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 IODINE-CONTAINING ELECTRIC INCANDESCENT
 LAMP WITH HEAT CONSERVING ENVELOPE
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3,209,188

FIG. 1.

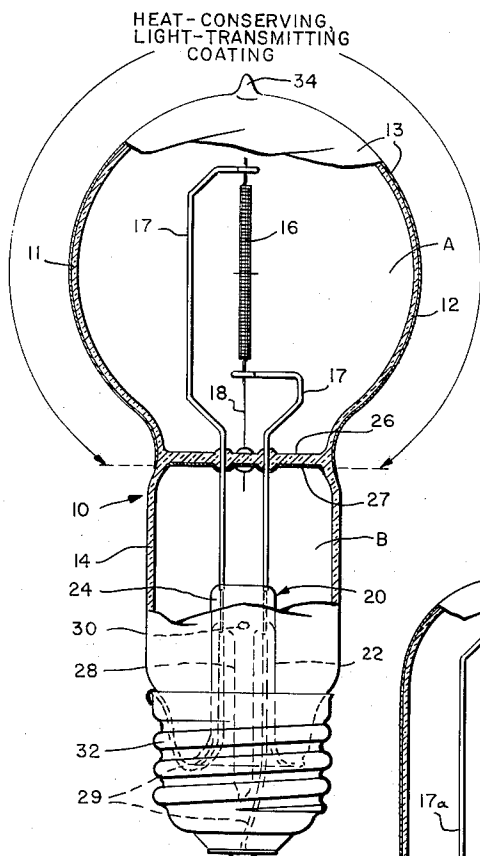


FIG. 2.

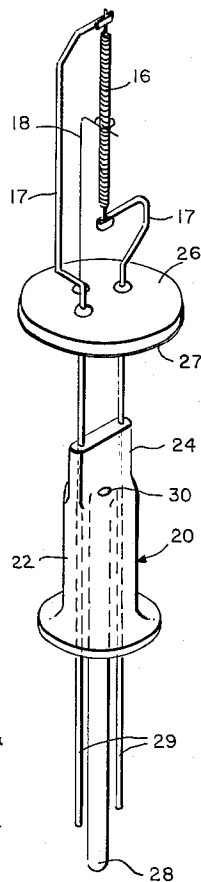
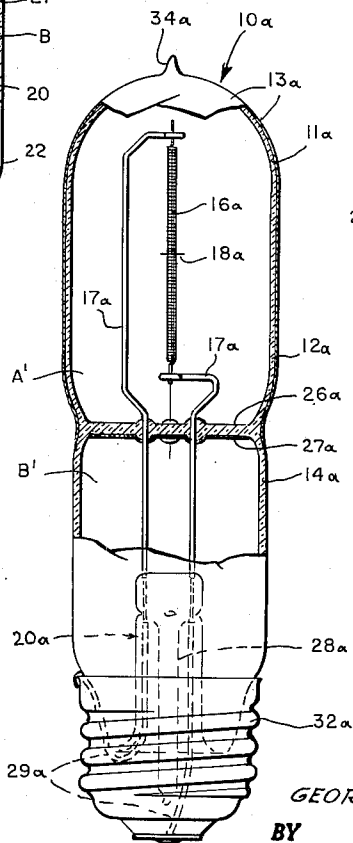


FIG. 3.



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IODINE-CONTAINING ELECTRIC INCANDESCENT LAMP WITH HEAT CONSERVING ENVELOPE

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This invention relates in general to electric lamps and, more particularly, to an improved electric incandescent lamp for general lighting service.

Recently there has been developed and marketed a very compact high efficiency electric incandescent lamp having a tungsten filament wherein the undesirable erosion of the filament by progressive vaporization and the resultant bulb blackening during life are minimized by means of iodine vapor that is sealed within the lamp. The wattage rating of the filament and the dimensions and configuration of the bulb are so correlated that the normal operating temperature of the inside surface of the bulb walls is within the range of about 250 to 1200° C. At this temperature the iodine vapor combines chemically with vaporized tungsten particles deposited on the bulb surfaces and starts a regenerative gettering cycle that re-deposits the vaporized tungsten back onto the filament. The progressive deterioration of the filament and attendant blackening of the bulb by vaporized tungsten are, accordingly, reduced to a minimum resulting in a marked increase in both the lumen maintenance and useful life of the lamp.

In order to meet the critical bulb wall temperature either very high wattages or very small bulb sizes have heretofore been required. For example, tubular 500 watt 120 volt lamps of this type now being marketed have a length of about 4½" and an outside diameter of about ¾". A 100 watt 28 volt lamp of ellipsoidal configuration, on the other hand, would have a major diameter of about 1⅝" and a minor diameter of about ⅝". High wattage compact lamps of this type and the manner in which the iodine vapor coats with the vaporized tungsten and the filament to effect the desired regenerative gettering cycle are described in detail in U.S. Patent No. 2,883,571 issued April 21, 1959, to E. G. Fridrich et al.

The small bulb sizes presently required in order to obtain the high bulb wall temperature necessary for the desired iodine-tungsten reaction has prevented the use of such lamps for general lighting purposes because the lamp dimensions and shapes are unsuitable for existing fixtures and sockets. In addition, the base temperature of such lamps exceed by a large margin the safe temperature limits established for sockets of the type employed in general lighting fixtures.

It is accordingly the general object of this invention to provide an iodine-containing electric incandescent lamp that exhibits the improved performance of such lamps and permits the use of more suitable bulb shapes and sizes for a given wattage rating.

Another and more specific object is the provision of a high-efficiency iodine-containing electric incandescent lamp that can be made in a variety of wattages and sizes and which can be safely operated in existing general lighting fixtures and sockets.

The aforesaid objects, and others which will become apparent as the description proceeds, are achieved by providing a heat conserving means on the envelope which raises the wall temperature thereof to the critical temperature required for the iodine-tungsten reaction but which otherwise would not be attained either because of the size or configuration of the envelope. Specifically,

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a thin coating of tin oxide or the like, such as the so-called "EC" coating marketed by the Corning Glass Works, which reflects infrared radiations but transmits visible radiations generated by the filament is provided on the exterior of the envelope to effect the required increase in the bulb wall temperature without deleteriously decreasing the light output of the lamp. The base temperature is maintained within safe limits by isolating one end of the envelope from the filament to provide a relatively cool basal end portion and attaching the base to this end portion.

A better understanding of the invention will be obtained by referring to the accompanying drawing wherein:

FIG. 1 is an elevational view of a lamp which embodies this invention, a portion of the envelope being broken away to show the interior of the lamp in greater detail;

FIG. 2 is a perspective view of the filament mount employed in the lamp shown in FIG. 1; and

FIG. 3 is an elevational view, partly in section, of an alternative lamp embodiment.

With particular reference now to the drawing, in FIG. 1 there is shown a lamp 10 that comprises a light-transmitting envelope 11 of globular configuration that has a filament 16 sealed therein. The envelope has a body portion 12 of generally spherical configuration and a basal end portion 14 of generally cylindrical configuration to which suitable terminal means such as a base 32 is secured. The diameter of the basal end portion is considerably smaller than the aforesaid body portion, as shown. The filament 16 comprises a linear coil of tungsten wire that is supported within the spherical body portion 12 of the envelope by a pair of rigid inner lead wires 17 hermetically sealed through a vitreous circular partition 26. The partition, in turn, hermetically seals off the body portion from the basal end portion thereby dividing the envelope into two separate chambers A and B that are defined by the aforesaid body portion and basal end portion, respectively. The filament 16 is centrally located within chamber A, preferably symmetrical about the geometrical center of the bulbous portion 12. The inner lead wires 17 comprise part of a filament mount 20 that is sealed to the basal end portion 14.

As shown more particularly in FIG. 2, the filament mount 20 comprises the usual flare tube 22 one end whereof is sealed around the end of the inner lead wires 17 to form a press 24. The circular partition 26 is resiliently coupled to the flare tube 22 by means of the inner lead wires 17 which are hermetically sealed through the partition. To avoid strains the partition is preferably fabricated from a hard glass such as Nonex (Corning 7740) the coefficient of expansion whereof matches that of the inner leads. The ends of the inner lead wires 17 within chamber A are suitably bent and clamped to the ends of the filament 16 to hold the latter in substantial alignment with the axis of the mount. A support wire 18 embedded in the partition 26 may be provided to prevent the excessive movement of the filament in a lateral direction. The mount 20 also includes the usual exhaust tube 28 which extends from the opposite end of the flare tube 22 and communicates with an aperture 30 located near the press 24. A pair of outer lead wires 29 are also provided at this end of the mount and are joined to the inner leads 17 within the stem press 24.

Fabrication of the lamp 10 in accordance with this invention is achieved by sealing the rim of the flare tube 22 to the basal end portion 14 of the envelope 11 in the usual manner and concurrently sealing the intermediate portion of the envelope to the circular partition 26, thereby forming the aforementioned chambers A and B. As shown in FIG. 1, chamber A contains the tungsten fila-

ment 16, the support wire 18 and the innermost ends of the inner lead wires 17, whereas chamber B contains the remainder of the inner leads and the flare tube 22. Chamber A is evacuated and a predetermined quantity of iodine vapor, such as 0.25 micromole per cc. of chamber volume, is fed therein through a glass tubulation attached to the bowl end of the body portion 12, which tubulation is then sealed off leaving a protruding tip 34 as shown. Chamber B is evacuated through the exhaust tube 28 which is then sealed off in the usual manner. The base 32 is then attached to the basal end portion 14 and the outer leads 29 are connected to the base terminals in the regular manner to complete the lamp. Since the basal end portion 14 is isolated or partitioned off from the filament 16, it will operate at a much lower temperature than the body portion 12 and thereby maintain the base temperature of the lamp 10 within safe limits. If desired, the chamber B can be filled with nitrogen to provide increased cooling of the basal end portion 14 and to minimize the danger of arcing therein.

In order to retard the vaporization of the filament 16 as much as possible and prevent the possibility of arcing, chamber A in addition to iodine vapor also desirably contains a filling of inert gas, such as argon, krypton, xenon or nitrogen or a mixture thereof at a pressure of about 500 mm. of mercury for example. The inner leads 17 and support wire 18 are also fabricated from a refractory metal, such as tungsten, molybdenum or platinum for example, that is not deleteriously corroded by the iodine. If molybdenum is used, an overwinding of tungsten wire can be used to cool the leads and prevent the undesirable formation of molybdenum iodide as disclosed in the aforesaid Fridrich et al. patent. The outer leads 29 located within the basal end portion 14 can be fabricated from the usual material such as nickel or nickel-plated iron or the like.

The wattage rating of the filament 16 is such that it operates at a temperature above 1400° C., which temperature is required to effect the dissociation of the tungsten iodide into tungsten and iodine vapor and thus sustain the desired tungsten gettering cycle described in the aforementioned patent to Fridrich et al. However, in contrast to the very small bulbs used in the prior art designs the size of the spherical body portion 12 compared to the size and rating of the filament 16 is such that the inner wall surfaces of the body portion, or at least a part thereof, are too remote from the filament to attain a minimum normal operating temperature of about 250° C. necessary to trigger the desired iodine-tungsten reaction. That is to say, the bulb size is considerably larger than would normally be used in a conventional iodine-cycle lamp. The resultant deficiency in bulb wall temperature is overcome in accordance with this invention by providing a thin heat-conserving light-transmitting coating 13 on the spherical body portion 12 of the envelope 11. As shown in FIG. 1, this coating is preferably located on the outer surface of the body portion 12 and terminates at the necked-in region where the partition 26 is joined to the envelope.

Any material that reflects infrared radiations but transmits visible radiations generated by the filament 16 and which will withstand the relatively high temperatures involved can be used as the coating 13, as for example, a substantially transparent optically thin iridescent layer comprised essentially of tin oxide or titanium dioxide. It has been found that the bulb wall temperature of a given lamp is surprisingly increased by about 100° C. when an exterior coating of tin oxide, such as the so-called "EC" coating marketed by the Corning Glass Works, is applied to the envelope. Coatings of this character will transmit up to about 90% of the visible radiations generated by the filament and transmitted by the envelope.

The increase in bulb wall temperature effected by the heat-conserving light-transmitting coating 13 permits the use of filaments of lower wattage rating or, conversely, larger size bulbs than was heretofore possible in such io-

dine-containing lamps. Thus, in contrast to the practice heretofore, envelopes having a minimum dimension greater than about 1½ inches can be employed with filaments of a rating as low as 100 watts thereby permitting the use of more practical bulb sizes and configurations.

In order to insure that the surface of the partition 26 that faces towards the filament 16 also operates at a sufficiently high temperature, the opposite face thereof, that is, the one disposed toward the base 32, is desirably coated with a layer 27 of infrared reflecting material, preferably one which also reflects visible radiations, as for example a layer of aluminum or the like. A coating of this character will not only serve to further reduce the temperature within chamber B, and thus the base temperature of the lamp, but will reflect back into the chamber A and out of the lamp light rays that would otherwise be lost in the basal end portion 14. Of course, if the reflective coating 27 is electrically conductive an area free from coating must be provided around at least one of the outer lead wires 29 to prevent a short circuit.

In order to minimize the possibility of breakage due to thermal shock, the envelope 11, flare tube 22 and partition 26 are preferably fabricated from a suitable thermally shock-resistant glass, such as Nonex or the like, or from quartz.

The following specific examples will illustrate the wide selection of wattage ratings and bulb sizes afforded by this invention. If the filament 16 employed in the lamp 10 shown in FIG. 1 has a wattage rating of 100 watts at 120 volts and a length of about 1", the diameter of the spherical body portion 12 would be approximately 2" and that of the basal end portion 14 approximately 1½". A tungsten filament of this size and rating operates at a temperature of about 2500° C. and is therefore susceptible to erosion by progressive evaporation. It should also be noted that this temperature is considerably higher than the minimum filament temperature of about 1400° C. necessary to effect the decomposition of the tungsten iodide into tungsten and iodine vapor. The overall lamp length in this case would be about 4⅞", the same as that of a standard 100 watt A19 general lighting lamp. Since the 2" (or so-called G16) bulb used in this particular embodiment is ⅜" smaller than the A19 bulb normally used with this wattage filament, the higher bulb wall temperature produced by this reduction in bulb size plus the increase effected by the heat-conserving coating 13 will provide the minimum bulb wall temperature of about 250° C. required for the iodine-tungsten reaction. The base 32 in this case would be a conventional medium screw type employed on ordinary general lighting lamps of this size.

General lighting lamps of higher wattage rating can also be provided by proportionately increasing the size of the filament and envelope. For example, by employing a coiled filament 16 that has a rating of 1000 watts at 120 volts, and increasing the maximum diameter of the envelope 11 to approximately 5" (a G40 type bulb), a high-efficiency iodine-containing general lighting lamp suitable for industrial or office lighting and the like can be provided. The base 32 in this case would be of the mogul type conventionally employed on general lighting lamps of this size.

This invention is not limited to lamps having globular-shaped envelopes. The same advantageous results can, for example, also be achieved by using an envelope 11a of generally cylindrical configuration thereby to provide a tubular-shaped lamp 10a such as that shown in FIG. 3. In this case, both the body portion 12a and basal end portion 14a of the envelope 11a are of generally cylindrical configuration and the coiled tungsten filament 16a is proportionately lengthened and positioned to extend along and be substantially coincident with the envelope axis. One of the inner lead wires 17a is lengthened to accommodate the longer filament, as shown. The envelope 11a is also divided into two separate chambers A' and B' by a partition 26a, and a heat-conserving light-

transmitting coating 13a is provided on the body portion 12a of the envelope in the same manner as described above in connection with the globular-shaped lamp 10. A support 18a may also be provided to prevent the filament from sagging or to restrict its lateral movement, and a reflective coating 27a may be provided on one side of the partition 26a to further reduce the base temperature.

As a specific example of a suitable correlation of design parameters for a tubular-shaped lamp of the aforesaid construction, the filament 16a may have a rating of 100 watts at 120 volts and have a length of approximately 1½". The outside diameter of the envelope 11a in this case would be approximately 1¼" (a T10 type bulb), the length of chamber A' approximately 2" and the overall lamp length approximately 4⅞". The base 32a would be of the medium screw type generally used for this size general lighting lamp.

As will be appreciated from the foregoing, the desired objects of the invention have been achieved by providing an iodine-containing lamp that not only exhibits the improved efficiency and life effected by the gettering action of the iodine, but which can be made in a variety of wattage and bulb-size combinations heretofore not available or practical. Moreover, a lamp of this type has been provided which can be used for general lighting purposes and be safely operated in existing sockets and fixtures.

While several embodiments have been shown and described in detail, it will be appreciated that various modifications in the configuration and organization of parts can be made without departing from the spirit and scope of this invention.

I claim:

1. An electric incandescent lamp comprising, a light-transmitting vitreous envelope, a tungsten filament sealed within said envelope and having a predetermined rated voltage, said filament when lighted at said rated voltage having an operating temperature above 1400° C. and being susceptible at such temperature to erosion by vaporization of tungsten onto the walls of said envelope with resultant blackening thereof, a quantity of iodine in said envelope sufficient to combine chemically with said vaporized tungsten at a temperature between about 250 to 1200° C. and sustain a regenerative gettering cycle that redeposits such vaporized tungsten on said filament, lead wires sealed through said envelope and connected to and supporting said filament, the enclosed portions of said lead wires being fabricated from a metal that is substantially resistant to the corrosive action of said iodine, the dimensions and spatial relationship of said envelope relative to said filament being such that part of the filament-enclosing portion of said envelope is heated to a temperature below 250° C. when the filament is operated at its rated voltage, and light-transmitting means on the filament-enclosing portion of said envelope for conserving heat generated by said filament and maintaining the operating temperature of the inner surface of said envelope portion above 250° C. when the lamp is operated at said rated voltage.

2. An electric incandescent lamp as set forth in claim 1 wherein said light-transmitting heat-conserving means comprises a thin coating of infrared-reflecting material selected from the group consisting of tin oxide and titanium dioxide.

3. An electric incandescent lamp as set forth in claim 1 wherein said light-transmitting heat-conserving means comprises a thin layer of tin oxide on the outer surface of said envelope.

4. An electric incandescent lamp as set forth in claim 1 wherein said light-transmitting heat-conserving means comprises a thin layer of titanium dioxide on the outer surface of said envelope.

5. An electric incandescent lamp comprising; an envelope having a basal end portion and a light-transmitting

body portion that are hermetically sealed off from one another by a partition and evacuated; a coiled tungsten filament sealed within and located substantially centrally of said body portion; said filament having a predetermined rated voltage and, when lighted at such voltage, having an operating temperature above 1400° C. and being susceptible at such temperature to progressive vaporization whereby tungsten particles are deposited on the inner wall surfaces of said body portion with attendant blackening thereof; a quantity of iodine in said body portion sufficient to combine chemically with said deposited tungsten particles at a temperature between about 250 to 1200° C. and sustain a regenerative gettering cycle that redeposits the vaporized tungsten on said filament; terminal means secured to said basal end portion; lead wires extending through said basal end portion and sealed through the partition between said basal end and body portions and connecting said filament with said terminal means; the portions of said lead wires within said body portion being fabricated from a refractory metal selected from the group consisting of tungsten, molybdenum and platinum and comprising supports for said filament; the dimensions and spatial relationship of the body portion of said envelope relative to said filament being such that said body portion is heated to a temperature below 250° C. when the filament is operated at its rated voltage; and light-transmitting means on the body portion of said envelope for conserving heat generated by said filament and maintaining the operating temperature of the inner surface of said body portion above 250° C. when the lamp is operated at the aforesaid rated voltage.

6. An electric incandescent lamp as set forth in claim 5 wherein; the minimum dimension of the body portion of said envelope is greater than about one and a half inches, and said light-transmitting heat-conserving means comprises an infrared-reflecting coating on the outer surface of said body portion.

7. An electric incandescent lamp as set forth in claim 5 wherein, the body portion of said envelope is of generally spherical configuration, and said filament is substantially symmetrical about the geometrical center of said body portion.

8. An electric incandescent lamp as set forth in claim 5 wherein; the body portion of said envelope is of generally spherical configuration, the basal end portion of said envelope is of generally cylindrical configuration and has a diameter considerably smaller than the diameter of said body portion, and said filament is of generally linear configuration and extends along the axis of said envelope.

9. An electric incandescent lamp as set forth in claim 5 wherein the body portion of said envelope also contains a filling of inert gas, and the basal end portion contains a filling of nitrogen.

10. An electric incandescent lamp as set forth in claim 5 wherein, said envelope is of generally cylindrical configuration, and said filament is of linear configuration and substantially aligned with the axis of said envelope.

11. An electric incandescent lamp as set forth in claim 5 wherein the partition between the body and basal end portions of said envelope is coated with infrared-reflecting material.

12. An electric incandescent lamp as set forth in claim 5 wherein the partition between the body and basal end portions of said envelope is coated with material that reflects both infrared and visible radiations.

13. An electric incandescent lamp having a predetermined rated voltage and comprising, in combination, a sealed light-transmitting envelope containing a filling of inert gas and from about .01 to 1 micromole of iodine per cubic centimeter of envelope volume, a tungsten filament supported within said envelope and adapted when lighted at said rated voltage to attain an operating temperature above 1400° C. and heat the inner surface of

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said envelope to a temperature below 250° C., and light-transmitting means on at least a portion of said envelope for conserving heat generated by said filament and maintaining the operating temperature of the inner surface of said envelope above 250° C.

14. An electric incandescent lamp as set forth in claim 13 wherein said light-transmitting heat-conserving means comprises a thin coating of infrared-reflecting material.

15. An electric incandescent lamp having a predetermined rated voltage and comprising, in combination, a sealed light-transmitting envelope having a substantially spherical body portion approximately two inches in diameter and a generally cylindrical end portion of smaller diameter, a filling of inert gas and a predetermined amount of iodine within said envelope, a pair of lead wires sealed through said envelope and having iodine-resistant end portions that extend into the spherical body portion thereof, a coiled tungsten filament having a rating of approximately 100 watts at said rated voltage and a length of approximately one inch connected to the inner end portions of said lead wires and supported thereby in centrally located position within the spherical body portion of said envelope, means for maintaining the operating temperature of the cylindrical end portion of said envelope below that of said spherical portion, terminal means secured to the cylindrical end portion of said envelope and connected to said lead wires, and a coating of light-transmitting infrared-reflecting material on the outer surface of the spherical body portion of said envelope that conserves a sufficient amount of the heat generated by said filament to maintain the inner surface of the spherical portion of said envelope at a temperature above 250° C. when the lamp is operated at its rated voltage.

16. An electric incandescent lamp having a predeter-

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mined rated voltage and comprising, in combination, a sealed light-transmitting envelope of tubular configuration that is approximately 1¼ inches in diameter and defines an elongated chamber approximately two inches in length, a filling of inert gas and a predetermined amount of iodine within said envelope, a pair of lead wires sealed through one end of said envelope and having inwardly extending iodine-resistant end portions, a coiled tungsten filament having a rating of approximately 100 watts at said rated voltage and a length of approximately 1½ inches connected to the inner end portions of said lead wires and supported thereby in said chamber in substantially coaxial relationship with said envelope, terminal means secured to the sealed end of said envelope and connected to said lead wires, and a coating of light-transmitting infrared-reflecting material on the outer surface of said envelope that conserves a sufficient amount of the heat generated by said filament to maintain the inner surface of the portion of said envelope that defines said chamber at a temperature above 250° C. when the lamp is operated at its rated voltage.

References Cited by the Examiner

UNITED STATES PATENTS

25	1,425,967	8/22	Hoffman	313—112
	1,994,056	3/35	Trompeter	313—222 X
	2,103,028	12/37	Bol	313—43 X
	2,142,104	1/39	Birdseye	313—43 X
30	2,859,369	11/58	Williams et al.	313—110 X
	2,879,449	3/59	Macksoud	313—113 X
	2,883,571	4/59	Fridrich et al.	313—222 X

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