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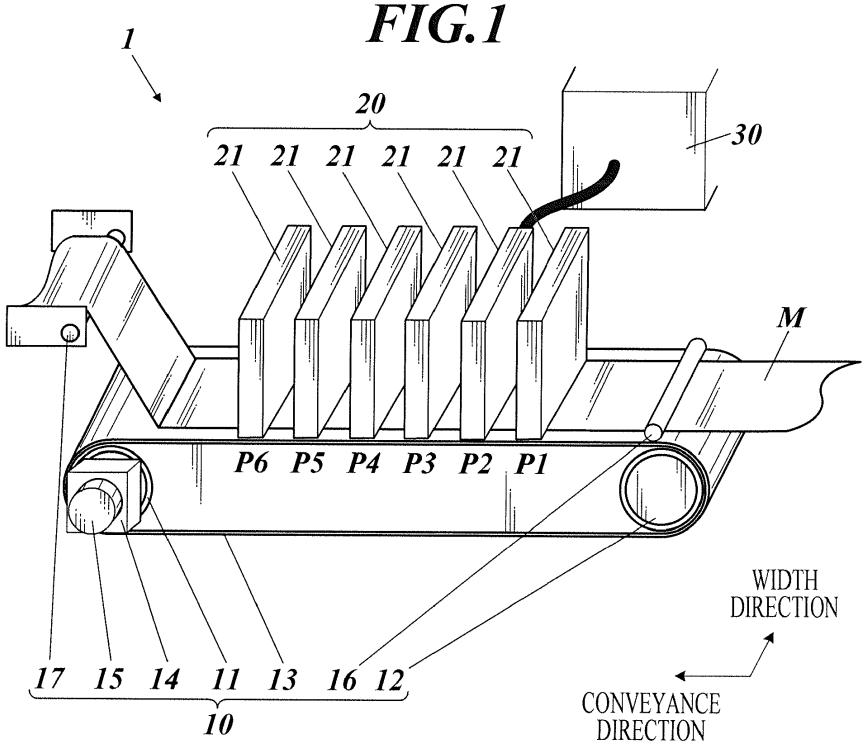
(54) **INKJET RECORDING APPARATUS**

(57) An inkjet recording apparatus (1) includes multiple ink dischargers (21) which each discharge an ink of one color which is different from each other and which is among basic colors, the first spot color, and the second spot color. The first spot color and the second spot color are in different hue ranges from each other among three hue ranges in a hue circle which are partitioned by hues corresponding to Y, M and C. A first ink discharger which discharges an ink of the first spot color is disposed at an outer side in the conveyance direction of an arrangement range of ink dischargers discharging inks of Y, M, and C. A second ink discharger discharges an ink of the second spot color and is disposed at a side opposite to the side of the first ink discharger in the conveyance direction across the arrangement range.

FIG.1



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Description

Background

Technological field

[0001] The present invention relates to an inkjet recording apparatus.

Description of the Related art

[0002] Conventionally, there is an inkjet recording apparatus which records an image and the like on a recording medium conveyed by a conveyor with an ink discharged from nozzles on an ink discharger and landed on desired positions. Further, there is an inkjet recording apparatus which can record a color image on a conveyed recording medium with inks discharged at appropriate timings from multiple ink dischargers which discharge inks of different colors from each other and which are disposed at different positions from each other in the conveyance direction of the recording medium.

[0003] There is known a technique for improving color reproducibility of a recorded image by an inkjet recording apparatus provided with, in addition to the ink dischargers which discharge respective inks of process colors (basic colors) including yellow, magenta, cyan, and black, ink dischargers which discharge respective inks of spot colors other than yellow, magenta, and cyan, so that an image of a color obtained by color mixing of at least one of yellow, magenta, and cyan and at least one of the spot color (for example, see Japanese Unexamined Patent Application Publication No. 2005-88207) is recorded. For mixing multiple colors, inks of colors to be mixed need to land in a certain vicinity range on the recording medium.

Summary

[0004] However, in the above described inkjet recording apparatus, during conveyance of the recording medium, the position of the recording medium may be shifted (for example, the recording medium may move diagonally) in the width direction which is orthogonal to the conveyance direction. The amount of relative shift in the width direction of the recording medium between two different points in the conveyance direction tends be larger if the distance between the two different points is larger.

[0005] When the recording medium is shifted as described above, as the ink landing position on the recording medium are also shifted in the width direction, desired color mixing is not performed between the inks discharged from the multiple ink dischargers and color misregistration occurs in the recorded image. In particular, in an inkjet recording apparatus using spot color inks, the larger the number of ink colors to be used, that is, the larger the number of ink dischargers, the larger the arrangement range in the conveyance direction of the multiple ink dischargers. As a result, there is a problem that relative shift of ink landing position in the width direction is likely to be large between ink dischargers which are arranged at large intervals in the conveyance direction, and that the color misregistration due to the shift of ink landing position becomes remarkable.

[0006] An object of the present invention is to provide an inkjet recording apparatus with which color misregistration in recorded images can be suppressed.

[0007] In order to achieve at least one of the above objects, the inkjet recording apparatus reflecting one aspect of the present invention records an image on a recording medium using inks of basic colors and spot colors, the basic colors including yellow, magenta, cyan, and black, the spot colors each having a different hue from yellow, magenta, and cyan and including a first spot color and a second spot color having different hues from each other, the image including a portion where at least one of yellow, magenta and cyan is mixed with at least one of the spot colors, the inkjet recording apparatus including:

a conveyer which conveys a recording medium; and
multiple ink dischargers which each discharge, on a recording medium conveyed by the conveyor, an ink of one color which is different from each other and which is among the basic colors, the first spot color, and the second spot color,
wherein the first spot color and the second spot color are in different hue ranges from each other among three hue ranges in a hue circle which are partitioned by hues corresponding to yellow, magenta and cyan,
wherein the multiple ink dischargers are disposed at different positions from each other in a conveyance direction of the recording medium conveyed by the conveyor,
wherein the multiple ink dischargers include a first ink discharger which discharges an ink of the first spot color and which is disposed at an outer side in the conveyance direction of an arrangement range of ink dischargers discharging inks of yellow, magenta, and cyan among the multiple ink dischargers, and
wherein the multiple ink dischargers include a second ink discharger which discharges an ink of the second spot color and which is disposed at a side opposite to the outer side in the conveyance direction across the arrangement range.

Brief Description Of The Drawings

[0008] The advantages and features provided by one or more embodiments of the invention will become more fully understood from the detailed description given hereinbelow and the appended drawings which are given by way of illustration only, and thus are not intended as a definition of the limits of the present invention.

FIG. 1 shows an outlined configuration of an inkjet recording apparatus.
FIG. 2 is a schematic drawing showing a configuration of a head unit.
FIG. 3 is a block diagram showing a main functional configuration of the ink jet recording apparatus.
FIG. 4 is a figure showing an arrangement order of head units.
FIG. 5 is a diagram showing positions of ink colors in a hue circle.
FIG. 6 is a figure showing another example of arrangement order of head units.
FIG. 7 is a diagram showing positions of ink colors in a hue circle according to Modification 1.
FIG. 8A is a figure showing an arrangement order of head units according to Modification 1.
FIG. 8B is a figure showing an arrangement order of head units according to Modification 1.
FIG. 9 is a figure showing an arrangement order of head units according to Modification 2.

Detailed Description Of Embodiments

[0009] Hereinafter, embodiments of the inkjet recording apparatus according to the present invention will be described with reference to the drawings.

[0010] FIG. 1 shows an outlined configuration of an inkjet recording apparatus 1 of the embodiment according to the present invention.

[0011] The ink jet recording apparatus 1 includes a conveyor 10, a recorder 20, a controller 30, and the like.

[0012] The conveyor 10 includes a driving roller 11, a driven roller 12, a conveyance belt 13 (conveyance member), a conveyance motor 14, a rotary encoder 15, a pressing roller 16, a separating roller 17, and the like.

[0013] The driving roller 11 is driven by the conveyance motor 14 and rotates around a rotation axis. The conveyance belt 13 is a loop belt which is supported inside by the driving roller 11 and the driven roller 12 (hereinafter, also collectively described as conveyance rollers) and circles according to the rotating action of the driving roller 11. The driven roller 12 rotates on a rotation axis parallel to the rotation axis of the driving roller 11 in accompany with the circling movement of the conveyance belt 13. A material which flexibly bends on the contacting face with the conveyance rollers and reliably supports a recording medium M is used for the conveyance belt 13 (for example, a belt of resin such as rubber, and a belt of steel). The recording medium M may be more reliably placed on the conveyance belt 13 with a material and/or configuration which causes the recording medium M to be sucked to the conveyance belt 13.

[0014] The conveyance motor 14 causes the driving roller 11 to rotate at the rotation speed according to the control signals from the controller 30. The conveyance motor 14 is also able to cause the driving roller 11 to rotate reversely in inverse of the regular conveyance direction. The conveyor 10 performs a conveyance action to convey the recording medium M in the moving direction (a conveyance direction) of the conveyance belt 13 with the conveyance belt 13 circling at a speed according to the rotation speed of the driving roller 11 in a state where the recording medium M is placed on the conveyance face of the conveyance belt 13.

[0015] The recording medium M may be conveyed intermittently, with a break during the ink discharge in the conveyor 10, for example. The conveyance operation of the conveyor 10 here includes actions of taking a break from conveyance, as described above.

[0016] In the present embodiment, fabric is used as the recording medium M. The recording medium M is pulled out (wound) from a roll (a recording medium winder) on which the recording medium M is rolled, and is supplied onto the conveyance belt 13. The conveyor 10 in the present embodiment is configured to be able to convey a recording medium M of two meters in width (in the width direction perpendicular to the conveyance direction) and approximately 4000 meters in length as a whole roll. The conveyor 10 may convey a recording medium M smaller than two meters in width in the width direction. The conveyor 10 may be configured to be able to convey a recording medium M larger than two meters in width in the width direction. The maximum width of a conveyable recording medium M may be smaller than two meters in the width direction.

[0017] The recording medium M is not limited to fabric as mentioned above, and various kinds of media on the surface of which ink may be fixed, such as paper and sheet resin may be used. Instead of a long recording medium M pulled out from a roll, a short recording medium M such as a sheet of paper may be used.

[0018] The rotary encoder 15 outputs a pulse signal (a detection signal) to the controller 30 and the head controller 24 (FIG. 3) every time the driving roller 11 rotates by a predetermined angle. The rotary encoder 15 may be, though not limited thereto, configured to have a code wheel which has multiple slits arranged on a predetermined circumference and rotates in accompany with the driving roller 11, a light source which throws light upon the slits of the code wheel, and a light receiver which detects light emitted by the light source and passing through the slits, for example, so as to output pulse signals based on results of light detection by the light receiver to the controller 30 and the head controller 24. The pulse signals here may be output at timings of rise and fall of each of two square waves (Phase A and Phase B). The two square waves each have a cycle equal to the cycle of light reception of the light passing through the slits and have phases different from each other by an angle of 90°. With such a configuration, the rotation direction of the driving roller 11 may be detected by the phases of Phase A and Phase B.

[0019] The pressing roller 16 presses the recording medium M supplied to the conveyance face of the conveyor belt 13 against the conveyance face to remove gaps (such as wrinkles) of the recording medium M from

the conveyance face.

[0020] The separating roller 17 separates the recording medium M from the conveyance face by pulling the recording medium M which has been conveyed thereto and is being sucked to the conveyor belt 13 with a predetermined force, to send the separated recording medium M to a finishing device (not shown in the drawings). In the present embodiment, the followings are included as finishing devices: a dryer to dry the recording medium M on which an image is recorded, a device to steam the recording medium M to produce good colors and to fix ink, a washer to wash out stains or ink not yet fixed, a cutter to cut the recording medium M at a predetermined position, and the like.

[0021] The recorder 20 includes six head units 21 (ink dischargers). Each of the head units 21 has multiple recording elements which each perform the action of ink discharge to discharge an ink on the basis of image data, and performs an image recording operation to record an image(s) on the recording medium M conveyed by the conveyor 10 with the multiple recording elements performing the action of ink discharge. The respective six head units 21 discharge inks of different colors from each other. Specifically, the head units 21 each discharge an ink of one of the six colors (yellow (Y), magenta (M), cyan (C), black (K), orange (O), and blue (B)).

[0022] Among these six colors, four colors consisting of three primary colors (Y, M and C) used for expressing colors by subtractive color mixing and black (K) which is difficult to be obtained by merely superimposing the three primary colors are referred to as process colors (basic colors). They are used as a combination of fundamental colors used for recording images in various image forming apparatuses such as an inkjet recording apparatus.

[0023] O and B are colors of different hues from Y, M, and C among the process colors, and are referred to as spot colors. In the present embodiment, the spot colors are mixed with at least one of Y, M, and C among the process colors so as to express colors different from the process colors.

[0024] In the inkjet recording apparatus 1 of the present embodiment, inks of the process colors and inks of O (first spot color) and B (second spot color) are used. As a result, it is possible to express colors obtained by mixing colors of at least one of Y, M, and C with O or B, in addition to colors obtained by mixing the process colors only.

[0025] The color mixing in image formation by the inkjet recording apparatus 1 is performed by landing inks of different colors within a predetermined vicinity range on the recording medium M. A mixed color is expressed using an effect that different colors are recognized to be one mixed color by an observer (usually from a macroscopic viewpoint) of the recording medium M. Therefore, it is not always necessary to discharge inks to be mixed in a liquid state on the recording medium M. The inks of different colors may be discharged to land at positions close to each other (or overlap at least partly with each other) and to be solidified at different timings from each other (that is, not to be mixed in a liquid state).

[0026] In the present embodiment are used reactive dye inks suitably used for a recording medium M of natural fibers such as cotton and hemp. The reactive dye inks are discharged onto the recording medium M and then subjected to steaming (heating and humidification) processing. As a result, the dye molecules are covalently bonded to molecules of the recording medium and then the recording medium M is colored in a stable state.

[0027] The six head units 21 are arranged at different positions in the conveyance direction of the recording medium M with predetermined intervals. In such a configuration, each of the head units 21 forms an image corresponding to the color of ink discharged from the recording elements. The inkjet recording apparatus 1 forms a color image of a recording target by recording images of Y, M, C, K, O, and B superimposed on the same area of the recording medium M.

[0028] The arrangement order of the six head units 21 will be described in detail later.

[0029] FIG. 2 is a schematic drawing showing the configuration of the head unit 21. FIG.2 shows a plane view of the entire head unit 21 viewed from the side facing the conveyance face of the conveyor belt 13.

[0030] The head unit 21 includes 54 recording heads 22 which each have multiple recording elements to discharge ink. In each of the recording heads 22, the recording elements are arranged continuously in the range of approximately 72 mm in the width direction. Each of the recording elements of the recording head 22 has a pressure chamber to store ink therein, a piezoelectric element attached on the wall surface of the pressure chamber, and the nozzle 23. In the recording element, when a driving signal to deform the piezoelectric elements is input, the deformation of the piezoelectric elements deforms the pressure chamber and changes the pressure in the pressure chamber, and ink is discharged from the nozzles 23 which communicate with the pressure chamber. The positions of the ink discharge openings of the nozzles 23 in the recording elements are shown in FIG. 2. The arrangement direction of the recording elements in each of the recording head 22 is not limited to the width direction which is perpendicular to the conveyance direction, but may be a direction crossing the conveyance direction at an angle other than the right angle.

[0031] In the head unit 21, head modules 22M are each configured with two recording heads 22 which are arranged adjacent to each other in the conveyance direction, such that the nozzles 23 of the recording elements are arranged alternately in the width direction. In the head unit 21, a line head is configured with 27 head modules 22M which are arranged in a staggered pattern, such that positional ranges of the head modules 22M partially overlap in the width direction, in a positional relationship where ink dischargeable ranges from the nozzles are successive and continuous in the recording width of an image (approx. 2 m) in the width direction. The head units

21 are used at fixed positions during the image recording. As the head units 21 discharge inks consecutively at predetermined intervals at positions different in the conveyance direction in accompany with the conveyance of the recording medium M, the image(s) is recorded in a single pass mode. The number of the head modules 22M (corresponding to the number of the recording heads 22) may be suitably varied according to the length of the recording medium M in the width direction.

[0032] FIG. 3 is a block diagram showing the main functional configuration of the ink jet recording apparatus 1.

[0033] The ink jet recording apparatus 1 includes a conveyance driver 101 and the rotary encoder 15 arranged in the conveyor 10, the head controller 24 and the head driver 221 arranged in the head units 21, the controller 30, the image processor 41, an operation receiving display (operation/display unit) 42, an input/output interface 43, a bus 44, and the like.

[0034] The conveyance driver 101 sends driving signals to the conveyance motor 14 on the basis of control signals sent by the controller 30 to cause the driving roller 11 to rotate at a predetermined speed, further causing the conveyance belt 13 to move at a predetermined moving speed.

[0035] The head controller 24 outputs various control signals and image data to the head driver 221 at appropriate timings based on the control signals from the controller 30, the number of pulse signals input from the rotary encoder 15, and the like.

[0036] The head driver 221 sends driving signals to the recording elements of the recording heads 22 to deform the piezoelectric elements in accordance with the control signals and the image data input from the head controller 24, causing ink to be discharged from openings of the respective nozzles 23.

[0037] The controller 30 includes a CPU (Central Processing Unit) 31, a RAM 32 (Random Access Memory), a ROM 33 (Read Only Memory), and a storage 34.

[0038] The CPU 31 reads out programs for various controls and setting data stored in the ROM 33, stores them in the RAM 32, and executes the programs to perform various kinds of calculation processing. The CPU 31 integrally controls the overall operation of the ink jet recording apparatus 1.

[0039] The RAM 32 provides the CPU 31 with working memory space to temporally store data therein. The RAM 32 may include a non-volatile memory.

[0040] The ROM 33 stores various programs and setting data to be executed by the CPU 31 therein. Instead of the ROM 33, a rewritable non-volatile memory such as an EEPROM (Electrically Erasable Programmable Read Only Memory), flash memory, etc. may be used.

[0041] The storage 34 stores print jobs (image recording command) input from an external device 2 via the input/output interface 52 and image data concerning the print jobs therein. As the storage 34, an HDD (Hard Disk Drive) may be used, for example, and a DRAM (Dynamic Random Access Memory) may be used in combination therewith.

[0042] Under the control of the controller 30, the image processor 41 performs predetermined image processing on the image data stored in the storage 34, and stores the image data after the image processing in the storage 34. The image processing performed by the image processor 41 includes rasterizing processing for converting PDL (Page Description Language) data input from the external device 2 and stored in the storage 34 into raster format image data; color conversion processing for converting image data of each color component of R, G, and B into image data of color components of C, M, Y, K, O, and B; halftone processing on the image data; and the like. The generated image data of each of C, M, Y, K, O, and B is supplied to the head unit 21 of a corresponding ink color among the six head units 21. Under the control of the controller 30 and the head controller 24 , the action of ink discharge is performed on the basis of the supplied image data.

[0043] The above-described various image processing may be performed by the controller 30, without providing the image processor 41. The external device 2 outside the inkjet recording apparatus 1 may perform the various kinds of image processing, so that the processed image data may be stored in the storage 34.

[0044] The operation receiving display 42 includes a display device such as a liquid crystal display or an organic electroluminescent display, an input device such as operation keys and touch panel superimposed on the screen of the display. The operation receiving display 42 displays various kinds of information on the display, and outputs, to the controller 30, the operation signals generated by conversion of the input operation by a user to the input devices.

[0045] The input/output interface 43 intermediates transmission of data between the external device 2 and the controller 30. The input/output interface 43 is configured with, for example, a kind of serial interface, parallel interface, or a combination thereof.

[0046] The bus 44 is a path for transmission of signals between the controller 30 and each of other devices.

[0047] The external device 2 is a personal computer, for example, and sends the print jobs, image data, etc. to the controller 30 via the input/output interface 52.

[0048] The components of the inkjet recording apparatus 1 are not limited to the above, and other components may be provided as necessary. For example, a sensor (an abnormality detector) to detect placement abnormalities (such as gaps on the recording medium M or adhesion of foreign substances on the recording medium M) may be arranged on the upstream side of the head units 21 in the conveyance direction.

[0049] Next, the arrangement order of the six head units 21 will be described.

[0050] FIG. 4 is a figure showing the arrangement order of the six head units 21 in the present embodiment. This figure shows the arrangement positions of the six head units 21 in the conveyance direction (referred to be

PI to P6 in order from the upstream side in the conveyance direction) and the colors of inks discharged from the head units 21 arranged in the respective arrangement positions PI to P6. In the present embodiment, as shown in FIG. 4, the head units 21 discharging inks of O, Y, M, K, C, and B are arranged in this order from the upstream side in the conveyance direction.

[0051] By arranging the head units 21 in such an order, occurrence of color misregistration in a recorded image can be suppressed. The reason will be explained below.

[0052] If different color inks discharged from respective head units 21 are not landed at desired positions in the inkjet recording apparatus 1, color mixing between these different colors is not appropriately performed and color misregistration occurs in the recorded image.

[0053] Specifically, according to the inkjet recording apparatus 1 of the present embodiment, if the conveyance belt 13 meanders, the recording medium M is shifted in the width direction (that is, the recording medium M moves diagonally) between different positions in the conveyance direction. The landing position of the inks discharged from the respective head units 21 are then shifted relative to each other in the width direction, and the above color misregistration occurs. The meandering of the conveyance belt 13 is caused by the shift of the contacting range of the conveyance belt 13 on the conveyance roller in the width direction due to an uneven distribution in the width direction of force received by the conveyance belt 13 from the conveyance roller.

[0054] If the recording medium M moves diagonally due to the meandering of the conveyance belt 13 or the like, the amount of relative shift in the width direction of the recording medium M is likely to be larger between two points with a larger interval in the conveyance direction. Therefore, as for the head units 21 with larger arrangement interval in the width direction among the six head units 21, the relative shift of ink landing position is likely to be larger in the width direction and more color misregistration is likely to occur in the recorded image.

[0055] However, among the six color inks used in the inkjet recording apparatus 1, some of the combinations of colors are not used by mixing colors with each other. Even if the ink landing position is shifted between inks of such combinations, it does not result in color misregistration in the recorded image. Combination of colors which are not used by mixing colors may be explained on the basis of the relative relationship of hues in a hue circle.

[0056] FIG. 5 is a diagram showing positions of colors of the inks discharged from the six head units 21 in a hue circle.

[0057] The hue circle represents hues, one of the three elements of color, annularly in such an order that they appear to continuously change. In the hue circle of FIG. 5, Y, R (red), M, B, C, and G (green) are arranged clockwise in this order, at 60 degree intervals. Hereinafter, three ranges in the hue circle partitioned by the positions of hues corresponding to Y, M, and C are set as hue ranges A1 to A3. The hue range A1 is a range partitioned by positions corresponding to hues of Y and M, the hue range A2 is a range partitioned by positions corresponding to hues of M and C, and the hue range A3 is a range partitioned by positions corresponding hues of C and Y.

[0058] Between the spot colors used in the inkjet recording apparatus 1 of the present embodiment, O is in the hue range A1 and B is in a hue range A2 which does not include O.

[0059] In view of the colors of the dyes that can be used for the reactive dye ink used in the present embodiment, it is easy to prepare an orange ink in the hue range A1 and a blue ink in the hue range A2. Therefore, O and B are used as the two spot colors in the present embodiment.

[0060] Here, orange used as the spot color has, for example, a hue in the range of 7.5R to 7.5YR in the Munsell hue circle, and blue used as the spot color has, for example, a hue in the range of 7.5B to 7.5PB in the Munsell hue circle.

[0061] In recording an image by the inkjet recording apparatus 1, a spot color in a certain hue range in the hue circle is used by color mixing with the process colors having hues corresponding to both edges of the hue range including the spot color (the process colors having hues between which the hue range including the spot color ranges) (hereinafter referred to as "neighboring process color" for convenience). On the other hand, the spot color is not usually used by being mixed with a process color having a hue different from the hues corresponding to both edges of the hue range including the spot color (hereinafter referred to as "an opposite process color" for convenience). This is because a color obtained by color mixing of a spot color and its opposite process color is close to an achromatic color and therefore such color mixing does not contribute to improvement in color reproducibility of a recorded image.

[0062] Specifically, between the spot colors of the present embodiment, O may be used by color mixing with Y and/or M, which are neighboring process colors for O, while O may not be used by color mixing with C, which is an opposite process color to O. Similarly, B may be used by color mixing with M and/or C, which are neighboring process colors for B, while B may not be used by color mixing with Y, which is an opposite process color to B.

[0063] In the image recording by the inkjet recording apparatus 1, spot colors in different hue ranges are also not used by color mixing with each other, for the same reason as the reason why a spot color is not used by color mixing with the opposite process color. Therefore, the two spot colors (O and B) of the present embodiment are used without being mixed together.

[0064] In the above-described color conversion processing by the image processor 41, image data of C, M, Y, K, O, and B is individually generated so that conditions regarding whether or not to perform color mixing are satisfied. Specifically, as for the image data of O and

C, which are colors not mixed with each other, pixels (ON pixels) of ink discharge are arranged in a positional relationship where inks of O and C are not discharged so close to each other as to be recognized as a mixed color. As for the image data of B and Y and image data of O and B, ON pixels are also arranged in the same positional relationship.

[0065] As shown in FIG. 4, in the inkjet recording apparatus 1 of the present embodiment, the head units 21 discharging the two spot colors (O and B) which are not used by color mixing with each other are disposed at both edges (PI and P6) in the conveyance direction. That is, a head unit 210 (the first ink discharger) discharging an ink of O among the two spot colors is arranged outside the arrangement range of the head units 21Y, 21M, and 21C respectively discharging inks of Y, M, and C in the conveyance direction, and a head unit 21B (the second ink discharger) discharging an ink of B among the two spot colors is arranged outside the arrangement range of the head units 21Y, 21M, and 21C and at an opposite side of the head unit 210 in the conveyance direction.

[0066] Then, the head units 21 at the upstream edge and at the downstream edge in the conveyance direction respectively discharge inks of O and B, which are not used by color mixing with each other. The relative shift of the ink landing position in the width direction is likely to be large between such head units 21. As a result, even if the relative shift of landing position of the ink discharged from such head units 21 occurs in the width direction due to meandering of the conveyance belt 13, color misregistration does not occur in the recorded image.

[0067] As a result of such arrangement, the head units 21Y, 21M, and 21C discharging inks of Y, M, and C, which are frequently mixed, can be arranged close to each other (P2, P3, and P5). Therefore, it is possible to reduce the relative shift of the landing position in the width direction between the process color inks to be mixed together, and to suppress color misregistration in the recorded image.

[0068] Further, the head unit 21C discharging an ink of C, which is the opposite process color to O among the two spot colors, is disposed at a position (P5) which is farthest from the position (P1) of the head unit 210 in the conveyance direction within the arrangement range of the head units 21Y, 21M, and 21C.

[0069] Further, the head unit 21Y discharging an ink of Y, which is the opposite process color to B among the two spot colors, is disposed at a position (P2) which is farthest from the position (P6) of the head unit 21B in the conveyance direction within the arrangement range of the head units 21Y, 21M, and 21C.

[0070] As a result, an ink of a spot color and an ink of the opposite process color which are not mixed with each other are discharged from the respective head units 21 in such a positional relationship that they are apart by a large interval in the conveyance direction. Therefore, even if the relative shift of landing position in the width direction occurs between inks discharged from these head units 21 due to the meandering of the conveyance belt 13, color misregistration is not caused in the recorded image.

[0071] Further, as a result of such arrangement, the head unit 21 discharging an ink of a spot color and the head unit 21 discharging an ink of a neighboring process color which may be mixed with the spot color can be arranged relatively close to each other. Specifically, the positions of the head units 210, 21Y, and 21M discharging inks of O, Y, and M which may be mixed together can be closely arranged (P1 to P3), and the positions of the head units 21B, 21C, and 21M discharging inks of B, C, and M to be mixed together can be closely arranged (P3, P5, P6). Therefore, it is possible to reduce the relative shift of the ink landing position in the width direction between a spot color and process colors which may be mixed together, and it is possible to suppress color misregistration in the recorded image.

[0072] As shown in FIG. 6, the arrangement order of the six head units 21 may be reversed from that in FIG. 4. Even with this arrangement order of FIG. 6, the same effect of suppressing color misregistration as in FIG. 4 can be obtained.

(Modification 1)

[0073] Next, Modification 1 of the above embodiment will be described. In the present modification, the spot colors to be used are different from those in the above embodiment. Points different from the above embodiment will be described below.

[0074] In the present modification, a dispersed dye ink in which a dye is dispersed in the ink is used. The dispersed dye ink may be suitably used for a recording medium M of chemical fibers such as polyester, acetate, and the like.

[0075] In the present modification, the spot colors are red (R) and violet (V).

[0076] FIG. 7 is a diagram showing positions of the colors of inks discharged from the six head units 21 in hue circle according to the present modification. As shown in this figure, among the spot colors used in the present modification, R is in the same hue range A1 as O in the above embodiment, and V is in the same hue range A2 as B in the above embodiment. Therefore, for the same reasons as the above embodiment, among the spot colors of the present modification, R may be used by color mixing with Y and/or M, while R may not be used by color mixing with C. V may be used by color mixing with M and/or C, while V may not be used by color mixing with Y. The spot colors R and V are used without color mixing.

[0077] In view of the colors of the dyes that can be used for the dispersed dye ink, it is easy to prepare a red ink in the hue range A1 and a violet ink in the hue range A2. Therefore, R and V are used as the two spot colors in the present modification.

[0078] Here, red used as the spot color has, for example, a hue in the range of 7.5RP to 7.5R in the Munsell

hue circle, and violet used as the spot color has, for example, a hue in the range of 7.5PB to 7.5P in the Munsell hue circle.

[0079] FIGs. 8A and 8B are figures each showing an arrangement order of the head units 21 according to the present modification.

[0080] In the present modification, as shown in FIG. 8A, the head units 21 discharging inks of R, Y, M, K, C, and V are arranged in this order from the upstream side in the conveyance direction.

[0081] The arrangement order shown in FIG. 8A is the same as that of FIG. 4 in the above embodiment except that O is replaced with R, which is in the same hue range A1 as O, and B is replaced with V, which is in the same hue range A2 as B. By arranging the head units 21 in such an order, it is possible to arrange the head units 21 for discharging inks which are not mixed together (that is, inks of R and V, inks of R and C, or inks of Y and V) at positions separated from each other in the conveyance direction. Therefore, even if the relative shift of landing position in the width direction occurs between inks discharged from head units 21 of one of these combinations due to the meandering of the conveyance belt 13, color misregistration does not occur in the recorded image.

[0082] As shown in FIG. 8B, the arrangement order of the six head units 21 may be reversed from that in FIG. 8A.

(Modification 2)

[0083] Next, Modification 2 of the above embodiment will be described. In the present modification, inks of three spot colors (O, R, and B) are used. Therefore, the recorder 20 includes seven head units 21 (six head units 21 as in the above embodiment and one head unit 21R discharging an ink of R). Points different from the above embodiment will be described below.

[0084] FIG. 9 is a figure showing an arrangement order of head units 21 according to the present modification.

[0085] In the present modification, as shown in this figure, the head units 21 discharging inks of R, O, Y, M, K, C, and B are arranged in this order from the upstream side in the conveyance direction. Since O and R among the three spot colors of the present modification are in the same hue range A1, they may be used by being mixed together. Therefore, the head units 210 and 21R discharging inks of O and R are arranged at positions close to each other, that is, at positions adjacent to each other in the conveyance direction as shown in FIG. 9.

[0086] In FIG. 9, the positions of the head unit 210 and the head unit 21R may be exchanged. Further, the arrangement order of the seven head units 21 may be reversed from that in FIG. 9.

[0087] An example of using inks of three spot colors O, R and B is described above. However, the present modification is not limited to this. The present modification includes any examples using three or more spot colors and two or more of the spot colors are in the same hue range. In any of such examples, the head units 21 discharging inks of spot colors in the same hue range are preferably arranged at positions adjacent to each other. For example, when spot colors of O, B and V are used, the head units 21B and 21V discharging inks of B and V are preferably arranged adjacent to each other.

[0088] As described above, the inkjet recording apparatus 1 according to the present embodiment records an image on a recording medium using inks of process colors (basic colors) and spot colors, the basic colors including yellow, magenta, cyan, and black, the spot colors each having a different hue from yellow, magenta, and cyan and including a first spot color and a second spot color having different hues from each other, the image including a portion where at least one of yellow, magenta and cyan is mixed with at least one of the spot colors. The inkjet recording apparatus includes a conveyer 10 which conveys a recording medium M; and multiple head units 21 which each discharge, on a recording medium M conveyed by the conveyor 10, an ink of one color which is different from each other and which is among the process colors, O (the first spot color), and B (the second spot color). The respective spot colors of O and B are in different hue ranges from each other among three hue ranges in a hue circle which are partitioned by hues corresponding to yellow, magenta and cyan. The multiple head units 21 are disposed at different positions from each other in a conveyance direction of the recording medium M conveyed by the conveyor 10. The multiple head units 21 include a head unit 210 (the first ink discharger) which discharges an ink of O and which is disposed at an outer side in the conveyance direction of an arrangement range of the head units 21 discharging inks of yellow, magenta, and cyan among the multiple head units 21. The multiple head units 21 include a head unit 21B (the second ink discharger) which discharges an ink of B and which is disposed at a side opposite to the outer side in the conveyance direction across the arrangement range.

[0089] According to the relationship of hues of the two spot colors (O and B) in such a configuration, at least one of the process colors is sandwiched between the two spot colors (O and B) in a hue circle. The two spot colors having such a relationship of hues contribute to improvement in color reproducibility of the recorded image when they are each mixed with process colors at both edges of the hue range including the spot color. On the other hand, since the effect of improving the color reproducibility is not enhanced even if the two spot colors themselves are mixed together, these spot colors are usually used without mixing together.

[0090] In the above configuration, the head unit 210 and the head unit 21B discharging inks of these spot colors are arranged at positions sandwiching the head units 21Y, 21M, and 21C for the process color. Since the interval is large between the head unit 210 and the head unit 21B arranged as above, a shift of the recording medium M in the width direction is likely to be large between

these head units due to meandering of the conveyance belt 13 and the like. However, the inks discharged by the head unit 210 and the head unit 21B are not mixed with each other. Therefore, even if a relative shift in the width direction occurs in the ink landing position due to the shift of the recording medium M, color misregistration is not caused in the recorded image.

[0091] According to a conventional arrangement where the head units 21 where two spot colors are collectively arranged on one side of the arrangement range of the head units 21C, 21M, and 21Y for the process colors, the head units 21 are arranged in a positional relationship where one spot color is sandwiched between the other spot color and C, M, and Y. Therefore, there is a problem that the head unit 21 for the one spot color is apart from each of the head units 21 for C, M, and Y by a large interval. To deal with this problem, the head units 210 and 21B for the two spot colors are arranged on both sides of the arrangement range of the head units 21Y, 21M, and 21C as in the above configuration. As a result, it is possible to reduce the interval between the head unit 21 for each of the spot colors and the head units 21 for C, M, and Y. Therefore, it is possible to reduce the relative shift of the landing position in the width direction between an ink of the spot color and inks of process colors to be mixed with the spot color, and it is possible to suppress color misregistration in the recorded image.

[0092] As a result of arranging the head unit 210 and the head unit 21B as in the above configuration, the interval between the head units 21Y, 21M, and 21C discharging inks of respective process colors become short. Therefore, it is possible to reduce the relative shift of landing positions in the width direction between inks of Y, M, and C which may be mixed together, and it is possible to suppress color misregistration in the recorded image.

[0093] Further, if the first spot color is in a hue range A1 ranging between a hue of Y and a hue of M, and the second spot color is in a hue range A2 ranging between a hue of M and a hue of C, it is possible to easily prepare an ink of a reactive dye or a dispersed dye of a spot color with the above characteristics.

[0094] Further, if the first spot color is O and the second spot color is B, it is possible to easily prepare an ink of a reactive dye of a spot color having the above characteristics.

[0095] Further, if the first spot color is R and the second spot color is V, it is possible to easily prepare an ink of a dispersed dye of a spot color having the above characteristics.

[0096] Further, one of the multiple head units 21 discharges an ink of a color (opposite process color) which is Y, M, or C, and which has a hue different from hues between which a hue range including the first spot color ranges, the one of the multiple head units being disposed at a position farthest from the head unit 21 corresponding to the first ink discharger in the conveyance direction in the arrangement range of the head units 21Y, 21M, and 21C.

Another of the multiple head units 21 discharges an ink of a color (opposite process color) which is Y, M, or C, and which has a hue different from hues between which a hue range including the second spot color ranges, the another of the multiple head units being disposed at a position farthest from the head unit 21 corresponding to the second ink discharger in the conveyance direction in the arrangement range of the head units 21Y, 21M, and 21C. More specifically, the head unit 21C discharging an ink of C is disposed at a position farthest from the head unit 210 in the conveyance direction in the arrangement range of the head units 21Y, 21M, and 21C.

The head unit 21Y discharging an ink of Y is disposed at a position farthest from the head unit 21B in the conveyance direction in the arrangement range of the head units 21Y, 21M, and 21C.

[0097] Since the above-described effect of improving the color reproducibility is not enhanced even if a spot color and an opposite process color to the spot color are mixed together, they are usually used without color mixing.

[0098] In the above configuration, the interval is large between a pair of head units 21, one discharging an ink of the spot color and the other discharging an ink of the opposite process color. Therefore, the shift of the recording medium M in the width direction tends to be large due to meandering of the conveyance belt 13 and the like between the head units 21. However, since the ink of the spot color and the ink of the opposite process color discharged from the respective head units 21 are not mixed, even if a relative shift occurs in the ink landing position in the width direction due to the shift of the recording medium M, color misregistration is not caused in the recorded image.

[0099] Further, as a result of arranging the pair of head units 21 as described above (one for discharging an ink of the spot color and another for discharging an ink of the opposite process color), the head unit 21 for discharging an ink of the spot color can be brought relatively close to the head unit 21 for discharging an ink of a neighboring process color to be mixed with the spot color. Therefore, it is possible to reduce the relative shift of the landing position in the width direction between an ink of the spot color and each of the inks of process colors to be mixed with the spot color, and it is possible to suppress color misregistration in the recorded image.

[0100] Further, according to the inkjet recording apparatus 1 of Modification 2, the spot colors include a third spot color (R) which has a different hue from the first spot color (O) and the second spot color (B). The third spot color (R) is in a hue range including a predetermined spot color either the first spot color (O) or the second spot color (B). The multiple head units 21 include a head unit 21R which discharges the third spot color (R) and which is disposed at a position adjacent to one of the head units which discharges an ink of the predetermined spot color in the conveyance direction. With such a configuration, it is possible to further improve the color reproducibility

of the recorded image by using more spot colors, while suppressing color misregistration.

[0101] Further, if the recording medium is fabric, it is possible to achieve an effect of suppressing color misregistration and improving desired color reproducibility by applying the above configurations, while color mixing of process colors and spot colors is effective for improving color reproducibility.

[0102] It should be noted that the present invention is not limited to the above-described embodiment and modifications, and various changes may be made.

[0103] For example, the spot colors are not limited to those shown in the above embodiment and in each modification. Spot colors may include any other arbitrary color having different hue from Y, M, and C and being mixed with at least one of Y, M, and C. For example, colors (green and the like) in the hue range A3 in FIG. 5 may be used.

[0104] If three spot colors are in different hue ranges from one another, the arrangement order of the head units is determined as described in the above embodiment for two of the spot colors, and the head unit for the remaining one spot color is arranged at a position adjacent to any of the two spot colors.

[0105] Further, the position of the head unit 21K for discharging the ink of K (black) is not limited to the position described in the above embodiment and each modification. For example, in FIGs. 4, 6, 8A, 8B, and 9, the position of the head unit 21K and the position of the head unit 21 M may be exchanged. Further, the position of the head unit 21K may be changed as long as there is not effect on the coloring of ink of another color, for example, to one of the edges in the conveying direction. This is because the ink of the head unit 21K (black) remains achromatic even if it is mixed with inks of other color(s). Therefore, even if relative shift of landing position occurs between a black ink and each of the inks of other colors, color misregistration is not caused in the recorded image

[0106] The hue circle is not limited to those of the above embodiment (one in which Y, R, M, B, C, and G are arranged at 60 degree intervals). Other kinds of hue circle may also be used where hues corresponding to Y, R, M, B, C, and G are arranged in this order, such as a Munsell hue circle and a PCCS hue circle.

[0107] Further, in the above embodiment and each modification, examples in which the recording medium M is conveyed by the conveyor 10 having the conveyance belt 13 has been described, but the present invention is not limited to this. The conveyor 10 may have a conveyance drum as a conveyance member, and convey the recording medium M held on the outer peripheral surface of the rotating conveyance drum, for example. Since a shift in the width direction of the recording medium M may also occur in an inkjet recording apparatus using such a conveying drum, it is possible to suppress color misregistration due to the shift of the recording medium M by applying the present invention.

[0108] Although embodiments of the present invention have been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and not limitation, the scope of the present invention should be interpreted by terms of the appended claims.

[0109] Japanese Patent Application No. 2018-013175 filed on January 30, 2018, including description, claims, drawings, and abstract of the entire disclosure is incorporated herein by reference in its entirety.

Claims

1. An inkjet recording apparatus (1) which records an image on a recording medium using inks of basic colors and spot colors, the basic colors including yellow, magenta, cyan, and black, the spot colors each having a different hue from yellow, magenta, and cyan and including a first spot color and a second spot color having different hues from each other, the image including a portion where at least one of yellow, magenta and cyan is mixed with at least one of the spot colors,
   the inkjet recording apparatus comprising:

   a conveyer (10) which conveys a recording medium; and
   multiple ink dischargers (21) which each discharge, on a recording medium conveyed by the conveyor, an ink of one color which is different from each other and which is among the basic colors, the first spot color, and the second spot color,
   wherein the first spot color and the second spot color are in different hue ranges from each other among three hue ranges in a hue circle which are partitioned by hues corresponding to yellow, magenta and cyan,
   wherein the multiple ink dischargers are disposed at different positions from each other in a conveyance direction of the recording medium conveyed by the conveyor,
   wherein the multiple ink dischargers include a first ink discharger which discharges an ink of the first spot color and which is disposed at an outer side in the conveyance direction of an arrangement range of ink dischargers discharging inks of yellow, magenta, and cyan among the multiple ink dischargers, and
   wherein the multiple ink dischargers include a second ink discharger which discharges an ink of the second spot color and which is disposed at a side opposite to the outer side in the conveyance direction across the arrangement range.

2. The inkjet recording apparatus according to claim 1, wherein the first spot color is in a hue range ranging

between a hue of yellow and a hue of magenta, and wherein the second spot color is in a hue range ranging between a hue of magenta and a hue of cyan.

3. The inkjet recording apparatus according to claim 2, wherein the first spot color is orange and the second spot color is blue.

4. The inkjet recording apparatus according to claim 2, wherein the first spot color is red and the second spot color is violet.

5. The inkjet recording apparatus according to any one of claims 1 to 4,
wherein one of the multiple ink dischargers discharges an ink of a color which is yellow, magenta, or cyan, and which has a hue different from hues between which a hue range including the first spot color ranges, the one of the multiple ink dischargers being disposed at a position farthest from the first ink discharger in the conveyance direction in the arrangement range, and
wherein another of the multiple ink dischargers discharges an ink of a color which is yellow, magenta, or cyan, and which has a hue different from hues between which a hue range including the second spot color ranges, the another of the multiple ink dischargers being disposed at a position farthest from the second ink discharger in the conveyance direction in the arrangement range.

6. The inkjet recording apparatus according to any one of claims 2 to 4,
wherein one of the multiple ink dischargers discharging an ink of cyan is disposed at a position farthest from the first ink discharger in the conveyance direction in the arrangement range, and
wherein another of the multiple ink dischargers discharging an ink of yellow is disposed at a position farthest from the second ink discharger in the conveyance direction in the arrangement range.

7. The inkjet recording apparatus according to any one of claims 1 to 6,
wherein the spot colors include a third spot color which has a different hue from the first spot color and the second spot color and which is in a hue range including a predetermined spot color either the first spot color or the second spot color, and
wherein the multiple ink dischargers include a third ink discharger which discharges the third spot color and which is disposed at a position adjacent to one of the ink dischargers which discharges an ink of the predetermined spot color in the conveyance direction.

8. The inkjet recording apparatus according to any one of claims 1 to 7,
wherein the recording medium is fabric.

FIG.1

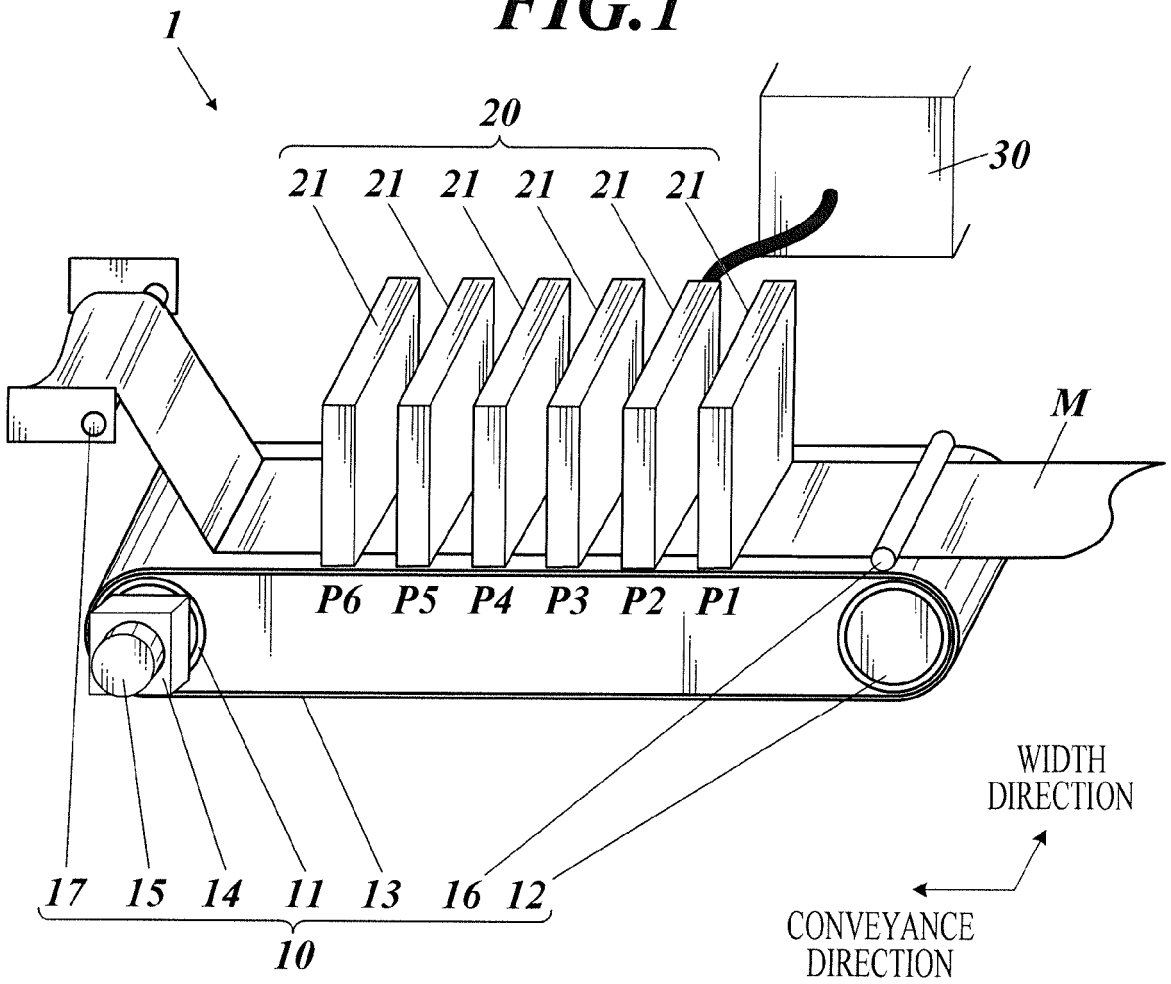
1
20
21 21 21 21 21 21
30
M
P6 P5 P4 P3 P2 P1
17 15 14 11 13 16 12
10
WIDTH DIRECTION
CONVEYANCE DIRECTION

FIG.2

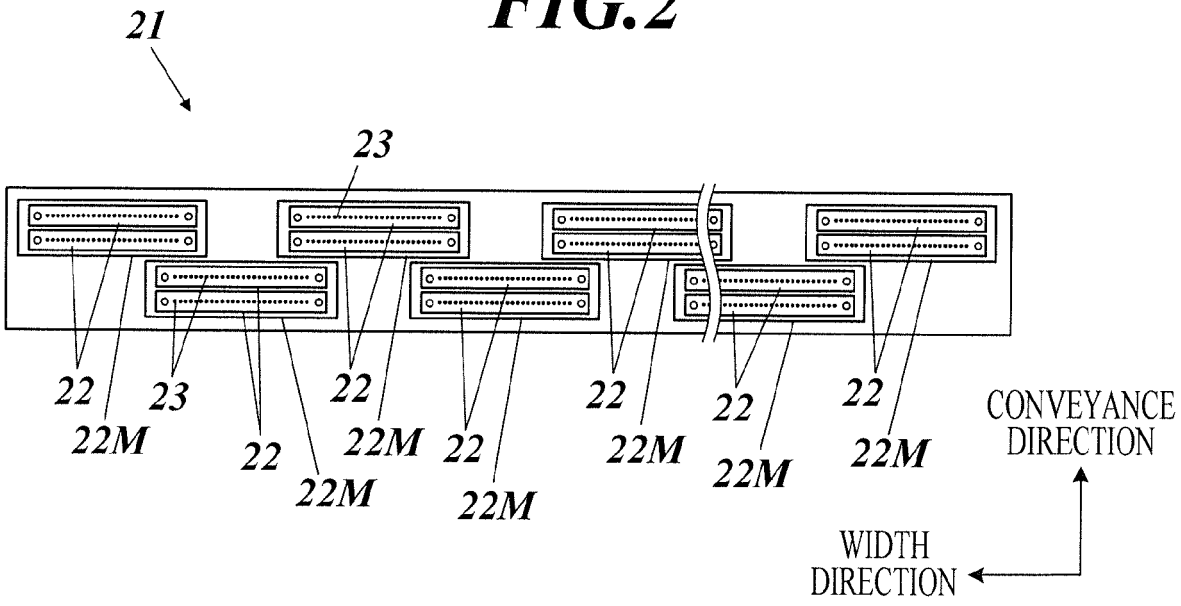
21
23
22 22M
23
22 22M
22 22M
22 22M
22 22M
22 22M
22 22M
CONVEYANCE DIRECTION
WIDTH DIRECTION

FIG.3

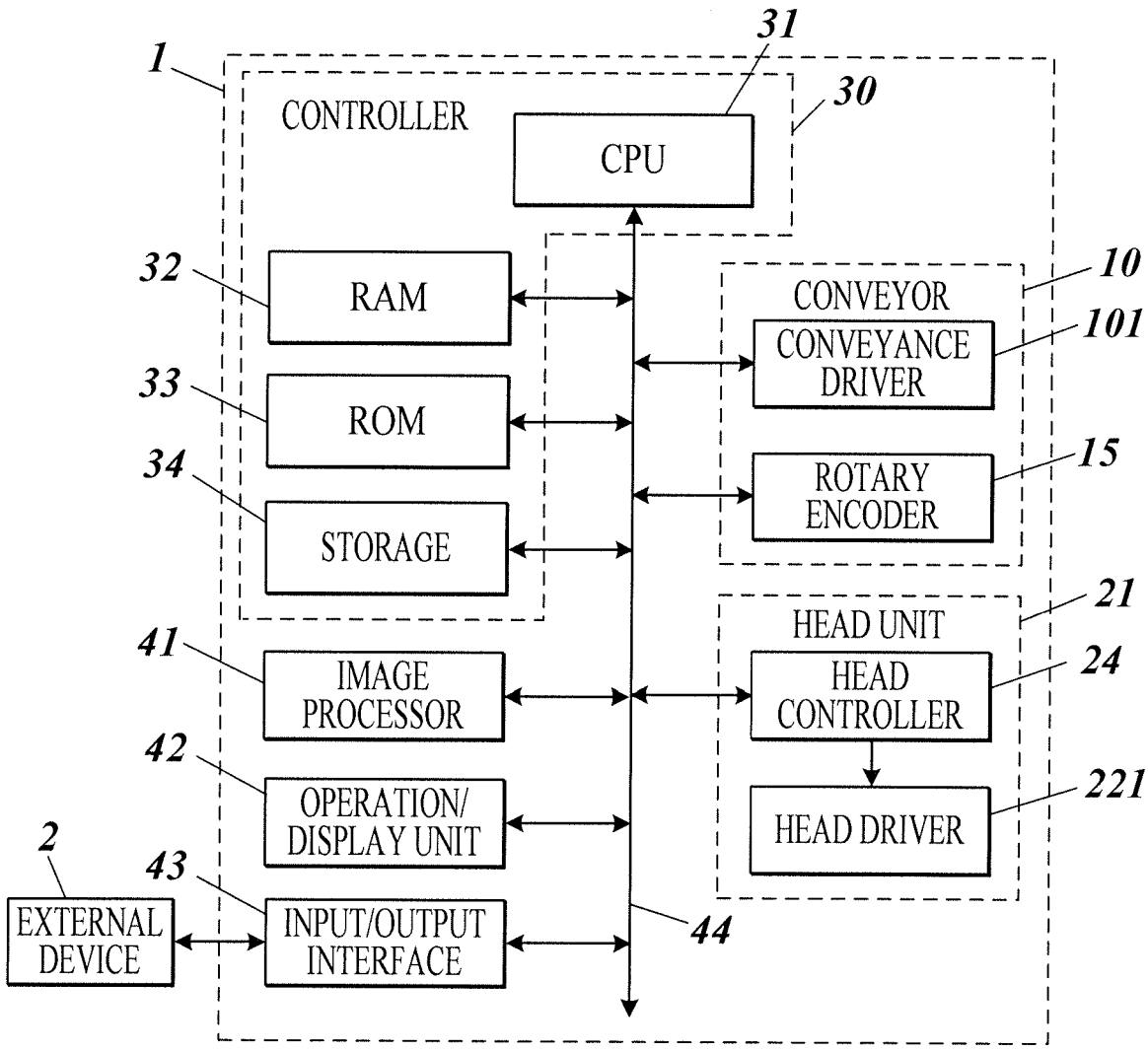

FIG.4

ARRANGEMENT POSITION OF HEAD UNIT	P1	P2	P3	P4	P5	P6
COLOR OF INK	O	Y	M	K	C	B

FIG.5

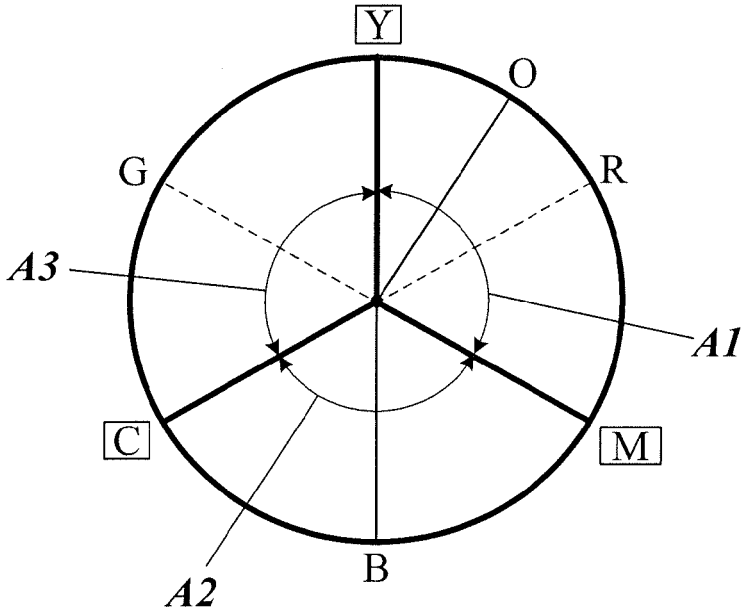

FIG.6

ARRANGEMENT POSITION OF HEAD UNIT	P1	P2	P3	P4	P5	P6
COLOR OF INK	B	C	K	M	Y	O

FIG.7

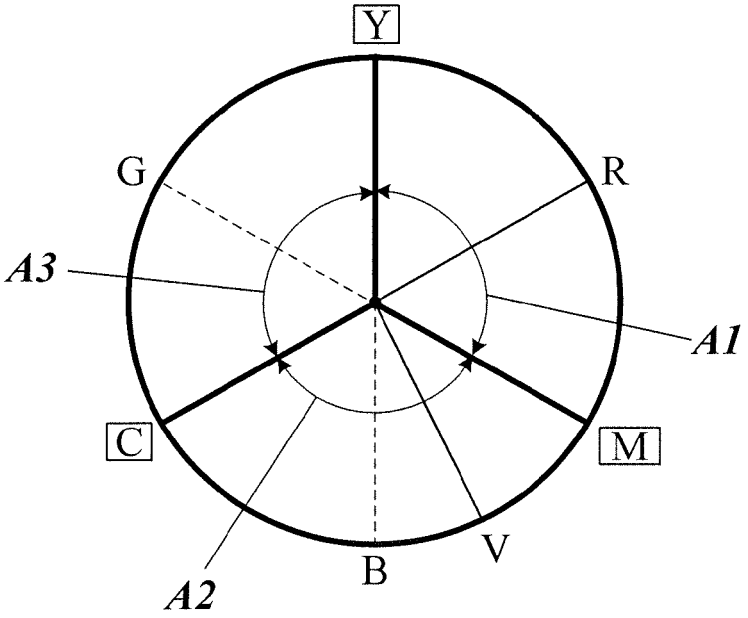

FIG.8A

ARRANGEMENT POSITION OF HEAD UNIT	P1	P2	P3	P4	P5	P6
COLOR OF INK	R	Y	M	K	C	V

FIG.8B

ARRANGEMENT POSITION OF HEAD UNIT	P1	P2	P3	P4	P5	P6
COLOR OF INK	V	C	K	M	Y	R

FIG.9

ARRANGEMENT POSITION OF HEAD UNIT	P1	P2	P3	P4	P5	P6	P7
COLOR OF INK	R	O	Y	M	K	C	B

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EUROPEAN SEARCH REPORT

Application Number
EP 19 15 4509

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B41J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	31 May 2019	João, César

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31-05-2019

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