Feb. 16, 1943. S. C. MILLER 2,310,983

ELECTRODE FOR LUMINOUS TUBES AND METHOD OF PRODUCING THE SAME

Filed Feb. 20, 1940

Fig. 1.

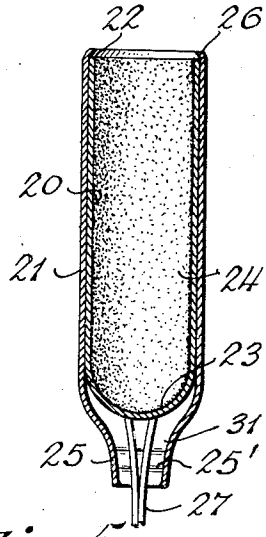


Fig. 2.

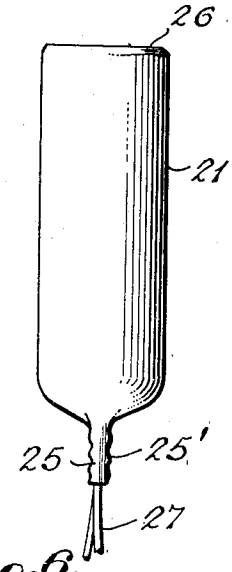


Fig. 3.

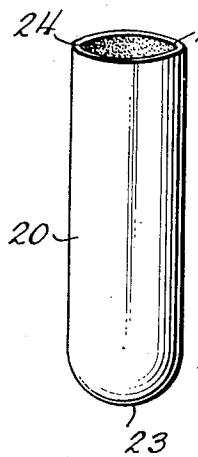


Fig. 4.

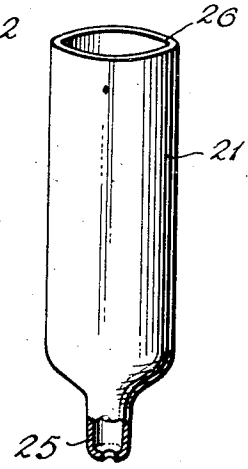


Fig. 5.

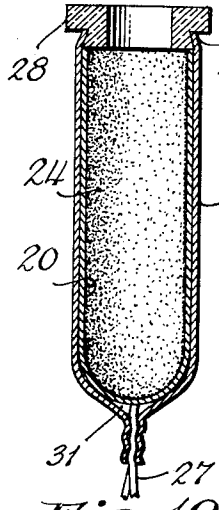


Fig. 6.

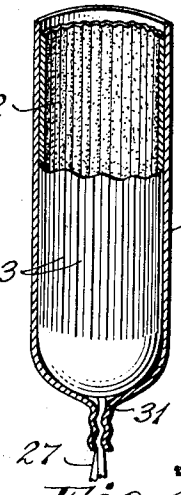


Fig. 7.

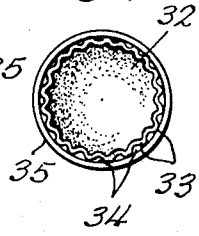


Fig. 8.

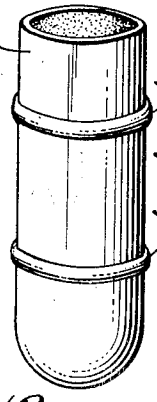


Fig. 9.

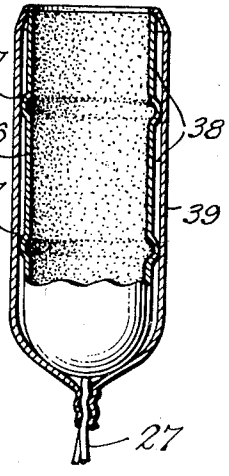


Fig. 10.

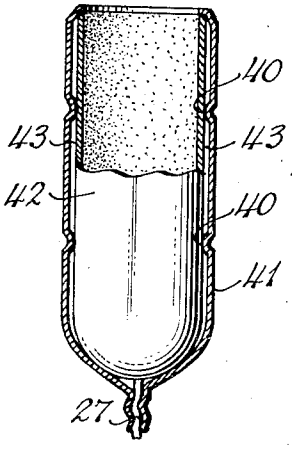


Fig. 11.

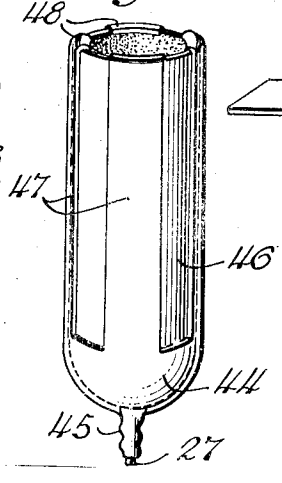


Fig. 13.

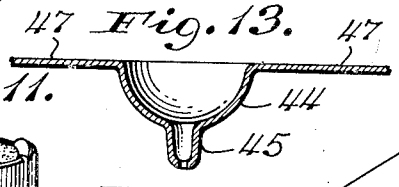
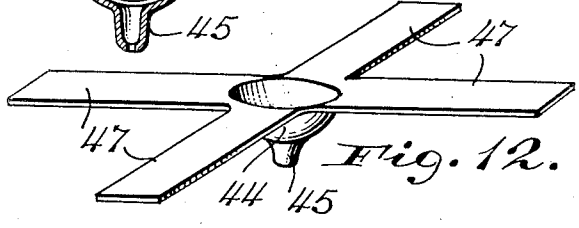


Fig. 12.



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UNITED STATES PATENT OFFICE

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ELECTRODE FOR LUMINOUS TUBES AND METHOD OF PRODUCING THE SAME

Samuel C. Miller, New York, N. Y.

Application February 20, 1940, Serial No. 319,820

12 Claims. (Cl. 176—126)

My present invention relates generally to luminous devices of the so-called neon tube variety, and has particular reference to the electrodes employed in such devices.

Coordinately, my invention relates to an improved procedure for manufacturing and assembling such electrodes.

The electrode to which my invention has primary reference is usually of substantially cylindrical character, one end being open and facing in the direction of the glass tube within which it is mounted, the other end being closed. A lead in wire extends through the glass tube and into electrical connection with the electrode.

Where the lead in wire is associated with the closed end of the electrode by a crimping engagement between the wire and the material of the electrode, numerous well known disadvantages ensue. The electrode becomes tapered at the point of attachment to the lead in wire, and since the tapered end is in the direct path of bombardment of the electrified particles to which the electrode is subsequently subjected, an undesirable concentration of heat results. This not only shortens the useful life of the electrode, but also prevents the uniform heating of the electrode and the glass tube during the usual heat treatment to which the device is subjected, during manufacture, for purposes of eliminating impurities.

Furthermore, where the interior surface of the electrode has been coated with a layer of protective electron-emitting material, such as barium oxide, the coating is broken or otherwise impaired by the process of crimping the electrode into association with the lead in wire.

In an effort to overcome these difficulties, electrodes have heretofore been constructed with a smoothly rounded substantially hemispherical closed end, and the lead in wire has been associated with such an electrode by spot welding. However, the process of effecting the spot weld requires that an electrical contact be applied to the inner surface of the electrode, and where the electrode has been coated with a protective layer of the character mentioned, such layer has frequently been impaired, or even destroyed, because of this procedure.

It is a general object of my present invention to provide an electrode of the character mentioned, whose structural nature and method of creation and assembly permits all of the foregoing disadvantages to be obviated, and which allows a number of new advantages, not heretofore capable of accomplishment, to be attained.

The present improved electrode, which may be of no greater size or weight than the ordinary one, and whose method of manufacture is unusually simple and inexpensive, is characterized by a smoothly rounded closed end which may, if desired, carry a protective coating of unbroken, unimpaired character and uniformity. It is further characterized by a relationship of parts which not only avoids undesirable concentration of heat, but also retards the transmission of heat from the electrode to the glass tube within which it is mounted, thereby allowing a more uniform heating of the electrode and the glass tube, both during the preliminary heat treatment and during the useful life of the device as a whole.

Briefly, an electrode constructed in accordance with the present invention comprises an electrically-conductive cup-shaped shell having a smoothly rounded closed end, in combination with an electrically-conductive envelope mounted on said shell and in electrical contact therewith. This forms an electrical entity having numerous advantages. In the first place, the lead in wire may be secured to the envelope, and through it to the electrode as a whole, without requiring any distortion or undesirable handling of the cup-shaped shell, or any disturbance or impairment of any protective delicate coating that may be applied to the interior surface of the latter. In the second place, the lead in wire may be connected to the envelope in any convenient or desired manner, either by crimping the envelope or otherwise, and without requiring any painstaking care or delicate precautions. In the third place, the double-walled nature of the resultant electrode serves to retard the conduction of heat from the cup-shaped shell to the glass tube within which the electrode is mounted.

In a preferred embodiment, the envelope is provided with an attenuated neck into which the lead in wire passes and in which it may be firmly engaged by a simple crimping operation. Preferably, the lead in wire passes through the envelope and its end is brought into contact with the closed end of the shell, thereby fulfilling the additional function of conducting excess heat rearwardly away from the closed end of the shell.

In accordance with my invention, it is feasible, if desired, to provide appreciable heat-insulating spaces between the shell and envelope to enhance the heat-retarding effect. One way of accomplishing this result in a simple and efficient manner is to configure the shell and the envelope

relative to each other, as by ridges or other convolutions, to form appreciable heat-insulating spaces between them.

I achieve the foregoing objects and such other objects and advantages as may hereinafter appear or be pointed out, in the manner illustratively exemplified in the accompanying drawing in which:

Figure 1 is a longitudinal cross sectional view through an electrode embodying the features of the present invention;

Figure 2 is a view taken at right angles to Figure 1;

Figure 3 is a perspective view of the cup-shaped shell of Figure 1, shown by itself;

Figure 4 is a perspective view of the envelope of Figures 1 and 2, shown by itself; prior to assembly with the shell;

Figure 5 is a cross sectional view through an assembled electrode, showing a slight modification;

Figure 6 is a cross sectional view of an assembled electrode showing a further modification;

Figure 7 is a top end view of Figure 6;

Figure 8 is a modified electrode shell shown in perspective by itself;

Figure 9 is a cross sectional view of an assembled electrode in which the shell of Figure 8 is employed;

Figure 10 is a view similar to Figure 9 showing a modification;

Figure 11 is a perspective view of an assembled electrode showing a further modification;

Figure 12 is a perspective view of the envelope entering into the construction of Figure 11, during a step in its manufacture; and

Figure 13 is a fragmentary cross sectional view of this envelope.

In the construction I have chosen to illustrate in Figures 1–4 a substantially cylindrical shell 20 is snugly mounted within an envelope 21.

The shell 20, shown by itself in Figure 3, is of any suitable electrically-conductive material, such as iron, nickel, or the like. It may have a thickness as low as, or less than, .008 of an inch. It is preferable in the form of a substantially cylindrical tube whose free edge 22 defines an open end through which the electrified particles are intended to pass when the electrode is used. The closed end 23 is smoothly rounded, and by this term I mean to signify that the internal surface at this end is devoid of sharply angulated regions or reentrant portions, and conforms to the smooth gentle curvature of the kind that is typified by a hemisphere. In practice, I have found that the desirable advantages of the present invention may be achieved by making the closed end 23 conform substantially to a hemispherical contour.

The internal surface of the shell 20 may be coated, if desired, as indicated at 24, with a layer of electron-emitting protective material, such as a barium-strontium salt held together with a butyl acetate binder, this salt changing to a protective oxide under the influence of the heat that is engendered during the preliminary treatment to which the device is subjected for purifying purposes.

The envelope 21, shown in Figures 1, 2 and 4, is also of any suitable electrically-conductive material, and has been shown in the form of a substantially cylindrical element adapted to fit snugly and frictionally over and around the shell 20. Certain advantages of the present invention may be achieved by making the fit a so-called "driving fit," or by otherwise associating the envelope in secure electrical contact with the inner shell; but for the achievement of certain additional advantages hereinafter to be mentioned, the fit is preferably of mere "frictional" variety, which is wholly adequate to provide a firm electrical bond, but which at the same time leaves a microscopic heat-insulating space or multiplicity of spaces between the shell and the envelope.

The envelope 21 might have a thickness as small as, or less than, approximately .008 of an inch, so that the total thickness of the envelope and shell may be made to be no greater than the thickness of the ordinary one piece electrode heretofore employed.

In the envelope illustrated, an attenuated neck 25 is formed at the rear end, and the length of the envelope is so chosen that when the envelope is applied over the shell 20, the free edge 26 may be bent or spun over the free edge 22 of the shell, as shown most clearly in Figure 1, while the attenuated neck portion 25 extends rearwardly for a slight distance beyond the rounded end 23 of the shell.

In assembling the device, one or more lead in wires 27 are caused to pass through the neck 25 and this neck is then distorted, as by crimping to the form 25', to engage the wire or wires 27 in a firm manner, as shown most clearly in Figs. 1 and 2. Preferably, the wire or wires 27, when passed into and through the neck 25, are caused to extend into contact with the rounded end 23 of the shell, as shown in Figure 1. This physical contact furnishes a convenient means of conducting excess heat from the closed end of the shell 20 rearwardly through the wire or wires 27.

While the rounded end 23, by its reflective qualities, prevents the concentration of any undue heat on this region of the electrode, nevertheless, the end 23 is in the direct path of bombardment of the electrified particles, and for this reason, it is desirable that as much heat as possible be withdrawn from this portion of the electrode.

It is sometimes desirable to mount an insulating member, such as a heat-resistant ceramic collar at the open end of the electrode. The present invention lends itself readily to such a construction. By way of example, I have shown in Figure 5 an electrode assembly of the character hereinbefore described, in combination with a ceramic collar 28. It will be observed that this collar may be conveniently held in position by the inturned edge 29 of the envelope 30. Since it is desirable to turn the edge 29 inwardly, in any event, as shown in Figures 1 and 2, this step in the process of assembly may be caused, at the same time, to engage a suitable portion of the collar 28 as shown in Figure 5.

The "frictional" fit between the inner shell and the outer envelope, as hereinbefore mentioned, provides for a multiplicity of minute heat-insulating spaces between these two elements. These spaces, together with the larger spaces around the closed end of the inner shell, as indicated by the reference numerals 31 in Figures 1 and 5, serve to retard the transmission of heat from the inner shell to the envelope around it. This results in a more uniform heating of the electrode in general, and of the envelope in particular; and since the heat from the electrode is transmitted through the lead in wires to the glass tube in which the electrode is arranged, the ultimate result is a more uniform and gradual heating of the glass tube.

This is highly desirable, and minimizes the stresses that are inevitably set up both during the preliminary heat treatment and during the regular usage of the device.

To enhance this effect, it may be desirable under certain circumstances to impart special configurations to the shell and the envelope so as to provide relatively larger heat-insulating spaces. One way to accomplish this is illustrated in Figures 6 and 7, in which I have illustratively shown an inner shell 32 provided on its exterior surface with longitudinal convolutions or ridges 33. The formation of these ridges is most conveniently accompanied, in practice, by the formation of corresponding depressions on the inner surface of the shell, but it will be understood that the important structural feature resides in the fact that the irregularities are on the exterior surface of the shell, whereby longitudinal heat-insulating spaces 34 are provided between the shell 32 and the envelope 35.

In Figures 8 and 9 I have shown another way in which such spaces may be provided. In this case, the shell 36 is provided with circumferential protrusions, such as the ridges 37, these irregularities providing heat-insulating spaces 38 between the shell 36 and the envelope 39.

In Figure 10, I achieve the same general purpose by providing inwardly projecting protrusions, such as the circumferential ridges 40, on the envelope 41, while the shell 42 is left with a substantially smooth exterior surface. This provides the spaces 43 which serve to retard the transfer of heat from the shell 42 to the envelope 41.

In each case, however, it will be observed that the shell and the envelope are in firm electrical contact and form a single electrical unit.

A number of the foregoing advantages may be achieved in a somewhat different fashion as indicated in Figures 11–13. In this embodiment of the invention, the envelope is formed of an integral element which may be stamped, spun, or otherwise shaped into a sort of spider, as shown most clearly in Figures 12 and 13. This spider has a medial portion 44 which is substantially cup-shaped and provided with the attenuated neck 45. When this device is assembled with the shell 46, the radiating arms 47 are bent or spun into substantial conformity with spaced longitudinal areas of the shell 46, the free ends 48 being ultimately bent over to engage the free edge of the shell 46. These spaced longitudinal envelope portions serve to establish a firm electrical bond between the envelope and the shell 46, and the spaces between them serve to retard the transfer of heat from the shell 46 to the envelope. The neck 45 is adapted to be crimped or otherwise engaged around a lead in wire or wires in the manner heretofore described.

It will be understood that certain phases of my invention are not necessarily restricted to the particular shapes shown in the present drawings. For example, the electrode elements may be somewhat shorter or longer, or may have configurations other than the substantially cylindrical ones illustrated. It is important to observe, however, that the closed end of the inner shell always presents, on its interior, a smoothly rounded contour which avoids the undesirable concentration of heat, and helps to distribute the heat more uniformly throughout the entire body of the shell as a result of the inherent ability of this rounded surface to reflect, into varying angular directions, the electrified particles that impinge upon it.

Needless to say, the inner surface of the shell need not be provided with any special protective coating, but where such coating is necessary or desirable, the practice of the present invention assures that it will remain unbroken and unimpaired during the manufacture and assembly of the electrode.

In practice, it is the preferred procedure to construct the shell and envelope separately, to coat the inner surface of the shell (where such coating is desired) then to assemble the shell and the envelope and finally to attach the lead in wires to the envelope. During the latter step, whether it be performed before the shell and envelopes are assembled, or after they have been brought together, no special precautions need be taken to safeguard the shell or the coating that may be in it.

While crimping of the neck 25, 45, etc. to the lead in wires is illustrated, it will be understood that spot welding may also be employed. In such procedure it may be after or simultaneous with the crimping operation or without crimping. The side walls of the neck 25, 45 etc. are contacted by the welding electrodes and under such conditions of production this welding operation does not injure or deform the interior of the shell 28 or the corresponding member in the other embodiments.

In general, it will be understood that those skilled in the art may make changes in the details herein described and illustrated without departing from the spirit and scope of the invention as expressed in the appended claims. It is therefore intended that these details be interpreted as illustrative and not in a limiting sense.

Having thus described my invention and illustrated its use, what I claim as new and desire to secure by Letters Patent is:

1. In an electrode for luminous devices, the combination comprising an electrically-conductive shell, its internal surface having an uninterrupted and interiorly smoothly rounded closed end, an electrically-conductive envelope on said shell and in electrical contact therewith, and a lead-in wire secured to said envelope to leave said shell unimpaired and to have substantially uniform heat transmission characteristics.

2. In an electrode for luminous devices, the combination comprising an electrically-conductive shell, its internal surface having a smoothly rounded closed end, an electrically-conductive envelope on said shell and in electrical contact therewith, and a lead-in wire secured to said envelope, said lead-in wire passing through said envelope and extending into electrically conducting contact with the closed end of said shell to leave said shell unimpaired and to have substantially uniform heat transmission characteristics.

3. In an electrode for luminous devices, the combination comprising an electrically-conductive shell, its internal surface having a smoothly rounded closed end, an electrically-conductive envelope on said shell and in electrical contact therewith, and a lead-in wire secured to said envelope, said envelope being provided with an attenuated neck into which the lead-in wire passes, said neck being crimped into engagement with said wire to leave said shell in the condition aforesaid.

4. In an electrode for luminous devices, the combination comprising an electrically-conduc-

tive shell, its internal surface having a smoothly rounded closed end, the interior surface being provided with an unbroken uniform protective electron-emitting coating, an electrically-conductive envelope on said shell and in electrical contact therewith, and a lead-in wire secured to said envelope to leave said shell unimpaired and to have substantially uniform heat transmission characteristics.

5. In an electrode for luminous devices, the combination comprising an electrically-conductive shell, its internal surface having a smoothly rounded closed end, an electrically-conductive envelope on said shell and in electrical contact therewith, and a lead-in wire secured to said envelope, said shell and envelope being relatively configured to provide appreciable heat-insulating spaces between them.

6. In an electrode for luminous devices, the combination comprising an electrically-conductive shell, its internal surface having a smoothly rounded closed end, an electrically-conductive envelope on said shell and in electrical contact therewith, and a lead-in wire secured to said envelope, said shell and envelope being relatively configured to provide appreciable heat-insulating spaces between them, said configuration comprising protrusions on at least one of said elements.

7. In an electrode for luminous devices, the combination comprising an electrically-conductive shell, its internal surface having a smoothly rounded closed end, an electrically-conductive envelope on said shell and in electrical contact therewith, and a lead-in wire secured to said envelope, said shell and envelope being relatively configured to provide appreciable heat-insulating spaces between them, said configuration comprising longitudinal ridges on at least one of said elements.

8. In an electrode for luminous devices, the combination comprising an electrically-conductive shell, its internal surface having a smoothly rounded closed end, an electrically-conductive envelope on said shell and in electrical contact therewith, and a lead-in wire secured to said envelope, said shell and envelope being relatively configured to provide appreciable heat-insulating spaces between them, said configuration comprising circumferential ridges on at least one of said elements.

9. In an electrode for luminous devices, the combination comprising an electrically-conductive shell, its internal surface having a smoothly rounded closed end and interiorly coated with a layer of electron-emitting protective material, an electrically-conductive envelope of conducting material on said shell and in electrical contact therewith, the free edge of the envelope being turned in to engage over the corresponding edge of the shell, and a lead-in wire secured to said envelope.

10. In an electrode for luminous devices, the combination comprising an electrically-conductive shell, its internal surface having a smoothly rounded closed end, an electrically-conductive envelope on said shell and in electrical contact therewith, the free edge of the envelope being turned in to engage over the corresponding edge of the shell, a ceramic collar mounted on the shell and engaged by said turned in edge, and a lead-in wire secured to said envelope.

11. In an electrode for luminous devices, the combination comprising an electrically-conductive shell, its internal surface having a smoothly rounded closed end, an electrically-conductive envelope on said shell and in electrical contact therewith, and a lead-in wire secured to said envelope, said envelope comprising a medial portion to which said lead-in wire is secured, and spaced longitudinal portions extending from said medial portion into engagement with the free edge of the shell.

12. The method of constructing and assembling an electrode, which consists in first shaping an electrically-conductive shell so as to provide its internal surface with a smoothly rounded closed end, then coating the interior surface with an unbroken layer of protective electron-emitting material, and then fitting said shell within an electrically-conductive envelope adapted to be secured to a lead-in wire.

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