Nov. 29, 1949 R. K. BRAUNSDORFF 2,489,261

METALLIC FILAMENT INCANDESCENT ELECTRIC LAMP AND THE MANUFACTURE THEREOF

Original Filed Feb. 29, 1944

Fig. 1.

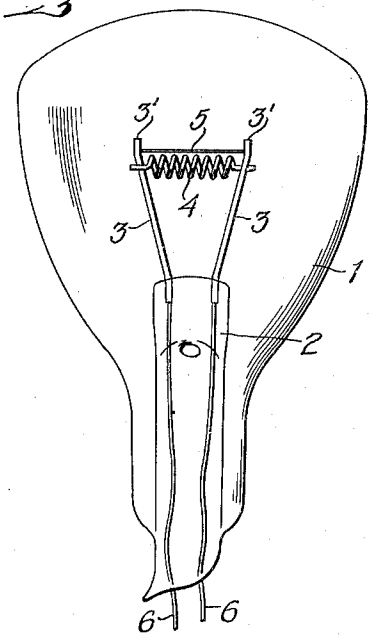


Fig. 2.

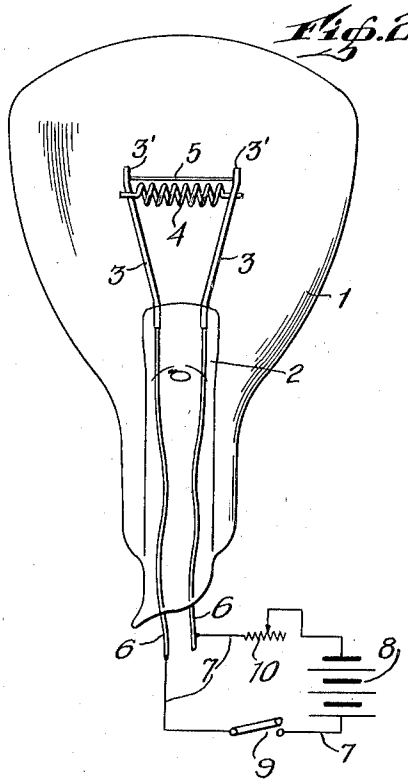


Fig. 3.

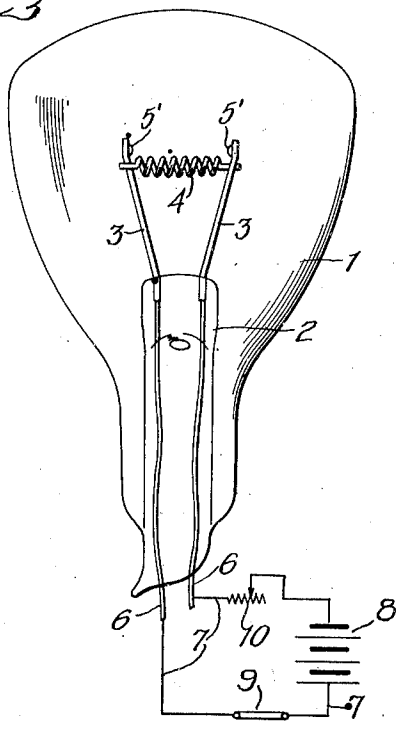
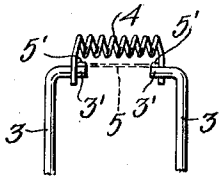


Fig. 4.



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METALLIC FILAMENT INCANDESCENT ELECTRIC LAMP AND THE MANUFACTURE THEREOF

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Continuation of application Serial No. 524,385, February 29, 1944. This application April 15, 1948, Serial No. 21,276

11 Claims. (Cl. 176—16)

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This invention relates to tungsten incandescent lamps and the manufacture thereof.

It is known that zirconium in the form of a powder, paste or the like is useful in evacuated envelopes used for incandescent lamps as a getter for absorbing residual gases remaining after evacuation of the envelope or evolved during the operation of the electric device. In my application Serial No. 480,438, filed March 25, 1943, abandoned October 11, 1945; and application Serial No. 621,047 filed October 8, 1945, Patent No. 2,444,423 issued July 6, 1948; and application Serial No. 621,046 filed October 8, 1945, Patent No. 2,462,837 issued March 1, 1949, I have set forth the use of solid zirconium metal as a getter material in several forms.

I have now found that the getter action may be substantially improved by volatizing zirconium in the sealed envelope by burning out or flashing a metallic wire of zirconium connected across the terminals of the tungsten filament and disposed in the vicinity of the filament. The momentary arc resulting from the flash apparently combines the residual oxygen and nitrogen which may be present with the zirconium and the zirconium metal apparently has the property of absorbing its own oxides and nitrides into molten or metallic form, thereby offering new metallic surfaces for further getter action. The getter action produced by the flash of the zirconium metal is so pronounced in some cases as to render less important the obtaining of the usual high vacuum prior to seal off. For example, envelopes cleaned up in this fashion having original air content at atmospheric pressure would later on high voltage ionization test, show satisfactory degree of exhaust, indicating combination of the zirconium with the oxygen and nitrogen present in the atmosphere sufficient to avoid the necessity of the usual evacuating or high evacuating step.

One object of the invention therefore is the volatilizing or flashing of zirconium metal in the manufacture of the incandescent lamp as below set forth.

A further object of the invention is the utilization of two distinct phases in the getter action by the use of zirconium metal, one phase being the initial flash to combine the gases in the arc or vaporization condition of zirconium followed by the second phase or prolonged getter action from the residue material remaining after the flash of the zirconium within the intense heat range of the filament.

For a better understanding of the invention

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reference may be had to the accompanying drawings wherein—

Figs. 1, 2 and 3 illustrate steps in the manufacture of a miniature incandescent lamp according to the invention; and

Fig. 4 shows a slightly modified form of filament mount.

Referring to the drawings, I have chosen for illustrating the invention the application thereof to miniature incandescent lamps. Figs. 1, 2 and 3 show three different steps in the manufacture. The lamp embodies the conventional envelope 1 containing a conventional press 2. Mounted in the press 2 are two conventional support wires 3 carrying a conventional filament 4 as, for example, the major filament of a double filament headlight lamp. The support wires 3 project up above the filament 4 and across the ends 3' is fastened a wire 5 of zirconium. Fig. 2 illustrates the connection of the leads 6 to an electric supply circuit 7 with a source of direct current 8 supplying the circuit 7, such for example as a battery. A switch 9 is shown in the circuit 7 for connecting and disconnecting the leads 6 across the supply circuit. At 10 is shown a conventional resistance in one side of the circuit 7 for controlling the voltage applied to the filament 4 and the zirconium wire 5. Fig. 3 illustrates a third step in the manufacture of the incandescent lamp wherein the zirconium wire is burned out or flashed out and caused to be balled back into solid getter material 5' on the support wires.

The connection of the zirconium wire across the leads of the filament provides a simple and inexpensive way of practicing the zirconium flashing step in the manufacture. The zirconium wire may be burned or flashed out before the filament 4 reaches an oxidizing temperature but this has the disadvantage among others, that the zirconium flash would be expected to absorb by almost instantaneous arc condition the gas residue and therefore that getter action is expected in too short a period of time and the further disadvantage that the flash would tend to volatilize and splash metallic vapor over on the comparatively cold tungsten filament which is not desirable because of its tendency to combine to form zirconium tungstate. An alternative is to choose the zirconium wire of a size and length such that both the zirconium section 5 and the filament 4 are simultaneously brought up to a lighted condition. The lighting of the lamp filament in itself will prevent deposit of any zirconium vapor metal on the filament surface. By choosing the correct diameter of the zirconium wire it can be arranged

that the zirconium wire will fail, that is, flash or burn out at a current value under that of the filament wire 4. This provides two sources of heat for driving out residual gases from the leads and these gases are slowly combined or absorbed during the period of lightup. Even with the presence of air in the bulb, the zirconium flash or arc appears to absorb the same prior to any appreciable oxidation of the filament 4. This is a function of wire size and may be carefully controlled during mounting. This method of lamp manufacture where the zirconium wire is flashed prior to or after the filament 4 reaches an oxidizing temperature contributes toward a higher lamp quality. A pre-oxidation of secondary metal in the bulb is obtained and residual atmospheric air is cleaned up, preparing the lamp for the regular burning of the main filament throughout the normal life of the lamp. Moreover, there is no evidence of deposit on the bulb walls and the arcing and volatization of the zirconium does not produce any silvering action. Zirconium has a relatively high melting point, namely above that of the nickel leads 3 but under that of the tungsten filament 4 and as above pointed out, the zirconium functions in the manner indicated to produce the highly useful results obtained. The solid zirconium remaining at the ends of the wire 5 after flashing and the solid material resulting from the flashing of the wire and the combination of the residual gases with the volatilized zirconium remain after the flash as protuberances or balls 5' to carry on the getter action during the normal life of the lamp. It is observed that the solid zirconium and zirconium alloy material 5' are in close vicinity to the heated filament 4 and therefore in the hottest part of the bulb which is the most satisfactory relationship existing for continued satisfactory getter action.

In Fig. 4 is illustrated a slightly different form of filament and mount wherein the upper ends 3' of the nickel lead wires 3 are turned inwardly towards each other and the filament 4 is mounted above the inwardly turned ends 3' of the wires. The zirconium wire 5 in this case, as shown in dotted lines, is originally connected directly across the inwardly turned end lead tips 3'. This provides the shortest practical length for convenience and low cost of wire and also positions the wire in the most favorable position to secure the further getter action. It also minimizes the voltage required to arc out this bridging or short-circuiting zirconium wire 5 to obtain the solid residual getter material 5'. In both the modifications I have shown the zirconium wire as a straight wire connected directly across the tip ends of the lead wires but it is understood that the zirconium wire may be caused to assume any suitable shape as for example, a small U shape so as to avoid interference at welding.

I have obtained particularly good results by so choosing the zirconium wire 5 with respect to the filament 4 as to cause the lighting of the filament 4 prior to the burn out or flashing of the zirconium. For example, with the full filament voltage of 6 volts I have provided a zirconium wire 5 which flashed out at around about 4½ volts, at which voltage the filament 4 was burning dimly at the time the burn or flash out occurred. There was no damage to the filament 4 during the time that the zirconium wire was incandescent and the voltage went up to the normal 6 volts as determined by the supply circuit 7 and the resistance regulator 10.

By the use of this method in the manufacture of the incandescent lamp bulbs it is unimportant whether high vacuums are initially obtained by the usual evacuating apparatus since the zirconium flash or arc appears to dispose of any air which is trapped inside the sealed bulb or tube. For example, an incandescent lamp, though not initially evacuated, was in effect evacuated by the flashing or arcing of the zirconium wire inside the bulb, and the lamp even with no initial evacuation gives satisfactory results. By the use of the invention imperfect evacuations are rendered harmless and it is not essential to obtain high vacuums.

This invention may be applied to other types of bulbs of the gas-filled or evacuated type wherein a high chemical purity is desired. It is also applicable to electric bulbs having various types of metallic supporting leads and electrodes, as for instance, leads of nickel or platinum sheathed leads. By introducing a piece of zirconium wire in or about the operative or heated portion of the bulb and across the terminals thereof, the flashing operation will cause part of the zirconium wire to provide the getter action, while the remaining parts of the zirconium wire will ball back on the leads to which they are attached. Since these zirconium parts or balls remain in the vicinity of the operative portion of the bulb, they act as a sponge to absorb residual gases that might destroy the chemical purity within the bulb. By using zirconium wire of the order of five thousandths of an inch thick, it is possible to obtain zirconium globules or balls ranging from .010 to .015 inch on the electrodes.

The degree of getter action obtained by flashing zirconium wire in an evacuated or gas-filled bulb wherein the remaining portions of the zirconium remain in the vicinity of the operative part of the bulb, is quite pronounced. For example, starting with an atmosphere of air in the tube sufficient getter action was obtained to maintain a clear bulb during the burnout period and with a reduced degree of burning intensity adequate getter action may be obtained throughout the entire life performance of the tube. On the assumption that air content is 80% nitrogen and 20% oxygen, I found that the zirconium would meet and sustain this gas condition without providing excessive oxidation or blackening. As above pointed out, the zirconium metal has the property of absorbing its own nitrides and oxides into molten or metallic form, thereby offering new metallic surfaces for further getter action and tubes cleaned up in this fashion having original air content at atmospheric pressure would later test satisfactory indicating the elimination of the oxygen and nitrogen present in the atmosphere by combination with the flashing volatilized zirconium. Tubes made in this manner have a satisfactory degree of exhaust.

The initial flashing of the zirconium getter wire as above set forth results in an initial clean-up of oxide residue, forming stable oxides of zirconium which in the final form is non-reactive. Dependent on the amount of oxide present zirconium oxide will be formed to the degree of first combustion and thrown off immediately on the glass walls of the bulb or envelope as a stable oxide. As a zirconium oxide it will be less blackening than normal discoloration of the envelope due to the burning of the tungsten filament. This invention has the further advantage of leaving a substantial quantity of unconsumed

or excess zirconium metal attached to the leads near the tungsten filament, namely in a high temperature zone which will continue to provide gettering action. By being so disposed on the supporting leads by the flashing operation at a point where the temperature of the zirconium reaches a minimum of 400° C. and above, we accomplish absorption of residual gases slowly given off by the leads. Co, CO_2 and H_2 and other gases are probably present within the nickel structure. With the continued burning of the tungsten filament and associated heating of leads these gases are slowly given off to contaminate either the vacuum or argon-filled atmosphere that is intentionally introduced into the lamp bulb. Since it is desired to retain the high chemical purity of the argon gas alone, it is important to absorb any residual gases that may destroy this purity of atmosphere. Forming zirconium oxide results in a stable salt, while the excess of zirconium metal acts as a sponge to take up residual gases. The invention can be practiced in a manner to provide sufficient excess zirconium on the leads in the hot zone to last the entire life of the tungsten filament. In order to get adequate functioning it is necessary to mount the zirconium structure or wire which is flashed in the high temperature zone where the excess or balled up zirconium is subject to continued heating.

The invention has marked utility in evacuated envelopes wherein the getter wire and deposit may be melted in a hot zone which is subjected to a temperature high enough to cause the getter to act as a sponge in the absorption of the deleterious gases evolved during the normal life of the envelope with the flashing out of the filament wire also taking place in the high temperature zone.

By lighting the filament and the getter wire together and then flashing out the getter wire, the metallic vapor produced by the flashing out process is not deposited on the filament.

While I prefer zirconium as the getter of which the wire is made, the invention has some utility with other getter metals and particularly metals from the same family as zirconium such, for example, as tantalum.

This application is a continuation of my application Serial No. 524,385, filed February 29, 1944, abandoned April 17, 1948.

I claim:

1. The method of gettering an incandescent lamp having a metallic filament comprising the steps of mounting a getter wire in close proximity to the filament for electrical energization, energizing and lighting and flashing out the getter wire and preventing the deposition of vaporized getter wire on the filament during the flashing out by simultaneously lighting the filament and the getter wire.

2. The method of gettering an incandescent lamp having an unshielded metallic filament comprising the step of mounting a getter wire in close proximity to the filament for electrical energization, energizing and lighting and flashing out the getter wire and preventing the deposition of vaporized getter wire on the filament during the flashing out by simultaneously lighting the filament and the getter wire.

3. The method of gettering a metallic filament incandescent lamp comprising connecting a wire of a gettering material across the filament terminals in the lamp and in close proximity to the filament, passing an electric current through

the filament and zirconium to bring them to a lighted condition and then burn out the wire to getter the lamp, said lighting of the filament and zirconium prior to the burning out of the latter preventing the deposition of getter material on the filament.

4. The method of gettering an incandescent lamp having a metallic filament comprising the steps of mounting a zirconium getter wire in close proximity to the filament for electrical energization, energizing and lighting and flashing out the getter wire and preventing the deposition of vaporized getter wire on the filament during the flashing out by simultaneously lighting the filament and the getter wire.

5. The method of gettering a metallic filament incandescent lamp comprising connecting a getter wire of zirconium across the filament terminals in the lamp and in close proximity to the filament, passing an electric current through the filament and zirconium to bring them to a lighted condition and then burn out the wire to getter the lamp, said lighting of the filament and zirconium prior to the burning out of the latter preventing the deposition of getter material on the filament.

6. The method of gettering a metallic filament incandescent electric lamp which comprises the steps of connecting a wire of a getter metal directly across the terminals of the filament and at points closely adjacent the filament and then passing sufficient current through the getter wire to burn out and flash the same with the ends of the getter wire balling up at the filament terminals to leave thereon a gettering material which continues its gettering function during the normal life of the lamp.

7. The method of making and gettering an incandescent lamp which comprises the steps of connecting a wire of zirconium and the like across the terminals of the lamp immediately adjacent to the filament and burning out and flashing said zirconium wire, said wire being volatilized while the filament of the lamp is heated to a temperature below the oxidizing temperature.

8. The method of making and gettering an incandescent lamp which comprises the steps of connecting a wire of zirconium and the like across the terminals of the lamp and burning out and flashing said zirconium wire, the filament of said lamp glowing at the time the zirconium wire is burned out whereby part of said zirconium combines with the oxygen residue to initially clean up the lamp by forming stable oxides of zirconium and the remainder of said zirconium attached to the terminals of the lamp and subjected to a minimum temperature of 400° C. operates to absorb residual gases contaminating the atmosphere during the life of the lamp.

9. The method of making and gettering an incandescent lamp which comprises the steps of connecting a wire of zirconium and the like across the terminals of the lamp and burning out and flashing said zirconium wire, said zirconium wire upon being burned out balling up upon the terminals to leave a continuing gettering material.

10. The method of making and gettering an incandescent lamp which comprises the steps of connecting a wire of zirconium and the like directly across the terminals of the lamp for energizing the filament and burning out and flashing said zirconium wire, said zirconium wire being closely positioned to the filament of the

lamp and upon burning out balling up at the terminals to leave thereon a continuing gettering material to continuously absorb contaminating gases given off by the metallic members in the lamp during the life of the lamp, and said flashed portion of the zirconium wire combining with the remaining oxygen in the lamp to form stable zirconium oxides.

11. The method of making a sealed envelope having electric terminals therein and a filament across said terminals which comprises the steps of connecting across said terminals at a point adjacent the filament a wire containing a getter material and flashing and burning out said wire while the filament is heated to a point below the normal operating temperature.

REGINALD K. BRAUNSDORFF.

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