May 26, 1970 HINOMARU FUJIO ET AL 3,514,276

METHOD OF MANUFACTURING NONLINEAR FLUORESCENT LAMPS

Filed May 17, 1967

FIG. 1

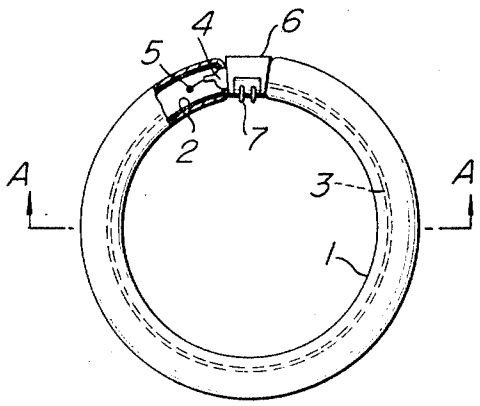


FIG. 2

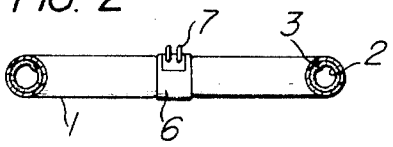


FIG. 3

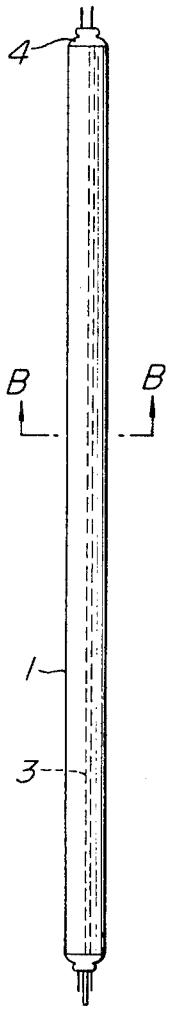
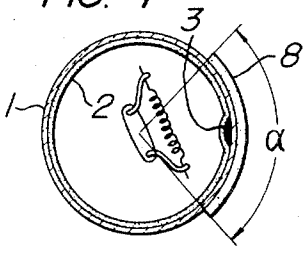


FIG. 4



INVENTORS
Hinomaru Fujio
Kazunori Fukunaga

BY Stevens, Davis, Miller & Mosher
ATTORNEYS

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METHOD OF MANUFACTURING NONLINEAR FLUORESCENT LAMPS

Hinomaru Fujio, Osaka, and Kazunori Fukunaga, Kyoto-shi, Japan, assignors to Matsushita Electronics Corporation, Osaka, Japan, a corporation of Japan

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ABSTRACT OF THE DISCLOSURE

Method of manufacturing nonlinear rapid start fluorescent lamps of the type having a starting strip positioned along the inside wall of the lamp and extending along the length of the lamp. The glass tube which forms the lamp is heated and then shaped after a thermal ray-reflecting film is applied on the outside surface of the tube covering the starting strip over the entire length of the strip to protect the strip from the action of the thermal ray during heating and shaping.

The present invention relates to an improved method of manufacturing fluorescent lamps and more particularly to an improved method of manufacturing circular and other nonlinear rapid start fluorescent lamps of the type having an electrically starting strip formed on the inside wall of the lamp.

While there are various kinds of rapid start fluorescent lamps which do not use a glow starter, rapid start fluorescent lamps or tubes which employ a starting strip attached to the inside surface of the tube as a starting aid are particularly simple in construction and at the same time have good starting characteristics. In fluorescent lamps of this type the starting strip is composed principally of graphite or the like containing an appropriate additive, and placed between the inside surface of a glass tube over which a fluorescent film is applied, or on the inside surface of a fluorescent film, extending along the length of the tube with a width of less than several millimeters. The starting strip may be either electrically connected to the electrodes of the lamp or left unconnected.

Linear fluorescent lamps employing starting strips may be manufactured without any particular difficulties and readily put in practical use. However, prior to the present invention many difficulties have been encountered in any attempt to manufacture fluorescent lamps utilizing starting strips in circular or other nonlinear shaped lamps.

In a previous method of manufacturing a circular or other nonlinear shaped fluorescent lamp, a fluorescent film and a starting strip were applied on the inside surface of a slender linear glass tube and electrodes were mounted on both ends of the tube. The tube was heated at a high temperature to soften it and then bent and formed into any desired shape by using a shaping roller. Air from the tube was then evacuated and the tube sealed enclosing mercury and a rare gas therein. With this method of manufacture it was very difficult to control the shape of the tubes and in addition, cracks often occurred in the starting strip interrupting the electrical connection therein.

It is an object of the present invention to overcome the shortcomings and disadvantages of the prior art by providing a new and improved method of manufacturing fluorescent lamps employing a starting strip therein.

It is another object of the present invention to more evenly distribute the effect of the heat applied to the tube in order that the tube may be softened more uniformly.

In the method of manufacturing nonlinear rapid start fluorescent lamps incorporating a starting strip described in the present invention, a thermal ray reflecting film is applied to the outside of the tube in such a manner as to cover said strip prior to heating said tube and forming it into a desired shape, thereby preventing the starting strip from absorbing a disproportionate amount of the heat applied to the tube which results in nonuniform softening of the tube.

Other details, objects and advantages of the present invention will become apparent from the following description of the present embodiment thereof, taken in conjunction with the drawings which accompany and form part of the specification.

FIG. 1 is a plan view partly broken away of a ring shaped rapid start fluorescent lamp manufactured in accordance with the method of the present invention.

FIG. 2 is a cross sectional view taken along A—A of FIG. 1.

FIG. 3 is a plan view of the tube of a fluorescent lamp prior to being shaped in accordance with the method of the present invention.

FIG. 4 is a cross-sectional view of a fluorescent lamp taken along B—B of FIG. 3 being formed into a circular shape in accordance with the method of the present invention.

Referring to the drawings, a glass tube **1** is provided with an electrically conductive starting strip **3** positioned on the inside surface of the tube and extending along the total length of the tube. Over the electrically conductive starting strip **3** and the remaining portion of the inside surface of the tube there is applied a fluorescent film **2**. On both ends of the tube **1**, stems **4** are attached in a hermetic seal through which lead wires from electrodes **5** positioned in the tube are lead out of the tube **1**, and connected to pins **7** of a base **6**. Predetermined amounts of mercury and rare gas are enclosed in the tube **1**.

In manufacturing fluorescent lamps of this type first, the starting strip **3** and the fluorescent film **2** are applied on the inside surface of a linear glass tube **1** as shown in FIG. 3, and the stems **4** through which the electrodes **5** are connected are attached to both ends of the tube and are hermetically sealed. Prior to the present invention, the tube thus prepared, as illustrated in FIG. 3, was then directly heated and shaped in order to form a predetermined design. In accordance with the present invention, however, as shown in the expanded cross-sectional view of FIG. 4, a white powder of titanium oxide is applied on the outside surface of the tube over a peripheral range, centered at the strip and forming an angle α of 90° from the center of the cross section of the tube, thereby forming a thermal ray reflective film **8** preventing the starting strip from absorbing a large amount of heat whereby the portion of the glass tube located adjacent to the strip would be disproportionally softened resulting in an unbalance with the remaining portion of the tube. After the thermal ray reflective film **8** is applied to the tube, the tube is heated and bent into any desired form. After the desired shape of the tube is attained, the thermal ray reflecting film **8** is brushed off the tube and any remanent thereof is wiped off with a piece of cloth. The air from within the tube is removed and the tube sealed to enclose predetermined amounts of mercury and rare gas therein. The base **6** is then attached to the tube providing a circular fluorescent lamp as shown in FIG. 1.

In accordance with the present invention a considerable number of circular fluorescent lamps have been manufactured avoiding the disadvantages of cracks or interruptions in the starting strip and improper shaping of the tubes otherwise experienced in the manufacture of non-

linear tubes by the utilization of prior art methods of manufacture.

In addition to titanium oxide TiO_2, the material of the thermal ray reflecting film **8** applied to the outside surface of the tube **1** may be composed of white powder such as aluminum oxide Al_2O_3, or zinc oxide ZnO and the like, which do not change in quality at the melting point of glass and will not sinter together with glass. These materials are normally suspended in an acetic acid ester containing nitrocellulose and the suspension is applied on the outside surface of the tube **1** by any appropriate methods.

There is a possibility that if the suspension is composed of only the above named ingredients, the film is apt to peal off during the heating operation of the tube, and therefore it is preferable to mix with the suspension further low melting inorganic materials having a melting or softening point below 600° C., such as boron trioxide (B_2O_3), or low melting glasses containing B_2O_3 such as $mCaO \cdot nBaO \cdot pB_2O_3$, where $m=0.15$, $n=0.20$ and $p=0.65$ for instance, or borates such as $Pb(BO_2)_2$ or the like. With such low melting inorganic materials, as long as the compound B_2O_3 therein is below a predetermined amount, they will never sinter together with the glass tube during the heating operation and can be readily wiped off after the tube has been bent into a desired form.

With regard to the predetermined amount of B_2O_3 referred to above, the ratio of B_2O_3 to the white material may be in the range of 0.2–5% by weight, preferably in the range of 0.2–1.5% and ideally about 1.0%. For example, a suspension of the following composition has been employed with good results.

Al_2O_3 as the white material 700 g.
B_2O_3 as the low melting material 7 g.
nitrocellulose 70 g.
butyl acetate 800 cc.

If the thermal ray reflecting film **8** is spread over too large a portion of the outer surface of the tube **1**, the heating function will not be performed sufficiently, thus it is preferable that the thermal ray reflecting film **8** is only applied to the peripheral portion of the tube centered at the starting strip and subtended by an angle α of 90° taken at the center of the cross section of the tube **1**.

In addition to the materials mentioned above the produce the thermal ray reflective film **8**, metallic plate may also be employed.

The present invention therefore provides a method whereby non-linear rapid start fluorescent lamps having starting strips on the surface of the tube may be efficiently manufactured without impairing the starting strips therein or incurring the other disadvantages of the prior art.

While the method of this invention has been shown as particularly applicable to circular fluorescent lamps, it is to be understood that fluorescent lamps of U-shape,

W-shape or any other desired shape may be similarly formed and that various changes in the steps of the method may be made by those skilled in the art without departing from the spirit of the invention as claimed.

We claim:

1. In a method of manufacturing non-linear rapid start fluorescent lamps having a starting strip provided on the inside surface of a glass tube and extending along the length of said tube, wherein the tube is heated to soften it and then is formed to a desired shape, the improvement comprising applying a thermal ray-reflecting film including a white inorganic material and a low melting inorganic material to the outside of said tube in such a manner as to cover said strip over its entire length prior to the heating of said tube, the ratio of said low melting inorganic material to said white inorganic material being in the range of 0.2–5% by weight so as to prevent said ray-reflecting film from being sintered or peeled off during the heating and shaping operation of the tube to thereby protect said strip from the action of the thermal ray.

2. An improvement in a method for manufacturing non-linear rapid start fluorescent lamps as defined in claim **1**, wherein said low melting inorganic material has a melting or softening point below 600° C.

3. An improvement in a method for manufacturing non-linear rapid start fluorescent lamps as defined in claim **2**, wherein said white inorganic material is selected from the group consisting of Al_2O_3, TiO_3, and Zno, and said low melting inorganic material is selected from the group consisting of B_2O_3, a low melting glass and a borate.

4. An improvement in a method for manufacturing nonlinear rapid start fluorescent lamps as defined in claim **3**, wherein the low melting inorganic material is B_2O_3 and the ratio of said B_2O_3 to the white inorganic material is in the range of 0.2–1.5% by weight.

5. An improvement in a method for manufacturing nonlinear rapid start fluorescent lamps as defined in claim **1**, wherein said thermal ray-reflecting film is a metallic plate.

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S. LEON BASHORE, Primary Examiner

S. R. FRIEDMAN, Assistant Examiner

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