DIRECT FILAMENT ENCLOSED INCANDESCENT LAMPS AND CONTACT MEANS THEREFOR

Roger C. Millikan, Schenectady, and Ludwig A. Osburg, South Glens Falls, N.Y., assignors to General Electric Company, a corporation of New York
Filed Dec. 15, 1966, Ser. No. 601,927
Int. Cl. H01J 5/48, 5/50
U.S. Cl. 313—318

6 Claims

ABSTRACT OF THE DISCLOSURE

In an electric incandescent lamp wherein an incandescent filament is fused directly through a quartz-like bulb wall, the emerging end of the filament is protected from oxidation by embedding the same in a massive heat sink of metal or metal alloy formed thereabout.

This application discloses an improved type of incandescent lamp wherein an incandescent filament is disposed within a quartz or quartz-like envelope and is passed in a heat resistant hermetic seal directly through the quartz or quartz-like wall thereof. More specifically, this application discloses a method of making electrical contact to the incandescent filament after it has passed through the envelope wall. This constitutes the use of a massive plug of soft metal which makes good electrical contact to the incandescent filament and serves as a heat sink to protect it from oxidation by over-heating during operation.

Present-day incandescent lamps have reached highest efficiencies in the trademarked Quartzline type lamp which is disclosed, for example in Fridrich et al. Patent No. 2,883,571, issued Apr. 21, 1959, and assigned to the General Electric Company. In lamps of the Quartzline type a relatively large cooled incandescent filament which may be any suitable refractory, high resistance metal but which is most generally of tungsten, is concentrically disposed axially along a relatively small dimension quartz tube so that the cross-sectional dimension of the helix comprising the incandescent filament is a substantial portion of the cross-sectional dimension of the quartz tube. This results in operation of the quartz wall at a high temperature and also causes the tungsten filament to operate at a high efficiency. Deterioration of the tungsten filament is prevented or minimized by the inclusion of an atmosphere of elemental iodine so that the iodide regenerative cycle returns evaporated tungsten from the inner bulb wall to the filament thus insuring high efficiency and long life of operation.

In the copending and concurrently filed application of R. C. Millikan, application Serial No. 601,930 there is disclosed and claimed improvements to the aforementioned type lamp wherein the incandescent filament is sealed directly through the respective ends of the lamp envelope in a manner so as to preclude separation of the tungsten from the high silica material of which the envelope is made during operation at high temperatures as high as 1000° C., for example, and thus greatly simplifies the manufacture of such lamps by eliminating intermediate contact members for achieving hermetic seals which do not so deteriorate.

While the lamps of the aforementioned Millikan application are a great improvement on lamps of the prior art and facilitate greatly reduced costs of fabrication resulting in superior lamps having less probability of failure due to seal failure, the lamps are subject to deterioration by degradation of the incandescent filament that is exterior of the envelope and exterior of the seal. We have found that the exposed tungsten filament, being of small dimension and being operated at a high temperature is extremely susceptible to oxidation at temperatures of operation and tend to limit the life of the lamps so formed. Accordingly, it is an object of the present invention to provide improved incandescent lamps having direct filament-through envelope seals which have long life and do not deteriorate by filament burn-out exterior of the envelope.

A further object of the present invention is to provide incandescent lamps of the type described having means for protecting the exposed portion of the incandescent filament outside of the lamp envelope from premature destruction due to oxidation during operation.

Briefly stated, in accord with the present invention, we provide incandescent filament lamps wherein the filament passes directly through a quartz or quartz-like envelope wall in which the configuration of the lamp body exterior of the point of emergence of the incandescent filament constitutes a re-entrant aperture terminating in a point through which the sealed-through filament emerges. The interior portion of this aperture is filled with a massive body of a soft-intermediate melting point metal or alloy, as for example nickel, which is molded to fit the configuration of the aperture and which protects the emerging filament from oxidation during operation, both by limiting the amount of contaminating atmosphere to which it may be exposed by serving as a massive heat sink so as to greatly reduce the temperature of the incandescent filament external of the envelope.

The novel features believed characteristic of the present invention are set forth in the appended claims. The invention itself, together with further objects and advantages thereof, may best be understood by reference to the following detailed description taken in connection with the attached drawing in which:

FIGURE 1 is a vertical cross-sectional view, with parts broken away, of a lamp constructed in accord with the present invention and,

FIGURE 2 is an alternative embodiment to the device of FIGURE 1 also shown in vertical cross-section with parts broken away.

In FIGURE 1 of the drawing there is illustrated an incandescent lamp comprising an envelope member including a large hollow tubular section and a pair of smaller tubular sections and 4 at opposite ends thereof. An incandescent filament passes concentrically through the envelope and is directly sealed at regions 6 and 7 through the material of the envelope. This sealing may be accomplished, for example, by heating the tungsten filament to a white heat with, for example, a flowing hot gas which may be a noble or inert gas while at the same time heating the envelope material to cause the same to melt or deform and come into contact with the incandescent filament in the absence of any intervening gaseous or other impurity layer and form an intimate hermetic seal. Such a seal does not crack, craze or spall under repeated operations at temperatures up to 1000° C., for example, even in view of the difference in coefficient of expansion between the incandescent tungsten or other refractory material and the quartz, or quartz-like material of which the envelope is made.

Although quartz is one preferred envelope material with which the invention may be practiced because of its high temperature of softening, this is a function of silica (SiO2) of which quartz is made. However, the same desirable qualities are found in other light-transmitting, vitreous quartz-like materials having a high proportion of silica, as for example, Corning Vycor, which is approximately 95% silica, and also has sealing problems in that it has a low, quartz-like coefficient of thermal expansion. Such material will be referred to herein, as quartz-like materials. For convenience, hereafter it will simply be re-
ferred to as "quartz." The method of preparing such seals is set forth in greater detail in the aforementioned copending application of R. C. Millikan, the entire disclosure of which is incorporated hereinto by reference thereto.

Emerging end 8 of incandescent filament 5, as it leaves sealing region 6 enters into a hollow cusp-shaped aperture in restricted tubular portion 3 of envelope 1 which portion forms in an inverted way with a point-like rounded portion surrounding the point of emergence of filament end 8 from quartz sealing region 6. The entire portion of pointed aperture 9 surrounding the point of emergence is filled with a solidified mass 10 of metal or metal alloy which firmly electrically and mechanically connecting to envelopes 9 of filament 5. A lamp lead 11 is also embedded within metallic mass 10 to provide electrical and mechanical connection of the lamp to a source of electrical energy to cause lamp operation. Solidified metallic mass 10 completely fills the interior end of cusp-shaped pointed aperture 9 in tubular portion 3 of envelope 1 during its formation when it is formed as a liquid within aperture 9. As mass 10 solidifies and contracts upon cooling, it separates slightly by a matter of several angstrom units in any dimension from the interior wall of aperture 9. This separation, however, although sufficient to preclude the existence of an hermetic seal between the nickel and quartz is inessentially small and does not cause any mechanical instability so that the electrode lead 11 is firmly supporting the device and no strain of support is transmitted to end portion 8 of filament 5. A similar metallic mass 10 is located in the opposite aperture 9 within constricted tubulation 4 of envelope 1 at the opposite end thereof and a similar electrode lead 11 is embedded therein. Metallic mass 10 is composed of a metal or metallic alloy having a melting point of between approximately 600° C. and 1300° C. If the melting point is below 600° C., mass 10 may become too soft at the temperature at which the lamp operates, for the end of the lamp approaches this temperature, even though the filament itself may be at 1000° C. for example. If the melting point of metallic mass 10 is above approximately 1500° C., the silica material of the envelope may be undesirably softened and deformed in melting the metal or metal alloy to form mass 10. In addition to nickel, mass 10 may conveniently be lead, tin or any solder or alloy of lead, tin or nickel whose melting point is within this range.

In addition to providing a good mechanical and electrical contact between filament end member 8 and lamp lead 11 and serving to relieve filament end 8 from all mechanical stress due to the support of the lamp by the lead 11, nickel mass 10 serves an additional and overwhelmingly important function. Since end portion 8 of filament 5 is exterior of the quartz envelope and is heated by the same current which causes the portions thereof which are imbedded in the quartz and which are enclosed within the hollow portion of envelope 1 to become incandescent and emit light as well as heat, it tends also to become very hot. Such a raise in temperature of end portion 8, if permitted would soon cause that portion of the filament to become oxidized to the point of destruction. Those portions of filament 5 which are enclosed within quartz envelope 1, within hollow portion thereof, are protected from oxidation by the enclosure. End portion 8, on the other hand, is not. Since end portion 8 is not protected from ambient atmosphere, it must be kept from the exceedingly high temperatures attendant incandescence to protect against destructive oxidation. The resistance of end portion 8 to the flow of electrical current, which would produce the increase in temperature thereof, must also produce an increase in temperature of mass 10 of nickel which is involved thermal contact therewith. Accordingly, mass 10 serves a function which precludes end portion 8 of filament 5 from being raised to such high temperatures as would permit the oxidation thereof and subsequent destruction.

In FIGURE 2 of the drawing an alternative embodiment of the invention illustrated in FIGURE 1 is shown. In FIGURE 2, like components are identified by like numbers. Envelope 1 comprises a first tubular section 2 and a pair of end portions 3 and 4, through which a concentrically located incandescent filament 5 passes in close proximity to the interior wall thereof. Incandescent filament 5 is sealed into hermetic seal through the quartz constituting envelope 1 at seal regions 6 and 7 and at an end portion 8 of filament 5 extends into a pointed aperture in the quartz envelope 1 exterior of the seal. This aperture is filled with a mass 10 of elemental nickel which is intimate mechanical and electrical connection with filament end portion 8 and is completely fills the volume of end aperture 9. A metallic end cap 12 having a cup-shaped configuration surrounds the end of quartz envelope 1 and is suitably bonded by welding, brazing, or other suitable mechanical means to nickel mass 10 to provide intimate mechanical, electrical, and thermal contact thereto. Electrical contact to the device is made by suitable contact connections to electrode members 12 which are disposed at opposite ends of envelope 1.

The electric lamps constructed in accord with the present invention are made substantially as the lamps disclosed and claimed in the aforementioned copending application of R. C. Millikan. After the lamp has been sealed through the quartz tubulation at either end thereof, the envelope is preferably held in a vertical position and a pointed nickel rod is pressed into the top of the aperture 9 at the point where filament end 8 emerges from the quartz seal region 6. A protective atmosphere, preferably of hydrogen or nitrogen, is directed into the region of the emergence of filament end 8 and the temperature of the quartz in this vicinity is raised to a temperature which is just sufficient to cause melting of the nickel but insufficient to cause sufficient softening of the quartz as to adversely affect either the characteristics of the quartz-to-tungsten seal or the physical configuration of the region of emergence of the filament end 8 from seal region 6 of envelope 1. Upon filling of the aperture 9 to a sufficient degree as to insure adequate mechanical, electrical, and thermal contact to filament end 8, lamp lead and support member 11 is inserted into the molten nickel and the source of heat, which may conveniently be a source of superheated gas or an electrical resistance coil is removed and mass 10 is allowed to solidify. Sufficient filling may be obtained in a 0.150° diameter aperture by the use of from 1 to 5 grams of nickel. After solidification the lamp may be conveniently inverted and the same process repeated with respect to the other end thereof completing the fabrication of the seal.

After the seal has been fabricated, additional protection against the possible deterioration of the filament end 8 by any slight leakage of air through the anstrom unit of magnitude separation of nickel mass 10 from quartz or quartz-like material tubulation 3 may be minimized by the porosity therein of a suitable thermoplastic resin which is sufficient to exclude all air therefrom and yet capable of maintaining its air-impenetrable characteristics and physical strength under operating temperature conditions thereat.

While the invention has been set forth herein with respect to certain embodiments and examples thereof, many modifications and changes will readily become apparent to those skilled in the art. Accordingly by the appended claims we intend to cover all such modifications and changes as fall within the true spirit and scope of the invention.

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

1. An incandescent lamp wherein an incandescent filament is sealed directly through an envelope of a light-transmissive, vitreous material having low quartz-like
3,448,322

thermal expansion characteristics, the improvement comprising:
(A) a cusp-shaped aperture in an end region of said envelope terminating in an inwardly disposed point through which said incandescent filament emerges from said envelope material;
(B) heat sink means including a solidified mass of a metallic material substantially filling at least the inner region of said aperture and making a good electrical and a strong mechanical connection between said emerging filament and the inner walls of said aperture; and
(C) electrical terminal means in intimate electrical contact with said metallic mass to permit application of an energizing voltage to said incandescent filament.

2. The improvement of claim 1 wherein the metallic mass within said aperture is a metal or metal alloy having a softening point above the operating temperature of the lamp envelope end and a melting point below the softening point of the lamp envelope.

3. The improvement of claim 1 wherein the lamp envelope is made of quartz.

4. The improvement of claim 1 wherein the metallic material is selected from the group consisting of nickel, lead, tin and alloys thereof having a melting point between approximately 600° C. and 1500° C.

5. The improvement of claim 1 wherein the lamp envelope is of quartz and the metallic material is selected from the group consisting of nickel, lead, tin and alloys thereof.

6. The improvement of claim 5 wherein the metallic material is nickel.

References Cited
UNITED STATES PATENTS
1,531,265 3/1925 Devers 174—50.61
2,009,094 7/1935 Peters 313—318

JAMES W. LAWRENCE, Primary Examiner.
R. F. HOSSFELD, Assistant Examiner.

U.S. Cl. X.R.
174—50.52; 313—174, 331