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(54) [TITLE OF THE INVENTION]

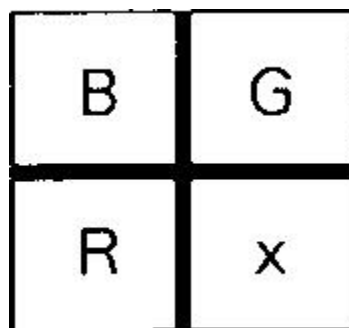
Display Panel and Image Displaying Device Having Said
Display Panel

[Problem]

To improve image quality by reducing visual interference caused by horizontal stripes or vertical stripes due to differences in the luminosity, through reducing differences in luminosity is between rows and differences in luminosity is between columns in a two-row, two-column basic arrangement.

[Means for Solving the Problem]

When configuring a two-row, two-column pattern through three RGB primary color display elements and one element that does not contribute to the image display, an arrangement is used that focuses on the luminosity of each possible display element to minimize the difference between the total luminosity of a first row and the total luminosity of the second row, and also the difference between the total luminosity of a first column and the total luminosity of a second column.



[Patent Claims]

[Claim 1]

A display panel for displaying a color image wherein primary color display elements are arranged in a matrix, wherein:

a basic arrangement of two rows and two columns is formed by three primary color display elements and one element that does not contribute to the image display; and

of the primary color display elements, the primary color display element that has the highest luminosity value and the primary color display element that has the second-highest luminosity value are arranged at opposite corner positions of the basic arrangement.

[Claim 2]

A display panel set forth in claim 1, wherein:

of the primary color display elements, green (G) and red (R) are arranged at opposite corner positions of the basic arrangement.

[Claim 3]

An image displaying device for producing a display through causing electrons that are emitted from an electron source to fly toward fluorescent materials of individual color components that are arranged in the form of a matrix on a display panel, wherein:

for one pixel of the display panel, a total of four elements are structured in two rows and two columns from three primary color display elements and one element that does not contribute to the image display, wherein, of the primary color display elements, the primary color display element that has the highest luminosity value and the primary color display element that has the second-highest luminosity value are disposed at opposite corner positions of a basic arrangement.

[Claim 4]

An image displaying device set forth in claim 3, wherein:

of the primary color display elements, green (G) and red (R) are arranged at opposite corner positions of the basic arrangement.

[Claim 5]

An image displaying device set forth in claim 3, wherein:

the electron source has an arrangement of surface conduction-type electron emitting elements.

[Detailed Explanation of the Invention]

[0001]

[Field of Technology of the Invention]

The present invention relates to a display panel for producing a color display using primary color display elements that are arranged in a matrix, and to an image displaying device equipped with said display panel.

[0002]

[Prior Art]

Conventionally two types of electron emitting elements have been known: hot cathode elements and cold cathode elements. Of these, in cold cathode elements there are known surface conduction-type emitting elements and electric field emission-type elements (hereinafter termed "FE-type"), and metal/insulating layer/metal-type emitting elements (hereinafter termed "MIM-type"), and the like, for example.

[0003]

As surface conduction-type emitting elements there are, for example, M. I. Elinson, *Radio Eng. Electron Phys.*, 10, 1290, (1965), and other known examples, described below. [0004]

The surface conduction-type emitting element is that which uses a phenomenon wherein electron emission is produced through the flow of an electric current in parallel with the film surface in a thin film with a small area, formed on a substrate. As this type of surface conduction-type emitting element there are reported, in addition to those that use the SnO₂ thin film through the aforementioned Elinson, or the like, those that use Au thin films (G. Dittmer: "Thin Solid Films," 9, 317 (1972)), those that use In₂O₃/SnO₂ thin films (M. Hartwell and C. G. Fonstad: "IEEE Trans. ED Conf.," 519 (1975)) those which use carbon thin films (H. Araki, et al: *Vacuum*, Vol. 26, No. 1, 22 (1983)), etc.

[0005]

As typical examples of element structures for these surface conduction-type emitting elements, FIG. 18 shows a plan view of an element according to M. Hartwell, referenced above. In this figure, 3001 is a substrate and 3004 is a conductive thin film made from a metal oxide formed through sputtering. The conductive thin film 3004 is formed in a flat shape, in the shape of the letter H, as illustrated. An electron emitting portion 3005 is formed through carrying out, on this conductive thin film 3004, an electrical treatment known as electrical forming, described below. In the figure, the spacing L is set to between 0.5 and 1 mm and the width W is set to 0.1 mm. Note that, for convenience in illustration, the electron emitting portion 3005 is shown as a rectangular shape in the center of the conductive thin film 3004, but this is a schematic representation, and does not express faithfully the actual position or shape of the electron emitting portion. [0006]

In the surface conduction-type emitting elements described above, including the element according to M. Hartwell, typically the formation of the electron emitting portion 3005 has been through carrying out an electrical treatment, known as electrical forming, on the conductive thin film 3004 prior to performing electron emission. That is, electrical forming is formation of an electron emitting portion through application of a current, for example formation of the electron emitting portion 3005 into a state of high electrical resistance through locally breaking down, or deforming, or altering the conductive thin film 3004 through applying electric power through the application of a constant DC voltage, or a DC voltage that is stepped up at an extremely slow rate of about 1 V per minute, for example, across the conductive thin film 3004. Note that cracking occurs in a portion of the conductive thin film 3004 that has been locally broken down, deformed, or altered. When an appropriate voltage is applied to the conductive thin film 3004 after this electrical forming, electron emission occurs in the vicinity of the cracking.

[0007]

W. P. Dyke & W. W. Dolan, "Field emission," *Advances in Electron Physics*, 8, 89 (1956) or C. A. Spindt, "Physical properties of thin-film field emission cathodes with molybdenum cones," *J. Appl. Phys.*, 47, 5248 (1976), and like, for example, are known as examples of the FE type.

[0008]

A cross-sectional drawing of an element according to C. A. Spindt is shown in FIG. 19 as a typical example of the structure of an FE-type element. In this figure, 3010 is a substrate, 3011 is an emitter line made from an electrically conductive material, 3012 is an emitter cone, 3013 is an insulating layer, and 3014 is a gate electrode. In this element electric field emission is produced from the tip end portion of the emitter cone 3012 through application of an appropriate voltage between the emitter cone 3012 and the gate electrode 3014.

[0009]

As other structures for FE-type elements, there are also examples wherein the emitter and the gate electrode are arranged on the substrate essentially in parallel with the plane of the substrate, rather than being a layered structure as in FIG. 19.

[0010]

Additionally, C. A. Mead, "Operation of tunnel-emission Devices, J. Appl. Phys., 32, 646 (1961), and the like, for example, are known as examples of the MIM type. A typical example of the structure of an MIM-type element is shown in FIG. 20. This figure is a cross-sectional drawing, where, in the figure, 3020 is a substrate, 3021 is a bottom electrode made from a metal, 3022 is a thin insulating layer with a thickness of about 100 Å, and 3023 is a top electrode that is made from a metal with a thickness of between about 80 and 300 Å. In the MIM type, electron emission is produced from the surface of the top electrode 3023 through the application of an appropriate voltage between the top electrode 3023 and the bottom electrode 3021.

[0011]

The cold cathode element, described above, is able to produce electron emission at a temperature that is low when compared to that of a hot cathode element, so there is no need for a heater for heating. Because of this, the structure is simpler than that of the hot cathode element, making it possible to form finer devices. In addition, there is less of a problem with thermal melting of the substrate, and the like, even when a large number of elements are laid out with high density on the substrate. Furthermore, unlike the hot cathode element where the response speed is slow because the operation is through heating by a heater, the cold cathode element has the benefit of a fast response speed.

[0012]

Because of this, there is active research into the application of cold cathode elements.

[0013]

For example, among cold cathode elements, the surface conduction-type emitting element in particular has a simple structure and can be manufactured easily, so has the benefit of enabling the formation of a large number of elements across a large area. Given this, there is research into methods for laying out and driving a large number of elements, as disclosed in Japanese Unexamined Patent Application Publication S64-31332, for example, by the present applicant.

[0014]

Moreover, with regard to the application of surface conduction-type emitting elements, there is research into, for example, image forming devices such as image

displaying devices, image printing devices, and the like, and into charged beam sources, etc.

[0015]

In particular, as applications for image displaying devices, there is research into image displaying devices that use combinations of surface conduction-type emitting elements and fluorescent materials that emit light through exposure to an electron beam, as disclosed in, for example, US Patent 5,066,883, Japanese Unexamined Patent Application Publication H2-257551, and Japanese Unexamined Patent Application Publication H4-28137, by the present applicant. It is anticipated that image displaying devices that use combinations of surface conduction-type emitting elements and fluorescent materials will have characteristics that are superior to those of conventional image displaying devices that use other methods. For example, when compared to the liquid crystal displaying devices that have been popular in recent years, these are self-illuminated, and thus superior in the point that there is no need for a backlight and the point that the field of view is wide.

[0016]

Moreover, a method for lining up and driving a large number of FE-type elements is disclosed in, for example, US Patent 4,904,895 by the present applicant. Furthermore, the flat-panel-type displaying device reported by R. Meyer, et al., is known, for example, as an example wherein the FE type is applied to an image displaying device. (R. Meyer: "Recent Development on Microtips Display at LETI," Tech. Digest of 4th Int. Vacuum Microelectronics Conf., Nagahama, pp. 6-9 (1991))

In addition, an example of an application of an image displaying device wherein a large number of MIM-type elements are lined up is disclosed in Japanese Unexamined Patent Application Publication H3-55738 by the present applicant.

[0017]

[Problem Solved by the Present Invention]

Conventionally, prescribed arrangements wherein three fluorescent materials for R, G, and B, lined up in the horizontal direction to form a single pixel, have been used for the pixel arrangement in such image displaying devices. However, if, in the stripe arrangement, the fluorescent materials are in shapes that are approximately square, as in FIG. 3 (a), then the pixel that combines the R, G, and B will be long in the horizontal direction, reducing the resolution in the horizontal direction. Moreover, because fluorescent materials of identical colors will be lined up in the vertical direction, there is a shortcoming in that vertical stripes will be visible when an image is displayed.

[0018]

In order to solve this problem one may consider a checkerboard arrangement, such as depicted in FIG. 3 (b). In this checkerboard arrangement, the resolution is improved by using, as the basic arrangement as a single pixel, two elements horizontally and two elements vertically, as depicted in the figure, with two elements assigned to green (G), and one element each assigned to red (R) and blue (B), in order to improve the resolution.

[0019]

Although the resolution is improved, as anticipated, when this checkerboard arrangement is used to form a color

display, the red and blue display elements are lined up in one row of two rows in the horizontal direction or in one column of two columns in the vertical direction, and so to the viewer red horizontal lines and blue horizontal lines will appear alternately or red vertical lines in blue vertical lines will appear alternately, causing a reduction in image quality.

[0020]

Furthermore, with the checkerboard arrangement described above the elements cannot produce their maximum performance, because the green outputs of the two elements are each limited to half in order to protect achieve a color balance.

[0021]

[MEANS FOR SOLVING THE PROBLEM]

The present invention contemplates this point, and is to provide a display panel, and image displaying device that comprises said display panel, able to improve the image quality by reducing the visual interference caused by horizontal stripes or vertical stripes due to luminosity differences, by reducing the difference in luminosity between columns or difference in luminosity between rows in a two-row, two-column basic arrangement.

[0022]

In order to solve this problem, the display panel of the present invention, for example, is provided with the structures shown below. Specifically, it is a display panel for displaying a color image, with primary color display elements arranged in a matrix, where a two-row, two-column basic arrangement is formed from three primary color display elements and one element that does not contribute to the image display, where, of the primary color display elements, the primary color display element that has the highest luminosity value and the primary color display element that has the second-highest luminosity value are arranged at opposite corner positions in the basic arrangement.

[0023]

[Embodiments of the Invention]

An embodiment according to the present invention will be explained in detail below following the appended drawings.

[0024]

Typically, when primary color display elements are arranged in two rows and two columns and one desired color is repeated in spatial additive color mixing, it is necessary to consider the luminosity values of the individual elements in arranging the primary color display elements.

[0025]

If the chromaticities of the three primary color display elements RGB, expressed in the CIE-XYZ, chromaticity coordinates are

$R(XR, YR, ZR)$, $G(XG, YG, ZG)$, $B(XB, YB, ZB)$

the luminosity values of the three primary color display elements will be YR , YG , and YB .

[0026]

Specifically, when the three primary colors of the NTSC system are selected as the three primary color display elements RGB, and a C light source is selected as the base stimulus, the result will be:

$YR=0.30$, $YG=0.59$, $YB=0.11$

[0027]

For each row and each column, the sum of the luminosities can be calculated by the elements that are laid out for each of the elements m_{11} , m_{12} , m_{21} , and m_{22} of the matrix M when such three primary color display elements and one non-display element are laid out in a two-row, two-column matrix M , and if that which has the greatest luminosity difference between rows and the greatest luminosity difference between columns is used as the maximum luminosity difference between rows or columns, the less the maximum luminosity difference, the less the luminosity stripe differences will be, and the less the observer will be made to feel that there is striped interference in the display device.

[0028]

FIG. 21 is that wherein luminosities are totaled for each of the rows and columns, and the maximum luminosity difference between rows or columns is calculated when the three primary color display elements and one non-display element are arranged in two rows and two columns, as described above. In the case of using the three primary colors of the NTSC system, the minimum value among the maximum luminosity differences between columns and rows will be 0.40, where this occurs when the red (R) and green (G) are arranged at opposite corner positions.

[0029]

That which is arranged in this way is FIG. 1. In the figure, B indicates the blue display element, R indicates the red display element, G indicates the green display element, and x indicates the non-display element. FIG. 2 displays the arrangement in a second embodiment of the present invention, where the green display element and the non-display element in the embodiment in FIG. 1 have been switched.

[0030]

It was confirmed in the above that the problem area explained already in the Prior Art section is improved when an image is actually display using a display panel that is generated by repeating the arrangement in FIG. 1 or FIG. 2 in two dimensions

[0031]

< Structure and Manufacturing Method for the Display Panel >

A specific example will be presented to explain the structure and manufacturing method for a display panel used in the image displaying device wherein the present invention is applied.

[0032]

FIG. 4 is a perspective diagram of a display panel used in the present invention, showing a partial cutaway structure for a panel in order to show the internal structure.

[0033]

In the figure, 1005 is a rear plate, 1006 is a side wall, and 1007 is a faceplate, where an airtight container for preserving a vacuum in the interior of the display panel is formed from 1005 through 1007. When assembling this airtight container, it is necessary to have adequate strength in the portions at which each of the members are joined together, and to seal in order to maintain airtightness, where the sealing is achieved through, for example, coating frit glass onto the junction portions and firing for at least 10 minutes at between 400°C and 500°C in atmosphere or in a

nitrogen ambient gas. The method for drawing a vacuum in the interior of the airtight container will be described below. [0034]

A substrate 1001 is secured to the rear plate 1005, and $N \times M$ surface conduction-type emitting elements 1002 are formed on the substrate 1001. (Here N and M are positive integers no less than 2, set as appropriate depending on the number of pixels that are to be displayed. For example, in a displaying device that is to be for a display in a high quality television, preferably the number is set to no less than $N = 3000$ and $M = 1000$. In the present embodiment these are set to $N = 3072$ and $M = 1024$). The aforementioned $N \times M$ cold cathode elements are connected in a simple matrix through M row direction lines 1003 and N column direction lines 1004. The part that is structured from 1001 through 1004, described above, is termed a "multi-electron beam source." Note that the structure and method for manufacturing the multi-electron beam source will be described in detail below. [0035]

In the present embodiment, the structure is one wherein the substrate 1001 of the multi-electron beam source is secured to the rear plate 1005 of the airtight container, but if the substrate 1001 of the multi-electron beam source has sufficient strength, the substrate 1001 itself of the multi-electron beam source may be used as the rear plate of the airtight container. [0036]

Moreover, a fluorescent film 1008 is formed on the bottom surface of the faceplate 1007. The present embodiment is for a color display device, and thus fluorescent materials of the three primary colors of red (R), green (G), and blue (B), used in the field of CRTs, are coated onto the fluorescent film 1008 part. For example, if following FIG. 1, the fluorescent materials of the individual colors are coated separately in stripe shapes, as shown in FIG. 5, where black electrical conductors 1010 are provided between the stripes of the fluorescent materials of the individual colors. The purpose for providing the black electrical conductors 1010 is to prevent discoloration from occurring in the display, even if there is some misalignment of the positions exposed to the electron beam, to prevent a reduction in display contrast through preventing reflections of outside light, and also to prevent charging of the fluorescent film through the electron beam. Although graphite is used as the main component of the black electrical conductors 1010, another material may be used instead insofar as it is suitable for the purpose described above. [0037]

Moreover, a metal back 1009 that is publicly known in the field of CRTs may be provided on the surface on the rear plate side of the fluorescent film 1008. The purposes for providing the metal back 1009 are to improve the light utilization rate by reflecting, on a mirror surface, a portion of the light that is produced by the fluorescent film 1008, to protect the fluorescent film 1008 from collisions by negative ions, to act as an electrode for the application of a voltage electron beam acceleration, to act as an electrically conductive path for electrons that have excited the fluorescent film 1008, etc. The metal back 1009 is formed through a method wherein the fluorescent film 1008 is

formed on the faceplate substrate 1007, followed by a process for smoothing the fluorescent film surface, and then performing low-pressure vapor deposition of Al thereon. Note that the metal back 1009 is not used when a fluorescent material for low-voltage use is used in the fluorescent film 1008. [0038]

Moreover, although not used in the present embodiment, a transparent electrode that uses ITO, for example, as the material may be provided between the faceplate substrate 1007 and the fluorescent film 1008 for the purpose of applying an acceleration voltage or improving the conductivity of the fluorescent film. [0039]

Moreover, Dx1 through Dx m , Dy1 through Dy n , and Hv are terminals for electrical connections for the airtight structure, provided for connecting electrically the display panel and electric circuits that are not shown. Dx1 through Dx m are connected electrically to the row direction lines 1003 of the multi-electron beam source, Dy1 through Dy n are connected electrically to the column direction lines 1004 of the multi-electron beam source, and Hv is connected electrically to the metal back 1009 of the faceplate. [0040]

Moreover, in order to draw a vacuum in the interior of the airtight container, an exhaust pipe and a vacuum pipe, not shown, are connected after assembly of the airtight container, and the interior of the airtight container is drawn to a vacuum level of about 10^{-7} Torr. The exhaust pipe is sealed thereafter, but in order to maintain the vacuum level within the airtight container, a getter film (not shown) is formed at a prescribed position within the airtight container, either immediately prior to or immediately following sealing. The getter film is a film that is formed through a vapor deposition, through heating, through a heater or through high-frequency heating, a getter material that has, for example, Ba as the main component, to maintain the interior of the airtight container at a vacuum level of between 1×10^{-5} and 1×10^{-7} Torr through the effect of adsorption by the getter film. [0041]

The basic structure of the display panel of the present embodiment, and the manufacturing method thereof, have been explained above. [0042]

A method for manufacturing a multi-electron beam source used in the display panel of the present embodiment will be explained next. There are no limitations on the materials or shapes of the cold cathode elements, or on the manufacturing method, in the multi-electron beam source used in the image displaying device of the present embodiment, insofar as the electron sources are sources wherein cold cathode elements are interconnected in a simple matrix. Thus, for example, surface conduction-type emitting elements, or cold cathode elements of the FE type or MIM type may be used. [0043]

Note that in a state wherein a displaying device that has a large screen and that is also inexpensive is needed, the surface conduction-type emitting element is particularly preferred among these cold cathode elements. That is, the

FE type requires an extremely high precision manufacturing technology given that the relative positioning and the shapes of the emitter cones and gate electrodes greatly control the electron emission characteristics, where this factor interferes with increasing the area and achieving a reduction in the manufacturing cost. Moreover, with the MIM type there is the need for the film thickness of the insulating layer, and of the electrode thereon, to be thin and uniform, where this factor interferes with increasing the area and achieving a reduction in the manufacturing cost. In regard to this point, with the surface conduction-type emitting element the method for manufacturing is relatively simple, making it easy to increase the area and reduce the manufacturing cost. Moreover, the present inventors, discovered that, among surface conduction-type emitting elements, those wherein the electron emitting portion or the surrounding parts thereof are formed from microparticle films are superior in electron emission characteristics in particular, and manufacturing can be carried out easily. Consequently, this is the most suitable for use as a multi-electron beam source for an image displaying device with high brightness and a large screen. Given this, in the display panel of the embodiments described above, surface conduction-type emitting elements wherein the electron emitting portions or the surrounding parts thereof are formed from microparticle films are used. Given this, the basic structure, manufacturing method, and characteristics of an ideal surface conduction-type emitting element will be explained first, and the structure of a multi-electron beam source wherein a large number of elements are connected in a simple matrix will be described thereafter.

[0044]

< Ideal Element Structures and Manufacturing Methods for Surface Conduction-type Emitting Elements >

Typical structures for surface conduction-type emitting elements wherein the electron emitting portions or the surrounding parts thereof are formed from microparticle films may be of two types: a flat type and a vertical type.

[0045]

< Flat Surface Conduction-type Emitting Elements >

The element structure, and manufacturing method, for a flat surface conduction-type emitting element will be explained first. That which is shown in FIG. 6 is a plan view (a) and cross-sectional drawing (b) for explaining a structure of a flat surface conduction-type emitting element. In the figure, 1101 is a substrate, 1102 and 1103 are element electrodes, 1104 is a conductive thin film, 1105 is an electron emitting portion formed through an electrical forming process, and 1113 is a thin film formed through an electrical activating process.

[0046]

The substrate 1101 may use, for example, any of a variety of glass substrates, such as quartz glass, blue sheet glass, or the like, various types of ceramic substrates such as alumina, or a substrate wherein an insulating layer that uses, for example, SiO₂ as the material, is layered on any of the substrates described above, or the like.

[0047]

Additionally, the element electrodes 1102 and 1103 that are provided on the substrate 1101, in parallel with and facing the substrate surface, are formed from an electrically

conductive material. For example, an appropriate material may be selected from metals such as Ni, Cr, Au, Mo, W, Pt, Ti, Cu, Pd, Ag, and the like, or from alloys of these metals, metal oxides such as In₂O₃-SnO₂, semiconductors such as polysilicon, and the like. The electrode may be formed easily using, for example, a combination of a film forming technology such as low-pressure vapor deposition with a patterning technology such as photolithography, etching, and the like; however the electrode may be formed through another method instead (such as, for example, a printing technology).

[0048]

The shapes of the element electrodes 1102 and 1103 are designed as appropriate for the purpose for which the electron emitting element is to be used. Generally the electrode spacing L is normally designed by selecting an appropriate numeric value in the range of several hundred Å to several hundred μm, but of this the range of several μm to several tens of μm is preferred when applied to a displaying device. Moreover, for the thickness d of the element electrode, normally a suitable numeric value is selected from a range between several hundred Å and several μm.

[0049]

Additionally, a microparticle film is used in the conductive thin film 1104 part. The microparticle film referred to here indicates a film that includes a large number of microparticles as structural elements (including groups of island shapes). If the microparticle film is observed under a microscope, normally a structure will be observed wherein the individual microparticles are located separately from each other, or a structure will be observed wherein the microparticles are adjacent to each other, or a structure will be observed wherein the microparticles overlap each other.

[0050]

The particle sizes of the microparticles used in the microparticle film are included in a range from several Å to several thousand Å, but, of this, that which is preferred is a range from 10 Å to 200 Å. Moreover, the film thickness of the microparticle film is set as appropriate in consideration of various conditions such as those described below. That is, there are conditions that are required to make good electrical connections with the element electrode 1102 or 1103, conditions necessary for carrying out good electrical forming, described below, conditions necessary for making the electrical resistance of the microparticle film itself have an appropriate value, described below, etc.

[0051]

Specifically, the film thickness is set in a range between several Å and several thousand Å, and preferably is between 10 Å and 500 Å.

[0052]

The materials that can be used for forming the microparticle film include metals such as Pd, Pt, Ru, Ag, Au, Ti, In, Cu, Cr, Fe, Zn, Sn, Ta, W, and Pb, oxides such as PdO, SnO₂, In₂O₃, PbO, and Sb₂O₃, borides such as HfB₂, ZrB₂, LaB₆, CeB₆, YB₄, and Gd₂B₄, carbides such as TiC, ZrC, HfC, TaC, SiC, and WC, nitrides such as TiN, ZrN, HfN, semiconductors such as Si, Ge, and carbon, and so forth, where the material is an appropriate selection from these.

[0053]

The conductive thin film 1104 is formed from a microparticle film, as described above, and the sheet resistance value thereof is included in a range of between 10^{-3} and 10^{-7} ohms per square.

[0054]

Note that because preferably there are good electrical connections between the conductive thin film 1104 and the element electrodes 1102 and 1103, a structure is used wherein portions thereof overlap each other. In the example in FIG. 6, the way in which they are overlapped is that of sequentially layering, from the bottom, the substrate, the element electrode, and the conductive thin film, but, in some cases, the layering, from the bottom, may be in the sequence of the substrate, the conductive thin film, and the element electrode.

[0055]

Moreover, the electron emitting portions 1105 are parts of a cracking shape formed in a portion of the conductive thin film 1104, electrically having the property of having higher resistance than that of the surrounding conductive thin film. The cracking is formed through carrying out an electrical forming process, described below, on the conductive thin film 1104. In the cracking, there may be an arrangement of microparticles with particle sizes between several Å and several hundred Å. Note that precise and accurate depictions of the positions and shapes of the actual electron emitting portions would be difficult, so these are shown schematically in FIG. 6. Moreover, an element wherein a portion of the thin film 1113 is removed is depicted in the plan view (a).

[0056]

Moreover, the thin film 1113 is a thin film made from carbon or a carbon compound, covering the electron emitting portions 1105 and the surroundings thereof. The thin film 1113 is formed through carrying out an electrical activating process, described below, after the electrical forming process.

[0057]

The thin film 1113 may be a single crystal graphite, polycrystalline graphite, amorphous carbon, or a mixture thereof, and although the film thickness is no greater than 500 Å, no greater than 300 Å is even more preferred.

[0058]

While the basic structure of a preferred element has been described above, elements such as the following were used in the embodiments.

[0059]

That is, a blue sheet glass was used for the substrate 1101, and an Ni thin film was used for the element electrodes 1102 and 1103. The thickness d of the element electrodes was 1000 Å, and the electrode spacing L was 2 μm .

[0060]

Pd or PdO was used as the principal material in the microparticle film, where the thickness of the microparticle film was approximately 100 Å, with 100 μm for the width W .

[0061]

An ideal method for manufacturing the flat surface conduction-type emitting element will be explained next. FIG. 7 (a) through (d) are cross-sectional drawings for

explaining the manufacturing steps of the surface conduction-type emitting elements, where the reference numbers for the individual members are identical to those in FIG. 6, described above.

[0062]

1) First element electrodes 1102 and 1103 are formed on the substrate 1101, as depicted in FIG. 7 (a).

[0063]

When forming these electrodes, after the substrate 1101 is thoroughly cleaned in advance using a cleaning agent, purified water, or an organic solvent, the material for the element electrodes is deposited. (A low-pressure film technology such as, for example, a vapor deposition method, a sputtering method, etc., may be used as the method for depositing.) The deposited electrode material is then patterned using photolithography and an etching technology, to form the pair of element electrodes (1102 and 1103) shown in (a) in the same figure.

[0064]

2) The conductive thin film 1104 is formed next as depicted in (b) in this figure.

[0065]

When forming this, first an organic metal solution is coated onto the substrate of (a) in the figure and dried, and after a heated firing process to form the microparticle film, patterning to a prescribed shape is performed using photolithography and etching. Here the organic metal solution is a solution of an organic metal compound that uses, as its principal element, the material of the microparticles used in the conductive thin film. (Specifically, in the present embodiment, Pd was used as the principal element. Moreover, in this embodiment a dipping method was used for the coating method, although a spinning method, spraying method, or the like may be used instead.)

Additionally, the method for forming the conductive thin film made from the microparticle film may use, for example, a low-pressure vapor deposition method, a sputtering method, a chemical gas phase deposition method, etc., instead of the method of coating with an organic metal solution that is used in the present embodiment.

[0066]

3) Following this, an appropriate voltage is applied across the element electrodes 1102 and 1103 from the power supply 1110 for forming, to carry out the electrical forming process to form the electron emitting portions 1105, as depicted in (c) in the figure.

[0067]

The electrical forming process is a process wherein an electric current is applied to the conductive thin film 1104 that is made from the microparticle film, to thereby break down, deform, or alter a portion thereof as appropriate to change to a structure that is ideal for carrying out electron emission. In the parts of the conductive thin film, made from the microparticle film, that have been modified to a structure that is ideal for carrying out electron emission (that is, the electron emitting portions 1105), suitable cracking is formed in the thin-film. Note that the electrical resistance measured between the element electrodes 1102 and 1103 is much higher after formation of the electron emitting portions 1105 when compared to prior to the formation.

[0068]

Explaining the conduction method in more detail, FIG. 8 depicts an example of voltage waveforms that are well-suited for application from the forming power supply 1110. When forming the conductive thin film made from the microparticle film, a pulsed voltage is preferred, and in the case of the present embodiment, a triangle wave pulse with a pulse width T1 is applied continuously, with pulse spacing of T2, as shown in this figure. At this time, the peak value Vpf of the triangle wave pulse is stepped up sequentially. Moreover, monitor pulses Pm for monitoring the state of formation of the electron emitting portion 1105 are inserted between the triangle wave pulses at appropriate intervals, to measure, using an ammeter 1111, the currents that flow at those times.

[0069]

In the embodiment, the pulse width T1 is 1 ms, the pulse spacing T2 is 10 ms, and the peak value Vpf is stepped up by 0.1 V with each pulse, under a vacuum ambient gas at, for example, 10^{-5} torr. Additionally, the monitor pulse Pm is inserted at a rate of one for each five triangle wave pulses applied. The voltage Vpm of the monitor pulse is set to 0.1 V, so as to not have an adverse effect on the forming process. Given this, the conduction relating to the forming process is terminated at the stage that the electrical resistance between the element electrodes 1102 and 1103 has reached 1×10^6 ohms, that is, when the current measured by the ammeter 1111 when the monitor pulse is applied is no less than 1×10^{-7} A.

[0070]

Note that the method described above is a preferred method for the surface conduction-type emitting elements of the present embodiment, but when there is, for example, a change in design of the surface conduction-type emitting elements, such as, for example, the material or film thickness of the microparticle film or the element electrode spacing L, preferably the conduction conditions will be modified in response as appropriate as well.

[0071]

4) Following this, an electrical activating process is carried out by applying an appropriate voltage between the element electrodes 1102 and 1103 from an activation power supply 1112, as shown in FIG. 7 (d), to improve the electron emission characteristics.

[0072]

The electrical activating process is a process wherein an electric current is applied under conditions that are appropriate to the electron emitting portion 1105 that was formed by the electrical forming process described above, to deposit carbon or a carbon compound in the surroundings thereof. (In the figure, the deposits made from the carbon or the carbon compound are shown schematically as the member 1113.) The emission current at a given applied voltage can be increased, typically by 100 times or more, through carrying out the electrical activating process, when compared to prior to the process.

[0073]

Specifically, voltage pulses are applied periodically in a low-pressure ambient gas in a range between 10^{-4} and 10^{-5} torr, to deposit carbon or a carbon compound sourced from an organic compound that exists in the low-pressure ambient gas. The deposits 1113 may be of single crystal

graphite, polycrystalline graphite, or amorphous carbon, or a mixture thereof, with a film thickness of no greater than 500 Å, and more preferably no greater than 300 Å.

[0074]

An example of voltage waveforms that are suited for application from the activation power supply 1112 is shown in FIG. 9 (a) to explain the electrical method in more detail. While in the present embodiment the electrical activating process was carried out through periodic application of a constant-voltage square wave, specifically the square wave voltage Vac was 14 V, the pulse width T3 was 1 ms, and the pulse spacing T4 was 10 ms. Note that the conduction conditions described above are preferred conditions for the surface conduction-type emitting elements of the present embodiment, but if there is a change in the design of the surface conduction-type emitting elements, preferably the conditions will also be modified in response thereto.

[0075]

1114, shown in FIG. 7 (d), is an anode electrode for capturing the emission current Ie that is emitted from the surface conduction-type emitting element, and is connected to a DC high-voltage power supply 1115 and an ammeter 1116. (Note that when the activating process is performed after the substrate 1101 has been assembled into the display panel, the fluorescent face of the display panel is used as the anode electrode 1114.) While the voltage is applied from the activation power supply 1112, the state of progress of the electrical activation process is monitored by measuring the emission current Ie using the ammeter 1116, to control the operation of the activation power supply 1112. An example of the emission current Ie measured by the ammeter 1116 is shown in FIG. 9 (b), and when application of the pulse voltage from the activation power supply 1112 is started, the emission current Ie rises as time elapses, but eventually saturation is reached, after which there is substantially no further increase. The electrical activating process is terminated by stopping the application of voltage from the activation power supply 1112 at the point that the emission current Ie becomes substantially saturated in this way.

[0076]

Note that the conduction conditions described above are preferred conditions for the surface conduction-type emitting elements of the present embodiment, but if there is a change in the design of the surface conduction-type emitting elements, preferably the conditions will also be modified in response thereto.

[0077]

The flat surface conduction-type emitting element depicted in FIG. 7 (e) was manufactured as described above.

[0078]

< Vertical Surface Conduction-type Emitting Element >

A typical structure of another surface conduction-type emitting element wherein the electron emitting portion or the surroundings thereof is formed from a microparticle film, specifically the structure of a vertical surface conduction-type emitting element, will be explained next.

[0079]

FIG. 10 is a schematic cross-sectional drawing for explaining the basic structure of the vertical type, where, in this figure, 1201 is a substrate, 1202 and 1203 are element electrodes, 1206 is a step difference forming member, 1204

is a conductive thin film that uses a microparticle film, 1205 is an electron emitting portion formed through the electrical forming process, and 1213 is a thin film formed through the electrical activating process.

[0080]

The point of difference of the vertical type from the flat type described above is that one of the element electrodes (1202) is provided on a step difference forming member 1206, and the conductive thin film 1204 is coated over a side face of the step difference forming member 1206. Consequently, the element electrode spacing L in the flat type in FIG. 6 is set as the step difference height L_s of the step difference forming member 1206 in the vertical type. Note that the substrate 1201, the element electrodes 1202 and 1203, and the conductive thin film 1204 that uses the microparticle film may use the same materials that were listed in the explanation for the flat type. Additionally, an electrically insulative material such as, for example, SiO_2 , may be used in the step difference forming member 1206.

[0081]

A method for manufacturing the vertical surface conduction-type emitting element will be explained next. FIG. 11 (a) through (f) are cross-sectional drawings for explaining the manufacturing steps, where the reference numbers for the individual members are identical to those in FIG. 10.

[0082]

1) The element electrode 1203 is formed first on the substrate 1201, as depicted in FIG. 11 (a).

[0083]

2) An insulating layer for forming the step difference forming member is layered next, as depicted in (b) in the figure. The insulating layer may be through layering, for example, SiO_2 through a sputtering method; however another film forming method such as, for example, a low-pressure vapor deposition method, a printing method, or the like, may be used instead.

[0084]

3) The element electrode 1202 is formed next on the insulating layer, as depicted in (c) in this figure.

[0085]

4) A portion of the insulating layer is removed using, for example, an etching method, to expose the element electrode 1203, as depicted in (d) in this figure.

[0086]

5) A conductive thin film 1204 that uses a microparticle film is formed next, as depicted in (e) in this figure. In doing so, a film forming technology such as, for example, a coating method, or the like, may be used, the same as with the flat type, described above.

[0087]

6) Electron emitting portions are formed next through carrying out the electrical forming process, the same as with the flat type. (The same process as the electrical forming process for the flat type, explained using FIG. 7 (c), may be carried out.)

7) An electrical activating process is performed next, the same as with the flat type, to deposit carbon or a carbon compound around the electron emitting portions. (A process that is the same as the electrical activating process for the flat type, explained using FIG. 7 (d), may be carried out.)

The vertical surface conduction-type emitting element depicted in FIG. 11 (f) is manufactured as described above.

[0088]

< Characteristics of the Surface Conduction-Type Emitting Element Used in the Displaying Device >

Although element structures and manufacturing methods have been explained above for flat and vertical surface conduction-type emitting elements, the characteristics of the elements used in a displaying device will be described next.

[0089]

FIG. 12 shows typical examples of the (emission current I_e)-(element applied voltage V_f) curve and (element current I_f)-(element applied voltage V_f) curve for elements used in the displaying device. Note that the emission current I_e is remarkably small when compared to the element current I_f , and given that graphing with identical scales would be difficult, these curves are shown, with respective arbitrary units, on two graphs given that these vary with modifications in design parameters such as the sizes and shapes, and the like, of the elements.

[0090]

The elements used in the display device have the three characteristics, described below, in relation to the emission current I_e .

[0091]

First, the emission current I_e rises abruptly when a voltage of a magnitude that is at least a given voltage (termed the "threshold voltage V_{th} ") is applied to the element, but at voltages less than the threshold voltage V_{th} , substantially no emission current I_e is detected.

[0092]

That is, this is a nonlinear element that has a clear threshold voltage V_{th} with respect to the emission current I_e .

[0093]

Second, the emission current I_e will vary depending on the voltage V_f that is applied to the element, enabling the magnitude of the emission current I_e to be controlled by the voltage V_f .

[0094]

Third, the speed of response of the current I_e that is emitted from the element with respect to the voltage V_f that is applied to the element is fast, enabling the electric charge of the electrons emitted from the element to be controlled by the length of time over which the voltage V_f is applied.

[0095]

Because of characteristics such as described above, the surface conduction-type emitting element is well suited for use in a display device. For example, it is possible to produce a display through sequentially scanning the display screen through the use of first characteristics in a displaying device wherein, for example, a large number of elements is provided corresponding to pixels in a display screen. That is, during driving a voltage, no less than the threshold voltage V_{th} , is applied as appropriate depending on the desired light emission brightness, to the element, and a voltage less than the threshold voltage V_{th} is applied to the elements that are in the non-selected state. A display can be carried out by scanning the display screen sequentially through switching sequentially the elements that are driven.

[0096]

Moreover, because the brightness of light emission can be controlled through the use of second characteristics and/or third characteristics, a gradation display can be produced.

[0097]

< Structure of a Multi-electron Beam Source wherein a Large Number of Elements are Interconnected in a Simple Matrix >

The structure of a multi-electron beam source wherein the surface conduction-type emitting elements described above are arrayed on a substrate and connected in a simple matrix will be described next.

[0098]

That which is depicted in FIG. 13 is a plan view of a multi-electron beam source used in the display panel 14 of FIG. 4. Surface conduction-type emitting elements similar to those depicted in FIG. 6 are arrayed on a substrate, and these elements are interconnected into the form of a simple matrix through row direction line electrodes 1003 and column direction line electrodes 1004. Electrical isolation is maintained through the formation of an insulating layer (not shown) between electrodes at the parts wherein the row direction line electrodes 1003 and the column direction line electrodes 1004 intersect.

[0099]

A cross-section along A-A' in FIG. 13 is shown in FIG. 14.

[0100]

Note that the multi-electron source of this type of structure is manufactured through forming in advance, on a substrate, row direction line electrodes 1003, column direction line electrodes 1004, a layer (not shown) for insulating between the electrodes, and element electrodes and a conductive thin film for the surface conduction-type emitting elements, followed by performing the electrical forming process and the electrical activating process through applying electrical power to each of the elements through the row direction line electrodes 1003 and the column direction line electrodes 1004.

[0101]

< Structure of the Display Device >

FIG. 15 is a block structural diagram of a critical portion of a display device in the embodiment. In this figure, 101 is an image displaying panel that uses surface conduction-type emitting elements manufactured as described above, and is connected to an external electric circuit through Dx1 from the terminal Dx1, and through Dyn from Dy1. Moreover, the high-voltage terminal Da on the image display panel 101 is connected to an external high-voltage power supply Va, so as to accelerate the emitted electrons. Of these, scan signals for sequentially driving, one row at a time, the multi-electron beam sources provided within the panel, that is, the groups of surface conduction-type emitting elements that are matrix connected in the form of a matrix of M rows and N columns, are applied to the terminals Dx1 through DxM. On the other hand, modulation signals, for controlling the electron beams outputted from each of the surface conduction-type emitting elements in the single row that is selected by the scan signal are applied to the terminals Dy1 through Dyn. In the present embodiment, the scan signals are of negative

polarity, and the modulation signals are of positive polarity. The elements to which scan signals and modulation signals are applied simultaneously emit light over only those intervals.

[0102]

The various structures will be explained following the flow of the image signal.

[0103]

An inputted composite image signal is separated into luminosity signals for the three primary colors (RGB) and horizontal and vertical synchronization signals (H_SYNC, V_SYNC) by a decoder 103. Various types of timing signals are generated by the timing signal generating circuit 104 synchronized to the H_SYNC and V_SYNC signals. The RGB luminosity signals are sampled and held at appropriate times in the S/H circuit 105, and converted into a digital signal of, for example, 8 bits for each color component (where it is assumed that an A/D converting circuit is also built-in). The RGB digital data for one line, obtained in this way, is outputted in parallel, through a S/P converting circuit, to an image signal processing circuit 107.

[0104]

Although the details are set forth below, this image signal processing circuit 107 generates data for the individual color components corresponding to the applicable line of the image displaying panel 101 from the inputted RGB data for the one line, and outputs them to a pulse width modulating circuit 108.

[0105]

The pulse width modulating circuit 108 is structured from D/A converters for converting to analog voltage signals, a triangle wave generating circuit, and a comparator for comparing therebetween, where a pulse width modulating signal is generated corresponding to each of the digital data that were inputted in parallel, and these are applied through the terminals Dy1 through Dyn of the display panel to the individual surface conduction-type emitting elements within the display panel 101, to drive one line unit. Here the line that is driven is selected by the scanning circuit 102. The scanning circuit 102 selects a line depending on the timing signal that is supplied from the timing signal generating circuit 104.

[0106]

The image signal processing circuit 107 in the embodiment will be explained next. Here, in the fluorescent film 1008 of the display panel in the embodiment, the fluorescent materials of the individual color components are arranged in a pattern such as in FIG. 1.

[0107]

Fundamentally, two lines on the display panel correspond to one line of the inputted image signal. That is, when the arrangement of FIG. 1 is used, two lines are driven when an image signal of one scan line is inputted.

[0108]

FIG. 16 depicts a block structural diagram of the image signal processing circuit 107 when the fluorescent film pattern of the first embodiment is applied.

[0109]

In the figure, 201a and 201b are registers that have the capacity for storing only image data commensurate with one line of the display panel 101.

[0110]

As explained above, two lines are driven for one input line, and thus a multiplying circuit 204, as shown in the diagram, is provided in order to double the frequency of the inputted horizontal synchronization signal, and a counter 205, for counting the doubled signal, is provided. This counter is used for selecting either the registers 201a or 201b, and fundamentally need only be able to discriminate between odd number lines and even number lines on the display panel, and thus the count value is one bit. That is, the selector 202 selects sequentially either the registers 201a or 201b in accordance with the output signal from the counter 205, and outputs the output data to the pulse width modulating circuit 108.

[0111]

If the arrangement of FIG. 1 is used, the registers 201a and 201b are connected so that the inputs of the individual registers will store the color components shown in FIG. 1, for data of an RGBRGB... format that is stored in the S/P converting circuit 106, as in FIG. 17. Note that the figure depicts only the registers 201a and 201b for the RGB data for first one pixel.

[0112]

For the image signal inputted for a single scan line, data is supplied to, and stored in, two registers. Given this, an image can be displayed in the pattern shown in FIG. 1 by driving the registers 201a and 201b sequentially.

[0113]

Note that, for the register 201b, the figure shows a case wherein memory for storing the non-display element is provided, but actually there is no need to provide memory for the non-display element portion, so the capacity of the register 201a can be halved. Moreover, as can be appreciated by the explanation thus far, if the image is displayed by the pattern in FIG. 1, the number of surface conduction-type electron emitting elements that correspond to the even lines in the display panel may be half as many as for the odd lines.

[0114]

Moreover, there will also be other patterns, aside from those in FIG. 1 and FIG. 2, wherein the maximum luminosity differences between rows and between columns will be 0.40 as indicated in FIG. 21. However, the patterns with the same values are fundamentally patterns wherein FIG. 1 or FIG. 2 have been rotated, so there is substantially no difference.

[0115]

Moreover, if the pattern of FIG. 1 is defined as M and the pattern of FIG. 2 is defined as N, then a 4 x 4 pattern wherein row one column one and row two column two are made from M and row one column two and row two column one are made from N may also be used.

[0116]

As explained above, the present embodiment has the effect of improving the image quality through reducing the appearance of horizontal or vertical colored stripes.

[0117]

[Effects of the Invention]

As explained above, the present invention can improve the image quality by reducing visual interference caused by horizontal stripes or vertical stripes due to luminosity differences through reducing luminosity differences

between rows or luminosity differences between columns in a two-row, two-column basic arrangement.

[0118]

[Brief Descriptions of the Drawings]

FIG. 1 is a diagram depicting an arrangement pattern for color components in a first embodiment.

FIG. 2 is a diagram depicting an arrangement pattern for color components in a first embodiment.

FIG. 3 is a diagram depicting a typical striped arrangement and an arrangement considered by the inventors.

FIG. 4 is a perspective diagram showing an image displaying device of an embodiment of the present invention, with a portion of the display cut away.

FIG. 5 is a plan view illustrating the arrangement of the fluorescent material on the faceplate of the display panel in the present embodiment.

FIG. 6 is a plan view and a cross-sectional drawing of a planar surface conduction-type emitting element used in an embodiment.

FIG. 7 is a drawing depicting steps for manufacturing a flat surface conduction-type emitting element in an embodiment.

FIG. 8 is a diagram showing the waveform of the applied voltage during an electrical forming process in an embodiment.

FIG. 9 is a diagram showing the applied voltage waveform and changes in the emission current I_e during the electrical activating process in an embodiment.

FIG. 10 is a cross-sectional drawing of a surface conduction-type emitting element of a vertical type in an embodiment.

FIG. 11 is a drawing depicting steps for manufacturing a perpendicular surface conduction-type emitting element in an embodiment.

FIG. 12 is a diagram showing typical characteristics of a surface conduction-type emitting element used in an embodiment.

FIG. 13 is a plan view of a substrate for a multi-electron beam source used in an embodiment.

FIG. 14 is a partial cross-sectional drawing of a substrate for a multi-electron beam source used in an embodiment.

FIG. 15 is a block structural diagram of the driving portion of a display device in an embodiment.

FIG. 16 is a block structural diagram of the image signal processing circuit in FIG. 15.

FIG. 17 is a diagram depicting the state of storage of image data in the group of registers in FIG. 16.

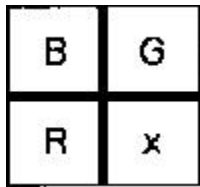
FIG. 18 is a diagram depicting an example of a surface conduction-type emitting element.

FIG. 19 is a diagram depicting an example of an FE-type element.

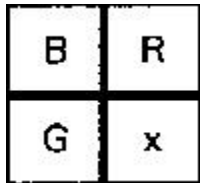
FIG. 20 is a diagram depicting an example of an MIM-type element.

FIG. 21 is a diagram depicting luminosity differences between rows through various color component combinations.

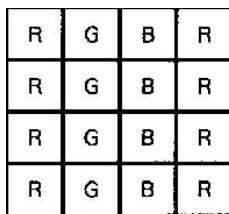
[FIG. 1]



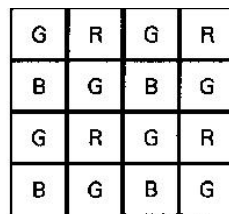
[FIG. 2]



[FIG. 3]

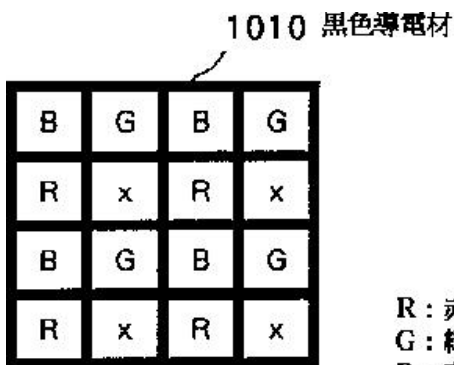


(a)



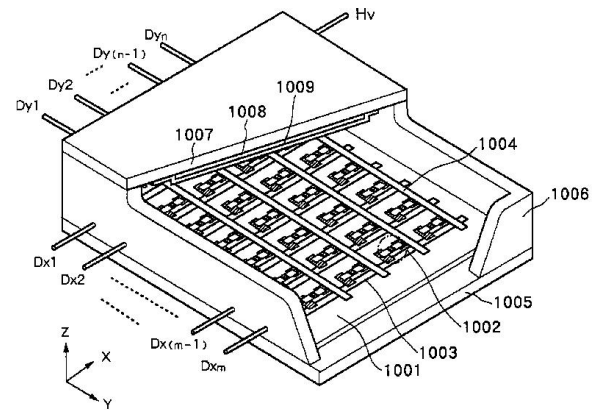
(b)

[FIG. 5]

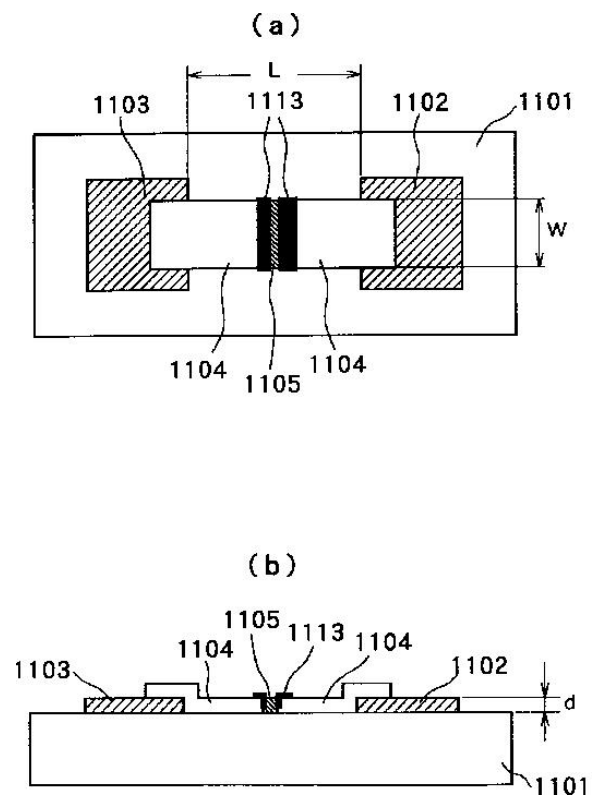


1010: Black Conductive Material
R: Red Fluorescent Body
G: Green Fluorescent Body
B: Blue Fluorescent Body
x: Non-Display Element

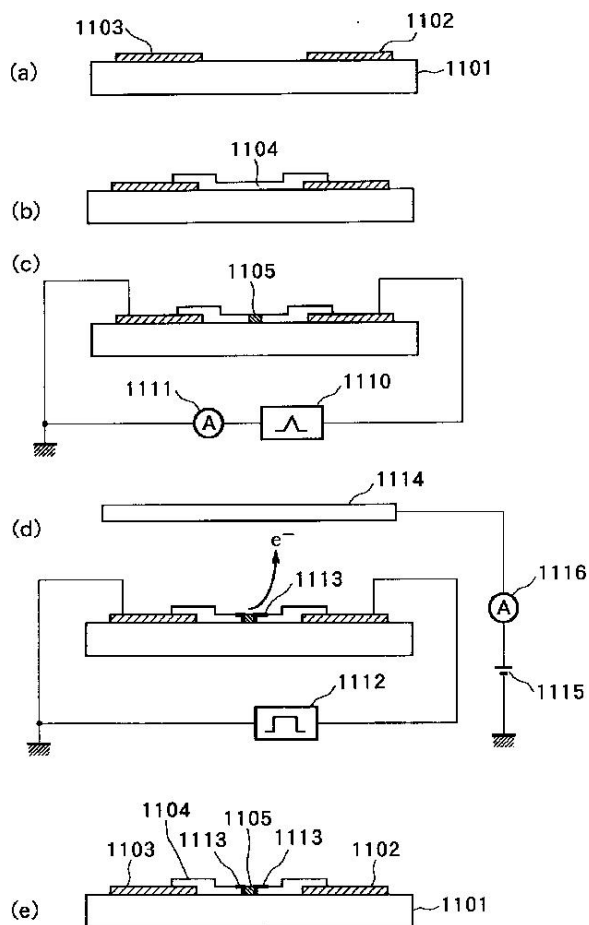
[FIG. 4]



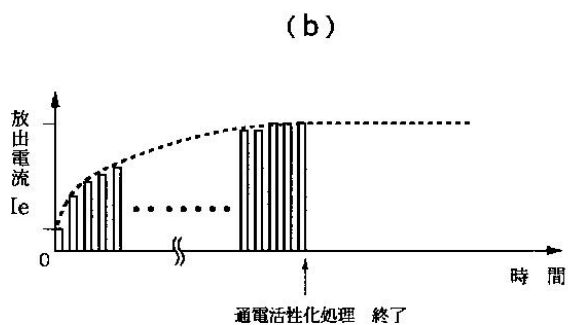
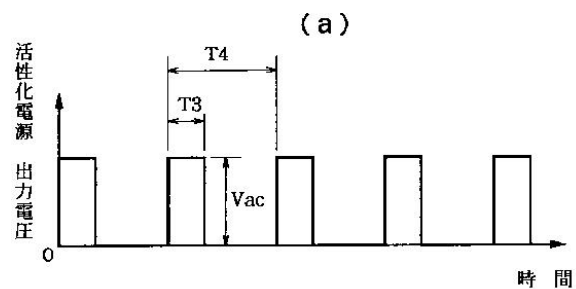
[FIG. 6]



[FIG. 7]

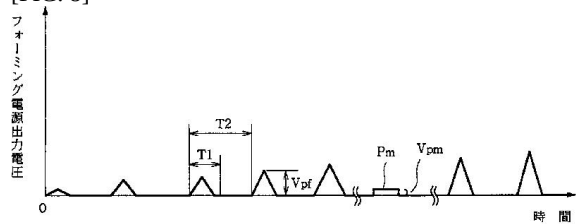


[FIG. 9]



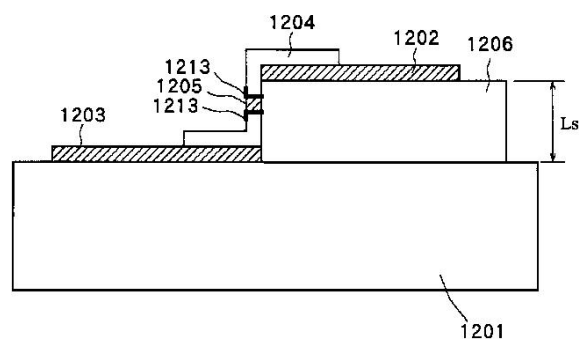
(a) [VERTICAL AXIS] Activated Power Source Output Voltage
 [HORIZONTAL AXIS] Time
 (b)
 [VERTICAL AXIS] Emission Current I_e
 [MIDDLE] Electrical Activation Process Completed
 [HORIZONTAL AXIS] Time

[FIG. 8]

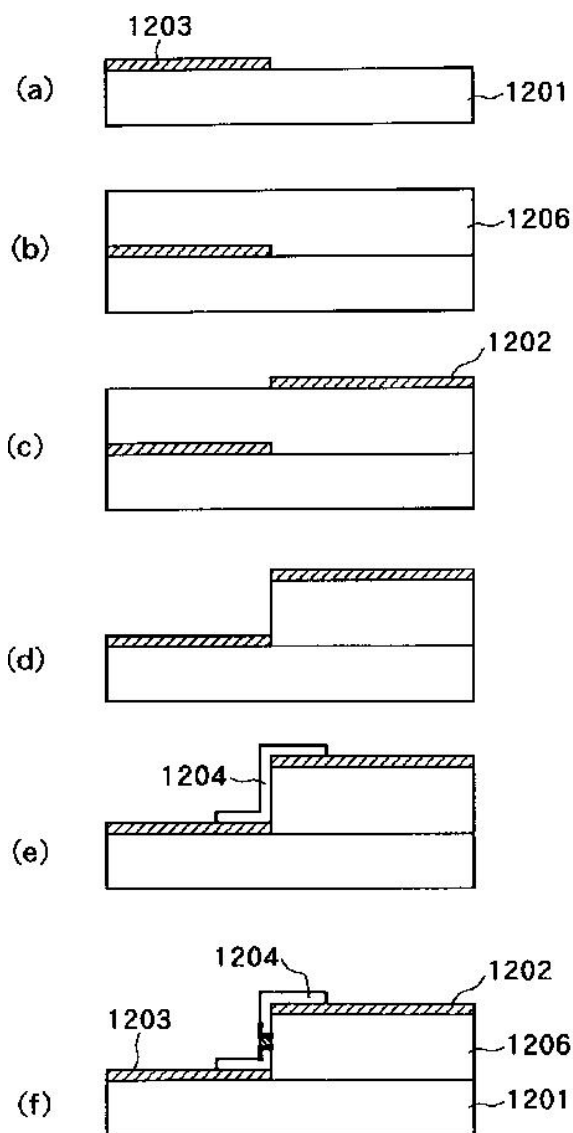


[VERTICAL AXIS] Forming Power Supply Output Voltage
 [HORIZONTAL AXIS] Time

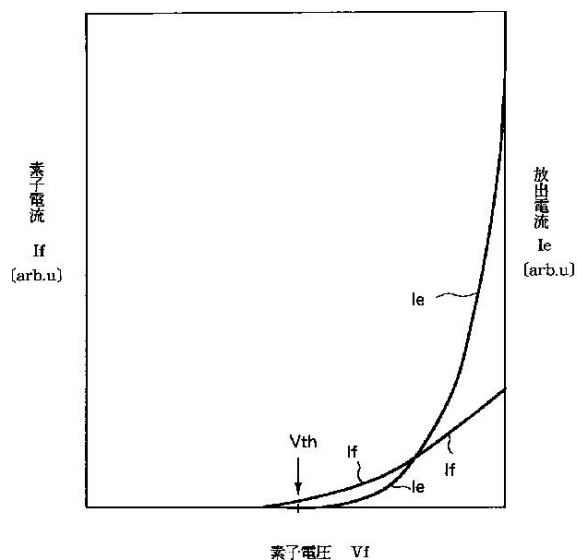
[FIG. 10]



[FIG. 11]

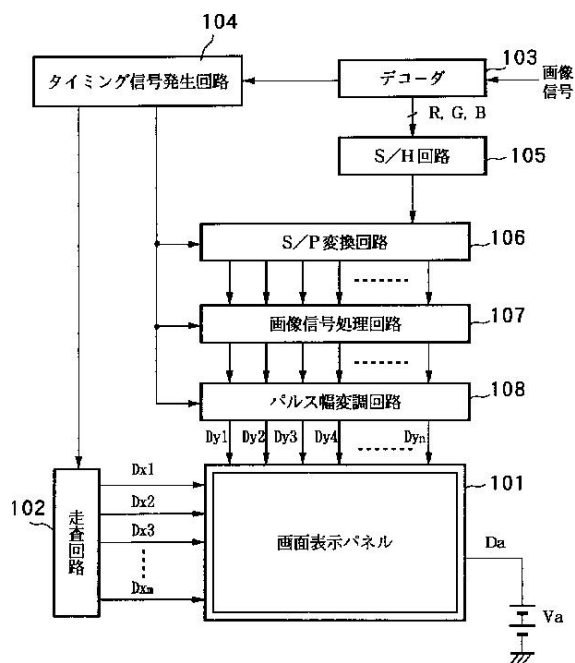


[FIG. 12]



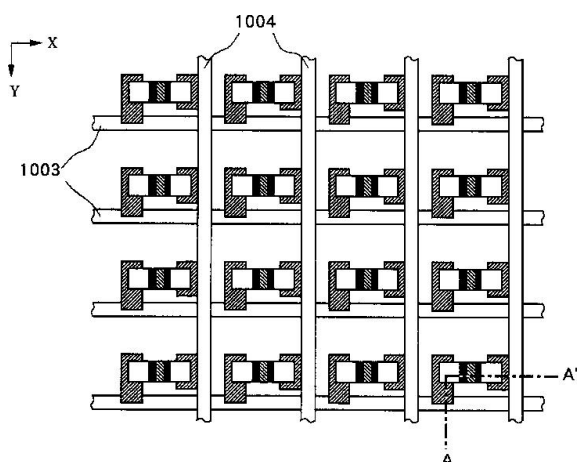
[LEFT] Element Current
[RIGHT] Emission Current
[BOTTOM] Element Voltage

[FIG. 15]

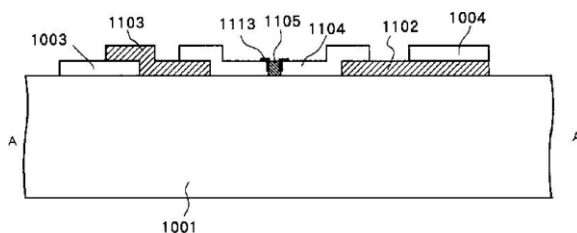


104: Time Signal Generating Circuit
103: Decoder
[UPPER RIGHT] Image Signal
105: S/H Circuit
106: S/P Converting Circuit
107: Image Signal Processing Circuit
108: Pulse Width Modulating Circuit
102: Scanning Circuit
101: Image Displaying Panel

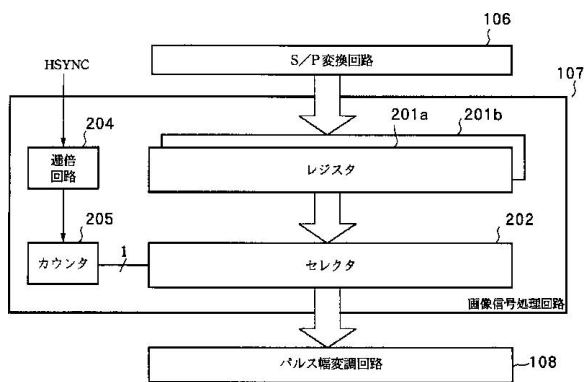
[FIG. 13]



[FIG. 14]

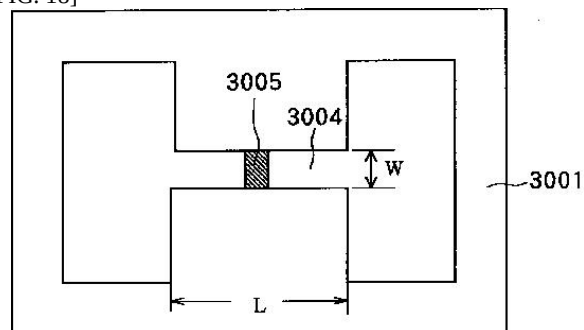


[FIG. 16]

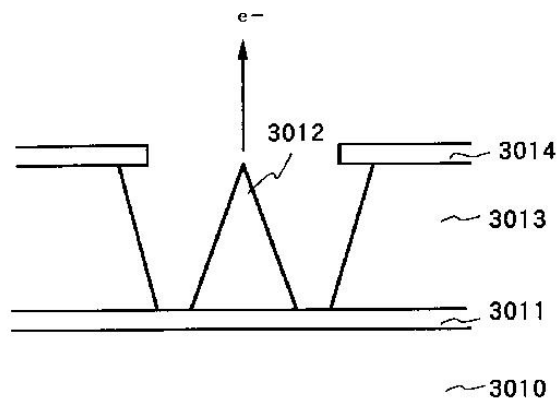


106: S/P Converting Circuit
 107 [BOTTOM RIGHT] Image Signal Processing Circuit
 204: Multiplying Circuit
 205: Counter
 201a: Register
 202: Selector
 108: Pulse Width Modulating Circuit

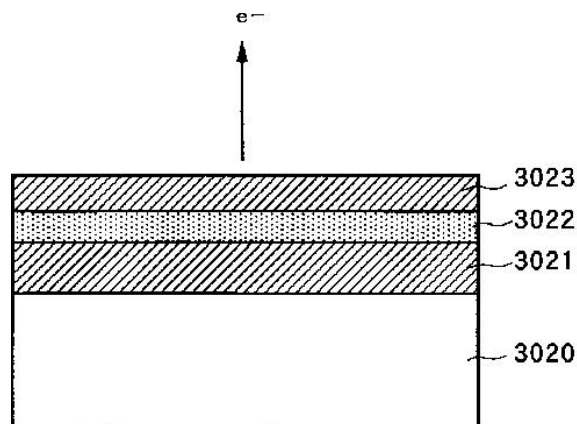
[FIG. 18]



[FIG. 19]



[FIG. 20]



[FIG. 21]



				Sum of Luminosity for Each Row and Column				Maximum Luminosity Difference between Rows or Columns
				First Row	Second Row	Third Row	Fourth Row	
				行・列ごとの輝度合				行間・列間の最大輝度差
m11	m12	m21	m22	1行目	2行目	3行目	4行目	
R	G	B	x	0.89	0.11	0.41	0.59	0.78
R	G	x	B	0.89	0.11	0.30	0.70	0.78
R	B	G	x	0.41	0.59	0.89	0.11	0.78
R	B	x	G	0.41	0.59	0.30	0.70	0.40
R	x	G	B	0.30	0.70	0.89	0.11	0.78
R	x	B	G	0.30	0.70	0.41	0.59	0.40
G	R	B	x	0.89	0.11	0.70	0.30	0.78
G	R	x	B	0.89	0.11	0.59	0.41	0.78
G	B	R	x	0.70	0.30	0.89	0.11	0.78
G	B	x	R	0.70	0.30	0.59	0.41	0.40
G	x	R	B	0.59	0.41	0.89	0.11	0.78
G	x	B	R	0.59	0.41	0.70	0.30	0.40
B	R	G	x	0.41	0.59	0.70	0.30	0.40
B	R	x	G	0.41	0.59	0.11	0.89	0.78
B	G	R	x	0.70	0.30	0.41	0.59	0.40
B	G	x	R	0.70	0.30	0.11	0.89	0.78
B	x	R	G	0.11	0.89	0.41	0.59	0.78
B	x	G	R	0.11	0.89	0.70	0.30	0.78
x	R	G	B	0.30	0.70	0.59	0.41	0.40
x	R	B	G	0.30	0.70	0.11	0.89	0.78
x	G	R	B	0.59	0.41	0.30	0.70	0.40
x	G	B	R	0.59	0.41	0.11	0.89	0.78
x	B	R	G	0.11	0.89	0.30	0.70	0.78
x	B	G	R	0.11	0.89	0.59	0.41	0.78



TRANSLATOR CERTIFICATION

Date: January 13, 2023

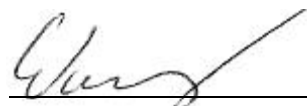
To whom it may concern:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

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- Japanese Patent Application Number: JP H11 185654 A



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