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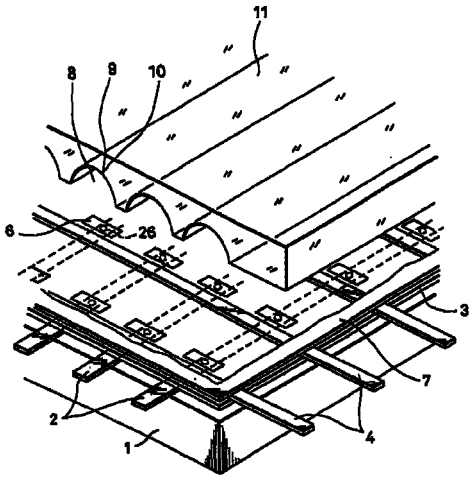
(54) FLAT DISPLAY

(57) A flat display device comprises first electrode (2) formed on a first substrate (1) by coating, an insulation layer (3) formed on the first substrate (1) by coating so as to cover the first electrode (2), wherein dielectric constant and thickness thereof are selected so as to block the function of a dielectric layer covering a discharge electrode of AC type PDP, second electrode (4) formed on the insulation layer (3) by coating such that it opposes and intersects the first electrode (2), so as to form matrix electrode in cooperation with the first electrode (2) via the insulation layer, plural island-like electrodes (6) formed in the vicinity of the second electrode (4) on the insulation layer (3) and connected to the first electrode (2) through each conductor (26) passing through the insulation layer (3), and dielectric layer (7) formed on the insulation layer by coating such that it covers the second electrode (4) and the plural island-like electrodes (6), wherein discharge is selectively conducted between the second electrode (4) and the plural island-like electrodes (6) located in the vicinity of the second electrode (4) of the plural island-like electrodes (6). Consequently, there is a flat display device of a simple structure thereby securing an easy production and cheap price, in which discharge operation is stabilized and cross-talk between adjacent display cells is difficult to occur thereby securing a high resolution.

FIG. 4



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Description

TECHNICAL FIELD

[0001] The present invention relates to a flat type display device called PDP.

BACKGROUND ART

[0002] A conventional flat type display device called PDP (Plasma Display Panel) having the most popular structure is so-called double-electrode opposed discharge type PDP. In this double-electrode opposed discharge type PDP, first and second electrodes, each comprised of plural stripe-like electrodes which opposes each other across a discharge space while intersecting each other, are provided on glass substrates on front and rear sides composing a tube containing discharge gas, the front and rear sides being' disposed in parallel to each other. A voltage is selectively applied between plural electrodes each composing the first and second electrodes so as to generate discharge at an intersecting point of selected electrodes to attain luminescent display.

[0003] Although such PDP is originally a single-color luminescent display device, a, color PDP can be constructed by forming red, green and blue light-producing fluorescent layers cyclically in order at predetermined positions in the tube such that they are coated and then irradiating ultraviolet ray generated by discharge to those fluorescent layers so as to allow them to generate lights.

[0004] In such color PDP, because the fluorescent layers must be formed at positions where scattered substances from the electrodes and the like, generated by discharge in the tube or ion impact cannot adhere easily, the formation positions for the fluorescent layers are limited. Further, there is a fear that a sufficient luminance cannot be obtained from the fluorescent layers depending on the position in which the fluorescent layer is formed.

[0005] The conventional color PDP involves a double-electrode discharge type color PDP in which XY electrodes are disposed on the same plane of the rear side glass substrate such that they intersect each other and the fluorescent layer is formed on the front side glass substrate.

[0006] Hereinafter, a structure of the conventional double-electrode discharge type color PDP will be described with reference to FIGS. 1, 2. The first electrode (X electrode) 2 comprised of plural stripe-like electrodes is disposed on the rear side glass substrate 1 and then, the second electrode (Y electrode) comprised of plural stripe-like electrodes is disposed on the X electrode 2 so that they intersect (cross perpendicularly) each other. An insulation layer 3 is disposed at an intersecting point between the X electrode 2 and the Y electrode 4 so as to electrically separate the X electrode 2 and the Y electrode 4. A dielectric layer 7 is formed so as to cover the surfaces of the X electrode 2 and the Y electrode 4 and the surface of the rear side glass substrate 1 so that the X electrode 2 and the Y electrode are coated therewith thereby each forming AC type electrode. Reference numeral 20 in FIG. 2 denotes a discharge path between the X electrode 2 and the Y electrode 4.

[0007] Although not shown, red, green and blue light producing fluorescent layers are formed cyclically in order on the front side glass substrate so that it is coated therewith.

[0008] Because in this color PDP, the fluorescent layers are separated securely from the discharging electrodes, no scattered substance flies from the discharging electrodes, namely, the X electrode 2 and the Y electrode 4 to the fluorescent layer.

[0009] Further, because this fluorescent material layer is so-called transmission type fluorescent material layer through which light produced from the fluorescent material layer by receiving ultraviolet ray generated by discharge is transmitted so that it is emitted outside from the front side glass substrate, this has a feature that color purity of the produced light is excellent.

[0010] Next, the conventional color PDP called three-electrode discharge type PDP will be described with reference to FIG. 3. First electrode (X electrode) 2 comprised of plural stripe-like electrodes disposed longitudinally in parallel is formed on the rear side glass substrate 1 and then, dielectric layer 35 is formed on the surfaces of the rear side glass substrate 1 and the X electrode 2 so that the X electrode is covered. Partition walls 31 are provided between respective stripe-like electrodes composing the X electrode 2 on the dielectric layer 35. Then, a fluorescent material layer 9 is formed on side faces of these partition walls 31 and the dielectric layers between the adjacent partition walls 31.

[0011] Second electrode (Y electrode) 4 comprised of plural stripe-like electrodes are formed on the front side glass substrate (not shown) such that it opposes and intersects the plural stripe-like electrodes composing the X electrode 2 on the rear side glass substrate 1 and sustain electrode 34 comprised of plural stripe-like electrodes connected in common is also formed thereon, such that its stripe-like electrodes are in parallel to and near the respective electrodes composing the Y electrodes 4.

[0012] A dielectric layer 33 is formed on the Y electrodes 4 and the sustain electrode 34 and a protective layer 32 is formed on the dielectric layer 33 thereby forming an AC type discharge electrode.

[0013] In this PDP, address discharge between the X electrode 2 and the Y electrode 4 is relayed to sustain discharge between the Y electrode 4 and the sustain electrode 34 on the front side glass substrate. Because the X electrode 2 is irrelevant to the sustain discharge, the fluorescent material layer is little damaged by discharge like the above described double-electrode dis-

charge type PDP.

[0014] Because this fluorescent material layer 9 is so-called reflection type fluorescent face in which light produced by the fluorescent material layer by receiving ultraviolet ray generated by discharge is irradiated outside from the surface of the fluorescent material layer 9 through the front side glass substrate, it has such a feature that its luminance is high.

[0015] Next, a number of problems to be solved about the above conventional PDP will be described. First, as regards the double-electrode discharge type PDP, the X electrode as the lower layer discharge electrode is divided to apparently two sections, right and left, by the Y electrode 4 as the upper layer electrode as evident from a sectional view of FIG. 2 and therefore, a following problem will occur.

[0016] That is, as shown in FIG. 2, a pair of discharge paths 20, which go from the X electrode 2 to the Y electrode 4, are formed on both sides of the Y electrode 4. In this case, depending on deviation of the characteristic of the X electrode 2 and the Y electrode 4, the pair of the discharge on both sides are not equal and in an extreme case, discharge may occur on any one of them. This leads to error discharge such as cross-talk or error display.

[0017] The insulation layer 3 exists between the X electrode 2 which is the lower layer electrode and the Y electrode 4 which is the upper layer electrode. Because this insulation layer 3 is formed integratedly with the dielectric layer 7, the dielectric layer 7 on the X electrode 2, which is the lower layer electrode, is thicker than that on the Y electrode 4, which is the upper layer electrode. This may lead to a difference of the characteristic between the X electrode 2 and the Y electrode 4, providing a problem on driving the electrodes. Further, if the insulation layer 3 is made thin, capacity between both the electrodes increases so that withstand voltage between the electrodes drops, thereby also providing a problem on driving the electrodes.

[0018] In the case of the transmission type fluorescent material layer, the fluorescent material layer is formed on only the front side glass substrate. As compared to a case where the fluorescent material layer is formed on the side faces of the partition wall and bottom face as in the aforementioned three-electrode discharge type PDP, the quantity of the fluorescent material layer is limited, so that there is a limit in improvement of the luminance. Further, because usually, the fluorescent material is white, there is such a disadvantage that the contrast is low.

[0019] On the other hand, the three-electrode discharge type PDP also has a problem. Because in this type PDP, the fluorescent material layer is formed on the rear side glass substrate, color of light produced by the fluorescent material layer arid color of light produced by discharge gas mix with each other so that color purity drops.

[0020] The three-electrode discharge type PDP is comprised of three electrodes by adding another electrode or a sustain electrode to two electrodes originally required for the XY matrix type PDP. Therefore, production cost increases, which is a problem also on production. Further, because the discharge electrode is located on the front side glass substrate, light produced by the fluorescent material layer is interrupted by the electrode. To avoid this phenomenon, a transparent electrode or very thin electrode or dielectric layer or protective layer having high transparency has to be produced. This makes production complicated thereby leading to an increase of cost.

[0021] In views of the above described problems, the present invention intends to propose a flat display device having a simple structure and securing an easy production and cheap price, in which discharging operation thereof is stabilized and cross-talk between adjacent display cells is difficult to generate thereby making it possible to secure a high resolution.

[0022] Further, the present invention intends to propose a flat display device having a simple structure and securing an easy production and cheap price, in which cross-talk between adjacent display cells is difficult to generate thereby making it possible to secure a high resolution and capable of conducting color display at high luminance.

[0023] Still further, the present invention intends to propose a flat display device having a simple structure and securing an easy production and cheap price, in which cross-talk between adjacent display cells is difficult to generate and capable of conducting color display at high luminance, high contrast and high resolution.

DISCLOSURE OF THE INVENTION

[0024] According to a first invention, there is provided a flat display device comprising first and second substrates opposing each other at a predetermined gap for composing a tube filled with discharge gas, first electrode comprised of plural stripe-like electrodes, formed on the first substrate by coating, an insulation layer formed on the first substrate by coating so as to cover the first electrode, wherein dielectric constant and thickness thereof are selected so as to block the function of a dielectric layer covering a discharge electrode of AC type PDP, second electrode formed on the insulation layer and comprised of plural stripe-like electrodes which opposes through the insulating layer and intersects the plural stripe-like electrodes composing the first electrode, so as to form a matrix electrode in cooperation with the first electrode, plural island-like electrodes formed on the insulation layer in the vicinity of the plural stripe-like electrodes composing the second electrode and connected to the plural stripe-like electrodes composing the first electrode, through each conductor passing through the insulation layer, and dielectric layer formed on the insulation layer by coating such that it covers the second electrode and the plural island-like

electrodes, wherein
discharge is selectively conducted between the plural stripe-like electrodes composing the second electrode and the plural island-like electrodes located in the vicinity of the plural stripe-like electrodes composing the second electrode, of the plural island-like electrodes.

[0025] According to this first invention, it is possible to obtain a flat display device having a simple structure and securing an easy production and cheap price, in which discharging operation is stabilized and cross-talk between adjacent display cells is difficult to generate, thereby making it possible to secure a high resolution.

[0026] According to a second invention, there is provided a flat display device according to the first invention wherein the plural island-like electrodes are formed in the vicinity of only one side of the plural stripe-like electrodes composing the second electrode on the insulator.

[0027] According to the second invention, the same effect as the first invention can be obtained.

[0028] According to a third invention, there is provided a flat display device according to the first invention wherein each of the plural island-like electrodes is formed on the insulation layer in a space formed at every third piece of the plural stripe-like electrodes composing the second electrode such that it is in the vicinity of the stripe-like electrodes on both sides of the second electrode.

[0029] According to this third invention, the same effect as the first invention is obtained. However, because the number of the island-like electrodes and the conductors are reduced by substantially half as compared to the second invention, its structure is further simplified, production method is further facilitated and its price is further reduced.

[0030] According to a fourth invention, there is provided a flat display device according to the first, second or third invention wherein plural grooves are provided in the second substrate such that they are extended in an extending direction of the plural stripe-like electrodes composing the first electrode corresponding thereto and light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of the grooves by coating.

[0031] According to this fourth invention, the same effect as the first, second or third invention is obtained and it is possible to obtain a flat display device capable of conducting high luminance color display.

[0032] According to a fifth invention, there is provided a flat display device according to the first, second or third invention wherein plural grooves are provided in the second substrate such that they are extended in an extending direction of the plural stripe-like electrodes composing the first electrode corresponding thereto and light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of the plural grooves via color filter layer of the same primary color by coating.

[0033] According to this fifth invention, the same effect as the first, second or third invention is obtained and it is possible to obtain a flat display device capable of conducting high luminance, high contrast color display.

[0034] According to a sixth invention, there is provided a flat display device according to the first, second or third invention wherein plural grooves are provided in the second substrate such that they are extended in an extending direction of the plural stripe-like electrodes composing the first electrode corresponding thereto, a black layer is formed on an inner face of a groove apart by every predetermined number of the plural grooves, and light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of the plural grooves in which no black layer is formed, of the plural grooves.

[0035] According to this sixth invention, the same effect as the first, second or third invention can be obtained and it is possible to obtain a flat display device capable of conducting high luminance, high contrast color display.

[0036] According to a seventh invention, there is provided a flat display device according to the first, second or third invention wherein plural grooves are provided in the second substrate such that they are extended in an extending direction of the plural stripe-like electrodes composing the first electrode corresponding thereto, a black layer is formed on an inner face of a groove apart by every predetermined number of the plural grooves, and light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of the plural grooves in which no black layer is formed, of the plural grooves via a color filter layer .of the same primary color.

[0037] According to this seventh invention, the same effect as the first, second or third invention can be obtained and it is possible to obtain a flat display device capable of conducting high luminance, high contrast color display.

[0038] According to an eighth invention, there is provided a flat display device according to the sixth invention wherein formation of the island-like electrode and the conductor is omitted in each of the plural stripe-like electrodes corresponding to a groove in which the black layer is formed of the plural stripe-like electrodes composing the first electrode.

[0039] According to this eighth invention, the same effect as the sixth invention can be obtained and it is possible to obtain a flat display device having a simpler structure than the sixth invention.

[0040] According to a ninth invention, there is provided a flat display device according to the seventh invention wherein formation of the island-like electrode and the conductor is omitted in each of the plural stripe-like electrodes corresponding to a groove in which the black layer is formed of the plural stripe-like electrodes

composing the first electrode.

[0041] According to this ninth invention, the same effect as the seventh invention can be obtained and it is possible to obtain a flat display device having a simpler structure than the seventh invention.

[0042] According to a tenth invention, there is provided a flat display device according to the sixth invention wherein each of the plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a groove in which the black layer is formed of the plural stripe-like electrodes composing the first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of the plural island-like electrodes of the plural stripe-like electrodes composing the second electrode.

[0043] According to this tenth invention, the same effect as the sixth invention can be obtained and it is possible to obtain a flat display device capable of driving the first and second electrodes at high speeds thereby its discharging operation being further stabilized.

[0044] According to an eleventh invention, there is provided a flat display device according to the seventh invention wherein each of the plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a groove in which the black layer is formed of the plural stripe-like electrodes composing the first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of the plural island-like electrodes of the plural stripe-like electrodes composing the second electrode.

[0045] According to this eleventh invention, the same effect as the seventh invention can be obtained and it is possible to obtain a flat display device capable of driving the first and second electrodes at high speeds thereby its discharging operation being further stabilized.

[0046] According to a twelfth invention, there is provided a flat display device according to the sixth invention wherein each of the plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a groove in which the black layer is formed of the plural stripe-like electrodes composing the first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of the plural island-like electrodes of the plural stripe-like electrodes composing the second electrode, while formation of the dielectric layer on the island-like electrode is omitted.

[0047] According to this twelfth invention, the same effect as the sixth invention can be obtained and it is possible to obtain a flat display device capable of driving the first and second electrodes at high speeds thereby its discharging operation being further stabilized.

[0048] According to a thirteenth invention, there is provided a flat display device according to the seventh invention wherein each of the plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a groove in which the black layer is formed of the plural stripe-like electrodes composing the first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of the plural island-like electrodes of the plural stripe-like electrodes composing the second electrode, while formation of the dielectric layer on the island-like electrode is omitted.

[0049] According to this thirteenth invention, the same effect as the seventh invention can be obtained and it is possible to obtain a flat display device capable of driving the first and second electrodes at high speeds thereby its discharging operation being further stabilized.

[0050] According to a fourteenth invention, there is provided a flat display device according to the first, second or third invention wherein plural rows of dents are provided in the second substrate in an extending direction of the plural stripe-like electrodes composing the first electrode corresponding thereto, and light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of the plural rows of the dents by coating.

[0051] According to the fourteenth invention, the same effect as tile first, second or third invention can be obtained and it is possible to obtain a flat display device capable of conducting high luminance color display.

[0052] According to a fifteenth invention, there is provided a flat display device according to the first, second or third invention wherein plural rows of dents are provided in the second substrate in an extending direction of the plural stripe-like electrodes composing the first electrode corresponding thereto, and light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of the plural rows of the dents via color filter layer of the same primary color by coating.

[0053] According to the fifteenth invention, the same effect as the first, second or third invention can be obtained and it is possible to obtain a flat display device capable of conducting high luminance, high contrast color display.

[0054] According to a sixteenth invention, there is provided a flat display device according to the first, second or third invention wherein plural rows of dents are provided in the second substrate in an extending direction of the plural stripe-like electrodes composing the first electrode corresponding thereto, a black layer is formed on an inner face of a dent apart by every predetermined number of the plural rows of the dents, and light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of the plural rows of dents in which no black layer is formed, of the rows of the dents.

[0055] According to this sixteenth invention, the same effect as the first, second or third invention can be obtained and it is possible to obtain a flat display device

capable of conducting high luminance, high contrast color display.

[0056] According to a seventeenth invention, there is provided a flat display device according to the first, second or third invention wherein plural rows of dents are provided in the second substrate in an extending direction of the plural stripe-like electrodes composing the first electrode corresponding thereto, a black layer is formed on an inner face of a dent apart by every predetermined number of the plural rows of the dents, and light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of the plural rows of dents in which no black layer Is formed, of the rows of the dents, via a color filter layer of the same color.

[0057] According to the seventeenth invention,, the same effect as the first, second or third invention can be obtained and it is possible to obtain a flat display device capable of conducting high luminance, high contrast color display.

[0058] According to an eighteenth invention, there is provided a flat display device according to the sixteenth invention wherein formation of the island-like electrode and the conductor is omitted in each of the plural stripe-like electrodes corresponding to a dent row in which the black layer is formed of the plural stripe-like electrodes composing the first electrode.

[0059] According to the eighteenth invention, the same effect as the sixteenth invention can be obtained and it is possible to obtain a flat display device having a simpler structure than the sixteenth invention.

[0060] According to a nineteenth invention, there is provided a flat display device according to the seventeenth invention wherein formation of the island-like electrode and the conductor is omitted in each of the plural stripe-like electrodes corresponding to a dent row in which the black layer is formed of the plural stripe-like electrodes composing the first electrode.

[0061] According to the nineteenth invention, the same effect as the seventeenth invention can be obtained and it is possible to obtain a flat display device having a simpler structure than the seventeenth invention.

[0062] According to a twentieth invention, there is provided a flat display device according to the sixteenth invention wherein each of the plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a dent row in which the black layer is formed of the plural stripe-like electrodes composing the first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of the plural island-like electrodes of the plural stripe-like electrodes composing the second electrode.

[0063] According to the twentieth invention, the same effect as the sixteenth invention can be obtained and it is possible to obtain a flat display device capable of driving the first and second electrodes at high speeds thereby its discharging operation being further stabilized.

[0064] According to a twenty first invention, there is provided a flat display device according to the seventeenth invention wherein each of the plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a dent row in which the black layer is formed of the plural stripe-like electrodes composing the first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of the plural island-like electrodes, of the plural stripe-like electrodes composing the second electrode.

[0065] According to the twenty first invention, the same effect as the seventeenth invention can be obtained and it is possible to obtain a flat display device capable of driving the first and second electrodes at high speeds thereby its discharging operation being further stabilized.

[0066] According to a twenty second invention, there is provided a flat display device according to the sixteenth invention wherein each of the plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a dent row in which the black layer is formed of the plural stripe-like electrodes composing the first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of the plural island-like electrodes, of the plural stripe-like electrodes composing the second electrode, while formation of the dielectric layer on the island-like electrode is omitted.

[0067] According to the twenty second invention, the same effect as the sixteenth invention can be obtained and it is possible to obtain a flat display device capable of driving the first and second electrodes at high speeds thereby its discharging operation being further stabilized.

[0068] According to a twenty third invention, there is provided a flat display device according to the seventeenth invention wherein each of the plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a dent row in which the black layer is formed, of the plural stripe-like electrodes composing the first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of the plural island-like electrodes of the plural stripe-like electrodes composing the second electrode, while formation of the dielectric layer on the island-like electrode is omitted.

[0069] According to the twenty third invention, the same effect as the seventeenth invention can be obtained and it is possible to obtain a flat display device capable of driving the first and second electrodes at high speeds thereby its discharging operation being further stabilized.

[0070] According to a twenty fourth invention, there is provided a flat display device according to the first-twenty third invention wherein a hole is made in each of

the plural island-like electrodes and the conductor connected to the island-like electrode such that it goes therethrough and the dielectric layer is formed on an inner face of the hole so as to form a hollow electrode.

[0071] According to the twenty fourth invention, the same effect as the first-twenty third invention can be obtained and it is possible to obtain a flat display device having a lowered discharge voltage and a high light production efficiency.

[0072] According to a twenty fifth invention, there is provided a flat display device according to the first-twenty fourth invention wherein the first substrate is a rear side substrate while the second substrate is a transparent front side substrate.

[0073] According to this twenty fifth invention, the same effect as the first-twenty fourth invention can be obtained and the first, second electrodes, the island-like electrode, the insulation layer and the dielectric layer do not have to be transparent.

[0074] According to a twenty sixth invention, there is provided a flat display device according to the first-twenty fourth invention wherein the second substrate is a rear side substrate while the first substrate is a transparent front side substrate.

[0075] According to this twenty sixth invention, the same affect as the first-twenty fourth invention can be obtained.

BRIEF DESCRIPTION OF DRAWINGS

[0076]

FIG. 1 is a partial perspective view of a conventional double-electrode opposed-face discharge type, flat display device (PDP).

FIG. 2 is a partial sectional view of a conventional double-electrode opposed-face discharge type, flat display device (PDP).

FIG. 3 is a disassembly partial perspective view of a conventional three-electrode opposed-face discharge type, flat display device (PDP).

FIG. 4 is a disassembly partial perspective view of a flat display device according to an embodiment of the present invention.

FIG. 5 is a sectional partial view of a flat display device according to an embodiment of the present invention.

FIG. 6 is a disassembly partial perspective view of a flat display device according to an embodiment of the present invention.

FIG. 7 is a sectional partial view of a flat display device according to an embodiment of the present invention.

FIG. 8 is a sectional partial view of a flat display device according to another embodiment of the present invention.

FIG. 9 is a disassembly partial perspective view of a flat display device according to still another embodiment of the present invention.

FIG. 10 is a sectional partial view of a flat display device according to still another embodiment of the present invention.

FIG. 11 is a plan view of electrode allocation of a flat display device according to still another embodiment of the present invention.

FIG. 12 is a disassembly partial perspective view of a flat display device according to still another embodiment of the present invention.

FIG. 13 is a sectional partial view of a flat display device according to still another embodiment of the present invention.

FIG. 14 is a disassembly perspective partial view of a flat display device according to still another embodiment of the present invention.

FIG. 15 is a perspective partial view showing an example of a front side glass substrate of a flat display device according to still another embodiment of the present invention.

FIG. 16 is a disassembly perspective partial view of a flat display device according to still another embodiment of the present invention.

FIG. 17 is a disassembly perspective partial view of a flat display device according to still another embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0077] First, FIG. 4 to FIG. 7 are referred and an example of the flat display device (PDP) according to an embodiment of the present invention will be described. FIG. 4 is a disassembly perspective partial view of an example of the flat display device (PDP). FIG. 5 is a sectional partial view, FIG. 6 is a perspective partial view, and FIG. 7 is a sectional partial view.

[0078] First, a structure of this flat display device will be described together with a production method thereof with reference mainly to FIG. 4. For example, the X electrode 2, which is a first electrode comprised of plural stripe-like electrodes having a predetermined width, is formed on a rear side glass substrate 1 such that they are spaced at a predetermined interval in parallel to each other. This X electrode 2 is formed by printing conductive paste such as silver and nickel on the rear side glass substrate 1 through a screen and then, baking it. This X electrode 2 may be formed by photo-etching method, thin film method such as vacuum deposition method or other method.

[0079] Next, an insulation layer (composed of low-melting point material such as glass having a relatively low dielectric constant) 3 for covering the X electrode 2 and insulating between the X electrode 2 and a Y electrode 4 which will be formed later is formed on the rear side glass substrate 1 and the X electrode 2. This insulation layer 3 is formed by printing a low-melting point glass paste for example, on the rear side glass substrate 1 and the X electrode 2 through a screen and

baking it.

[0080] The thickness of the insulation layer 3 may be usually about 0.02-0.03 mm because a withstand voltage of about 200 V is sufficient if it is intended to insulate an interval between the X electrode 2 and the Y electrode 4.

[0081] However, to block the function of the insulation layer 3 as a dielectric layer for covering the discharge electrode of the AC type PDP, the thickness of the insulation layer 3 is set to about 0.04 mm or more, for example, about 0.04-0.08 mm. If material having an extremely low dielectric constant is used for the insulation layer 3 in order to satisfy the condition of the dielectric layer which does not cause discharge, the thickness of the insulation layer 3 can be reduced more,

[0082] Referring to FIG. 7, the upper Y electrode 4 is disposed so as to apparently divide the lower X electrode 2. However, if the insulation layer 3 is treated not to exert the function as a dielectric layer for covering the discharge electrode of the AC type PDP, no discharge occurs on the right side of the Y electrode 4.

[0083] Then, an island-like electrode and a conductor for connecting that island-like electrode to the X electrode 2 which is the lower electrode will be described with reference to FIGS. 4, 5, 6 as well as FIG. 7. A through hole 5 is made in the insulation layer 3 near the Y electrode 4 and a column-like, for example, cylindrical (square pole, rectangular pole and the like are permitted) conductor 26 is formed in the through hole 5 by baking conductive paste. Then, the island-like electrode (small electrode) 6 is formed on the insulation layer 3 such that it is connected to the conductor 26. This island-like electrode 6 is formed at the same time as the Y electrode 4. Consequently, the island-like electrode 6 is electrically connected to the X electrode 2 through the conductor 26.

[0084] Meanwhile, the island-like electrode 6 may be formed by baking conductive paste such as silver, nickel like the X electrode 2 and Y electrode 6.

[0085] As a result, the Y electrode 4 and the island-like electrode 6 are disposed in parallel on the insulation layer 3. The surfaces of the Y electrode 4 and island-like electrode 6 are covered by dielectric layer 7.

[0086] The dielectric layer 7 is set thinner than the insulation layer 3, for example, to about 0.01 mm - 0.02 mm so as to increase the capacitance, so that it is capable of accumulating the same wall charge as the ordinary AC type PDP. Although not shown, protective layer is usually formed on the surface of the dielectric layer 7 using a material highly resistant to ion impact having a large secondary electron emission rate such as magnesium oxide. Discharge is excited from an electric field shape prior to the discharge as shown by a discharge path 20.

[0087] Next, a structure of the front side glass substrate 11 will be described with reference to FIGS. 4 and 5. The front side glass substrate 11 has plural grooves 8 formed corresponding to the X electrodes (first electrodes) 2 on the rear side glass substrate 1.

[0088] It is permissible to form rows of dents instead of the grooves 8. In this case, plural rows of the dents correspond to the plural grooves 8. The shape of the dent is, for example, of dome.

[0089] This groove 8 can be formed easily by chemical etching method, sand blast method or the like applied to the front side glass substrate 11.

[0090] The red, green and blue beam producing fluorescent material layers 9 are formed cyclically in order on an inner face of each of the plural grooves 8 in the front side glass substrate 11. The formation of the fluorescent material layers 9 in the groove 8 is carried out by coating with fluorescent material according to for example, screen printing method.

[0091] In case of the dent, the red, green and blue beam producing fluorescent material layers 9 are formed cyclically in order on the inner face of each of the plural rows in the front side glass substrate 11.

[0092] The depth of the groove 8 is preferred to be about 0.1 - 0.2 mm. In the normal PDP, the width of the groove 8 is about 0.15 - 0.5 mm. Because the thickness of fluorescent material layers 9 is about 0.01 mm, the groove 8 is never completely filled with the fluorescent material. Even if the chemical etching method or sand blast method is used for formation of the groove 8, generally, the sectional shape of the groove 8 is substantially inverted U shape as shown in FIG. 5 which makes advantages for improvement of the luminance and field angle of the fluorescent material layer 9.

[0093] The fluorescent material layers 9 for producing red, green and blue beams, which are primary colors, are formed directly on the inner face of the groove 8 in the front side glass substrate 11 or instead, as shown in FIG. 4 and 5 after forming color filters 10 of red, green and blue, which are primary colors, on the inner face of the groove 8, corresponding red, green and blue beam producing fluorescent material layers are formed on those red, green and blue color filters 10 respectively.

[0094] Generally, the color filter 10 can be formed easily by mixing each pigment with low-melting glass and coloring with each primary color and then printing through screen or the like.

[0095] The front side glass substrate 11 is matched with the rear side glass substrate 1 and vacuum-sealed with glass frit or the like. Then, mixed gas suitable for discharge such as neon, argon and xenon is charged into a space between the both glass substrates 1 and 11 at an about 0.5 atmospheric pressure. Consequently, the flat display device is completed.

[0096] In the flat type display unit shown in FIGS. 4-7, the X electrode (first electrode) 2, the insulation layer 3, the Y electrode (second electrode) 4, the island-like electrode 6, the dielectric layer 7 and the conductor 26 are provided on the rear side glass substrate 1 and the grooves 8 (dent rows may be used instead), fluorescent material layer 9 and the color filter 10 are provided on

the front side glass substrate 11. It is also permissible to provide the front side glass substrate 11 with the X electrode (first electrode) 2, the insulation layer 3, the Y electrode (second electrode) 4, the island-like electrode 6, the dielectric layer 7 and the conductor 26, and the rear side glass substrate 1 with the grooves 8 (dent rows may be used instead), the fluorescent material layer 9 and the color filters 10.

[0097] In the latter case, such components as the electrodes provided on the front aide glass substrate 11 may be formed of transparent material. However, if the transparency of each component on the front side glass substrate 11 becomes a problem when those components are not made of transparent material, the position of the X electrode 2 is made to correspond to the partition wall between the groove 8 and the groove 8 formed in the rear side glass substrate 1. Further, a protruding portion which protrudes up to the through hole 21 which connects the island-like electrode 6 with the X electrode 2 may be provided on the X electrode 2.

[0098] Next, a flat display device (PDP) according to another embodiment of the present invention will be described with reference to a sectional view thereof in FIG. 8. In an example shown in FIG. 8, a through hole 24 which goes through the island-like electrode 6 and the conductor 26 are formed and the dielectric layer 7 is formed in the hole 24 too so as to form so-called hollow electrode 21. Although the island-like electrode 6 and the X electrode 2, which is the lower electrode, are electrically connected to each other through the conductor 26, the hole 24 is not filled completely with conductive paste and dielectric layer 7 and is dent-like and further, the diameter of that dent is of a dimension suitable for generation of the hollow effect (in ordinary PDP, the diameter is about 0.05 mm). In AC discharge between the Y electrode 4 and the island-like electrode 6, the hollow effect is generated at a timing that the island-like electrode 6 is actuated as a cathode, so that discharge voltage drop and light generation efficiency increase are found. Here, this hollow electrode 21 functions as a hollow cathode.

[0099] Meanwhile, an entire inner peripheral face of this hole 24 may be coated with the dielectric layer 7 and the dielectric layer 7 does not always have to be applied up to the X electrode 2 at the bottom of the hole 24. That is, the hollow cathode 21 may be actuated as a DC electrode while the island-like electrode 6 operates as an AC electrode.

[0100] If adjacent display cells exist very nearby in case of the flat display device shown in FIGS. 4-7, so-called cross-talk, namely, error discharge is likely to occur between the island-like electrode 6 and two second electrodes (Y electrodes) 4 located on both sides thereof, so that not only discharge is generated between adjacent electrodes, but also discharge is also generated between electrodes located on opposite sides across the island-like electrode 6. Particularly in a high resolution PDP, its operating voltage range is narrowed.

[0101] Then, a flat display device according to still another embodiment of the present invention, which is an improvement of the flat display device shown in FIGS. 4-7, will be described with reference to FIGS. 9-12. FIG. 9 is a perspective partial view of a flat display device according to still another embodiment of the present invention. FIG. 10 is a sectional partial view thereof. FIG. 11 is a plan view showing an electrode allocation. FIG. 12 is a disassembly perspective partial view thereof.

[0102] First, a structure of the flat display device will be described together with a production method thereof with reference to FIGS. 9, 10. The X electrode 2, which is a first electrode, is formed on the rear side glass substrate 1 so that plural stripe-like electrodes each having a predetermined width are disposed in parallel to each other at a predetermined interval. This X electrode 2 is formed by printing conductive paste such as silver and nickel on the rear side glass substrate 1 through a screen and then, baking it. This X electrode 2 may be formed by photo-etching method, thin film method such as vacuum deposition method or other method.

[0103] Next, an insulation layer 3 for covering the X electrode 2 and insulating between the X electrode 2 and a Y electrode 4, which will be formed later, is formed on the rear side glass substrate 1 and the X electrode 2. This insulation layer 3 is formed by printing a low-melting point glass paste, for example, on the rear side glass substrate 1 and the X electrode 2 through a screen and baking it.

[0104] The thickness of the insulation layer 3 may be usually about 0.02-0.03 mm because a withstand voltage of about 200 V is sufficient if it is intended to insulate an interval between the X electrode 2 and the Y electrode 4.

[0105] However, to block the function of the insulation layer 3 as a dielectric layer for covering the discharge electrode of the AC type PDP, the thickness of the insulation layer 3 is set to about 0.04 mm or more, for example, about 0.04-0.08 mm. If material having an extremely low dielectric constant is used for the insulation layer 3 in order to satisfy the condition for the dielectric layer which does not cause discharge, the thickness of the insulation layer 3 can be reduced more.

[0106] Then, an island-like electrode and a conductor for connecting that island-like electrode to the X electrode 2 which is the lower electrode will be described with reference to FIG. 9 as well as FIG. 10. A through hole 5 is made in the insulation layer 3 near the Y electrode 4 and a column-like, for example, cylindrical conductor 26 is formed in the through hole 5 by baking conductive pasta. The size and shape of the through hole 5 are determined depending on electrode width and pixel pitch. Any shape such as square and rectangle except a circle is permitted.

[0107] Then, the island-like electrode 6 is formed on the insulation layer 2 such that it is connected to the conductor 26. This island-like electrode 6 is formed at

the same time as the Y electrode 4. Consequently, the island-like electrode 6 is electrically connected to the X electrode 2 through the conductor 26. Meanwhile, the island-like electrode 6 may be formed by baking conductive paste such as silver, nickel like the X electrode 2 and Y electrode 6.

[0108] As a result, the Y electrode 4 and the island-like electrode 6 are disposed in parallel on the insulation layer 3. In this example, the Y electrodes 4 are disposed symmetrically on the right and left sides of the island-like electrode 6. Then, the surfaces of the Y electrodes 4 and the island-like electrode 6 are coated with the dielectric layer 7.

[0109] The thickness of the dielectric layer 7 is set smaller than that of the insulation layer 3, for example, to about 0.01 mm - 0.02 mm so as to increase the capacitance, so that it is capable of accumulating the same wall charge as the ordinary AC type PDP. Although not shown, usually, the surface of the dielectric layer 7 is coated with a material highly resistant to ion impact having a large secondary electron emission rate such as magnesium oxide.

[0110] As shown in FIG. 10, electric fields 22, 23 of two dependent display cells 1, 2 are formed between the island-like electrode 6 and the Y electrodes 4, 4 on both sides thereof. That is, dependent discharge is generated each between the left half of the island-like electrode 6 and the Y electrode 4 on the left aide and between the right half of the island-like electrode 6 and the Y electrode 4 on the right side.

[0111] FIG. 11 shows a relation of allocation of the X electrodes 2 (X1, X2, X3, ...), the Y electrode 4 (Y1, Y2, Y3, ,...) and the island-like electrode 6 (S112, S212, S312, ..., 3134, "234, S334, ...).

[0112] The Y electrodes Y1, Y2 are disposed on both sides of each of the island-like electrodes S112, 212, 312, ... and the Y electrodes Y3, Y4 are disposed on both sides of each of the island-like electrodes S134, 234, 334, ... Looking in different way, the two Y electrodes Y2, Y3 are disposed between the island-like electrodes S112, 212, 312, ... and the island-like electrodes S134, 234, 334, ...

[0113] The island-like electrodes S112, 134, ... are disposed on the X electrode X1. The island-like electrodes S212, 234, ... are disposed on the X electrode X2. The island-like electrodes S312, 334, ... are disposed on the X electrode X3.

[0114] Further, the X electrodes X1, X2, X3, ... are disposed so as to oppose and intersect the Y electrodes Y1, Y2, Y3, ... with a predetermined gap.

[0115] Next, a structure of the front side glass substrate 11 will be described with reference to FIG. 12. Plural grooves 8 (plural rows of dents may be used instead) are formed in the front side glass substrate 11 corresponding to the X electrodes (first electrode) 2 on the rear side glass substrate 1.

[0116] This groove 8 can be formed easily by chemical etching method, sand blast method or the like applied to the front side glass substrate 11.

[0117] The red, green and blue beam producing fluorescent material layers 9 are formed cyclically in order on an inner face of each of the plural grooves 8 in the front side glass substrate 11. The formation of the fluorescent material layers 9 in the groove 8 is carried out by coating with fluorescent material according to for example, screen printing method.

[0118] The depth of the groove 8 is preferred to be about 0.1 - 0.2 mm. In the normal PDP, the width of the groove 8 is about 0.15 - 0.5 mm. Because the thickness of fluorescent material layers 9 is about 0.01 mm, the groove 8 is never completely filled with the fluorescent material. Even if the chemical etching method or sand blast method is used for formation of the groove 8, generally, the sectional shape of the groove 8 is substantially inverted U shape which makes advantages for improvement of the luminance and field angle of the fluorescent material layer 9.

[0119] The fluorescent material layers 9 for producing red, green and blue beams, which are primary colors, are formed directly on the inner face of the groove 8 in the front side glass substrate 11 or instead, after forming color filters 10 of red, green and blue, which are primary colors, on the inner face of the groove 8, corresponding primary colors red, green and blue beam producing fluorescent material layers 9 are formed on those red, green and blue color filters 10.

[0120] Generally, the color filter 10 can be formed easily by mixing each pigment to low-melting glass and coloring with each primary color and then printing through screen or the like.

[0121] The front side glass substrate 11 is matched with the rear side glass substrate 1 and vacuum-sealed with glass frit or the like. Then, mixed gas suitable for discharge such as neon, argon and xenon is charged into a space between the both glass substrates 1 and 11 at an about 0.5 atmospheric pressure. Consequently, the flat display device is completed.

[0122] Next, a modification of the flat display device shown in FIGS. 9-12 will be described with reference to FIG. 13. If an area of the island-like electrode 6 is relatively small like a case of a high resolution PDP, low layer partition walls (for example, made of an insulator having a low dielectric constant such as a low-melting glass) 29, which is about 0.02 - 0.03 mm high, are formed on the dielectric layer 7 corresponding to substantially the center of the island-like electrode 6 and the dielectric layer 7 corresponding to an intermediate between first and second X electrodes 4 on the right and left sides respectively of the island-like electrode 6 in order to separate the adjacent discharge cells clearly, such that these partition walls are extended in an extending direction of the X electrodes 2. Consequently, the island-like electrodes 6 can be separated more clearly from a viewpoint of structure, so that the operating range is expanded and cross-talk between adjacent display calls can be decreased,

[0123] Further, by providing the grid-like partition wall 29 for surrounding each display cell on the dielectric layer 7 as shown in FIG. 14, the cross-talk between adjacent display cells can be reduced.

[0124] Usually,a screen of every display device is composed of light producing portion and non-light producing portion and by coloring the non-light producing portion with black, the contrast ratio is increased.

[0125] However, the front side glass substrate 11 of the above described flat display device (PDP) has a small non-light producing portion relative to coated area of the fluorescent material layer, which is the light producing portion. For the reason, there is a problem about the contrast ratio.

[0126] Acceleration and stabilization of so-called address discharge are very important for attaining high resolution in the PDP having any structure. It has been well known that in the PDP, supplying charged particles or quasi-stable atoms, which tell the start of discharge, namely so-called priming to discharge cells is an effective way for reducing discharge delay time and stabilizing the operation.

[0127] However, because in the conventional PDP, light emission of this auxiliary discharge reduces the contrast of a screen and for other reasons, an effective, simple-structure auxiliary discharge mechanism has not been achieved.

[0128] A structure of the glass substrate in which the above described problems have been solved will be described with reference to a perspective view shown in FIG. 15. Reference numeral 11 denotes a glass substrate (although it is a front side glass substrate here, it may be a rear side glass substrate). Then, plural grooves 8 each having a concave curved face (plural rows of dents may be used instead) are provided in the front side glass substrate 11 such that they have the same width, depth and shape (for example, U-letter shaped in section).

[0129] The grooves 8 are formed by applying the sand blast method, chemical etching method or the like to the front side glass substrate 11. Meanwhile, reference numeral 8BR denotes partition wall between the adjacent grooves 8.

[0130] Black layer (for example, black glass layer) BL, red light producing fluorescent material layer 9R, green light producing fluorescent material layer 9G and blue light producing fluorescent material layer 9B are formed cyclically in order in each of the plural grooves (plural rows of dents may be used instead) by coating.

[0131] Because three neighboring grooves 8 having the red, green and blue light producing fluorescent material layers 9R, 9G, 9B compose a single color pixel, the groove 8 having the black layer BL as if it separates these color pixels improve the contrast ratio of the color image composed of many color pixels.

[0132] Although there is a fear that lights from the respective color fluorescent material layers 9R, 9G, 9B in the plural grooves 8 diffuse to mix with each other to some extent, an existence of the concave curved face groove 8 coated with the black layer has an effect of reducing the mixing of the colors as well as improving of the contrast ratio.

[0133] If the groove 8 coated with the black layer BL is disposed between neighboring grooves 8 coated with the respective fluorescent material layers 9R, 9G, 9B or between neighboring two grooves 8, the contrast ratio of the color image is improved further.

[0134] Although in this example, the width of the groove 8 coated with the black layer BL is the same as the width of each of the grooves 8 coated with the respective color fluorescent material layers 9R, 9G, 9B, it does not always have to be the same. That is, the width of the groove 8 coated with the black layer BL may be larger or smaller than the width of each of the grooves 8 coated with the respective color fluorescent material layers 9R, 9G, 9B.

[0135] Although in this example, the width of the groove 8 coated with each color fluorescent material layer 9R, 9G, 9B is the same, it does not always have to be the same. It is permissible to change the width of the groove 8 coated with each color fluorescent material layer 9R, 9G, 9B for each color so as to adjust color balance.

[0136] A structure of a flat display device containing the front side glass substrate 11 shown in FIG. 15 will be described with reference to a disassembly perspective partial view of FIG. 16. For example, the X electrode 2, which is a first electrode, is formed on the rear side glass substrate 1 so that plural stripe-like electrodes each having a predetermined width are disposed in parallel to each other at a predetermined interval. This X electrode 2 is formed by printing conductive paste such as silver and nickel on the rear side glass substrate 1 through a screen and then, baking it. This X electrode 2 may be formed by photo-etching method, thin film method such as vacuum deposition method or other method.

[0137] Next, an insulation layer 3 for covering the X electrode 2 and insulating between the X electrode 2 and a Y electrode 4, which will be formed later, is formed on the rear side glass substrate 1 and the X electrode 2. This insulation layer 3 is formed by printing a low-melting point glass paste, for example, on the rear side glass substrate 1 and the X electrode 2 through a screen and baking it.

[0138] The thickness of the insulation layer 3 may be usually about 0.02-0.03 mm because a withstand voltage of about 200 V is sufficient if it is intended to insulate an interval between the X electrode 2 and the Y electrode 4.

[0139] However, to block the function of the insulation layer 3 as a dielectric layer for covering the discharge electrode of the AC type PDP, the thickness of the insulation layer 3 is set to about 0.04 mm or more, for example, about 0.04-0.08 mm. If material having an extremely low dielectric constant is used for the insula-

tion layer 3 in order to satisfy the condition for the dielectric layer which does not cause discharge, the thickness of the insulation layer 3 can be reduced more.

[0140] Although FIG. 16 shows a case where the front side glass substrate 11 of FIG. 15 is applied to the front side glass substrate 11 of the flat display device, it is permissible to form the above described plural grooves 8 in the rear side glass substrate 1 and then form the black layer BL, the red fluorescent material layer 9R, the green fluorescent material layer 9G and the blue fluorescent material layer 9B cyclically in order in each of the plural grooves 8 (plural rows of dents may be used instead).

[0141] In this case, the X electrodes 2, the Y electrodes 4 and the island-like electrodes 6 are disposed on the front side glass substrate 11 so as to form a reflection fluorescent face type, double-electrode discharge PDP.

[0142] Next, a modification of the flat display device of FIG. 17 will be described. Although the island-like electrode 6 for discharge corresponding to each of the grooves 8 (plural rows of dents may be used instead) coated with the black layer BL is not formed as shown in FIG. 16, it is permissible to form the auxiliary discharge island-like electrode 27 in this portion as shown in FIG. 17. This auxiliary discharge island-like electrode 27 is not restricted to the AC type, but may be so-called DC type electrode whose surface is not coated with the dielectric layer. Because light produced by the auxiliary discharge island-like electrode 27 does net go out of the groove 8 coated with the black layer BL, there is no fear that the contrast of the screen is reduced. Because the auxiliary discharge by this auxiliary discharge island-like electrode 27 is always turned on irrespective of the image signal, effective priming can be always supplied to pixels adjacent the auxiliary discharge cell.

Claims

1. A flat display device comprising:

first and second substrates opposing each other at a predetermined gap for composing a tube filled with discharge gas;

first electrode comprised of plural stripe-like electrodes, formed on said first substrate by coating;

an insulation layer formed on said first substrate by coating so as to cover said first electrode, wherein dielectric constant and thickness thereof are selected so as to block the function of a dielectric, layer covering a discharge electrode of AC type PDP;

second electrode formed on said insulation layer and comprised of plural stripe-like electrodes opposing and intersecting the plural stripe-like electrodes composing said first electrode via said insulation layer, so as to form matrix electrode in cooperation with said first electrode;

plural island-like electrodes formed on said insulation layer in the vicinity of the plural stripe-like electrodes composing said second electrode and connected to the plural stripe-like electrodes composing said first electrode, through each conductor passing through said insulation layer; and

dielectric layer formed on said insulation layer by coating such that it covers said second electrode and said plural island-like electrodes, wherein

discharge is selectively conducted between the plural stripe-like electrodes composing said second electrode and the plural island-like electrodes located in the vicinity of the plural stripe-like electrodes composing said second electrode, of said plural island-like electrodes.

2. The flat display device as claimed in claim 1 wherein said plural island-like electrodes are formed on only one side of the plural stripe-like electrodes composing said second electrode on said insulator,

3. The flat display device as claimed in claim 1 wherein each of said plural island-like electrodes is formed on said insulation layer in a space formed at every third piece of the plural stripe-like electrodes composing said second electrode such that it is in the vicinity of the stripe-like electrodes on both sides composing said second electrode.

4. The flat display device as claimed in claims 1, 2 or 3 wherein plural grooves are provided in said second substrate such that they are extended in an extending direction of the plural stripe-like electrodes composing said first electrode corresponding thereto and light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of said grooves by coating.

5. The flat display device as claimed in claims 1, 2 or 3 wherein plural grooves are provided in said second substrate such that they are extended in an extending direction of the plural stripe-like electrodes composing said first electrode corresponding thereto and light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of said plural grooves via a color filter layer of the same primary color by coating.

6. The flat display device as claimed in claims 1, 2 or 3 wherein plural grooves are provided in said second substrate such that they are extended in an

extending direction of the plural stripe-like electrodes composing said first electrode corresponding thereto,

a black layer is formed on an inner face of a groove apart by every predetermined number of said plural grooves, and
light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of said plural grooves in which no black layer is formed, of said plural grooves.

7. The flat display device as claimed in claims 1, 2 or 3 wherein plural grooves are provided in said second substrate such that they are extended in an extending direction of the plural stripe-like electrodes composing said first electrode corresponding thereto,

a black layer is formed on an inner face of a groove apart by every predetermined number of said plural grooves, and
light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of said plural grooves in which no black layer is formed, of said plural grooves via a color filter layer of the same primary color.

8. The flat display device as claimed in claim 6 wherein formation of said island-like electrode and said conductor is omitted in each of said plural stripe-like electrodes corresponding to a groove in which said black layer is formed of the plural stripe-like electrodes composing said first electrode.

9. The flat display device as claimed in claim 7 wherein formation of said island-like electrode and said conductor is omitted in each of said plural stripe-like electrodes corresponding to a groove in which said black layer is formed of the plural stripe-like electrodes composing said first electrode.

10. The flat display device as claimed in claim 6 wherein each of said plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a groove in which said black layer is formed of the plural stripe-like electrodes composing said first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of said plural island-like electrodes of the plural stripe-like electrodes composing said second electrode.

11. The flat display device as claimed in claim 7 wherein each of said plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a groove in which said black layer is formed of the plural stripe-like electrodes composing said first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of said plural island-like electrodes of the plural stripe-like electrodes composing said second electrode.

12. The flat display device as claimed in claim 6 wherein each of said plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a groove in which said black layer is formed of the plural stripe-like electrodes composing said first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of said plural island-like electrodes of the plural stripe-like electrodes composing said second electrode, while formation of said dielectric layer on said island-like electrode is omitted.

13. The flat display device as claimed in claim 7 wherein each of said plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a groove in which said black layer is formed of the plural stripe-like electrodes composing said first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of said plural island-like electrodes of the plural stripe-like electrodes composing said second electrode, while formation of said dielectric layer on said island-like electrode is omitted.

14. The flat display device as claimed in claims 1, 2 or 3 wherein plural rows of dents are provided in said second substrate in an extending direction of the plural stripe-like electrodes composing said first electrode corresponding thereto, and

light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of said plural rows of the dents by coating.

15. The flat display device as claimed in claims 1, 2 or 3 wherein plural rows of dents are provided in said second substrate in an extending direction of the plural stripe-like electrodes composing said first electrode corresponding thereto, and

light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of said plural rows of the dents via color filter layer of the same primary color by coating.

16. The flat display device as claimed in claims 1, 2 or

3 wherein plural rows of dents are provided in said second substrate in an extending direction of the plural stripe-like electrodes composing said first electrode corresponding thereto,

a black layer is formed on an inner face of a dent apart by every predetermined number of said plural rows of the dents, and
light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of said plural rows of dents in which no black layer is formed, of said rows of the dents.

17. The flat display device as claimed in claims 1, 2 or 3 wherein plural rows of dents are provided in said second substrate in an extending direction of the plural stripe-like electrodes composing said first electrode corresponding thereto,

a black layer is formed on an inner face of a dent apart by every predetermined number of said plural rows of the dents, and
light producing fluorescent material layers of different primary colors are formed cyclically in order on an inner face of each of said plural rows of dents in which no black layer is formed, of said rows of the dents, via a color filter layer of the same color.

18. The flat display device as claimed in claim 16 wherein formation of said island-like electrode and said conductor is omitted in each of said plural stripe-like electrodes corresponding to a dent row in which said black layer is formed of the plural stripe-like electrodes composing said first electrode.

19. The flat display device as claimed in claim 17 wherein formation of said island-like electrode and said conductor is omitted in each of said plural stripe-like electrodes corresponding to a dent row in which said black layer is formed of the plural stripe-like electrodes composing said first electrode.

20. The flat display device as claimed in claim 16 wherein each of said plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a dent row in which said black layer is formed of the plural stripe-like electrodes composing said first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of said plural island-like electrodes of the plural stripe-like electrodes composing said second electrode.

21. The flat display device as claimed in claim 17 wherein each of said plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a dent row in which said black layer is formed of the plural stripe-like electrodes composing said first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of said plural island-like electrodes, of the plural stripe-like electrodes composing said second electrode.

22. The flat display device as claimed in claim 16 wherein each of said plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a dent row in which said black layer is formed of the plural stripe-like electrodes composing said first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of said plural island-like electrodes of the plural stripe-like electrodes composing said second electrode, while formation of said dielectric layer on said island-like electrode is omitted.

23. The flat display device as claimed in clam 17 wherein each of said plural island-like electrodes connected to plural stripe-like electrodes each corresponding to a dent row in which said black layer is formed of the plural stripe-like electrodes composing said first electrode, forms an auxiliary discharge electrode for always generating discharge with stripe-like electrodes in the vicinity of said plural island-like electrodes of the plural stripe-like electrodes composing said second electrode, while formation of said dielectric layer on said island-like electrode is omitted.

24. The flat display device as claimed in claims 1-23 wherein a hole is made in each of said plural island-like electrodes and said conductor connected to said island-like electrode such that it goes therethrough and the dielectric layer is formed on an inner face of said hole so as to form a hollow electrode.

25. The flat display device as claimed in claims 1-24 wherein said first substrate is a rear side substrate while said second substrate is a transparent front side substrate.

26. The flat display device as claimed in claims 1-24 wherein said second substrate is a rear side substrate while said first substrate is a transparent front side substrate.

FIG. 1

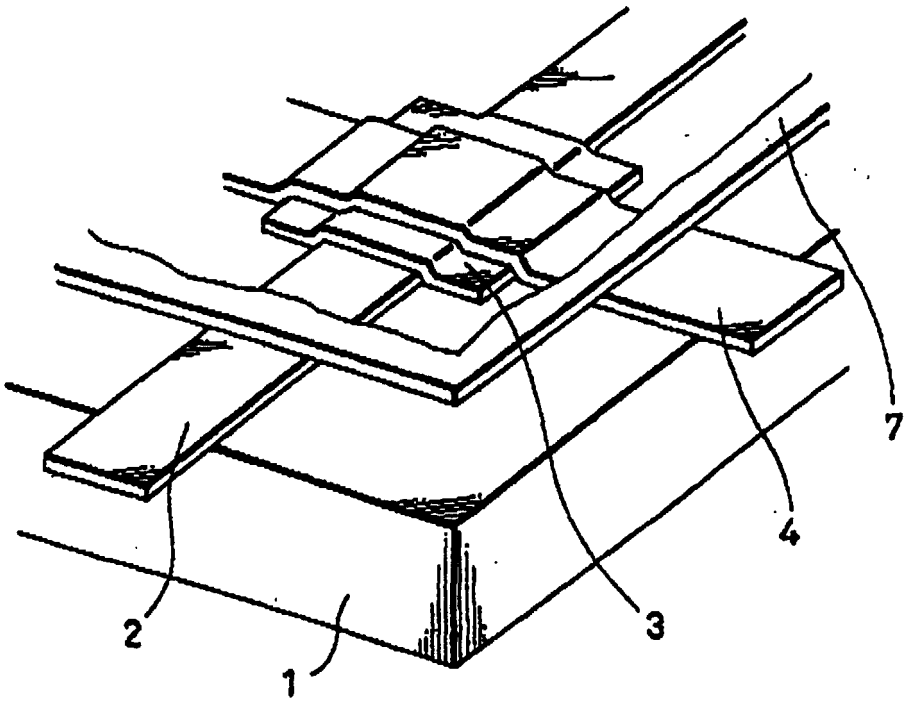


FIG. 2

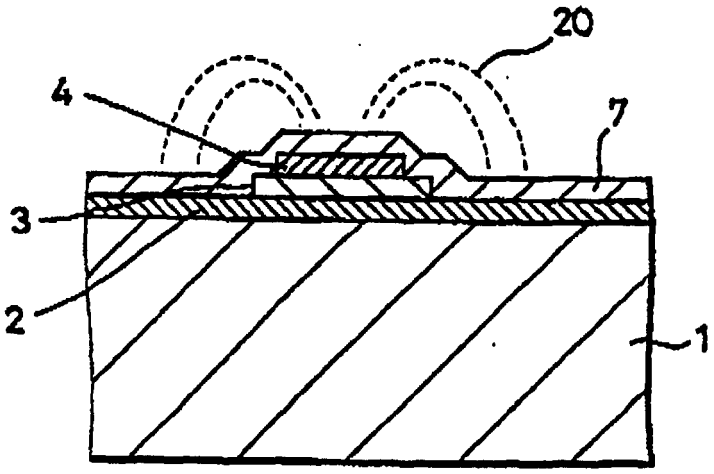


FIG. 3

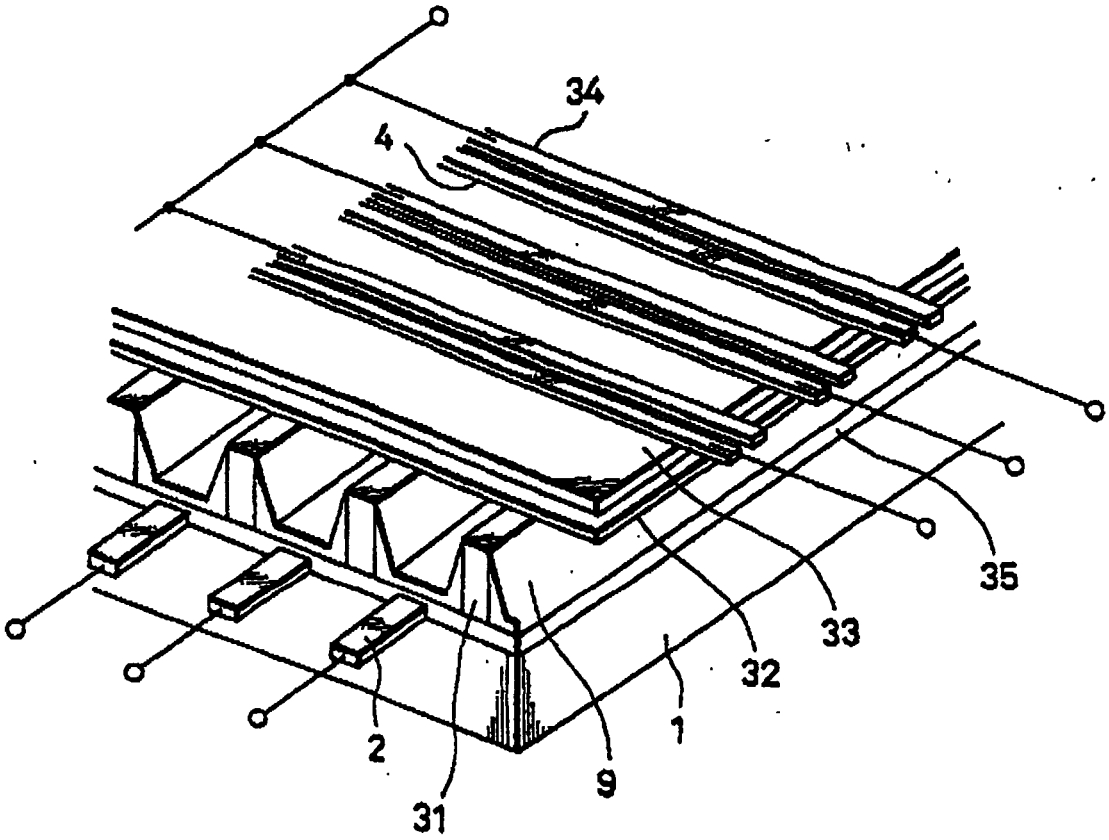


FIG. 4

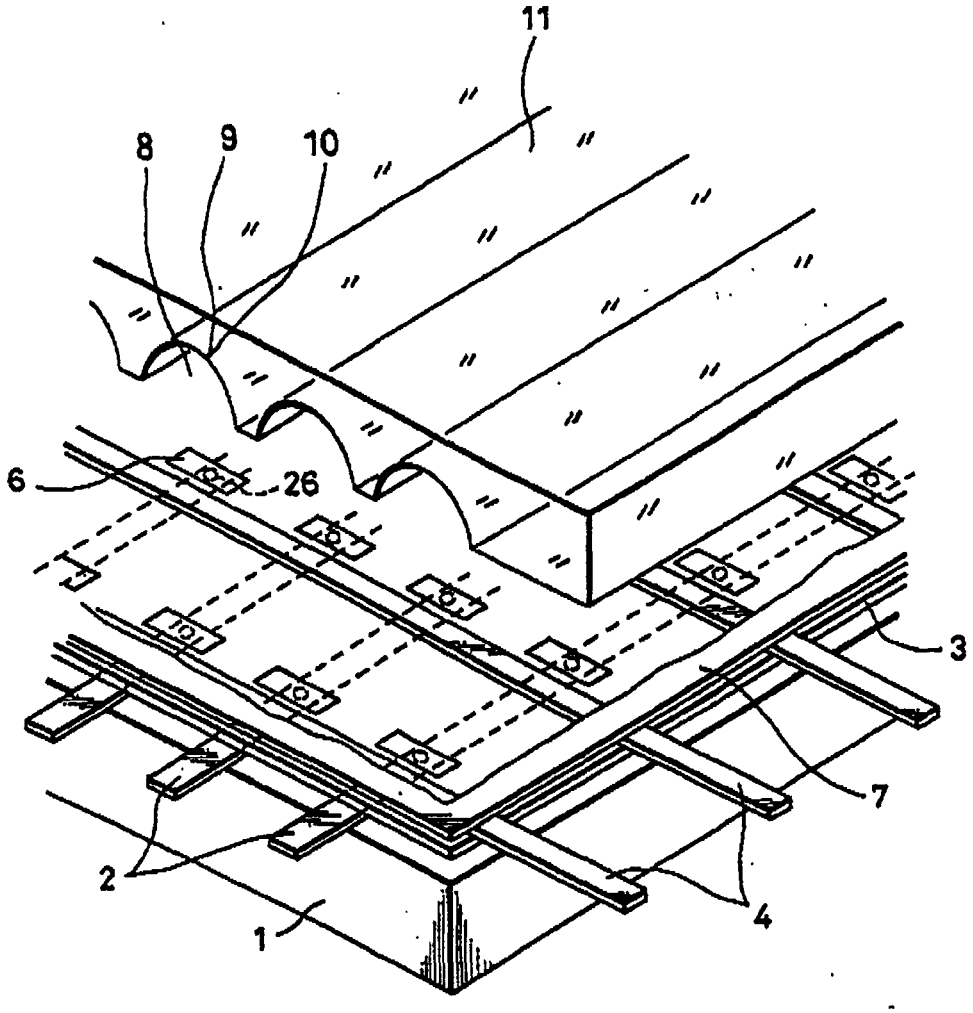


FIG. 5

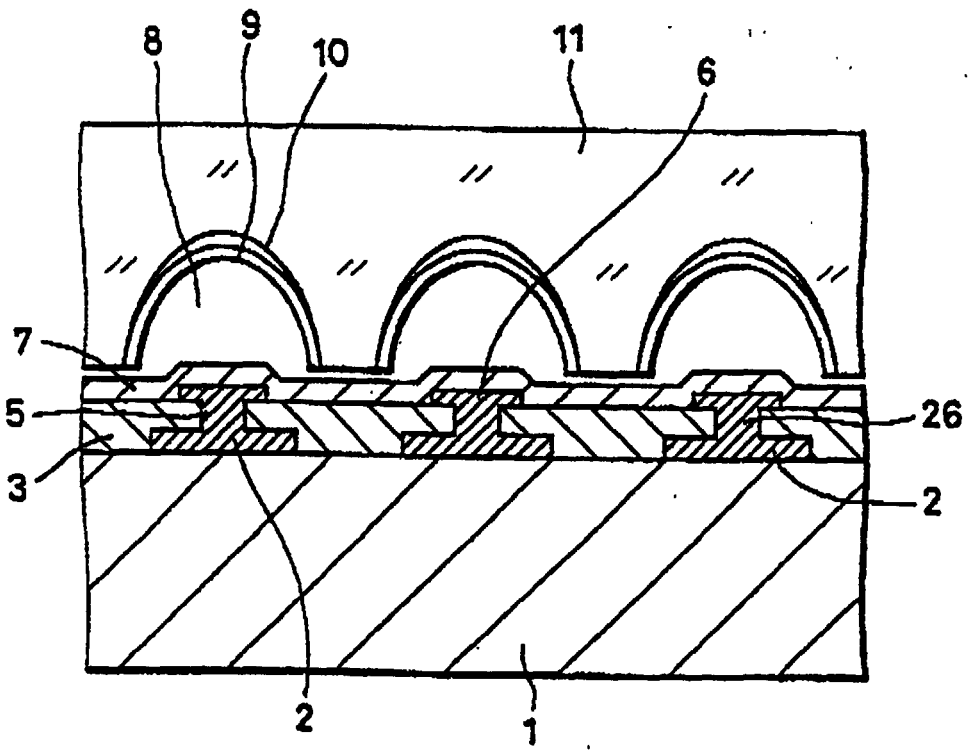


FIG. 6

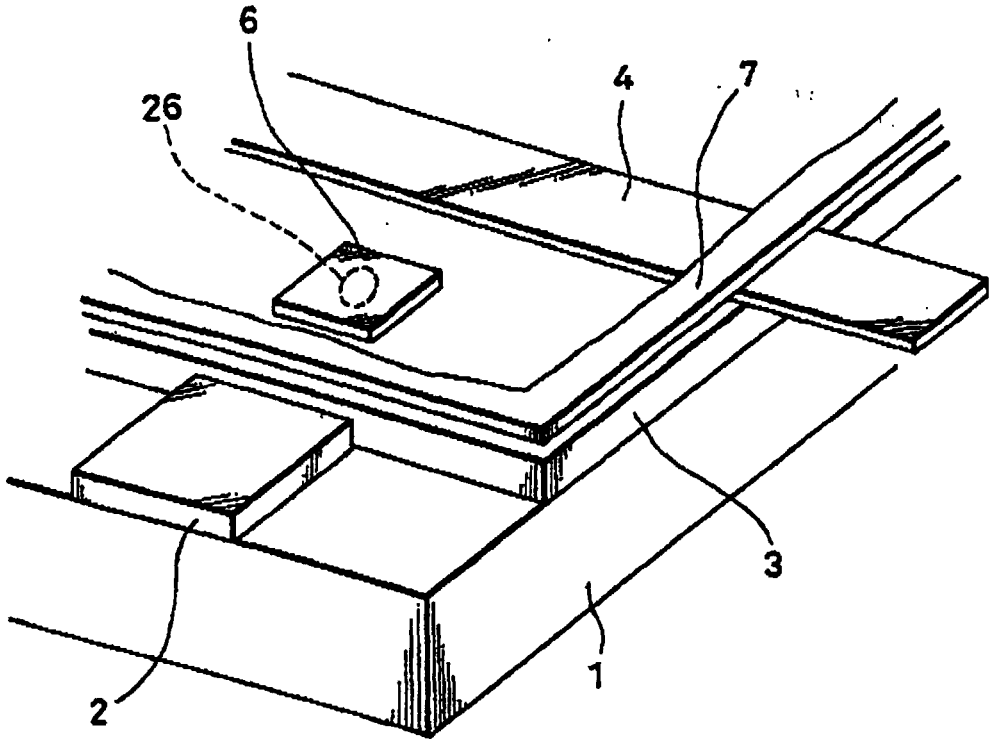


FIG. 7

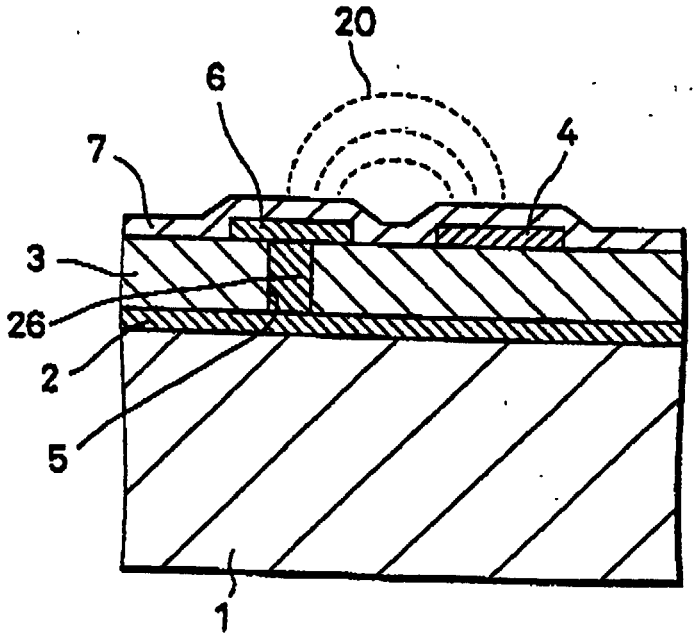


FIG. 8

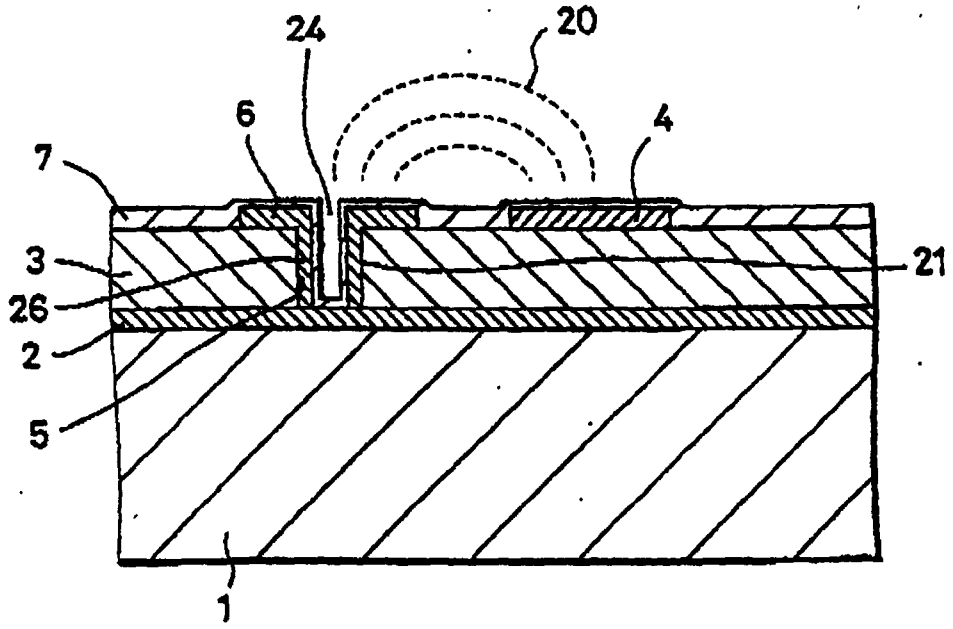


FIG. 9

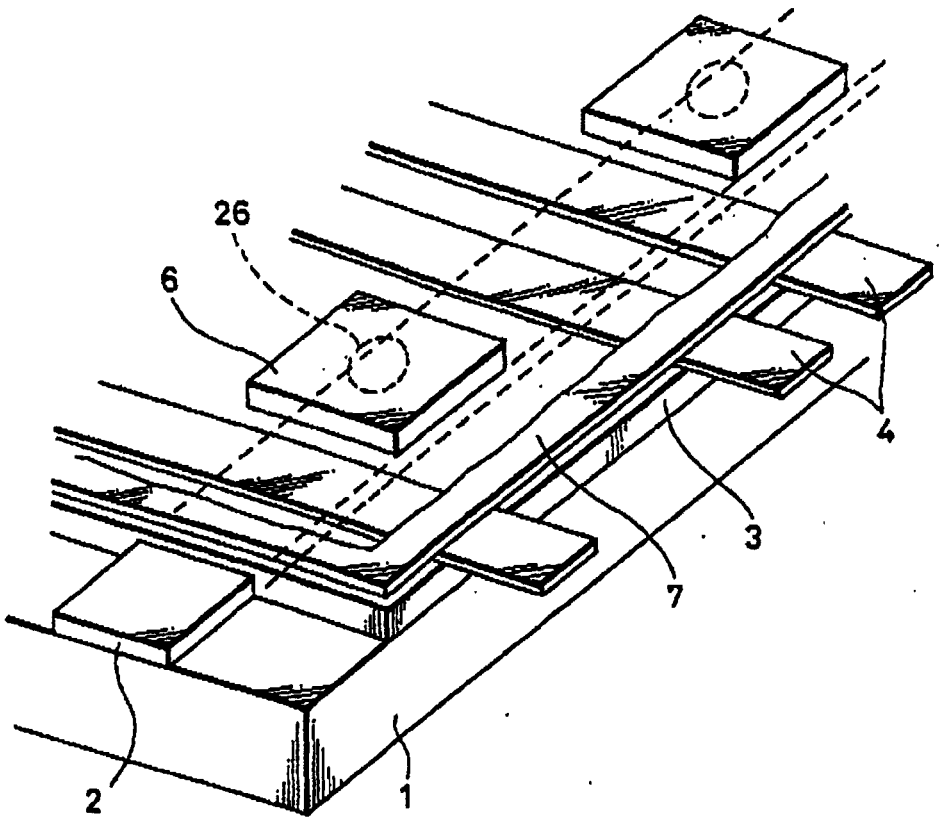


FIG. 10

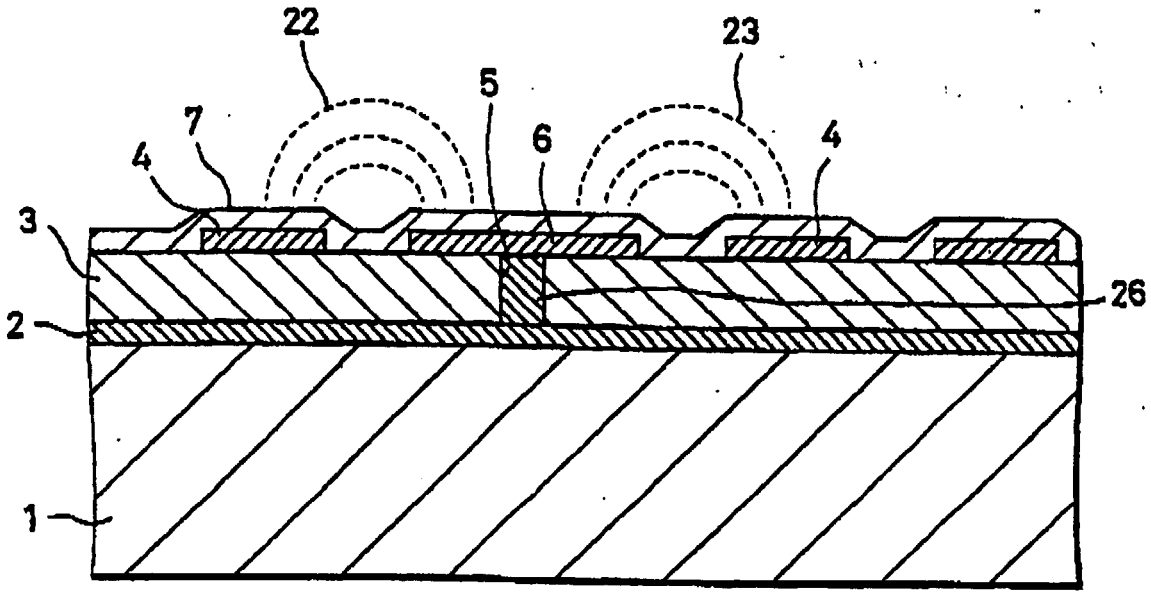


FIG. 11

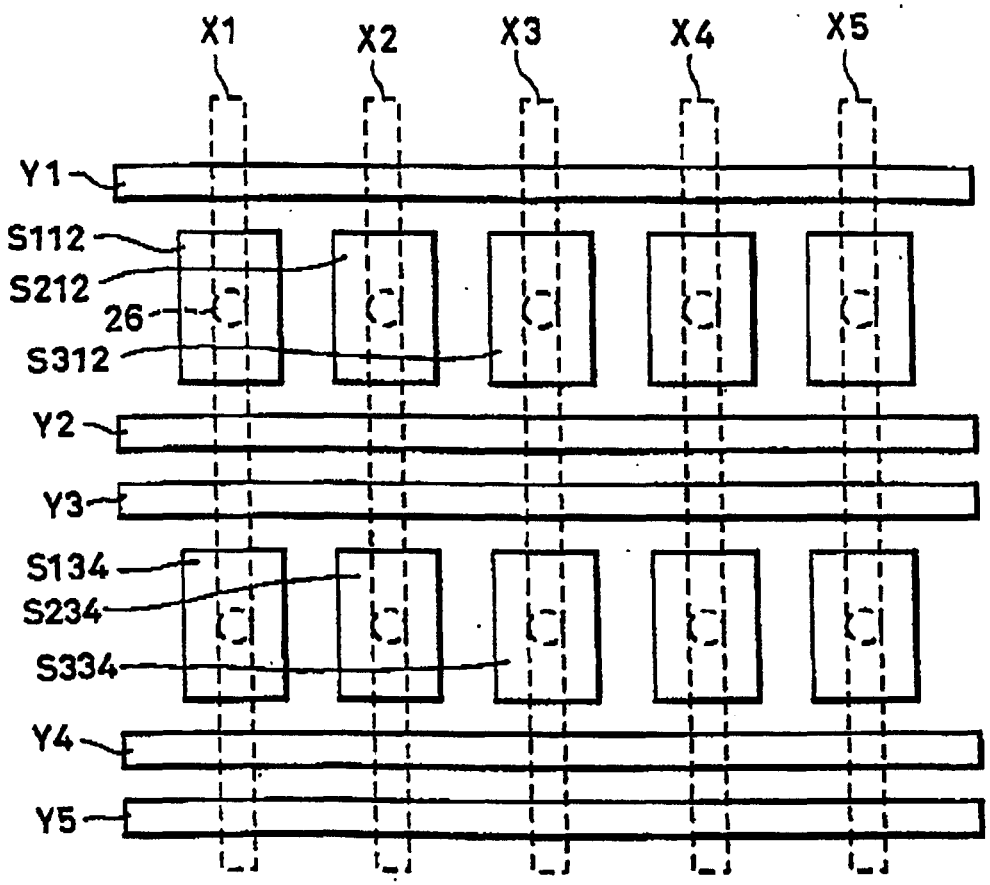


FIG. 12

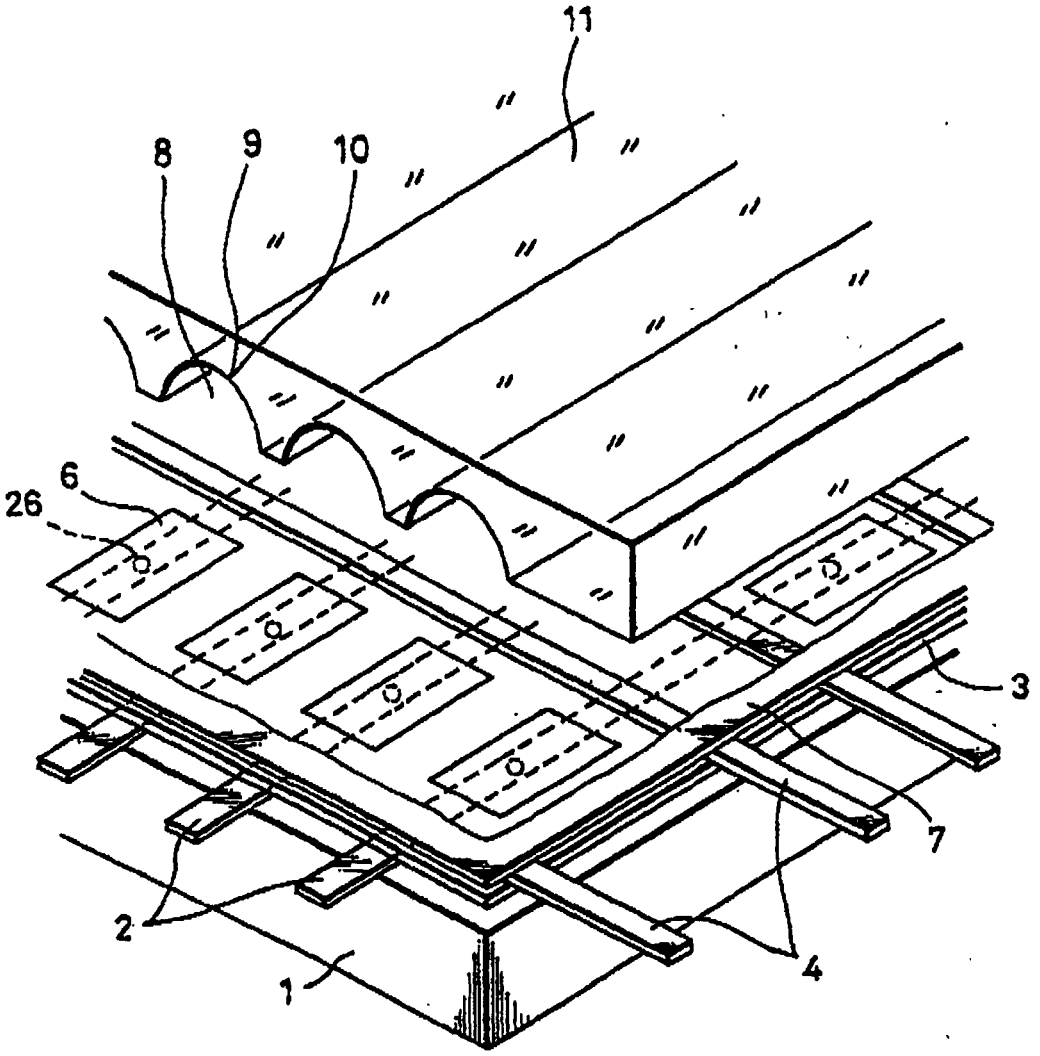


FIG. 13

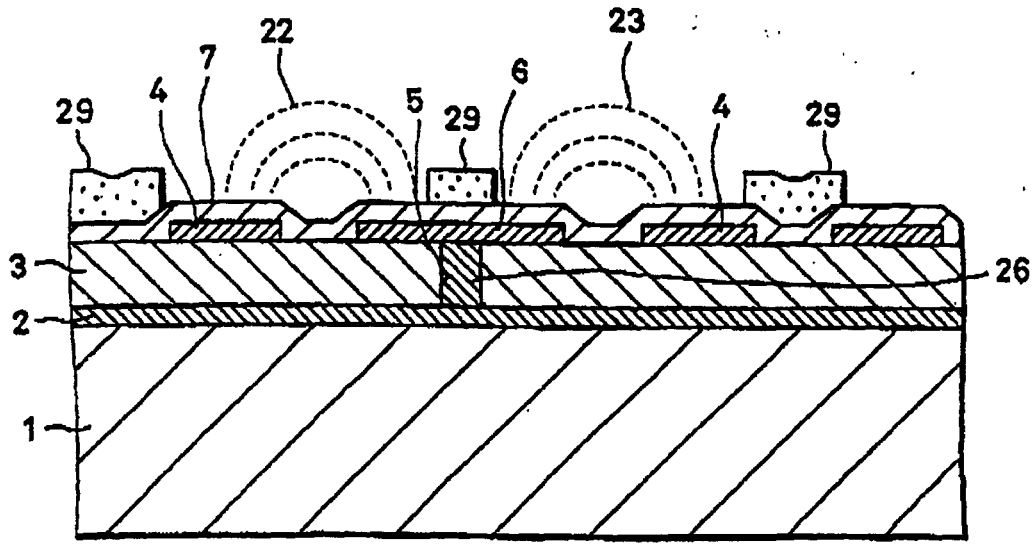


FIG. 14

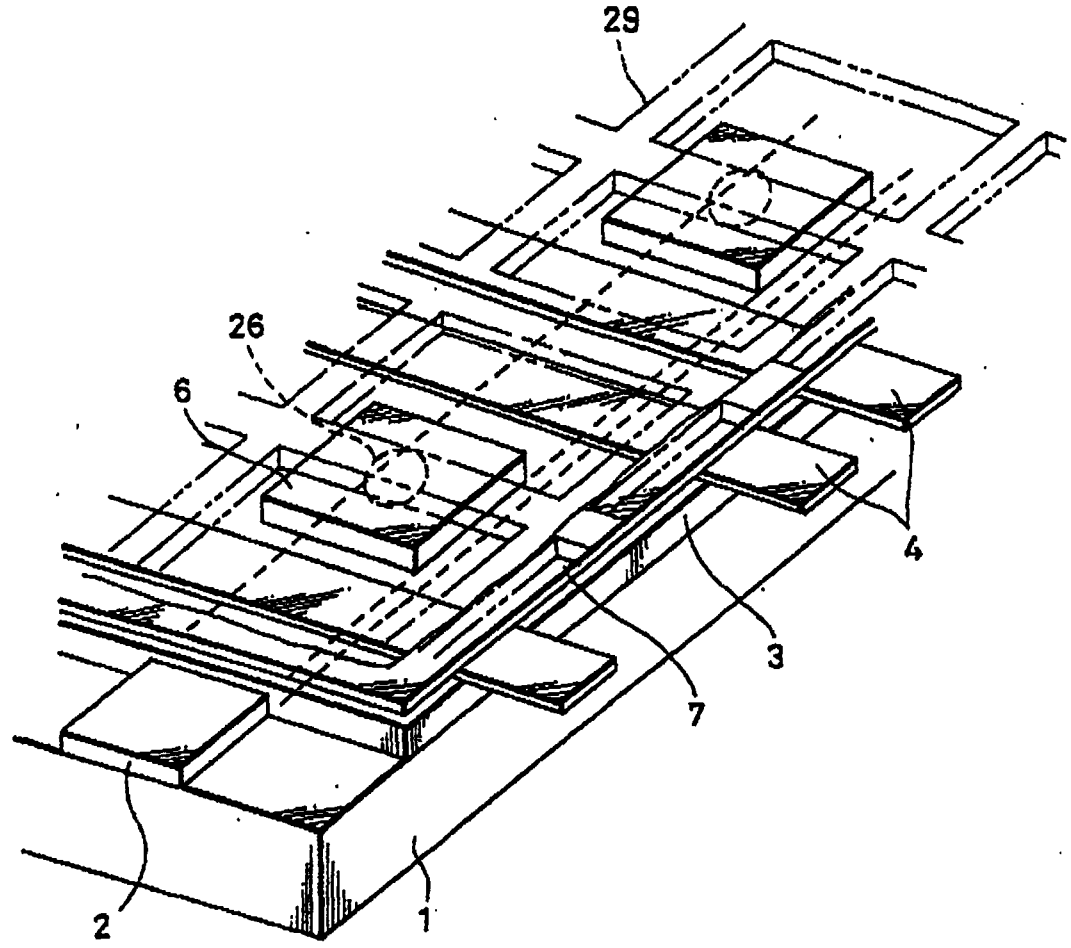


FIG. 15

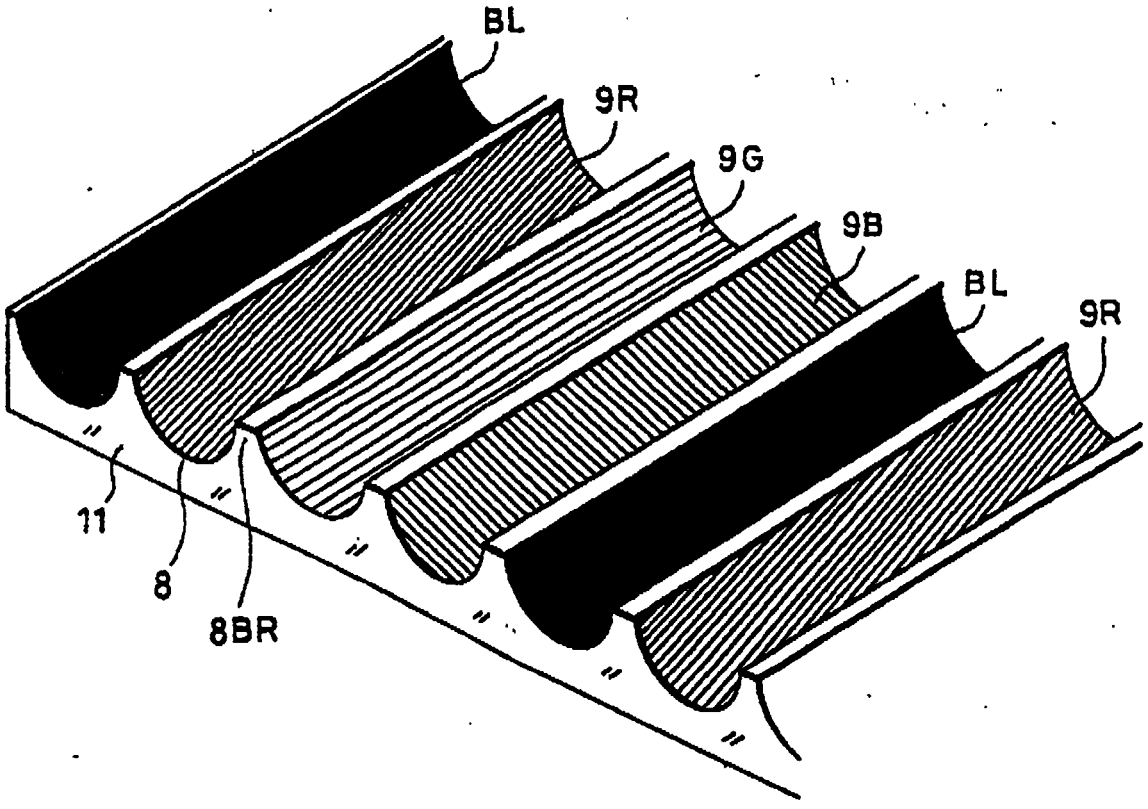


FIG. 16

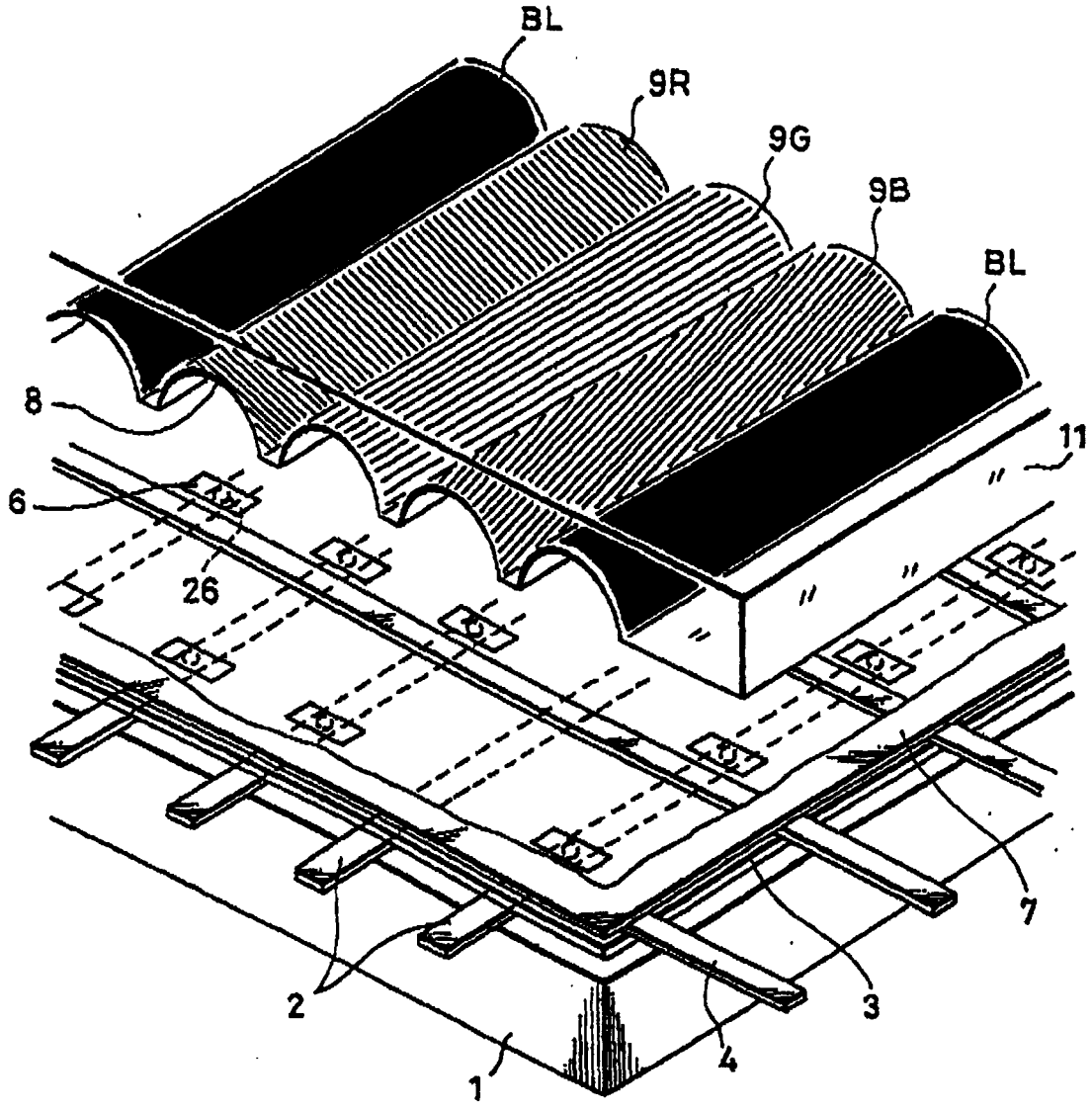
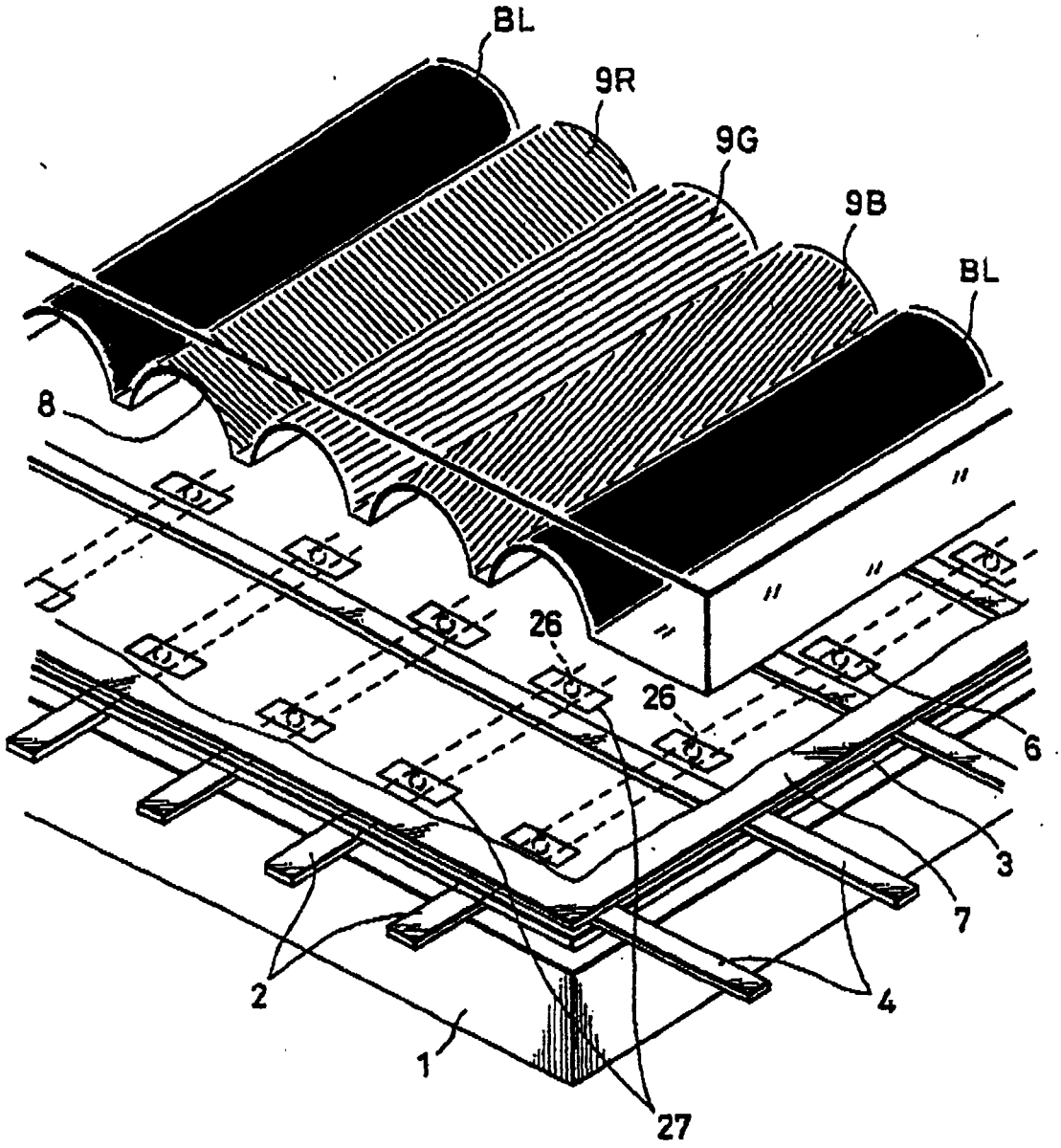


FIG. 17



DESCRIPTION OF REFERENCE NUMERALS

1 ... REAR SIDE GLASS SUBSTRATE

2 ... FIRST ELECTRODE

3 ... INSULATION LAYER

4 ... SECOND ELECTRODE

5 ... THROUGH HOLE

6 ... ISLAND-LIKE ELECTRODE

7 ... DIELECTRIC LAYER

8 ... GROOVE (OR DENT)

8BR ... PARTITION WALL

9 ... FLUORESCENT MATERIAL LAYER

10 ... COLOR FILTER

11 ... FRONT SIDE GLASS SUBSTRATE

20 ... DISCHARGE PATH

21 ... HOLLOW CATHODE

22 ... ELECTRIC FIELD PRIOR TO DISCHARGE OF DISPLAY CELL 1

23 ... ELECTRIC FIELD PRIOR TO DISCHARGE OF DISPLAY CELL 2

24 ... HOLE

26 ... CONDUCTOR

27 ... AUXILIARY DISCHARGE ISLAND-LIKE ELECTRODE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/02742

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] H01J11/02, 17/49

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] H01J11/02, 17/49

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2000
Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP, 1-146225, A (Fujitsu General Limited), 08 June, 1989 (08.06.89), Full text; all drawings	1-3,14,15, 25,26
Y	Full text; all drawings,	4,5
A	Full text; all drawings, (Family: none)	6-13,16-24
Y	JP, 10-255666, A (Fujitsu Limited), 25 September, 1998 (25.09.98), Full text; all drawings (Family: none)	4,5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 August, 2000 (01.08.00)	15 August, 2000 (15.08.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)