

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a flat type display device according to an alternating current plasma discharge display, and a production method thereof.

Description of the Related Art

[0002] In general, there are flat type plasma discharge display devices adopting the so-called matrix type display style, that is, the two electrode system comprising first and second electrodes including a plurality of parallel electrodes called X electrodes and Y electrodes arranged for executing the targeted display according to the plasma discharge between the electrodes selected from both electrode groups (for example, see the official gazette of Japanese Patent Application Laid-Open (JP-A) No. 6-52802).

[0003] In this kind of a matrix type plasma discharge display device, the peripheral part of the first and second substrates facing with each other is sealed so as to provide an airtight space between the substrates. A first electrode group comprising one of the discharge electrodes with first electrodes arranged elongating in a first direction is formed on the inner surface of the first substrate, and a second electrode group comprising the other one of the discharge electrodes with second electrodes arranged elongating in a second direction crossing with the first direction is formed on the inner surface of the second substrate.

[0004] A dielectric layer is formed on both surfaces of the first and second electrode groups, and further, a surface layer of MgO, or the like, is formed thereon.

[0005] Furthermore, a fluorescent material for emitting a light of a predetermined color is disposed, for example, on both sides of one of the first and second electrodes. In this configuration, discharge is generated by applying a predetermined alternating current voltage between selected first and second electrodes so that a light is emitted from the fluorescent material by an ultraviolet ray generated at the time for executing light emission of a predetermined color so as to execute, for example, a targeted color display.

SUMMARY OF THE INVENTION

[0006] The general matrix type plasma discharge display devices are according to so-called negative glow discharge, with the electrode interval set at, for example, from 130 μm to 200 μm . However, since the negative glow discharge has relatively large driving voltage and driving current so that a power consumption is large due to the high driving power. In the flat type display devices with the trend toward a larger size these days, reduction

of the power consumption is highly demanded.

[0007] The present invention is to provide an alternating current driving type matrix type plasma discharge display device capable of reducing the power consumption, and a production method thereof.

[0008] A flat type display device according to the present invention basically has the cathode glow discharge as the discharge style.

[0009] That is, a flat type display device according to the present invention comprises a first substrate and a second substrate disposed facing with each other, a first electrode group comprising a plurality of first electrodes to serve as one of discharge electrodes, formed on the first substrate side, and a plurality of partition walls arranged parallel with a certain interval, and a second electrode group comprising a plurality of second electrodes to serve as the other one of the discharge electrodes, formed on the second substrate side.

[0010] The second electrodes are formed at least on one side surface of the partition walls other than the top surface, or formed in the partition walls such that one side rim faces to at least one side surface of the partition walls or is disposed in the vicinity of the side surface.

[0011] According to the configuration, the plasma discharge display can be provided by the first and second electrodes mainly by the cathode glow discharge.

[0012] Moreover, a targeted flat type display device can be obtained by a first production method of a flat type display device according to the present invention comprising a first electrode group formation step of forming a plurality of first electrodes to serve as one of discharge electrodes, disposed parallel with a first direction along the substrate surface of a first substrate as the main elongating direction thereof, formed on the first substrate, a partition wall formation step of forming a plurality of partition walls arranged parallel, elongating in a second direction along the substrate surface of a second substrate, formed on the second substrate, a second electrode group formation step of forming a plurality of second electrodes to serve as the other one of the discharge electrodes, disposed parallel on at least one side surface of the partition walls other than the top surface, by jumping a conductive material from obliquely above in the direction crossing with the second direction, a step of forming a fluorescent material in the groove parts between the adjacent partition walls, and a step of sealing the peripheral parts of the first and second substrates with the first and second substrates facing with each other such that the first and second directions are crossed.

[0013] Furthermore, a second production method of the present invention for obtaining a flat type display device for obtaining a flat type display device, wherein the partition walls are formed with the partition wall main body and the laminated insulating layer, and the second electrodes are formed with the conductive layer disposed between the partition wall main body and the laminated insulating layer, with one side end of the second

electrodes disposed facing to the side surface of the partition wall or disposed adjacent to the side surface, comprises a first electrode group formation step of forming a plurality of first electrodes to serve as one of discharge electrodes, disposed parallel with a first direction along the substrate surface of a first substrate as the main elongating direction thereof, formed on the first substrate side, a second electrode group formation step of forming a plurality of second electrodes disposed parallel to serve as the other one of the discharge electrodes, elongating in a second direction on a second substrate or on an insulating layer formed on the second substrate, a step of laminating the insulating layer, covering the second electrodes, a partition wall formation step of forming a plurality of partition walls, by a groove process with a depth from the laminated insulating layer to the second substrate or the insulating layer formed on the substrate, a step of forming a fluorescent material in the groove parts between the adjacent partition walls, and a step of sealing the peripheral parts of the first and second substrates with the first and second substrates facing with each other such that the first and second directions are crossed.

[0014] According to the above-mentioned flat type display device according to the present invention, since the discharge display is executed mainly by the cathode glow discharge, the driving power can be reduced compared with the case with the negative glow discharge, and the power saving effect can be improved particularly in a large screen display.

[0015] Moreover, according to the device of the present invention, since the partition walls are formed parallel on the second substrate, and the second electrodes are formed on the side surface thereof, or facing to the side surface, or in the vicinity thereof, the second electrodes can be separated electrically with each other by the partition walls. Therefore, since discharge parts independent with each other can be formed in the groove parts between side walls, fluorescent material with different colors can be provided successively in the adjacent groove parts in a color display so that a high density can be achieved.

[0016] Furthermore, according to the above-mentioned first production method of the present invention, since the conductive material is formed by jumping from the oblique direction with respect to the partition walls in forming the second electrodes on the side surface of the partition walls, the second electrodes can be formed certainly on the side surface.

[0017] Moreover, according to the above-mentioned second production method of the present invention, since the partition walls comprise a partition wall main body and a laminated insulating layer formed thereon, with the second electrodes disposed therebetween in forming the second electrodes in the partition walls, the second electrodes can be formed certainly at the predetermined position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a schematic perspective view of the principal part of an embodiment of a flat type display device according to the present invention;

FIG. 2 is a schematic perspective view of the principal part of the embodiment of the flat type display device according to the present invention at the first substrate side;

FIGS. 3A and 3B are perspective views in a step of the embodiment of the production method of the flat type display device according to the present invention;

FIGS. 4A and 4B are perspective views in a step of the embodiment of the production method of the flat type display device according to the present invention;

FIGS. 5A and 5B are perspective views in a step of the embodiment of the production method of the flat type display device according to the present invention;

FIG. 6 is a perspective view in a step of the embodiment of the production method of the flat type display device according to the present invention;

FIG. 7 is a schematic perspective view of the principal part of another embodiment of a flat type display device according to the present invention;

FIGS. 8A to 8C are cross-sectional views in a step of the embodiment of the production method of the flat type display device according to the present invention; and

FIGS. 9A and 9B are cross-sectional views in a step of the embodiment of the production method of the flat type display device according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] A flat type display device according to the present invention comprises a flat container with a flat space disposed between both substrates provided by disposing first and second substrates facing with each other and sealing the peripheries thereof by airtight frit sealing, or the like.

[0020] A first electrode group comprising a plurality of first electrodes to be one of discharge electrodes arranged parallel is formed on the first substrate side, and a plurality of partition walls are arranged parallel as well as a second electrode group comprising a plurality of second electrodes to be the other one of the discharge electrodes arranged parallel is formed on the second substrate side.

[0021] The plurality of the first electrodes in the first electrode group can be arranged parallel with a predetermined interval with one direction along the substrate

surface of the first substrate (hereinafter referred to as the X direction) as the main elongating direction thereof.

[0022] The partition walls are formed, elongating in the direction along the substrate surface of the second substrate, crossing with the X direction, for example, orthogonal direction (hereinafter referred to as the Y direction), parallel with each other with a predetermined interval. For example, the second electrodes of the second electrode group are attached and formed on at least one side surface of each partition wall.

[0023] The second electrodes can also be formed across the bottom surface of the groove parts between the surfaces facing with each other of the adjacent partition walls.

[0024] As mentioned above, the second electrodes can be formed by attaching on the side surface of each partition wall, or by providing with a conductive layer elongating along the elongating direction of the partition walls in the partition walls with one side rim thereof facing to one side surface of each partition wall or disposed in the vicinity of the side surface at a position closer to the side surface.

[0025] In the case of forming the second electrodes with a conductive layer, the partition walls comprise a partition wall main body and a laminated insulating layer formed by laminating on the top surface thereof, with the above-mentioned conductive layer, that is, the second electrodes disposed between the partition wall main body and the laminated insulating layer.

[0026] The second electrodes can be disposed, for example, on both side surfaces of each partition wall. In this case, the second electrodes on both side surfaces of each partition wall are formed electrically separately with each other. And further, in this case, the second electrodes on the surfaces facing with each other of the adjacent partition walls are connected electrically at the end parts thereof. Or the second electrodes on the surfaces facing with each other are connected electrically by providing the second electrodes elongating on the bottom part of the groove parts between the partition walls across the second electrodes on the surfaces facing with each other.

[0027] Then, a common terminal can be provided out of the second electrodes connected with each other.

[0028] Moreover, a fluorescent material to be excited for light emission by a vacuum ultraviolet ray generated by the plasma discharge later described is applied in the groove parts between the surfaces facing with each other of the adjacent partition walls.

[0029] For example, in the case of a color display, for example, fluorescent materials R, G, B to emit a light of red, green and blue are formed in every three groove parts with a predetermined order.

[0030] The interval between the first and second electrodes at the shortest distance is set at 50 μm or less, or less than 50 μm , preferably at 20 μm or less, for example, 10 μm .

[0031] Furthermore, projecting bars in parallel cross-

es are formed in the first substrate.

[0032] The projecting bar parts in parallel crosses comprise, for example, projecting bars elongating along the Y direction facing to each partition wall of the second substrate, and crossing projecting bar parts, crossing with the projecting bar parts and elongating in the X direction between the first electrodes.

[0033] An example of an embodiment of a flat type display device according to the present invention will be explained with reference to FIG. 1 showing a partial cut schematic perspective view, but the device of the present invention is not limited to the example.

[0034] In the device of the present invention, first and second substrates 1 and 2, each comprising, for example, a glass substrate are provided facing with each other, with the peripheries of both substrates 1 and 2 sealed airtight by frit sealing, or the like (not illustrated).

[0035] In this example, with the first substrate 1 as the front side substrate, the light emission display is observed from the first substrate 1 side. In this case, at least the first substrate 1 comprises a transparent glass substrate to transmit the display light.

[0036] The inner surface of the first substrate 1 is provided with a first electrode group 31 formed by arranging a plurality of first electrodes 21 comprising a transparent conductive layer, such as ITO (indium tin oxide), parallel with each other like stripes with the main elongating direction thereof in the X direction along the substrate surface of the substrate 1.

[0037] In the case the first electrodes 21 comprise a transparent conductive layer, since the conductivity is relatively low, narrow bus electrodes 21b having the excellent conductivity, comprising for example Al are attached along the main elongating direction of each electrode 21 as needed in order to compensate the conductivity of the first electrodes 21.

[0038] Moreover, as shown in the principal part schematic plan view of FIG. 2, projecting bars 3 in parallel crosses comprising projecting bar parts 3y elongating across the first electrodes 21 in a direction crossing with the X direction, for example, in the Y direction orthogonal thereto, and crossing projecting bar parts 3x elongating in a direction crossing therewith, for example, in the X direction orthogonal thereto are formed in the first substrate 1.

[0039] The projecting bar parts 3y of the projecting bars 3 in parallel crosses are formed, corresponding to partition walls 4 to be formed on a second substrate 2 side later described.

[0040] Moreover, the crossing projecting bar parts 3x are formed between the first electrodes 21, partially astride of the electrodes 21, or without astride thereof.

[0041] Then, a dielectric layer 5 comprising, for example SiO_2 is attached on the entire inner surface of the first substrate 1, and further, a surface layer 6 having a small work function and capable of projecting the electrodes, comprising for example MgO is formed thereon.

[0042] A plurality of stripe-like partition walls 4 are ar-

ranged parallel, elongating along the Y direction on the inner surface of the second substrate 2. As mentioned above, the partition walls 4 are set in an interval corresponding to the projecting bar parts 3y of the projecting bars 3 of the first substrate 1.

[0043] Second electrodes 22 are formed along the Y direction on the side surface of the partition walls 4, except the top part thereof so as to form a second electrode group 31.

[0044] The example shown in FIG. 1 is the case with the second electrodes 22 formed on both side surfaces and the bottom surface in the groove parts 7 formed between the adjacent partition walls 4, that is, with a U-shaped cross-section.

[0045] The inside of each groove part 7 is applied with fluorescent materials R, G and B each to emit a light of red, green or blue subject to excitation by a vacuum ultraviolet ray to be generated by the plasma discharge later described alternately, that is, in every three groove part 7.

[0046] Furthermore, a surface layer 8 comprising, for example the above-mentioned MgO is formed, covering the second electrodes 22 and the fluorescent materials R, G and B.

[0047] In this configuration, the partition walls 4 and the projecting bar parts 3y of the projecting bars 3 in parallel crosses are butted with each other via the dielectric layer 5, and the surface layers 6 and 8 in the example shown in the figure. According to the height and the thickness thereof, the interval between the first and second substrates 1 and 2 is set. At the same time, the interval between the first and second electrodes 21 and 22 are set at a predetermined interval, in particular, at a distance for the cathode glow discharge, that is, at 50 μm or less, or less than 50 μm , preferably 20 μm or less, for example at 10 μm .

[0048] According to the cooperation of the first and second substrates 1 and 2 with the crossing bar parts 3y and the partition walls 4, an isolated discharge region for containing the discharge can be formed. In the region, a picture element region for light emission of each color can be provided.

[0049] Then, with the air exhausted therefrom, a predetermined gas, for example, at least one gas selected from the group consisting of He, Ne, Ar, Xe, and Kr, for example, a gas mixture of Ne (96%) and Xe (4%), that is, a so-called Penning gas is sealed in the airtight space formed by the first and second substrates 1 and 2 at a pressure capable of stably maintaining a discharge with a high luminance and a high efficiency, for example, at 0.05 to 5.0 atmospheric pressure.

[0050] In the device of the present invention, by applying a predetermined voltage between selected first and second electrodes 21 and 22, the cathode glow discharge is generated at the parts wherein they are crossed. According to the vacuum ultraviolet ray generated by the discharge, a light is emitted from the fluorescent material disposed at the crossing part so as to

execute the targeted light emission display.

[0051] Accordingly, in the flat type display device according to the present invention, the discharge is of the cathode glow discharge. In this case, even if a negative glow discharge is generated partially due to unevenness of the intervals of the parts contributing to the discharge of the first and second electrodes 21 and 22, basically the cathode glow discharge can be generated dominantly. Therefore, the driving power can be reduced compared with the case of the negative glow discharge. In particular, the power consumption to be problematic in a large screen display can be reduced.

[0052] Next, an example of an embodiment of a production method of a flat type display device according to the present invention will be explained. The example is of the case for obtaining the flat type display device with the above-mentioned configuration of FIG. 1, but the production method of the present invention is not limited thereto.

[0053] First, an example of the production method of the first substrate 1 side will be explained.

[0054] In this case, as shown in the partial schematic perspective view of FIG. 2, the first substrate 1 comprising, for example, a transparent glass substrate is prepared, and the first electrodes 21 are formed on the inner surface of the first substrate 1.

[0055] As to the formation of the first electrodes 21, a transparent conductive layer, for example, ITO is formed on the entire inner surface of the substrate 1 at for example about 300 nm thickness. With pattern etching by photolithography, predetermined patterns facing with each other with a predetermined interval, that is, side rims facing with each other in the example of the figure, are formed so as to have, for example, the stripe-like first electrodes 21. That is, by applying the photo resist layer on the ITO formed on the entirety and baking, the predetermined patterns are exposed and developed so as to form an etching mask for the patterns corresponding to the electrode 21 patterns. Then, with the etching mask, for example, the transparent conductive layer is etched with an etching liquid of a mixture of, for example hydrochloric acid and ferric chloride for forming the first electrodes 21.

[0056] Next, the bus electrodes 21b are formed as needed. As to the formation of the bus electrodes 21b, a material with a good conductivity, for example, Al is deposited covering the entirety of the first electrodes 21 formed on the inner surface of the first substrate 1 by about 1 μm thickness. The bus electrodes 21b having a width sufficiently smaller than the width of the electrodes 21 are formed along each one side rim of each electrode 21 by the pattern etching by photolithography as mentioned above, using phosphoric acid as the etching liquid.

[0057] Thereafter, the above-mentioned projecting bars 3 in parallel crosses comprising the projecting bar parts 3y and the crossing projecting bar parts 3x are formed by, for example a printing method with for exam-

ple a 20 μm height and a 30 to 40 μm width.

[0058] Then, although it is not illustrated, the dielectric layer 7 explained with reference to FIG. 1, comprising, for example SiO_2 is formed on the entirety by the CVD (chemical vapor deposition) method, or the like, and the surface layer 6 is formed thereon by depositing, for example MgO by about 0.5 to 1.0 μm thickness.

[0059] Next, an example of a production method of the second substrate 2 will be explained with reference to a partial perspective view of each step shown in FIGS. 3A to 5B, and FIG. 6.

[0060] In this case, as shown in FIG. 3A, the second substrate 2 comprising, for example, a glass substrate is prepared. The partition walls 4 arranged parallel elongating in the Y direction with a predetermined distance in the X direction are formed on one principal plane thereof. A connecting part 4c for connecting both ends of the partition walls 4 (only one end is shown in FIG. 3) with each other is formed.

[0061] The partition walls 4 and the connecting parts 4c can be formed by a printing method, for example, by superimposition printing of a glass paste by a plurality of times. The printing thickness per each printing in this case is about 10 μm . By repeating the printing operation, a stripe-like printing is executed with a 50 to 80 μm height (thickness). Thereafter, baking is executed at, for example 500°C to 600°C. Accordingly, the partition walls 4 can be formed with a 30 to 60 μm thickness.

[0062] Thereafter, the conductive layer is formed on at least one side surface of the partition walls 4 except the top part of the partition walls 4 so as to form the above-mentioned second electrodes 11. In this example, the second electrodes 11 are formed across both side surfaces of the partition walls 4 and the bottom surface of the groove parts 7 formed between the partition walls 4.

[0063] In this case, first, as shown in FIG. 3B, the conductive material 9 is attached with respect to the partition walls 4 formed along the Y direction from obliquely above from corresponding one side surface side of the partition walls 4 onto mainly the one side surface as schematically shown by the arrows.

[0064] Then, as schematically shown by the arrows in FIG. 4A, the conductive material 9 comprising, for example, Al is jumped from obliquely above from the other side surface side of the partition walls 4, that is, from obliquely above at the opposite side with respect to the obliquely above direction explained in FIG. 3B by for example, a deposition method having the orientation in the jumping direction so as to be attached mainly on the other side surface of the partition walls 4.

[0065] Furthermore, as schematically shown by the arrows in FIG. 4B, the similar conductive material, such as Al is jumped from above the substrate 1 along the substantially the vertical direction to the substrate surface so as to attach the conductive material 9 on the bottom part in the groove parts 7.

[0066] Thereafter, as shown in FIG. 5A, the stripe-like

etching resists 10 comprising the photo resist are formed by photolithography in the groove parts 7 and elongating above the connecting parts 4c therefrom.

[0067] In this case, the thickness of the etching resists 10 is set at a thickness capable of exposing the conductive material 9 formed on the top part of the partition walls 4 in the groove parts 7 to the outside. Next, with the etching resists 10 as a mask, the conductive material 9 is etched so as to eliminate the conductive material 9 on the top part of the partition walls 4 elongating above the connecting parts 4c, and the conductive material 9 formed on both side surfaces of each partition wall 4 is separated electrically.

[0068] Thereafter, as shown in FIG. 5B, the etching resists 10 are eliminated.

[0069] Accordingly, the second electrode group 32 with the second electrodes 22 formed by the conductive material 9 formed on the bottom surface and on each one side surface of the partition walls 4 facing with respect thereto is formed for each groove part 7.

[0070] In this case, terminal parts 22a elongating above the connecting parts 4c of the partition walls 4 can be formed at the end part of each second electrode 21.

[0071] FIG. 5B shows an example with all the terminal parts 22a of the second electrodes 22 formed at the same end part, but for example, it is also possible to provided on both ends of the groove parts 7 in every other adjacent second electrodes 22.

[0072] Thereafter, as shown in FIG. 6, according to the repeating operation of applying and baking a light sensitive fluorescent slurry each having R, G or B color successively in the groove part 7 between the partition walls 4, the red, green and blue fluorescent materials R, G and B are formed.

[0073] Furthermore, as explained with reference to FIG. 1, the surface layer 8 of MgO , or the like, is formed on the entirety. Accordingly, the second substrate 2 can be produced.

[0074] Thereafter, the first and second substrates 1 and 2 are faced with each other with the above-mentioned positional relationship so that the peripheries thereof are frit sealed. According to the above-mentioned gas exhaustion and the predetermined gas sealing, the targeted flat type display device is obtained.

[0075] In this case, the terminal part at the end part of each first electrode 21 and the terminal part 22a of the second electrode 22 can elongate outside the outside part of the substrates 1 and 2 outside the airtight space so as to serve as a feeding terminal.

[0076] The above-mentioned example is the case of forming the second electrodes 22 on the inner side surface and the bottom surface of the groove parts 7. In the case of forming the electrodes 22 on the bottom surface of the groove parts 7, the electrodes 22 function as a light reflecting surface so that the light emitted rearward from the fluorescent materials R, G and B can be reflected so as to be outputted efficiently to the front panel side,

that is, onward from the first substrate 1, and thus the effect of achieving a bright display can be provided. However, for example, they can be formed only on one side surface of the groove parts 7. In this case, the steps of FIGS. 4A and 4B can be omitted.

[0077] Moreover, in the case of forming the second electrodes 22 only on both side surfaces of the groove parts 7 except the bottom surface, the step of FIG. 4B can be omitted.

[0078] Furthermore, the above-mentioned method is the case of forming the partition walls 4 according to the superimposition printing of the repeating pattern printing of the glass paste. For example, it is also possible to form by printing on the entirety by for example, 50 to 80 μm , drying, and forming patterns by sand blasting. In this case, a sand blasting mask is formed. For the mask formation, a light sensitive film is laminated on the entirety, it is exposed and baked in the parallel stripes, and developed so as to form a mask with a predetermined pattern. Thereafter, according to sand blasting through the opening of the mask, the glass layer is eliminated at the unnecessary part. Then, by eliminating the light sensitive film and baking at 500 to 600°C, the partition walls 9 of a predetermined height can be formed.

[0079] Moreover, the above-mentioned example is the case with the second electrodes 22 attached in the groove parts 7. As shown in the partial cut perspective view of FIG. 7, it is also possible to embed the stripe-like conductive layer comprising the second electrodes 22 in the partition walls 4 elongating in the elongating direction (Y direction) of the partition walls 4.

[0080] This embodiment is the case with the second electrodes 22 disposed closer to the corresponding one side surface of each partition wall 4 so that one side rim of the second electrodes 22 faces to each corresponding one side surface of each partition wall 4.

[0081] An example of a forming method of the second electrodes 22 and the partition walls 4 in this case will be explained with reference to the partial schematic cross-sectional view in each step shown in FIGS. 8 and 9.

[0082] In this case, as shown in FIG. 8A, the conductive layer 11 to finally form the second electrodes is formed like stripes, on the second substrate 2, or on the insulating layer formed on the second substrate 2, elongating in the Y direction orthogonal to the paper surface of the figure. The stripe-like conductive layer 11 is formed with predetermined width and interval by, for example forming a conductive material such as Al on the entirety by deposition, and pattern etching by photolithography.

[0083] Or the conductive layer 11 with the above-mentioned pattern is formed by printing a conductive paste, such as a silver paste.

[0084] Thereafter, as shown in FIG. 8B, the insulating layer 12 is formed on the entirety by printing an insulating paste, such as a lead glass paste on the entirety and drying.

[0085] Next, as shown in FIG. 8C, stripe-like sand blasting mask 13 is formed, covering for example, the one side rim of the stripe-like insulating layer 11 along the elongating direction of the conductive layer 11, that is, in the Y direction. The mask 13 can be formed by, for example laminating a dry film resist on the insulating layer 12, and thereafter by eliminating the groove part 7 forming parts by the above-mentioned exposing and developing treatment.

[0086] Then, as schematically shown by the arrows in FIG. 9A, according to sand blasting from above the substrate 2, the parts not covered with the mask 13 is engraved so as to form the groove parts 12, that is, to form the partition walls 4 between the groove parts 7.

[0087] Then, as shown in FIG. 9B, the mask 13 is eliminated.

[0088] Accordingly, the partition walls 4 with the insulating layer 12 formed on the partition wall main body 4A can be formed. And further, the second electrodes 22 can be formed with the end rim facing to one side surface of the partition walls 4.

[0089] Thereafter, according to for example, screen printing, the fluorescent materials R, G and B of each color are formed in each groove part 7 with a predetermined arrangement order.

[0090] Thereafter, with the same steps as mentioned above, the targeted flat type display device according to the present invention shown in FIG. 7 can be obtained. The parts corresponding to those in FIG. 1 are applied with the same numerals and redundant explanation is not given in FIG. 7.

[0091] According to the above-mentioned production method of the present invention, the flat type display device according to the present invention with the interval between the first and second electrodes 21 and 22 sufficiently narrow for enabling the cathode glow discharge can be obtained.

[0092] The flat type display device according to the present invention and the production method thereof are not limited to the above-mentioned examples, but can be executed with various modifications.

[0093] Examples of the various modifications include the first and second substrates 1 and 2 provided with the front and rear panels themselves comprising the airtight flat container comprising the flat type display device as mentioned above, or provided with the substrates facing with each other disposed in the airtight container.

[0094] Moreover, although in the above-mentioned example, the light emission display is observed from the first substrate 1 side, it is also possible to observe from the second substrate 2 side. In this case, the second substrate 2 and the second electrodes 22 comprise a transparent conductive layer.

[0095] As mentioned above, according to the device of the present invention, since the cathode glow discharge is adopted, the driving power can be reduced compared with the case of the negative glow discharge. Or in the case the driving power is the same as or close

to the conventional size, the light emitting efficiency and the light emitting brightness can be improved. For example, in the case of the same driving power as the conventional one, the brightness was improved by more than 40%.

[0096] Moreover, since the second electrodes 22 are formed on the side surface of the partition walls 4, the interval between the first and second electrodes 21 and 22 can be set at an interval sufficiently small for generating the cathode glow discharge at 50 μm or less, and further 20 μm or less as mentioned above.

[0097] Furthermore, since a large space in the groove parts 7 set by the partition walls 4 can be provided as the discharge space thereof as well as each fluorescent material R, G and B can be formed between the partition walls 4, the application area of the fluorescent materials can be large so that a bright display can be provided.

[0098] Moreover, since the fluorescent materials R, G and B are applied on the adjacent groove parts 7, the picture element pitch can be sufficiently small.

[0099] Since the heat generation can be reduced according to the reduction of the driving power, use of a heat discharging fan can be avoided, or the number or the power of the heat discharging fans can be reduced, or the number and area of the heat discharging fins can be reduced, and thus a small size and a light weight of the device as a whole can be achieved in a large area display.

[0100] Moreover, in the case of providing the first and second substrates 1 and 2 with the glass substrate, in particular, an inexpensive lead glass in the actual production, a large contraction is generated in a heat treatment in the production process. The contraction is generated by, for example as much as 20 to 30 μm from 10 cm by a several hundred degree heat treatment. Besides, irregularity per each product is large, and further, since the contraction differs in the center part of the screen and the peripheral part thereof. Therefore, in the case of executing electrode forming steps of a plurality of patterns in the same substrate, since, for example, error is generated in each part in positioning the exposing mask in the pattern etching and irregularity is generated among the products, a problem arises in the yield and the reliability particularly in the case of forming the discharge electrode distance by 50 μm or less, or less than 50 μm , preferably 20 μm or less in the cathode glow discharge, wherein a high accuracy is demanded for the size accuracy.

[0101] In contrast, according to the configuration of the present invention, since the first and second electrodes 21 and 22 are formed on different substrates, that is, on the first and second substrates 1 and 2, the interval between the electrodes 21 and 22 can be set at a predetermined narrow distance, and thus the cathode glow discharge can be executed certainly.

[0102] Moreover, as mentioned above, according to the cooperation of the projecting bars 3 and the partition walls 4, the interval between the first and second sub-

strates 1 and 2 are set, that is, the discharge space can be set. In the case of the parallel crosses with the crossing projecting bar parts 3x provided in the projecting bars 3, even in the case the substrates 1 and 2 are displaced, the interval between the substrates 1 and 2, that is, the interval between the first and second electrodes 1 and 2 are maintained at a predetermined interval.

[0103] Furthermore, according to the production method of the present invention, despite the configuration wherein the second electrodes of the targeted flat type display device according to the present invention are formed on the side surface of the partition walls, they can be formed easily and certainly according to the jumping operation of the conductive material in the oblique direction, or the formation of the conductive layer in the partition walls, and thus the flat type display device with a high reliability and the homogeneous characteristic can be obtained.

[0104] Having described preferred embodiments of the present invention with reference to the accompanying drawings, it is to be understood that the present invention is not limited to the above-mentioned embodiments and that various changes and modifications can be effected therein by one skilled in the art without departing from the scope of the present invention as defined in the appended claims.

Claims

1. A flat type display device comprising:

a first substrate (1) and a second substrate (2) disposed facing with each other,
a first electrode group (31) comprising a plurality of first electrodes (21) to serve as one of discharge electrodes, formed on the first substrate (1) side, and
a plurality of partition walls (4) arranged parallel with a certain interval, and a second electrode group (31) comprising a plurality of second electrodes (22) to serve as the other one of the discharge electrodes, formed on the second substrate (2) side,

wherein the second electrodes (22) are formed at least on one side surface of both side surfaces of the partition walls (4), or formed in the partition walls (4) such that one side rim faces to at least one side surface of the partition walls (4) or is disposed in the vicinity of the side surface, and

the plasma discharge display by the cathode glow discharge is mainly executed.

2. The flat type display device according to claim 1, wherein the first electrodes (21) are disposed with a first direction (X) along the substrate surface of the first substrate (1) the main elongating direction

thereof, and

the plurality of the partition walls (4) are formed parallel, elongating in a second direction (Y) crossing with the first direction (X) along the substrate surface of the second substrate (2).

3. The flat type display device according to claim 1, wherein the second electrodes (22) are formed across the bottom surface of the groove between the adjacent partition walls (4). 5
4. The flat type display device according to claim 1, wherein the second electrodes (22) are formed separately with each other with respect to both side surfaces of the partition walls (4), and 10

the second electrodes (22) formed on the side surfaces of the adjacent partition walls (4), facing with each other are connected electrically at the end part. 15
5. The flat type display device according to claim 1, wherein the partition walls (4) are formed with a partition wall main body and a laminated insulating layer laminated on the partition wall main body, and 20

the second electrodes (22) are formed with a conductive layer disposed between the partition wall main body and the laminated insulating layer, with one side end of the conductive layer disposed facing to the side surface of the partition wall (4) or disposed adjacent to the side surface. 25
6. The flat type display device according to claim 1, wherein a fluorescent material is applied in the groove parts between the surfaces of the adjacent partition walls (4), facing with each other. 30
7. The flat type display device according to claim 1, wherein fluorescent materials each to emit a light of red, green or blue are applied in every three groove parts between the surfaces of the adjacent partition walls (4), facing with each other, with a predetermined order. 35
8. The flat type display device according to claim 1, wherein the discharge mainly by the cathode glow discharge is started with the interval between the first and second electrodes set at 50 μm or less. 40
9. The flat type display device according to claim 1, wherein the discharge mainly by the cathode glow discharge is started with the interval between the first and second electrodes set at 20 μm or less. 45
10. The flat type display device according to claim 2, wherein projecting bars in parallel crosses comprising projecting bar parts elongating along the second direction (Y) and crossing projecting bar parts elongating along the direction crossing with the partition 50

walls are formed in the first substrate (1).

11. A production method of a flat type display device wherein comprising:

a first electrode group formation step of forming a plurality of first electrodes (21) to serve as one of discharge electrodes, disposed parallel with a first direction (X) along the substrate surface of a first substrate (1) as the main elongating direction thereof, formed on the first substrate side,

a partition wall formation step of forming a plurality of partition walls (4) arranged parallel, elongating in a second direction (Y) along the substrate surface of a second substrate (2), formed on the second substrate side,

a second electrode group formation step of forming a plurality of second electrodes (22) disposed parallel to serve as the other one of the discharge electrodes, on at least one side surface of the partition walls (4) other than the top surface, by jumping a conductive material from obliquely above in the direction crossing with the second direction (Y),

a step of forming a fluorescent material in the groove parts between the adjacent partition walls (4), and

a step of sealing the peripheral parts of the first and second substrates with the first and second substrates (1, 2) facing with each other such that the first and second directions (X, Y) are crossed.

12. A production method of a flat type display device for obtaining a flat type display device,

wherein the partition walls (4) are formed with the partition wall main body and the laminated insulating layer, and

the second electrodes (22) are formed with the conductive layer disposed between the partition wall main body and the laminated insulating layer, with one side end of the second electrodes (22) disposed facing to the side surface of the partition wall (4) or disposed adjacent to the side surface, characterized in comprising:

a first electrode group formation step of forming a plurality of first electrodes (21) disposed parallel to serve as one of discharge electrodes, disposed with a first direction (X) along the substrate surface of a first substrate (1) as the main elongating direction thereof, formed on the first substrate (1),

a second electrode group formation step of forming a plurality of second electrodes (22) disposed parallel to serve as the other one of the discharge electrodes, elongating in a sec-

ond direction (Y) on a second substrate (2) or on an insulating layer formed on the second substrate (2),

a step of laminating the insulating layer, covering the second electrodes (22),

5

a partition wall formation step of forming a plurality of partition walls (4), by a groove process with a depth from the laminated insulating layer to the second substrate (2) or the insulating layer formed on the substrate,

10

a step of forming a fluorescent material in the groove parts between the adjacent partition walls (4), and

a step of sealing the peripheral parts of the first and second substrates with the first and second substrates (1, 2) facing with each other such that the first and second directions (X, Y) are crossed.

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FIG. 1

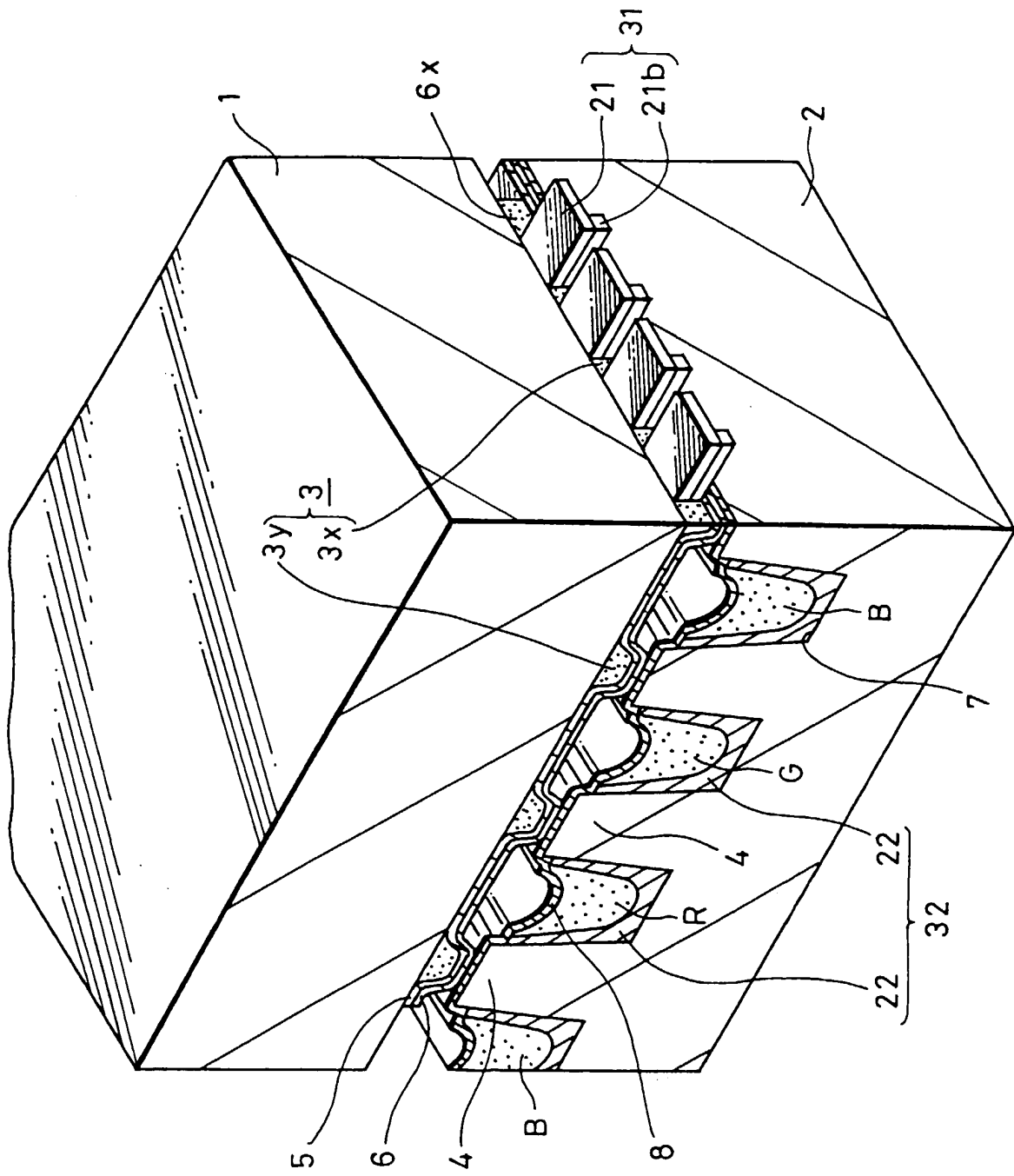


FIG. 2

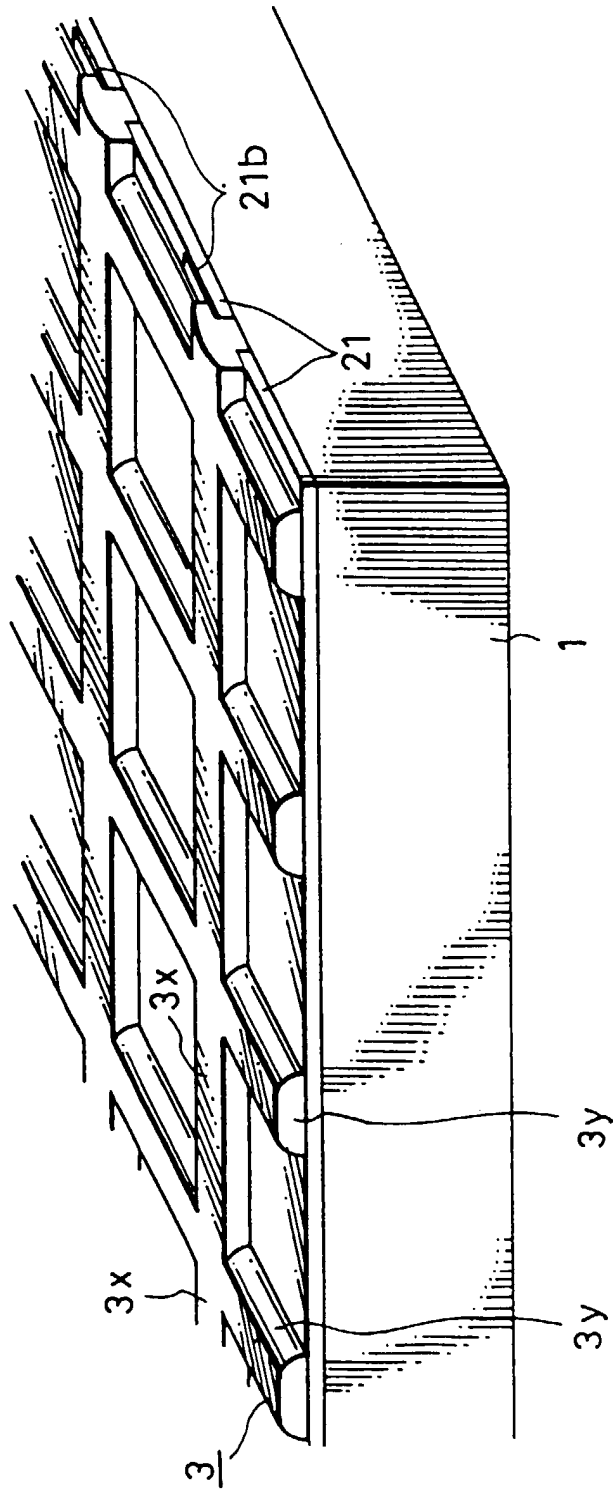


FIG. 3A

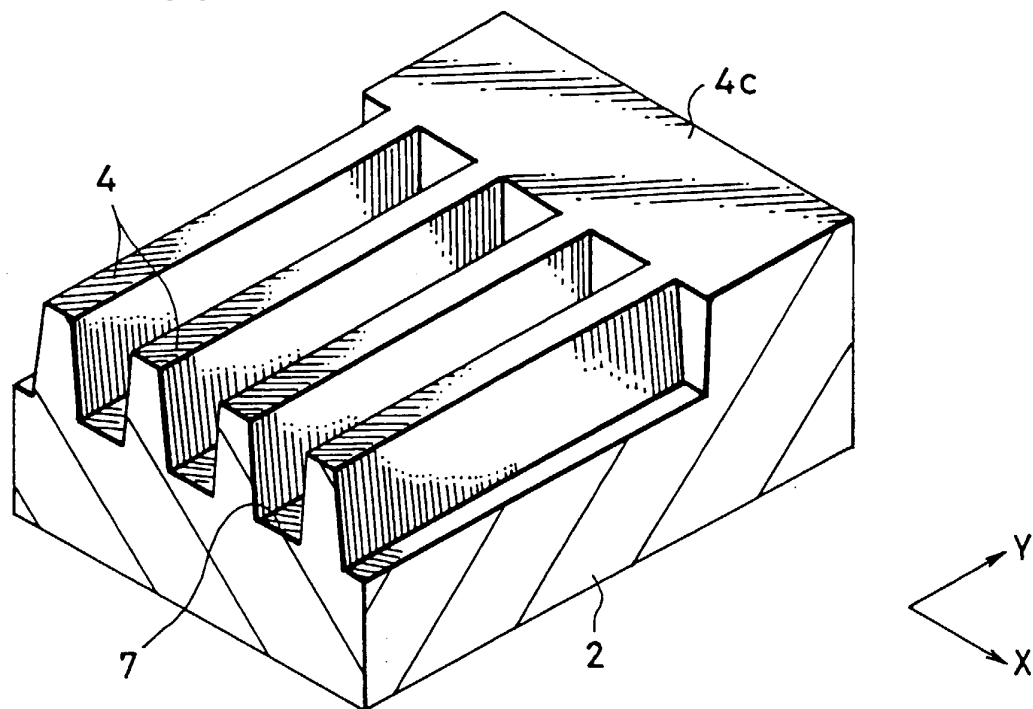


FIG. 3B

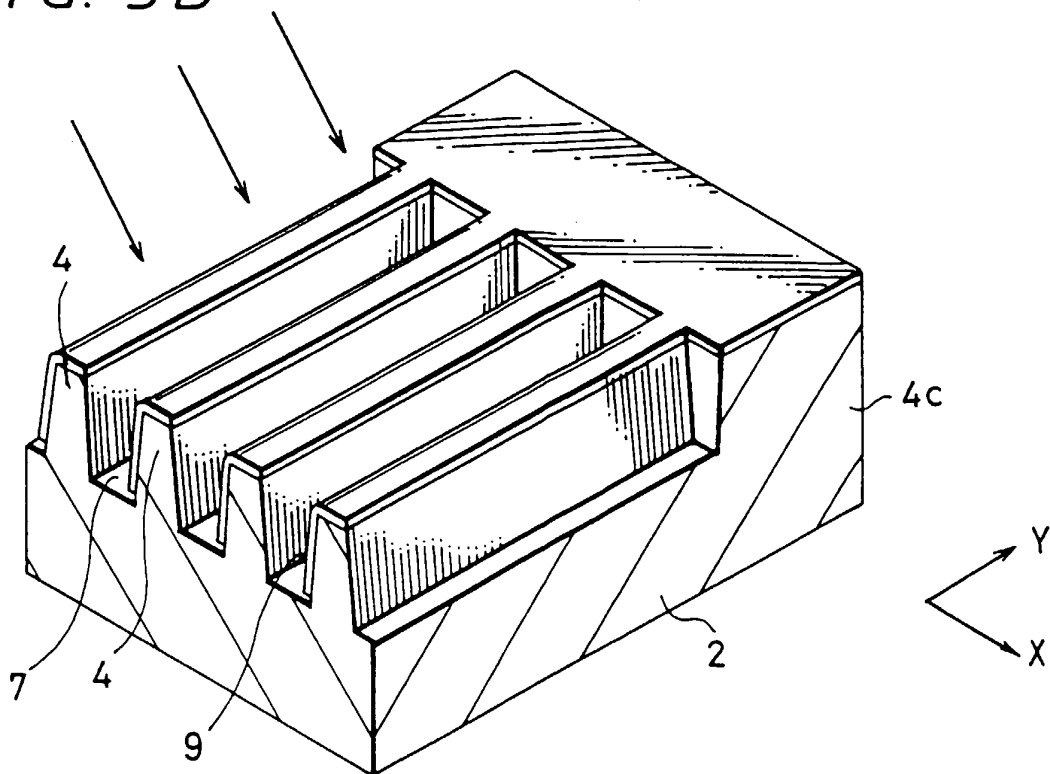


FIG. 4A

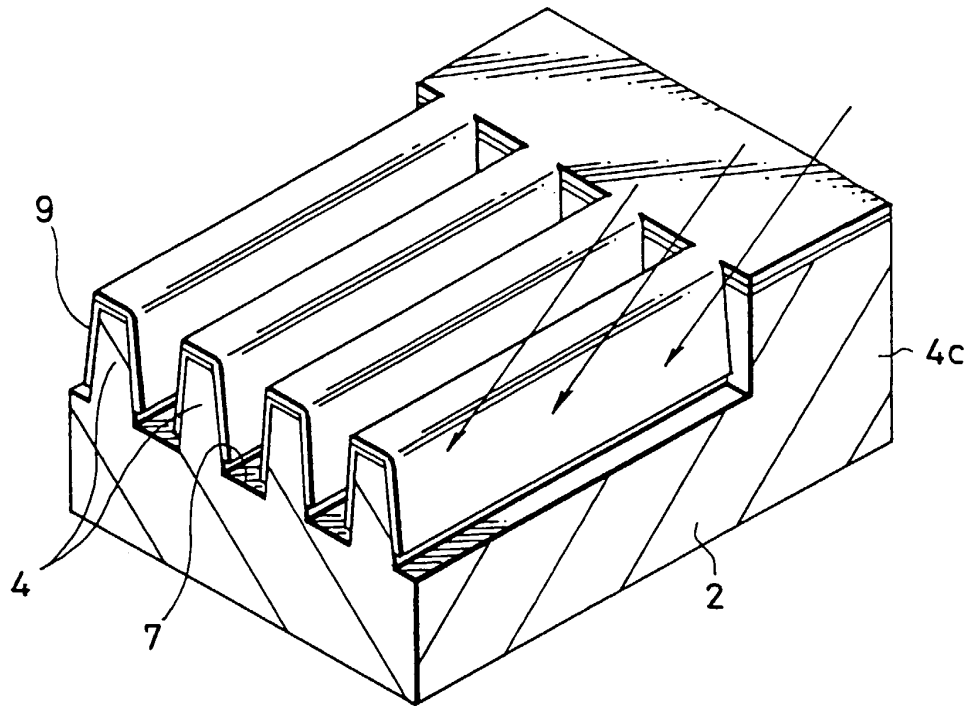


FIG. 4B

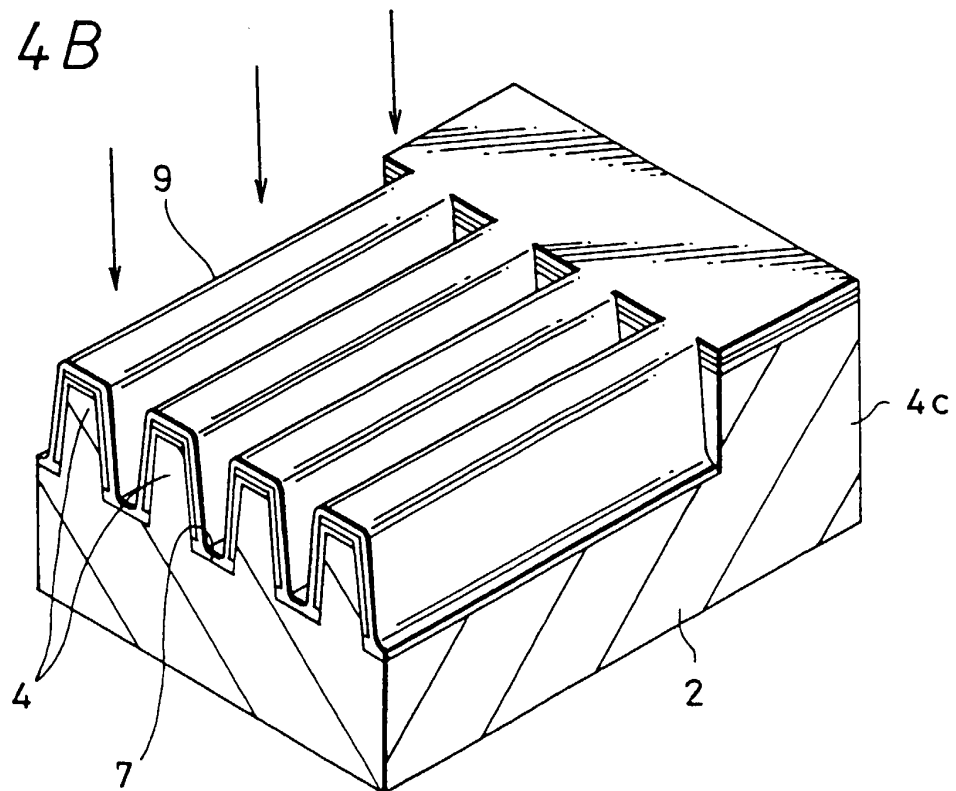


FIG. 5A

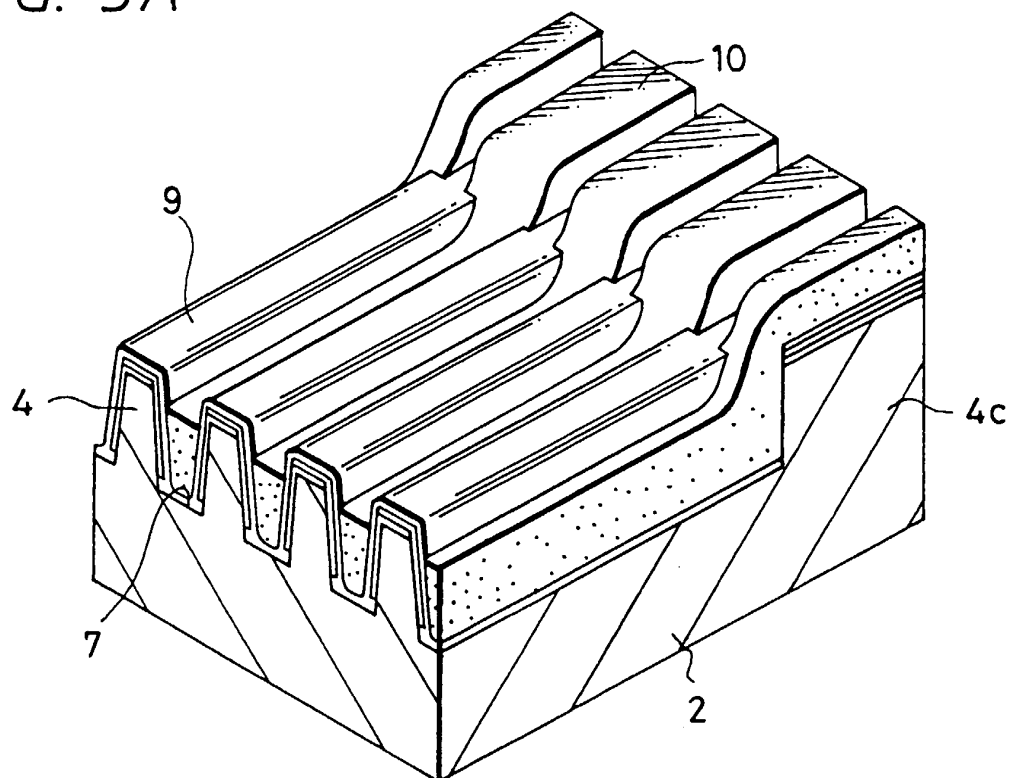
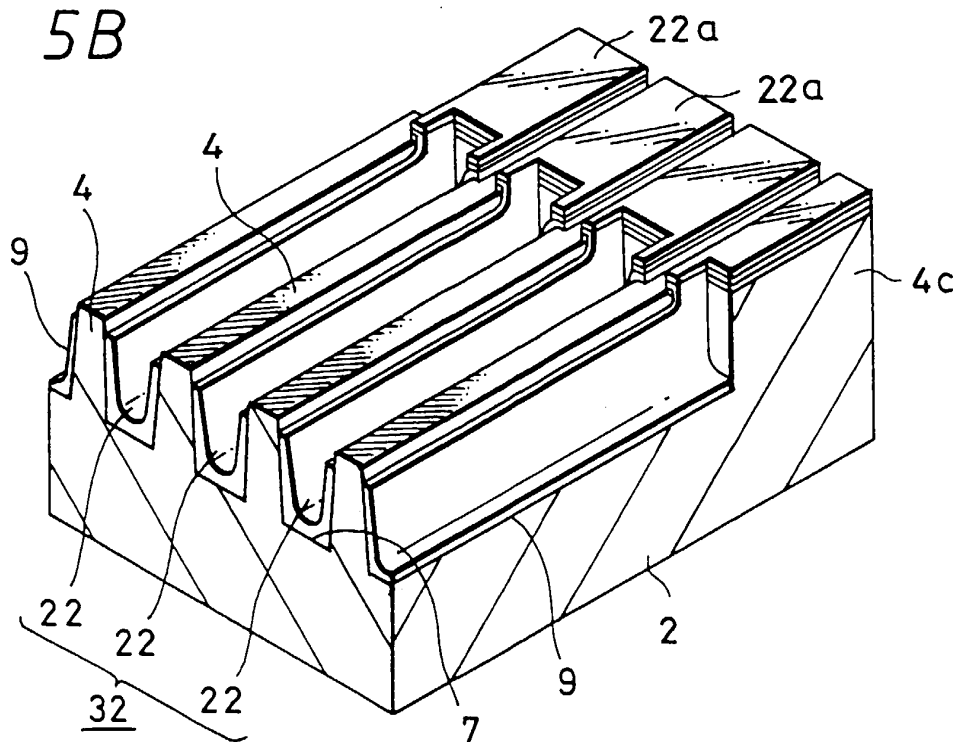


FIG. 5B



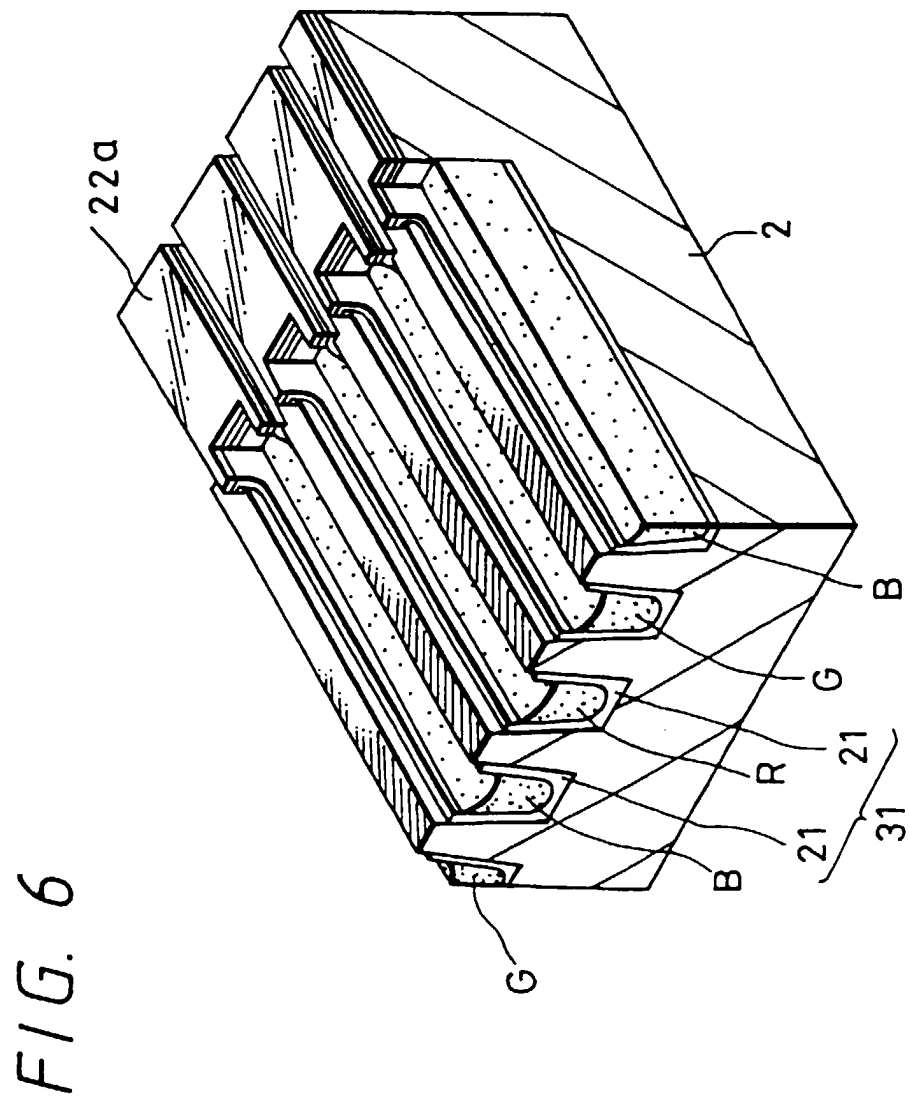
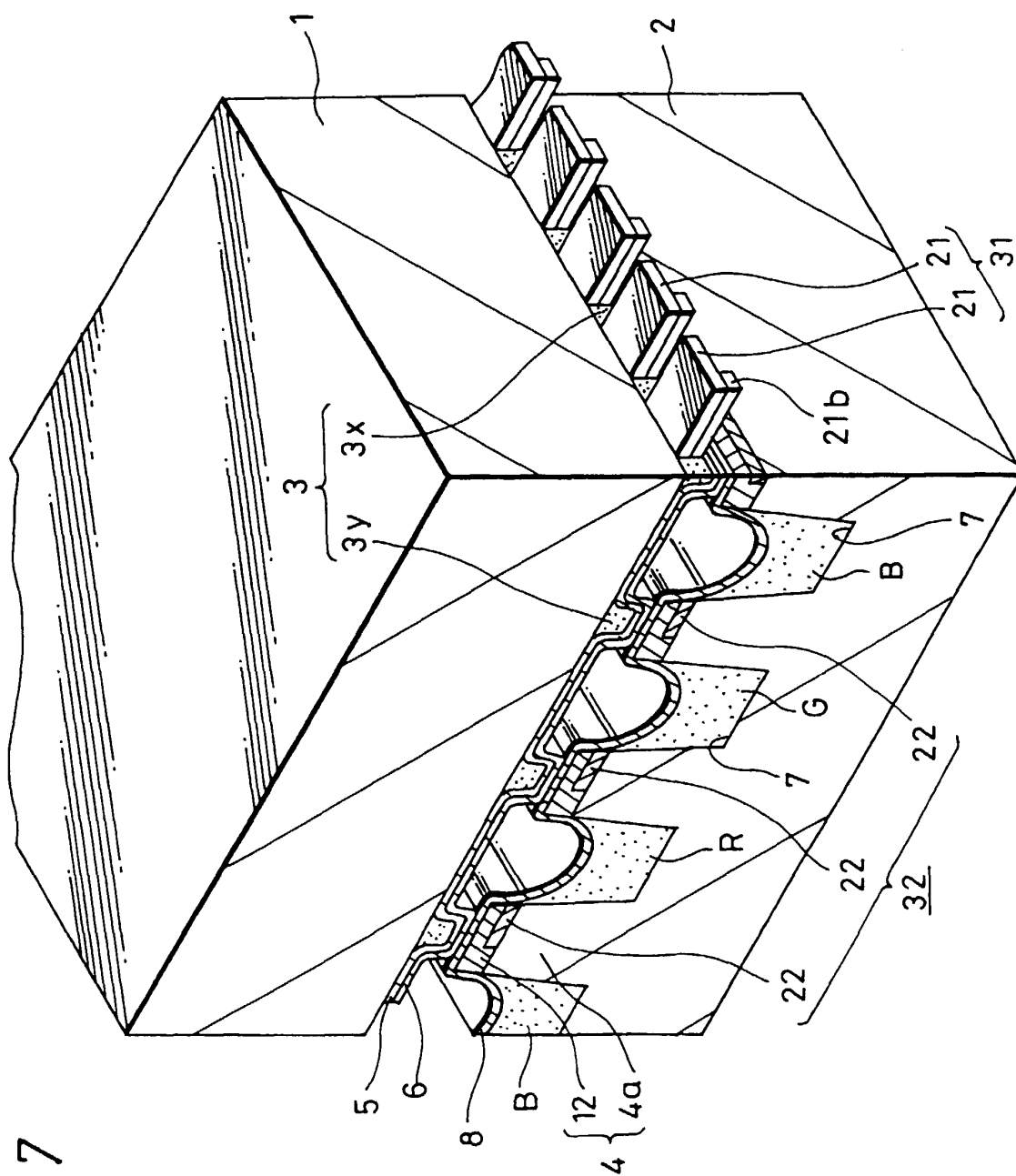


FIG. 7



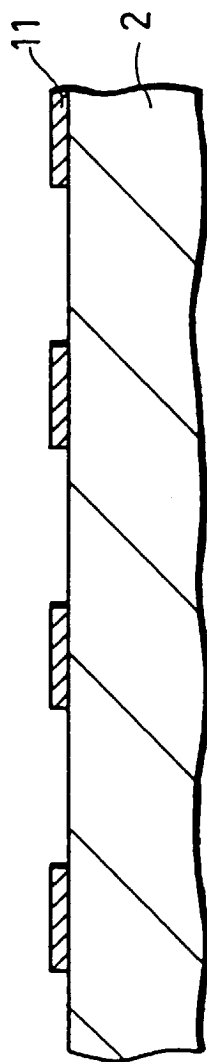


FIG. 8A

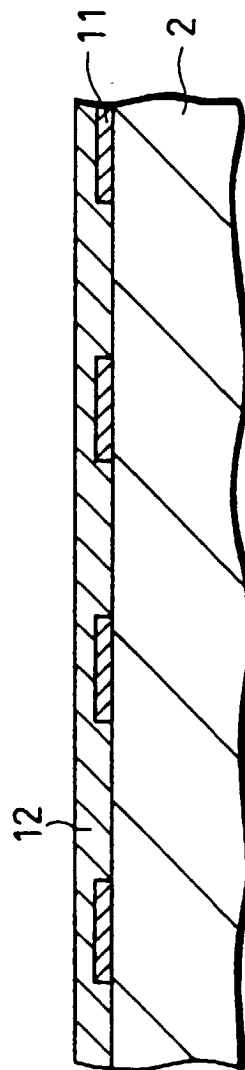


FIG. 8B

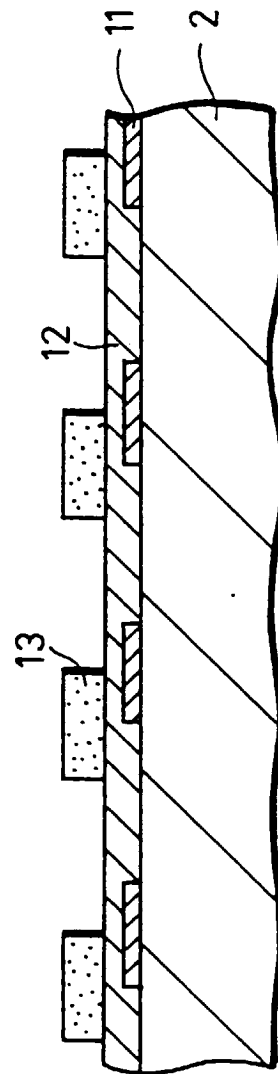


FIG. 8C

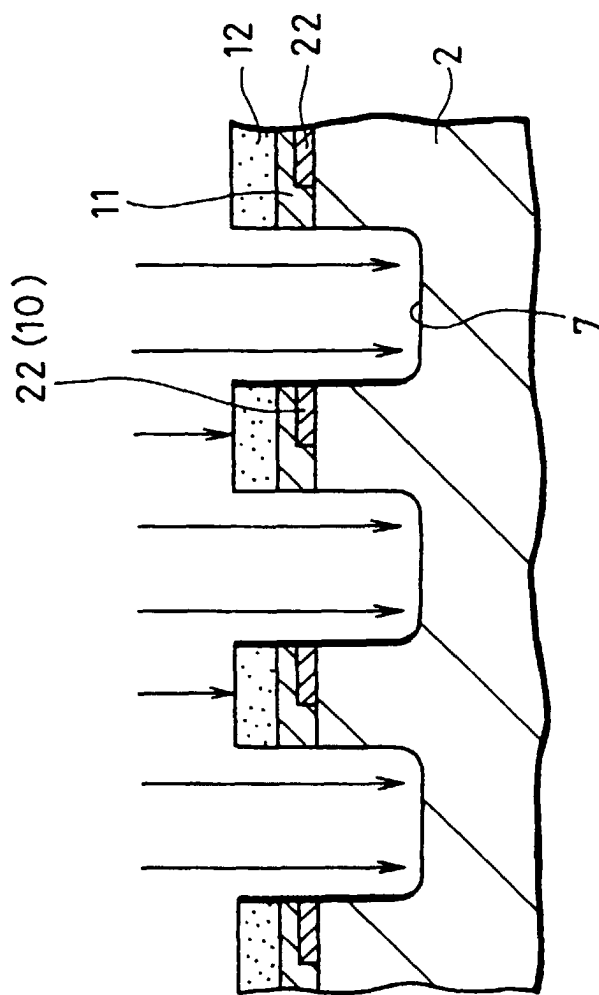


FIG. 9A

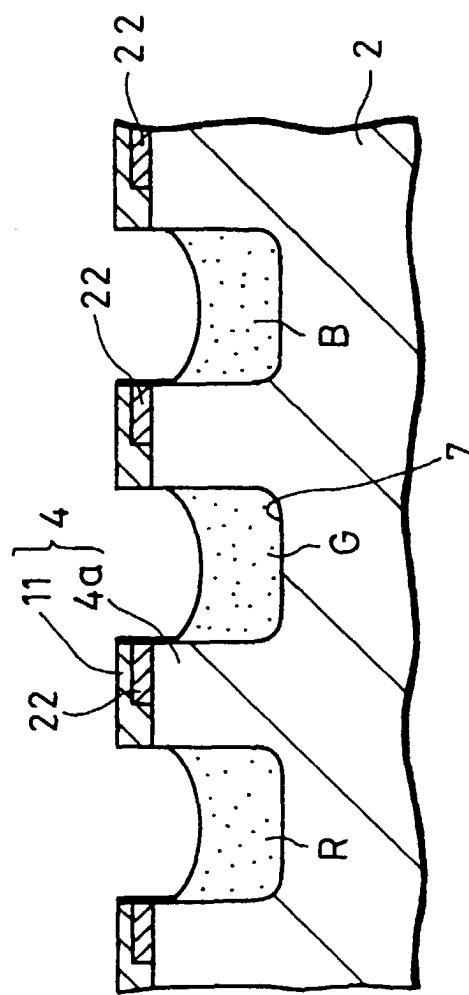


FIG. 9B



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 40 2118

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
E	EP 1 045 421 A (SONY CORP) 18 October 2000 (2000-10-18) * column 4, line 23 - line 47; claims 1,2; figure 1 * * column 6, line 25 - column 7, line 22; claim 8; figure 4 * ---	1,2,6, 8-11	H01J17/49 H01J9/24
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 08, 30 August 1996 (1996-08-30) & JP 08 095500 A (NORITAKE CO LTD;KYUSHU NORITAKE KK), 12 April 1996 (1996-04-12) * abstract * -----	1,5,12	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H01J
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 6 November 2000	Examiner DE RUIJTER, F
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 40 2118

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The members are as contained in the European Patent Office EDP file on
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06-11-2000

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EP 1045421	A	18-10-2000	NONE		
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82