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Fujii et al.

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[54] **ANODE SUBSTRATES FOR MULTI-DIGIT TYPE FLUORESCENT DISPLAY TUBES**

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[52] **U.S. Cl.** ..... **313/109.5,** 313/108 R

[51] **Int. Cl.** **H01j 7/42,** H01k 1/60

[58] **Field of Search** ..... 313/108 R, 109.5

[56] **References Cited**

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[57] **ABSTRACT**

The anode substrate for use in a multi-digit type fluorescent tube comprises an insulator substrate printed with conductors for electrically interconnecting corresponding segment electrodes, an insulator substrate overlying the printed conductors and provided with a plurality of perforations above the printed conductors, a plurality of segment electrodes formed on the insulator film at the positions of the perforations, the electrodes including integral connectors extending through the perforations and respectively connected to the printed conductors, phosphor films applied onto respective segment electrodes, the segment electrodes being arranged in a predetermined pattern to display predetermined letters, and a protective film overlying the insulator film and provided with a plurality of the segment electrodes.

3 Claims, 6 Drawing Figures

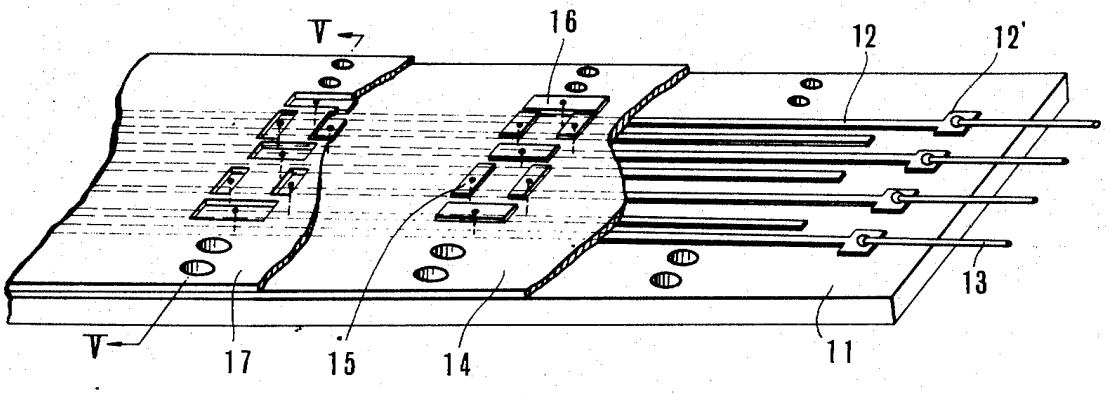


FIG. 1

PRIOR ART

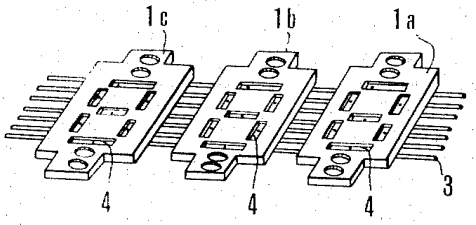


FIG. 2 PRIOR ART

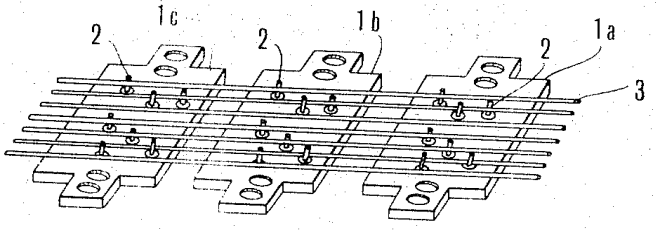


FIG. 3 PRIOR ART

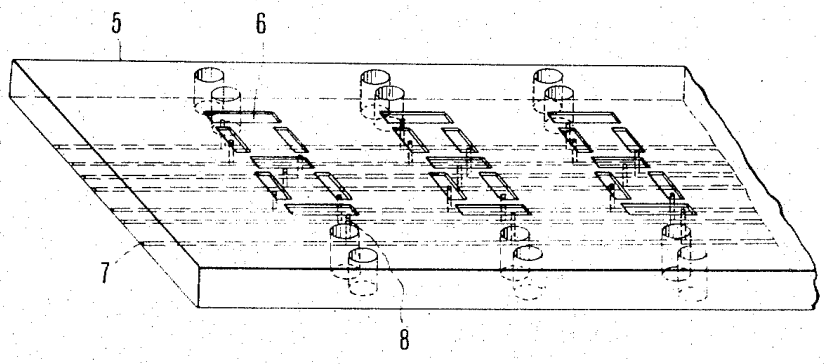


FIG. 4

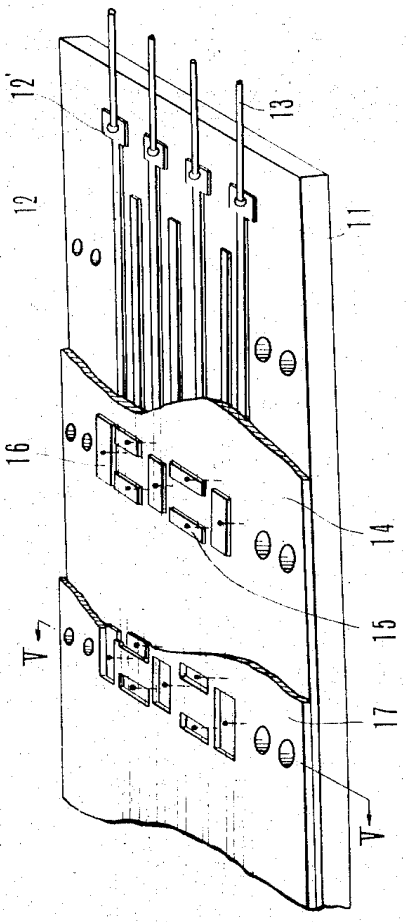


FIG. 5

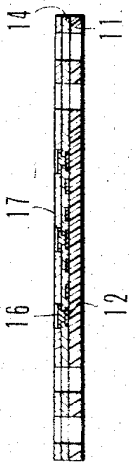
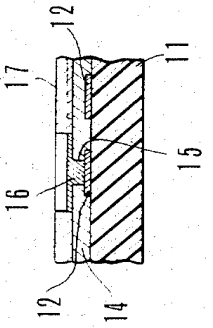


FIG. 6



ANODE SUBSTRATES FOR MULTI-DIGIT TYPE FLUORESCENT DISPLAY TUBES

The imsulator film, the segment electrodes with connectors and the protective film are formed by using appropriate perforated masks and the assembly of the insulator substrate, insulator film, segment electrodes and protective film is baked to bond them together into an integral structure. After the baking, films of a phosphor are applied to the exposed surfaces of the segment electrodes.

BACKGROUND OF THE INVENTION

This invention relates to an anode substrate especially suitable for use in a multi-digit type fluorescent display tube and a method of manufacturing such an anode substrate.

In view of recent requirement for the miniaturization of the display apparatus, reduction in the number of assembling steps, simplification of maintainance and uniformity of the quality, a number of proposals have been made regarding a multidigit type fluorescent display tube, that is a fluorescent tube comprising a single envelope and an anode substrate for displaying a plurality of digits or letters and contained in the envelope. However, there are many problems to be solved.

Since the multi-digit type fluorescent tube can be operated on the time division basis it is necessary to interconnect the segment electrodes of corresponding digits within the envelope. According to a prior art construction, as shown in FIGS. **1** and **2**, a plurality of anode substrates **1***a*, **1***b*, **1***c* — of the required number of digits are arranged side by side and terminals **2** for respective segment electrodes are projected on the rear side of each substrate. Terminals **2** of corresponding segment electrodes are interconnected by lead wires **3**. As shown in FIG. **1**, each substrate is provided with seven discrete luminous segment electrodes **4** which are arranged in the form of FIG. **8**. Each segment electrode is coated with a phosphor and by selective energization of these segment electrodes digits **0** to **9** are selectively displayed.

With this construction, it requires much labour and time to connect terminals to segment electrodes and to interconnect corresponding terminals with lead wires **3**. Among many connections there may occur some imperfect connections thereby increasing rejects.

To obviate these difficulties, an arrangement as shown in FIG. **2** has been proposed. More particularly, a plurality of recesses **6** are formed in the upper surface of a substrate **5** made of an insulator such as ceramic. Grooves **7** for receiving lead wires **3** are formed on the lower surface of the substrate. The recesses **6** are connected with grooves **7** through perforations. Accordingly, by filling an electroconductive substance such as graphite or the like in these recesses, grooves and perforations, it is possible to form conductors acting as the segment electrodes, lead wires and terminals interconnecting them. However, this construction requires complicated and expensive metal moulds so that it is not suitable for mass production.

As above described, the substrate is made of ceramic. However, a long substrate for use in multi-digit type display device is required to have a large thickness in order to prevent warping or deformation formed at the time of firing. This increases the length of the perforations **8**. With a long perforation, it is difficult to perfectly fill it with the conductive material, thus forming an incomplete terminal. When changing the pattern of the digits or the number of digits it is necessary to change expensive metal mould, thereby increasing the cost of manufacturing.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide an improved anode substrate for use in a multi-digit type fluorescent display tube, which is thin but flat.

Another object of this invention is to provide an improved anode substrate for use in a multi-digit type fluorescent digit tube wherein corresponding segment electrodes are interconnected accurately.

Further object of this invention is to provide an improved method of manufacturing an anode substrate for use in a multi-digit type fluorescent display tube according to which various component elements can be readily formed through the use of perforated masks, thereby saving cost and labour.

In accordance with one aspect of the invention there is provided an anode substrate for use in a multi-digit type fluorescent display tube comprising an insulator substrate, printed conductors printed on the substrate for electrically interconnecting corresponding segment electrodes, an insulator film overlying the printed conductors, the insulator film being provided with a plurality of perforations above the printed conductors, a plurality of segment electrodes formed on the insulator film at the positions of the perforations, the electrodes including integral connectors extending through the perforations and respectively connected to the printed conductors, phosphor films applied onto the surfaces of the respective segment electrodes, the segment electrodes being arranged in a predetermined pattern to display predetermined letters, and a protective film overlying the insulator film, the insulator film being provided with a plurality of perforations to expose the segment electrodes, the insulator substrate, the insulator film, and the protective film being bonded together into an integral structure.

According to another aspect of this invention, there is provided a method of manufacturing an anode substrate for use in a multi-digit type fluorescent display tube comprising the steps of preparing an insulator substrate, printing on the insulator substrate a plurality of electric conductors adapted to interconnect corresponding segment electrodes, applying an insulator film on the substrate, the insulator film including a plurality of perforations above the electric conductors, applying the segment electrodes and connectors on the insulator film with the connectors extended through the perforations and connected to the respective electric conductors, applying a protective film on the insulator film, the protective film including a plurality of perforations to expose respective segment electrodes and baking the assembly to bond the insulator substrate, the insulator film and the protective film into a integral structure.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** shows a perspective view of a prior art anode substrate for a multi-digit type fluorescent display tube;

FIG. **2** is a perspective rear side view of the anode substrate shown in FIG. **1**;

FIG. 3 is a perspective view of another prior art anode substrate;

FIG. 4 is a perspective view, partly broken away, of one example of the anode substrate embodying the invention and utilized for multi-digit type fluorescent display tube

FIG. 5 is a sectional view of the anode substrate shown in FIG. 4, taken along a line V — V and

FIG. 6 is an enlarged view of a portion of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of this invention shown in FIGS. 4, 5 and 6 comprises a rectangular substrate 11 of an insulator, ceramic for example. Printed conductors 12 are formed on the surface of the substrate for electrically interconnecting corresponding segment electrodes for displaying digits in a manner to be described later in more detail. Lead wires 13 are connected to one ends 12' of the printed conductors 12 by soldering, brazing or welding. An insulator film of crystal glass or the like is applied on the surface of the substrate to cover the printed conductors 12 by using a perforated mask, for example, the insulator film being provided with perforations in which connectors 15 for electrically interconnecting the segment electrodes (to be described later) and the printed conductors 12 are to be formed. Segment electrodes 16 arranged in a predetermined pattern are formed on the insulator film 16 by using a perforated mask or the like to overlie connectors 15. Actually, the connectors 15 and segment electrodes 16 are formed by a single step thus establishing electrical connections between segment electrodes 16 and the printed conductors 12. A protective film 17 of crystal glass or the like is applied on the insulator film 14 by using a mask or the like. The film 17 is provided with perforations surrounding segment electrodes 16.

The anode substrate fabricated in this manner are then baked to bond various component parts into an integral structure. Then, a phosphor is applied onto the surfaces of the segment electrodes by coating or printing.

Although in the above described method of fabrication, the printed conductors 12, insulator film 14, segment electrodes 16 and protective film 17 are sequentially formed on the substrate 11 it will be clear that the insulator film 14 and protective film 17 may be prepared independently and then laminated on the substrate.

As above described, in accordance with this invention, there is provided an inexpensive anode substrate for use in a multi-digit type fluorescent display tube. The anode substrate can be made very thin, that is to have about 1 mm overall thickness without warping. Moreover, it is possible to provide low resistance and positive electrical connections between corresponding segment electrodes. Further, it is possible to manufacture digits of different patterns by merely changing the mask.

The novel anode substrate is scaled in an evacuated envelope (not shown) to complete a multi-digit type fluorescent display tube.

Although the invention has been shown and described in terms of a preferred embodiment thereof it should be understood that many changes and modifications will be obvious to one skilled in the art without departing from the true spirit and scope of the invention as defined in the appended claims.

What is claimed is

1. An anode substrate for use in a multi-digit type fluorescent display tube comprising an insulator substrate, printed conductors printed on said substrate for electrically interconnecting corresponding segment electrodes, an insulator film overlying said printed conductors, said insulator film being provided with a plurality of perforations above said printed conductors, a plurality of segment electrodes formed on said insulator film at the positions of said perforations, said electrodes including integral connectors extending through said perforations and respectively connected to said printed conductors, phosphor films applied onto the surfaces of said respective segment electrodes, said segment electrodes being arranged in a predetermined pattern to display predetermined letters, and a protective film overlying said insulator film, said protective film being provided with a plurality of perforations to expose said segment electrodes, said insulator substrate, said insulator film and said protective film being bonded together into an integral structure.

2. The anode substrate according to claim 1 wherein said insulator film and said protective film are made of crystal glass.

3. The anode substrate according to claim 1 wherein said insulator film and said protective film are formed by using masks.

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