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INCANDESCENT LAMP

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This invention relates to incandescent lamps and more particularly to incandescent lamps employing a refractory filament of tungsten or the like.

It has been known for some time that ordinary tungsten filament lamps show a marked decline in luminous efficiency during life, and after a certain length of time the luminous output is reduced to such an extent as to render the lamp undesirable as a light source. One of the causes of this decline in luminous efficiency is that the tungsten which is evaporated from the filament during the burning of the lamp, condenses on the inner surface of the bulb and forms a relatively poor light transmitting film. Various expedients in the form of chemical getters and the like have been proposed as a remedy for this condition. While these prior chemical agents may have, to a certain extent, tended to prevent the formation of the non-transparent film of tungsten, they have at the same time introduced other conditions which more than offset the gain in transparency. Thus most of the proposed chemicals have such a high vapor pressure as to cause deleterious reaction with the filament when the lamp is being used. Other types of chemical getters for this purpose, tend to attack the glass and to release gases which react deleteriously with the filament, while other proposed agents have such an initial light absorption characteristic as to reduce the initial luminous efficiency of the lamp.

Accordingly, it is one of the principal objects of this invention to provide a tungsten filament incandescent lamp with a specially chosen chemical means to maintain the luminous efficiency.

A feature of the invention relates to an improved method of maintaining the luminous efficiency of a tungsten filament lamp by providing the inner surface of the lamp bulb with a coat of a material which has initially a substantially negligible light absorption power and which during the life of the lamp reacts with the evaporated tungsten to prevent the latter from forming a layer of appreciable light absorbing power.

Another feature relates to the use of a material of low vapor pressure for coating the inside surface of a tungsten filament lamp bulb to maintain the luminous efficiency thereof.

A further feature relates to a coating material which maintains the luminous efficiency of a tungsten filament lamp and which reacts with the evaporated tungsten to form a gas which itself has gettering powers.

A further feature relates to the method of manufacturing lamps, radio tubes and the like employing a specially chosen reversible getter for water vapor. In accordance with this feature the getter is so chosen that it is effective in one direction at the temperature at which the lamp or tube is ordinarily processed on the usual automatic lamp or tube making machine, and is effective in the reverse direction at the normal operating temperature of the lamp or bulb.

A still further feature relates to a method of manufacturing tungsten filament lamps or tubes by employing a specially chosen anti-discoloration material for preventing the deposition of a discoloring film of tungsten on the inner wall of the lamp or bulb, in conjunction with a specially chosen reversible getter for cooperation with the anti-discoloration material.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detailed descriptions and the appended claims.

In carrying out the above-noted and other features of the invention, I have found that certain inorganic salts, such for example as sodium carbonate, potassium hydroxide, and potassium nitrate, preferably the latter, possess the property of being able to absorb or dissolve the tungsten evaporated from the usual incandescent filament without forming a film having appreciable light absorption. In accordance with the invention, therefore, the inner surface of the lamp bulb is provided with a coating of one or more of these chemicals, and while any well-known coating process may be employed, preferably the chemical is applied by spraying. Preferably also the material is applied in such a thin and uniform coat as to be substantially completely transparent. Thus 10 grams of potassium nitrate may be dissolved in 500 cc. of distilled water and the solution sprayed on to the inner surface of the lamp bulb. The spray may, if desired, be confined to any particular part of the lamp wall as disclosed for example in Patent No. 1,999,014. The sprayed bulb may then have the usual tungsten filament mounted therein and may be provided with a filling of nitrogen or other inert gas or gases. By employing a bulb coating of potassium nitrate as above described, I have found that the average lumen output of a coated lamp of a given size and rating may be increased by at least 12.8 per cent over the ordinary uncoated lamp. In one particular lamp having the bulb provided

with 0.05 gram potassium nitrate, it was found that after 1000 hours, burning at rated voltage, there was a reduction in luminous output of approximately only 5% as compared with a reduction of approximately 17.5% for the uncoated lamp.

I have found that the use of potassium nitrate in the quantity above specified does not materially affect the initial light transmitting power of the bulb. The average reduction in light transmitting power of the coated bulb is found to be less than 1.0%. Thus the normal or uncoated bulb had a light transparency of approximately 98.4%, while the coated bulb had a light transparency of approximately 97.7%. While I do not wish to be limited to any particular theory as to the improvement in luminous output, probably the tungsten that is evaporated from the filament dissolves or reacts with the coating of potassium nitrate in accordance with the following equation:

$$2KNO_3+W=K_2WO_4+NO_2$$

In accordance with this equation it is possible to calculate the amount of potassium nitrate required to effect the necessary dissolution or reaction with the evaporated tungsten to prevent forming of a brownish or otherwise non-transparent film. Thus in the case of a tungsten filament in the form of a 6000/20 coil, approximately 0.1 gram of potassium nitrate would be required to dissolve approximately 5% of the weight of the filament. Furthermore the NO_2 gas that is liberated is probably in itself effective as a getter for the deleterious gases and vapors that may be liberated during the life of the lamp. In any event, I have found that the use of potassium nitrate has the following characteristics which render it peculiarly suitable for the purpose of preventing discoloration by the evaporated tungsten:

1. Low light absorption initially.

2. Low light absorption of the compound or solution formed with the deposited tungsten.

3. Formation of the tungsten compound or solution at the normal operating temperature of the lamp.

4. The vapor pressure of the potassium nitrate is so low that at the normal operating temperature of the lamp, the vapors of the nitrate do not attack the filament.

While potassium nitrate is the preferred type of coating material, sodium carbonate and potassium hydroxide have been found useful for the purposes described.

Lamps containing a coating of potassium nitrate or other similar discoloration preventing material cannot be satisfactorily exhausted on standard high production gas filling machinery because of the difficulty of completely eliminating the water vapor from the coating material during the short time normally allowed for exhaust on such lamp machines. This difficulty may be overcome by baking the lamps at a temperature of 450 to 500° C. for approximately 10 minutes. This baking procedure is, however, slow, thus adding unduly to the cost of the lamp. I have found it desirable, therefore, in carrying out the procedure described hereinabove on the usual automatic exhaust schedule to provide a specially chosen material which is capable of getting any water vapor which may be released during the life of the lamp or tube. In accordance with the invention, this material should preferably have the property of being reversible so far as the acquiring and release of water vapor is concerned. I have found that this material should be of such a nature that it is capable of releasing substantially all its water vapor during the normal automatic exhaust schedule, and is capable of reacquiring undesirable water vapor at the normal operating temperature of the lamp or bulb. During the usual exhaust or flushing schedule the bulb is usually heated to about 450 to 550 degrees centigrade, whereas during life the normal operating temperature is about 125 degrees centigrade, I have found that one of the materials which is eminently suitable to exhibit the desired reversibility at these temperatures is calcium hydroxide. While calcium hydroxide is preferred, other similar reversible getters such as magnesium or barium perchlorates $(MgClO_4)_2$ and $Ba(ClO_4)_2$ respectively or lithium hydroxide or strontium hydroxide or barium hydroxide are useful for this purpose. The particular reversible getter which is chosen should preferably be correlated to the temperature of the exhaust or flushing operations and to the normal operating temperature of the lamp. Calcium hydroxide is particularly suitable because the vapor pressure of the released water vapor at the normal exhaust or flushing temperature of the bulb is quite appreciable but becomes substantially negligible at the normal operating temperature of the bulb. However, strontium and barium hydroxides may be used in certain cases.

The cycle of operations in the use of the reversible getter described is believed to be as follows. A small amount of the calcium oxide or hydroxide is placed in the bulb, preferably although not necessarily, on the inner surface thereof. If the oxide is used, it is quite probable that some of it will change to the hydroxide because of exposure to the atmosphere. However, during the process of exhausting the bulb or during the process of flushing the bulb with gas, the bulb is heated to a temperature of between 450 and 550 degrees centigrade, and small amounts of the hydroxide are substantially completely decomposed into the corresponding oxide and water, the latter being carried away by the flushing gas, or flowing into the exhaust line in the case of a vacuum lamp or bulb. This oxide is then capable, during the life of the lamp, of combining with any water vapor that may be released either from the parts of the lamp or from the anti-discoloration material described hereinabove. Since during the normal use of a lamp or bulb the temperature does not rise very much higher than 125 degrees centigrade, the oxide is capable of getting and retaining the water vapor.

The use of calcium hydroxide in the manner described has been found very effective in connection with the use of the potassium nitrate anti-discoloration material. It has been found for example, that a standard gas-filled lamp, the inner surface of which was coated with potassium nitrate when baked, flushed, and filled on a standard lamp making machine had its normal life lengthened approximately 400% by the incorporation of this getter material. By the expression "reversible water vapor getter" as employed in the claims is meant a compound or compounds such as described hereinabove and having the property of releasing water vapor when subjected to the temperatures employed during the usual automatic exhaust schedule of the lamp, and of again taking up either the original released or other water vapor in its vicin-

ity at the usual operating temperatures of the lamp.

What I claim is:

1. In combination a normally transparent lamp envelope, a tungsten filament mounted within said envelope, a coating of potassium nitrate on the inner wall of said envelope said coating being of sufficient thinness as to be substantially wholly transparent, and a reversible water-vapor getter mounted within said envelope said getter being continuously effective during the life of the lamp.

2. In combination a normally transparent lamp envelope, a tungsten filament mounted within said envelope, a coating of material on the inner surface of said envelope said material being substantially wholly transparent and capable of reacting with the evaporated filament material to maintain the light transmitting power of the envelope, and a quantity of a reversible water-vapor getter on the interior of the envelope.

3. The method of manufacturing a tungsten filament lamp which includes the step of applying to the inner wall of the enclosing envelope a material of sufficient thinness as to be substantially wholly transparent and capable of reacting with the evaporated tungsten to maintain the transparency of the envelope, also applying a reversible water-vapor getter inside the envelope, subjecting the envelope to baking and exhaust, and subsequently sealing off the envelope.

4. The method of manufacturing a tungsten filament lamp which includes the steps of spraying potassium nitrate on the inner wall of the lamp envelope, applying a quantity of a reversible water vapor getter within the envelope and exhausting and baking the envelope to drive out the water content of the nitrate, and subsequently sealing off the envelope.

5. The method of manufacturing a tungsten filament lamp which includes the steps of applying potassium nitrate to the inner surface of the lamp envelope, applying a quantity of a reversible water vapor getter within the envelope, baking and exhausting the envelope, and subsequently sealing off the envelope.

6. The method of manufacturing a tungsten filament lamp which includes the steps of coating the inner surface of the lamp envelope with potassium nitrate, introducing a reversible water vapor getter within the envelope, baking the envelope to drive out any water vapor in the getter, removing from the envelope the water vapor released by the getter, and then sealing off the envelope.

7. In combination, a normally transparent sealed lamp envelope, a tungsten filament mounted within said envelope, a coating of material on the inner surface of said envelope, said material being substantially wholly transparent and capable of reacting wtih the evaporated filament material to maintain the light transmitting power of the envelope, and a quantity of a reversible water-vapor getter comprising an oxide of an alkaline earth metal on the interior of the envelope.

8. In combination, a normally transparent sealed envelope, a tungsten filament mounted within said envelope, and a transparency-preserving coating on the inner wall of the envelope comprising an intimate mixture of potassium nitrate and a reversible water vapor getter including calcium oxide.

9. The method of manufacturing a tungsten filament lamp which includes the steps of applying a coating of potassium nitrate to the inner wall of the lamp envelope, applying a quantity of calcium hydroxide within the envelope, exhausting the envelope, and baking the envelope at a temperature of the order of 500 degrees centigrade for approximately five to ten minutes, and subsequently sealing off the envelope.

10. In combination, a light-transmitting lamp envelope, a tungsten filament mounted within said envelope, a coating of material on the inner surface of said envelope, said material being substantially wholly transparent and capable of reacting with the evaporated filament material to maintain the light transmitting power of the envelope, and a quantity of a reversible water-vapor getter on the interior of the envelope.

11. The combination of claim 10 in which the lamp envelope is normally translucent.

12. In combination, a sealed, light-transmitting lamp envelope, a tungsten filament mounted within said envelope, and a coating on the inner wall of the envelope comprising an intimate mixture of potassium nitrate and a reversible water-vapor getter of the calcium oxide type.

13. The combination of claim 12 in which the lamp envelope is normally translucent.

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