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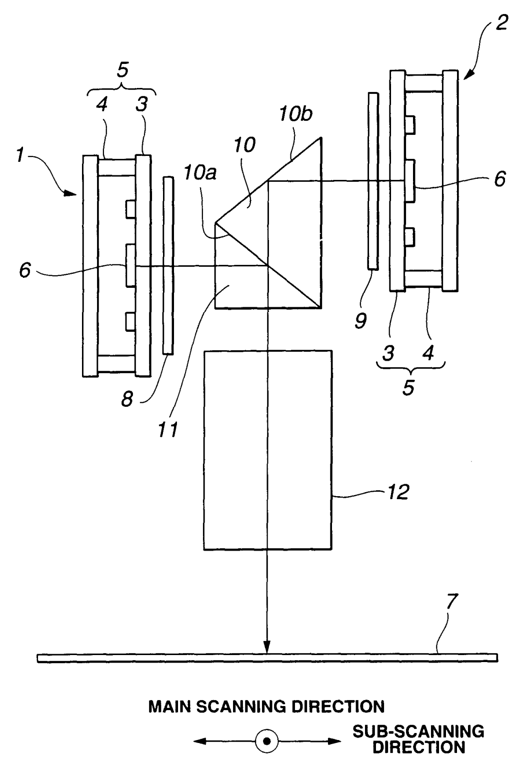
(54) Optical printer head

(57) An optical printer head including a plurality of light sources (1,2) which is capable of providing a distinct image free of colour shade and colour fading. ion-like lights different in luminous colour emitted from a plurality of fluorescent luminous tubes (1,2) acting as the light sources are guided to a common equi-magnification image formation element (12) using a dichroic optical element (10), so that they are superposed on each other on a record medium (7) while being kept aligned with each other, resulting in an image being formed on the record medium (7). The optical members (1,2) are so arranged that optical path lengths of the dot-like lights different in luminous colour may be rendered substantially equal to each other.

FIG.1



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Description

[0001] This invention relates to an optical printer head, and more particularly to an optical printer head in which a plurality of luminous elements are incorporated to record an image or the like on a record medium.

[0002] Now, a conventional optical printer head in which a fluorescent luminous tube is incorporated as a light source will be described with reference to Fig. 5. The optical printer head generally designated at reference numeral 101 in Fig. 5 is arranged in the form of a write head for a fluorescent printer in a housing (not shown). The housing is provided therein with a silver salt sheet 20 in a manner to be opposite to the optical printer head 101. The silver salt sheet 20 may be constituted by a silver salt paper or a silver salt developing paper. The silver salt sheet 20 and optical printer head 101 are moved relative to each other in a sub-scanning direction or in a lateral direction in Fig. 5.

[0003] The optical printer head 101 includes three fluorescent luminous tubes 100 (100R, 100G, 100B), which are constructed so as to emit dot-like lights of red, green and blue luminous colors from anodes 30 (30R, 30G, 30B) thereof, respectively. The anodes 30 each are constituted of a plurality of luminous dots arranged in a row or in an offset manner at predetermined intervals in a direction normal to the sheet of Fig. 5. Thus, the luminous dots of each of the fluorescent luminous tubes are arranged in a main scanning direction, whereas the three fluorescent luminous tubes 100R, 100G and 100B are arranged side by side in the sub-scanning direction of the silver salt sheet 20. The printer head 101 also includes image formation elements of equi-magnification (hereinafter referred to as "equi-magnification image formation elements") 40 respectively provided for the fluorescent luminous tubes 100 and color filters 50R, 50G and 50B provided in correspondence to the respective fluorescent luminous tubes and therefore respective luminous colors. The image formation elements 40 and color filters 50 (50R, 50G, 50B) are arranged outside the fluorescent luminous tubes 100R, 100G and 100B, respectively. Three kinds of lights emitted from the luminous dots of the fluorescent luminous tubes 100R, 100G and 100B pass through the equi-magnification image formation elements 40 and color filters 50R, 50G and 50B and then are irradiated on the silver salt sheet 20, respectively.

[0004] In the conventional optical printer head 101 thus constructed, a color image is subject to color separation, to thereby obtain color data for the respective colors, resulting in the fluorescent luminous tube 100R, 100G and 100B being driven by means of the color data corresponding thereto. In synchronism with the driving, the optical printer head 101 and silver salt sheet 20 are moved relative to each other in the sub-scanning direction or in the lateral direction in Fig. 5, to thereby permit dot-like light emitted from each of the fluorescent luminous tubes 100R, 100G and 100B to be irradiated on the silver salt sheet 20, resulting in a latent image being formed thereon. Then, the latent image is developed, resulting in the original color image being reproduced on the silver salt sheet 20.

[0005] The conventional optical printer head thus constructed is moved relative to the developing paper. This causes the optical printer head to require a large space, so that it is substantially impossible to form the optical printer head into a small size.

[0006] Also, in the conventional optical printer head 101, it is required to accurately align lights of three colors emitted from the fluorescent luminous tubes 100 with each other on the developing paper. However, the alignment is affected by optical distortion of the equi-magnification image formation elements with an increase in resolution and length of the paper, so that it is substantially difficult to attain uniform alignment of the lights over a whole width of the paper. More specifically, the equi-magnification image formation elements 40 each are formed by accumulating a plurality of bar-like lenses. Disturbance in array of the lenses causes linearity of a luminous pattern and a whole pitch thereof to be varied, leading to a variation properties of the equi-magnification image formation elements 40 depending on the equi-magnification image formation element 40.

[0007] Such a variation in properties of the equi-magnification image formation elements 40 for the respective fluorescent luminous tubes 101, even when the luminous dots or anodes 30R, 30G and 30B of the fluorescent luminous tubes 100R, 100B and 100G are uniformly arranged in juxtaposition to each other with predetermined accuracy as shown in Fig. 6, fails to permit lights of the luminous dots which permeate through the image formation elements 40 to form an image in a desired manner on the developing paper or solver salt sheet 20. Thus, an attempt to drive the fluorescent luminous tubes at predetermined timings by means of an image signal obtained by color separation to superpose dot-like lights of the respective colors on each other on the developing paper, resulting in reproducing the original color image results in a failure because the dot-like lights fail to be aligned with each other on the developing paper.

[0008] Further, the conventional optical printer head causes a variation in relative velocity between the optical printer head and the developing paper during relative movement therebetween, resulting in misregistration occurring in superposition of the lights, leading to color shift and color fading.

[0009] The present invention has been made in view of the foregoing disadvantage of the prior art.

[0010] Accordingly, it is an object of the present invention is to provide an optical printer head which is capable of accurately superposing lights emitted from a plurality of light sources on each other on a record medium while aligning the lights with each other, resulting in a distinct image free of color shift and color fading being formed on the record medium.

[0011] In accordance with the present invention, an optical printer head is provided. The optical printer head includes a plurality of light sources, an optical element for selectively reflecting lights at a predetermined wavelength emitted from the light sources and permitting lights at other wavelengths emitted therefrom to permeate therethrough while aligning optical axes of the lights with each other, and an equi-magnification image formation element for superposing the lights permeating through the optical element on each other at a substantially identical position on a record medium, to thereby form an image thereon.

[0012] The light sources used in the present invention may include at least two selected from the group consisting of a first light source for emitting light in a predetermined direction, a second light source for emitting light in a direction opposite to the first light source and a third light source for emitting light in a direction perpendicular to the first and second light sources. The optical element may be constituted by a dichroic optical element.

[0013] The optical printer head of the present invention may also include an optical member arranged in proximity to the optical element so as to permit optical path lengths of the lights of the light sources in the optical element to be substantially equal to each other. Alternatively, the optical printer head of the present invention may further include a light absorbing member arranged in proximity to the optical element so as to absorb light other than light introduced from the light sources into the optical element.

[0014] At least one of the light sources may be combined with an optical filter. Alternatively, the light sources each may be a monochromatic light source constituted by a combination of an optical filter and a fluorescent luminous tube.

[0015] The first and second light sources each may include a plurality of luminous dots arranged in a row at substantially equal intervals, wherein the luminous dots of the light sources which correspond to each other form an image at a substantially identical position on the record medium. Also, the first and second light sources and the third light source each may include a plurality of luminous dots arranged in a row in a luminous pattern which permits the luminous dots to form a mirror image with respect to each other.

[0016] The light sources may be constructed so as to emit lights different in luminous color, respectively. Alternatively, the light sources each may be constructed so as to exhibit at least one different luminous color.

[0017] These and other objects and many of the attendant advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings; wherein:

Fig. 1 is a sectional view showing a first embodiment of an optical printer head according to the present invention;

Fig. 2 is a sectional view showing a second embodiment of an optical printer head according to the present invention;

Fig. 3 is a schematic view showing an optical element and optical members incorporated in an optical printer head by way of example;

Fig. 4 is a perspective view showing functions of the optical printer head shown in Fig. 2;

Fig. 5 is a schematic view showing a conventional optical printer head by way of example;

Fig. 6 is a perspective view showing disadvantages of the conventional optical printer head of Fig. 5;

Fig. 7 is a sectional view showing an optical path of each of luminous elements incorporated in the optical printer head shown in Fig. 2; and

Fig. 8 is a schematic view showing formation of an image on a developing paper by means of lights of red (G), green (G) and blue(B) colors permeating through lenses.

[0018] Now, the present invention will be described in detail with reference to the accompanying drawings.

[0019] An optical printer head according to the present invention includes a plurality of light sources. However, a single or a single set of equi-magnification image formation lens array (selfoc lens array) is arranged so as to common to the light sources. Lights emitted from the light sources are introduced into the equi-magnification image formation lens array while keeping optical axes of the lights aligned with each other by means of a specific optical element, to thereby be superposed on each other at the same position on a record medium, leading to exposure of the record medium, resulting in an image being synthesized. The following two embodiments each have a plurality of light sources different in luminous color incorporated therein. Also, in each of the embodiments, a dichroic optical element such as a mirror, a filter or the like is used. Two or three such light sources are arranged.

[0020] Referring first to Fig. 1, an embodiment of an optical printer head according to the present invention is illustrated. An optical printer head of the illustrated embodiment includes a first fluorescent luminous tube 1 arranged so as to emit light in a predetermine direction and acting as a first light source, as well as a second fluorescent luminous tube 2 arranged opposite to the first fluorescent luminous tube 1 so as to emit light in a direction opposite to that of the light of the first flourescent luminous tube 1 while being kept parallel to the light of the first fluorescent luminous tube 1 and acting as a second light source.

[0021] In the illustrated embodiment, the fluorescent luminous tubes 1 and 2 each include an envelope 5 formed by sealedly joining an anode substrate 3 made of glass to a box-like casing 4. The anode substrate 3 is formed on a portion thereof positioned in the envelope

5 with a light-permeable anode conductor and a phosphor deposited on the anode conductor, which cooperate with each other to provide an anode 6. The anode 6 is constructed in the form of a plurality of luminous dots arranged in a row or in an offset manner at predetermined intervals in a direction normal to the sheet of Fig. 1. In the illustrated embodiment, the luminous dots are arranged in a row. Also, in the illustrated embodiment, the direction in which the luminous dots are arranged is defined to be a main scanning direction and the fluorescent luminous tubes 1 and 2 are arranged in a sub-scanning direction of a record medium 7.

[0022] The first fluorescent luminous tube 1 has a ZnO:Zn phosphor incorporated therein. The ZnO:Zn phosphor is a zinc oxide phosphor which has a wide luminous spectrum and exhibits a luminous color between a blue region and a red region. Also, a filter 8 of a green color is arranged for the fluorescent luminous tube 1, to thereby provide a green luminous color. When a blue filter is used, a blue luminous color is provided.

[0023] The second fluorescent luminous tube 2 has a $(Zn_{1-x},Cd_x)S:Ag,Cl$ phosphor which is a (Zn, Cd)S phosphor incorporated therein, because a ZnO:Zn phosphor fails to exhibit sufficient energy in a red region in view of sensitive characteristics of a photosensitive layer (for example, a cyan layer) photosensitized at a red color in a silver salt sheet acting as the record medium 7. The $(Zn_{1-x},Cd_x)S:Ag,Cl$ phosphor has an x value of between 0.75 and 0.80 and has a peak wavelength of between 650 nm and 660 nm, resulting in exhibiting a reddish to orange luminous color and has been widely used in a fluorescent display device. Also, a red filter 9 is provided for the second fluorescent luminous tube 2, so that it may exhibit a red luminous color.

[0024] The optical printer head of the illustrated embodiment also includes an optical element 10 and an optical member 11 arranged between the first fluorescent luminous tube 1 including the filter 8 and the second fluorescent luminous tube 2 including the filter 9. The optical element 10 and member 11 function to align optical axes of lights emitted from the fluorescent luminous tubes 1 and 2 with each other. Then, the lights are permitted to be incident on a common equi-magnification image element (selfoc lens array) 12. In the illustrated embodiment, the optical element 10 is constituted by a dichroic optical element which is formed into a prism-like configuration and of which two faces each act as a dichroic mirror (filter). Also, the equi-magnification image formation element 12 incorporated in the illustrated embodiment is an optical system formed by integrating a plurality of refractive index distribution type lenses with each other so as to provide a single continuous real image of equi-magnification. Thus, the equi-magnification image formation element 12 carries out a function like a spherical lens which permits light to meander at a constant cycle with a continuous variation in refractive index in the lens, to thereby reproduce an erecting equi-magnification real image increased in resolution.

[0025] As shown in Fig. 1, dot-like light of a green or blue color emitted from the first fluorescent luminous tube 1 is reflected by a first reflecting surface 10a of the dichroic optical element 10 which exhibits a function of selectively reflecting light or permitting the light to permeate therethrough depending on a wavelength of the light, resulting an optical path of the light being changed in a downward direction by an angle of 90 degrees. Color components of the light emitted from the first fluorescent luminous tube 1 other than a green or blue component thereof are caused to permeate through the reflecting surface 10a, to thereby be separated from the green or blue component.

[0026] Dot-like light of a red luminous color emitted from the second fluorescent luminous tube 2, as shown in Fig. 1, is reflected by a second reflecting surface lOb of the dichroic optical element 10 which selectively carries out a reflecting function depending on a wavelength of the light, resulting in an optical path of the light being downwardly changed by 90 degrees, so that the light may permeate through the first reflecting surface 10a. Components of the light other than a red component thereof are permitted to permeate through the second reflecting surface 10b without being reflected thereby. In the illustrated embodiment, the second fluorescent luminous tube 2 is constructed so as to emit light of a red color by cooperation between the phosphor of a red luminous color and the red filter 9, therefore, the second reflecting surface 10b may be constituted by a total reflection mirror.

[0027] The dot-like lights different in color emitted from the first and second fluorescent luminous tubes 1 and 2 are then incident on the common equi-magnification image formation element 12 while keeping optical axes thereof aligned with each other, resulting in forming an image at the same position on the record medium 7 while being superposed on each other. Thus, the illustrated embodiment provides an image significantly distinct as compared with the prior art.

[0028] The optical member 11 of a triangle in cross section like a prism, as shown in Fig. 1, is arranged in proximity to a portion of the optical element 10 facing the first fluorescent luminous tube 1. Thus, light emitted from the first fluorescent luminous tube 1 is permitted to permeate through the optical member 11 and then is reflected by the first reflecting surface 10a of the dichroic optical element 10. Then, it permeates through the optical member 11 in an outward direction. Light emitted from the second fluorescent luminous tube 2 permeates through the dichroic optical element 10 and optical member 11 in order and then is outwardly discharged therefrom. A distance by which lights emitted from the fluorescent luminous tubes 1 and 2 travel in the dichroic optical element 10 and that by which they travel in the optical member 11 are different from each other. However, in the illustrated embodiment, the optical member 11 has an index of refraction and dimensions suitably set so as to permit a length of the optical path of the light emitted form the first fluorescent luminous tube 1 and that from the second fluorescent luminous tube 2 to be substantially equal to each other. Thus, although the first and second fluorescent luminous tubes 1 and 2 are arranged in manners different from each other with respect to the equi-magnification image formation image 12, arrangement of both fluorescent luminous tubes 1 and 2 is carried out so as to permit an optical length of the light path between the first fluorescent luminous tube 1 and the equi-magnification image formation element 12 and that between the second fluorescent luminous tube 2 and the element 12 to be equal to each other. Thus, image formation is carried out at a position (focal position) of an equidistance from the first and second fluorescent luminous tubes 1 and 2, so that the fluorescent luminous tubes 1 and 2 carry out image formation in the same state on the record medium 7.

[0029] Setting of the focal positions of the fluorescent luminous tubes 1 and 2 on the record medium 7 while aligning them with each other as described above is carried out by positioning one of the fluorescent luminous tubes with respect to the optical element 10 and optical member 11 and then moving the other fluorescent luminous tube in all directions along the optical path, to thereby find a position at which focuses of both fluorescent luminous tubes 1 and 2 are superposed on each other.

[0030] A color image is subject to color separation, to thereby obtain color data on red (R) and green (G) or blue (B) colors, so that the fluorescent luminous tubes are driven by means of the color data corresponding thereto. In synchronism with the driving, the optical printer head and record medium 7 are moved relative to each other in the sub-scanning direction or the lateral direction in Fig. 1, so that dot-like lights emitted from the fluorescent luminous tubes are irradiated on the same position on the record medium 7, resulting in a latent image being formed thereon. Then, the latent image is developed, so that the original image may be reproduced on the record medium 7.

[0031] In the illustrated embodiment, luminous dots of both fluorescent luminous tubes are arranged by means of coordinates common to both. Even when the dots of both fluorescent luminous tubes are arranged in an offset manner, the arrangement pattern may be common to both fluorescent luminous tubes.

[0032] Referring now to Fig. 2, another or a second embodiment of an optical printer head according to the present invention is illustrated. An optical printer head of the illustrated embodiment includes a first fluorescent luminous tube 1 acting as a first light source for emitting light in a predetermined direction, a second fluorescent luminous tube 2 arranged so as to be opposite to the first fluorescent luminous tube 1 and acting as a second light source for emitting light in a direction parallel to the light emitted from the first fluorescent tube 1 and opposite thereto, and a third fluorescent luminous tube 13 acting as a third light source for emitting light in a direction perpendicular to the lights emitted from the first and second fluorescent luminous tubes 1 and 2.

[0033] The first fluorescent luminous tube 1 includes a ZnO:Zn phosphor and a blue filter 14, to thereby emit dot-like light of a blue color therefrom. The second fluorescent luminous tube 2 includes a ZnO:Zn phosphor and a green filter 8, to thereby emit dot-like light of a green color therefrom. The third fluorescent luminous tube 13 includes a (Zn, Cd)S phosphor and a red filter 9, resulting in emitting dot-like light of a red color therefrom. The fluorescent luminous tubes may be constructed into the same structure as those in the first embodiment described above.

[0034] The optical printer head of the illustrated embodiment also includes a single optical element 10 and two optical members 11a and 11b arranged among the fluorescent luminous tubes 1, 2 and 13 each including the filter. The optical element 10 and optical members 11a and 11b function to align optical axes of the lights emitted from the fluorescent luminous tubes 1, 2 and 13 with each other when the lights permeate therethrough. Then, the lights are incident on an equi-magnification image formation element (selfoc lens array) 12 common to the fluorescent luminous tubes 1, 2 and 13. The equi-magnification image formation element 12, optical element 10 and optical members 11 may be constructed in substantially the same manner as those in the first embodiment described above, except design factors or requirements for application of them to the three fluorescent luminous tubes 1, 2 and 13. Thus, they exhibit substantially the same function as those in the first embodiment.

[0035] As shown in Fig. 2, dot-like light of a blue color emitted from the first fluorescent luminous tube 1 permeates through the first optical member 11a and then is reflected by a first reflecting surface 10a of a dichroic optical element 10 selectively carrying out a reflection function and a permeation function depending on a wavelength of light guided thereto, resulting in an optical path of the light being changed by an angle of 90 degrees in a downward direction. Light of wavelengths other than a wavelength of the light of a blue color is permitted to permeate through the first optical member 11a without being reflected by the first reflecting surface 10a.

[0036] Also, as shown in Fig. 2, dot-like light of a green color emitted from the second fluorescent luminous tube 2 is reflected by a second reflecting surface 10b of the dichroic optical element 10 which selectively carries out a reflection function depending on a wavelength of light guided thereto, so that an optical path of the light may be downwardly changed by an angle cf 90 degrees. Then, the light is discharged from the first reflecting surface 10a and then permeates through the second optical member 11a. Light other than the light of a green color is reflected by the second reflecting surface 10b of the dichroic optical member 10.

[0037] Further, as shown in Fig. 2, dot-like light of a red color emitted from the third fluorescent luminous tube 13 is permitted to permeate through the second optical member 11b, the second reflecting surface 10b of the dichroic optical element 10, the first reflecting surface 10a thereof and the first optical member 11a in order.

[0038] Then, the dot-like lights thus emitted from the first, second and third fluorescent luminous tubes 1, 2 and 13 are incident on the equi-magnification image formation element 12 common thereto while keeping optical axes thereof aligned with each other, resulting in forming an image at the same position on a record medium 7 while being superposed on each other.

[0039] The image thus formed on the record medium or developing paper 7 by the lights of the red, green and blue colors is shown in Fig. 8. In Fig. 8, ①indicates an image formed on the developing paper when three light source trains are used, ②indicates an image formed thereon when groups of three light sources combined are arranged in an offset manner in order and ③indicates an image formed thereon when a combination of one light source train and light sources arranged in an offset manner is used.

[0040] Alignment of the optical axes (X) with each other means that a lens center of the selfoc lens array is aligned with a center of the luminous pattern in parallel.

[0041] Also, superposition of the lights on each other at same position means that the same patterns of red (R), green (G) and blue (B) colors are superposed on each other, as in the case of ①and ②described above. Also, in the case of ③described above, X coordinates of the R, G and B patterns are the same and Y coordinates thereof are substantially coincident with each other. In other words, the same patterns at least contact with each other in proximity to the optical axes, overlap in a predetermined luminous pattern region arranged in an offset manner or are present in the region.

[0042] In Fig. 8, the R, G and B lights are shown in a manner to suspended in a space in order to clarify superposition of the R, G and B lights. Actually, the image is formed on the same plane or developing paper.

[0043] In the illustrated embodiment as well as the first embodiment described above, the first and second optical members 11a and 11b each exhibiting a suitable optical function are incorporated, so that an optical path length of the light between each of the fluorescent luminous tubes 1, 2 and 13 and the equi-magnification image formation element 12 is substantially equal. More particularly, the fluorescent luminous tubes 1, 2 and 13 are not arranged in the same manner with respect to the equi-magnification image formation element 12, however, a position (focal position) at which light from each of the fluorescent luminous tubes 1, 2 and 13 forms an image is permitted to be the same. Thus, the fluorescent luminous tubes 1, 2 and 13 are permitted to direct the dot-like light to the same position on the record medium 7 for image formation.

[0044] The optical element 10 and optical members 11a and 11b each are made of borosilicate crown glass (BK:7, Shot Glass Welke® in German), have a refractive index of 1.52 which is substantially equal to that of soda-lime glass generally used for a fluorescent luminous tube. When an optical member and a fluorescent luminous tube joined to each other have substantially the same refractive index, refraction of light at a joint therebetween is hard to occur, to thereby prevent attenuation of the light and the like. Fig. 7 shows an optical path of light emitted from each of the luminous elements, wherein solid lines indicate optical paths obtained when the optical members 10, 11a and 11b are mounted in the optical printer head, and broken lines indicate optical paths obtained when the optical members 11a and 11b are not mounted therein. In connection with an optical path of light emitted from the fluorescent luminous tube 13, when the optical members 11a and 11b are not mounted, an optical path length by which the light travels in the optical member 10 arranged on a left side in Fig. 7 is caused to be different from that by which it travels therein on the right side, so that a focal position thereof is defined at a location different from A and B, leading to a failure in accurate formation of an image.

[0045] In an optical path of light emitted from the fluorescent luminous tube 2 as well, absence of the optical member 11a causes the light to have a focal position different from D and C. Thus, the optical members 11a and 11b permit any light to have a focus on the same position so long as it travels on the optical path of the light emitted from each of the fluorescent luminous tubes.

[0046] The optical members 10, 11a and 11b are formed at portions thereof other than portions thereof on which lights of the fluorescent luminous tubes 1, 2 and 13 are incident and a portion thereof from which synthesized light is discharged with a light absorbing film 20. In the illustrated embodiment, the film 20 is formed of an acrylic black paint. However, it may be formed of any other suitable material so long as it has light absorbing properties.

[0047] The light absorbing film 20 absorbs, for example, of light of the fluorescent luminous tube 13, a G light component reflected by the second reflecting surface 10b of the optical element 10. Absence of the light absorbing film 20 causes the G light component to be reflected by an inner surface of the optical member 11b, leading to a reduction in contrast.

[0048] The dichroic element 10 selectively carries out reflection and transmission of R, G and B light components of the light depending on a wavelength thereof, so that it does not basically require a color filter or optical filter. However, it often causes leakage of light at a wavelength other than the selected wavelength; therefore, when it is desired to increase purity of a color photosensitized, use of a color filter is effective. For example, when a developing paper is exposed to light, photosensitive regions for R, G and B colors of the developing paper are at wavelengths of 580 to 750 nm, 500 to 580 nm and 350 to 500 nm, respectively. Thus, the color filter is effectively used when light separation is carried out near boundary wavelengths of 580 nm and 580 nm among the colors. The color filters effective for color separation at the wavelengths described above may be commercially available under tradenames R:SC 42, G: BPM 53 and B:BPN 45 from Fuji Photo Film Co., Ltd.

[0049] As described above, setting of the focuses of the fluorescent luminous tubes 1, 2 and 13 on the record medium 7 while aligning or superposing the focuses with or on each other is carried out by positioning one of the fluorescent luminous tubes with respect to the optical element 10 and optical members 11a and 11b and then moving the remaining fluorescent luminous tubes in all directions along the optical paths to find a position at which the focuses are superposed on each other.

[0050] In the illustrated embodiment, the color image is subject to color separation to obtain color data on red, green and blue colors, so that the fluorescent luminous tubes are driven by the color data corresponding thereto, respectively. In synchronism with the driving, the optical printer head and record medium 7 are moved relative to each other in the sub-scanning direction or in the lateral direction in Fig. 2, the dot-like lights of the respective colors are irradiated on the same position on the record medium 7, to thereby form a latent image. Then, the latent image is developed, resulting in the original full-color image being reproduced on the record medium.

[0051] Thus, the illustrated embodiment, as shown in Fig. 4, permits the red, green and blue luminous dots emitted from the fluorescent luminous tubes to be incident on the common equi-magnification image formation element 12 while keeping optical axes of the luminous dots aligned with each other by means of the optical element 10, resulting in an image being formed on the record medium 7. Thus, even when there is any possible variation in properties of the equi-magnification image formation element 12 depending on the element 12, it is ensured that the luminous dots for forming an image on the record medium 7 are collected at a fixed position while considering the variation. Thus, the illustrated embodiment eliminates disadvantages such as color shift and the like encountered in the prior art.

[0052] In the illustrated embodiment, the first and second fluorescent luminous tubes 1 and 2 have the luminous dots formed into a common configuration and the luminous dots arranged in a common pattern. Even when the luminous dots of each of the fluorescent luminous tubes 1 and 2 are arranged in an offset manner, the arrangement pattern may be common to both fluorescent luminous tubes. On the contrary, a pattern of the luminous dots of the third fluorescent luminous tube 13 has relationship of an mirror image to the pattern of the luminous dots of each of the first and second fluorescent luminous tubes 1 and 2. Therefore, in the illustrated embodiment, when a dot pattern of the anode of the fluorescent luminous tube is arranged in an offset manner or in plural rows, it is required to prepare two kinds of patterns or a pattern for the first and second fluorescent luminous tubes 1 and 2 and a pattern for the third fluorescent luminous tube 13. Alternatively, the illustrated embodiment may be so constructed that the same dot pattern is prepared for each of the three fluorescent luminous tubes, wherein any one set of dot patterns for the fluorescent luminous tubes of the same construction (dot patterns for the first and second fluorescent luminous tubes or that for the third fluorescent luminous tube) are shifted by one dot in a longitudinal direction of the dot train to superpose the dots on each other and the image data are shifted by one dot depending on a direction of shifting thereof.

[0053] In this instance, a common dot pattern is formed in each of the fluorescent luminous tubes in which one luminous dot is rendered ineffective (or an effective image formation region is reduced by one luminous dot) or additional one luminous dot is previously provided, so that the additional luminous dot may be selectively used to eliminate a problem of the luminous dot to be rendered ineffective.

[0054] The illustrated embodiment may be modified so as to combine any one of the first and second fluorescent luminous tube 1 and 2 with the third fluorescent luminous tube 3.

[0055] In each of the first and second embodiments described above, such a prism-like element as shown in Fig. 3 (②) is used as the dichroic optical element. Alternatively, a filter-like dichroic element or dichroic filter as shown in Fig. 3 (①) may be used for this purpose.

[0056] Also, in each of the embodiments described above, the fluorescent luminous tubes are used as the light sources. Alternatively, any other suitable luminous element such as a field-emission type luminous element, a light emitting diode, a plasma display panel, an inorganic or organic electroluminescent element, a combination of a liquid crystal shutter and a back light, a combination of a PLZT shutter and a back light, or the like may be used to this end. Also, any combination of such light sources may be used as a composite light source.

[0057] Further, in each of the above-described embodiments, the fluorescent luminous tube having a ZnO:Zn phosphor which has a wide luminous spectrum and exhibits a luminous color between a blue region and a red region incorporated therein and that having a (Zn, Cd)S phosphor which exhibits a red luminous color incorporated therein are used as the light sources.

[0058] Alternatively, monochromatic light sources respectively exhibiting blue, green and red luminous colors may be used to this end. In addition, a light source which exhibits any two of blue, green and red luminous colors, a light source of a white color which exhibits three luminous colors or a combination thereof may be likewise used for this purpose.

[0059] Moreover, in the illustrated embodiment, the selfoc lens array is used as the equi-magnification image formation element. Alternatively, a plastic lens array, a roof mirror lens array or the like may be used for this purpose.

[0060] A dichroic filter is in the category of a non-metallic interference filter and functions to reflect a portion of visible light at a selected wavelength and permit the remaining light to permeate therethrough. The details are described in Color Science Handbook, pp 783-860, edited by Color Society of Japan and published by the Tokyo University.

[0061] In Fig. 3, ②indicates a structure of the optical element and members. The element and members designated at reference characters 10, 11a and 11b each are made of glass (BK7). Also, the element 10 is provided with the dichroic filters 10a and 10b. The element 10 is adhesively mounted on surfaces thereof on which the filters are formed with the members 11a and 11b by means of a transparent adhesive.

[0062] The filter 10a functions to permit R and B light components of light downwardly guided thereto to permeate therethrough and reflect a G light component thereof. Also, it reflects a G light component of light guided thereto from a right-hand side and permits R and B light components thereof to permeate therethrough. The filter 10b permits R and G light components of light downwardly guided thereto to permeate therethrough and reflects a B light component thereof. In addition, it reflects a B light component guided thereto from a left-hand side and permits R and G light components thereof to permeate therethrough.

[0063] This permits the R light component to permeate through the filters 10a and 10b and then be incident on the lens. The G light component is reflected by the filter 10a, to thereby be downwardly changed in optical path. Then, it permeates through the filter 10b and then is incident on the lens. The B light component is reflected by the filter 10b, to thereby be downwardly changed in optical path and then is incident on the lens.

[0064] The optical printer head of the first embodiment described above does not have the optical member 11b incorporated therein. Thus, no light is downwardly incident on the optical members in the embodiment. Also, the filter 10a is constituted by a dichroic filter. Alternatively, a total reflection mirror may be used therefor.

[0065] In Fig. 3 (①, a dichroic filter is formed on a flat glass member in the structure of Fig. 3 (②, to thereby provide an optical element. The dichroic filter is constructed in substantially the same manner as in Fig. 3 (②. In Fig. 3 (①, the filter 10a functions to permit R and B light components of light downwardly guided thereto to permeate therethrough and reflect a G light component thereof. Also, it reflects a G light component of light guided thereto from a right-hand side and permits R and B light components thereof to permeate therethrough. The filter 10b permits R and G light components of light downwardly guided thereto to permeate therethrough and reflects a B light component thereof. In addition, it reflects a B light component of light guided thereto from a left-hand side and permits R and G light components thereof to permeate therethrough.

[0066] This permits the R light component to permeate through the filters 10a and 10b and then be incident on the lens. The G light component is reflected by the filter 10a, to thereby be downwardly changed in optical path. Then, it permeates through the filter 10b and then is incident on the lens. The B light component is reflected by the filter 10b, to thereby be downwardly changed in optical path and then is incident on the lens.

[0067] The embodiments described above each may be applied to an optical printer head wherein a fluorescent luminous tube is used as a light source therefor. The optical printer head may be used as a write head for a fluorescent printer such as a color printer or the like.

[0068] The optical printer head of each of the above-described embodiments is so constructed that dot-like lights different in luminous color emitted from the plural fluorescent luminous tubes are guided to the common equi-magnification image formation element through the dichroic optical element, to thereby be superposed on each other on the record medium while being kept aligned with each other, resulting in an image being formed on the record medium. Also, the optical members are incorporated in the optical printer head, so that the optical path lengths of the dot-like lights different in luminous color may be rendered substantially equal to each other. Such construction provides a distinct image free of color shift and color fading.

[0069] As can be seen form the foregoing, in the present invention, the single optical element or lens is provided so as to be common to the plural light sources, leading to down-sizing of the whole optical printer head. Also, when lights emitted from the plural light sources are incident on the single optical element or lens, the lights travel on the same optical path. This eliminates misregistration between the dot-like lights even when the optical element or lens has optical distortion.

[0070] Also, the present invention is constructed so as to optically synthesize lights emitted from the plural light sources, to thereby facilitate alignment of the dot-like lights, resulting in the number of the optical elements or lens incorporated being reduced, leading to a reduction in manufacturing cost of the optical printer head. Further, this permits the plural light sources different in luminous color to be compactly arranged, to thereby reduce a delay treatment of a data circuit and a head transfer space, unlike the prior art wherein the light sources are arranged spatially apart from each other.

Claims

1. An optical printer head comprising a plurality of light sources (1,2), characterised by: an optical element (10) for selectively reflecting lights at a predetermined wavelength emitted from the light sources

and permitting lights at other wavelengths emitted therefrom to permeate therethrough while aligning the optical axes of the lights with each other; and an equi-magnification image formation element (12) for superposing the lights permeating through the optical element (10) on each other at a substantially identical position on a record medium (7), in order to form an image thereon.

2. An optical printer head as claimed in claim 1, characterised in that the light sources include at least two selected from the group consisting of a first light source (1) for emitting light in a predetermined direction, a second light source (2) for emitting light in a direction opposite to the first light source (1) and a third light source (13) for emitting light in a direction perpendicular to the first and second light sources (1,2).

3. An optical printer head as claimed in Claim 1 or Claim 2, characterised in that the optical element (10) is constituted by a dichroic optical element.

4. An optical printer head as claimed in any preceding Claim, characterised by an optical member (11a, 11b) arranged in proximity to the optical element (10) so as to permit optical path lengths of the lights of the light sources (1,2,13) in the optical element (10) to be substantially equal to each other.

5. An optical printer head as claimed in any preceding Claim, characterised by a light absorbing member (20) arranged in proximity to the optical element (10) so as to absorb light other than light introduced from the light sources (1,2,13) into the optical element (10).

6. An optical printer head as claimed in any preceding Claim, characterised in that at least one of the light sources (1,2,13) is combined with an optical filter (8,9,14).

7. An optical printer head as claimed in any preceding Claim, characterised in that the light sources (1,2,13) are each a monochromatic light source constituted by a combination of an optical filter and a flourescent luminous tube.

8. An optical printer head as claimed in any preceding Claim, characterised in that the first and second light sources (1,2) each include a plurality of luminous dots arranged in a row at substantially equal intervals, and the luminous dots of the light sources (1,2) which correspond to each other form an image at a substantially identical position on the record medium (7).

9. An optical printer head as claimed in any preceding Claim, characterised in that the first and second light sources (1,2) and the third light source (13) each include a plurality of luminous dots arranged in a row in a luminous pattern which permits the luminous dots to form a mirror image with respect to each other.

10. An optical printer head as claimed in any preceding Claim, characterised in that the light sources (1,2,13) respectively emit lights which are different in luminous colour.

11. An optical printer head as claimed in any preceding Claim, characterised in that the light sources (1,2,13) each exhibit at least one different luminous colour.

FIG.1

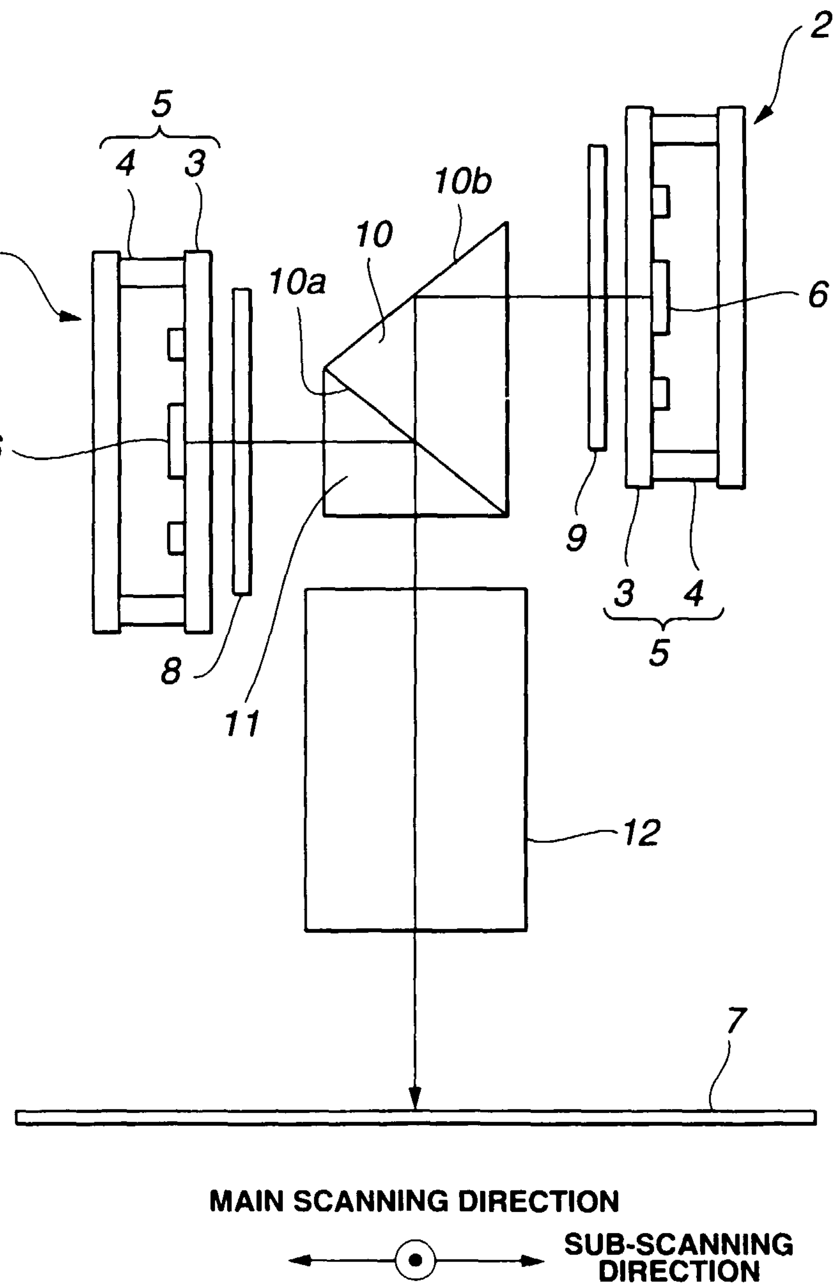

5
4
3
1
10b
10
10a
2
6
6
9
3
4
5
8
11
12
7
MAIN SCANNING DIRECTION
SUB-SCANNING DIRECTION

FIG.2

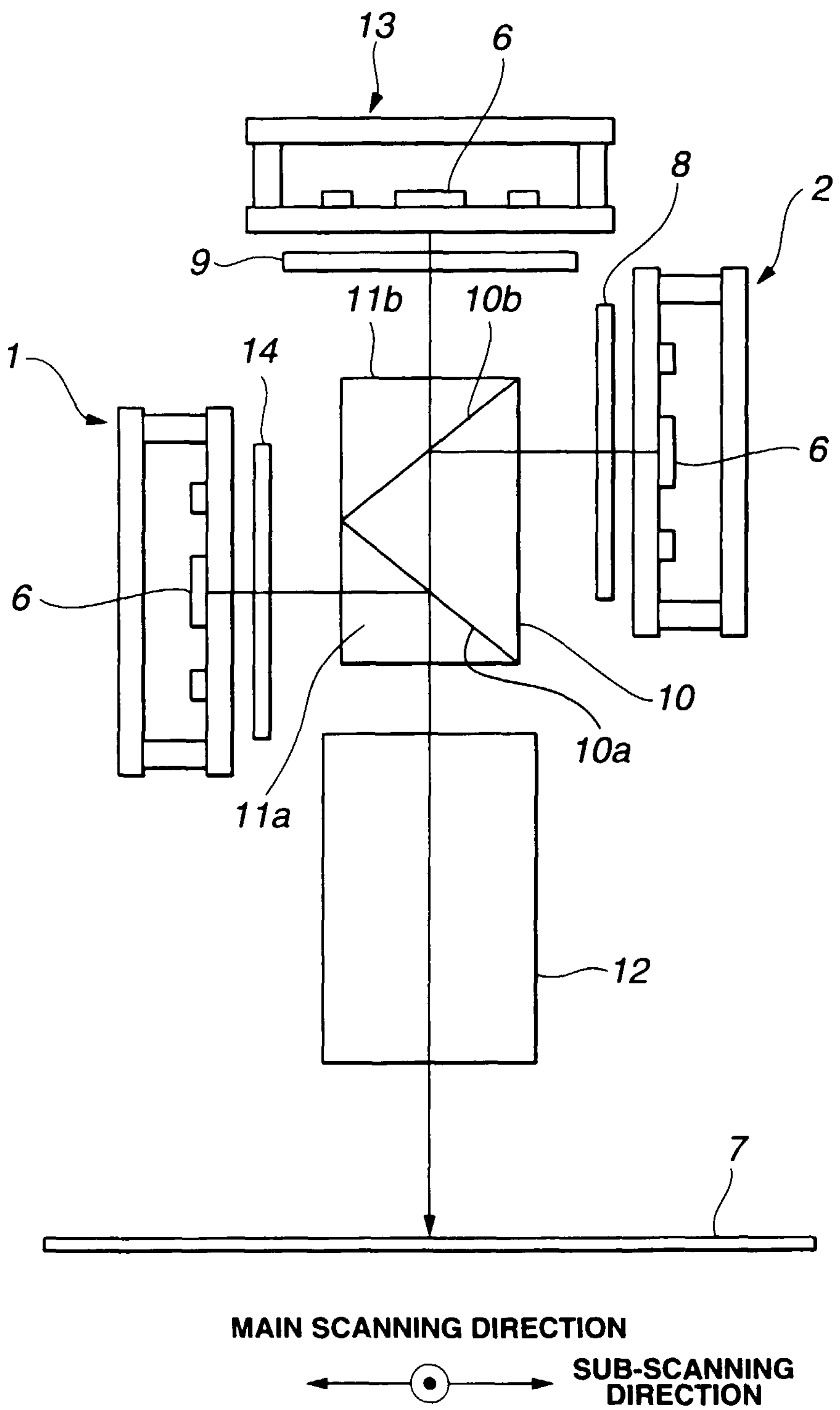

13
6
8
2
9
11b
10b
1
14
6
6
10
10a
11a
12
7
MAIN SCANNING DIRECTION
SUB-SCANNING DIRECTION

FIG.3

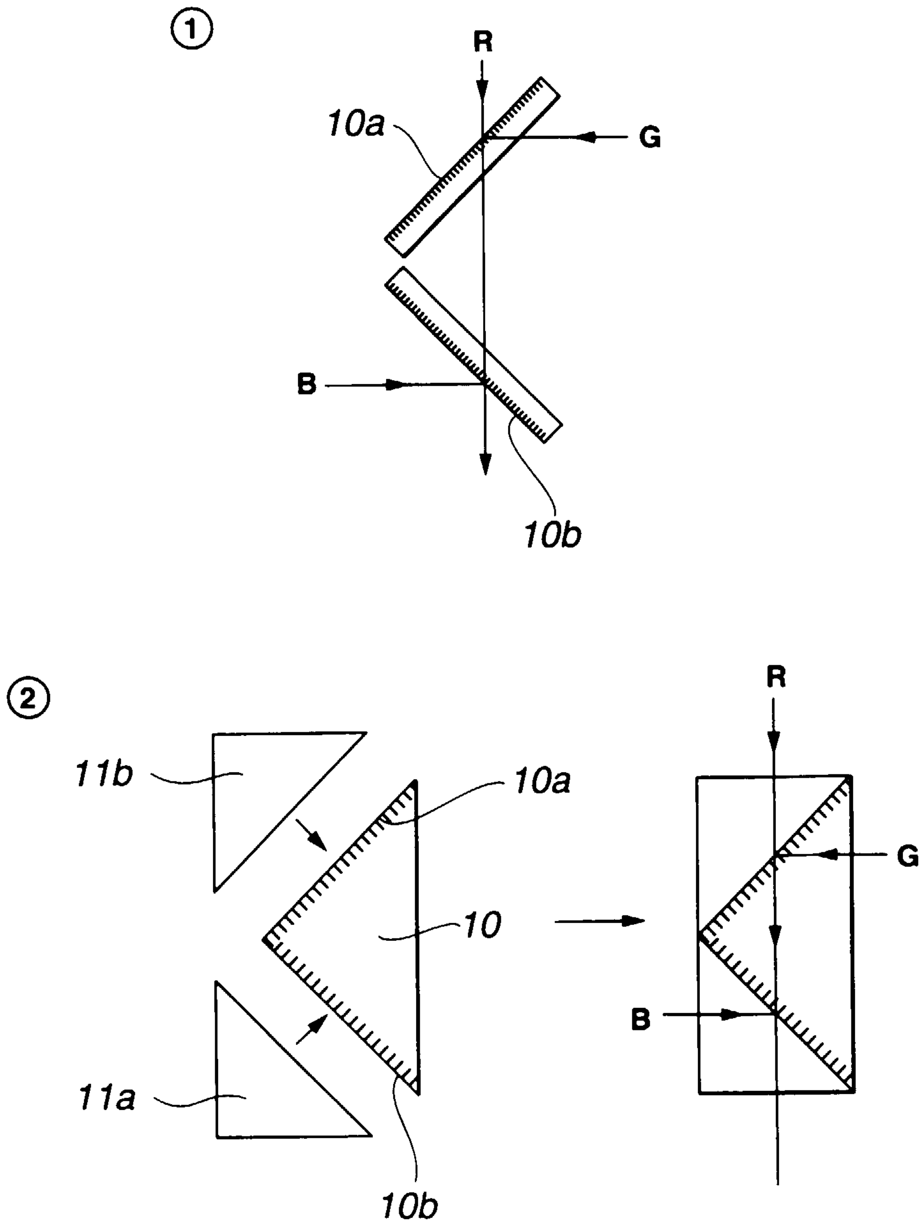


FIG.4

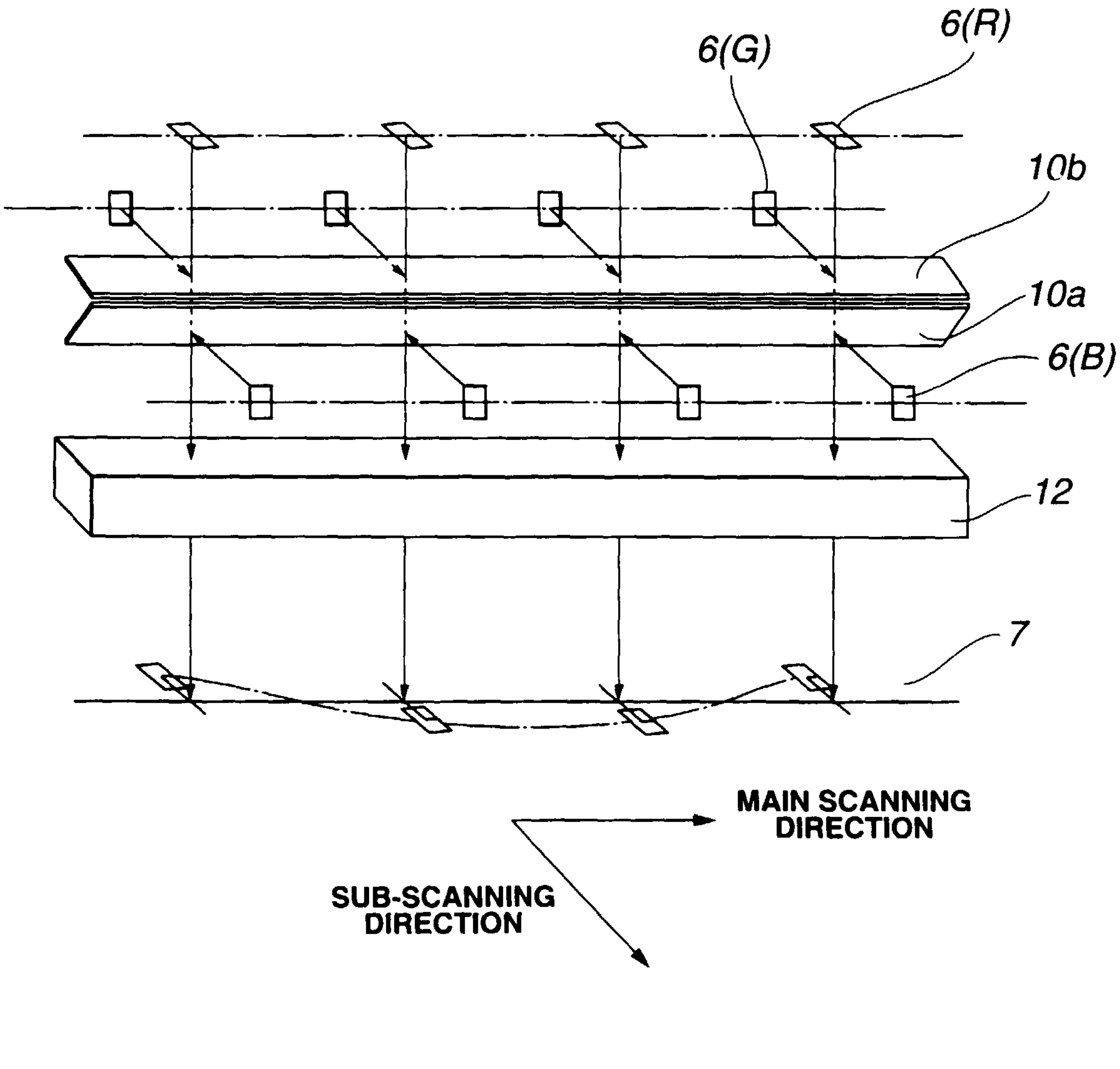

6(G)
6(R)
10b
10a
6(B)
12
7
MAIN SCANNING DIRECTION
SUB-SCANNING DIRECTION

FIG.5

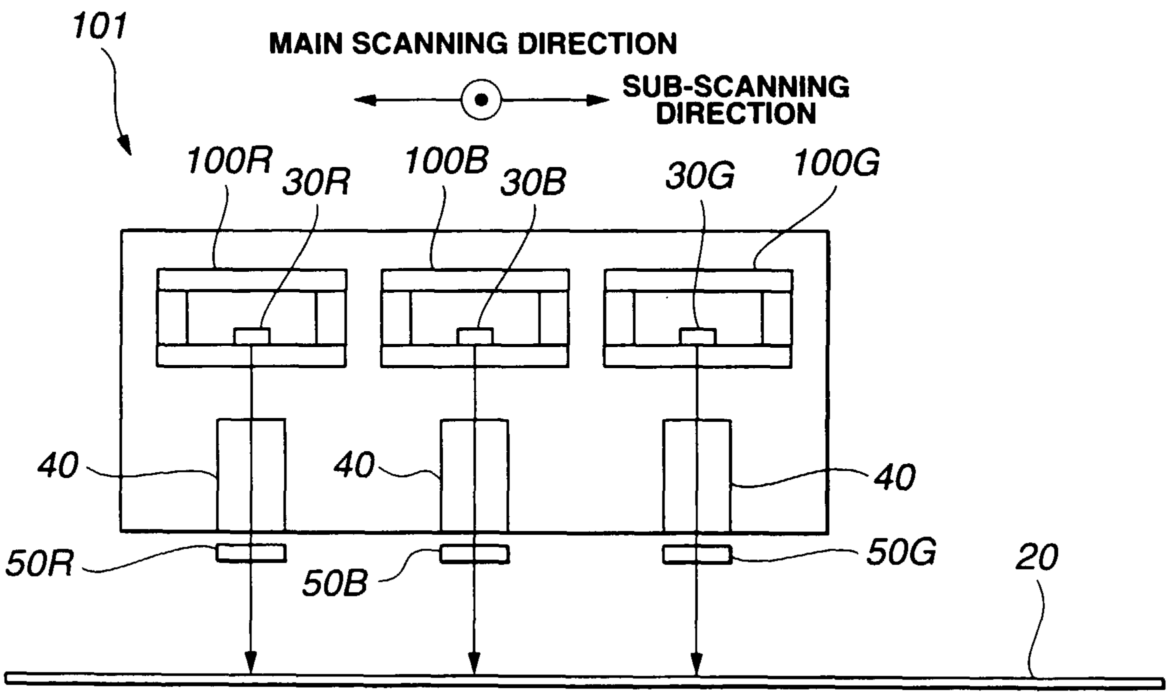

101
MAIN SCANNING DIRECTION
SUB-SCANNING DIRECTION
100R
30R
100B
30B
30G
100G
40
40
40
50R
50B
50G
20

FIG.6

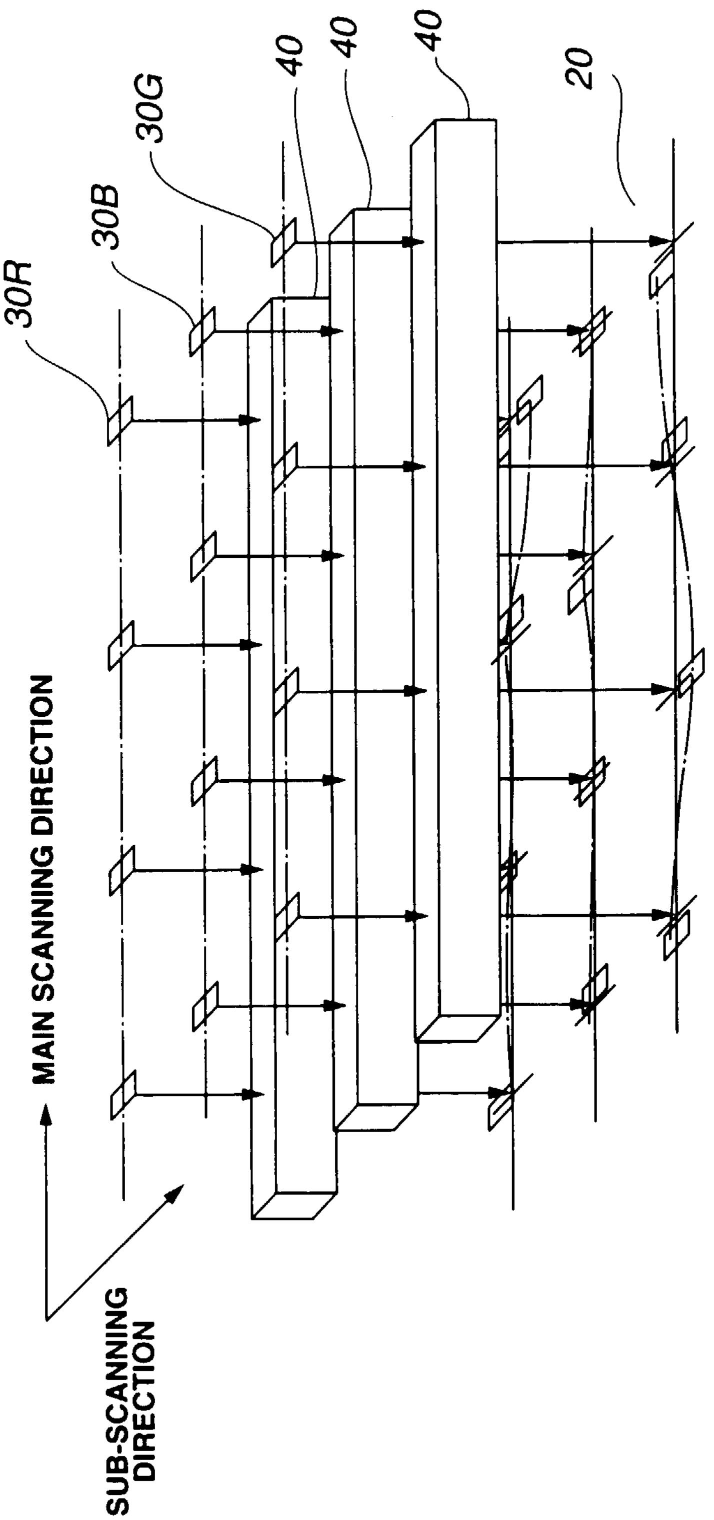

MAIN SCANNING DIRECTION
SUB-SCANNING DIRECTION
30R
30B
30G
40
40
40
20

FIG.7

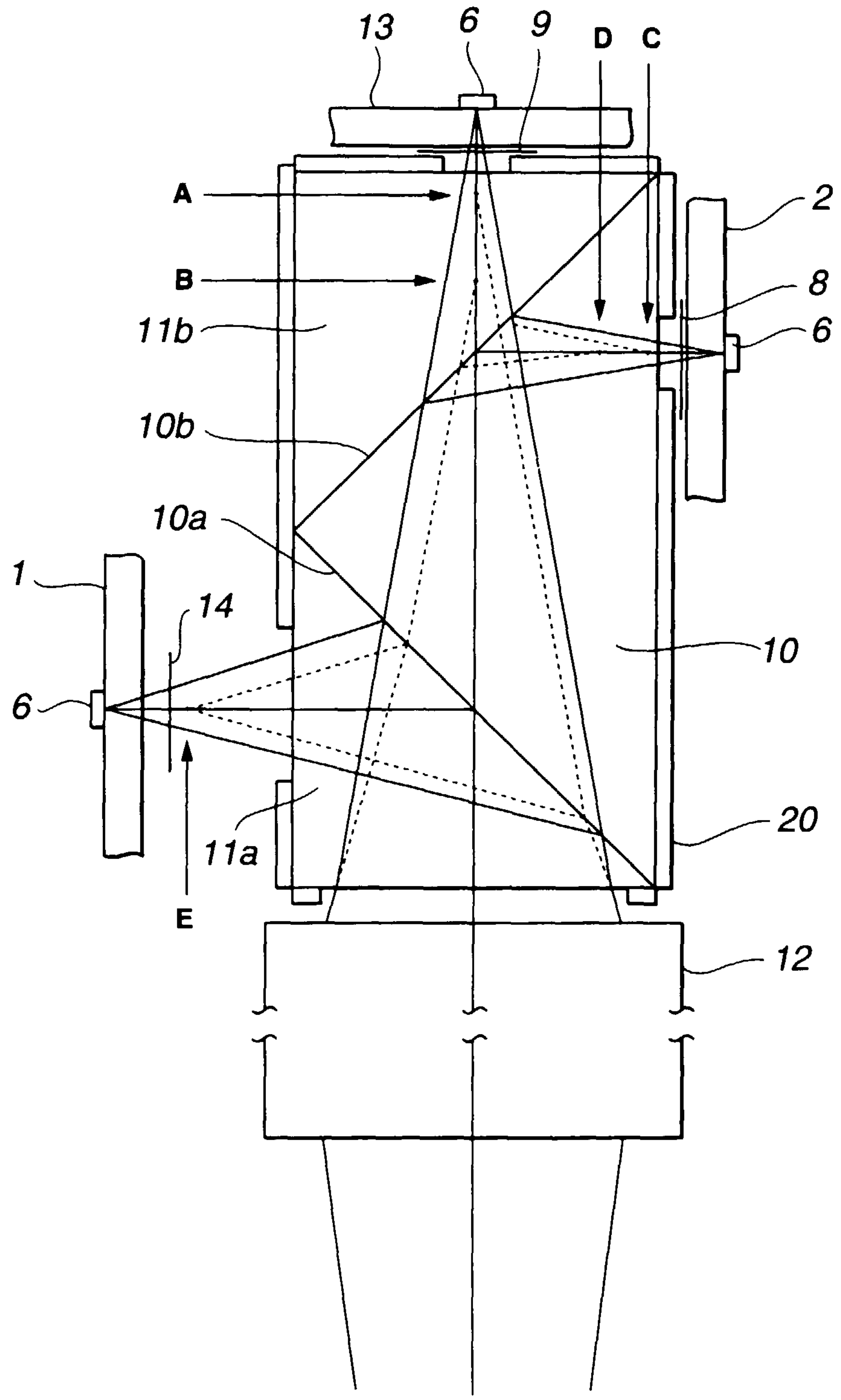
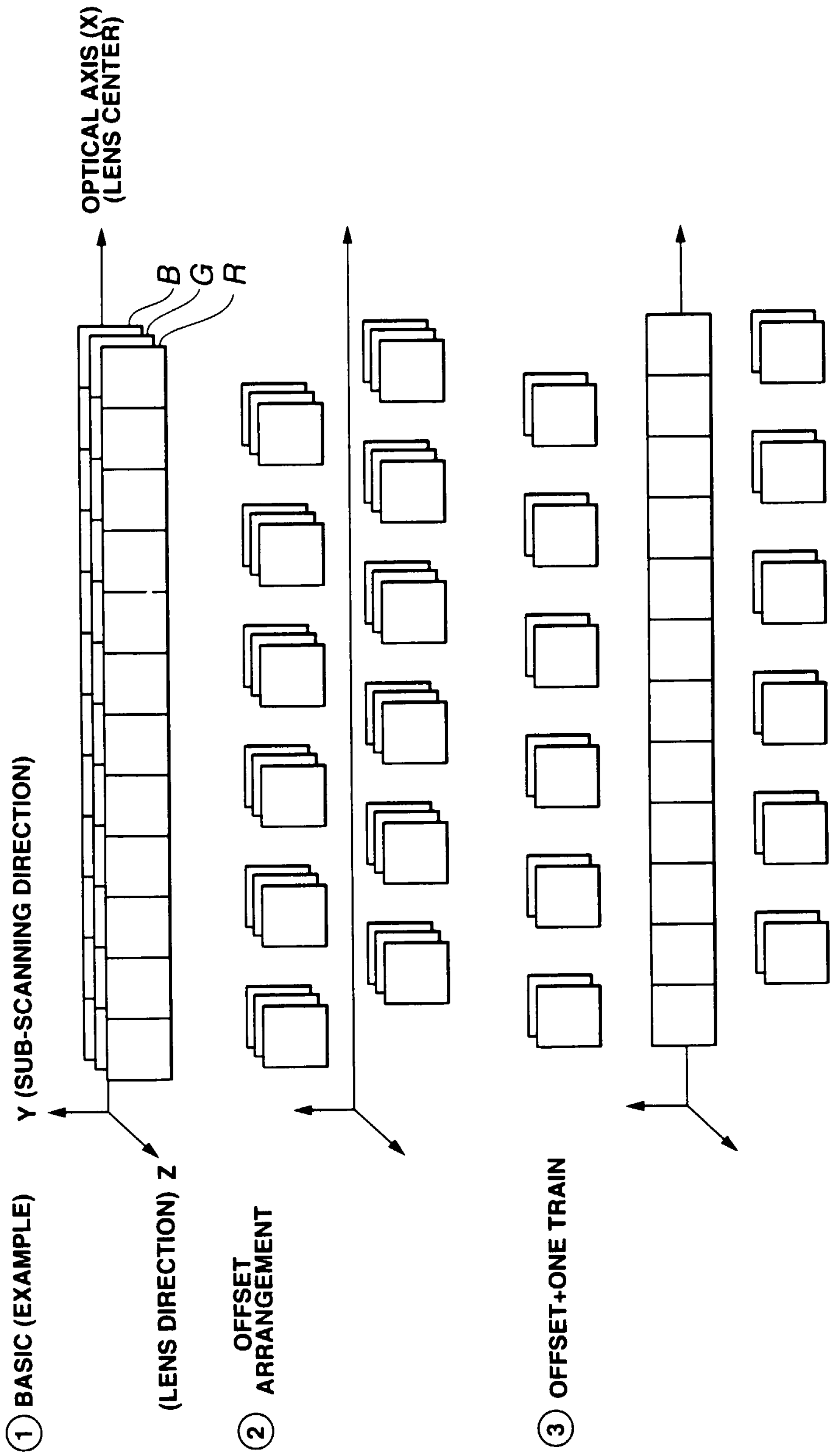


FIG.8


OPTICAL AXIS (X)
(LENS CENTER)
B
G
R
Y (SUB-SCANNING DIRECTION)
(LENS DIRECTION) Z
① BASIC (EXAMPLE)
② OFFSET ARRANGEMENT
③ OFFSET+ONE TRAIN

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 30 2399

DOCUMENTS CONSIDERED TO BE RELEVANT

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B41J
G02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 July 2000	De Groot, R

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