(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 050 090 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
01.01.2014 Bulletin 2014/01

(21) Application number: **07812141.5**

(22) Date of filing: **14.06.2007**

(51) Int Cl.:
H05B 33/06 *(2006.01)*

(86) International application number:
PCT/US2007/071179

(87) International publication number:
WO 2008/016750 (07.02.2008 Gazette 2008/06)

(54) **ELECTROLUMINESCENT DISPLAY HAVING A PIXEL ARRAY**

ELEKTROLUMINESZENZANZEIGE MIT PIXELANORDNUNG

DISPOSITIF ÉLECTROLUMINESCENT AYANT UN ENSEMBLE DE PIXELS

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR

(30) Priority: **31.07.2006 US 461056**

(43) Date of publication of application:
22.04.2009 Bulletin 2009/17

(73) Proprietor: **Motorola Mobility LLC**
Libertyville, IL 60048 (US)

(72) Inventors:
- **JONNALAGADDA, Krishna, D.**
  Algonquin, Illinois 60102 (US)
- **CHASON, Marc, K.**
  Schaumburg, Illinois 60194 (US)
- **GAMOTA, Daniel, R.**
  Palatine, Illinois 60074 (US)
- **ZHANG, Jie**
  Buffalo Grove, Illinois 60089 (US)

(74) Representative: **Openshaw, Paul Malcolm**
Openshaw & Co.
8 Castle Street
Farnham
Surrey GU9 7HR (GB)

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EP 2 050 090 B1

Printed by Jouve, 75001 PARIS (FR)

Description

FIELD OF THE INVENTION

[0001] This invention relates generally to luminescent displays. More particularly, this invention relates to electroluminescent displays arranged in pixel arrays.

BACKGROUND

[0002] Electroluminescent panels, lamps, and displays are light-emitting media for use in many applications. Electroluminescent (EL) panels are essentially a capacitor structure with an inorganic phosphor sandwiched between two electrodes. The resistance between the two electrodes is almost infinite and thus direct current (DC) will not pass through it. When an alternating voltage is applied, the build-up of a charge on the two surfaces effectively produces an increasing field (called an electric field) energizing the phosphors and resulting in the emission of light. The increase in voltage in one direction increases the field and this causes a current to flow. The voltage then decreases and rises in the opposite direction. This also causes a current to flow. The net result is that current flows into the electroluminescent panel and thus energy is delivered to the panel. This energy is converted to visible light by the inorganic phosphor, with little or no heat produced in the process. Application of an alternating current (AC) voltage across the electrodes generates a changing electric field within the phosphor particles, causing them to emit visible light. By making one or both of the electrodes so thin, transparent or translucent that light is able to pass through and be emitted to the environment, an optically transmissive path is available.

[0003] One particular area in which electroluminescent panels can be useful is in lighted advertising displays at the point of product purchase. In today's competitive global environment, local customization of the advertising display is often desirable to accommodate language nuances, local regulations, and cultural morses. Prior art displays are fabricated to depict a predetermined graphic or text, and thus are not amenable to situations where dynamic messages need to be displayed. This makes local customization very costly and/or impractical, with long lead times when changes in the message are needed. Additionally, producing small volumes of a display containing a fixed message can be costly, due to the cost of tooling.

[0004] US 6 738 031 B2 discloses a matrix array display device has an array of pixels on a substrate which each have a display element, for example an electroluminescent display element, and associated control circuit including a storage capacitor and a light sensing element connected thereto for regulating charge stored on the capacitor and responsive, for example, to light emitted from the display element so as to regulate operation of the display element. The light sensing elements comprise thin film semiconductor devices each having a strip of semiconductor material with laterally-spaced, doped, contact regions and the associated storage capacitor is formed by a conductive layer extending substantially transversely of the strip over one contact region with intervening dielectric material.

[0005] US 5 585 695 A discloses a thin film electroluminescent display module sealed against moisture with driver chip and optional lens. The module is formed on a transparent substrate upon which a sequence of patterned thin layers is deposited and a patterned sealing layer and driver circuit(s) are applied.

[0006] US 5 880 705 A discloses an electroluminescent display formed on a ceramic substrate having a front ceramic surface and a back ceramic surface. The ceramic substrate includes a metal core that provides structural support electrical ground, and heat dissipation. Electroluminescent cells are mounted on the front ceramic surface and driver circuits for driving the of electroluminescent cells are mounted on the back ceramic surface. The driver circuits are positioned directly behind said electroluminescent cells. Connectors extend through said ceramic substrate and the electroluminescent cells to different driver circuits.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The accompanying figures, where like reference numerals refer to identical or functionally similar elements throughout the separate views and which together with the detailed description below are incorporated in and form part of the specification, serve to further illustrate various embodiments and to explain various principles and advantages all in accordance with the present invention.

FIGs. 1-4 are partial cross-sectional views of an electroluminescent display in accordance with certain embodiments of the present invention.

FIG. 5 is a partially exploded isometric view of an electroluminescent display in accordance with certain embodiments of the present invention.

DETAILED DESCRIPTION

[0008] As required, detailed embodiments of the present invention are disclosed herein.

[0009] An electroluminescent display contains an array of dynamically addressable pixels. The pixels are arranged on one side of a carrier substrate. Conductive vias in the substrate are electrically connected to each of the pixels. Each pixel consists of a bottom electrode that is coupled to a via, an electroluminescent material, and a dielectric material. A common top electrode is disposed on the dielectric material. Driver circuit conductors are situated on the other side of the substrate, electrically coupled to each of the conductive vias and to the common top electrode, so that each pixel can be individually ad-

dressed to illuminate the electroluminescent material on individual pixels. Referring now to FIGs. 1 and 5, a pixelated electroluminescent (EL) display 100 is formed on a substrate 110 that has an array of pixel elements 120 disposed on an upper surface thereof. In one embodiment, the pixel elements are arranged in a regular array, but can also be arranged in a variety of layouts. Although depicted as squares in FIG. 5, the pixel elements can be any of a number of shapes, such as, but not limited to, diamond, triangular, square, rectangular, pentagonal, hexagonal, octagonal, round, elliptical and polygonal. Compared to prior art EL displays, the pixel elements are generally smaller in size, closer together, and more numerous. Each of the pixels is electrically coupled to a conductive via 130 in the substrate, such that each pixel can be electrically routed to a location on the opposite side of the substrate. In one embodiment, the pixels are situated on top of a via, so that the via is contained within the perimeter of the pixel outline. In an alternate embodiment, the pixels are arranged so that the via is outside the perimeter of the pixel, and the pixel is then electrically coupled to the via by means of a conductive circuit trace on the upper surface of the substrate. Some of the various configurations of via and pixel are shown in FIG. 1, where the via is in the center of the pixel 132, the via is located off-center near the edge of the pixel 134, and the via is located remote from the pixel 136. These various arrangements can be used solely or in mixed fashion, as suits the needs of the designer in laying out the pixels and the electrical connections. The conductive vias 130 are formed in conventional fashion, such as, for example, plated through holes in a printed circuit board, and optionally filled with an electrically conductive or non-conductive material. Any of numerous methods familiar to those of ordinary skill in the art will suffice, as long as there is an electrical pathway from the pixel element to the other side of the substrate.

[0010] Each pixel element 120 contains a bottom electrode 140 that is disposed on the top surface of the substrate 110. The bottom electrode is typically an electrically conductive material such as copper, carbon, silver, platinum, titanium, indium-tin oxide, conductive alloys, etc. that is mechanically affixed to the surface of the substrate. These electrodes may be formed in conventional fashion, such as electroless plating, electroplating, screen printing, vacuum deposition, etc. Overlying each electrode is an EL material 150 containing a phosphor. In one embodiment shown in FIG. 1, the EL material 150 is arranged such that it substantially corresponds to the size and shape of the bottom electrode 140. An example is shown in FIG. 2 where the EL material 150 is larger than the corresponding bottom electrode. Configuring the display so that the EL material is the same size and shape as the bottom electrode will provide the sharpest image when the EL material is energized, since the resolution of the pixel is defined in this case by having all of the EL material energized. In the case where the EL material is larger than the bottom electrode, only those portions of the EL material that lie directly above the electrode will be energized, and those portions that do not overlie an electrode will not be energized. However, due to field effects, there will be some "drop-off" experienced at the boundary defined by the electrode, and the image may not be as sharp. Overlying each portion of the EL material 150 is a transparent or translucent dielectric material 160 that insulates the EL material from the other electrode. In one embodiment shown in FIG. 1, the dielectric material 160 is arranged such that it also substantially corresponds to the size and shape of the bottom electrode 140 and intervening EL material. In the example shown in FIG. 2, the dielectric material 160 is larger than the corresponding bottom electrode, and can actually span two or more pixels. In this configuration, portions of the dielectric material may also touch the surface of the substrate. The dielectric material 160 can, in one embodiment, be continuous over the entire pixel array, facilitating manufacture of the display.

[0011] Overlying the dielectric material 160 is a common top, or second, electrode 170. The second electrode is transparent or translucent so as to enable the EL material 150 to transmit the emitted visible light when energized. The top and bottom electrodes are electrically separated by EL material 150 and dielectric material 160. The top electrode 170 acts in concert with the bottom electrode 140 to form a capacitor-like structure that causes the phosphors in the EL material 150 that is sandwiched between the electrodes to fluoresce when the two electrodes are electrically energized. Since each bottom electrode in the array is individually addressable, the top electrode does not need to be individually addressable, but can instead be electrically common to all the bottom electrodes. Optionally, a second dielectric material 180 can be placed between the individual pixel elements 120 to fill in the space between the elements. This facilitates the formation of the top electrode 170, allowing it to be a single continuous layer over the pixels 120 and the second dielectric 180.

[0012] A driver circuit 190 is electrically coupled to each of the pixel elements 120 and to the top electrode 170. Driver circuits are commonly known and used in devices such as liquid crystal displays (LCD) to selectively address the various segments of the LCD. In simplistic form, driver circuits contain a plurality of switches (typically transistors) that can be turned on and off to address the various pixels as desired. Each of the switches 192 is coupled to a single conductive via, and in turn, to a single pixel, so as to make each pixel individually addressable. Another portion 194 of the driver circuit 190 is coupled to the common top electrode 170. When any one or more of the individual switches 192 is enabled, an electrical circuit is completed from the bottom electrode through the EL material to the top electrode, causing that individual segment of EL material to fluoresce and emit visible light. By selectively energizing the various pixels, the array of pixels can be caused to form a dynamic display that can be rapidly changed, much in

the manner of an LCD.

[0013] Driver circuit conductors are situated on the bottom of the substrate 110, opposite the side that contains the pixels 120. The driver circuit can be located anywhere, on a separate module or even on the top surface, as long as the conductors leading to the driver circuits are electrically coupled to the vias. This facilitates the routing of the various electrical connections required to couple the individual pixels in the array to the driver circuit. In one embodiment, the circuitry on the back side of the substrate is routed in multiple layers. In another embodiment, the driver circuit 190 is laminated to the back side of the substrate to form a monolithic package.

[0014] Having now described our invention, we now present additional examples. Referring now to FIGs. 3 and 4, a pixelated EL display 300 has the arrangement of the EL material and the dielectric material reversed from that shown in FIGs. 1 and 2. That is, a layer of dielectric material 160 is first disposed on each of the bottom electrodes 140, then a layer of EL material 150 is disposed on top of the dielectric material. The common top electrode 170 is then formed on top of the EL material. All other portions of the structure are similar to that described for FIGs. 1 and 2.

[0015] In summary, operation of a pixelated electroluminescent display according to the invention can be carried out by coupling an array of dynamically addressable pixels on one side of a carrier substrate to a driver circuit situated on the other side of the substrate. Conductive vias in the substrate electrically connect each of the pixels to the driver. Each pixel consists of a bottom electrode that is coupled to a via, an electroluminescent material, a dielectric material, and a common top electrode. The driver circuit makes each pixel individually addressable to illuminate the electroluminescent material in individual pixels.

Claims

1. An electroluminescent display (100), comprising:

a substrate (110);
an array of pixel elements (120) arranged on a first face of the substrate (110), the electroluminescent display (100) **characterised in that** the substrate (110) comprises an array of conductive vias (130, 132, 134, 136); wherein each pixel element (120) comprises:

a first electrode (140) electrically coupled to one of the conductive vias (130, 132, 134, 136);
electroluminescent material (150) disposed directly only on the first electrode (140) to substantially correspond to the size and shape of the first electrode (140); and
a transparent or translucent dielectric material (160) disposed directly on the electroluminescent material (150) to substantially correspond to the size and shape of the first electrode (140);

the electroluminescent display (100) further comprising:

a transparent or translucent second electrode (170) disposed directly on the dielectric material (160), that overlies and is common to all of the pixel elements (120) in the array of pixel elements (120); and
a driver circuit (190) situated on an opposing second face of the substrate (110) and electrically coupled to each of the conductive vias (130, 132, 134, 136) and to the second electrode (170), such that each pixel element (120) is individually addressable so as to illuminate the electroluminescent material (150) on individual pixel elements (120).

2. The electroluminescent display as defined in claim 1, wherein the first electrode (140) is situated on the conductive via (130, 132, 134).

3. The electroluminescent display as defined in claim 1 or claim 2, wherein the first electrode (140) is electrically coupled to the conductive via (130,136) by means of a conductive circuit trace.

4. The electroluminescent display as defined in any of claims 1 to 3, wherein the driver circuit (190) is laminated to the second face of the substrate (110).

5. The electroluminescent display as defined in any of claims 1 to 4, further comprising a second dielectric material (180) disposed on the first face of the substrate (110) between the individual pixel elements (120).

Patentansprüche

1. Elektrolumineszenzanzeige (100), umfassend:

ein Substrat (110),
eine Anordnung von Pixelelementen (120), die auf einer ersten Seite des Substrats (110) angeordnet ist, wobei die Elektrolumineszenzanzeige (100) **dadurch gekennzeichnet ist, dass** das Substrat (110) eine Anordnung von leitfähigen Durchgangsleitungen (130, 132, 134, 136) umfasst, wobei jedes Pixelelement (120) Folgendes umfasst:

eine erste Elektrode (140), die elektrisch mit einer der leitfähigen Durchgangsleitungen

(130, 132, 134, 136) gekoppelt ist,
elektrolumineszentes Material (150), das direkt nur auf der ersten Elektrode (140) angeordnet ist, um im Wesentlichen der Größe und der Form der ersten Elektrode (140) zu entsprechen; und
ein transparentes oder lichtdurchlässiges dielektrisches Material (160), das direkt auf dem elektrolumineszenten Material (150) angeordnet ist, um im Wesentlichen der Größe und der Form der ersten Elektrode (140) zu entsprechen; und

wobei die Elektrolumineszenzanzeige (100) weiter Folgendes umfasst:

eine transparente oder lichtdurchlässige zweite Elektrode (170) die direkt auf dem dielektrischen Material (160) angebracht ist, die über allen Pixelelementen (120) in der Anordnung von Pixelelementen (120) liegt und diesen gemeinsam ist; und
eine Antriebseinheit (190), die sich auf einer gegenüber liegenden zweiten Seite des Substrats (110) befindet und elektrisch mit jedem der leitfähigen Durchgangsleitungen (130, 132, 134, 136) und der zweiten Elektrode (170) verbunden ist, so dass jedes Pixelelement (120) individuell adressierbar ist, um das elektrolumineszente Material (150) auf individuellen Pixelelementen (120) zu beleuchten.

2. Elektrolumineszenzanzeige nach Anspruch 1, wobei sich die erste Elektrode (140) auf der leitfähigen Durchgangsleitung (130, 132, 134) befindet.

3. Elektrolumineszenzanzeige nach Anspruch 1 oder Anspruch 2, wobei die erste Elektrode (140) mit Hilfe einer leitfähigen Schaltspur mit der leitfähigen Durchgangsleitung (130, 136) gekoppelt ist.

4. Elektrolumineszenzanzeige nach einem der Ansprüche 1 bis 3, wobei die Antriebseinheit (190) an die zweite Seite des Substrats (110) laminiert ist.

5. Elektrolumineszenzanzeige nach einem der Ansprüche 1 bis 4, weiter umfassend ein zweites dielektrisches Material (180), das auf der ersten Seite des Substrats (110), zwischen den individuellen Pixelelementen (120) angebracht ist.

Revendications

1. Dispositif d'affichage électroluminescent (100), comprenant :

- un substrat (110) ;
- un réseau d'éléments de pixel (120) agencés sur une première face du substrat (110),

le dispositif d'affichage électroluminescent (100) étant **caractérisé par le fait que** le substrat (110) comprend un réseau de trous d'interconnexion conducteurs (130, 132, 134, 136) ; chaque élément de pixel (120) comprenant :

- une première électrode (140) électriquement couplée à l'un des trous d'interconnexion conducteurs (130, 132, 134, 136) ;
- une matière électroluminescente (150) disposée directement uniquement sur la première électrode (140) pour correspondre sensiblement à la dimension et à la forme de la première électrode (140) ; et
- une matière diélectrique transparente ou translucide (160) disposée directement sur la matière électroluminescente (150) pour correspondre sensiblement à la dimension et à la forme de la première électrode (140) ;

le dispositif d'affichage électroluminescent (100) comprenant en outre :

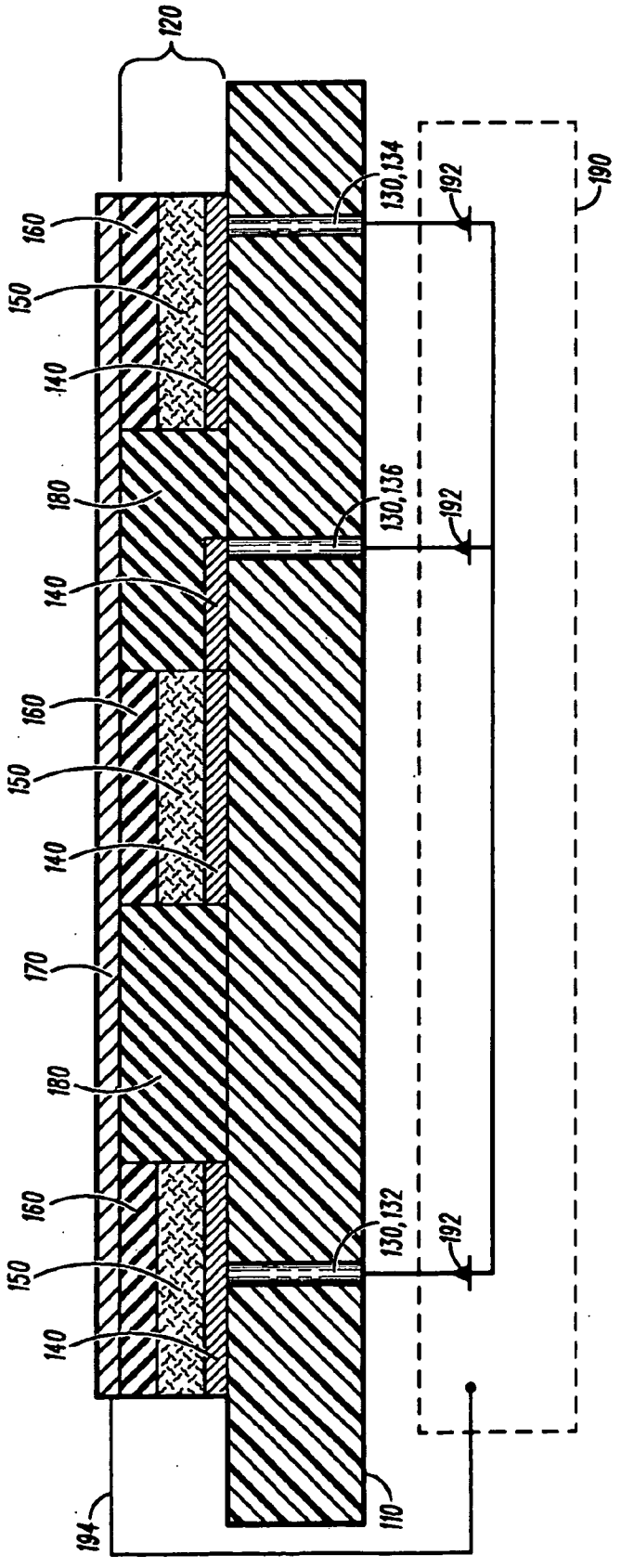
- une seconde électrode transparente ou translucide (170) disposée directement sur la matière diélectrique (160), qui recouvre et est commune à tous les éléments de pixel (120) du réseau d'éléments de pixel (120) ; et
- un circuit d'attaque (190) situé sur un seconde face opposée du substrat (110) et électriquement couplé à chacun des trous d'interconnexion conducteurs (130, 132, 134, 136) et à la seconde électrode (170), de telle sorte que chaque élément de pixel (120) est individuellement adressable de façon à éclairer la matière électroluminescente (150) sur des éléments de pixel individuels (120).

2. Dispositif d'affichage électroluminescent selon la revendication 1, dans lequel la première électrode (140) est située sur le trou d'interconnexion conducteur (130, 132, 134).

3. Dispositif d'affichage électroluminescent selon l'une des revendications 1 ou 2, dans lequel la première électrode (140) est électriquement couplée au trou d'interconnexion conducteur (130, 136) au moyen d'une piste de circuit conductrice.

4. Dispositif d'affichage électroluminescent selon l'une quelconque des revendications 1 à 3, dans lequel le circuit d'attaque (190) est stratifié sur la seconde face du substrat (110).

5. Dispositif d'affichage électroluminescent selon l'une quelconque des revendications 1 à 4, comprenant en outre une seconde matière diélectrique (180) disposée sur la première face du substrat (110) entre les éléments de pixel individuels (120).


120
130,134
192
190
160
150
140
180
130,136
192
140
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150
140
170
180
160
130,132
192
150
140
194
110

FIG. 1

100

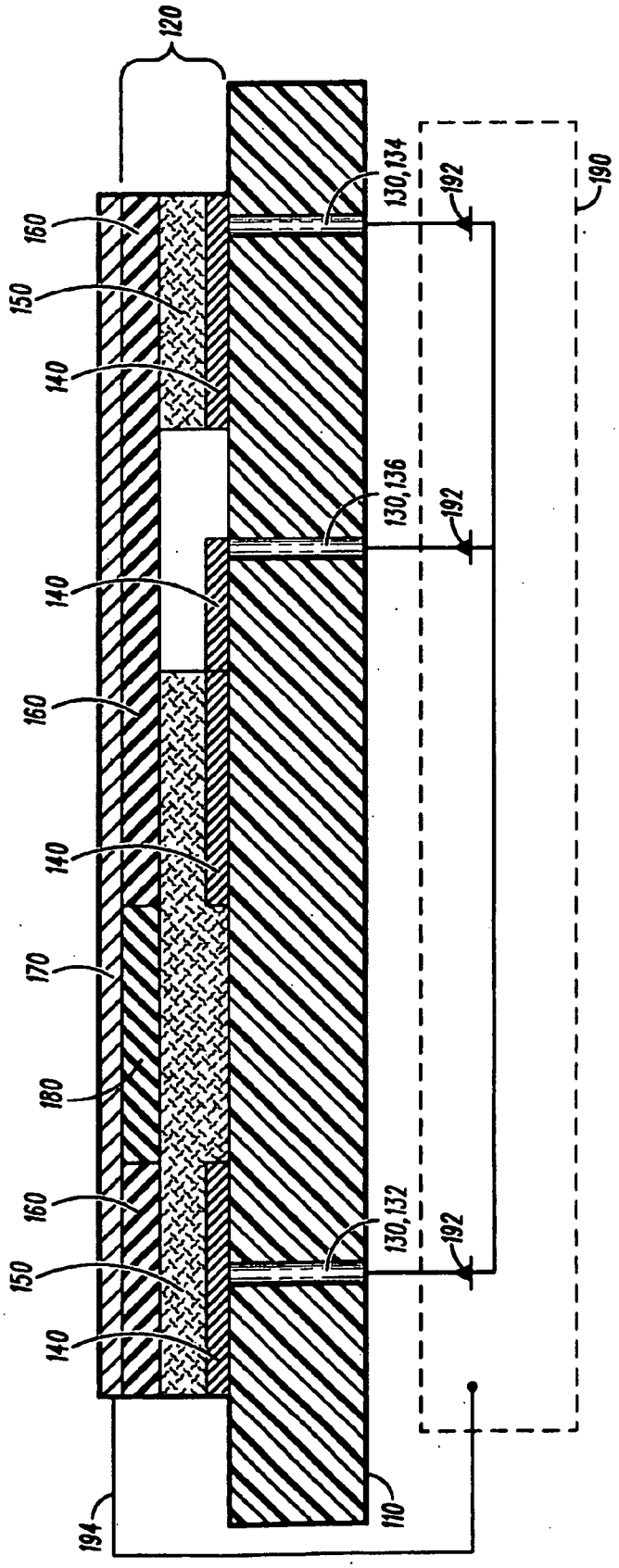

120
130,134
192
190
160
150
140
130,136
192
140
160
140
170
180
160
130,132
192
150
140
194
110

FIG. 2

200

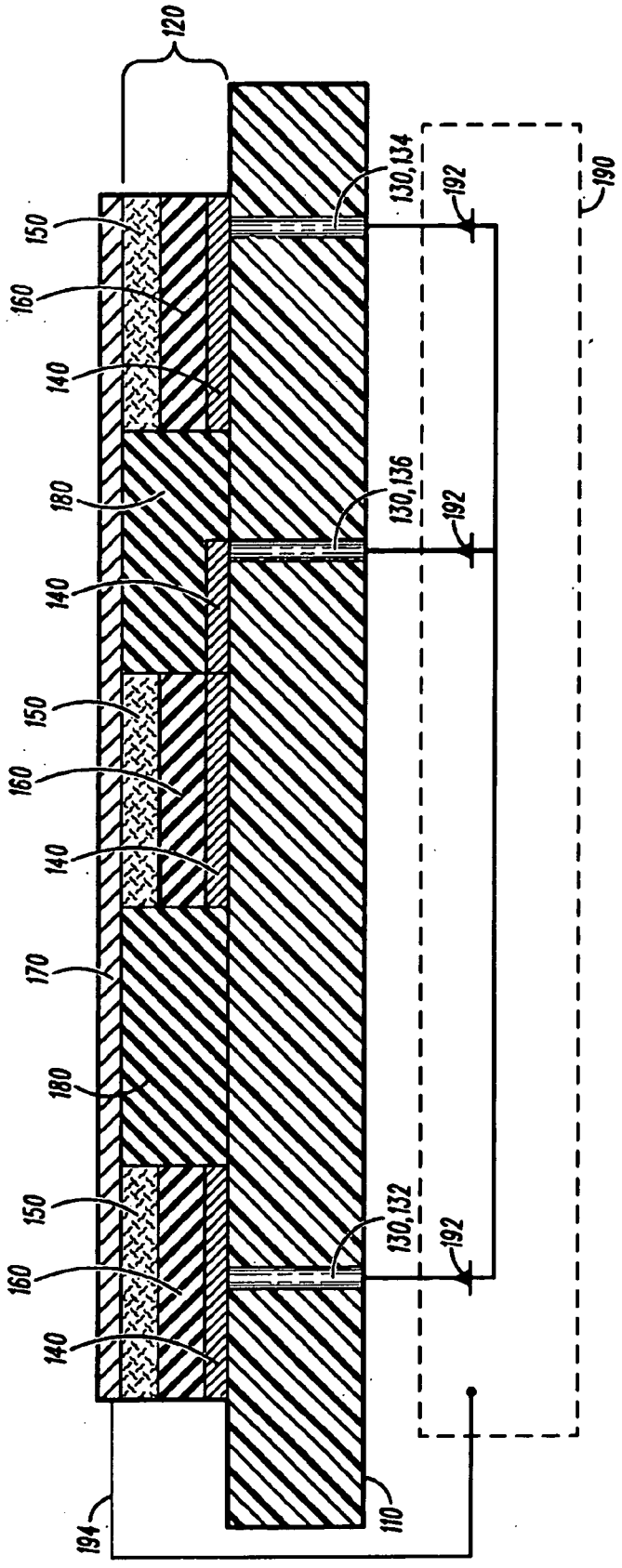

120
130,134
192
190
150
160
140
180
130,136
192
140
150
160
140
170
180
150
130,132
192
160
140
194
110

FIG. 3

300

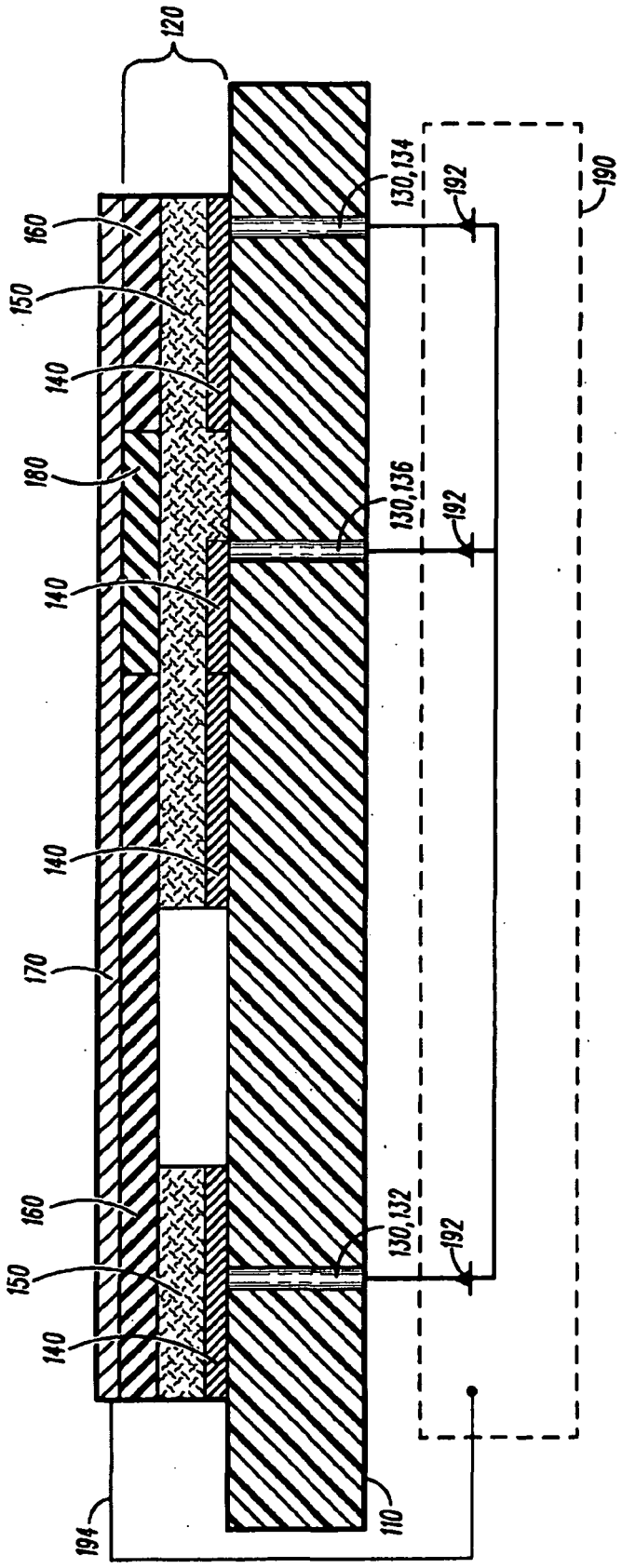
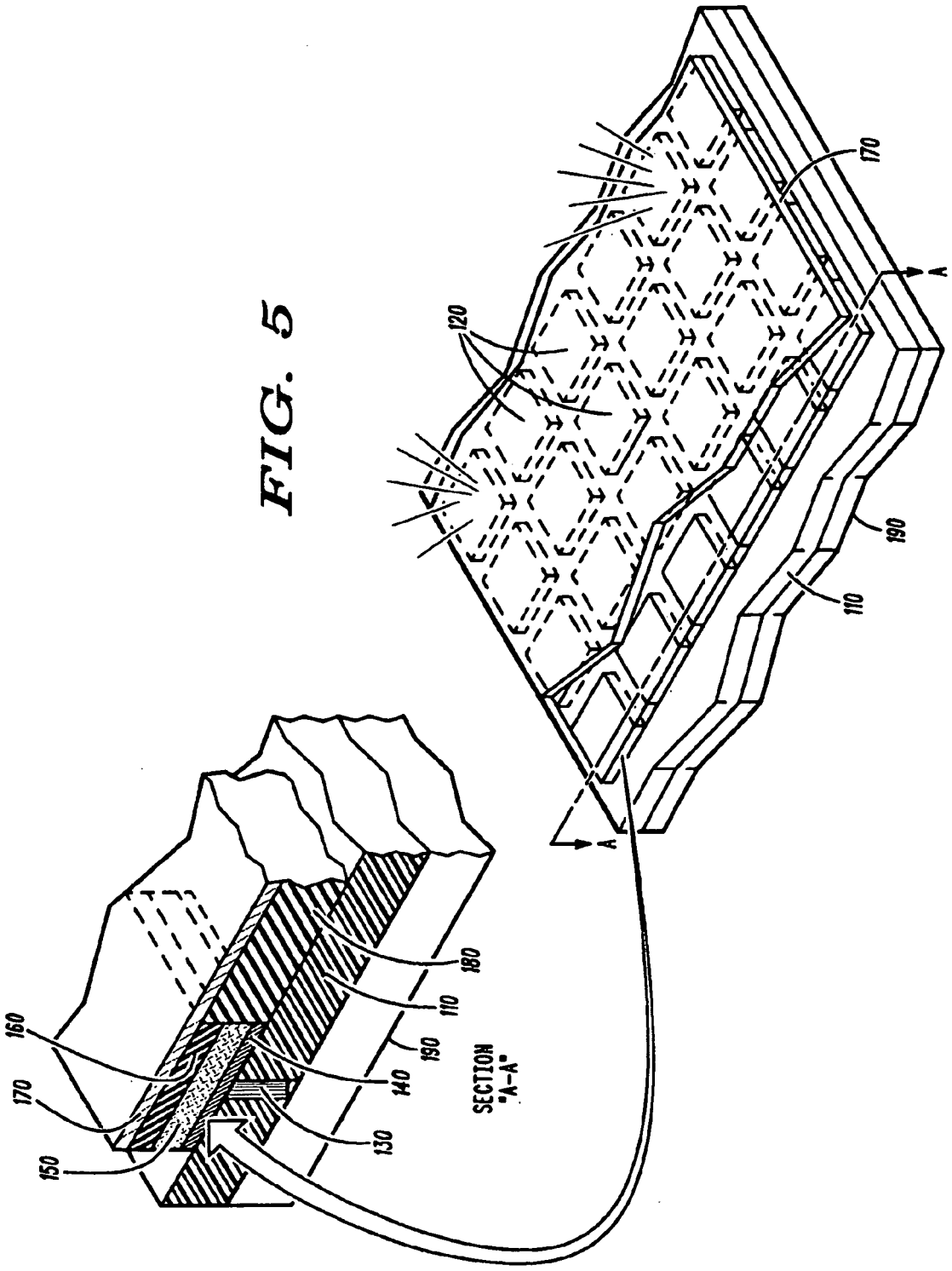

120
130,134
192
190
160
150
140
180
130,136
192
140
140
170
160
130,132
192
150
140
194
110

FIG. 4

400

FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6738031 B2 **[0004]**
- US 5585695 A **[0005]**
- US 5880705 A **[0006]**

专利名称(译)	具有像素阵列的电致发光显示器		
公开(公告)号	EP2050090B1	公开(公告)日	2014-01-01
申请号	EP2007812141	申请日	2007-06-14
[标]申请(专利权)人(译)	摩托罗拉公司		
申请(专利权)人(译)	MOTOROLA，INC.		
当前申请(专利权)人(译)	MOTOROLA MOBILITY LLC		
[标]发明人	JONNALAGADDA KRISHNA D CHASON MARC K GAMOTA DANIEL R ZHANG JIE		
发明人	JONNALAGADDA, KRISHNA, D. CHASON, MARC, K. GAMOTA, DANIEL, R. ZHANG, JIE		
IPC分类号	H05B33/06		
CPC分类号	H05B33/06		
优先权	11/461056 2006-07-31 US		
其他公开文献	EP2050090A4 EP2050090A2		
外部链接	Espacenet		

摘要(译)

电致发光显示器包含可动态寻址的像素阵列。像素布置在载体基板的一侧。衬底中的导电通孔电连接到每个像素。每个像素包括耦合到通孔的底部电极，电致发光材料和电介质材料。公共顶部电极设置在介电材料上。驱动器电路导体或连接器位于基板的另一侧并且电耦合到每个导电通孔和公共顶部电极，使得每个像素可以被单独寻址以照射各个像素上的电致发光材料。

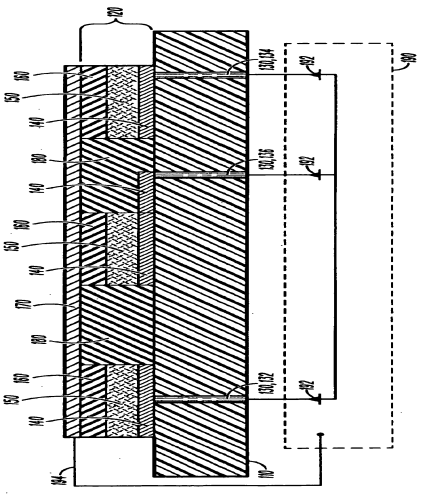

FIG. 1