stem containing a zirconium compound; Fig. 2 shows a vacuum lamp containing loosely a zirconium compound and Fig. 3 illustrates a modification in which the zirconium compound is applied on a filament support.

The lamp shown in Fig. 1 comprises the usual sealed bulb 1 containing a tungsten filament 2, wound in a spiral too small and close to be here illustrated, in such way as to give the effect of a larger diameter. The filament is mounted upon anchor wires 3, 4, which in turn are carried by a glass stem 5. As shown in section at the base of the lamp, the bulb is exhausted during manufacture through a tube 6, which after exhaust is sealed off. The lamp is provided as usual with a base 7, which is cemented in place as indicated at 8.

In the tube 6 is provided a capsule 9 containing a zirconium compound, preferably the chloride, $ZrCl_4$. This capsule is introduced through the exhaust tube 6 during the manufacture of the lamp and is held in place by glass wool 10 as illustrated. The lamp contains a gas, such as argon or nitrogen at substantial pressure, say at 600 m. m. of mercury to reduce evaporation of the fila-

ment in accordance with Langmuir U. S. Patent 1,180,159, issued April 18, 1916.

As already stated the benefits of my invention are not confined to an incandescent lamp which is charged with an inert gas. Fig. 2 shows an incandescent lamp of the vacuum type in which a tungsten filament 11 is wound in zig-zag manner over two sets of anchors 12, 13 which are in turn mounted spaced apart upon a glass pedestal 14. The filament is mounted in the well known manner in an evacuated bulb 15 and is electrically connected to the contacts of an external screw base 16. Within the evacuated bulb is provided a small amount of zirconium compound which may be placed within a receptacle as shown in Fig. 1 or may be placed loosely within the bulb as shown at 17 in Fig. 2.

Other ways of locating the zirconium compound may be devised to secure the benefits of my invention. For example, as shown in Fig. 3, a small quantity of the zirconium compound together with a suitable binder may be applied as indicated at 18, 19 upon the conductors 3 serving to supply current to the filament, or as indicated at 20, 21 upon one of the anchors 4 which supports the filament. In Fig. 3 a zirconium compound has been indicated as placed upon both the anchors and the supply conductors, but the compound may be placed upon only one of these members. As a binder for the zirconium chloride or other halogen compound of zirconium, the material known as film stock, comprising a compound of cellulose, such as cellulose acetate, may be used. The zirconium compound may be present to the amount of a few milligrams. An excess is allowable as only the vapor of the compound comes into contact with the filament.

As zirconium chloride has a low vapor pressure it may be placed almost anywhere, either in a gas-filled or in a vacuum lamp, except in direct contact with the filament. When placed upon some part of the lamp having during operation a temperature not substantially higher than the temperature of the bulb, the vapor of the zirconium compound will have a pressure not substantially greater than the residual gas pressure in a first-class vacuum, that is, a pressure of less than a micron of mercury. Due to this small vapor pressure the zirconium is supplied to the filament continuously in such small amounts as to compensate for the zirconium which is lost by evaporation at the operating temperature of the filament. In other words due to the low vapor pressure of the zirconium chloride an equilibrium is established between the incandescent filament and the zirconium chloride vapor which comes in contact with it, so that a low but substantially constant content of zirconium is maintained in the filament. The zirconium content produced in the filament does not exceed a few per cent and probably less than two per cent. It is difficult to determine the exact amount in so small a mass which is losing tungsten during the life of the lamp as well as gaining zirconium.

The zirconium atoms in the tungsten appear to have a function of preventing slip of crystal planes by a "keying" action, that is the solid solution of tungsten and zirconium is formed in different parts of the crystal and the difference in atomic size of this solid solution serves as a "key" to prevent displacement of crystal planes.

The zirconium compound acts in the nature of a getter to continuously deposit on the filament in small amounts a substance (that is zirconium), which acts beneficially to maintain the filament intact when operating at incandescence, both by reducing the vapor pressure and by counteracting faulting. In devices, such as gas-filled lamps both functions are of marked benefit. The improvement in life at a given efficiency has been found to be of the order of magnitude of fifty per cent. Although described with particular reference to electric lamps my invention is applicable in general to devices in which a body of tungsten is operated at incandescence and I wish it to be understood that the accompanying claims are intended to include devices other than lamps presenting the described conditions.

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

1. An incandescent lamp comprising a sealed bulb, a tungsten filament therein, and a zirconium compound which is decomposable at incandesence located in said bulb outside of the immediate vicinity of the filament and having at the temperature prevailing at the region of location a vapor pressure not greater substantially than the residual pressure in a first-class vacuum.

2. An incandescent lamp comprising a sealed bulb, a tungsten filament mounted therein, and zirconium chloride positioned in said bulb to attain a temperature at which the vapor pressure of said compound is of the order of the residual gas pressure of a first-class vacuum.

2. An incandescent lamp comprising a bulb, a tungsten filament therein, and means for supplying zirconium to said filament during the incandescence thereof in such measure that a zirconium content not exceeding a few per cent is maintained in said filament during the life of the lamp.

4. The method of preserving a tungsten incandescent body when operating at temperatures at which volatilization is substantial which consists in supplying into contact with said body the vapor of zirconium chloride at a pressure not substantially high-

than the residual gas pressure of a first-ass vacuum.

5. The method of reducing the volatiliza-on of a tungsten filament in an incandes-nt lamp which consists in continuously pplying zirconium to said filament while candescent at such rate that the zirconium ntent of said filament is maintained no reater than a few per cent.

6. The method of reducing the volatiliza-on and crystal faulting of a tungsten in-candescent body in a lamp containing an inert gas at substantial pressure which consists in operating said body in contact with the vapor of zirconium chloride at a pressure corresponding to the vapor pressure of said compound at substantially the operating temperature of the lamp bulb.

In witness whereof, I have hereunto set my hand this 28th day of August, 1924.

GORTON R. FONDA.