

PATENT SPECIFICATION

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(54) LUMINESCENCE DISPLAY TUBE BASE PLATE

(71) We, NIPPON ELECTRIC KAGOSHIMA, LIMITED, a Company duly organized and existing under the laws of Japan and having its executive office at 12699, Takemoto, Izumi-shi, Kagoshima, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a base plate assembly used in a luminescence display tube for displaying characters.

15 A display tube of the type described is known, wherein electrons emitted thermally from a cathode are directed through a grid to luminescent segments arranged on the front or viewing surface of an insulative substrate. The segments are selectively supplied with a positive potential to make them luminesce in a desired pattern. The grid serves to distribute the electrons substantially uniformly over the segments. Usually, the grid serves also to accelerate the electrons. A display tube for substantially simultaneously displaying a plurality of desired characters (usually digits) often includes a plurality of grids, one for each digit.

This invention will be described below with specific reference to a luminescence display tube for displaying a plurality of digits, although the invention is equally well applicable to a luminescence display tube for only one digit or to a tube for displaying one or more characters other than digits.

In a luminescence display tube, an insulative substrate and luminescent segments formed on the substrate in a plurality of groups corresponding to the respective digits form a base plate assembly together with supports attached thereto for a cathode and grids, and leads extended

outwardly from the base for the segments, the cathode, and the grids. As will be detailed below, there are various drawbacks to base plate assemblies of conventional construction, such as relatively low efficiency of manufacture, production of spurious luminescence and/or unwanted display, and consumption of superfluous electric energy.

According to the present invention there is provided a base plate assembly for a luminescence display tube in which a cathode is disposed in front of its base plate assembly and a grid is disposed between the cathode and the base plate assembly, the base plate assembly comprising an insulative substrate with luminescent segments arranged on its front surface, segment leads connected to the segments and extended outwardly of the substrate from one of the surfaces of the substrate and lead means connected to conductive grid support means and extended outwardly of the substrate from a surface of the substrate other than said one of its surfaces.

A related invention forms the subject matter of our co-pending application number 44258/73 (Serial No. 1 433 390) which discloses an embodiment identical to that of figure 4 of this specification.

Embodiments of the present invention will now be described in detail, by way of example, with reference to the accompanying drawings in which:—

Figure 1 is a schematic perspective view, partly cut away, of a luminescence display tube;

Figure 2 is a schematic perspective view of an improved base plate assembly of conventional structure;

Figure 3 is a similar view of a base plate assembly according to a first embodiment of the present invention; and

Figure 4 is a like view of a base plate assembly according to a second em-

bodiment of this invention

Before describing the preferred embodiments of the present invention, the background of the invention will be detailed with reference to Figures 1 and 2 in order to facilitate understanding of the invention.

Referring to Figure 1, a luminescence display tube for a plurality of digits comprises a vacuum envelope 11, a base plate assembly 12 held within the envelope 11 by means not shown, a cathode 13 extending longitudinally within the envelope 11 in front of the base plate assembly 12, a plurality of grids 14 interposed between the cathode 13 and the base plate assembly 12 (one for each digit) and a plurality of stem leads 15 for the cathode 13, the grids 14, and anode segments of the base plate assembly 12. The grids 14 serve to distribute the electrons emitted by the cathode 13 substantially uniformly on the anode segments selectively supplied with a positive potential through relevant ones of the stem leads 15. It is assumed here for mere convenience of description that the display tube is for numerals of eight digits.

Referring to Figure 2, an example of the conventional base plate assemblies 12 comprises an insulative substrate 20 of a ceramic material, glass, steatite, or the like and a plurality of luminescent segments 21 arranged in groups on the front surface of the substrate 20. The front surfaces of the luminescent segments 21 are flush with the front surface of the substrate 20 and it should be understood that such an arrangement is included within the scope of the expression "arranged on the front surface." The luminescent segments 21 of each group are arranged in a substantial figure of eight and comprise an additional segment for a decimal point and a further additional segment (which may be dispensed with) for displaying the digit "4". In the manner known in the art, each of the luminescent segments 21 forms an anode segment mentioned with reference to Figure 1 together with an electroconductive film (not shown) placed behind the luminescent segment. The base plate assembly 12 further comprises a plurality of segment leads 22a, 22b, 22c, 22d, 22e, 22f, 22g, 22h, and 22i, connected to the electroconductive films situated behind the corresponding luminescent segments 21, grid supports 23 for the respective grids 14 arranged on the front surface of the substrate 20 in pairs on both sides of the luminescent segment groups, grid leads 241, 242, 243, 244, 245, 246, 247 and 248 connected to at least one each of the respective pairs of the grid supports 23, a pair of cathode supports 251 and 252, and

a pair of cathode leads 261 and 262 connected to the respective cathode supports 211 and 252.

The supports 23 and 25 (251 and 252) and the leads 22 (22a, 22b, . . . , and 22i), 24 (241, 242, . . . , and 248) and 26 (261 and 262) are usually soldered to respective metallized layers (not shown), formed on the front surface of the substrate 20. The connections between the electroconductive films and the respective segment leads 22, between the grid supports 23 and the respective grid leads 24, and between the cathode supports 25 and the respective cathode leads 26 are formed through the printed circuit techniques preferably in layers interposed between layers of a laminated ceramic substrate 20. It is usual that the luminescent layers are subsequently laid on the respective electroconductive films to form the luminescent segments 21. It has, however, been often the case that the luminescent layers are inevitably laid also on the supports 23 and 25 and on the leads 22, 24, and 26. The luminescent layers which happen to be laid on some or all of the grid supports 23 and on the grid leads 24 produce spurious luminescence thereat in operation. The luminescent layers which happen to be laid on some or all of the leads 22, 24, and 26 often bridge such leads. Inasmuch as a luminescent material is a semiconductor, each of such luminescent layers serves as a resistor having a value of the order of several hundred ohms to several kilohms providing shorts between such leads 22, 24, and/or 26 and to provide unwanted display and superfluous loads to a power supply (not shown) for the display tube. Removal of the unwanted luminescent layers are quite troublesome.

Referring further to Figure 2, the free ends of the leads 22, 24, and 26 may be connected together by frame members 271, 272, 273, and 274 into four groups. This enables the electroconductive films to be formed electrically and simultaneously by applying a voltage therefor between the lead groups. The luminescent segments 21 are similarly formed electrically and simultaneously. It has, however, been inevitable because each of the lead frames, such as those united together by the frame members 271, 272, and 273, comprises both segment and grid leads 22 and 24, that spurious luminescent layers are also formed where unwanted, such as on the grid supports 23. Although useful in raising the efficiency of soldering the leads 22, 24, and 26 to the substrate 20 and forming the electroconductive films and the luminescent segments 21 on the substrate 20, adoption of the frame lead techniques is still defective from the point of view of its rela-

tively low efficiency of manufacture of the base plate assembly 12 and consequently the display tubes and production of spurious luminescence.

5 Referring now to Figure 3, similar components of a base plate assembly 12 according to a first embodiment of this invention are shown with like reference numerals. Unlike the conventional base plate assemblies exemplified in Figure 2, the segment leads 22 are shown herein extended outwardly of the substrate 20 from the longitudinal ends of its front surface and the grid leads 24 are extended outwardly of the substrate 20 from the longitudinal ends of its back surface. It is thus possible to unite the segment leads 22 and the grid leads 24 into different groups by frame members 271 and 272 on the one hand and by frame members 273 and 274 on the other hand to obviate the unwanted display in operation and the consumption of superfluous electric energy. The grouping of the segment leads 22 and the grid leads 24 into different frames further enables the voltage for electrically forming the luminescent segments 21 to be supplied only to the segment lead groups united together by the frame members 271 and 272. This avoids the unwanted formation of the luminescent layers on the grid supports 23, raises the efficiency of manufacture and prevents spurious luminescence from being produced during operation. The grid leads 24 are shown in Figure 3 extended farther than the segment leads 22 for mere convenience of illustration. Inasmuch as the electrons emitted by the cathode 13 do not acquire sufficient energy on reaching the cathode supports 251 and 252 supplied with the substantially same potential as the cathode 13, the spurious luminescent layers, if formed on these supports 251 and 252, do not luminesce. It is therefore possible to group the cathode leads 261 and 262 in either of the groups of the segment leads 22 and the groups of the grid leads 24. Incidentally, the segment and the grid leads 22 and 24 may be extended sideways from the substrate 20.

Referring finally to Figure 4, a base plate assembly 12 according to a second embodiment of this invention comprises similar components designated with like reference numerals as in the first embodiment. In contrast to the first embodiment, the grid supports 23 are formed on the back surface of the substrate 20, and so as to be accessible from the front side of the substrate 20 there is provided at least one window for each of the grid supports 23. In Figure 4, a passage for each of the grid supports 23 is provided by adjacent protrusions 28 extending sideways from the body of the substrate 20. The

grid supports 23 are attached to the back surfaces of the protrusions 28. The superfluous luminescent layers, if formed on the grid supports 23 and/or the grid leads 24, do not result in spurious luminescence when viewed from the front side. Attachment of the grid leads 23 to the back surface reduces the possibility of shorts between the segment and grid leads 22 and 24. As is the case with the first embodiment, the segment and grid leads 22 and 24 may be extended sideways from the substrate 20.

In connection with the first embodiment wherein the grid supports 23 are attached to the front surface of the substrate 20, it will be understood that the segment leads 22 may be attached to the back surface of the substrate 20 and the grid leads 24 may be attached to the front surface of the substrate 20.

WHAT WE CLAIM IS:

1. A base plate assembly for a luminescence display tube in which a cathode is disposed in front of its base plate assembly and a grid is disposed between the cathode and the base plate assembly, the base plate assembly comprising an insulative substrate with luminescent segments arranged on its front surface, segment leads connected to the segments and extended outwardly of the substrate from one of the surfaces of the substrate and lead means connected to conductive grid support means and extended outwardly of the substrate from a surface of the substrate other than the said one of its surfaces.

2. A base plate assembly as claimed in Claim 1, further comprising a plurality of supports for the grid, wherein the supports and the lead means for the grid are attached to the back surface of the substrate.

3. A base plate assembly as claimed in Claim 1 or 2, further comprising cathode supports attached to the front surface, the segment leads being divided into two groups, wherein cathode leads connected to the respective cathode supports and extended outwardly of the substrate are included in the groups of segment leads.

4. A base plate assembly as claimed in Claim 1 or 2, further comprising cathode supports attached to the front surface, the lead means for the grid being divided into two groups, wherein cathode leads connected to the respective cathode supports and extended outwardly of the substrate are included in the groups of the lead means.

5. A base plate assembly as claimed in Claim 2, wherein the supports for the grid attached to the back surface are accessible from the front side of the substrate through a plurality of passages formed



tively low efficiency of manufacture of the base plate assembly 12 and consequently the display tubes and production of spurious luminescence.

5 Referring now to Figure 3, similar components of a base plate assembly 12 according to a first embodiment of this invention are shown with like reference numerals. Unlike the conventional base plate assemblies exemplified in Figure 2, the segment leads 22 are shown herein extended outwardly of the substrate 20 from the longitudinal ends of its front surface and the grid leads 24 are extended outwardly of the substrate 20 from the longitudinal ends of its back surface. It is thus possible to unite the segment leads 22 and the grid leads 24 into different groups by frame members 271 and 272 on the one hand and by frame members 273 and 274 on the other hand to obviate the unwanted display in operation and the consumption of superfluous electric energy. The grouping of the segment leads 22 and the grid leads 24 into different frames further enables the voltage for electrically forming the luminescent segments 21 to be supplied only to the segment lead groups united together by the frame members 271 and 272. This avoids the unwanted formation of the luminescent layers on the grid supports 23, raises the efficiency of manufacture and prevents spurious luminescence from being produced during operation. The grid leads 24 are shown in Figure 3 extended farther than the segment leads 22 for mere convenience of illustration. Inasmuch as the electrons emitted by the cathode 13 do not acquire sufficient energy on reaching the cathode supports 251 and 252 supplied with the substantially same potential as the cathode 13, the spurious luminescent layers, if formed on these supports 251 and 252, do not luminesce. It is therefore possible to group the cathode leads 261 and 262 in either of the groups of the segment leads 22 and the groups of the grid leads 24. Incidentally, the segment and the grid leads 22 and 24 may be extended sideways from the substrate 20.

50 Referring finally to Figure 4, a base plate assembly 12 according to a second embodiment of this invention comprises similar components designated with like reference numerals as in the first embodiment. In contrast to the first embodiment, the grid supports 23 are formed on the back surface of the substrate 20, and so as to be accessible from the front side of the substrate 20 there is provided at least one window for each of the grid supports 23. In Figure 4, a passage for each of the grid supports 23 is provided by adjacent protrusions 28 extending sideways from the body of the substrate 20. The

grid supports 23 are attached to the back surfaces of the protrusions 28. The superfluous luminescent layers, if formed on the grid supports 23 and/or the grid leads 24, do not result in spurious luminescence when viewed from the front side. Attachment of the grid leads 23 to the back surface reduces the possibility of shorts between the segment and grid leads 22 and 24. As is the case with the first embodiment, the segment and grid leads 22 and 24 may be extended sideways from the substrate 20.

In connection with the first embodiment wherein the grid supports 23 are attached to the front surface of the substrate 20, it will be understood that the segment leads 22 may be attached to the back surface of the substrate 20 and the grid leads 24 may be attached to the front surface of the substrate 20.

WHAT WE CLAIM IS:

1. A base plate assembly for a luminescence display tube in which a cathode is disposed in front of its base plate assembly and a grid is disposed between the cathode and the base plate assembly, the base plate assembly comprising an insulative substrate with luminescent segments arranged on its front surface, segment leads connected to the segments and extended outwardly of the substrate from one of the surfaces of the substrate and lead means connected to conductive grid support means and extended outwardly of the substrate from a surface of the substrate other than the said one of its surfaces.

2. A base plate assembly as claimed in Claim 1, further comprising a plurality of supports for the grid, wherein the supports and the lead means for the grid are attached to the back surface of the substrate.

3. A base plate assembly as claimed in Claim 1 or 2, further comprising cathode supports attached to the front surface, the segment leads being divided into two groups, wherein cathode leads connected to the respective cathode supports and extended outwardly of the substrate are included in the groups of segment leads.

4. A base plate assembly as claimed in Claim 1 or 2, further comprising cathode supports attached to the front surface, the lead means for the grid being divided into two groups, wherein cathode leads connected to the respective cathode supports and extended outwardly of the substrate are included in the groups of the lead means.

5. A base plate assembly as claimed in Claim 2, wherein the supports for the grid attached to the back surface are accessible from the front side of the substrate through a plurality of passages formed



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through the substrate.

6. A base plate assembly of a luminescent display tube substantially as herein described with reference to Figure 3 or 4 of the accompanying drawings.

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