

[54] **SEQUENTIAL DISCHARGE FLUORESCENT LAMP**

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[51] Int. Cl. **H01j 17/00**

[58] Field of Search **313/190, 109, 220**

[56] **References Cited**

UNITED STATES PATENTS

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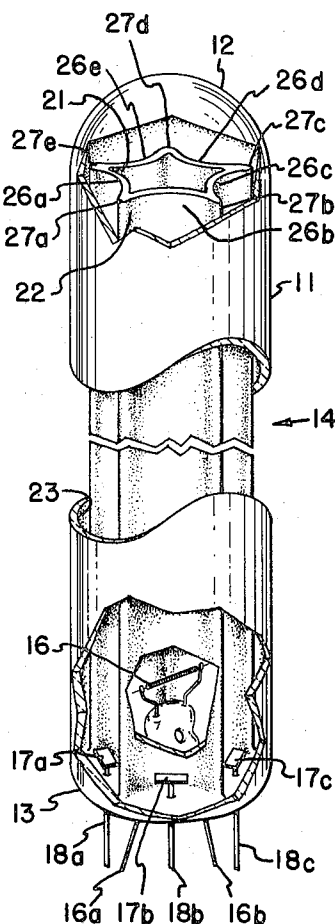
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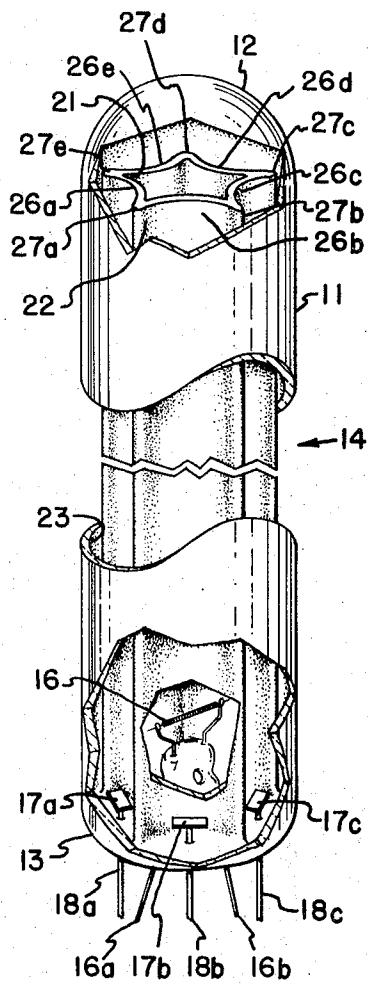
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[57] **ABSTRACT**

A fluorescent lamp having parallel sequential discharge paths along the space between a pair of concentrically positioned envelope members. At least one of the concentric envelope members is provided with grooves respectively extending along the discharge paths and functioning to stabilize the sequential discharges and to provide increased phosphor coating area.

8 Claims, 1 Drawing Figure





SEQUENTIAL DISCHARGE FLUORESCENT LAMP

BACKGROUND OF THE INVENTION

The invention is in the field of fluorescent lamps, of the type having a plurality of parallel sequential vapor discharge paths such as along the space between a pair of concentrically positioned envelope members.

U.S. Pat. No. 3,609,436 to John H. Campbell discloses a mercury vapor sequential discharge fluorescent lamp comprising, in a preferred embodiment, a pair of concentrically positioned tubular glass envelope members sealed together at their bottom ends and defining a vapor discharge path concentrically folded back upon itself between the bottom end of the inner envelope member and the bottom end of the space between the concentric envelope members. A common electrode is positioned near the bottom of the inner envelope member, and a plurality of switched electrodes are positioned in a circular configuration near the bottom end of the lamp between the concentric envelope members. The aforesaid switched electrodes are connected to switching circuitry which sequentially renders them operative with respect to the common electrode, whereby the vapor discharge in the space between the concentric envelope members rotates circularly from one to another of the switched electrodes at a suitable rate of speed such as several thousand complete rotations per second. Phosphor material is coated on one or more of the glass envelope surfaces in the lamp.

SUMMARY OF THE INVENTION

Objects of the invention are to provide an improved sequential discharge fluorescent lamp, and to improve the light-producing efficiency and stability of such lamps.

The invention comprises, briefly and in a preferred embodiment, a fluorescent lamp having parallel sequential discharge paths along the space between a pair of envelope members, at least one of the envelope members being provided with grooves respectively extending along the discharge paths. These grooves stabilize the discharge in the desired paths, provide increased phosphor coating area, and permit lamp operation on *dc.*, pulsed *dc.*, or *ac.*, in lieu of sequential switched operation. Preferably the envelope members comprise a pair of concentrically positioned glass tubes sealed together at their bottom ends and defining a vapor discharge region concentrically folded back upon itself between the bottom end of the inner tube and the bottom end of the lamp between the concentric tubes, the aforesaid grooves being provided at the surface of one or both of the tubes along the space between the tubes. These grooves preferably are provided along the outer surface of the inner tube.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE of the drawing is a perspective view, partly broken away, of a preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The lamp shown comprises a tubular glass outer envelope member 11 having a closed upper end 12 and hermetically sealed at the bottom end thereof to a glass

header 13 (not shown on the drawing). A tubular glass inner envelope member 14 is concentrically arranged within the outer member 11 and is sealed at the bottom end thereof to the header 13. The upper end of the inner envelope member 14 is open, and is spaced from the closed upper end 12 of the outer envelope member so as to provide a vapor discharge path from the inner envelope member 14 to the space between it and the outer envelope member 11. A common electrode 16, shown as being a filament type of cathode, is positioned within and near the bottom end of the inner envelope tube 14 and is supported by a pair of lead-in wires 16a, 16b which extend out of the lamp through the header 13. A plurality of additional electrodes 17a, 17b, etc., are arranged equally apart in a circular configuration near the bottom of the lamp in the space between the inner envelope member 14 and the outer envelope member 11, and are shown as being anodes in the form of small strips or plates of metal each individually supported by a lead-in wire 18a, 18b, etc., extending downwardly through the header 13 to the outside of the lamp. Phosphor coatings 21, 22, and 23 are respectively provided on the inner surface of the inner envelope member 14, on the outer surface thereof, and on the inner surface of the outer envelope member 11. A small amount of mercury is included in the lamp, along with an inert gas such as argon, as is customary in fluorescent lamps. Further details of the general lamp construction are disclosed in the above-referenced U.S. Pat. No. 3,609,436. In operation, switching circuitry is connected to electrodes 16 and 17 and functions to sequentially activate the various electrodes 17 in turn so that a mercury vapor discharge, which emits ultraviolet light, extends from the common electrode 16 upwardly through the inner envelope member 14 and then downwardly through the space between the inner and outer envelope members 14 and 11 in a manner which jumps from one to the next of the electrodes 17 so that the discharge rotates rapidly around the inner envelope member 14 and within the outer envelope member 11. Suitable switching circuitry and details of operation are disclosed in the above-referenced patent. The lamp shown with anodes is for sequential switching, pulsed *dc.*, or *dc.* To operate the lamp as with *ac.*, cathodes would be provided for the electrodes 17.

In accordance with the invention, at least one of the concentric envelope members is provided with a plurality of grooves respectively extending along the discharge paths to the switched electrodes 17. In the embodiment shown in the drawing, there are five switched electrodes 17, and the outer surface of the inner envelope member 14 is shaped to provide five grooves 26a, 26b, etc., extending along the length thereof and each being in centered facing relationship to the location of a respective switched electrode member 17a, 17b, etc. In the embodiment shown, the grooves 26 are concave in shape, and the adjacent grooves meet at and form elongated ribs 27a, 27b, etc., each of which is spaced inwardly from the inner surface of the outer envelope member 11. For convenience, the inner surface of the inner envelope member 14 is contoured similar to the outer surface thereof thus forming a wall of substantially uniform thickness.

In operation, the grooves 26 improve the lamp performance by helping to confine the rotating discharge temporarily in each of the desired paths between the switched electrodes 17 and the upper end of the lamp.

This results in a desirable more uniform distribution of ultraviolet energy produced by the discharge, causing improved uniformity of visible light generated by the phosphor coatings in response to the ultraviolet radiation. Also, the grooves are found to provide improved stability of the rotating discharge as it is switched from path to path, as it helps to prevent a tendency of two or more arc discharges from combining when a discharge to one of the switched electrodes 17 does not fully deionize sufficiently quickly after the next succeeding electrode is sequentially switched on, or when the impedance of one arc path is sufficiently lower than an adjacent one to cause the two arcs to merge resulting in a bright streak.

The elongated ribs 27 between adjacent grooves 26 should not touch nor be spaced closely adjacent to the inner surface of the outer envelope member 11. For example, in a lamp of 12 inches overall height and 3 inches outside diameter, it has been found advantageous to have each of the ribs 27 spaced approximately 1/16 of an inch to 1/8 of an inch from the inside surface of the outer envelope member 11. Such spacing (as contrasted with no spacing) seems to facilitate rotation of the discharge from one to another of the switched electrodes 17, perhaps because the discharge slides or shifts partially through the space between a rib 27 and the inner surface of the outer envelope member when being switched from one to another of the switched electrodes 17, in addition to shifting its path from one groove 26 to another over the top open end of the inner envelope member 14. Furthermore, such spacing provides a constriction between channels which would require a higher voltage than available during lamp operation to cause adjacent arcs to merge. Also, by spacing the ribs 27 inwardly from the outer envelope member 11, the phosphor coating on the ribs 27 and on the inner surface of the outer envelope member 11 at positions directly opposite to the ribs 27 contributes useful light output, and no undesirable dark stripes are produced as would be the case if the ribs 27 touched against, or were closely positioned adjacently to, the inner surface of the outer envelope member 11.

The grooved configuration of the inner envelope member 14 also has the desirable feature of having a greater area of phosphor coating, both on the inside and outside surfaces thereof, thus producing a greater amount of visible light output, it being desirable for this purpose that the phosphor coatings 22 and 23 be sufficiently thin so that visible light produced by the innermost phosphor coating 21 can pass through the coatings 22 and 23 so as to be usefully emitted externally of the lamp and, likewise, so that light emitted by the phosphor coating 22 can pass through the outermost

coating 23 and be usefully emitted from the lamp.

While preferred embodiments of the invention have been shown and described, various other embodiments and modifications thereof will become apparent to persons skilled in the art, and will fall within the scope of the invention as defined in the following claims.

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

1. A vapor discharge lamp comprising a pair of envelope members in parallel spaced apart relationship and electrode means defining a plurality of parallel sequential vapor discharge paths between and parallel to said envelope members, the surface of at least one of said envelope members being shaped to provide a plurality of grooves respectively extending along and facing said vapor discharge paths, each adjacent pair of said grooves defining a rib spaced sufficiently from the other of said envelope members to permit the vapor discharge of said lamp to shift from one groove to the next through the space between said rib and said other envelope member.

2. A lamp as claimed in claim 1 in which said pair of envelope members comprises a pair of concentrically positioned glass tubes.

3. A lamp as claimed in claim 2 in which the outer surface of the inner glass tube is shaped to provide said plurality of grooves.

4. A lamp as claimed in claim 3 including means hermetically interconnecting said concentric tubes at the bottom ends thereof, the top end of the outer tube being closed over and spaced from the top end of the inner tube, a common electrode positioned within and near the bottom of said inner tube, and a plurality of additional electrodes positioned in a circular configuration between said concentric tubes near the bottoms thereof, said vapor discharge paths extending upwardly from the respective said additional electrodes, each of said grooves facing and being symmetrical with respect to a respective one of said additional electrodes.

5. A lamp as claimed in claim 4 in which each of said grooves has a concave cross-sectional shape.

6. A lamp as claimed in claim 5 in which each pair of adjacent grooves forms a rib extending partly into the space between a pair of adjacent vapor discharge paths.

7. A lamp as claimed in claim 6 in which each of said ribs is parallel to, and spaced about 1/16 to 1/8 of an inch away from, the inner surface of the outer tube.

8. A lamp as claimed in claim 7 including coatings of phosphor on the inner and outer surfaces of the inner tube and on the inner surface of the outer tube.

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