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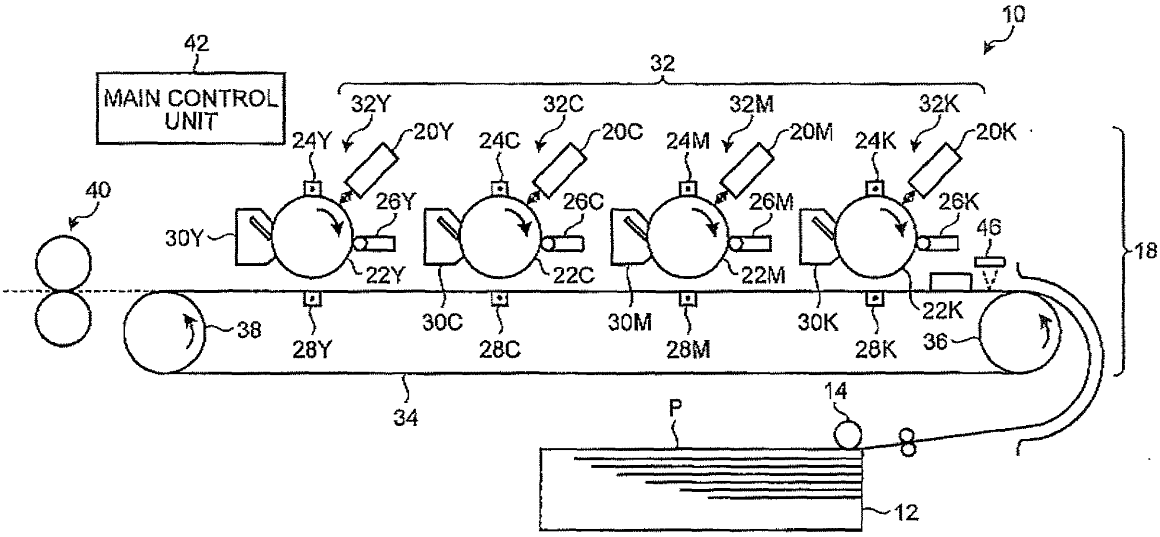
(54) Image forming apparatus

(57) An image forming apparatus (10) includes an exposing unit (20) including light emitting chips (44) arranged in a main-scanning direction; a developing unit (26) configured to develop an electrostatic latent image formed on a photosensitive element (22) to form a toner image; a transfer unit (28) configured to transfer the toner image to a medium (34); a detecting unit (50) configured to detect an amount of skew in an array direction of each light emitting chip (44); an adjusting unit (68) configured to generate a density correction image to be formed on the medium (34) through dithering, the density correction image having a higher resolution than that of a printing image and having the resolution increased with an increase in the amount of skew; and a correction unit (61) configured to perform skew correction on the density correction image on the basis of the amount of skew.

FIG.1



EP 2 541 332 A2

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an image forming apparatus.

BACKGROUND OF THE INVENTION

[0002] As an exposing unit to be used for forming an electrostatic latent image on a photosensitive element, there is known an exposing device in which a plurality of light emitting chips each having a plurality of light emitting elements arranged are disposed in a main-scanning direction (for example, Japanese Patent Application Laid-open No. 2007-145001).

[0003] Japanese Patent Application Laid-open No. 2007-145001 discloses an image forming apparatus including a recording element array in which a plurality of recording chips each having a plurality of recording elements arranged are disposed in the main-scanning direction. Japanese Patent Application Laid-open No. 2007-145001 also discloses that a line image in the main-scanning direction of image data is divided into a plurality of pixel groups and an image in each of the pixel groups thus divided is formed with a shift in a sub-scanning direction, thereby correcting a skew to be a shift between an array direction of the recording elements and a rotating axis direction of the photosensitive element (the main-scanning direction).

[0004] In an electrophotographic image forming apparatus, moreover, a dithering process is performed on image data of a multitone image received from an external device or the like by using a dither matrix to binarize the image data. Then, lighting and non-lighting of a light emitting element is controlled in accordance with the image data subjected to the dithering process to form an image.

[0005] In some cases in which a skew correction process is performed on the image data subjected to the dithering process by using the dither matrix, streaks are generated. This is because changes in shape of a pattern obtained by the dither matrix are caused in a position in which the image is shifted in a sub-scanning direction.

[0006] As the technique for preventing such streaks from being formed on an image, Japanese Patent Application Laid-open No. 2007-145001 discloses that a boundary position between recording chips and a division position for image data corresponding to one line in the skew correction are shifted. Moreover, Japanese Patent Application Laid-open No. 2009-027683 discloses that an image shift position in a sub-scanning direction in a skew correction is caused to be coincident with a position of a multiple of a size in a main-scanning direction of the dither matrix.

[0007] In Japanese Patent Application Laid-open No. 2007-145001 and Japanese Patent Application Laid-open No. 2009-027683, it is hard to suppress streaks generated when an application position of the dither matrix and the boundary position between the recording chips are coincident with each other. For this reason, in the image forming apparatus, streaks are also formed on a density correction image to be formed in a density correction of an image to be formed so that precision in the density correction is deteriorated.

[0008] Therefore, there is a need for an image forming apparatus capable of preventing streaks from being formed on a density correction image.

SUMMARY OF THE INVENTION

[0009] It is an object of the present invention to at least partially solve the problems in the conventional technology.

[0010] According to an embodiment, there is provided an image forming apparatus that includes a photosensitive element; an exposing unit including a plurality of light emitting chips arranged in a main-scanning direction, each of the light emitting chips including a plurality of light emitting elements arranged in the main-scanning direction; a light-emitting control unit configured to control the light emitting elements; a developing unit configured to develop an electrostatic latent image formed on the photosensitive element by the exposing unit to form a toner image; a transfer unit configured to transfer the toner image to a medium to form an image on the medium; a detecting unit configured to detect an amount of skew indicative of a shift amount in an array direction of each of the light emitting chips with respect to the main-scanning direction; a resolution adjusting unit configured to generate image data of a density correction image used for a density correction through a dithering process, the density correction image being formed on the medium, the density correction image having a higher resolution than that of a printing image to be formed on the medium and having the resolution increased with an increase in the amount of skew, the density correction image being divided into a plurality of sections in the main-scanning direction; and a correction unit configured to perform skew correction on the density correction image in a manner that shifts image data of the density correction image corresponding to each of the sections in a sub-scanning direction on the basis of the amount of skew.

[0011] The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is a typical view illustrating an example of a structure of an image forming apparatus according to the present embodiment;

Fig. 2 is a typical view illustrating an example of a structure of an exposing unit;

Fig. 3 is a functional block diagram illustrating a state in which a main control unit is divided every function implementing unit determined based on hardware and software;

Fig. 4 is a functional block diagram illustrating a write control unit;

Fig. 5 is a flow chart illustrating a flow of an image formation process;

Fig. 6 is a typical view illustrating a correspondence of an image of image data of a density correction image to a density correction image formed by the image forming apparatus through the image data of the density correction image every resolution;

Fig. 7 is a typical view illustrating an example of a skew correction image in each of the case in which a skew correction is not performed and the case in which two types of skew corrections are performed; and

Fig. 8 is a block diagram illustrating a hardware structure of the image forming apparatus according to the embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] An embodiment of an image forming apparatus will be described below in detail with reference to the accompanying drawings.

[0014] Fig. 1 is a typical view illustrating a structure of an image forming apparatus 10 according to the present embodiment.

[0015] The image forming apparatus 10 includes a paper feed tray 12, an image forming unit 18, a fixing unit 40, a main control unit 42, and a sensor 46.

[0016] The paper feed tray 12 accommodates a plurality of recording media P. The recording media P are conveyed to the image forming unit 18 via a paper feed roller 14 or a conveying unit which is not illustrated.

[0017] The image forming unit 18 includes an image forming unit 32 for forming an image having each color and a conveying belt 34. The image forming unit 18 forms an image on the recording medium P and the conveying belt 34 which will be described below.

[0018] The conveying belt 34 is supported at an inside through a driving roller 36 and a roller 38, and is conveyed along a rotation of the driving roller 36 and the roller 38.

[0019] The image forming unit 32 includes an image forming unit 32K for forming a toner image having a black color, an image forming unit 32M for forming a toner image having a magenta color, an image forming unit 32C for forming a toner image having a cyan color, and an image forming unit 32Y for forming a toner image having an yellow color. These image forming units 32 are arranged in a conveying direction of the conveying belt 34.

[0020] The image forming unit 32K includes a photosensitive element 22K to be rotated with a main-scanning direction set to be a rotation axis direction, a charging unit 24K for charging the photosensitive element 22K, an exposing unit 20K for forming an electrostatic latent image, a developing unit 26K for developing the electrostatic latent image with toner, a transfer device 28K for transferring the toner image onto a medium such as the conveying belt 34 or the recording medium P, and a cleaning member 30K for removing a deposit on the photosensitive element 22K. The image forming units 32M, 32C and 32Y also include photosensitive elements (22M, 22C and 22Y), charging units (24M, 24C and 24Y), exposing units (20M, 20C and 20Y), developing units (26M, 26C and 26Y), transfer devices (28M, 28C and 28Y), and cleaning members (30M, 30C and 30Y).

[0021] These image forming units 32 have the same structure except that toners to be used for a development in the developing units 26K have different colors from each other. Since these image forming units 32 are of a well-known electrophotography except that the exposing unit 20 has a structure which will be described below, moreover, detailed description will be omitted.

[0022] In the case in which each portion provided in each image forming unit 32 is generally described, furthermore, signs of C, M, Y and K will be omitted for the description.

[0023] The recording medium P supplied to the image forming unit 18 is conveyed by means of the conveying belt 34 and a toner image is sequentially transferred thereto by means of the image forming unit 32. The fixing unit 40 fixes, to the recording medium P, the toner image transferred to the recording medium P.

[0024] In the image forming apparatus 10 according to the present embodiment, the exposing unit 20 has a structure in which a plurality of optical elements is arranged in a main-scanning direction to be a rotating axis direction of the photosensitive element 22.

[0025] As described above, the main-scanning direction indicates a direction which is coincident with the rotating axis direction of the photosensitive element 22 (see a direction of an arrow X in Fig. 2). Moreover, a subscanning direction which will be described below indicates a direction which is orthogonal to the main-scanning direction.

[0026] Fig. 2 illustrates an example of the exposing unit 20.

[0027] As illustrated in Fig. 2, the exposing unit 20 has a structure in which a plurality of light emitting chips 44 is arranged in the main-scanning direction. Each of the light emitting chips 44 has a structure in which a plurality of light emitting elements 44A are arranged in the main-scanning direction. Examples of the light emitting element 44A include an LED (Light Emitting Diode).

[0028] The sensor 46 reads a density correction image formed on the conveying belt 34 or the recording medium P, a skew correction image or a light amount correction image.

[0029] The density correction image is used for a density correction and has a plurality of regions having different density values (tones), for example. The light amount correction image is used for correcting an amount of light emitted from each of the light emitting elements 44A in the exposing unit 20. Examples of the light amount correction image include an image having a predetermined reference density.

[0030] The skew correction image is used for a skew correction. In the present embodiment, a skew indicates a shift in an array direction of the light emitting elements 44A with respect to the main-scanning direction to be coincident with the rotating axis direction of the photosensitive element 22. Examples of the skew correction image include an elongated image which is long from one of ends to the other end in the main-scanning direction of the photosensitive element 22, a pair of images formed from one of the ends and the other end in the main-scanning direction of the photosensitive element 22, and the like.

[0031] For the sensor 46, it is preferable to use a well-known sensor for detecting the density correction image, the skew correction image and the light amount correction image. For example, it is preferable to use, as the sensor 46, a well-known sensor for detecting various images (the density correction image, the skew correction image and the light amount correction image) formed on the recording medium P or the conveying belt 34 and detecting presence of the images or tones of the images.

[0032] The density correction image, the skew correction image and the light amount correction image are formed in positions detected by the sensor 46 provided on the conveying belt 34.

[0033] The main control unit 42 controls each portion provided in the image forming apparatus 10. The main control unit 42 is configured to include a CPU (Central Processing Unit), a ROM (Read Only Memory) storing an image forming program and the like for executing an image formation process which will be described below, a RAM (Random Access Memory) storing data and the like, and a bus for connecting them. The main control unit 42 is electrically connected to each unit provided in the image forming apparatus 10.

[0034] Fig. 3 is a functional block diagram illustrating the main control unit 42 which is divided every function implementing unit determined based on hardware and software. The main control unit 42 includes an image processing unit 54, a detecting unit 50 and a write control unit 52. The sensor 46 is electrically connected to the detecting unit 50. The sensor 46 outputs a detection signal to the detecting unit 50.

[0035] The detection signal includes detection timings of various images formed on the conveying belt 34 and density information indicative of densities of the various images. The detecting unit 50 outputs the detection signal received from the sensor 46 to the image processing unit 54 and the write control unit 52.

[0036] In detail, in the case in which the detection signal received from the sensor 46 is a detection signal for the density correction image or the light amount correction image, the detecting unit 50 outputs the detection signal to the image processing unit 54. In the case in which the detection signal received from the sensor 46 is a detection signal for the skew correction image, moreover, the detecting unit 50 outputs the detection signal to the image processing unit 54 and the write control unit 52.

[0037] Whether the detection signal received from the sensor 46 is the detection signal for any of the skew correction image, the density correction image and the light amount correction image is determined as follows. For example, when an operating unit which is not illustrated is operated by a user to input a signal indicative of a density correction instruction and a density correction image is formed by the image forming unit 18, and the detecting unit 50 then receives the detection signal, the detecting unit 50 determines that the detection signal is the detection signal for the density correction image. When a signal indicative of a skew correction instruction is input, the skew correction image is formed by the image forming unit 18 and the detecting unit 50 then receives the detection signal, similarly, the detecting unit 50 determines that the detection signal is the detection signal for the skew correction image. When a signal indicative of a light amount correction instruction is input, the light amount correction image is formed by the image forming unit 18 and the detecting unit 50 then receives the detection signal, similarly, the detecting unit 50 determines that the detection signal is the detection signal for the light amount correction image.

[0038] The image processing unit 54 receives image data of a printing image (image to be printed on the recording medium P) or the like from an external device such as a personal computer and converts multitone image data of RGB into multitone image data of CMYK. Moreover, the image processing unit 54 has a dithering unit 54A, and uses a predetermined dither pattern to perform a dithering process on the multitone image data, thereby binarizing the image data. Then, the image data of the printing image subjected to the dithering process are output to the write control unit 52.

[0039] The write control unit 52 outputs, to the exposing unit 20 for each color, the detection signal received from the detecting unit 50 and the image data of the printing image subjected to the dithering process and received from the image processing unit 54 in the formation of a printing image.

[0040] Moreover, the write control unit 52 outputs, to the exposing unit 20 for each color, image data of the density correction image having a higher resolution than that of the printing image in the formation of the density correction image, which will be described below in detail.

[0041] The write control unit 52 includes a plurality of write control units 56 (56K, 56M, 56C and 56Y) corresponding to the image forming units 32 for respective colors.

[0042] Fig. 4 illustrates a structure of each of the write control units 56. Since the write control unit 56K, the write control unit 56Y, the write control unit 56M and the write control unit 56C have the same structure, they will be generally referred to as the write control unit 56 and description will be thus given.

[0043] The write control unit 56 includes an input image control unit 60, a skew correction processing unit 61, an LD data output unit 64, a resolution adjusting unit 68, a transfer rate control unit 70, and a photosensitive element driving speed control unit 72.

[0044] The skew correction processing unit 61 executes a skew correction processing. More specifically, the skew correction processing unit 61 shifts (moves) the image of the image data subjected to the dithering process in a sub-scanning direction depending on an amount of skew every sections which are preset in a main-scanning direction. Consequently, the skew correction processing unit 61 executes the skew correction processing.

[0045] In detail, the skew correction processing unit 61 includes a line memory 62 and a correction value calculating unit 66.

[0046] The line memory 62 is configured to include a plurality of line memories 62A to 62D. Each of the line memories 62A to 62D stores line image data corresponding to one line in the main-scanning direction. The line image data to be stored in each of the line memories 62A to 62D are sequentially stored and updated by the input image control unit 60.

[0047] The input image control unit 60 receives image data of a printing image input from the image processing unit 54, image data of a density correction image received from the resolution adjusting unit 68 which will be described below or the like, and outputs the line image data to the line memory 62 in relation to the received image data.

[0048] The input image control unit 60 includes an oscillator 60A, a counter 60B, a clear signal generating unit 60C and a line memory update signal output unit 60D.

[0049] The oscillator 60A oscillates a high frequency clock. A clock of the oscillator 60A is configured to be switchable into a frequency which is 1/P (P is an integer) times as great as a characteristic value of the oscillator through a frequency division. The write control unit 56 is operated based on a clock generated by the oscillator 60A.

[0050] As described above, moreover, the input image control unit 60 receives information indicative of the image data of the density correction image and the resolution of the density correction image from the resolution adjusting unit 68 which will be described below in the formation of the density correction image. Then, the input image control unit 60 generates a clock in the formation of the density correction image that is N times the frequency of that in the formation of the printing image in the oscillator 60A. The "N" indicates a ratio (hereinafter, "N-fold") (N is an integer) of the resolution of the density correction image to that of the printing image. Information indicative of the "N" is received as a clock change signal of the oscillator 60A from the resolution adjusting unit 68 which will be described below. In the present embodiment, it is assumed that the resolution of the printing image is preset.

[0051] The counter 60B counts a time required for forming an image corresponding to one dot in the main-scanning direction through the image forming unit 18, The clear signal generating unit 60C generates a line clear signal when the counter 60B reaches a specified value. Then, the clear signal generating unit 60C outputs the line clear signal thus generated to the counter 60B, the line memory update signal output unit 60D and the exposing unit 20. When receiving the line clear signal, the counter 60B resets a counter value to "0".

[0052] When receiving the image data of the printing image from the image processing unit 54, that is, in the formation of the printing image, the line memory update signal output unit 60D outputs a line memory update signal to the line memory 62 every time it once receives the line clear signal. On the other hand, when receiving the image data of the density correction image, that is, in the formation of the density correction image, the input image control unit 60 changes an update cycle of the line memory 62 and outputs the line memory update signal to the line memory 62 every time the line clear signal is generated at N times. In other words, in the formation of the density correction image, the input image control unit 60 changes the update cycle of the line memory 62 into 1/N. The "N" indicates an equal numeric value to 'N" which is a ratio of the resolution of the density correction image to that of the printing image (and so forth). Information indicative of the update cycle of the line memory 62 (that is, information indicative of 1/N) is received from the resolution adjusting unit 68.

[0053] The line memory 62 stores line image data corresponding to four lines in the main-scanning direction which are continuous in the sub-scanning direction in the separate line memories 62A to 62D every one-line image data. In detail, the line memory 62 stores the line image data corresponding to the four lines in the main-scanning direction every line in the line memories 62A to 62D in relation to the image data of the printing image in the formation of the printing image. Moreover, the line memory 62 stores the line image data corresponding to the four lines in the main-scanning direction every line in the line memories 62A to 62D in relation to the image data of the density correction image in the formation of the density correction image.

[0054] Although description will be given to the case in which the line memory 62 has four line memories 62A to 62D in the present embodiment, it is sufficient to employ a structure having line memories for the number of lines corresponding to a maximum skew amount which might be generated and the present embodiment is not restricted to the four line memories.

[0055] Every time the line memory update signal is received once, the line memory 62 updates the line image data stored in the respective line memories 62A to 62D from older line image data (stored most previously) to new (next) line image data in order. Thus, the line memory 62 repeats an update processing for holding the line image data corresponding to the four lines in the line memories 62A to 62D and overwriting and erasing the older data in order.

[0056] A timing for reading the line image data stored in the line memories 62A to 62D of the line memory 62 is controlled by the correction value calculating unit 66.

[0057] The correction value calculating unit 66 calculates a correction value for correcting a skew.

[0058] In detail, the correction value calculating unit 66 includes a skew correction area calculating unit 66A, a skew amount storing unit 66B, a read control unit 66C, a skew amount calculating unit 66D and a skew correction value calculating unit 66E.

[0059] The skew correction area calculating unit 66A and the skew amount calculating unit 66D receive a detection signal to be a detection result of a skew correction image from the detecting unit 50.

[0060] The skew correction area calculating unit 66A calculates a place in which a skew is generated from the detection signal received by the detecting unit 50, thereby computing a skew correction area. The skew correction area indicates a position in the main-scanning direction on a division section to be a skew correction target in the case in which an image of image data is divided into a plurality of division sections in the main-scanning direction. The skew correction area calculating unit 66A calculates the skew correction area from the detection signal by using a well-known calculating method. The skew correction area calculating unit 66A outputs information indicative of the skew correction area thus calculated to the read control unit 66C.

[0061] The skew correction area may be predetermined and stored in the skew correction area calculating unit 66A. In this case, the skew correction area calculating unit 66A outputs information indicative of the stored skew correction area to the read control unit 66C.

[0062] The skew amount calculating unit 66D calculates an amount of skew from the detection signal received from the detecting unit 50. A well-known method may be used to calculate the amount of skew. The skew amount storing unit 66B stores the amount of skew calculated by the skew amount calculating unit 66D.

[0063] The skew correction value calculating unit 66E calculates a skew correction value for correcting a skew from the amount of skew calculated by the skew amount calculating unit 66D by using a well-known method. Then, the skew correction value thus obtained is output to the read control unit 66C.

[0064] The read control unit 66C controls to read the line image data stored in the respective line memories 62A to 62D based on the information indicative of the skew correction area received from the skew correction area calculating unit 66A and the skew correction value received from the skew correction value calculating unit 66E. In detail, the read control unit 66C reads a pixel data group every division section from the line image data stored in the respective line memories 62A to 62D based on the information indicative of the skew correction area and the skew correction value.

[0065] In detail, the read control unit 66C reads a pixel data group every predetermined division section in the main-scanning direction of an image of image data in order from a pixel side on one of ends toward a pixel side on the other end in the main-scanning direction, and sequentially outputs the pixel data group to the LD data output unit 64. In the reading of the pixel data group, the read control unit 66C reads the pixel data group from any of the line memories 62A to 62D storing line image data on a line shifted in a sub-scanning direction depending on a skew correction value in the line memories 62A to 62D in a position corresponding to the skew correction area. By the read control of the read control unit 66C, therefore, a pixel data group in a division pixel group in a position shifted in the sub-scanning direction depending on an amount of skew is sequentially read from the line memories 62A to 62D and output to the LD data output unit 64.

[0066] In the present embodiment, it is assumed that information indicative of a division section (unit of division) in division of image data in the main-scanning direction is predetermined. It is assumed that the information indicative of the division section is stored in advance in the write control unit 56.

[0067] The division section in the main-scanning direction of the image data, which is a unit of shifting in the sub-scanning direction depending on the amount of skew, may be set to be any size. It is preferable that the division sections be determined so that an image of image data subjected to the dithering process is divided in positions corresponding to boundaries between the light emitting chips 44 which are adjacent to each other. By thus setting the division sections in the main-scanning direction of the image data, it is possible to further prevent streaks from being generated on a density correction image.

[0068] The resolution adjusting unit 68 outputs, through the input image control unit 60 to the skew correction processing unit 61, image data of a density correction image having a resolution which is higher than that in the case of the formation of a printing image and is increased with an increase in an amount of skew and information indicative of the resolution of the density correction image in the formation of the density correction image. The input image control unit 60 outputs, to the line memory 62, the image data of the density correction image thus received every line image data on one line in the main-scanning direction as described above.

[0069] In detail, the resolution adjusting unit 68 includes a resolution increase processing unit 74, an output unit 75, a dithering unit 76, a basic density correction image storing unit 77 and an output unit 78.

[0070] The basic density correction image storing unit 77 stores in advance image data of a basic density correction image which is a density correction image having a predetermined resolution. The basic density correction image storing unit 77 stores in advance the multitone image data which is not subjected to the dithering process. The predetermined resolution is equal to or higher than a resolution of a printing image. In the present embodiment, the basic density correction, image storing unit 77 stores in advance the basic density correction image to be a density correction image having an equal resolution to the resolution of the printing image.

[0071] The resolution increase processing unit 74 sets various conditions for forming a density correction image having a resolution which is higher than that of a printing image and is increased with an increase in an amount of skew based on the amount of skew calculated by the correction value calculating unit 66.

[0072] In detail, the resolution increase processing unit 74 includes a skew amount reading unit 74A, a dither matrix setting unit 74B and a driving condition setting unit 74C.

[0073] The skew amount reading unit 74A reads the amount of skew calculated by the skew amount calculating unit 66D from the skew amount storing unit 66B and outputs the amount of skew to the dither matrix setting unit 74B. The dither matrix setting unit 74B stores in advance plural types of dither matrices having resolutions which are higher than the resolution of the printing image and are different from each other. The dither matrix indicates a pattern to be used for binarizing a multitone image and is also referred to as a dither pattern. In the dithering process, an image on the multitone image data is divided every block depending on the dither matrix constituted by a threshold of M $\times$ M pixels (M is an integer) and is compared with the threshold of the dither matrix every block, thereby executing the binarization for each block.

[0074] By using the plural types of dither matrices having different resolutions from each other, the resolution of the image of the binarized image data which are obtained by executing the dithering process by utilizing each dither matrix is varied. More specifically, examples of the plural types of dither matrices having different resolutions include dither matrices having different sizes of dither patterns (in other words, there is varied the value of M in a dither pattern corresponding to the M $\times$ M pixels). With the dither matrix having a greater value of M, the image of the binarized image data which are obtained by executing the dithering process has a resolution reduced (a dot has a greater size). On the other hand, with the dither matrix having a smaller value of M, the image of the binarized image data which are obtained by executing the dithering process has a resolution increased (the dot has a smaller size).

[0075] The dither matrix setting unit 74B stores in advance plural types of dither matrices having resolutions which are higher than the resolution of the printing image and are different from each other in order to obtain an image having a higher resolution than the resolution of the printing image through the dithering process. The dither matrix setting unit 74B correspondingly stores in advance information indicative of a resolution and information indicative of a dither matrix to be used for implementing the resolution.

[0076] The dither matrix setting unit 74B reads the information indicative of the dither matrix corresponding to information increased with an increase in the amount of skew read from the skew amount calculating unit 66D, thereby setting a dither matrix to be used in the dithering process for image data of a multitone basic density correction image.

[0077] Consequently, the dither matrix setting unit 74B sets a dither matrix having a resolution which is higher than the resolution of the printing image and is increased with an increase in an amount of skew as a dither matrix to be used in a dithering process for image data of a basic density correction image. Moreover, the dither matrix setting unit 74B determines the resolution of the density correction image by setting the dither matrix.

[0078] The dither matrix setting unit 74B outputs information indicative of the dither matrix thus set to the dithering unit 76. Moreover, the dither matrix setting unit 74B outputs a resolution corresponding to the set dither matrix, that is, information indicative of the resolution of the density correction image to the output unit 75 and the driving condition setting unit 74C.

[0079] The driving condition setting unit 74C sets a driving condition of the image forming apparatus 10 based on the information indicative of the resolution of the density correction image which is received from the dither matrix setting unit 74B.

[0080] The driving condition is at least one of a rotating speed of the photosensitive element 22, a transfer rate in an output of the image data of the density correction image from the output unit 75 to the input image control unit 60, an update cycle of the line memory 62, a rate of a light emitting time of the light emitting elements 44A in the formation of an image corresponding to one line in the main-scanning direction, and a driving current for driving the light emitting elements 44A.

[0081] The driving condition setting unit 74C sets the driving condition based on the resolution of the density correction image and the resolution of the printing image which is predetermined.

[0082] More specifically, it is assumed that a ratio of the resolution of the density correction image which is received from the dither matrix setting unit 74B to the resolution of the printing image which is stored in advance is N-fold.

[0083] In this case, the driving condition setting unit 74C sets the driving current of the exposing unit 20 to be 1/N of that in the formation of the printing image when the density correction image is to be formed or sets the light emitting time of the light emitting element 44A in the image formation corresponding to one line to be 1/N of the time in the formation of the printing image.

[0084] Moreover, the driving condition setting unit 74C sets a line memory update cycle to be 1/N of that in the formation of the printing image when the density correction image is to be formed.

[0085] Furthermore, the driving condition setting unit 74C sets the driving speed of the photosensitive element 22 to be 1/N of that in the formation of the printing image according to a cyclic variable power (which is set to be 1/N) of the line memory update signal through the line memory update signal output unit 60D in the formation of the density correction image.

[0086] In addition, the driving condition setting unit 74C sets the transfer rate of the image data of the density correction image which is output from the output unit 75 of the resolution adjusting unit 68 to the input image control unit 60 to 1/N of the transfer rate of the image data of the printing image from the image processing unit 54 to the input image control unit 60 in the formation of the density correction image.

[0087] The driving condition setting unit 74C outputs each driving condition thus set to the output unit 78. The output unit 78 outputs each driving condition received from the driving condition setting unit 74C to the transfer rate control unit 70, the photosensitive element driving speed control unit 72, the input image control unit 60 and an LED control unit 64A.

[0088] The transfer rate control unit 70 receives information indicative of a transfer rate of the image data of the density correction image as the driving condition from the driving condition setting unit 74C. Then, the transfer rate control unit 70 controls the output unit 75 in order to transfer the image data of the density correction image at the transfer rate thus received.

[0089] The photosensitive element driving speed control unit 72 receives information indicative of the rotating speed of the photosensitive element 22 as the driving condition from the driving condition setting unit 74C. The photosensitive element driving speed control unit 72 controls a driving unit (not illustrated) of the image forming unit 18 in order to rotate the photosensitive element 22 at the rotating speed thus received in the formation of the density correction image.

[0090] The LD data output unit 64 receives information indicative of the driving current of the exposing unit 20 or information indicative of a rate of the light emitting time of the light emitting element 44A in an image formation for one line as the driving condition from the driving condition setting unit 74C. The LED control unit 64A of the LD data output unit 64 outputs an LED control signal corresponding to the driving current or the rate of the light emitting time to the exposing unit 20 in the formation of the density correction image. In the exposing unit 20, a driving current corresponding to the LED control signal thus received is applied to each of the light emitting elements 44A or a driving signal corresponding to the rate of the light emitting time is output to each of the light emitting elements 44A.

[0091] The dithering unit 76 performs the dithering process on the multitone image data of the basic density correction image stored in the basic density correction image storing unit 77 by using the dither matrix set by the dither matrix setting unit 74B. By the dithering process, the dithering unit 76 generates image data of a density correction image having a resolution which is higher than that of a printing image and is increased with an increase in an amount of skew. The dithering unit 76 outputs, to the output unit 75, the image data of the density correction image thus obtained.

[0092] The output unit 75 outputs, to the input image control unit 60, the image data of the density correction image received from the dithering unit 76 at the transfer rate set by the transfer rate control unit 70. Moreover, the output unit 75 outputs, to the input image control unit 60, information indicative of the resolution of the density correction image which is received from the dither matrix setting unit 74B.

[0093] Next, description will be given to a flow of an image formation process in the image forming apparatus 10. Fig. 5 is a flow chart illustrating the flow of the image formation process in the image forming apparatus 10 according to the present embodiment.

[0094] When receiving a print job from an external device such as a personal computer, the main control unit 42 of the image forming apparatus 10 reads an image forming program for executing the image formation process from the ROM and then executes a processing illustrated in Fig. 5.

[0095] First of all, the main control unit 42 determines whether a skew correction is executed or not (Step S100). When an operating instruction is given to an operating unit (not illustrated) by a user so that the main control unit 42 receives a signal indicative of a skew correction instruction from the operating unit, for example, it decides the execution of the skew correction (Step S100: Yes). When the operating instruction is given to the operating unit (not illustrated) by the user so that the signal indicative of the skew correction instruction is input, the main control unit 42 may store the signal in memory which is not illustrated. In the case in which the signal indicative of the skew correction instruction is stored in the memory, the main control unit 42 may make an affirmative determination in Step S100. In this case, the signal indicative of the skew correction instruction stored in the memory is cleared (erased) every time a power switch (not illustrated) of the image forming apparatus 10 is operated to supply a power to each unit of the image forming apparatus 10.

[0096] If the main control unit 42 decides that the skew correction is not executed (Step S100: No), the processing proceeds to Step S114 which will be described below.

[0097] Subsequently, the image processing unit 54 forms a skew correction image (Step S102). In detail, the image processing unit 54 stores in advance the image data of the multitone skew correction image. Then, the dithering unit 54A of the image processing unit 54 performs the dithering process on the image data of the skew correction image by using the same dither matrix as the dither matrix to be used in the dithering process for the image data of the printing image, and outputs the image data to the write control unit 52. When receiving the image data of the skew correction image, the write control unit 52 executes the same process as that in the process for the image data of the printing image through the input image control unit 60, the line memory 62 and the LD data output unit 64 in the write control unit 56 for each color. Consequently, the image forming unit 18 forms a skew correction image on the conveying belt 34.

[0098] Next, the detecting unit 50 detects the skew correction image (Step S104). The detecting unit 50 outputs, to the correction value calculating unit 66, a detection signal indicative of a result of a detection of the skew correction image which is detected.

[0099] The skew amount calculating unit 66D calculates an amount of skew based on the detection signal for the skew correction image which is received from the detecting unit 50, and stores the amount of skew in the skew amount storing unit 66B (Step S106 and Step S108). Consequently, the skew correction value calculating unit 66E calculates a skew correction value by using the amount of skew stored in the skew amount storing unit 66B and outputs the skew correction value to the read control unit 66C (Step S110).

[0100] Then, the skew correction area calculating unit 66A calculates a skew correction area based on the detection signal for the skew correction image which is received from the detecting unit 50, and outputs the skew correction area to the read control unit 66C (Step S112).

[0101] Subsequently, the main control unit 42 determines whether a density correction is executed or not (Step S114). When an operating instruction is given to the operating unit (not illustrated) by the user so that the main control unit 42 receives a signal indicative of a density correction instruction from the operating unit, for example, it determines the execution of the density correction(Step S114: Yes). When the operating instruction is given to the operating unit (not illustrated) by the user so that the signal indicative of the density correction instruction is input, the main control unit 42 may store the signal in memory (not illustrated). In the case in which the signal indicative of the density correction instruction is stored in the memory, the main control unit 42 may make an affirmative determination in Step S114. In this case, the signal indicative of the density correction instruction stored in the memory is cleared (erased) every time a power switch (not illustrated) of the image forming apparatus 10 is operated to supply a power to each unit of the image forming apparatus 10.

[0102] On the other hand, if the main control unit 42 determines that the density correction is not executed (Step S114: No), the processing proceeds to Step S134.

[0103] The skew amount reading unit 74A reads an amount of skew from the skew amount storing unit 66B (Step S116). Next, the dither matrix setting unit 74B sets a dither matrix having a resolution corresponding to the amount of skew read by the skew amount storing unit 66B (Step S118).

[0104] Subsequently, the driving condition setting unit 74C sets a driving condition based on the information indicative of the resolution of the density correction image which is received from the dither matrix setting unit 74B (Step S120). Then, the dithering unit 76 performs a dithering process on the image data of the basic density correction image stored in the basic density correction image storing unit 77 by using the dither matrix set by the dither matrix setting unit 74B (Step S122).

[0105] Thereafter, the output unit 78 outputs the driving condition set by the driving condition setting unit 74C to the output unit 75, the LED control unit 64A and the photosensitive element driving speed control unit 72 through the transfer rate control unit 70 (Step S124).

[0106] Next, the output unit 75 outputs, to the input image control unit 60, the image data of the density correction image received from the dithering unit 76 at the transfer rate set by the transfer rate control unit 70. Moreover, the output unit 75 outputs, to the input image control unit 60, information indicative of the resolution of the density correction image which is received from the dither matrix setting unit 74B (Step S126).

[0107] Then, the image forming unit 18 forms the density correction image (Step S128).

[0108] Subsequently, the detecting unit 50 detects a detection signal to be a result of a detection which is obtained by the sensor 46 for a density correction image formed on the conveying belt 34 (Step S130).

[0109] Thereafter, the image processing unit 54 executes a well-known density correction process for image data of a printing image based on the detection signal detected at Step S130 by the detecting unit 50 (Step S132).

[0110] Next, the main control unit 42 executes a printing image formation process for forming a printing image (Step S134) by using the image data of the printing image subjected to the density correction at Step S134 and the routine then ends.

[0111] By executing the image formation process, it is possible to form a density correction image having a resolution which is higher than that in the formation of a printing image and is increased with an increase in an amount of skew when the density correction image is to be formed.

[0112] Fig. 6 illustrates, for each resolution, a correspondence of an image of image data of a density correction image and a density correction image formed by the image forming apparatus 10 by using the image data of the density correction image.

[0113] By using image data (see image data 80A in (a) of Fig. 6) on the density correction image subjected to the dithering process utilizing a dither pattern having an equal resolution to that of the printing image, a density correction image is formed on the same driving condition as that of a printing image. In this case, the density correction image to be formed is set to be an image indicated as an image 82A in (a) of Fig. 6. In Fig. 6, a length Q is equivalent to a size of an image corresponding to one line in the main-scanning direction.

[0114] On the other hand, by using image data (see image data 80B in (b) of Fig. 6) on the density correction image subjected to the dithering process utilizing a dither pattern having a resolution which is a double (N = 2) of that of the printing image as illustrated in (b) of Fig. 6, a value of N on the driving condition is set to be "2", thereby forming the density correction image. In this case, the density correction image to be formed has a higher resolution than that of the density correction image (see the image 82A in (a) of Fig. 6) having an equal resolution to that of the printing image as illustrated in an image 82B of (b) of Fig. 6.

[0115] By using image data (see image data 80C in (c) of Fig. 6) on the density correction image subjected to the dithering process utilizing a dither pattern having a resolution which is four times (N = 4) as high as that of the printing image as illustrated in (c) of Fig. 6, furthermore, a value of N on the driving condition is set to be "4", thereby forming the density correction image. In this case, the density correction image to be formed has a higher resolution than that of the density correction image (see the image 82A in (a) of Fig. 6) having an equal resolution to that of the printing image as illustrated in an image 82C of (c) of Fig. 6.

[0116] In the image forming apparatus 10 according to the present embodiment, thus, the image formation process is executed. In the formation of the density correction image, consequently, there is formed a density correction image having a resolution which is higher than that in the formation of the printing image and is increased with an increase in an amount of skew.

[0117] In the image forming apparatus 10 according to the present embodiment, there is formed a density correction image having a higher resolution than that in the formation of the printing image with an increase in the amount of skew. Therefore, it is possible to prevent streaks from being generated on the density correction image.

[0118] In the image forming apparatus 10 according to the present embodiment, moreover, the density correction is carried out based on the result of the detection for the density correction image. Therefore, it is possible to carry out the density correction with high precision.

[0119] In the image forming apparatus 10 according to the present embodiment, furthermore, there is formed a density correction image having a higher resolution with an increase in the amount of skew. For this reason, reversely, there is formed a density correction image having a resolution which is higher than that of a printing image and is reduced with a decrease in the amount of skew. In the image forming apparatus 10, therefore, it is possible to shorten a time required for driving by reducing the value of "N" more greatly. Thus, it is possible to shorten a time required for forming the density correction image.

[0120] As described above, moreover, the driving condition setting unit 74C sets an N-fold ratio of the resolution of the density correction image received from the dither matrix setting unit 74B to the resolution of the printing image which is stored in advance. In this case, in the formation of the density correction image, the driving condition setting unit 74C sets the driving current of the exposing unit 20 to be 1/N of that in the formation of the printing image or sets the light emitting time of the light emitting element 44A in the formation of an image for one line to be 1/N of that in the formation of the printing image.

[0121] Therefore, it is possible to shorten the time required for forming the density correction image.

[0122] In the image forming apparatus 10 according to the present embodiment, furthermore, the driving condition setting unit 74C sets the driving speed of the photosensitive element 22 to be 1/N of that in the formation of the printing image according to a cyclic variable power (which is set to be 1/N) of the line memory update signal through the line memory update signal output unit 60D in the formation of the density correction image.

[0123] Therefore, it is possible to shorten the time required for forming the density correction image.

[0124] In the image forming apparatus 10 according to the present embodiment, moreover, the driving condition setting unit 74C sets the transfer rate of the image data of the density correction image which is output from the output unit 75 of the resolution adjusting unit 68 to the input image control unit 60 to 1/N of the transfer rate of the image data of the printing image from the image processing unit 54 to the input image control unit 60 in the formation of the density correction image.

[0125] Therefore, it is possible to shorten the time required for forming the density correction image.

[0126] In the image forming apparatus 10 according to the present embodiment, furthermore, it is possible to further prevent streaks from being generated on the density correction image by determining to divide the image of the image data subjected to the dithering process in positions corresponding to boundaries between the light emitting chips 44 which are adjacent to each other.

[0127] In the present embodiment, the description has been given to the case in which the skew amount calculating unit 66D calculates the amount of skew by using the well-known method from the detection signal received from the detecting unit 50. However, the skew amount calculating unit 66D may divide the skew correction image into a plurality of division sections every pixel number corresponding to the number of the light emitting elements 44A arranged in the light emitting chip 44 and may calculate the amount of skew for each of the division sections. The skew correction value calculating unit 66E may calculate a skew correction value every skew correction areas which are adjacent to each other according to the amount of skew for each division section and may output the skew correction value to the read control unit 66C. In this case, the skew correction value calculating unit 66E calculates the skew correction value for each skew correction area in order to obtain a minimum step between the skew correction areas which are adjacent to each other.

[0128] Consequently, a shift (a step) according to regions corresponding to the light emitting chips 44 arranged in the main-scanning direction can be prevented from being generated on an image which is formed.

[0129] Fig. 7 illustrates an example of a skew correction image in each of the case in which a skew correction is not performed and the case in which two types of skew corrections are performed.

[0130] As illustrated in Fig. 7, in the case in which the skew correction is not performed, an image 90 having a step on a boundary among skew correction areas P1 to P3 corresponding to each of the light emitting chips 44 is formed on the photosensitive element 22. In the case in which there is performed the well-known skew amount calculation in which a shift amount from a main-scanning direction in a whole array direction of the light emitting chips 44 is calculated in place of each of the skew correction areas, an image 92 having a greater step than the image 90 on the boundary among the skew correction areas P1 to P3 is formed though the skew correction is performed. In Fig. 7, a dotted-line 92A indicates a position in which an image is formed in the case of no skew correction, and a solid line 92B indicates a position in which an image is formed in the case of the skew correction.

[0131] In the case in which the skew correction value is calculated every skew correction area and the skew correction for each skew correction area is thus performed in order to minimize the step between the skew correction areas which are adjacent to each other, there is formed an image 94 in which the step on the boundary among the skew correction areas P1 to P3 is suppressed. In Fig. 7, a dotted-line 94A indicates a position in which an image is formed in the case of no skew correction, and a solid line 94B indicates a position in which an image is formed in the case of the skew correction.

[0132] In other words, as illustrated in Fig. 7, by calculating the skew correction value every skew correction area in order to minimize the step between the adjacent skew correction areas through the skew correction value calculating unit 66E, it is possible to prevent the shift (step) from being generated in regions corresponding to the light emitting chips 44 arranged in the main-scanning direction. In the image forming apparatus 10 according to the present embodiment, therefore, it is preferable to calculate the skew correction value for each skew correction area in such a manner that the step between the adjacent skew correction areas is minimized.

[0133] Other correction processes may be executed before the printing image formation process (Step S134), which is not illustrated in Fig. 5. For example, it is also possible to carry out a well-known color shift correction processing for correcting a color shift of an image having each color, a well-known light amount correction processing for correcting the light amount of the exposing unit 20 or the like. In this case, these other correction processes are performed before the printing image formation process (Step S134) and the density correction process (Steps S114 to S132).

[0134] By executing the light amount correction processing before the density correction process, thus, it is possible to form a density correction image in a proper light amount in the density correction process.

[0135] Although the description has been given to the case in which the image forming apparatus 10 is of a so-called tandem type which has the image forming units 32 (32K, 32M, 32C and 32Y) in the present embodiment, it is also possible to employ a structure in which a single image forming unit 32 is provided. Although the description has been given to the case in which the image forming apparatus 10 has such a structure as to transfer an image to the recording medium P from the photosensitive element 22 in the present embodiment, moreover, it is also possible to employ a structure in which an image is transferred to the recording medium P through an intermediate transfer member.

[0136] An image forming program to be executed in the image forming apparatus 10 according to the present embodiment is previously incorporated in ROM or the like and is thus offered. Moreover, the image forming program to be executed by the image forming apparatus 10 according to the present embodiment may be constituted to be recorded in a computer readable recording medium such as a CD-ROM, a flexible disk (FD), a CD-R, a DVD (Digital Versatile Disk) or the like in a file in an install enabling format or an executable format and to be thus offered.

[0137] Furthermore, the image forming program to be executed by the image forming apparatus 10 according to the present embodiment may be configured to be stored on a computer connected to a network such as the Internet and to be provided through downloading via the network. Moreover, the image forming program to be executed by the image forming apparatus 10 according to the present embodiment may be constituted to be provided or distributed via the network such as the Internet.

[0138] Moreover, the image forming program to be executed by the image forming apparatus 10 according to the present embodiment has a module structure including the respective units (the detecting unit 50, the write control unit 52 and the image processing unit 54). As actual hardware, a CPU (processor) reads and executes the image forming program from the ROM so that the respective units are loaded onto a main storage device and the detecting unit 50, the write control unit 52 and the image processing unit 54 are generated on the main storage device.

[0139] Although the description has been given by taking the example in which the image forming apparatus 10 according to the present embodiment is applied to an image forming apparatus having a printer function in the embodiment, it may be applied to an MFP having the printer function and at least one of a copy function, a scanner function and a facsimile function.

[0140] Fig. 8 is a block diagram illustrating an example of a hardware structure of the image forming apparatus

10 according to the present embodiment. As illustrated in Fig. 8, the image forming apparatus 10 has a structure in which a controller 270 and an engine unit (Engine) 260 are connected through a PCI (Peripheral Component Interface) bus. The controller 270 serves to control the whole image forming apparatus, drawing, a communication and an input from an operating unit which is not illustrated. The engine unit 260 is a printer engine which can be connected to the PCI bus or the like, and is a black and white plotter, a one-drum color plotter, a 4-drum color plotter, a scanner, a fax unit or the like, for example. The engine unit 260 includes an image processing part such as error diffusion or a gamma conversion in addition to a so-called engine part such as a plotter.

[0141] The controller 270 includes a CPU 271, a north bridge (NB) 273, system memory (MEM-P) 272, a south bridge (SB) 274, local memory (MEM-C) 277, an ASIC (Application Specific Integrated Circuit) 276, and a hard disk drive (HDD) 278, and has a structure in which the north bridge (NB) 273 and the ASIC 276 are connected through an AGP (Accelerated Graphics Port) 275. Moreover, the MEM-P272 further has ROM (Read Only Memory) 272a and RAM (Random Access Memory) 272b.

[0142] The CPU 271 serves to carry out a whole control of the image forming apparatus 10 and has a chip set constituted by the NB 273, the MEM-P 272 and the SB 274, and is connected to other apparatuses through the chip set.

[0143] The NB 273 is a bridge for connecting the CPU 271 to the MEM-P 272, the SB 274, and the AGP 275, and has a memory controller for controlling read/write from/to the MEM-P 272, and a PCI master and an AGP target.

[0144] The MEM-P 272 is system memory to be used as memory for storing a program or data, memory for loading a program or data, drawing memory for a printer or the like, and is constituted by the ROM 272a and the RAM 272b. The ROM 272a is a read only memory to be used as the memory for storing a program or data, and the RAM 272b is writable and readable memory to be used as the memory for loading a program or data, the drawing memory for a printer or the like.

[0145] The SB 274 is a bridge for connecting the NB 273 to the PCI device and peripheral device. The SB 274 is connected to the NB 273 through the PCI bus and a network interface (I/F) unit or the like is also connected to the PCI bus.

[0146] The ASIC 276 is an IC (Integrated Circuit) which is intended for an image processing use and has a hardware element for the image processing, and serves as a bridge for connecting the AGP 275, the PCI bus, the HDD 278 and the MEM-C 277 respectively. The ASIC 276 is constituted by a PCI target and an AGP master, an arbiter (ARB) serving as a nucleus of the ASIC 276, a memory controller for controlling the MEM-C 277, a plurality of DMACs (Direct Memory Access Controllers) for carrying out a rotation of image data through a hardware logic or the like, and a PCI unit for transferring data through the PCI bus together with the engine unit 260. An FCU (Facsimile Control Unit) 230, a USB (Universal Serial Bus) 240, and an IEEE1394 (the Institute of Electrical and Electronics Engineers 1394) interface 250 are connected to the ASIC 276 through the PCI bus. An operation displaying unit 220 is directly connected to the ASIC 276.

[0147] The MZM-C 277 is local memory to be used as a copying image buffer or a code buffer, and the HDD (Hard Disk Drive) 278 is a storage for storing image data, a program, font data and a form.

[0148] The AGP 275 is a bus interface for a graphics accelerator card which is proposed for increasing a speed of a graphic processing, and directly gives access to the MEM-P 272 in a high throughput, thereby increasing a speed of the graphics accelerator card.

[0149] According to the embodiment, it is possible to produce an effect that streaks can be prevented from being formed on a density correction image.

[0150] Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

Claims

1. An image forming apparatus (10) comprising:

a photosensitive element (22);
an exposing unit (20) including a plurality of light emitting chips (44) arranged in a main-scanning direction, each of the light emitting chips (44) including a plurality of light emitting elements (44A) arranged in the main-scanning direction;
a light-emitting control unit (64) configured to control the light emitting elements (44A);
a developing unit (26) configured to develop an electrostatic latent image formed on the photosensitive element (22) by the exposing unit (20) to form a toner image;
a transfer unit (26) configured to transfer the toner image to a medium (34; P) to form an image on the medium (34; P);
a detecting unit (50) configured to detect an amount of skew indicative of a shift amount in an array direction of each of the light emitting chips (44) with respect to the main-scanning direction;
a resolution adjusting unit (68) configured to generate image data of a density correction image used for a density correction through a dithering process, the density correction image being formed on the medium (34; P), the density correction image having a higher resolution than

that of a printing image to be formed on the medium (34; P) and having the resolution increased with an increase in the amount of skew, the density correction image being divided into a plurality of sections in the main-scanning direction; and
a correction unit (61) configured to perform skew correction on the density correction image in a manner that shifts image data of the density correction image corresponding to each of the sections in a sub-scanning direction on the basis of the amount of skew.

2. The image forming apparatus (10) according to claim 1, wherein the density correction image to be used in the skew correction is divided into the sections in the main-scanning direction in positions corresponding respectively to boundaries between the light emitting chips which are adjacent to each other.

3. The image forming apparatus (10) according to claim 1 or 2, wherein the resolution adjusting unit (68) includes
a first setting unit (74B) configured to set a dither matrix having a higher resolution with an increase in the amount of skew;
a dithering unit (76) configured to perform the dithering process on image data of a multitone basic image used for the density correction by using the dither matrix;
an output unit (75) configured to output the image data of the basic image that has been subjected to the dithering process as image data of the density correction image to the correction unit (61); and
a second setting unit (74C) configured to set a driving condition of the image forming apparatus (10) on the basis of the resolution of the density correction image.

4. The image forming apparatus (10) according to claim 3, wherein the correction unit (61) includes
a plurality of line memories (62A, 62B, 62C, 62D) each configured to store line image data corresponding to one line in the main-scanning direction in the image data that has been subjected to the dithering process; and
a read control unit (66C) configured to read pixel data groups corresponding to the respective sections from the line image data stored in any one of the line memories (62A, 62B, 62C, 62D) on the basis of the amount of skew and output the pixel data groups to the light-emitting control unit (64).

5. The image forming apparatus (10) according to claim 4, wherein the driving condition includes at least one of a rotating speed of the photosensitive element (22), a transfer rate in an output of the image data of the density correction image to the correction unit (61), an update cycle of the plurality of line memories (62A, 62B, 62C, 62D), a rate of a light emitting time of the light emitting elements (44A) to form an image corresponding to one line in the main-scanning direction, and a driving current for driving the light emitting elements (44A).

FIG.1

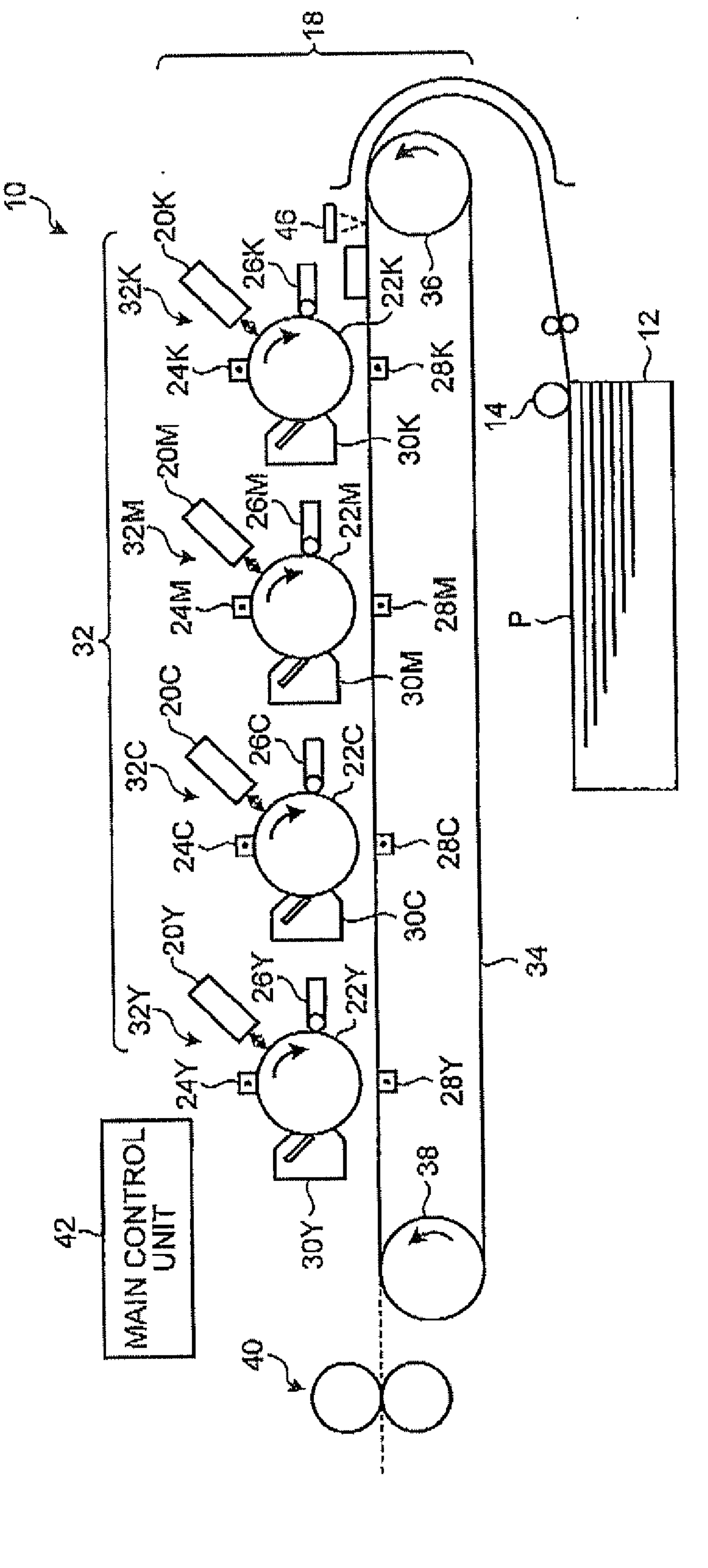

10
18
32
32Y
32C
32M
32K
20Y
20C
20M
20K
26Y
26C
26M
26K
22Y
22C
22M
22K
24Y
24C
24M
24K
28Y
28C
28M
28K
30Y
30C
30M
30K
46
36
38
34
40
42
MAIN CONTROL UNIT
14
12
P

FIG.2

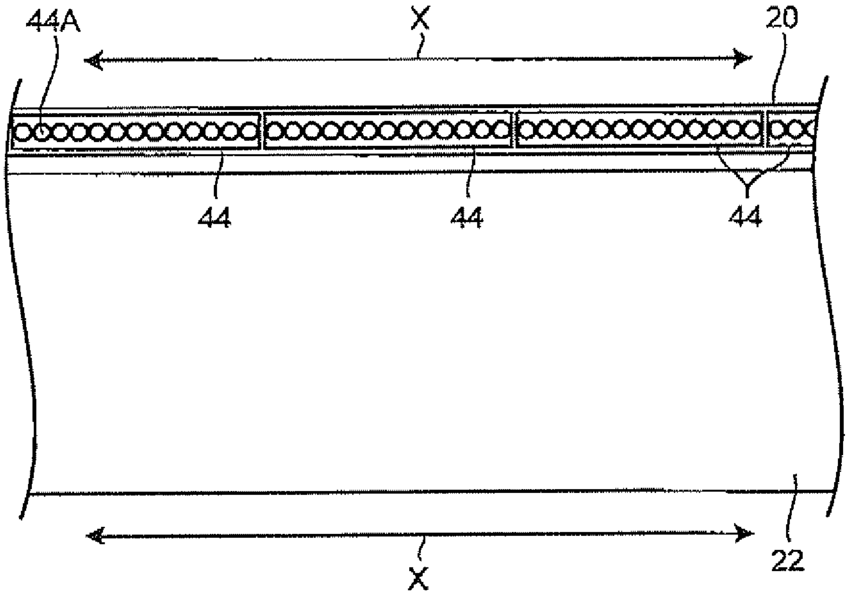


FIG.3

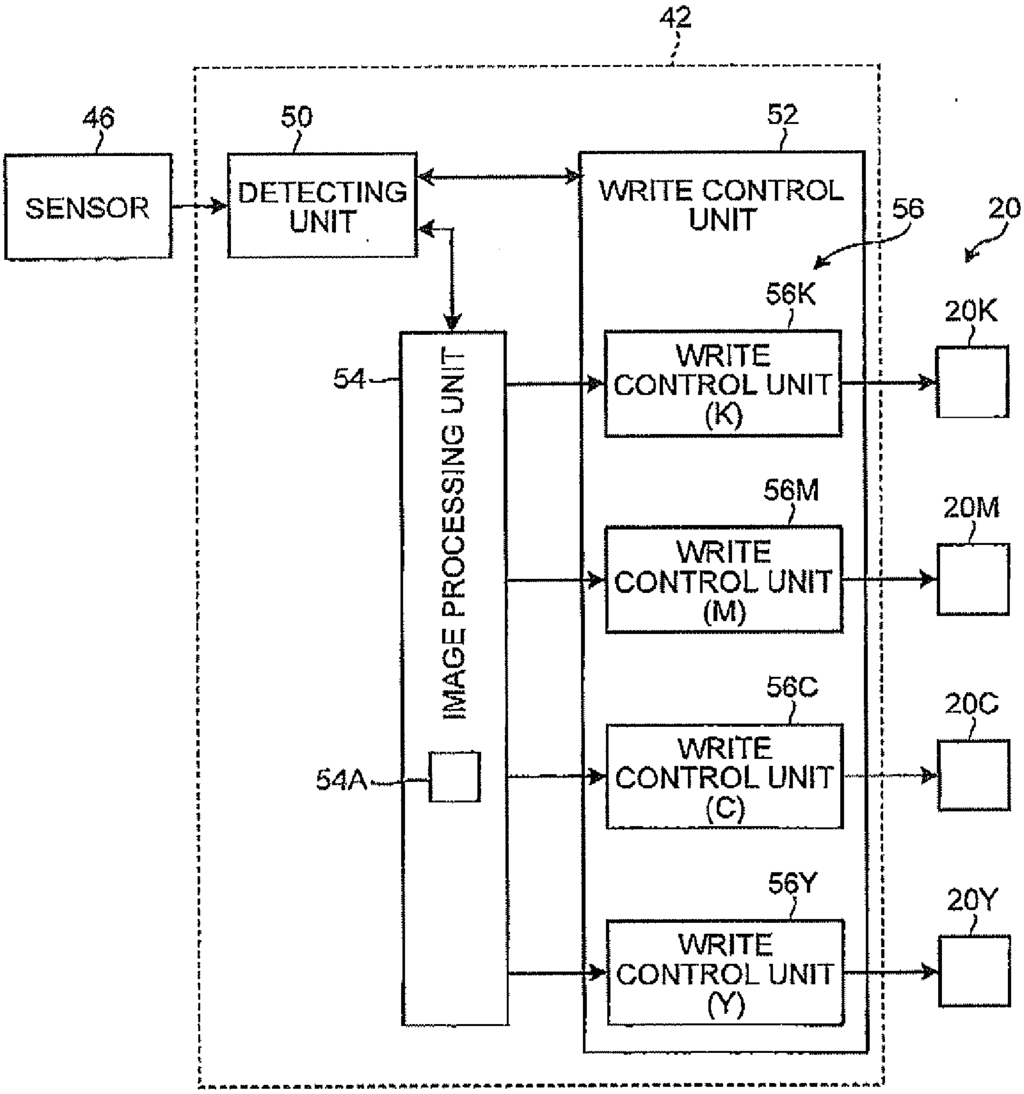

42
46
SENSOR
50
DETECTING UNIT
52
WRITE CONTROL UNIT
56
20
56K
WRITE CONTROL UNIT (K)
20K
54
IMAGE PROCESSING UNIT
56M
WRITE CONTROL UNIT (M)
20M
56C
WRITE CONTROL UNIT (C)
20C
54A
56Y
WRITE CONTROL UNIT (Y)
20Y

FIG.4

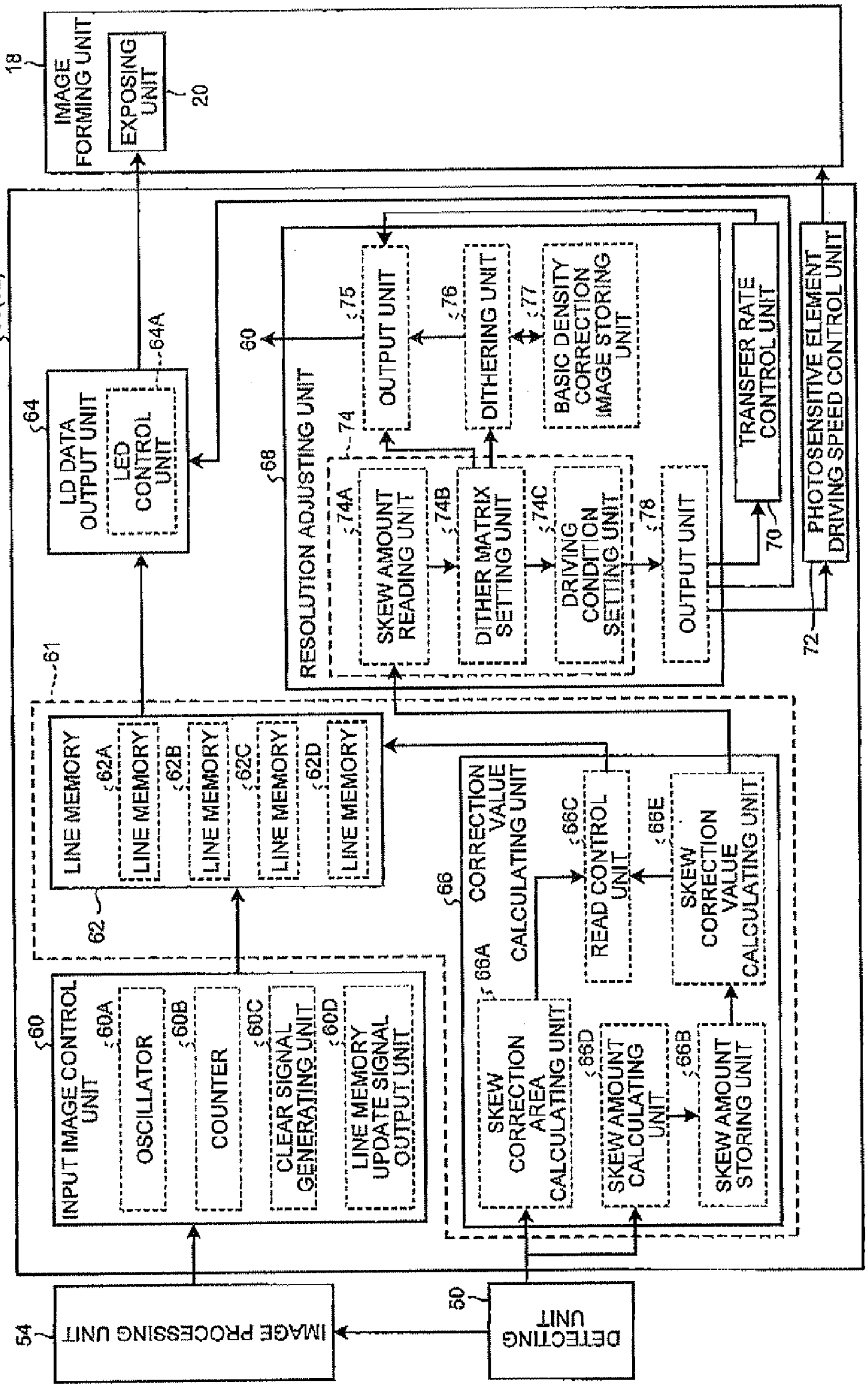

18
IMAGE FORMING UNIT
EXPOSING UNIT
20
56(52)
64
LD DATA OUTPUT UNIT
LED CONTROL UNIT
64A
61
LINE MEMORY
62A
LINE MEMORY
62B
LINE MEMORY
62C
LINE MEMORY
62D
LINE MEMORY
62
60
INPUT IMAGE CONTROL UNIT
60A
OSCILLATOR
60B
COUNTER
60C
CLEAR SIGNAL GENERATING UNIT
60D
LINE MEMORY UPDATE SIGNAL OUTPUT UNIT
68
RESOLUTION ADJUSTING UNIT
74
74A
SKEW AMOUNT READING UNIT
74B
DITHER MATRIX SETTING UNIT
74C
DRIVING CONDITION SETTING UNIT
78
OUTPUT UNIT
60
75
OUTPUT UNIT
76
DITHERING UNIT
77
BASIC DENSITY CORRECTION IMAGE STORING UNIT
TRANSFER RATE CONTROL UNIT
70
PHOTOSENSITIVE ELEMENT DRIVING SPEED CONTROL UNIT
72
66
CORRECTION VALUE CALCULATING UNIT
66A
SKEW CORRECTION AREA CALCULATING UNIT
66C
READ CONTROL UNIT
66E
SKEW CORRECTION VALUE CALCULATING UNIT
66D
SKEW AMOUNT CALCULATING UNIT
66B
SKEW AMOUNT STORING UNIT
54
IMAGE PROCESSING UNIT
50
DETECTING UNIT

FIG.5

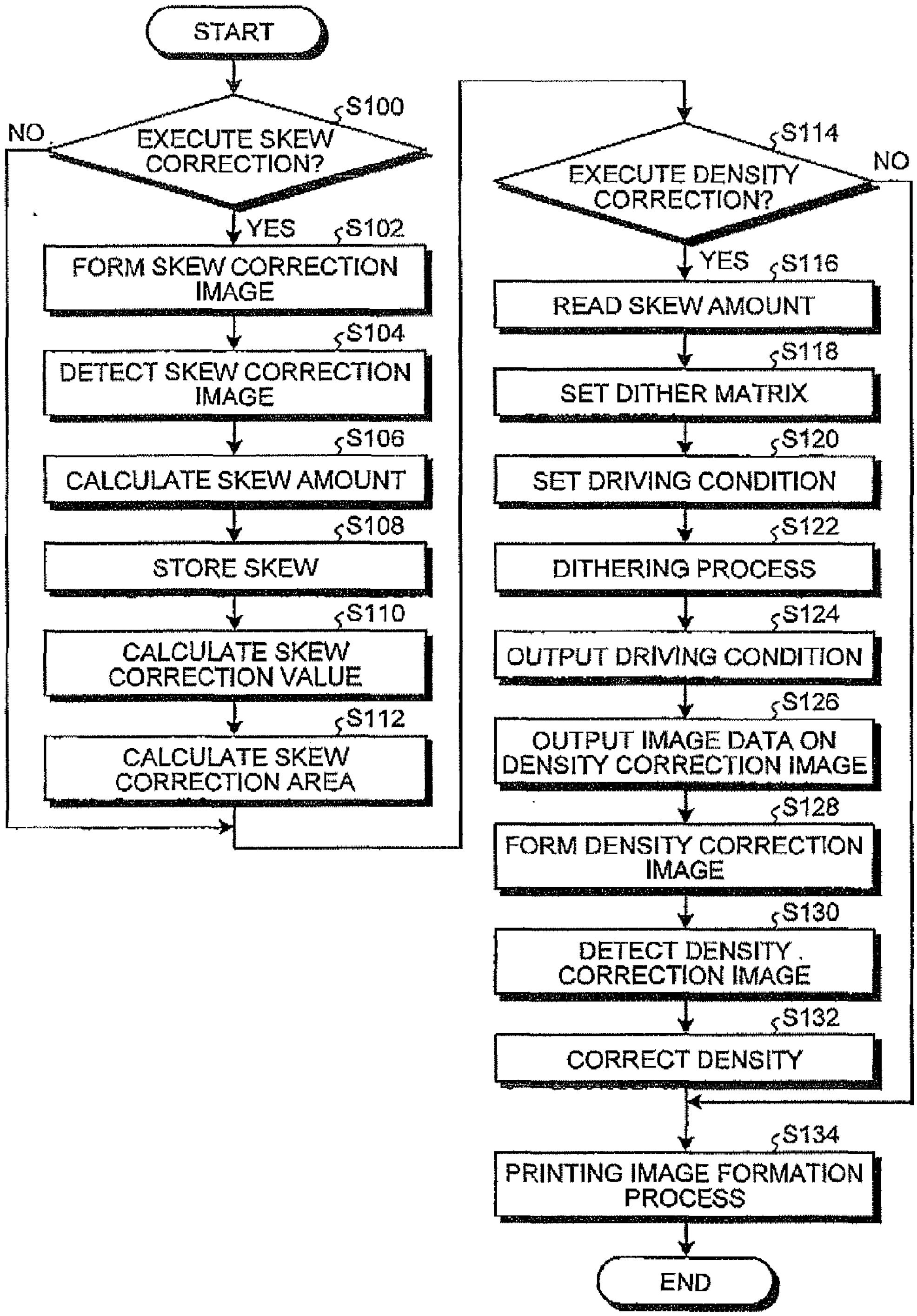

START
S100
EXECUTE SKEW CORRECTION?
NO
YES
S102
FORM SKEW CORRECTION IMAGE
S104
DETECT SKEW CORRECTION IMAGE
S106
CALCULATE SKEW AMOUNT
S108
STORE SKEW
S110
CALCULATE SKEW CORRECTION VALUE
S112
CALCULATE SKEW CORRECTION AREA
S114
EXECUTE DENSITY CORRECTION?
NO
YES
S116
READ SKEW AMOUNT
S118
SET DITHER MATRIX
S120
SET DRIVING CONDITION
S122
DITHERING PROCESS
S124
OUTPUT DRIVING CONDITION
S126
OUTPUT IMAGE DATA ON DENSITY CORRECTION IMAGE
S128
FORM DENSITY CORRECTION IMAGE
S130
DETECT DENSITY CORRECTION IMAGE
S132
CORRECT DENSITY
S134
PRINTING IMAGE FORMATION PROCESS
END

FIG.6

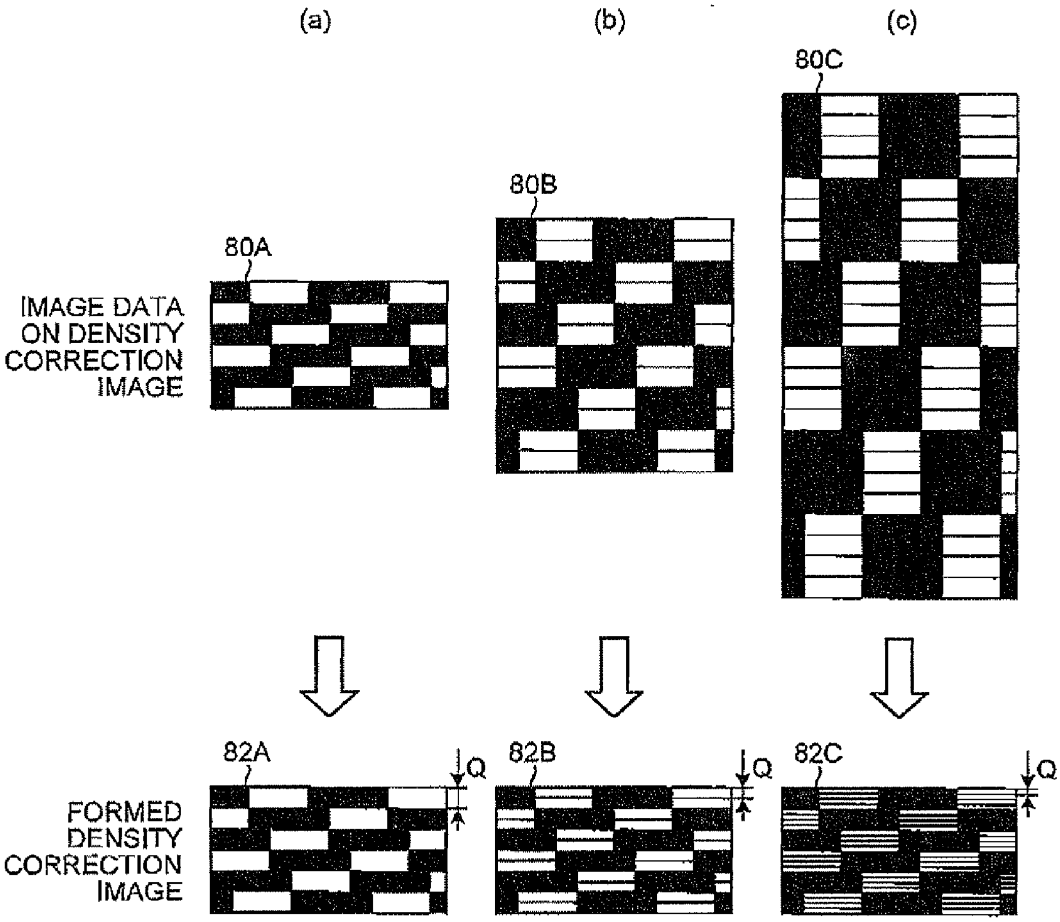

(a)
(b)
(c)
80A
80B
80C
IMAGE DATA ON DENSITY CORRECTION IMAGE
82A
82B
82C
Q
Q
Q
FORMED DENSITY CORRECTION IMAGE

FIG.7

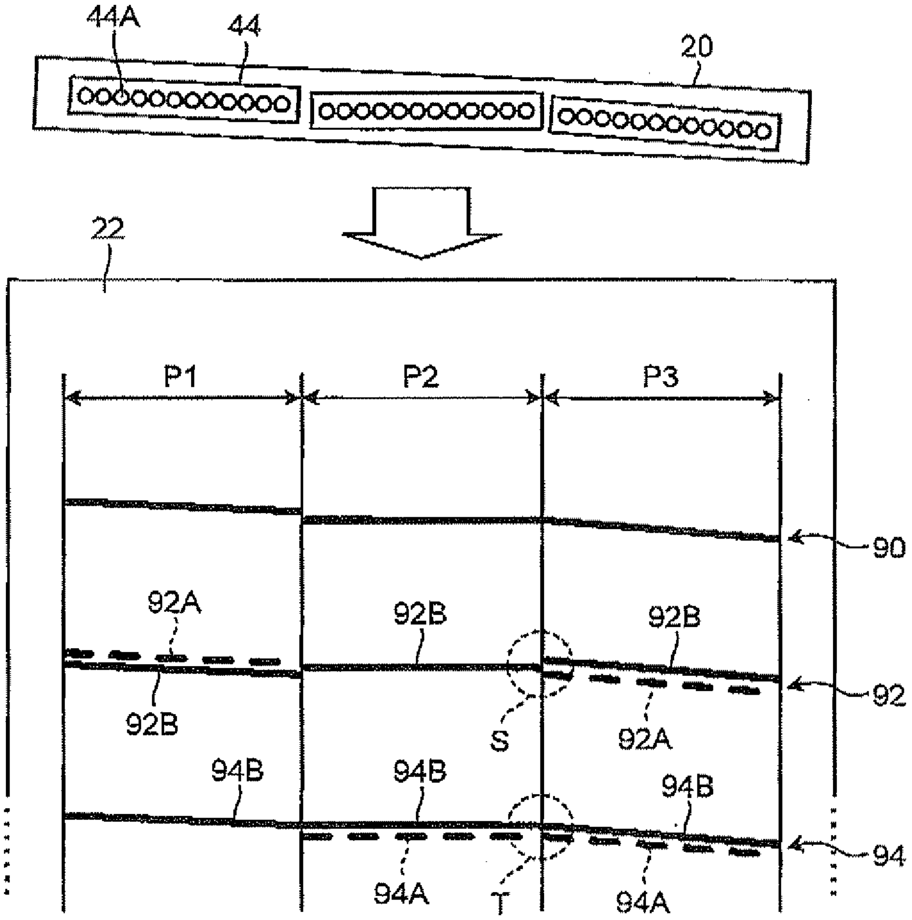
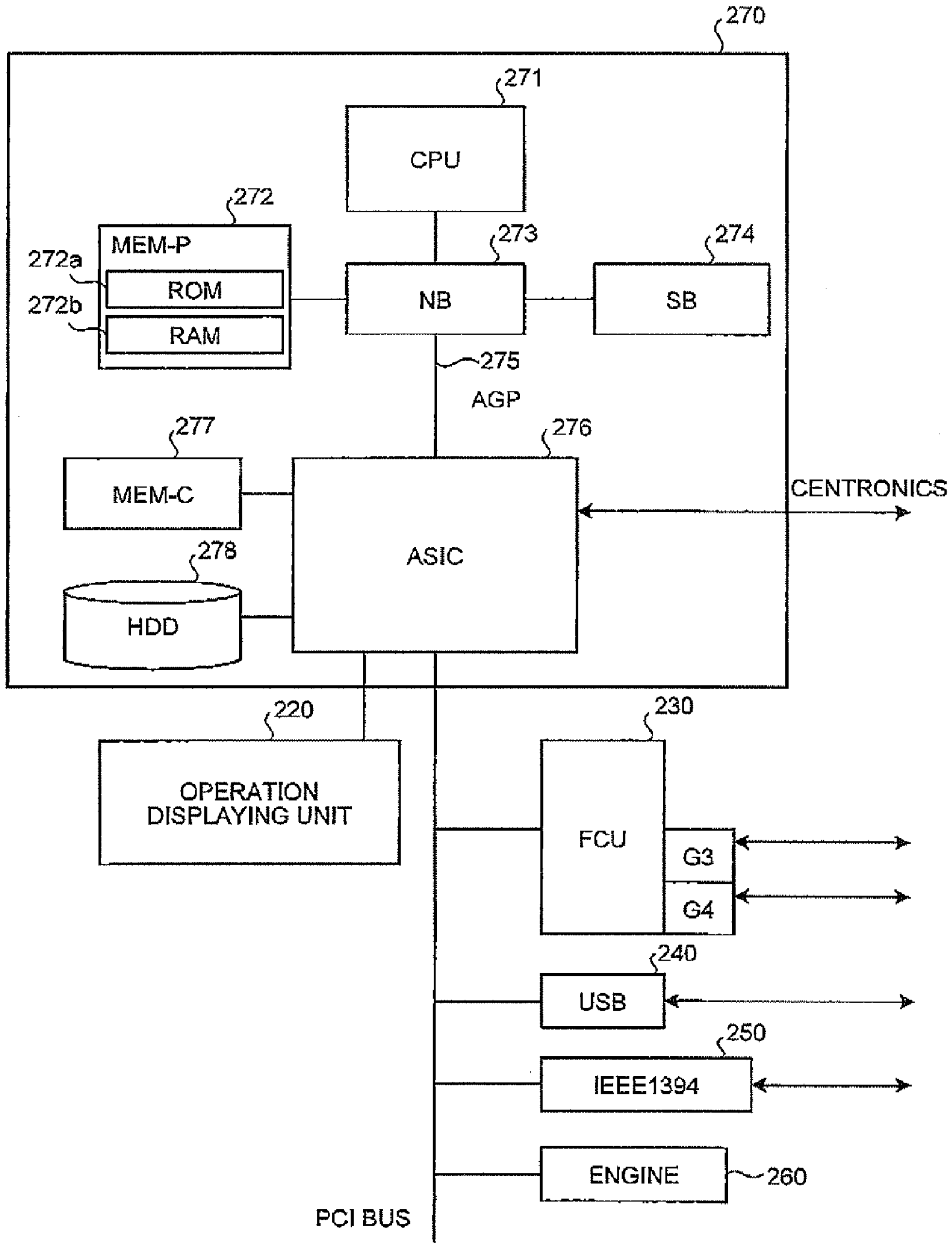

44A
44
20
22
P1
P2
P3
90
92A
92B
92B
92B
92
92B
S
92A
94B
94B
94B
94
94A
T
94A

FIG.8


270
271
CPU
272
MEM-P
272a
ROM
272b
RAM
273
NB
274
SB
275
AGP
277
MEM-C
276
ASIC
CENTRONICS
278
HDD
220
OPERATION DISPLAYING UNIT
230
FCU
G3
G4
240
USB
250
IEEE1394
ENGINE
260
PCI BUS

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2007145001 A **[0002] [0003] [0006] [0007]**
- JP 2009027683 A **[0006] [0007]**