March 4, 1969 J. F. ENGLISH 3,431,448

BROMINE REGENERATIVE CYCLE INCANDESCENT LAMPS

Filed Jan. 16, 1967

Fig. 1.

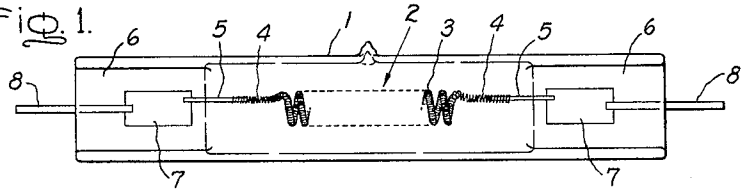


Fig. 2.
(PRIOR ART)

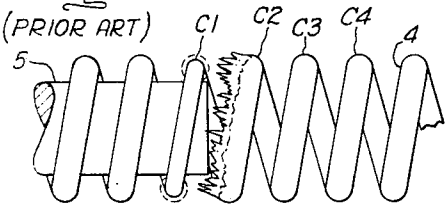


Fig. 3.

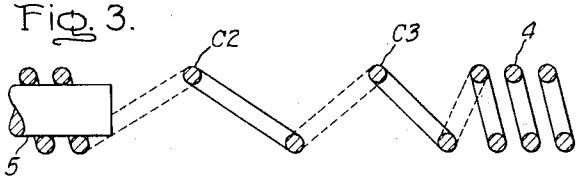


Fig. 4.

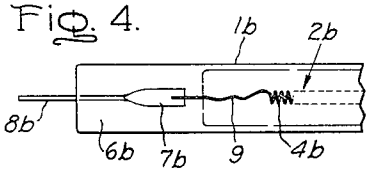


Fig. 5a.

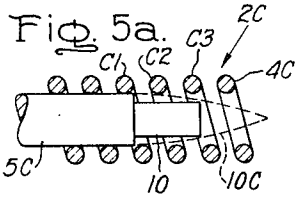


Fig. 5b.

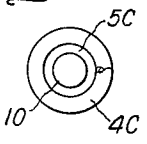


Fig. 6a.

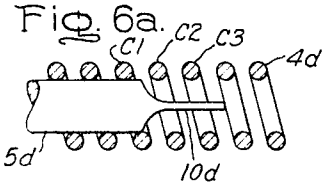


Fig. 6b.

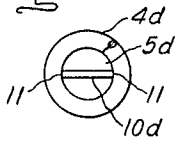


Fig. 7a.

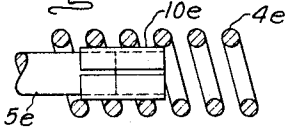


Fig. 7b.

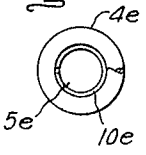


Fig. 8a.

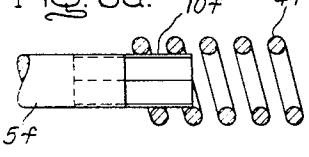
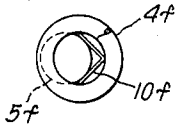


Fig. 8b.



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3,431,448

BROMINE REGENERATIVE CYCLE INCANDESCENT LAMPS

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U.S. Cl. 313—37 9 Claims
Int. Cl. H01j 61/52

ABSTRACT OF THE DISCLOSURE

In a regenerative cycle, coiled tungsten filament incandescent lamp containing bromine, an end attack or transfer of tungsten between coil turns, with consequent etching or erosion of one or more turns at the end of the filament by bromine, is minimized by designing the connection of those end turns to the lead wires to provide a gradual, rather than a steep or abrupt, temperature gradient downward between and from said coil turns toward the lead wires. This may be accomplished in a number of ways: For example, by stretching out several of the coil turns immediately adjacent to the inner ends of conventional lead wire spuds carrying the ends of the coiled filament; by stretching out several coil turns at the ends of the filament to infinity, so to speak, and continuing the resulting essentially straightened integral end portions of the filament into the seal portions of the enclosing envelope; and by, in any one of several ways, reducing the cross section of the terminal inner end portions of the aforesaid lead wire spuds.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates generally to electric incandescent lamps, and more particularly to tungsten filament lamps of the regenerative cycle type which comprise a compact sealed envelope of high melting point vitreous material containing a halogen as a regenerative getter which returns, to the filament, tungsten vaporized therefrom during operation. More particularly, the invention relates to such lamps employing bromine as the regenerative getter.

Description of the prior art

In the past, iodine had been used exclusively as the halogen regenerative getter in commercial lamps. For certain applications, bromine, especially in the form of compounds such as hydrogen bromide and hydrocarbons of bromine, has been more recently coming into use. However, bromine is much more reactive than iodine, so much so that it has lead to a problem referred to as end attack or tungsten transport activity at the leads wherein one or more adjacent coil turns at the end of the filament is eroded or etched sufficiently to lead to premature failure of the filament.

In a conventional form of lamp design, the filament comprises helically coiled end portions which are supported and electrically connected to lead-in conductors in the seal portion or portions of the envelope, by lead wire spuds which extend from the seal portion or portions and from the lead-in conductors therein, into the interior of the envelope, and are fitted snugly within the respective coiled end portions of the filament. In lamps of the single-ended type the lead-in conductors and spuds are in a single seal portion at one end of the lamp, whereas double-ended lamps have seal portions at opposite ends of an envelope, usually of tubular shape.

Summary of the invention

In accordance with the present invention, it has been found that the aforesaid end activity or tunsten transport at the leads is caused by a bromine attack due to a steep temperature gradient existing between adjacent coil turns at the end of the filament due to the abrupt termination of the lead wire spuds within tht coiled ends of the filament. The attack is particularly severe when the filament is operated at very high temperatures and efficiencies.

In further accord with the invention, therefore, the said end activity or tungsten transport is greatly minimized or even eliminated by employing a construction which provides or defines a gradual temperature gradient between adjacent turns at the end of the filament coil and downwardly along conductor means connecting said end of the filament coil with the lead-in conductor in the lamp seal.

Brief description of the drawing

Further features and advantages of the invention will appear from the following detailed description of species thereof and from the drawing wherein:

FIG. 1 is a side view of a form of lamp which may embody the invention;

FIG. 2 is a fragmentary detail showing a prior art filament connection or support and illustrating the effect of the bromine end attack or activity;

FIG. 3 is a fragmentary detail of a species of filament connection in accordance with the invention wherein several turns of the filament coil end are spread out to provide a gradual temperature gradient;

FIG. 4 is a side view of one end of a lamp embodying another species of the invention wherein the end of the filament is stetched out to be generally straight and to thereby provide a connection which greatly lessens the temperature gradient; and

FIGS. 5A and 5B to 8A and 8B are fragmentary side and end views of still other species of the invention wherein the cross section of the terminal end of the supporting lead wire spud of the FIG. 1 lamp is effectively reduced in cross section to minimize the action and effect of end attack or activity.

Description of the preferred embodiments

Referring to FIG. 1 of the drawing, the lamp illustrated therein comprises a tubular envelope **1** of high melting point vitreous material, preferably quartz or fused silica or the material known as 96% silica glass and sold under the name Vycor. The envelope **1** contains a tungsten wire filament **2** which comprises a helically coiled-coil body portion **3** extending longitudinally of the envelope, and helically single-coiled end leg portions **4**. The filament **2** is supported at each end by a tungsten lead wire spud **5** having its inner end extending into and tightly fitted within the coiled filament end legs **4**, and having its outer end extending into respective flattened pinch seals **6** at the ends of the envelope where it is connected, preferably by welding, to a molybdenum foil portion **7** of a lead-in conductor which also includes an outer molybdenum lead wire portion **8** which is also welded to the foil **7**.

The envelope **1** contains a filling of inert gas, such as nitrogen, argon, krypton or xenon or mixtures thereof, at a pressure exceeding several hundred torr, preferably at least about one atmosphere and up to several atmospheres. The envelope also contains bromine. Although elemental bromine might be used at very low concentrations, it is preferred that hydrogen be present to modify the reactivity of the bromine. It is therefore preferably used in the form of a compound such as hydrogen bromide, or a hydrocarbon of bromine, for example, methylene bromide (CH_2Br_2), methyl bromide (CH_3Br), bromoform ($CHBr_3$) or as carbon tetrabromide (CBr_4). Elemental bromine might be used in small concentrations of, for ex-

ample, about .01 to 1 torr or more, depending upon the designed life and efficiency of the lamp. Hydrogen bromide, or compounds yielding hydrogen bromide, may be used at concentrations to provide from about 0.2 torr to 80 torr or more.

Referring now to FIG. 2, when the lead wire spud **5** terminates abruptly within the helically coiled end or leg portion **4** of the filament, there is a steep temperature gradient between the turns of the coil **4** adjacent to and overlying the inner end of the spud **5**. The result, in a typical case, was an etching and reduction in wire diameter of coil turn C1 and a growth of tungsten crystals on the side of the adjacent turn C2 pointing generally in the direction from whence they came. In another case involving a different filament operating temperature, the turn C2 was attacked and reduced in diameter with a build up of crystals on turns C3 and C4. It will be evident that the etching or thinning of a coil turn can ultimately result in a burning out of the thin coil turn or a sagging of the filament **2** to a degree that, in some cases, the filament engages the envelope wall and melts it.

Referring to FIG. 3, the steep temperature gradient between turns of the coil leg **4** may be made gradual in a simple manner, if the coil pitch at the critical turns is greatly increased or stretched, as illustrated by the showing of the coil turns C2 and C3 which thereby constitute a conductor means defining a gradual temperature gradient. The stretching is preferably sufficient to provide a spacing between coil turns at least twice that of the conventional spacing used in the normal part of the coil. In this way, in accordance with the invention, the tugsten transfer activity, or end attack, is greatly minimized or even eliminated.

In the lamp shown in FIG. 4, the relatively thick lead wire spud **5** of FIGS. 1 and 3 is entirely eliminated, and the coil pitch of the end portion **4***b* of the filament **2***b* is, so to speak, made infinite by stretching the terminal end turns of the coil portion **4***b* out to a generally straight length of wire **9** which extends into the pinch seal **6***b* of the envelope **1***b*, where it is welded to a flattened foil portion **7***b* which is rolled out at the end of the molybdenum outer lead wire **8***b*. Here again, the temperature gradient from the end turns of coil **4***b* downwardly along the conductor means constituted by the straightened leg section **9** is made sufficiently gradual to minimize or eliminate the tungsten transfer or end attack. The entire coiled length of the filament **2***b* may consist of a helical single coil, as opposed to the coiled-coil body portion **3** in FIG. 1, and the filament coil **2***b* may be supported in conventional manner by spiral tungsten wire support members coiled about the filament at spaced points along its length and engageable with the inner wall of envelope **1***b*.

In the species shown in FIGS. 5A and 5B, the cycle activity or etching of turns of the helically coiled end portion **4***c* of the filament **2***c* is eliminated or reduced by reducing the diameter of a short terminal inner end portion of the spud **5***c* (corresponding to spud **5** in FIG. 1), for example, to a reduced cylindrical section **10**, or by tapering the end portion as indicated at **10***c* by broken lines. The clearance or spacing between reduced end portion **10** and the inside of the turn of coil **4***c* is preferably appreciably less than the spacing between turns of coil **4***c*. While in this case the temperature gradient between the critical turns C1 and C2 is not altered to the same degree as in FIGS. 3 and 4, any tungsten transfer which does take place occurs primarily from the surface of reduced spud portion **10** to coil turns C2 and C3 overlying it. When tungsten transfer does occur, the crystals eventually bridge this gap and act as a partial heat shunt between these turns and the spud.

In FIGS. 6A and 6B, the reduced end portion **10***d* of the spud **5***d* is in the form of a chiseled or thin strip portion protruding into the filament coil **4***d* to provide a gradual heat sink at the contact edges **11** (FIG. 6B) thereby effecting a flatter or more gradual temperature gradient between coil turns C1, C2 and C3.

In FIGS. 7A and 7B, the reduced cross section end of the spud **5***e* consists of a tungsten sheet metal sleeve **10***e* projecting from the inner end of the spud and also providing a gradual heat sink which effects a more gradual temperature gradient between turns of the coil **4***e*.

In FIGS. 8A and 8B, the reduced cross section end of the spud **5***f* consists of a tungsten sheet metal angle portion **10***f* which may be welded to the spud and with which the turns of coil **4***f* make a three point contact, thereby providing a gradual heat sink similar to that of FIGS. 7A and 7B.

It will be evident to those skilled in the art that other species and variations in construction may be made in the connection of the coiled filament end to the lead-in conductor in the seal, and which will provide a more or less gradual temperature gradient between turns of the coiled end of the filament whereby to effectively minimize or eliminate the destructive end attack or tungsten transfer activity caused by the bromine getter when there is a steep or abrupt temperature gradient, all within the spirit and scope of the present invention.

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

1. An electric incandescent lamp of the halogen regenerative cycle type comprising a compact sealed envelope having a seal portion at least at one end thereof and a lead-in conductor extending into said seal portion from the exterior, a helically coiled tungsten filament in said envelope, conductor means electrically connecting a helically coiled end portion of said filament with said lead-in conductor, said envelope containing a filling of inert gas and a source of bromine gas as the halogen, said conductor means defining a gradual temperature gradient between adjacent turns of the said helically coiled end portion of the filament and downwardly along said conductor means which minimizes destructive attack by bromine of said adjacent turns.

2. A lamp as set forth in claim **1** wherein said means comprises several end turns of the helically coiled end portion of the filament which are stretched out to a large pitch at least about twice that of the other turns of said coiled end portion and are connected to a heavier wire member which extends into said seal portion to said lead-in conductor.

3. A lamp as set forth in claim **1** wherein said means is an essentially straightened integral end portion of the filament wire which extends from the said helically coiled end portion of the filament into said seal portion to said lead-in conductor.

4. A lamp as set forth in claim **1** wherein said means comprises a tungsten spud member of wire heavier than the filament and which extends from said lead-in conductor within the said seal portion into tightly fitting engagement with the interior of said helically coiled end portion of the filament, said spud member having a terminal inner end portion of short length and reduced cross section which serves to reduce the temperature gradient between the turns of said coiled end portion adjacent to and enclosing said spud member.

5. A lamp as set forth in claim **4** wherein said reduced cross section end portion of said spud member is a solid portion of the wire of reduced diameter.

6. A lamp as set forth in claim **4** wherein said reduced cross section end portion of said spud member is a thin flattened portion of the wire which engages the overlying turns of the end portion of the filament at its edges.

7. A lamp as set forth in claim **4** wherein said reduced cross section end portion of said spud member is a hollow sleeve which engages the overlying turns of the end portion of the filament.

8. A lamp as set forth in claim **4** wherein said reduced cross section end portion of said spud member is a hollow

cylindrical sleeve which engages the overlying turns of the end portion of the filament.

9. A lamp as set forth in claim 4 wherein said reduced cross section end portion of said spud member is a hollow sheet metal angle portion which has a three-point engagement with the overlying turns of the end portion of the filament.

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U.S. Cl. X.R.

313—39, 42, 222, 223, 271, 331, 333, 341, 344