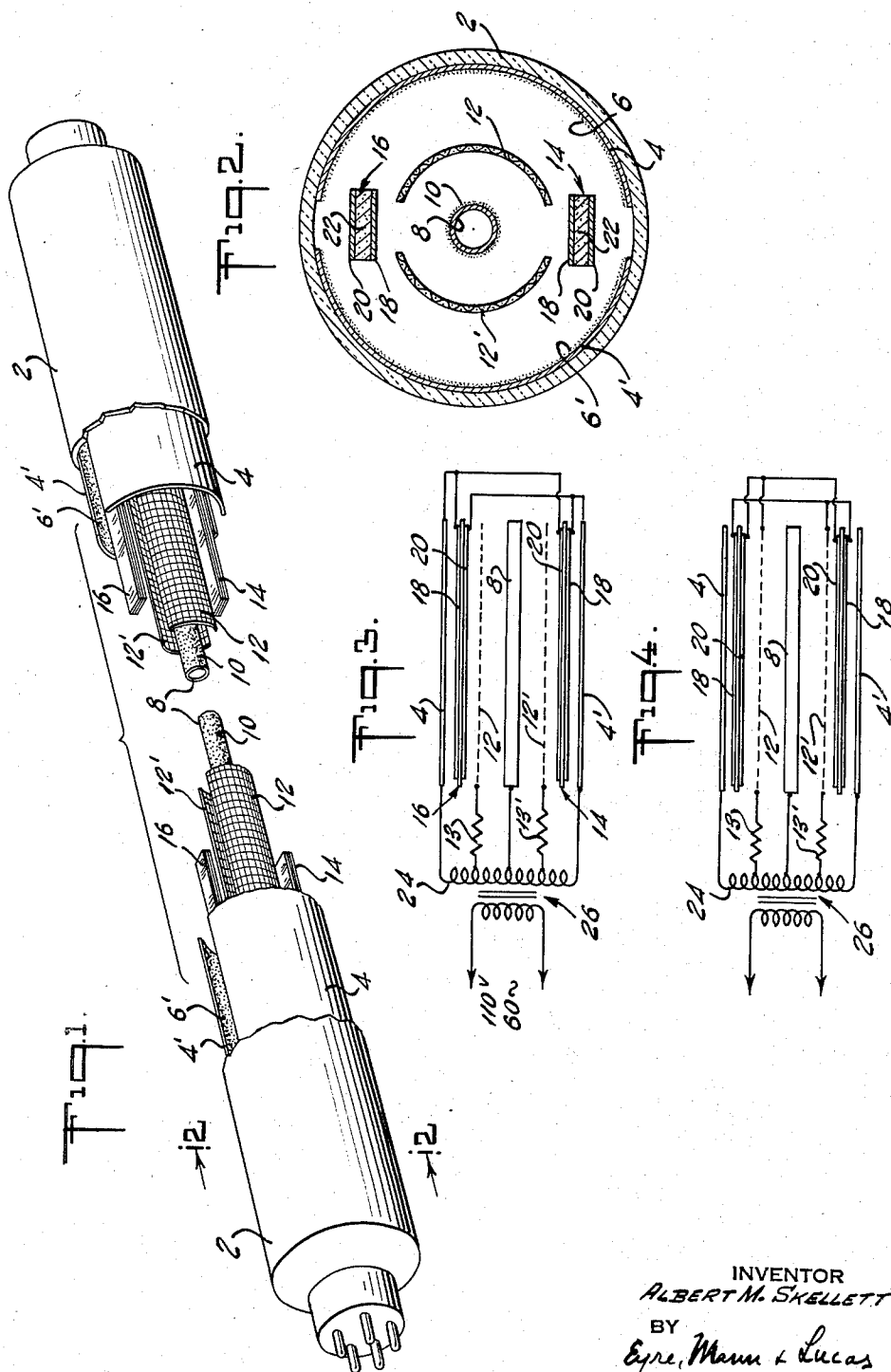


Feb. 16, 1960

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COLD CATHODE VACUUM LAMP
Filed July 15, 1958

2,925,511



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COLD CATHODE VACUUM LAMP

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Application July 15, 1958, Serial No. 748,726

8 Claims. (Cl. 313-103)

The present invention relates to cold cathode vacuum electronic devices of the type wherein the cathode comprises a conducting sleeve or the like coated with a porous sponge-like layer of magnesium oxide. In such type of device, once electron emission is initiated from the cathode coating, the emission becomes self-sustaining provided one or more electrodes of higher potential are present for collection of the emitted electron stream. The invention comprises primarily a novel fluorescent lamp utilizing such type of coated cathode.

Conventional fluorescent lamps contain mercury vapor, are subject to flicker upon change in pressure within the lamp, and are relatively slow in starting. The new lamp, being a vacuum lamp, is more reliable in operation, gives greater brilliance per square centimeter of luminous area and is fast starting. The new lamp operates on lower voltage than that required in conventional lamps.

In a copending application of the present applicant, Serial No. 745,149 filed June 27, 1958, novel means for initiating electron emission from magnesium oxide coated cathodes is described and claimed in connection with vacuum tube amplifiers and rectifiers. The starting means in the said copending application comprises an electro-luminescent element within an evacuated envelope and means for energizing the element to cause it to luminesce and irradiate the cathode coating with ultraviolet light. The lamp of the present invention utilizes similar electroluminescent elements for initiation of emission of electrons from the cathode during each one-half cycle of the impressed alternating voltage.

Briefly, the new lamp comprises an elongated tubular envelope of glass or the like having on its inner surface a thin transparent conducting layer, separated into two electrically isolated sections, and carrying on its inner surface a layer of cathodo-luminescent phosphor material, two electroluminescent starter elements and a cathode coated with a porous layer of magnesium oxide. In addition to the above mentioned elements the lamp may, and preferably does, include two grid like elements which serve to accelerate and collect electrons emitted from the cathode coating.

For a better understanding of the invention and of specific structures embodying the same reference may be had to the accompanying drawings of which:

Fig. 1 is a side view, partly broken away, of a lamp embodying the invention;

Fig. 2 is a transverse sectional view of the lamp of Fig. 1 taken on the line 2-2 of Fig. 1;

Fig. 3 is a diagrammatic circuit drawing showing the electrical connections to the elements of the lamp of Fig. 1; and

Fig. 4 is a diagram similar to Fig. 3 but representing different circuit connections.

In Fig. 1, to which reference may now be had, the internal electrical connections between the parts have been omitted for simplicity and the particular support means for the internal elements have not been shown

as any means for mounting the elements in a suitable press can be employed. The new lamp comprises an envelope 2 of glass on the inner wall of which is deposited a layer or film of transparent conducting material such as tin oxide, the layer being divided into two areas 4 and 4' (see Fig. 2) each covering slightly less than one-half of the circumference of the tube. For clarity the thickness of the film portions is exaggerated in the drawing. Deposited on the film portion 4 is a layer 6 of cathodo-luminescent phosphor material, for example, zinc sulfide activated with silver. A similar phosphor layer 6' is deposited on the conductive film portion 4'.

Extending axially of the tube 2 is the cathode which comprises a sleeve 8 of nickel or the like coated with a deposit 10 of magnesium oxide in sponge-like form. Semi-cylindrical wire mesh grids 12 and 12' are disposed between the respective layers 6 and 6' of the luminescent material and the coated cathode. Elongated starter elements 14 and 16 are positioned in the tube at opposite sides of the cathode and preferably in general alignment with the part of the glass tubing 2 which is not covered with the conductive film. Each starter element 14 and 16 comprises a sandwich of two thin metal strips 18 and 20 between which is a layer of electroluminescent phosphor 22. The phosphor should be one which emits ultraviolet light when excited. One suitable phosphor is zinc sulfide activated with lead and copper. Although not shown in Fig. 1 leads to the metal strips 18 and 20 of each starter element 14 and 16 to each grid 12 and 12' and to each conducting coating portion 4 and 4' are provided for connection externally in a suitable circuit.

Fig. 3, to which attention may now be had, illustrates one suitable circuit for the elements within the tube 2. In Fig. 3 the conducting elements of the tube 2 have been shown in exaggerated spaced relation. The conducting coating portions 4 and 4' are connected to opposite ends of the secondary 24 of an input transformer 26 the primary of which may be connected to alternating 110 v. 60 cycle supply lines. The grids 12 and 12' are connected through resistors 13 and 13', respectively, to the secondary 24 at points of lesser voltage and the sleeve 8 of the cathode is connected to the mid point of the secondary 24. The outer strip 18 of starter 16 is connected to the conducting layer portion 4 and to the conducting strip 20 of starter 14. Similarly the outer strip 18 of starter 14 is connected to the conducting film portion 4' and to strip 20 of starter 16.

With the above described connections the operation of the lamp of Fig. 1 is as follows: When alternating voltage is impressed across the primary of transformer 26 alternating voltage is impressed across strips 18 and 20 of each starter causing luminescence of the phosphor layer of each starter and irradiation of the coating 10 of the cathode. Electron emission is thus initiated from the cathode coating. During one-half cycle of the applied voltage, grid 12 will be positive with respect to the cathode and attract electrons therefrom. During such one-half cycle the conducting film 4 on the tube 2 will be at a still higher potential so that electrons from the cathode will be drawn through the grid 12 to the wall of the tube striking the cathodo-luminescent phosphor 6 thereon and causing it to glow and emit light. During the other one-half cycle of the impressed voltage, grid 12', and conductive layer 4' will be positive with respect to the cathode and electron emission from the cathode, initiated by the starter 14, will cause luminescence of the phosphor layer 6'. There will be a continuous emanation of light from the lamp, if the luminescence of layer 6 or 6' persists until the layer is again bombarded with electrons emitted from the cathode. With phosphor layers of less persistence the light will

flicker at 120 c.p.s. as in conventional mercury type fluorescent lamps.

Instead of the circuit of Fig. 3 the alternative current of Fig. 4 can be employed. In this embodiment of the invention the starter elements 14 and 16 are connected for operation at the potential of the grids 12 and 12' rather than that of the conductive layers 4 and 4'. As the operation of the circuit is not otherwise changed it is believed that no further description is necessary for an understanding of the alternative arrangement of Fig. 4.

Although, as heretofore indicated, the use of the grids 12 and 12' is preferred, they are not essential as the potentials applied to the conducting films 4 and 4' may be made sufficient to attract electrons emitted from the cathode. The starter elements insure initiation of electron emission during each one-half cycle. A circuit for such embodiment of the invention has not been illustrated, as it is the same as that of Fig. 3 except for the omission of the grid electrodes and the insertion of resistors 13 and 13' in the respective leads to the films 4 and 4'.

The particular voltages at which the electrodes operate are dependent upon the geometry of the tube but are generally of the order of four or five hundred volts maximum as compared to the high voltage of 900 or 1000 volts required for operation of mercury type fluorescent lamps.

The invention has now been described with reference to a particular embodiment thereof and to minor modification thereof. Obviously the particular elongated shape illustrated in Fig. 1 is not essential nor is the invention limited to the particular phosphors suggested as suitable for use in the new lamp. Although two starter elements, each of a length commensurate with the cathode, have been shown shorter elements can be used. This is true because when electron emission starts from any part of the cathode coating it spreads rapidly over the whole surface. For the same reason a single starter could be employed. Two starters provide slightly quicker starting, and hence are preferred.

The following is claimed:

1. A lamp comprising an evacuated envelope, two transparent conductive films on different portions of the inner wall of the envelope, a cathodo-luminescent phosphor layer on each film, a cathode within the envelope comprising a conductive member coated with a porous sponge-like layer of magnesium oxide and starting means in the envelope adapted when energized to irradiate the magnesium oxide coating with ultraviolet light to initiate electron emission therefrom, electrons from said coating when attracted to said conducting films by electric potentials impressed thereon, striking said cathodo-luminescent phosphor layer and causing luminescence thereof.

2. The lamp according to claim 1 wherein said starting means comprise at least one electroluminescent element and means for energizing the same.

3. The lamp according to claim 1 wherein grid electrodes are included within the envelope for accelerating electrons toward said conductive films.

4. The combination with the lamp of claim 1 of an energizing circuit for the elements thereof comprising a transformer having a primary winding adapted to be connected to a source of alternating voltage and a secondary winding, a connection between said cathode and the mid point of said secondary winding, means connecting said conductive films to opposite ends of said secondary winding and circuit means for energizing said starting means.

5. The lamp according to claim 1 wherein said starting means comprise two electroluminescent devices each including a layer of electroluminescent phosphor sandwiched between two conductive sheets.

6. A lamp comprising a generally cylindrical evacuated envelope, two transparent conductive films on different semi-cylindrical portions of the inner wall of the envelope, a cathodo-luminescent phosphor layer on each film, a cathode axially disposed within the envelope and comprising a conductive sleeve carrying a porous sponge-like coating of magnesium oxide, a pair of grid electrodes, one disposed between the cathode and each of the conductive films, and electroluminescent starting means within the envelope adapted when energized to irradiate the cathode coating with ultraviolet light to initiate electron emission therefrom, a source of alternating voltage and circuit means coupling said cathode, said films, said grids and said starting means to said source.

7. A cold cathode vacuum lamp and energizing circuit therefor comprising a transformer having a primary winding adapted to be coupled to a source of alternating voltage and a secondary winding, an evacuated envelope, a cathode within the envelope comprising a conductive member connected to the mid-point of said secondary winding and covered with a porous sponge-like coating of magnesium oxide, a transparent conductive film on part of the inner wall of the envelope and electrically connected to one end of said secondary winding, a second conductive film on another part of the inner wall of the envelope and connected to the other end of said secondary winding, a layer of cathodo-luminescent phosphor material on each conductive film and electroluminescent means in said envelope adapted when energized to irradiate said cathode coating to initiate electron emission therefrom, and means for energizing said electroluminescent means.

8. A lamp comprising a single walled evacuated envelope having cathodo-luminescent phosphor material therein, means for bombarding said material with electrons to cause luminescence thereof, said means comprising a cold cathode within the envelope having a porous sponge-like coating thereon of material adapted to emit a self-sustaining electron stream, and means within said envelope for initiating electron emission from said coating.

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