March 20, 1956 W. ELENBAAS ET AL 2,739,261

TUBULAR GAS DISCHARGE LAMP

Filed Sept. 30, 1952 2 Sheets-Sheet 1

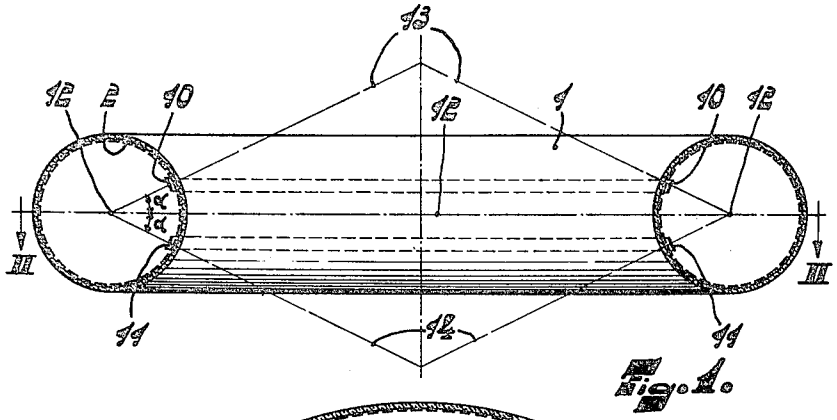

Fig. 1.

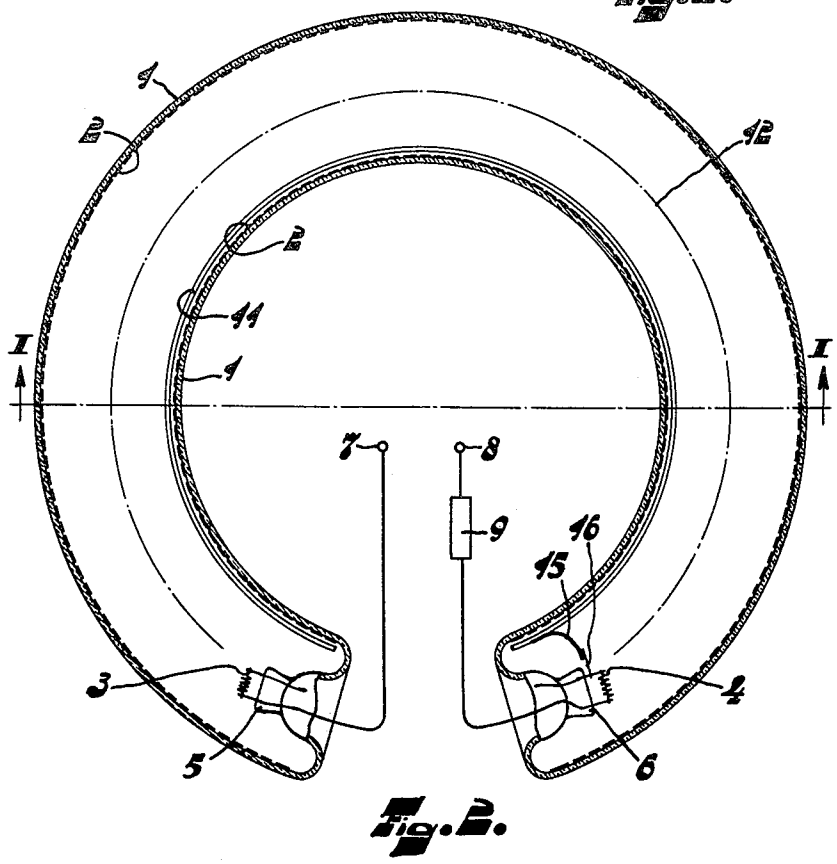

Fig. 2.

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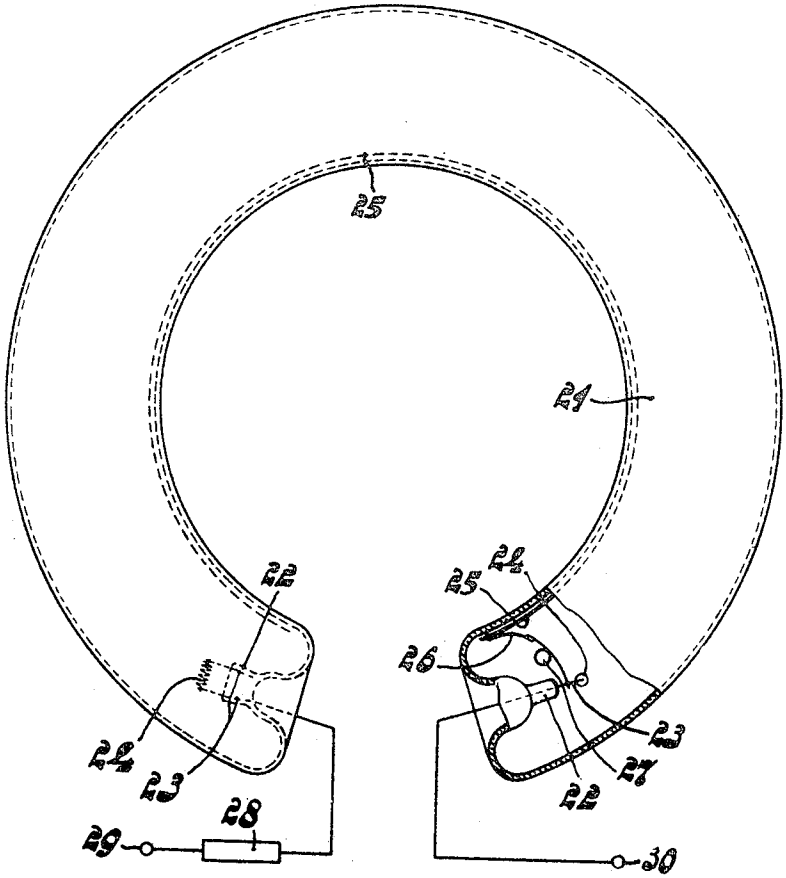

Fig. 3.

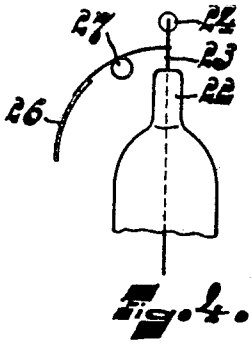

Fig. 4.

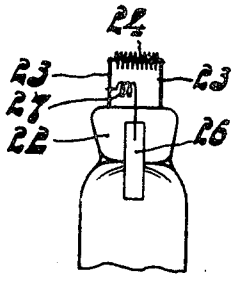

Fig. 5.

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TUBULAR GAS DISCHARGE LAMP

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Claims priority, application Netherlands October 13, 1951

6 Claims. (Cl. 313—185)

This invention relates to tubular gas discharge lamps, and more particularly to ring-shaped tubular discharge lamps of the type comprising a pair of activated main electrodes.

Lamps of the foregoing type are generally manufactured as straight tubes, the electrodes placed inside the tube in their proper position and interconnected in the correct arrangement, and the tubes are then given the shape of a ring, either closed or not closed, by bending around a cylindrical mandrel. However, such a technique of manufacture leads to difficulties in the proper operation of the completed lamp if an internal ignition electrode is used. In particular, the internal ignition electrode, which is in the form of one or two strip-like electrodes constituted by a mixture of graphite and glazing united to the inner surface of the tube, has discontinuities produced therein by the bending operation so that it no longer operates in a dependable manner. Furthermore, the bending operation produces distortions in the tube ends which frequently results in breaking of the electrical connection between a main electrode and the ignition electrode.

The principal object of the invention is to provide a tubular gas discharge lamp that will operate properly when bent to form a circular lamp.

According to the invention, a ring-shaped gas discharge lamp is provided with an internal ignition electrode arranged on the inner facing surface of the lamp tube in a plane parallel to a plane passing through the longitudinal axis or center line of the ring and spaced up to ⅛ of the internal tube circumference from the smallest internal ring circumference. If the lamp is provided with only one ignition electrode, it is preferably arranged along the smallest internal ring circumference, substantially in the plane passing through the center line of the ring. Where the lamp is provided with two ignition electrodes, each of them are preferably disposed on opposite sides of the plane passing through the center line of the ring, preferably about $\frac{1}{15}$ of the internal tube circumference from the smallest internal ring circumference.

According to a further aspect of the invention, the ignition electrode is electrically connected to a main electrode by means of a resilient member preferably comprising a helical metal wire in which the axis of the helix is substantially at right angles to the plane passing through the center line of the ignition electrode.

The invention will be described in connection with the accompanying drawing in which:

Fig. 1 is a sectional view of an annular lamp according to the invention in a plane passing through the axis of revolution of the ring;

Fig. 2 is a sectional view of the lamp shown in Fig. 1 in the plane passing through the center line of the ring;

Fig. 3 is a plan view of an annular discharge lamp, according to the invention, one end of which is cut open;

Figs. 4 and 5 are side and front views, respectively, of resilient elements connecting the ignition electrode to the main electrode.

Referring to Figures 1 and 2 which show a ring-shaped lamp according to the invention, an annular discharge vessel 1 of circular cross-section of a fluorescent lamp, a low-pressure mercury vapour discharge lamp, is filled with a rare gas, for example, argon, at a pressure of about 3 mm. of mercury and coated on the inner surface with a layer 2 of luminescent substances which convert the radiation produced in the discharge into radiation of longer wave-length. In the particular embodiment shown, the internal tube diameter is about 30 mm. and the diameter of the center line or longitudinal axis 12 of the ring is about 37 cms.

The ends of the discharge vessel 1, which are sealed in a vacuum-tight manner, are provided with activated wire main electrodes 3 and 4, the connections for the ends of which are led out through conventional pinch constructions 5 and 6. At least one of the ends of each main electrode 3, 4 is connected to a contact (not shown) of a cuff-like lamp cap (not shown) which surrounds the lamp ends, respectively. The contacts of the lamp cap are connected via the contacts of an associated lamp base (not shown) to the terminals 7 and 8 of a suitable supply source, for example, a direct current source of 220 volts. Inserted between the main electrodes 3, 4 and the supply source 7, 8 is a stabilizing resistor 9, for example, an incandescent lamp. It is obvious that in the case of an alternating current source of potential, the resistor 9 may be constituted by an inductor, a capacitor, combinations thereof or other impedances having a positive current voltage characteristic curve.

Arranged on the inner surface of the discharge vessel 1 are two strip-like auxiliary ignition electrodes 10 and 11, each of which are constituted by a mixture of graphite and glazing and exhibit a resistance of about 20 ohms per cm. length. The ignition electrodes 10, 11, the width of which is about 3 mm., are in planes normal to that of the plane of Fig. 1 of the drawing and are located on the inner wall of the tube such that the cones 13 and 14, co-axial with the ring-shaped lamp and passing through the center line 12 of the ring and through the ignition electrodes 10 and 11, respectively, form with the plane passing through the center line 12 an angle which is about 25° (Fig. 1). For an angle α of about 25°, in the particular embodiment shown, the ignition electrodes 10, 11 are each spaced about $\frac{1}{15}$ of the internal tube circumference from the smallest internal ring circumference. With such an arrangement of the ignition electrodes in the tube, it is assured that when the tube is bent around the mandrel, no discontinuities will be produced in the ignition electrodes and they will operate satisfactorily. The angle α may be increased up to about 45° in accordance with the invention and the spacing then will be about ⅛ of the internal tube circumference.

One end of the ignition electrode 11 is connected to the main electrode 4 by means of a metal strip 15 and a short metal wire 16 and the other end lies adjacent the other main electrode 3 (Fig. 2). The ignition electrode 10, which is not shown in Fig. 2, is similarly electrically connected to the main electrode 3 and insulated from the main electrode 4.

In principle, for direct current operation, only one ignition electrode is required. However, since it must be connected to the anode in order to insure independence from the polarity of the terminals 7 and 8, use is made of two ignition electrodes, one of which will always be positive. In alternating current operation, the use of only one ignition electrode suffices, and, in such a case, it is preferably arranged along the smallest internal ring circumference, substantially in the plane passing through the center line of the ring.

When the lamp is connected to the supply source, a glow discharge is initiated between the negative main

electrode and the ignition electrode insulated therefrom, this glow discharge, emanating from the said main electrode, passes along the ignition electrode and ultimately finds its way to the other main electrode. The main electrodes are caused by the glow discharge to assume emission temperature, whereupon this discharge passes into an arc discharge.

Referring to Fig. 3 which shows a further embodiment according to the invention, a discharge vessel **21** is bent into a substantially closed ring and comprises a low-pressure mercury vapour discharge tube, the inner surface of which is coated with a layer of fluorescent substances, the vessel **21** further containing a small supply of mercury and a rare gas filling. The ends of the discharge vessel **21** are sealed in a vacuum-tight manner by conventional pinch constructions **22**. Passing through these pinches **22** are lead-in wires **23** for activated wire main electrodes **24**. Arranged on the inner tube wall is an auxiliary ignition electrode **25**, about 3 mm. in width, constituted by a mixture of graphite and glazing having a resistance of about 20 ohms per cm. length. This ignition electrode **25** is connected to the right-hand electrode **24** and extends along the tube wall as far as the proximity of the left-hand main electrode.

The connection between the ignition electrode **25** and one of the lead-in wires for the right-hand main electrode **24** is constituted by a ferro-chromium strip **26** and a helically wound tungsten wire **27**. The strip **26** is secured to the ignition electrode **25** by heating. The tungsten wire or spring **27** is sealed at one end to the strip **26** and at the other end to one of the lead-in wires **23**. The axis of the helix is arranged at right angles to the plane defined by the center line of the ignition electrode **25**.

Figs. 4 and 5 are, respectively, side and front views showing the right-hand main electrode **24**, its lead-in wires **23**, the strip **26** and the spring **27** in the condition prior to inserting this electrode system in the end of the discharge vessel **21**. As may be seen from these figures, it will be necessary for the spring **27** to exert some pressure against the ignition electrode **25** during positioning in the discharge vessel if the strip **26** is to occupy the position shown in Fig. 3, and this assists in interconnection of the electrode **25** and the strip **26**. It is obvious that when the strip **26** is connected to the ignition electrode **25** and the discharge vessel **11** is bent to form a ring, the spring **27** will resiliently absorb the resulting variation in distance between the point of connection of the ignition electrode **25** to the strip **26** on the one hand, and the point of connection of the spring **27** to the lead-in wire **23** on the other, so that it is assured that the connection between the main and ignition electrodes remains intact even though production techniques are employed.

In the particular embodiment shown the helical tungsten wire **27** has a wire diameter of about 250 microns, a screw diameter of about 4 mm. and about three turns. Its material conserves its resilience at any temperature occurring during the manufacture of the tube.

At least one of the lead-in wires **23** for each electrode **24** is connected, by way of a lamp contact (not shown), an associated contact (similarly not shown) of a lamp base and a suitable series impedance **28**, for example, an incandescent lamp, to a terminal **29** and **30**, respectively, of a suitable supply source, for example, a 220 volts 50 c./s. light mains.

The internal tube diameter of the lamp is about 30 mm. and the largest ring diameter about 40 cm. The left-hand pinch **22** is shown in Fig. 3 turned through 90°. It is obvious that not only pinch constructions but also other electrode supports may be used.

While we have thus described our invention with specific examples and embodiments thereof, other modifications will be readily apparent to those skilled in the art without departing from the spirit and the scope of the invention as defined in the appended claims.

What we claim is:

1. In an electric discharge device, a ring-shaped light-transmissive envelope containing a low pressure ionizable gaseous medium, a pair of activated main electrodes within said envelope and at least one internal elongated strip-like ignition electrode having a central axis, said ring-shaped tubular envelope having a longitudinal axis through the center thereof and a minimum ring circumference and a given tube circumference, said ignition electrode being mounted on the inner surface of the envelope substantially in a plane parallel to a plane passing through the longitudinal axis and spaced from said minimum ring circumference a distance of not more than one-eighth said given tube circumference, and means within said envelope electrically connecting said ignition electrode to one of said main electrodes.

2. A ring-shaped tubular gas discharge lamp as claimed in claim 1 in which the connecting means between the main electrode and the ignition electrode comprises a resilient member constituted by a helical metal wire the axis of which is substantially at right angles to a plane passing through the central axis of the ignition electrode.

3. In an electric discharge device, a ring-shaped light-transmissive envelope containing a low pressure ionizable gaseous medium, a pair of activated main electrodes within said envelope and at least one internal elongated strip-like ignition electrode having a central axis, said ring-shaped tubular envelope having a longitudinal axis through the center thereof and a minimum ring circumference and a given tube circumference, said ignition electrode being mounted on the inner surface of the envelope substantially in a plane parallel to a plane passing through the longitudinal axis and spaced from said minimum ring circumference a distance of not more than one-fifteenth said given tube circumference, and means within said envelope electrically connecting said ignition electrode to one of said main electrodes.

4. In an electric discharge device, a ring-shaped light-transmissive envelope containing a low pressure ionizable gaseous medium, a pair of activated main electrodes within said envelope and two internal elongated strip-like ignition electrodes each having a central axis, said ring-shaped tubular envelope having a longitudinal axis through the center thereof and a minimum ring circumference and a given tube circumference, said ignition electrodes being mounted on the inner surface of the envelope substantially in a plane parallel to and on opposite sides of a plane passing through the longitudinal axis and spaced from said minimum ring circumference a distance of not more than one-fifteenth said given tube circumference, and means within said envelope electrically connecting each of said ignition electrodes to one of said main electrodes.

5. In an electric discharge device, a ring-shaped light-transmissive envelope containing a low pressure ionizable gaseous medium, a pair of activated main electrodes within said envelope and at least one internal elongated strip-like ignition electrode having a central axis, said ring-shaped tubular envelope having a longitudinal axis through the center thereof and a minimum ring circumference and a given tube circumference, said ignition electrode being mounted on the inner surface of the envelope substantially in a plane passing through the longitudinal axis and said minimum ring circumference, and means within the envelope electrically connecting said ignition electrode to one of said main electrodes.

6. In an electric discharge device, a ring-shaped light-transmissive envelope containing a low pressure ionizable gaseous medium, a pair of activated main electrodes within said envelope and at least one internal elongated strip-like ignition electrode having a central axis, said ring-shaped tubular envelope having a longitudinal axis through the center thereof, said ignition electrode being mounted on the inner surface of the envelope substan-

tially in a plane parallel to a plane passing through the longitudinal axis and defining an angle α between the latter plane and a straight line passing through said longitudinal axis and said central axis in the range between 0° and 45°, and means within the envelope electrically connecting said ignition electrode to one of said main electrodes.

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