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(54) **Xerographic light emitter array with long emission pixels**

(57) A xerographic light emitter array (20) uses organic light emitting diodes (OLEDs) operating at modest light levels to expose a photoreceptor drum or belt (14). This is accomplished by staging a single row array of emitters in the scan direction (104) with increased length of each emitter in the slow scan direction (110) and focusing the increased length and thus increased light level of each emitter onto the photoreceptor (14) in the scan direction (104). Increased emitter lifetime and the ability to operate at lower light levels are achieved in proportion to the length of the emitter. The focusing lens array (18) can include a divergent cylindrical lens (116), a Selfoc lens (118) and a convergent cylindrical lens (120). The emitters can be rectangular in shape to form a square spot on the photoreceptor (14) or the emitters can be elliptical in shape to form a circular spot on the photoreceptor (14).

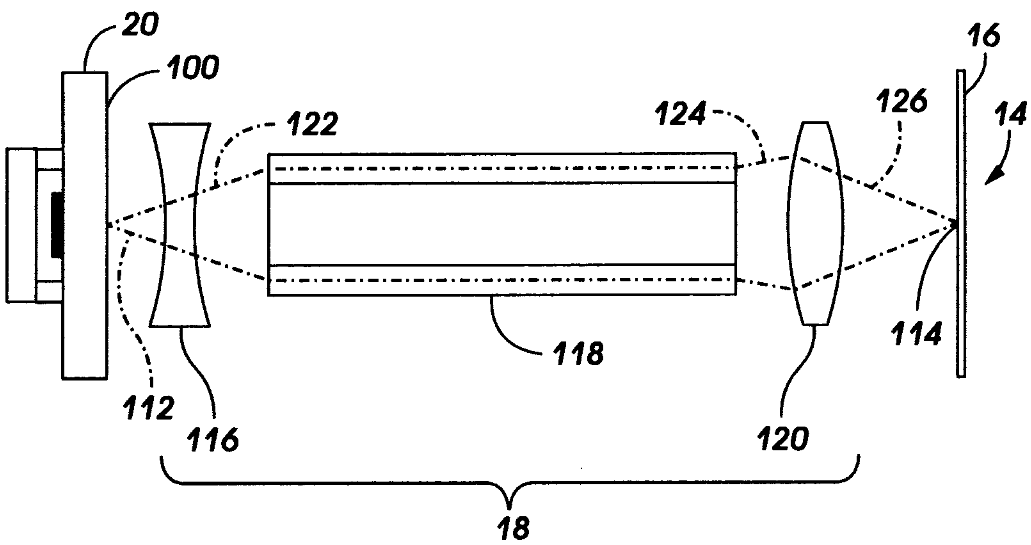

FIG. 3

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Description

This invention relates to xerographic imagers using a light emitter array and, in particular, to an organic light emitting diode (OLED) printbar used in such xerographic light emitter arrays.

One of the fundamental design challenges for xerographic imaging is getting enough light to the photoreceptor at sufficient print speed while providing adequate service lifetime of the printbar. Rapid progress in OLEDs has produced devices which can emit light levels greater than computer monitors (300 cd/m^2) and fluorescent tubes (3000 cd/m^2) in both white and in colours collectively spanning the visible spectrum.

Lifetime studies of OLEDs indicate that diode lifetime is determined by the total charge passed through the OLED. Thus, the OLEDs operate for short times at high brightness or for long times at low brightness. The lower end of the OLED brightness range is most stable, generally sustaining lifetimes of greater than 10,000 hours. The higher end of the OLED brightness range is less stable. For example, OLED devices operating at 1500 cd/m^2 currently have sustainable lifetimes of only about 500 hours.

In a linear page-width array of such OLEDs, there is not enough brightness to print at a reasonable speed with reasonable reliability for commercial uses. A single row OLED printbar having OLED emitters operating at 1500 cd/m^2 is illuminating a photoreceptor requiring about 7.5 ergs/cm^2. Thus, the print-speed of the single row device is about 0.29 pages per minute. Moderate print-speeds are above 5 pages per minute and a more desirable print-speed is about 30 pages per minute. The brightness deficit determined by this rough calculation is about 100x, especially when considering that the print-speed calculation for the single row page-width array of OLEDs leaves no room for dead time. In addition, inorganic page-width array of OLEDs leaves no room for dead time. In addition, inorganic diode based printbars typically have a duty cycle well under 50% in part to minimize blur in the process direction. Furthermore, the calculated print-speed is the speed before degradation, where the lifetime for the devices is the time to 50% output decay.

The brightness deficit of currently available OLED devices is too large to compensate simply by running the diodes harder. For example, operating the OLEDs even briefly at 1500 cd/m^2 would require such a high bias that the OLEDs would quickly become inoperative. Furthermore, doing so would only increase the print-speed of the single row array to 3 pages per minute. In addition, the total lifetime print volume of the xerographic imager (less than 9,000 pages) is insufficient.

Typically, the light emission pixels of the OLED array are imaged one to one through a lens array onto the photoreceptor. According, the light emission pixels are square or circular in shape and of equivalent size to the pixel spot on the photoreceptor in order to achieve the necessary resolution for the spots per inch (SPI).

Commonly assigned U.S. Patent Application (JAO 34125, D/96281, US Patent Application No. 08/785,230, filed January 17, 1997) to Fork, entitled "Integrating Xerographic Light Emitter Array", the disclosure of which is incorporated herein by reference, discloses one approach for using OLEDs operated at modest light levels to expose a photoreceptor drum or belt. This is accomplished by staging an array of emitters in the slow scan direction, and clocking the data through pixel driving shift-registers synchronized with the movement of the photoreceptor past the array in the slow scan direction. Increased emitter lifetime and the ability to operate at lower light levels are achieved in proportion to the number of stages.

Commonly assigned U.S. Patent Application (JAO 34128, D/96282, US Patent Application No. 08/785,233, filed January 17, 1997) to Fork et al., entitled "Integrating Xerographic Light Emitter Array with Grey Scale", the disclosure of which is incorporated herein by reference, discloses one approach for using OLEDs operated at modest light levels to expose a photoreceptor drum or belt. This is accomplished by staging rows of emitters in the slow scan direction and moving the object image down the rows synchronously with the movement of the photoreceptor past the array in the slow scan direction similar to U.S. Patent Application (JAO 34125, D/96281). However, the entire printbar can be rewritten during each line time of the photoreceptor, which allows the exposure of any spot on the photoreceptor to be varied over a number of grey levels equal to the number of stages.

Commonly assigned U.S. Patent Application (JAO 34150, D/96484, US Patent Application No. 08/785,231, filed January 17, 1997) to Fork, entitled "Self Replacing OLED Printbar", the disclosure of which is incorporated herein by reference, proposes another way to extend the lifetime of an OLED based printbar. This is accomplished by creating a plurality of OLED printbars on a substrate, having all the printbars share common optics and selecting a single row of emitters which operate at a high brightness and current. When one row burns out or decays to a level insufficient for printing, that row is deactivated, a new row is activated and printing continues.

It is an object of this invention to provide long rectangular emission pixels in an OLED array to be refocused on the photoreceptor at the required resolution but with increased brightness.

In accordance with the present invention, a xerographic light emitter array uses organic light emitting diodes (OLEDs) operating at modest light levels to expose a photoreceptor drum or belt. This is accomplished by staging a single row array of emitters in the scan direction with increased length of each emitter in the slow scan direction and focusing the increased length and thus increased light level of each emitter onto the photoreceptor in the scan direction. Increased emitter lifetime and the ability to operate at lower light levels are achieved in proportion to the length of the emitter. The focusing lens array can include a divergent cylindrical lens, a Selfoc lens and a convergent cylindrical lens. The emitters can be rectangular in shape to form a square spot on the photoreceptor or the emitters can be elliptical in shape to form a circular spot on the photoreceptor.

Other objects and attainments together with a fuller understanding of the invention will become apparent and appreciated by referring to the following description and claims taken in conjunction with the accompanying drawings.

Figure 1 is a schematic illustration of an exposure system for an OLED array in a xerographic imager formed according to the present invention.

Figure 2 is a schematic illustration of the rectangular emission pixels of the OLED array formed according to the present invention.

Figure 3 is a schematic illustration of the imaging system using the rectangular emission pixels of the OLED array of Figure 2 formed according to the present invention.

Figure 4 is a schematic illustration of a printbar of the OLED array of Figure 2 formed according to the present invention.

Figure 5 is a schematic illustration of the pattern anode and cathode electronics of the printbar of Figure 4 formed according to the present invention.

Figure 6 is a schematic illustration of a common electrode layout for an individual pixel of a second embodiment of the printbar of Figure 4.

Reference is now made to Figure 1, wherein there is illustrated an exposure system 10 for an OLED array 20 in accordance with this invention. The exposure system 10 includes a position encoder 12, a photoreceptor 14, an imaged line 16, a lens array 18, an OLED array 20 and control electronics 22. As the photoreceptor 14 drum rotates, data propagates through the OLED array 20 at the same velocity. The exposure system 10 stages the OLED array 20 in the slow scan direction 24 and moves the object image within the OLED array 20 synchronously with the rotation of the photoreceptive drum 14.

The individual light emission pixels of the OLED array 20 emit light which is focused by the lens array 18 as the imaged line 16 on the photoreceptor 14.

As best seen in Figure 2, the light emission pixels 100 of the OLED array 20 are rectangular in shape. The pixels 100 have a uniform width 102 along the scan direction 104. The pixels are separated from each other by a uniform distance 106. The pixels 100 have a uniform length 108 along the slow scan direction 110. The length 108 of the pixel 100 is N times the width 102 of the pixel. The N is typically within the range of greater than 1 to 8.

The rectangular pixels 100 of the OLED array 20 emit a diverging light beam 112, as shown in Figure 3. The diverging emitted light beam 112 is focused by lens array 18 to form square spots 114 on the imaged line 16 on the photoreceptor 14.

The lens array 18 of this illustrative example is a divergent or concave cylindrical lens 116, a Selfoc lens array (SLA) 118 and a convergent or convex cylindrical lens 120.

The diverging emitted light beam 112 from the rectangular pixel 100 of the OLED array 20 is further diverged by the cylindrical lens 116 to form a divergent light beam 122. The divergent light beam 122 is imaged without inversion by the SLA 118. The still divergent imaged beam 124 from the SLA is focused as a convergent light beam 126 by the cylindrical lens 120 to form a square spot 114 on the image line 16 on the photoreceptor 14.

The square spot 114 will have the same width and length as the width 102 of the light emission pixel. Therefore, the length of the light emission pixels is N times the length of the spot on the photoreceptor. The N is typically within the range of greater than 1 to 8.

Thus the brightness of the light emission in the slow scan direction is increased N times and refocused along the imaged line at the photoreceptor at the required resolution. The resulting spot has N times the optical power as the prior art systems. Increasing the length of the light emission pixels in the slow scan direction and refocussing this larger energy onto the spot on the photoreceptor increases the net optical output power.

The SLA images the printbar array 20 isotropically with direction restoration, i.e. the SLA does not invert the image as a single lens does. The SLA images all the light emission pixels of the OLED array in the scan direction with the required resolution. However, the refocusing of the light emission pixels in the slow scan direction requires the slow scan plane of best focus matches the scan plane of best focus over a reasonable depth of focus. On a first order basis, the long cylindrical lenses 116 and 120 on each side of the SLA 118 achieve refocusing of the long rectangular light emission pixels in the slow scan plane at the same focal plane as the scan plane.

However, the larger the N demagnification from the rectangular light emission pixel 100 to the square spot 114, the smaller the focal lengths of the long cylindrical lenses 116 and 120. The shorter focal lengths of the lenses are a limiting factor in terms of practical radii of curvatures of the cylindrical lenses 116 and 120.

The first divergent cylindrical lens 116 tends to cause loss of light due to the effective numerical aperture of the SLA. The capability of the lens array 18 to demagnify the long light emission pixels 100 must be traded-off against the light loss from the first imaging lens 116. The long light emission pixels gain a net power emission or brightness but lose power or brightness by the effective N.A. reduction of the added optics of the imaging lenses.

For example, a rectangular light emission pixel with a length 8 times its width which emits light though a 1.5x N.A. first cylindrical lens of the imaging system will have a net power or brightness of about 4 to 6 times of the spot at the imaged line on the photoreceptor. 8X demagnification can be achieved with a 1.5x aperture throughput loss for a net gain of about 4x to 6x.

In this illustrative example, for 600 SPI on the imaged line of the photoreceptor, each light emission pixel 100 has a width 102 of 35 µm, a length 108 of 280 µm, and a pixel separation distance 106 of 7 µm. This light emission pixel will yield an imaged spot on the photoreceptor of a square having a width of 35 µm, a length of 35 µm and a spot separation distance of 7 µm.

In the scan direction, the width of the light emission pixels is the same as the width of the spots on the imaged line of the photoreceptor. The cylindrical lens 116 and 120 have no optical power in the scan direction. The SLA 118 merely images, one to one, without inversion, the diverging beam 112 from the light emission pixels of the OLED array as a converging focused beam 126 to a spot 114 on the imaged line.

Each of the cylindrical lenses 116 and 118 can be fabricated from molded plastic to snap attach to the SLA for ease of assembly and ease of optical alignment.

The long light emission pixels need not be rectangular in shape. The long light emission pixels can be elliptical whereby the lens array focuses the resulting beam to form a circular spot with increased brightness on the imaged plane of the photoreceptor.

The printbar 200 of Figure 4 includes the LED array 20, a multiplexer 202 and a plurality of data line drivers 204. The multiplexer 202 and the data line drivers 204 form the control electronics 22 of Figure 1.

The LED array 20, for example, includes a single row of pixels extending in the direction of the rotation of the photoreceptor 14 (the "slow-scan" direction), and 8400 columns of pixels extending along an axis of rotation of the photoreceptor 14 (the "scan" direction). This forms a 14 inch-wide printbar having 600 spots per inch (SPI).

The data line drivers 204 can drive the LED array 20 with as many levels of grey as the driver electronics permit. In this example, the data line drivers 204 feed the anode side of the diodes and the multiplexer 202 feeds the cathode side of the diodes. Thus, in Figure 4, the anodes are common to all columns and the cathodes are common to all rows. However, the polarities can be reversed.

The multiplexer 202 may be implemented with monolithic polysilicon with bonded connections to silicon electronics, or any known technique for integrating circuits into a substrate.

Figure 5 shows an illustration of a portion of the LED array 20 in accordance with a first preferred embodiment of the invention. This embodiment includes the multiplexer 202 and the data line drivers 204 of Figure 4, and patterned anode electrodes 210 and patterned cathode electronics 220 crossing at 90 degrees. A single row of emitters can have a single cathode although to prevent crosstalk several cathodes may also be used. In this embodiment, no transistors are required within the emitting areas of the array 20. Either the cathode electrode layer or the anode electrode layer can be formed first and patterned to form either the cathode electrodes 220 or the anode electrodes 210, respectively. The organic emitting material is then deposited over the patterned set of either the cathode electronics 220 or the anode electronics 210. Subsequently, the other of the cathode electrode layer and the anode electrode layer is deposited over the organic emitting material and patterned to form the other of the cathode electronics 220 or the anode electronics 210. An example patterning technique uses a higher resolution stencil mask for the top cathode electrodes 220 or anode electrodes 210. Only a coarse evaporation aperture is needed for the organic layers.

Figure 6 illustrates a second embodiment of this invention using a common anode or common cathode configuration. Each pixel 300 of the array 20 includes a bottom electrode 302 of the diode, which is either the anode or cathode, a drive TFT 304, a row enable line 306 and a data line 308. The drain of the drive TFT 304 is connected to the data line 308. The source of the drive TFT 304 is connected to the bottom electrode 302 of the diode. The row enable line 306 is made of, for example, gate polysilicon and is connected to the gate of the drive TFT 304 of each pixel 300 in a row of the array 20. Thus, all the gates in a row are simultaneously turned on and off. Therefore, the gate voltage on the row enable line 306 controllably turns on and off the diodes of the corresponding row of the array.

The required pixel current is less than 10 µA and is sufficiently low that it can be provided by, for example, a small polysilicon TFT. The row enable lines 306 are, for example, gate polysilicon. A gate shunt (not shown) can increase conductance, but may be unnecessary because the row enable line is not switched rapidly. The date lines 308 are, for example, metal.

A storage capacitor is generally not needed to supply constant current to the OLED because only a single supply constant is used at a time for imaging. For this reason, the data lines are excited during an entire line time. Thus, the pixel line circuitry can be manufactured efficiently with only a single drive TFT 304 per pixel with no sample and hold circuitry needed. This removes concerns about leakage current which is the most sensitive property for polysilicon TFTs. The TFTs may be made from polysilicon, amorphous silicon or cadmium selenide. In addition, single crystal silicon drive transistors and their equivalents may be used inlieu of drive TFTs.

In this embodiment, the state properties of the pixels are important only when the rows are "on". Rows are either always on or always off. In other words, a row is not repeatedly switched on and off during operation, but is continually on when it is operated.

In this second embodiment of Figure 5, the top electrode and the organic materials are not illustrated. The top electrode, which is the other of the anode and the cathode, is a continuous layer deposited over the organic layers and is thus common to all pixels on the array. The pixels are isolated from each other by the high spreading resistance of the organic materials. The pixels are thus defined by the bottom electrode.

In this embodiment, the active area of the diode 302 does not overlap the drive TFT 304, the row enable line 306 or the data lines 308. To achieve a higher fill factor, the area of the pixel diode can be expanded to overlap these areas. This is particularly effective for top emitting pixels which use, for example, a transparent indium-tin-oxide anode. Top emitting pixels additionally eliminate source degeneration in NMOS architectures since, in such a common anode design, the data lines define the low voltage side of the TFT channel.

For either embodiment of Figures 4 and 5, a dielectric layer stack may be used to achieve directed emission by creating a microcavity structure as is commonly known. Doing so will increase the throughput of the relay lens, allowing an overall increase in the printspeed of the device. This dielectric layer can be deposited either before or after the TFT/LED fabrication stages, or both. If a high temperature process (i.e., a process performed at a temperature greater than 150 degrees C) is required, it may be preferable to deposit the dielectric layer stack before the other layers. However, low temperature deposition of organic layers could be used to form the stack, increasing the design flexibility.

In these embodiments, the number of pixels may be doubled by bringing data in from the top and the bottom of the column.

One particular advantage of OLEDs is that they may be spun cast or otherwise deposited on a wide variety of media, including existing circuitry. The organic layers and the cathode, which may be a magnesium-silver alloy or other low work function material of the OLED, can be preferably formed by a continuous layer that is not patterned at the pixel level. Spreading resistance can be used instead of organic layer patterning to control pixel-to-pixel interactions. Thus, only the anode layer needs to be broken up into isolated pixels. If emission through the top electrode is required, the emission may be achieved by various means such as making a transparent cathode, or by using a transparent anode which may be indium tin oxide in a common anode device.

Since, when constructing an OLED device, the OLEDs will probably be fabricated last, the drive circuits would most likely be used in a backside emitting display. The potentially fragile and sensitive cathode contact of the drive circuits is advantageously deposited in a continuous layer and does not require patterning at the pixel layer. The drive circuit advantageously can have a continuous ITO layer with close to a 100 percent fill factor. Materials such as PPV and TPD have an electron affinity well matched to the work function of an anode layer formed by indium tin oxide (ITO). Since ITO can be fabricated to be transparent, the anode side of the OLEDs is typically the emissive side. The cathode contact is, for example, an opaque metallic conductor such as aluminum, calcium or magnesium silver alloy.

If it is desirable to operate the OLEDs with less than 100 percent duty cycle, for example to reduce blur in the process direction, the OLED may be forced to be operative only within a reduced interval of each line time. This can be done for example, by placing a time-varying voltage on the common electrode, V_c.

The drive electronics for the pixels can be implemented using large-area-processed NMOS polysilicon TFTs, although designs using amorphous silicon, cadmium selenide or single crystalline silicon, and either PMOS or CMOS may also be considered. In the case of CMOS, the load transistors are replaced with p-channel TFTs.

The anode of the OLED can be a few percent smaller than the pixel and contacts the array through a window to the cathode contact.

There are many layout variations possible for implementing the circuits described herein with respect to the topology of the devices, the layers used for their fabrication, and the methods of processing.

Due to the density of connections required to address a 300 SPI or greater resolution printbar, multiplexers of some type may be required, since the wire bonding density limit is about 200 SPI. The same process steps used to fabricate the pixel circuitry could be applied to creating the peripheral data multiplexers could distribute the entire data flow to the array minimizing the number of wire bond connections.

Multi-wavelength arrays can be important for implementing pass colour or highlight color printing. OLEDs can be fabricated in a variety of colors, depending on the organic material used and the types of dyes used. It is plausible that a trilinear array of emitters could be used to perform cyan, magenta and yellow xerocolography with adequate wavelength separation. A quadralinear array could be used to add process black, but the width of the array could be used to add process black, but the width of the array would have to be increased correspondingly.

A more attractive alternative may be to use separate arrays for each color. This may be more practical due to the quadratic rolloff in lens transfer efficiency. Another way to provide color printing with this type of array uses separate LED printbars in four separate print developing units to print three colors in addition to process black.

There are hundreds of known organic compounds, both polymeric and molecular, which are currently applicable to OLEDs. Since all devices based on these compounds have electrical characteristics suitable for excitation with TFTs, this invention applies to all such compounds, including compounds not yet investigated. The OLEDs of this invention may use emitter materials such as poly[2-methoxy-5-(2'-ethyl-hexyloxy 0-1, 4-phenylene vinylene] (MEH-PPV), or tris (8-hydroxy) quinoline aluminum (AlQ) for example. Hole injection materials such as N, N'-diphenyl-N, N'-bis(3-methylphenyl) 1-1'biphenyl-4,4'diamine (TPD) are also applicable, as are additional electron transport layers, dopants, electrolytes, buffer layers, etc.

Claims

1. A xerographic light emitter array (20) and a lens array (18) for exposing an image onto a photoreceptor (14) comprising:

   a plurality of pixels (100) arranged in a row, wherein each pixel (100) includes a light emitter,
   a plurality of lenses (116,118,120), each lens or each group of lenses associated with one of said pixels (100),

   wherein each of said pixels (100) has a length in the slow scan direction (110) of said photoreceptor (14) which is greater than the width in the scan direction (104) of said photoreceptor (14), said lens or said group of lenses (116,118,120) focusing said light emitted from said pixel (100) onto said photoreceptor (14).

2. A xerographic light emitter array and a lens array for exposing an image onto a photoreceptor according to claim 1 wherein said pixel (100) is rectangular and said lens or said group of lenses (116,118,120) focus said light emitted from said pixel (100) onto a square spot on said photoreceptor (14).

3. A xerographic light emitter array and a lens array for exposing an image onto a photoreceptor according to claim 1 wherein said pixel (100) is elliptical and said lens or said group of lenses (116,118,120) focus said light emitted from said pixel (100) onto a circular spot on said photoreceptor (14).

4. A xerographic light emitter array and a lens array for exposing an image onto a photoreceptor according to claim 1, 2 or 3 wherein said length of said pixel (100) is greater than 1 to 8 times said width of said pixel (100).

5. A xerographic light emitter array and a lens array for exposing an image onto a photoreceptor according to any preceding claim wherein each group of lenses comprises a divergent cylindrical lens (116), a Selfoc lens (118) and a convergent cylindrical lens (120).

6. A xerographic light emitter array and a lens array for exposing an image onto a photoreceptor according to any preceding claim wherein each light emitter is an organic light emitting diode.

7. A method for operating a xerographic light emitter array (20) and a lens array (18) to expose an image onto a photoreceptor (14), comprising:

   arranging a plurality of pixels (100) in a row, each pixel (100) includes a light emitter, each pixel (100) having a length in the slow scan direction (110) of said photoreceptor (14) which is greater than the width in the scan direction (104) of said photoreceptor (14)
   emitting light from a plurality of said pixels (100) through a plurality of lenses (116,118,120), each lens or each group of lenses associated with one of said pixels (100),
   focusing said light emitted from said pixel by said lens or said group of lenses (116,118,120) onto said photoreceptor (14).

8. A method for operating a xerographic light emitter array and a lens array to expose an image onto a photoreceptor according to claim 7 wherein said pixel (100) is rectangular and said lens or said group of lenses (116,118,120) focus said light emitted from said pixel (100) onto a square spot on said photoreceptor (14).

9. A method for operating a xerographic light emitter array and a lens array to expose an image onto a photoreceptor according to claim 7 wherein said pixel (100) is elliptical and said lens or said group of lenses (116,118,120) focus said light emitted from said pixel (100) onto a circular spot on said photoreceptor (14).

10. A method for operating a xerographic light emitter array and a lens array to expose an image onto a photoreceptor according to any of claims 7, 8, or 9 wherein said length of said pixel (100) is greater than 1 to 8 times said width of said pixel (100).

11. A method for operating a xerographic light emitter array and a lens array to expose an image onto a photoreceptor according to any of claims 7 to 10 wherein each group of lenses comprises a divergent cylindrical lens (116), a Selfoc lens (118) and a convergent cylindrical lens (120).

12. A method for operating a xerographic light emitter array and a lens array to expose an image onto a photoreceptor according to any of claims 7 to 11 wherein each light emitter is an organic light emitting diode.

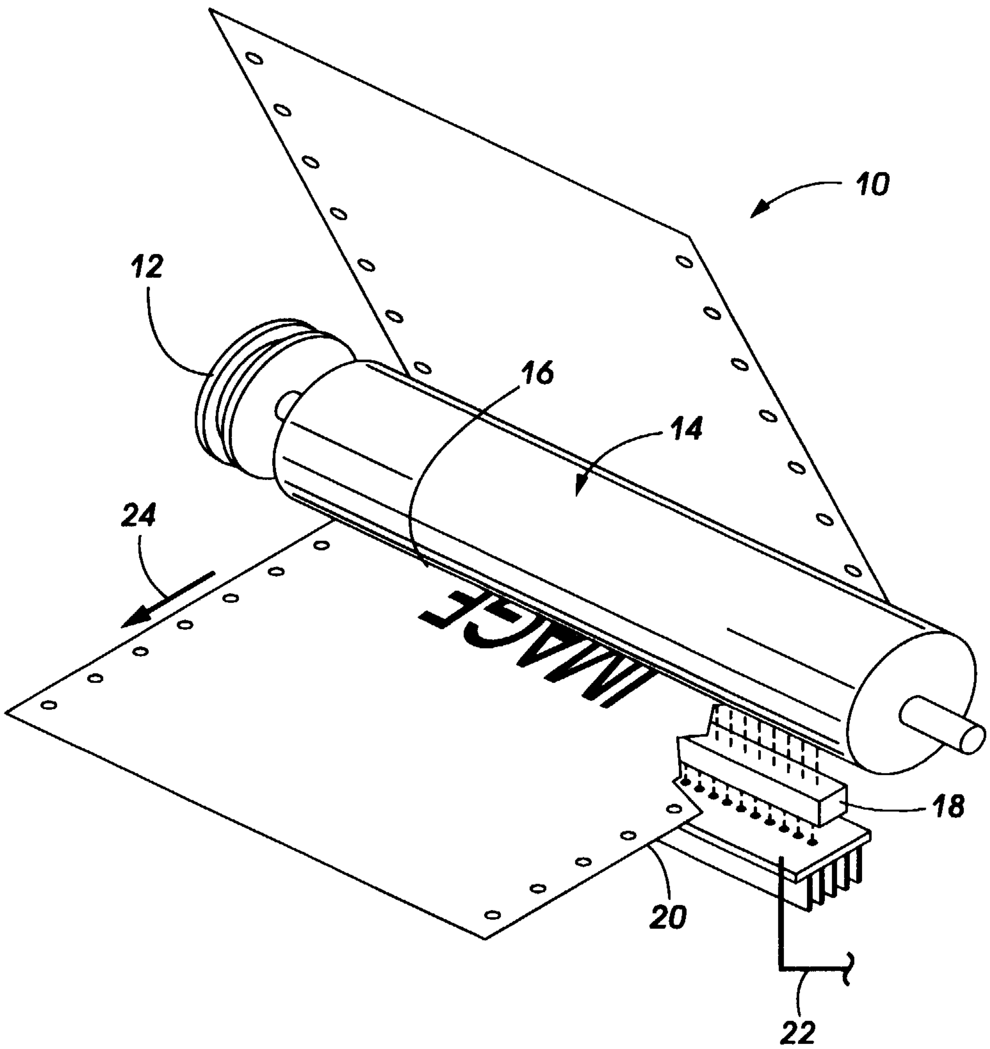

FIG. 1

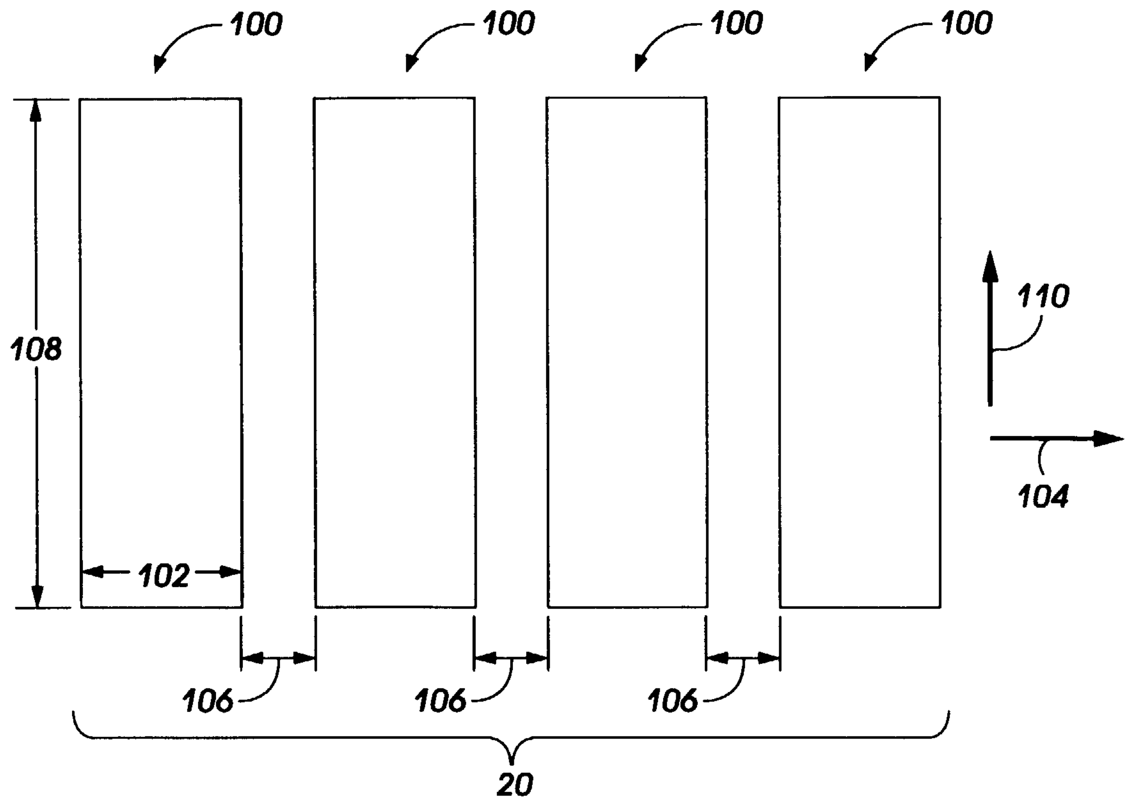
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FIG. 2

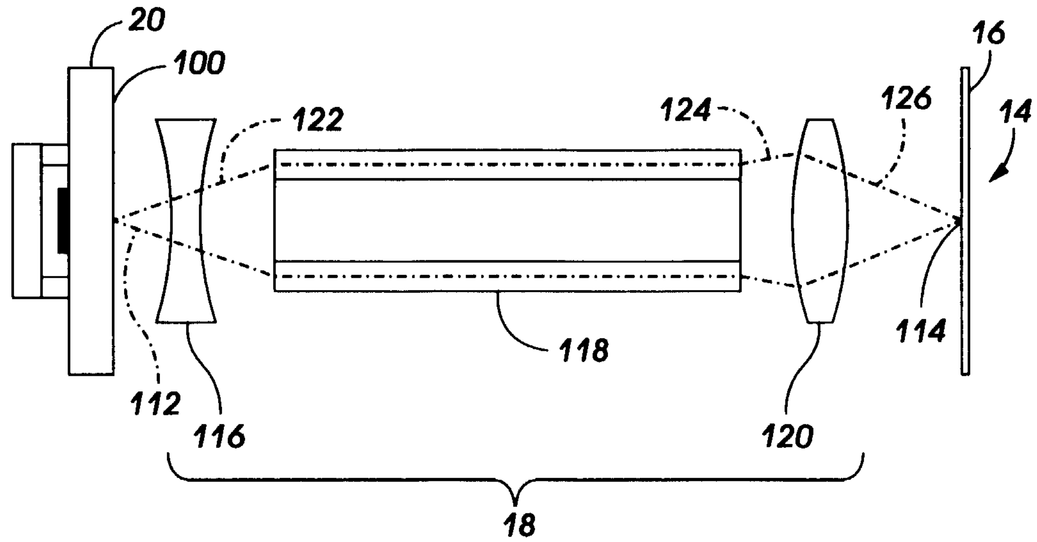
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FIG. 3

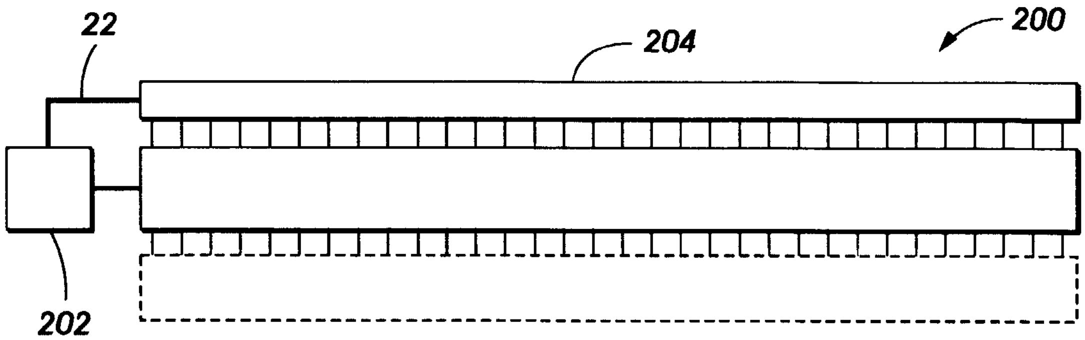

FIG. 4

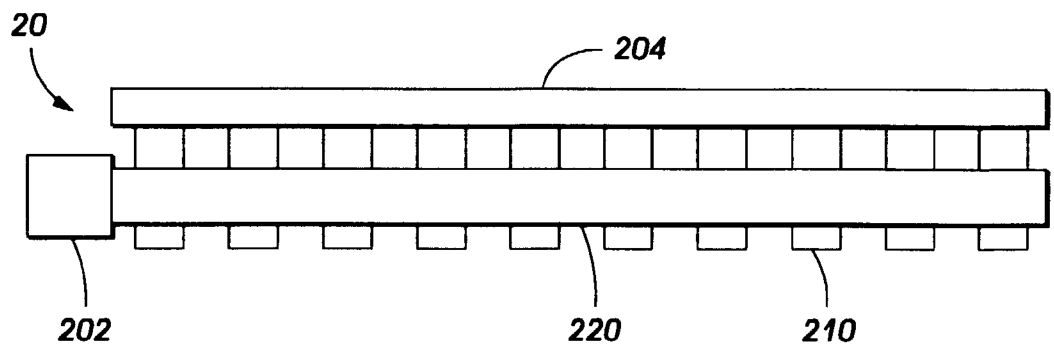

FIG. 5

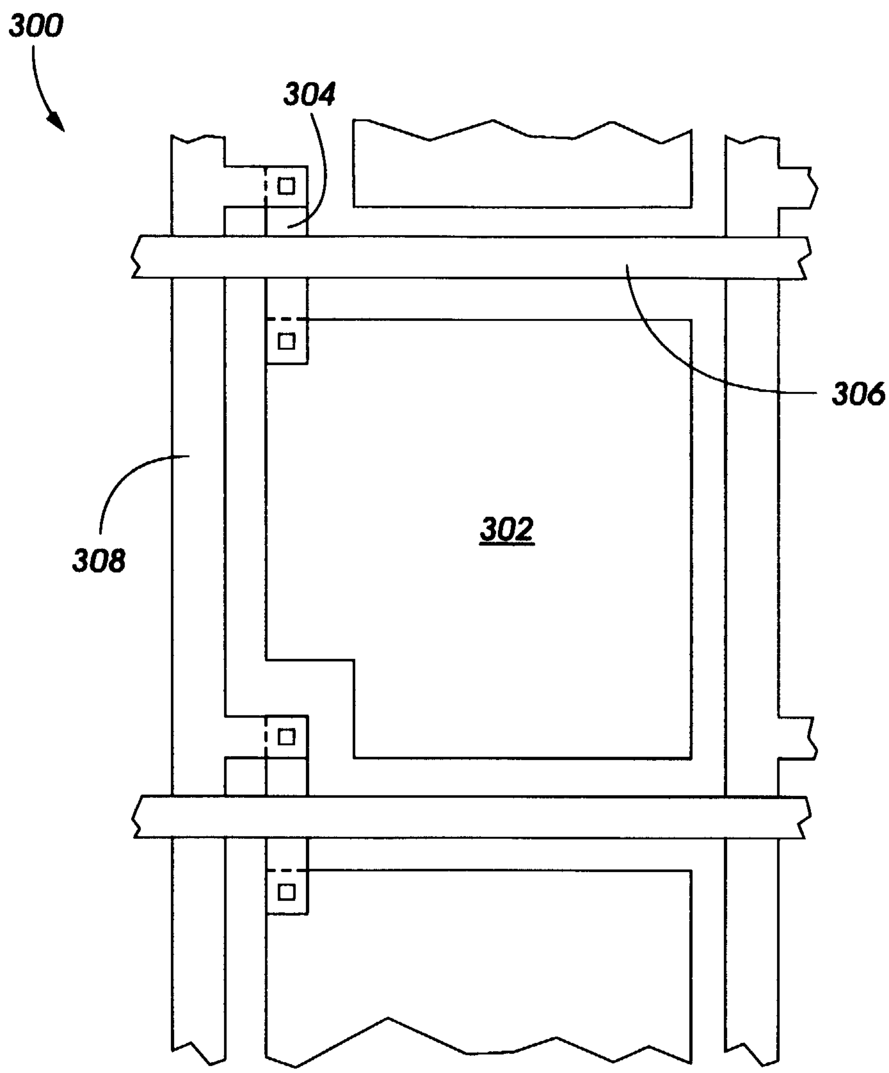

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 30 3401

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.6)
X	US 4 553 148 A (MARX RAINER ET AL) 12 November 1985	1,2,7,8	B41J2/45
Y	* column 3, line 30 - column 4, line 6; figures 1-3 *	6,12	
A		3-5	
Y	US 5 482 896 A (TANG CHING W) 9 January 1996 * column 3, line 8 - line 17; figure 7 *	6,12	
A	EP 0 398 422 A (OCE NEDERLAND BV) 22 November 1990 * column 2, line 19 - column 8, line 57; figure 5 *	1,4,7,10	
A	EP 0 694 408 A (EASTMAN KODAK CO) 31 January 1996 * column 3, line 16 - column 6, line 15; figures *	1,5,7,11	
A	US 5 615 198 A (KUBOKAWA HIDEJI) 25 March 1997 * column 3, line 64 - column 6, line 57; figures 2,3 *	1,5,7,11	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B41J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 July 1998	De Groot, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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