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

(11) EP 0 782 928 A1

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.07.1997 Bulletin 1997/28

(51) Int Cl.[6]: **B41J 2/455**

(21) Application number: **96308992.5**

(22) Date of filing: **11.12.1996**

(84) Designated Contracting States:
DE FR GB

(30) Priority: **22.12.1995 US 577793**

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(54) **Color xerographic printer with multiple linear arrays of surface emitting lasers with the same wavelengths**

(57) Described herein is a color printer (100) which uses multiple linear arrays (102) of surface emitting lasers of the same wavelength to simultaneously expose widely separated positions on a plurality of photoreceptors (140, 142, 144, 146). Modulated light beams (120, 124, 128, 132) from each array (102) is imaged by a first telecentric spherical lens group (134), an aperture (136) and a second telecentric spherical lens group (138) onto the photoreceptors (140, 142, 144, 146). The modulated light beams (120, 124, 128, 132) are angularly spaced from the aperture (136). The multiple linear arrays (102) can be closely spaced in a monolithic structure.

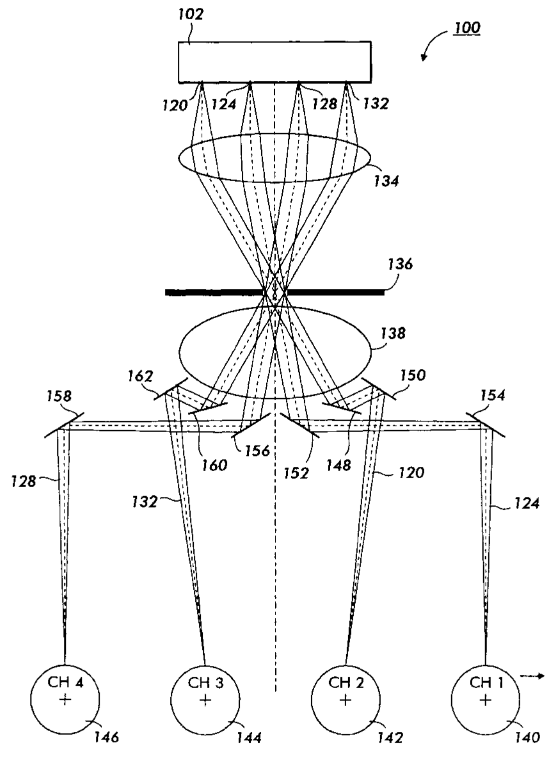

FIG. 4

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Description

This invention relates to a color xerographic printer, and, more particularly, to a color xerographic printer with a monolithic structure of multiple linear arrays of surface emitting lasers with the same wavelengths to simultaneously expose widely separated positions on the same or different photoreceptors.

A Raster Output Scanner (ROS) or a Light Emitting Diode (LED) print bar, known as imagers, used in xerographic printers are well known in the art. The ROS or the LED print bar is positioned in an optical scan system to write an image on the surface of a moving photoreceptor belt.

In a ROS system, a modulated beam is directed onto the facets of a rotating polygon mirror which then sweeps the reflected beam across the photoreceptor surface. Each sweep exposes a raster line to a linear segment of a video signal image.

However, the use of a rotating polygon mirror presents several inherent problems. Bow and wobble of the beam scanning across the photoreceptor surface result from imperfections in the mirror or even slight misangling of the mirror or from the instability of the rotation of the polygon mirror. These problems typically require complex, precise and expensive optical elements between the light source and the rotating polygon mirror and between the rotating polygon mirror and the photoreceptor surface. Additionally, optically complex elements are also needed to compensate for refractive index dispersion that causes changes in the focal length of the imaging optics of the ROS.

The LED print bar generally consists of a linear array of light emitting diodes. Each LED in the linear array is used to expose a corresponding area on a moving photoreceptor in response to the video data information applied to the drive circuits of the print bars. The photoreceptor is advanced in the process direction to provide a desired image by the formation of sequential scan lines.

In xerographic printer, a plurality of the light emitting elements of the LED print bars are imaged to a photoreceptor surface usually by closely spaced radially indexed glass fibers known as "selfoc" lenses.

Printing with LED bars requires a precisely fabricated "selfoc" lens for each light emitting element. Each full length "selfoc" lens bar must be straight and parallel with highly polished input and output facets. Each lens bar must have the same focal length and throughput efficiency. Even if these requirements are met, the "selfoc" lenses have short focal lengths and therefore must be positioned close to the photoreceptor surface where the lenses can collect toner and thereby require an additional cleaning mechanism. Due to their optical characteristics, the depth of focus of a "selfoc" lens is very short and consequently requires very precise placement to produce uniform spot exposures on the scan line.

Light emitting diodes, by their very nature, have a large spatial divergence, a broad spectrum and are unpolarized, all factors which severely limit the possible imaging of multiple LED arrays at multiple positions on a single photoreceptor or at multiple photoreceptors as needed in color xerographic printers. Prior LED print bar xerographic line printers have taught only line exposure at a single position on one photoreceptor.

US-A-5 337 074 and US-A-5 461 413 disclose using a single linear surface emitting laser array as the light source for a line printer.

A laser array has a smaller spatial divergence than a LED array and a smaller radiating aperture. Both of these factors increase the spot density. The narrow spectrum of laser beams enables optical separation of the laser beams in accordance with the present invention. The broad spectrum precludes similar separations of LED emissions.

It is an object of this invention to provide a single monolithic light source for a color xerographic printer with simple and inexpensive optics.

It is yet another object of this invention to provide a multiple laser array light source with the same wavelength for a color xerographic printer.

In accordance with one aspect of the present invention, there is provided a xerographic printer comprising:- at least one photoreceptor, at least one linear laser array for emitting modulated light beams having the same wavelength, a first telecentric lens means for refracting the modulated light beams, an aperture at which the telecentric lens means refracts the modulated light beams, and a second telecentric lens means for focusing the modulated light beams passing through the aperture onto the photoreceptor(s) to simultaneously expose a full scan line thereon.

In one embodiment of the present invention, the printer is a highlight color xerographic printer comprising first and second linear laser arrays for emitting first and second modulated light beams, each modulated light beam being angularly spaced from the other by the aperture, the second telecentric lens means focusing the first and second modulated light beams onto respective first and second regions of the photoreceptor to simultaneously expose a full scan line thereon.

In another embodiment of the present invention, the printer is a highlight color xerographic printer comprising first and second photoreceptors and first and second linear laser arrays for emitting first and second modulated light beams, each modulated light beam being angularly spaced from the other by the aperture, the second telecentric lens means focusing the first and second modulated light beams onto a respective one of the first and second photoreceptors to simultaneously expose a full scan line thereon.

In a further embodiment of the present invention, the printer is a full color xerographic printer comprising first, second, third and fourth linear laser arrays for emitting first, second, third and fourth modulated light beams, the second telecentric lens means focusing each of the first, second, third and fourth modulated light beams onto a respective one of first, second, third and fourth regions of the photoreceptor to simultaneously expose a full scan line thereon.

In yet a further embodiment of the present invention, the printer is a full color xerographic printer comprising first, second, third and fourth photoreceptors and first, second, third and fourth linear laser arrays for emitting first, second, third and fourth modulated light beams, the second telecentric lens means focusing each of the first, second, third and fourth modulated light beams onto a respective one of first, second, third and fourth photoreceptors to simultaneously expose a full scan line thereon.

Moreover, the invention also provides a color xerographic printer comprising at least two photoreceptors, at least two linear laser arrays for emitting at least two arrays of modulated light beams of the same wavelength, first telecentric lens means for refracting said at least two arrays of modulated light beams, an aperture, said telecentric lens means refracting said at least two arrays of modulated light beams at said aperture, each of said arrays of modulated light beams being angularly spaced from the other arrays of said modulated light beams at the aperture, and second telecentric lens means for focusing said at least two arrays of modulated light beams through said aperture onto said at least two photoreceptors to simultaneously expose a full scan line.

The invention further provides a color xerographic printer comprising a photoreceptor, at least two linear laser arrays for emitting at least two arrays of modulated light beams of the same wavelength, first telecentric lens means for refracting said at least two arrays of modulated light beams, an aperture, said telecentric lens means refracting said at least two arrays of modulated light beams at said aperture, each of said arrays of modulated light beams being angularly spaced from the other arrays of said modulated light beams at the aperture, and second telecentric lens means for focusing said at least two arrays of modulated light beams through said aperture onto different regions of said photoreceptors to simultaneously expose a full scan line.

In accordance with the present invention, a color printer uses multiple linear arrays of Vertical Cavity Surface Emitting Lasers (VCSELs) of the same wavelength to simultaneously expose widely separated positions on the same or different photoreceptors. A highlight color printer would use two or more linear laser arrays while a full color printer would use four or more linear laser arrays.

Each array is imaged by the same telecentric spherical lens and aperture to the photoreceptor. The linear beams are concentrically spaced around the axis of the imaging optics. The multiple linear arrays can be closely spaced in a monolithic structure or assembled in a precise unit. Light emitting elements in each array can be spaced or staggered for line imaging at the printed pixel density.

Other objects and attainments together with a fuller understanding of the invention will become apparent and appreciated by referring to the following description, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic illustration of the cross-section side view of a full color xerographic printer with monolithic multiple linear arrays of vertical cavity surface emitting lasers (VCSELs) and four photoreceptors formed according to the present invention;

Figure 2 is a schematic illustration of the front view of the monolithic multiple linear arrays of vertical cavity surface emitting lasers (VCSELs) of Figure 1 formed according to the present invention;

Figure 3 is a schematic illustration of the cross-section top view of the aperture of the linear light beams of the color xerographic printer with monolithic multiple linear arrays of vertical cavity surface emitting lasers (VCSELs) of Figure 1 formed according to the present invention;

Figure 4 is a schematic illustration of the cross-section side view of a full color xerographic printer of Figure 1 with fold mirrors formed according to the present invention;

Figures 5A to 5D are schematic illustrations of the cross-section top view of the apertures for the color xerographic printer with monolithic multiple linear arrays of vertical cavity surface emitting lasers (VCSELs) of Figure 1 formed according to the present invention; and

Figure 6 is a schematic illustration of the front view of the nonmonolithic structure combination of two monolithic multiple linear arrays of vertical cavity surface emitting lasers (VCSELs) formed according to the present invention.

Reference is now made to a full color printer 100 shown in Figure 1 which utilizes a monolithic structure 102 of four linear arrays of vertical cavity surface emitting lasers (VCSELs) to simultaneously expose four photoreceptors to enable one pass full color printing.

The monolithic array structure 102 of the printer 100 is selectively addressed by video image signals processed through Electronic Sub System (ESS) 104 and modulated by drive circuit 106 to produce a modulated beam from each individual VCSEL in the array.

The laser array structure 102, shown in detail in Figure 2, consists of a combination of four linear VCSEL arrays 108, 110, 112 and 114 arranged in parallel (or series) in the scan direction within the monolithic array 102, each array 108,110,112,114 emitting light at the same wavelength. The equally spaced individual VCSELs within each of the four linear arrays are arranged linearly in the scan plane direction with equal center to center spacing 116 between the individual VCSELs. The sagittal distance between the VCSEL arrays and the length of the arrays are such that they provide sufficient field angle for untruncated scanning beam separation for the optical system for the color printer 100.

The length of the individual linear VCSEL arrays 108, 110, 112 and 114 will equal the scan length along the photoreceptor divided by the optical system magnification and the length is independent of resolution.

Referring to both Figures 1 and 2, the VCSELs 118 in the first linear array 108 emit light 120, the VCSELs 122 in the second linear array 110 emit light 124, the VCSELs 126 in the third linear array 112 emit light 128, and the VCSELs 130 in the fourth linear array 114 emit light 132. The VCSELs have a half power beam divergence of about 8 to 10 degrees.

The monolithic VCSEL array structure 102 with its four linear arrays 108, 110, 112 and 114 can be made in many different ways. A high density array of vertical cavity surface emitting lasers can emit from the epitaxial side of the array, as described in US-A-5 062 115. A high density array of vertical cavity surface emitting lasers can emit from the substrate side of the array, as described in US-A-5 216 263. In both cases, all elements of the array emit at substantially the same wavelength and have no provision for control of the polarization state.

The VCSEL array structure 102 with its four linear arrays 108, 110, 112 and 114 may be either a monolithic diode laser array or two non-monolithic laser subarrays closely spaced into a single integrated array, as will be described fully later. With either type of source, the laser array structure 102 provides a substantially common spatial origin for all four laser beams.

Returning to the full color printer 100 of Figure 1, the monolithic array structure 102 is arranged symmetrically about the optical axis in both meridians with VCSEL arrays 108 and 110 equally spaced from the optical axis on one side in the process direction and VCSEL arrays 112 and 114 equally spaced from the optical axis on the opposite side also in the process direction. In the scan direction the mid-length of the monolithic structure 102 is spaced on the optical axis of the imaging lens.

The monolithic array structure 102 emits a linear array of modulated beams 120, 124, 128 and 132, at the same wavelength. Only the extreme rays of the beams are shown.

The linear beams 120, 124, 128 and 132 are diverging from the array 102 and are refracted by a multiple element spherical telecentric lens 134 through the circular aperture 136.

The spherical lens is telecentric in both tangential and sagittal meridians. The telecentric nature of the lenses 134 in both axes provides a flat field for good depth of focus and, at the same time, permits the passage all of the beams from the four linear arrays 120, 124, 128 and 132 without truncation, thus providing high power throughput of all the beams.

Although the main reason for the telecentricity is uniform power collection from all laser arrays, it also provides other essential requirements. A telecentric projection lens can image widely spaced VCSEL arrays with sufficient angular separation that permits the spatial separation of the emerging beams from each array, in order to direct them to their assigned xerographic stations.

The VCSEL arrays in the monolithic array structure 102 are at the object plane of the spherical telecentric lens 134.

The telecentric lens 134 collects the light cones from the four linear beams 120, 124, 128 and 132 and "bends" them toward (and through) the circular aperture 136.

The aperture 136 shown in Figure 1 also functions as a stop to control the spot size. The aperture 136 shown in Figure 3 is circular to provide round spots on the photoreceptor.

The four converging linear beams 120, 124, 128 and 132 pass through the aperture 136 and are focused by the spherical lens group 138 upon photoreceptors 140, 142, 144, 146. The spherical lens group 138 is a spherical triplet, which, in combination with lens group 134, focuses the beams 120, 124, 128, 132 with uniform size, energy and linearity in the proper position on the photoreceptors 140,142,144,146.

The spherical lens 138 will focus the first modulated linear beams 120 upon a first photoreceptor 140. The spherical lens 138 will focus the second modulated linear beams 124 upon a second photoreceptor 142. The spherical lens 138 will focus the third modulated linear beams 128 upon a third photoreceptor 144. The spherical lens 138 will focus the fourth modulated linear beams 132 upon a fourth photoreceptor 146.

The four beams 120, 124, 128 and 132 from the four arrays 108, 110, 112, 114 are imaged on the photoreceptors 140, 142, 144, 146 in good focus, without bow, with uniform energy and high linearity because the position of the VCSELs in the individual arrays are well controlled in the image plane and the characteristics of the telecentric spherical lens groups 134 and 138 are capable of high quality imaging.

The combination of spherical lenses 134 and 138 also provides good linearity to each of the four linear beams 120, 124, 128 and 132 along the corresponding four photoreceptors 140, 142, 144 and 146.

Since each laser beam is independently modulated with image information, a distinct latent image is simultaneously printed on each photoreceptor. All the VCSELs in the linear array will be addressed at the same time so that the linear array will simultaneously expose the entire line on the photoreceptor.

The photoreceptors 140, 142, 144 and 146 are charged by charging stations (not shown) prior to exposure by beams 120, 124, 128 and 132 respectively. After exposure, a development station (also not shown) develops the latent image formed in the associated image area on the photoreceptors 140, 142, 144, 146. A fully developed image is then transferred to an output sheet (not shown) at a transfer station (not shown) from each photoreceptor 140, 142, 144, 146. The charge, development and transfer stations are conventional in the art. Further details of xerographic stations in a multiple exposure single pass system are disclosed in US-A-4 661 901; US-A-4 791 452; and US-A4 833 503.

The full color printer 100 of Figure 1 utilizes a monolithic structure 102 of four linear arrays of vertical cavity surface emitting lasers (VCSELs) of the same wavelength to simultaneous expose four photoreceptors to enable one pass full color printing. Only monochrome lasers are needed with no specific polarization orientation to the beams required. No special thin film coatings are needed for the separation of beams.

In an illustrative embodiment, the four linear VCSEL arrays 108, 110, 112 and 114 are equally spaced 10mm apart in the monolithic array structure 102 with the total distance across the four arrays being approximately 30mm. This 30mm width gives sufficient angular divergence of the four scanning beams for clear, truncation free separation. The preferred length of each array is approximately 35mm. The object area of the complete VCSEL array will be approximately 30mm x 35mm. This geometry would require approximately 8.5X system magnification for a 297mm (11.7in) long scan line.

The wavelength of the four linear beams 120, 124, 128 and 132 produced by the VCSELs is 780nm.

The combined system magnification of lens 134 and lens 138 will be approximately 8.5 X to produce the required 297mm (11.7in) long scan.

The total optical path length from the common monolithic array structure source 102 to the individual photoreceptors 140, 142, 144 and 146 will be approximately 633mm. The distance from the last surface of lens 138 to the photoreceptors 140, 142, 144, 146 will be approximately 460mm.

The complete imaging lens (134 and 138) can be designed to produce acceptable pixel placement and differential bow, or can be corrected by the insertion of parallel plate glass windows as described in U.S. Patent Application No. 08/354,080, "Method and Apparatus for Elimination of Bow in a Raster Scanning System".

Since all four linear beams 120, 124, 128 and 132 are from a well controlled location, similarly dimensioned beams are input to the aperture 136. Thus the problem of maintaining equal optical path lengths for each beam reduces to the problem of maintaining substantially equal optical path lengths from the aperture 136 to the individual photoreceptors 140, 142, 144 and 146.

The size of the color printer 100 can be reduced by the use of folding mirrors in the optical path length after the spherical lens 138 as shown in Figure 4. First modulated linear beam 120 will be reflected by mirrors 148 and 150 to the second photoreceptor 142. Second modulated linear beam 124 will be reflected by mirrors 152 and 154 to the first photoreceptor 140. Third modulated beam 128 will be reflected by mirrors 156 and 158 to the fourth photoreceptor 146. Fourth modulated beam 132 will be reflected by mirrors 160 and 162 to the third photoreceptor 144.

Only a total of eight plane mirrors with standard coatings are required for light path folding.

The 630mm total optical path length is sufficient to accommodate the folding for up to 254mm (10 inch) photoreceptor separation in the process direction.

The object distance for the four photoreceptors do not have to be the same since the folding can accommodate the differences, but the projected scan length from start-of-scan (SOS) to end-of-scan (EOS) must be the same.

Similarly, the folding mirrors can be aligned so that the four linear beams expose four different positions on a single photoreceptor (not shown).

All of the VCSELs in the linear array will be addressed simultaneously so that the linear array will simultaneously expose all the pixels in a line on the photoreceptor. The term of art used to describe the entire line of pixels on the photoreceptor is the "scan line", although, technically, in this application the beam is not being scanned along a line. However, this application will conform to conventional nomenclature and describe the simultaneously exposed pixel line on the photoreceptor as a "scan line".

A ROS will scan a beam along the scan line of the photoreceptor sequentially exposing each pixel, one at a time. The present application with a linear laser array simultaneously exposes all the pixels along the scan line at the same time. The present application does not have the rotating mirror scanning element like the ROS and the linear laser array prints a line at a time while the ROS prints a pixel at a time.

The optical system of the color printer 100 shown in Figure 1 works equally well with only two linear VCSEL arrays, rather than four, and only two corresponding photoreceptors, rather than four, to provide a highlight color printer which prints black and white and a highlight color. Ideally, the VCSEL arrays would be arranged symmetrically about the optical axis such as linear VCSEL arrays 110 and 112 or linear VCSEL arrays 108 and 114.

However, because the lens 134 is spherical and telecentric and the lens 138 is spherical, any two of the linear VCSEL arrays 108, 110, 112 and 114 could be used despite being asymmetric about the optical axis or even on the same side of the optical axis. However, the extreme off-axis position of the VCSELs does influence the complexity of the imaging lens.

Also, the highlight color printer can be adapted with the proper folding of the beams by mirrors to expose two separated positions on a single photoreceptor.

Similarly, the optical system of the color printer 100 shown in Figure 1 works equally well with only one linear VCSEL arrays, rather than four, and only one corresponding photoreceptors, rather than four, to provide a black and white printer. The single linear array can be at any of the four spatial positions of the four linear VCSEL arrays. Alternately, the single linear array could be along the optical axis of the xerographic printer. Telecentric lenses will still be need for flat field, linearity, uniform spot size and uniform power and focusing is still needed in both meridians but cross-cylinder lenses could be used.

The aperture 136 (Figure 3) also functions as a stop to control the spot size by controlling the effective F/number of the imaging system. The aperture 136 in Figure 3 is circular to provide round spots in the scan line on the photoreceptor.

Spots that are narrower (or wider) in either in the sagittal or in the process direction can be generated by the usage of an aperture that is larger in the meridian where the smaller spot is required. This arrangement permits "high addressability" (higher scan line density with smaller spots) and/or overlapping larger spots of the same scan line density for "hyperacuity" printing in the process direction.

As shown in Figures 5A to 5D, the aperture 134 can be rectangular (Figures 5A and 5C) or ellipsoidal (Figures 5B and 5D).

The long axis of the rectangle or ellipse can be along the cross-scan or process or sagittal direction in Figures 5A and 5B to provide spots smaller in that cross-scan or process or sagittal direction on the photoreceptor for hyperacuity or other type of highly addressed printing. The narrow dimension of the aperture has sufficient value to produce the required overlapping spot size in the fast scan (tangential) direction.

Larger than conventional overlapping spots of the same density can also be generated in the fast scan direction by narrowing the width of the aperture in that direction.

A laser array structure 200 shown in Figure 6 is a non-monolithic combination of two monolithic structures 202 and 204 of VCSEL arrays. Each monolithic array structure 202, 204 contains two linear arrays of VCSELs emitting at the same wavelength. Monolithic array structure 202 has linear VCSEL arrays 206, 208 and monolithic array structure 204 has linear VCSEL arrays 210, 212.

Thus, the laser array structure 200 shown in Figure 6 emits the same wavelengths, similar to the monolithic array structure 102 shown in Figure 2. The advantage of this non-monolithic combination is that monolithic array structures 202 and 204 are easier to fabricate.

The sagittal separation between adjacent arrays on different monolithic array structures can be much larger than the tangential spacing between the VCSEL elements, since each array is imaged at a different exposure position. The sagittal spacing between monolithic subarray structures is minimized by locating the linear arrays near the edge of each monolithic subarray structure. However it is important to have the array elements on different monolithic subarray structures aligned parallel along the fast scan, and their SOS and EOS pixels to be aligned in the process or sagittal direction in order to avoid scan line misalignment on the four photoreceptors.

Gain guided VCSELs are well suited for the color printing applications of the embodiments because they exhibit essentially no astigmatism, although desired controlled astigmatism can be introduced by non-circular apertures. In addition, variation of the imaging lens' focal length due to the wavelength dependence of its refractive index can be compensated by (1) adding a glass plate to one array or by (2) monolithically adding an appropriate diffractive lens to individual elements of one array, as described in US-A-5 073 041.

A monolithic structure of two or four VCSEL arrays of the present invention is cheaper to manufacture than the two or four separate LED print bars of the prior art. The VCSEL arrays are accurately aligned within the monolithic structure as opposed to the prior art four separate LED print bars which must be accurately aligned with each other.

A monolithic structure of two or four VCSEL arrays considerably reduces the size and total spatial volume of a color xerographic printer. And monolithic source arrays are cost-effective since assemblies of multiple chips is reduced or in some cases eliminated.

While the invention has been described in conjunction with specific embodiments, it is evident to those skilled in the art that many alternatives, modifications and variations will be apparent in light of the foregoing description.

Claims

1. A xerographic printer (100) comprising:-

   at least one photoreceptor (140, 142, 144, 146),

   at least one linear laser array (102, 108, 110, 112, 114; 200, 202, 204, 206, 208, 210, 212) for emitting modulated light beams (120, 124, 128, 132) having the same wavelength,

   a first telecentric lens means (134) for refracting the modulated light beams (120, 124, 128, 132),

   an aperture (136) at which the telecentric lens means (134) refracts the modulated light beams (120, 124, 128, 132), and

   a second telecentric lens means (138) for focusing the modulated light beams (120, 124, 128, 132) passing through the aperture (136) onto the photoreceptor(s) (140, 142, 144, 146) to simultaneously expose a full scan line thereon.

2. A printer according to claim 1 wherein the first telecentric lens means (134) is a cross-cylindrical triplet and the second telecentric lens means (138) is a

cross-cylindrical triplet.

3. A printer according to claim 1 wherein the first telecentric lens means (134) is a spherical triplet and the second telecentric lens means (138) is a spherical triplet.

4. A printer according to claim 3 wherein the printer is a highlight color xerographic printer comprising first and second linear laser arrays (110, 112; 108, 114) for emitting first and second modulated light beams (124, 128; 120, 132), each modulated light beam (124, 128; 120, 132) being angularly spaced from the other by the aperture (136), the second telecentric lens means (138) focusing the first and second modulated light beams (124, 128; 120, 132) onto respective first and second regions of the photoreceptor (140, 142, 144 ,146) to simultaneously expose a full scan line thereon.

5. A printer according to claim 3, wherein the printer is a highlight color xerographic printer comprising first and second photoreceptors (140, 142, 144, 146) and first and second linear laser arrays (110, 112; 108, 114) for emitting first and second modulated light beams (124, 128; 120, 132), each modulated light beam (124, 128; 120, 132) being angularly spaced from the other by the aperture (136), the second telecentric lens means (138) focusing the first and second modulated light beams (124, 128; 120, 132) onto a respective one of the first and second photoreceptors (140, 142, 144, 146) to simultaneously expose a full scan line thereon.

6. A printer according to claim 3, wherein the printer is a full color xerographic printer comprising first, second, third and fourth linear laser arrays (108, 110, 112, 114; 206, 208, 210, 212) for emitting first, second, third and fourth modulated light beams (120, 124, 128, 132), the second telecentric lens means (138) focusing each of the first, second, third and fourth modulated light beams (120, 124, 128, 132) onto a respective one of first, second, third and fourth regions of the photoreceptor to simultaneously expose a full scan line thereon.

7. A printer according to claim 3, wherein the printer is a full color xerographic printer comprising first, second, third and fourth photoreceptors (140, 142, 144, 146) and first, second, third and fourth linear laser arrays (108, 110, 112, 114; 206, 208, 210, 212) for emitting first, second, third and fourth modulated light beams (120, 124, 128, 132), the second telecentric lens means (138) focusing each of the first, second, third and fourth modulated light beams (120, 124, 128, 132) onto a respective one of first, second, third and fourth photoreceptors (140, 142, 144, 146) to simultaneously expose a full scan line thereon.

8. A printer according to any one of claims 4 to 7 wherein the linear laser arrays (108, 110, 112, 114) are equally spaced and symmetric about the optical axis of the printer.

9. A printer according to any one of claims 4 to 7 wherein the linear laser arrays (108, 110, 112, 114) are nonsymmetric about the optical axis of the printer.

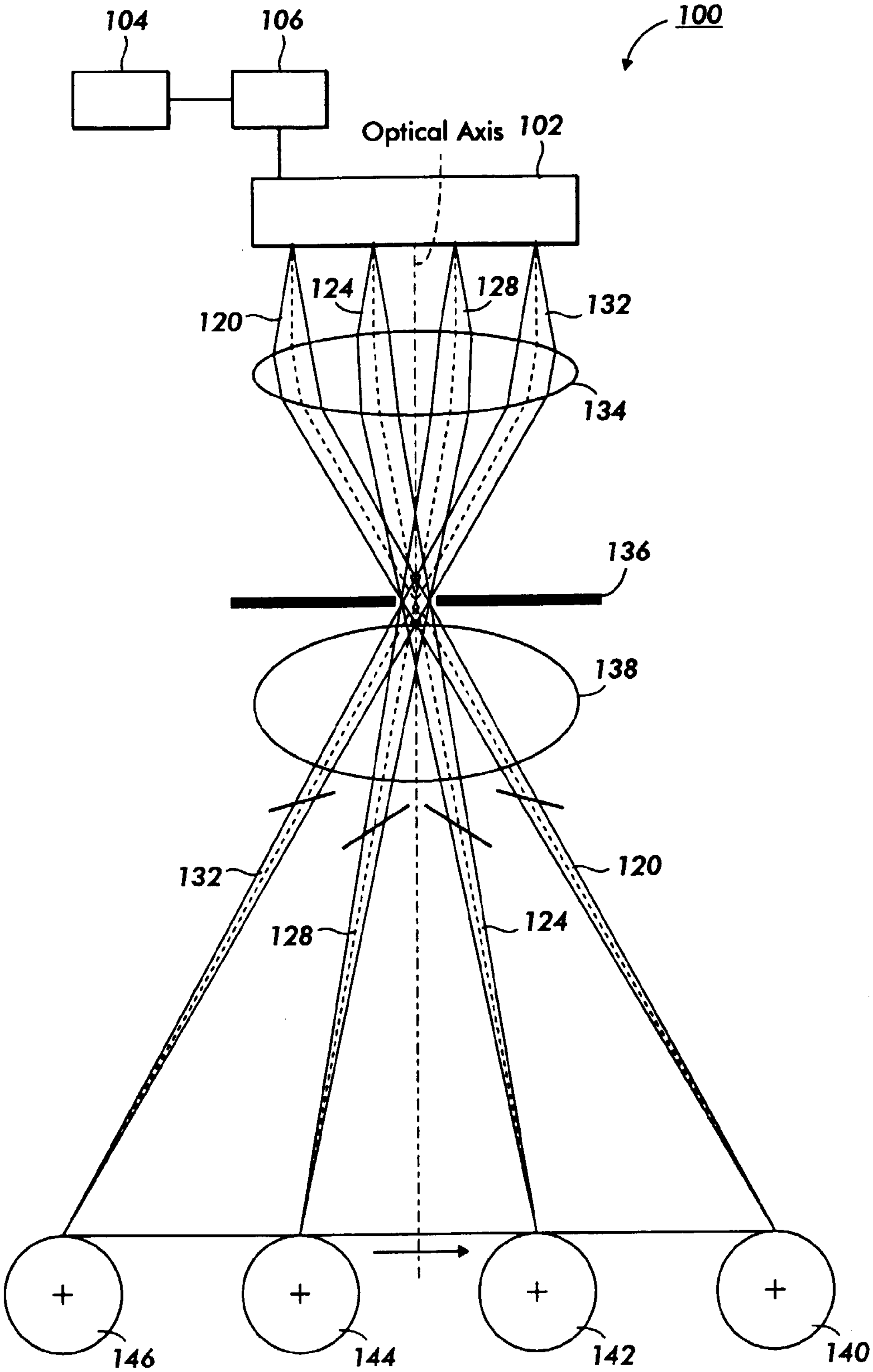

100
104
106
Optical Axis
102
124
128
120
132
134
136
138
132
120
128
124
146
144
142
140

FIG. 1

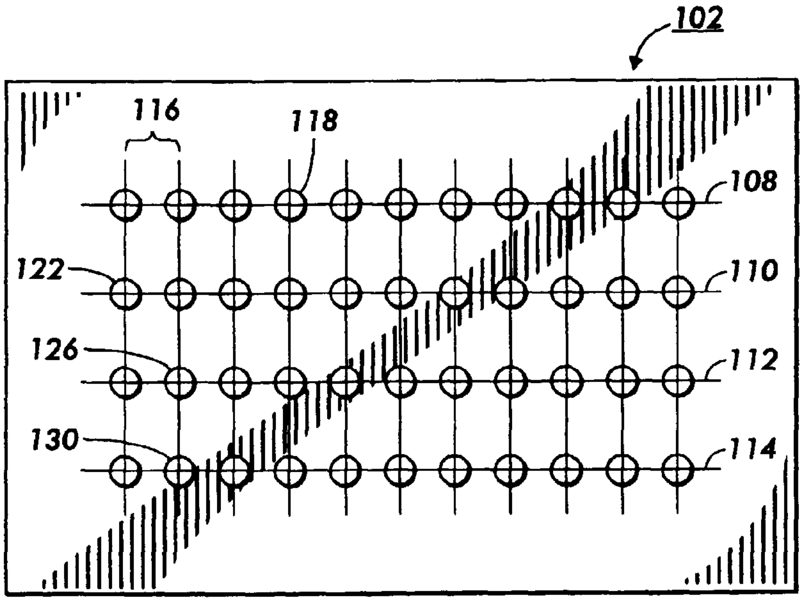

102
116
118
108
122
110
126
112
130
114

FIG. 2

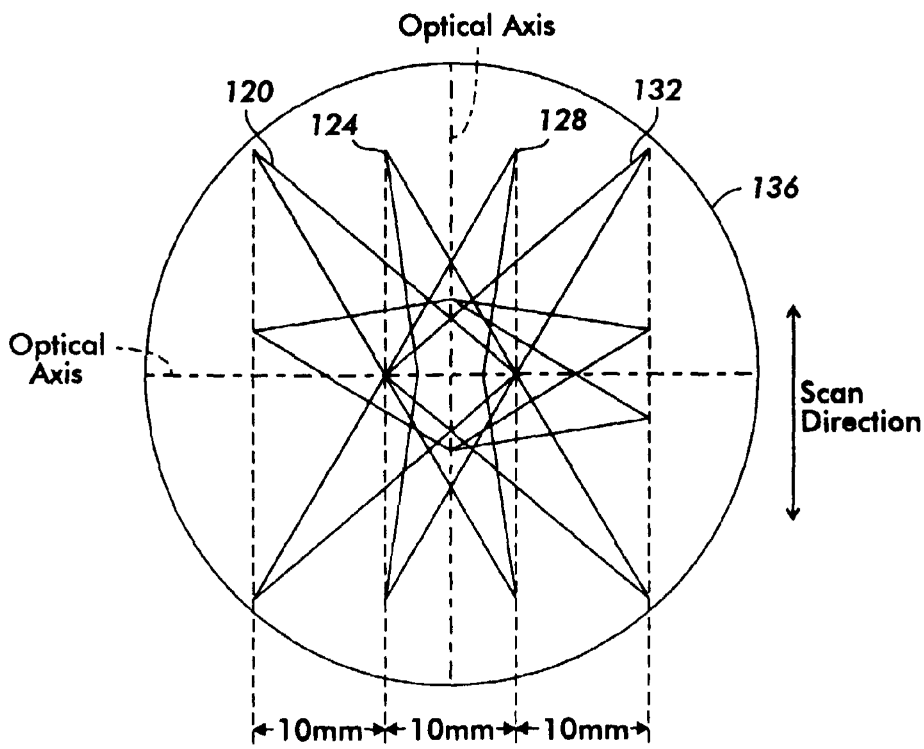
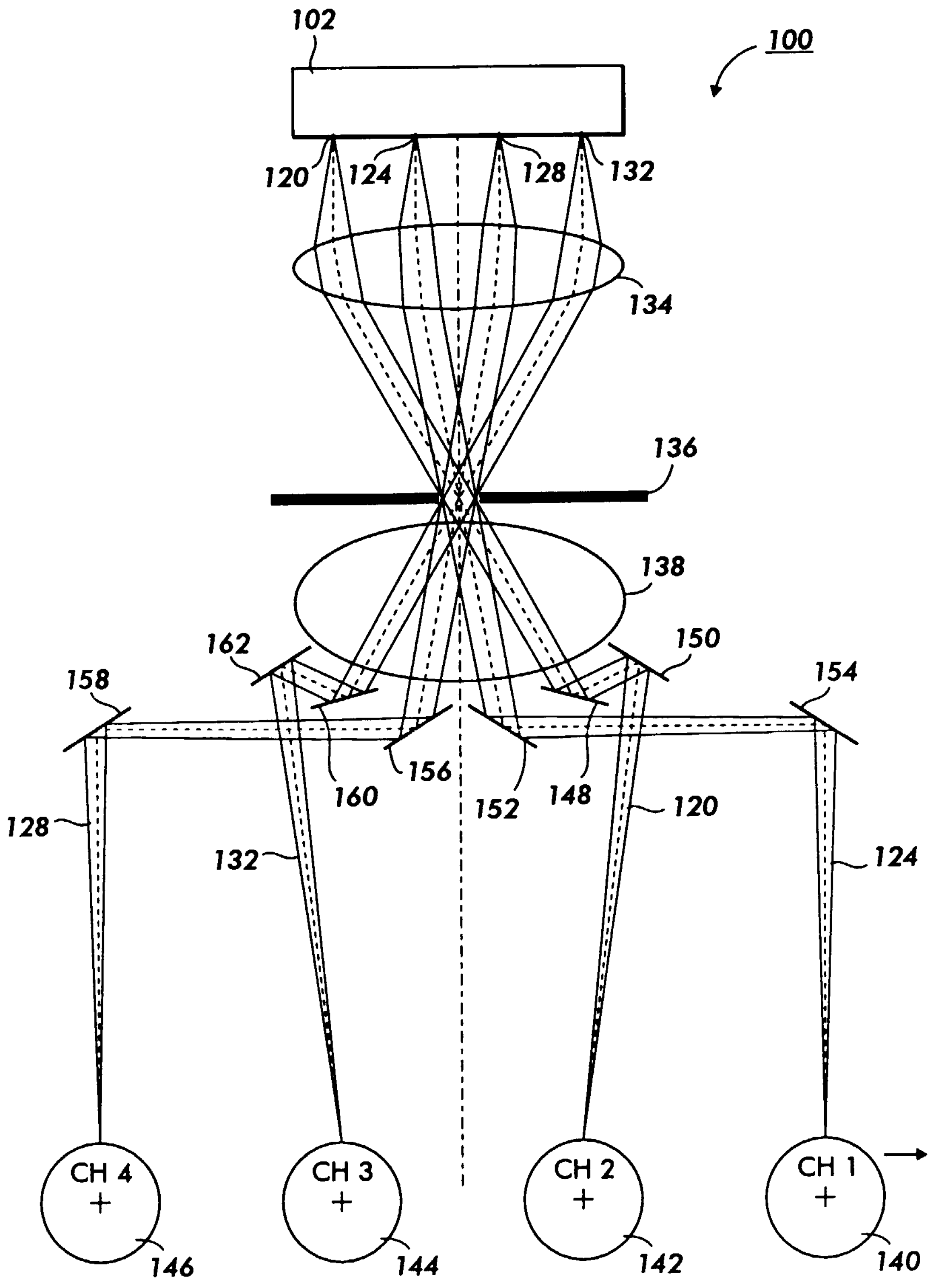

Optical Axis
120
124
128
132
136
Optical Axis
Scan Direction
10mm
10mm
10mm

FIG. 3



100
102
120
124
128
132
134
136
138
162
150
158
154
160
156
152
148
120
128
132
124
CH 4
CH 3
CH 2
CH 1
146
144
142
140

FIG. 4

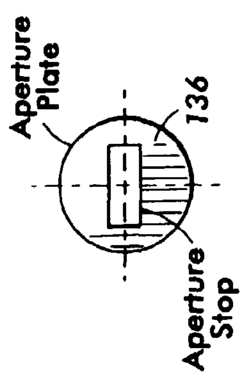


FIG. 5A

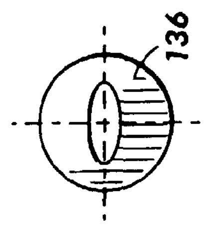


FIG. 5B

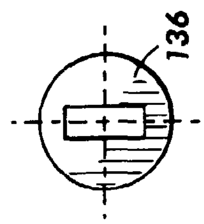


FIG. 5C

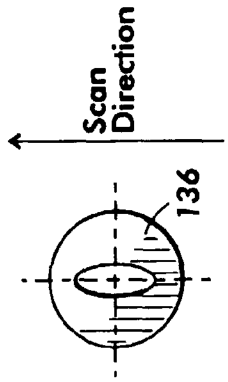


FIG. 5D

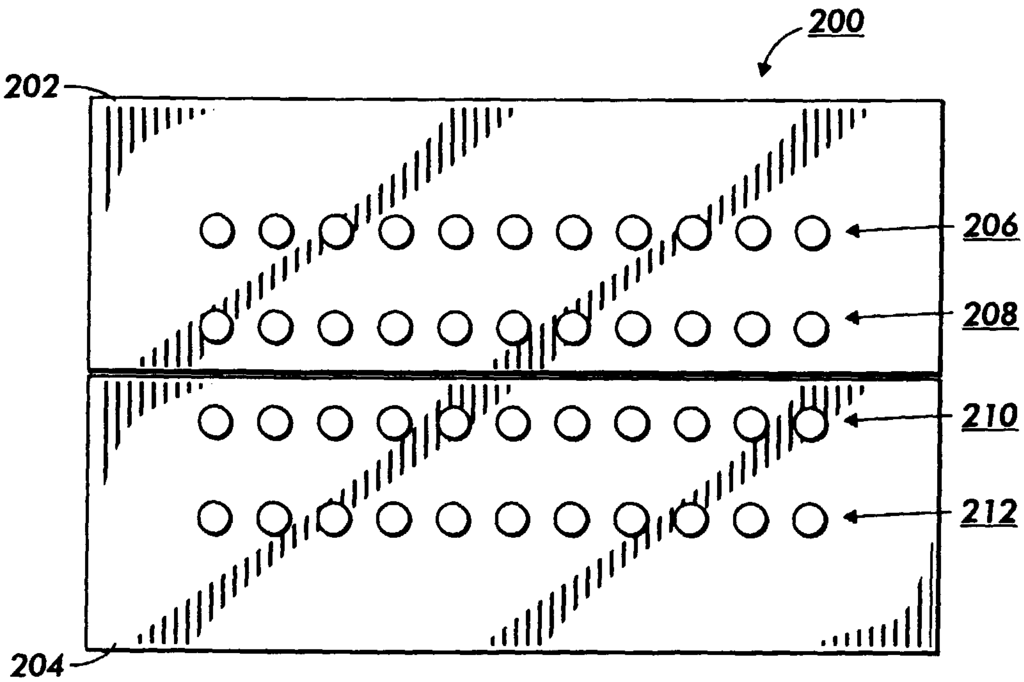


FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 8992

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)
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 360 (P-1569), 7 July 1993 & JP 05 053068 A (FUJI XEROX CO LTD), 5 March 1993, * abstract *	1	B41J2/455
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 670 (P-1845), 16 December 1994 & JP 06 265804 A (RICOH CO LTD), 22 September 1994, * abstract *	1	
D,A	US 5 461 413 A (ASKINAZI MARTIN ET AL) 24 October 1995 * column 2, line 54 - column 5, line 47; figure 3 *	1	
A	EP 0 625 846 A (EASTMAN KODAK CO) 23 November 1994 * column 13, line 56 - column 16, line 49; figures 5,6 *	1	

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	22 April 1997	De Groot, R

CATEGORY OF CITED DOCUMENTS

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