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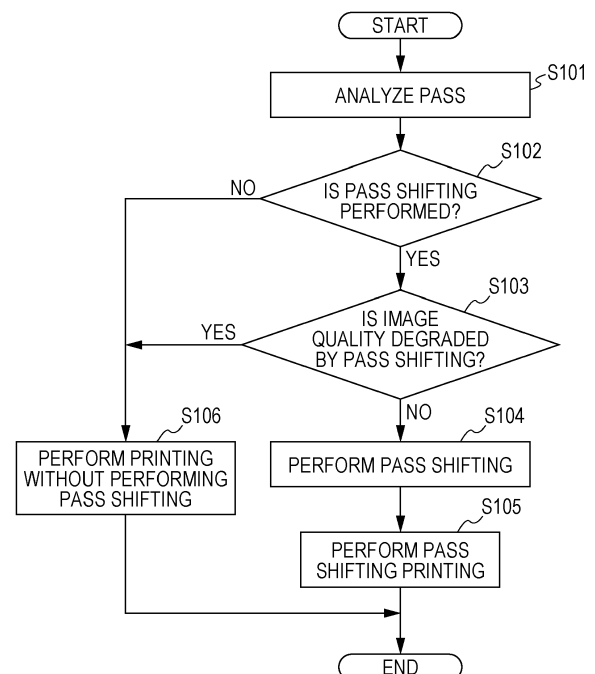
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(54) **PRINTING APPARATUS AND PRINTING METHOD**

(57) A printing mechanism unit that forms an image by ejecting first ink and second ink which have hues different from each other toward a recording medium, while moving multiple number of times with respect to the recording medium; a pass analysis unit that decides an ejection position of the ink in multiple paths through which the printing unit moves, when the image is formed; an execution unit that, when two paths different from each other of the multiple paths are referred to as a first path and a second path, performs ejection position change correction in which the ejection position is changed such that at least one ink of the first ink and the second ink which are ejected into the first path is ejected into the second path; and a determination unit that determines whether or not the execution unit performs the ejection position change correction, based on an amount of ejection per unit area of at least one ink of the first ink and the second ink with respect to the image, are provided.

FIG. 8



Description

BACKGROUND

1. Technical Field

[0001] The present invention relates to a printing apparatus and a printing method.

2. Related Art

[0002] A printing apparatus which performs printing on a recording medium using ink has been used (for example, JP-A-2010-5827). A printing apparatus described in JP-A-2010-5827 includes a transport unit which transports a recording medium, and a printing unit which includes multiple nozzles that eject ink on a recording medium which is being transported, while reciprocating in a direction intersecting a transport direction of the recording medium.

[0003] The printing apparatus has a possibility that significant deviation of a position where ink is landed on a forward path and a backward path of the printing unit occurs according to a distance between the recording medium and the printing unit, or a material of the recording medium, and quality of an image which is obtained is degraded. Accordingly, it is considered that ejection position change correction is performed in which ink that is ejected into the other path is ejected into one path such that the ink is ejected only in one path of either a forward path or a backward path of a printing unit.

[0004] However, the printing apparatus described in JP-A-2010-5827 has a possibility that inks of a portion where ejection position change correction is performed overlap, in a case where the ejection position change correction is performed. In this case, an area where inks overlap has a different hue from an area where inks do not overlap, at a portion in which the ejection position change correction is performed. As a result, degradation of image quality may occur in an obtained image.

SUMMARY

[0005] An advantage of some aspects of the invention is to provide a printing apparatus and a printing method which can prevent an obtained image from being degraded.

[0006] The advantage is achieved by the following aspects of the invention.

[0007] According to an aspect of the invention, there is provided a printing apparatus including: a printing unit that forms an image by ejecting first ink and second ink which have hues different from each other toward a recording medium, while moving multiple number of times with respect to the recording medium; a decision unit that decides an ejection position of the ink in multiple paths through which the printing unit moves, when the image is formed; an execution unit that, when two paths different

from each other of the multiple paths are referred to as a first path and a second path, performs ejection position change correction in which the ejection position is changed such that at least one ink of the first ink and the second ink which are ejected into the first path is ejected into the second path; and a determination unit that determines whether or not the execution unit performs the ejection position change correction, based on an amount of ejection per unit area of at least one ink of the first ink and the second ink with respect to the image, in which, in a case where the determination unit determines that the amount of ink of both the first ink and the second ink is less than a predetermined value, the execution unit performs the ejection position change correction of both the first ink and the second ink, and in which, in a case where the determination unit determines that the amount of ink of at least one of the first ink and the second ink is more than the predetermined value, the execution unit does not perform the ejection position change correction of both the first ink and the second ink.

[0008] Thereby, in a case where the amount of ejection per unit area of ink is relatively small, ejection position change correction can be performed. Hence, by performing the ejection position change correction, degradation of image quality which occurs in an obtained image can be prevented or suppressed.

[0009] In the printing apparatus of the aspect of the invention, the amount of ejection may be an amount of ejection per unit area of ink which is a target that is ejected onto the recording medium, in a case where the ejection position change correction is performed for ink which is the target of the ejection position change correction among the first ink and the second ink.

[0010] Thereby, it is possible to accurately determine whether or not in a case where ejection position change correction is performed, degradation of image quality occurs in an image.

[0011] In the printing apparatus of the aspect of the invention, in a case where the determination unit determines that the amount of ejection is less than the predetermined value, the execution unit may perform the ejection position change correction for ink with the smaller amount of ejection among the first ink and the second ink.

[0012] Thereby, degradation of image quality which occurs in an image in a case where ejection position change correction is performed can be more effectively prevented or suppressed.

[0013] In the printing apparatus of the aspect of the invention, the predetermined value may be a total sum of areas of the recording medium in a plan view, when the first ink and the second ink are landed on the recording medium.

[0014] Thereby, it is possible to more accurately determine whether or not in a case where ejection position change correction is performed, degradation of image quality occurs in an image.

[0015] In the printing apparatus of the aspect of the invention, the predetermined value may be set according to

a material of the recording medium.

[0016] Thereby, it is possible to more accurately determine whether or not in a case where ejection position change correction is performed, degradation of image quality occurs in an image.

[0017] In the printing apparatus of the aspect of the invention, the predetermined value may be set according to a material of the ink.

[0018] Thereby, it is possible to more accurately determine whether or not in a case where ejection position change correction is performed, degradation of image quality occurs in an image.

[0019] In the printing apparatus of the aspect of the invention, the predetermined value may be obtained by experimentally performing printing in advance.

[0020] Thereby, it is possible to more accurately determine whether or not in a case where ejection position change correction is performed, degradation of image quality occurs in an image.

[0021] According to another aspect of the invention, there is provided a printing method of performing printing by using a printing apparatus including a printing unit that forms an image by ejecting first ink and second ink which have hues different from each other toward a recording medium, while moving multiple number of times with respect to the recording medium, a decision unit that decides an ejection position of the ink in multiple paths through which the printing unit moves, when the image is formed, an execution unit that, when two paths different from each other of the multiple paths are referred to as a first path and a second path, performs ejection position change correction in which the ejection position is changed such that at least one ink of the first ink and the second ink which are ejected into the first path is ejected into the second path, and a determination unit that determines whether or not the execution unit performs the ejection position change correction, based on an amount of ejection per unit area of the first ink and the second ink with respect to the image, the method including: causing, in a case where a determination unit determines that the amount of ink of both the first ink and the second ink is less than a predetermined value, the execution unit to perform the ejection position change correction of both the first ink and the second ink; and causing, in a case where the determination unit determines that the amount of ink of both the first ink and the second ink is more than the predetermined value, the execution unit not to perform the ejection position change correction of both the first ink and the second ink.

[0022] Thereby, in a case where the amount of ejection per unit area of ink is relatively small, ejection position change correction can be performed. Hence, by performing the ejection position change correction, degradation of image quality which occurs in an obtained image can be prevented or suppressed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings, wherein like numbers reference like elements.

Fig. 1 is a side view schematically illustrating a first embodiment of a printing apparatus according to the invention.

Fig. 2 is a block diagram of the printing apparatus illustrated in Fig. 1.

Fig. 3 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 prints an image.

Fig. 4 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 performs ejection position change correction and prints an image.

Fig. 5 is a diagram illustrating pass analysis that the printing apparatus illustrated in Fig. 1 performs.

Fig. 6 is a diagram illustrating the ejection position change correction that the printing apparatus illustrated in Fig. 1 performs.

Fig. 7 is another diagram illustrating the ejection position change correction that the printing apparatus illustrated in Fig. 1 performs.

Fig. 8 is a flowchart illustrating a control operation of a control unit which is included in the printing apparatus illustrated in Fig. 1.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0024] Hereinafter, a printing apparatus and a printing method according to the invention will be described in detail, based on a preferred embodiment illustrated in the accompanying drawings.

First Embodiment

[0025] Fig. 1 is a side view schematically illustrating a first embodiment of a printing apparatus according to the invention. Fig. 2 is a block diagram of the printing apparatus illustrated in Fig. 1. Fig. 3 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 prints an image. Fig. 4 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 performs ejection position change correction and prints an image. Fig. 5 is a diagram illustrating pass analysis that the printing apparatus illustrated in Fig. 1 performs. Fig. 6 is a diagram illustrating the ejection position change correction that the printing apparatus illustrated in Fig. 1 performs. Fig. 7 is another diagram illustrating the ejection position change correction that the printing apparatus illustrated in Fig. 1 performs. Fig. 8 is a flowchart illustrating a control operation of a control unit which is included in the printing apparatus illustrated in Fig. 1.

[0026] Hereinafter, three axes of an x-axis, a y-axis, and a z-axis which are orthogonal to each other are il-

illustrated in Fig. 1, and Fig. 3 to Fig. 7 for the sake of convenient description. The x-axis is formed in one direction (width (depth in the figure) of the printing apparatus) of a horizontal direction, and the y-axis is formed in a direction (longitudinal direction of the printing apparatus) perpendicular to the x-axis in the horizontal direction, and the z-axis is formed in a vertical direction (up and down direction). In addition, a front end side of each arrow which is illustrated is referred to as a "positive side (+ side)", and a base end side thereof is referred to as a "negative side (- side)". An upper side of Fig. 1, and Fig. 3 to Fig. 7 is referred to as "top (top side)", and a lower side thereof is referred to as "bottom (bottom side)".

[0027] As illustrated in Fig. 1 and Fig. 2, a printing apparatus 1 executes a printing method of the invention, and includes a machine base 11, a transport mechanism unit (transport unit) 12 which transports a workpiece W as a recording medium (hereinafter referred to as the work W), a printing mechanism unit (printing unit) 13 which performs printing by providing ink 100 on the work W, a drying unit 2 which dries the ink 100 on the work W, and an elevation mechanism 14.

[0028] In the present embodiment, a direction orthogonal to a transport direction in which the work W is transported is referred to as an x-axis direction, a direction parallel with the transport direction is referred to as a y-axis direction, and a direction orthogonal to the x-axis direction and the y-axis direction is referred to as a z-axis direction.

[0029] The transport mechanism unit 12 includes a delivering device 3 which delivers the long work W which is wound in a roll shape, a winding device 4 which winds the printed work W, and a supporting device 5 which is provided on the machine base 11 and supports the work W during printing.

[0030] The delivering device 3 is disposed further on an upstream side than the machine base 11 in a sending direction (y-axis direction) of the work W. The delivering device 3 includes a sending roller (delivery reel) 31 to which the work W is wound in a roll shape and which sends the work W, and a tensioner 32 which applies tension to the work W between the sending roller 31 and the supporting device 5. The sending roller 31 is connected to a motor (not illustrated), and can be rotated by an operation of the motor.

[0031] In addition, a material to be printed can be used as the work W. The material to be printed includes textile which is printed, clothing, other clothing products, or the like. The textile includes fabric, knitted fabric, non-woven fabric, or the like of such as a natural fiber such as cotton, silk, or wool, a chemical fiber such as nylon, or a composite fiber to which the natural fiber and the chemical fiber are mixed. These may be coated with a pre-processing agent for promotion or the like of coloring or color determination. In addition, clothing or other apparel products also include textile or the like before or after being cut, which exist as a part of a state before being sewed, in addition to furniture of such as a T-shirt, a handkerchief,

a scarf, a towel, a carrier-bag, a clothing bag, a curtain, a sheet, or a bed cover which are sewed.

[0032] In addition to the aforementioned material to be printed, normal paper, fine paper, special paper for ink jet recording such as glossy paper, or the like can be used as the work W. In addition, for example, a plastic film for ink jet printing in which surface treatment is not made (that is, an ink absorbing layer is not formed), a material, which is coated with plastic, such as paper, or a material to which a plastic film is attached can also be used as the work W. The plastic is not limited in particular, and for example, polyvinyl chloride, polyethylene terephthalate, polycarbonate, polystyrene, polyurethane, polyethylene, and polypropylene can be used as the plastic.

[0033] The winding device 4 is disposed further on a downstream side than the machine base 11 in the sending direction (y-axis direction) of the work W with respect to the delivering device 3. The winding device 4 includes a winding roller (winding reel) 41 which winds the work W in a roll shape, and tensioners 42, 43, and 44 which apply tension to the work W between the winding roller 41 and the supporting device 5. The winding roller 41 is connected to a motor (not illustrated), and can be rotated by an operation of the motor. The tensioners 42 to 44 are arranged with a gap between each other in an ascending order from the winding roller 41.

[0034] The supporting device 5 is disposed between the delivering device 3 and the winding device 4. The supporting device 5 includes a main driving roller 51 and a follower roller 52 which are separately disposed in the y-axis direction, an endless belt 53 which is stretched over the main driving roller 51 and the follower roller 52 and supports the work W over an upper surface (supporting surface), and tensioners 54 and 55 which apply tension to the work W between the main driving roller 51 and the follower roller 52.

[0035] The main driving roller 51 is connected to a motor (not illustrated), and can be rotated by an operation of the motor. In addition, the follower roller 52 receives a rotating force of the main driving roller 51 through the endless belt 53, and can rotate in conjunction with the main driving roller 51.

[0036] The endless belt 53 has a front surface on which there is an adhesive layer with adhesiveness. A part of the work W is adhesively fixed to the adhesive layer, and the work W is transported in the y-axis direction. In addition, while the work W is transported, the work W is printed. In addition, after being printed, the work W is peeled from the endless belt 53.

[0037] The tensioners 54 and 55 are also disposed with a gap between each other in the y-axis direction in the same manner as the main driving roller 51 and the follower roller 52.

[0038] The work W can be interposed between the tensioner 54 and the main driving roller 51 for each endless belt 53, and the work W can be interposed between the tensioner 55 and the follower roller 52 for each endless belt 53. Thereby, the work W to which tension is applied

by the tensioners 54 and 55 is fixed to the endless belt 53 to be transported in a state where the tension is applied. By doing so, the work W is prevented, for example, from being wrinkled during transport, and thus, in a case of printing, the printing can be performed accurately and with high quality.

[0039] The printing mechanism unit 13 includes a carriage unit 132 including multiple ink jet heads 131 which perform recording by ejecting the ink 100 onto the work W for printing, and an X-axis table (not illustrated) which movably supports the carriage unit 132 in the x-axis direction. Each of the ink jet heads 131 includes a head body which is filled with the ink 100 and in which a head inner flow path is formed, and multiple nozzle groups 6 which respectively have openings.

[0040] The head body includes piezoelectric elements (piezoelectric members) respectively corresponding to ejection nozzles, and if pressure is applied to the piezoelectric elements, the ink 100 is ejected from the nozzle group 6 as droplets.

[0041] The ink jet heads 131 stands by at a position (standby position) far apart from the work W (endless belt 53) when viewing from the z-axis direction, in a state where the ink 100 is not ejected.

[0042] In the printing apparatus 1, the work W which is delivered by the delivering device 3 is intermittently sent (performs subscan) in the y-axis direction in a state of being adhesively fixed to the endless belt 53, and the ink 100 is ejected from the nozzle group 6 toward the work W which is adhesively fixed, while the carriage unit 132 reciprocates (performs main scan) in the x-axis direction. This operation can be performed until printing is completed and an image pattern is formed on the work W. The image pattern may be formed by multicolor printing (color printing), and may be formed by single color printing.

[0043] The ink 100 has four colors of, for example, cyan (C), magenta (M), yellow (Y), and black (K), which are obtained by mixing dye or pigment that is a colorant into water that is a solvent. In addition, various types of the ink 100 are independently ejected from the ink jet heads 131.

[0044] The elevation mechanism 14 illustrated in Fig. 1 and Fig. 2 can adjust a height of the nozzle group 6. The elevation mechanism 14 can be configured to include, for example, a motor, a ball screw, and a linear guide. In addition, an encoder can be embedded in the motor. A height of the ink jet head 131 can be detected based on the amount of rotation which is detected by the encoder. The elevation mechanism 14 is also electrically connected to a control unit 15.

[0045] As such, a distance between the nozzle group 6 and the work W can be adjusted by the elevation mechanism 14. Hence, it is possible to perform good printing in accordance with a material of the work W.

[0046] As illustrated in Fig. 1, the drying unit 2 is disposed between the supporting device 5 and the winding roller 41 of the winding device 4, further on a downstream

side than the printing mechanism unit 13 in the transport direction of the work W.

[0047] The drying unit 2 includes a chamber 21 and a coil 22 which is disposed within the chamber 21. The coil 22 is, for example, a light emitting unit which is configured by a nichrome wire and emits light by receiving electric power. In addition, the ink 100 on the work W which passes through the chamber 21 can be dried by heat that is generated by the coil 22.

[0048] As illustrated in Fig. 2, the control unit 15 is electrically connected to the drying unit 2, the transport mechanism unit 12, the printing mechanism unit 13, and the elevation mechanism 14, and has a function of controlling operations thereof. In addition, the control unit 15 includes a central processing unit (CPU) 151 and a storage unit 155.

[0049] The CPU 151 executes a program for various types of processing such as the aforementioned printing. In addition, the CPU 151 functions as a pass analysis unit (decision unit) 152, a determination unit 153, and an execution unit 154.

[0050] The pass analysis unit 152 performs pass analysis of deciding a position where the ink 100 is ejected on a forward path and a backward path, based on image data which is input.

[0051] The determination unit 153 determines whether or not pass analysis can be performed, as will be described. The execution unit 154 performs the pass analysis based on the determination results of the determination unit 153.

[0052] The storage unit 155 includes, for example, an electrically erasable programmable read only memory (EEPROM) which is a type of a nonvolatile semiconductor memory, or the like, and can store various programs or the like.

[0053] In the printing apparatus 1, the ink 100 is ejected while reciprocating is performed n number of times (n is a positive integer of two or larger) and thereby an image is formed as illustrated in Fig. 3. Hereinafter, detailed description thereof will be made, and a forward path of a first time is referred to as a first pass (pass of $n = 1$), and a backward path of a first time is referred to as a second pass (pass of $n = 2$). In addition, a forward path of a second time is referred to as a third pass (pass of $n = 3$), and a backward path of a second time is referred to as a fourth pass (pass of $n = 4$) (in the same manner, a positive integer is replaced with n also in the forward path of a third time or later). In addition, a printing area A1 which is printed in a first pass and a printing area A2 which is printed in a second pass have the same length L in the transport direction of the work W (also the same as at a printing area A3 or later).

[0054] In the printing apparatus 1, first, the printing area A1 is formed by ejecting the ink 100 onto an area, which is denoted by hatching, of the work W in Fig. 3 during a first pass. Subsequently, the printing area A2 is formed by shifting further on an upstream side than the printing area A1 in the transport direction. At this time,

the amount of the printing area A2 which is shifted is 1/4 of a length L of the printing area A1. That is, the printing area A1 and the printing area A2 overlap each other by 3/4 of the length L and are shifted by 1/4 of the length L. In the printing apparatus 1, printing areas A3, A4, A5, and A6 are formed in the same manner as this.

[0055] Hereinafter, a case where an image with dot density (density of droplets) of yellow (Y) of 100% and black (K) of 12% is printed will be described as an example. In addition, in this case, for example, yellow of 100% and black of 12% are uniformly divided into four passes to be printed, and a ratio between yellow (Y) and black (K) is 25:3 in each pass.

[0056] Although the same ink is used, spreading of the ink in case where printing is performed on the unprinted work W is different from spreading of the ink in a case where printing is performed on the printed work W. Accordingly, colors of the formed printing area differ between the cases where the area is formed by printing on unprinted part of the work W or printing on already printed part of the work W.

[0057] Thus, hereinafter, a color of an area made by printing on the unprinted work W in a ratio between yellow (Y) ink 100Y and black (K) ink 100K of 25:3 is referred to as a color a, and a color of an area made by printing on the work which is previously printed by using the ink 100 in the ratio between yellow (Y) ink 100Y and black (K) ink 100K of 25:3 is referred to as a color b.

[0058] In the printing apparatus 1, when printing of the first pass is completed, the entire printing area A1 is printed with the color a. When printing of the second pass is completed, a color of 1/4 area on a downstream side of the printing area A1 is maintained to be the color a. In addition, a color of an area where the printing area A1 and the printing area A2 overlap each other becomes a color a+b. In addition, 1/4 area on an upstream side of the printing area A2 has the color a. "+" indicates overlap of colors.

[0059] Now consider the print area colors when printing of the third pass is completed, a color of 1/4 area on the downstream side is the color a, and a color of an area where the printing area A1 and the printing area A2 overlap each other is the color a+b, in the printing area A1. In addition, an area where the printing area A1, the printing area A2, and the printing area A3 overlap each other has a color a+b+b (color a+2b). In addition, an area where the printing area A2 and the printing area A3 overlap each other has the color a+b. In addition, an area in which only the printing area A3 is printed has the color a.

[0060] If printing is performed in the same manner, when printing of the fourth pass is completed, areas of the color a, the color a+b, the color a+2b, a color a+3b, a color a+2b, the color a+b, and the color a are sequentially lined up from a downstream side. When printing of a fifth pass is completed, areas of the color a, the color a+b, the color a+2b, the color a+3b, the color a+3b, the color a+2b, the color a+b, and the color a are sequentially lined up from the downstream side. When printing of a

sixth pass is completed, areas of the color a, the color a+b, the color a+2b, the color a+3b, the color a+3b, the color a+2b, the color a+b, and the color a are sequentially lined up from the downstream side.

[0061] In the printing apparatus 1, the area of color a+3b becomes an actual product, and the areas of the color a, the color a+b, and the color a+2b are discarded. As such, in the printing apparatus 1, a portion which becomes a product by the printing of the fourth pass is obtained, and an area which becomes a product increases by the printing of a fifth pass or later passes.

[0062] In a general printing apparatus, in a case where ink is ejected toward an arbitrary position, deviation occurs at a landing position of the ink in a forward path and a backward path. This is because orientations of inertial forces acting on the ink in the forward path and the backward path are different from each other. Particularly, if a magnitude of ink droplets is relatively small or a distance between a nozzle and a recording medium is relatively long, significant deviation easily occurs at the landing position of the ink in the forward path and the backward path. In a case where the deviation occurs, "pass shifting" which will be described hereinafter is considered as means for reducing the deviation.

[0063] Hereinafter, an example of the pass shifting of the printing apparatus 1 will be described. Hereinafter, a case where the pass shifting is performed to the black ink 100 when printing a Y100% and K12% image will be described.

[0064] In the printing apparatus 1, the black (K) ink 100K which is (originally intended to be) ejected in the first pass, the third pass, and the fourth pass within the first to fourth passes is now ejected only in the second pass, that is, ejection position change correction (pass shifting) in which ejection position is changed is performed.

[0065] By performing the pass shifting, a ratio between yellow (Y) and black (K) in the first pass becomes 25:0. The ratio between yellow (Y) and black (K) in the second pass becomes 25:12. The ratio between yellow (Y) and black (K) in the third pass becomes 25:0. The ratio between yellow (Y) and black (K) in the fourth pass becomes 25:0. Thereby, ejecting the black (K) ink 100K into the first pass, the third pass, and the fourth pass can be omitted. Black (K) is printed only in the second pass by the pass shifting, and thereby, deviation of the landing position is not able to occur. In the same manner as also in the fifth pass to the eighth pass, the ink 100K of black (K) which is ejected into the fifth pass, the seventh pass, and the eighth pass is ejected into the sixth pass (also the same as in a ninth pass or later).

[0066] If printing is performed by performing the pass shifting, an image illustrated in Fig. 4 is obtained. Hereinafter, a color of an area that is made by printing on the work W on which the ink 100 is not landed is regarded as the color a, and a color of an area which is made by printing on the work that is previously printed by using the ink 100 is regarded as the color b, in a ratio between

yellow (Y) ink 100Y and black (K) ink 100K is 25:0. In addition, a color of an area that is made by printing on the work W on which the ink 100 is not landed is referred to as a color c in a ratio between the ink 100Y and the ink 100K is 25:12. In addition, a color of an area which is made by printing on the work that is previously printed by using the ink 100 is referred to as a color d in a ratio between the ink 100Y and the ink 100K is 25:12.

[0067] In a case where printing is performed in the same manner as the aforementioned printing method, when printing in the first pass is completed, an area of the color a is formed. When printing in the second pass is completed, areas of the color a, the color a+d, and the color c are sequentially formed in parallel from a downstream side in an ascending order. When printing in the third pass is completed, areas of the color a, the color a+d, the color a+b+d, the color b+c" and the color a are sequentially formed in parallel from a downstream side in an ascending order. When printing in the fourth pass is completed, areas of the color a, the color a+d, the color a+b+d, the color a+2b+d, the color 2b+c, the color a+b, and the color a are sequentially formed in parallel from a downstream side in an ascending order. When printing in the fifth pass is completed, areas of the color a, the color a+d, the color a+b+d, the color a+2b+d, the color 3b+c, the color a+2b, the color a+b, and the color a are sequentially formed in parallel from a downstream side in an ascending order. When printing in the sixth pass is completed, areas of the color a, the color a+d, the color a+b+d, the color a+2b+d, the color 3b+c, the color a+2b+d, the color a+b+d, the color a+d, and the color c are sequentially formed in parallel from a downstream side in an ascending order.

[0068] An image which is formed by performing the pass shifting has a portion in which areas of the color a+2b+d and the color 3b+c become actual products, and the other portions are discarded. In addition, printing in three passes of the four passes can be omitted with regard to the ink 100 in which the pass shifting is performed, and thereby, deviation of the landing position of the ink 100 in the forward path and the backward path can be reduced as described above. Furthermore, the ink 100 which is omitted by the pass shifting is allocated to other passes, and thus, a total amount of ejection of the ink 100 becomes equal and degradation of image quality is less likely to occur in view of the entire image.

[0069] However, although the pass shifting is performed, if a hue difference between the area of the color a+2b+d and the area of the color 3b+c is relatively large, such color difference is recognized as streak unevenness in a portion which actually becomes a product and image quality is degraded. The hue difference is caused by a large difference between the color a and the color b and a large difference between the color c and the color d. The difference between the color a and the color b and the difference between the color c and the color d are caused by the different spreading of droplets of the ink 100 according to whether or not droplets of other ink 100

exist at the position where the droplets of the ink 100 lands. That is, if there are a lot of droplets of the ink 100 which actually overlap at an area where the printing areas overlap each other, there is a possibility that the color difference increases to degrade the image quality significantly.

[0070] The printing apparatus 1 is configured such that, when the pass shifting is performed, droplets of the ink 100 are actually prevented from overlapping as much as possible, and degradation of image quality due to performing of the pass shifting is efficiently prevented or suppressed. Hereinafter, a control program of the printing apparatus 1 will be described in detail by using a flowchart illustrated in Fig. 8.

[0071] In step S101, pass analysis is performed based on image data which is input to the printing apparatus 1 (refer to Fig. 5). In a configuration illustrated in Fig. 5, 25 droplets of the yellow (Y) ink 100Y are illustrated and three droplets of the black (K) ink 100K are illustrated, in each of the printing areas A1 to A6, as an example.

[0072] Subsequently, in step S102, it is determined whether or not the pass shifting will be performed based on a work gap or the like. In a case where it is determined that there is a possibility that image quality is degraded if the pass shifting is not performed in step S102, it is determined whether or not the image quality is degraded by performing the pass shifting in step S103.

[0073] In step S103, it is determined whether or not the image quality is degraded based on the amount of ejection per unit area of the ink 100K in the printing area A2, although the pass shifting is performed. As illustrated in Fig. 6, in a case where it is determined that the ink 100K overlaps the ink 100Y or the ink 100K, or there is a high possibility that the ink 100K overlaps the ink 100Y or the ink 100K, at a movement destination (printing areas A1, A3, and A4), there is a possibility that image quality is degraded due to the overlap, and thus, the pass shifting is omitted. In addition, printing is performed by setting omission of the pass shifting (step S106).

[0074] Meanwhile, in step S103, as illustrated in Fig. 7, in a case where it is determined that the ink 100K does not overlap the ink 100Y or the ink 100K, or there is a low possibility that the ink 100K overlaps the ink 100Y or the ink 100K, at a movement destination (printing area A2), it is allowed to perform the pass shifting (S104). Then, printing is performed by setting performing of the pass shifting (S105).

[0075] In the printing apparatus 1, the determination is performed by respectively comparing the amount of ejection V_{Y2} per unit area of the ink 100Y in the printing area A2 and the amount of ejection V_{K2} per unit area of the ink 100K with a threshold value (predetermined value) T which is stored in the storage unit 155. In a case where one of the amount of ejection V_{Y2} and the amount of ejection V_{K2} is equal to the threshold value T or greater than the threshold value T, pass shifting of the ink 100Y and the ink 100K is omitted. In addition, in a case where both the amount of ejection V_{Y2} and the amount of ejection

tion V_{K2} are less than the threshold value T , it is allowed to perform the pass shifting for the ink 100Y or the ink 100K. Thereby, degradation of image quality, which is caused by overlapping the inks 100 ejected in different passes, can be prevented or suppressed by performing the pass shifting.

[0076] In the above description, a case where an area which actually becomes a product is formed in the four passes is described, but the invention is not limited to this. Forming of an area which actually becomes a product may be set to two passes, three passes, five passes, or more.

[0077] In addition, as described above, in the printing apparatus 1, the ink 100K whose amount of ejection per unit area is the smaller among the ink 100Y and the ink 100K becomes a target of pass shifting. Thereby, by performing the pass shifting, a possibility that the ink 100K whose ejection position is moved overlaps the ink 100 of a movement destination can be further lowered. Hence, degradation of image quality can be prevented or suppressed more effectively.

[0078] In addition, in the printing apparatus 1, as illustrated in Fig. 6 and Fig. 7, in a case where the pass shifting is performed for the ink 100K which is a target of the pass shifting, the determination may be performed by comparing the amount of ejection V_{Y2}' and V_{K2}' of the printing area A1 with the threshold value T (also the same as for the printing areas A3 and A4). In this case, it is possible to more accurately perform determination whether or not there is a possibility that the ink 100K whose ejection position is changed overlaps the ink 100 at the movement destination.

[0079] In addition, in the printing apparatus 1, the threshold value T stored in the storage unit 155 is obtained by experimentally printing on the work W in advance. If the amount of ejection per unit area of the ink 100 increases to some extent, whether or not image quality is degraded can be accurately grasped by obtaining the threshold value T from performing actual test printing. Hence, it is possible to accurately determine whether to perform the pass shifting or not. Furthermore, even in a case where the printing apparatus 1 ejects the ink 100 of droplets with sizes (volume) different from each other, the determination can be accurately made.

[0080] In addition, in the printing apparatus 1, the threshold value T is a total sum of areas of the ink 100Y or the ink 100K which is actually landed on the work W in each of the printing areas A1 to A6 in the work W in a plan view. Thereby, it is possible to set the threshold value T by adding a change of the threshold value T according to a material of the work W or a material of the ink 100. Hence, the following advantages are obtained.

[0081] In a case where the work W is configured by a material such as cotton or silk that the ink 100 is relatively difficult to permeate, the relatively great threshold value T can be set. Hence, it is possible to make the determination by adding ease of permeation of the ink 100. In addition, ease of permeation becomes different even by,

for example, woven fabric, a fabric type such as non-woven fabric, density of a fiber, a difference between pre-processing agents, a thickness of the work W , or the like, but the threshold value T can be set according to those.

Furthermore, ease of permeation of the ink 100 also becomes different according to a configuration material of the ink 100 such as dye, pigment, viscosity, or the like, but the threshold value T of the ink 100 can be set according to those.

[0082] As such, it is possible to appropriately set the threshold value T and to accurately perform the determination by obtaining the threshold value T from experimentally printing in advance.

[0083] As described above, in the printing apparatus 1, whether or not pass shifting is performed is based on the amount of ejection of first ink (ink 100Y) and second ink (ink 100K) for an image. In addition, in a case where the amount of ejection of both the first ink and the second ink is less than a predetermined value (threshold value T), it is allowed to perform ejection position change correction (pass shifting) of both the first ink and the second ink. In addition, in a case where the amount of ejection of at least one ink of the first ink and the second ink is greater than the predetermined value, the ejection position change correction of both the first ink and the second ink is prohibited from being performed. Thereby, the ink 100 overlaps by performing the pass shifting, and degradation of image quality which is obtained can be prevented or suppressed.

[0084] As described above, embodiments of a printing apparatus and a printing method according to the invention are described, but the invention is not limited to this, and each unit configuring the printing apparatus can be replaced with elements having an arbitrary configuration that can perform the same function. In addition, an arbitrary configuration element may be added thereto.

[0085] In addition, in each embodiment, a case where the printing mechanism unit ejects ink as droplets with the same size is described, but the invention is not limited to this, and the ink may be ejected as droplets with sizes of two types or more. In this case, the ejection position change correction described above may be performed for each ink of droplets with each size.

Claims

1. A printing apparatus (1) comprising:

a printing unit (13) configured to form an image by ejecting first ink (100Y) and second ink (100K) which have hues different from each other toward a recording medium (W), while moving multiple number of times with respect to the recording medium;
a decision unit (152) configured to decide an ejection position of the ink in multiple paths through which the printing unit moves, when the

image is formed;

an execution unit (154) configured to, when two paths different from each other of the multiple paths are referred to as a first path and a second path, to perform ejection position change correction in which the ejection position is changed such that at least one ink of the first ink and the second ink which are ejected into the first path is ejected into the second path; and

a determination unit (153) configured to determine whether or not the execution unit performs the ejection position change correction, based on an amount of ejection of at least one ink of the first ink and the second ink with respect to the image,

wherein, in a case where the determination unit determines that the amount of ink of both the first ink and the second ink is less than a predetermined value, the execution unit is configured to perform the ejection position change correction, and

wherein, in a case where the determination unit determines that the amount of ink of at least one of the first ink and the second ink is more than the predetermined value, the execution unit is configured not to perform the ejection position change correction of either the first ink or the second ink.

2. The printing apparatus according to Claim 1, wherein the amount of ejection is an amount of ejection per unit area of ink which is a target that is ejected onto the recording medium, in a case where the ejection position change correction is performed for ink which is the target of the ejection position change correction among the first ink and the second ink.

3. The printing apparatus according to Claim 1 or Claim 2, wherein, in a case where the determination unit determines that the amount of ejection is less than the predetermined value, the execution unit is configured to perform the ejection position change correction for ink with the smaller amount of ejection among the first ink and the second ink.

4. The printing apparatus according to Claim 1, wherein the amount of ejection is a total sum of areas of the recording medium in a plan view on which the first ink and the second ink are landed on the recording medium.

5. The printing apparatus according to any one of the preceding claims, wherein the predetermined value is set according to a material of the recording medium.

6. The printing apparatus according to any one of the preceding claims, wherein the predetermined value

is set according to a material of the ink.

7. The printing apparatus according to any one of the preceding claims, wherein the predetermined value is obtained by experimentally performing printing in advance.

8. A printing method of performing printing by using a printing apparatus (1) including a printing unit (13) that forms an image by ejecting first ink (100Y) and second ink (100K) which have hues different from each other toward a recording medium (W), while moving multiple number of times with respect to the recording medium, a decision unit (152) that decides an ejection position of the ink in multiple paths through which the printing unit moves, when the image is formed, an execution unit (154) that, when two paths different from each other of the multiple paths are referred to as a first path and a second path, performs ejection position change correction in which the ejection position is changed such that at least one ink of the first ink and the second ink which are ejected into the first path is ejected into the second path, and a determination unit (153) that determines whether or not the execution unit performs the ejection position change correction, based on an amount of ejection of the first ink and the second ink with respect to the image, the method comprising:

causing, in a case where a determination unit determines that the amount of ink of both the first ink and the second ink is less than a predetermined value, the execution unit to perform the ejection position change correction; and causing, in a case where the determination unit determines that the amount of ink of both the first ink and the second ink is more than the predetermined value, the execution unit not to perform the ejection position change correction of either the first ink and the second ink.

FIG. 1

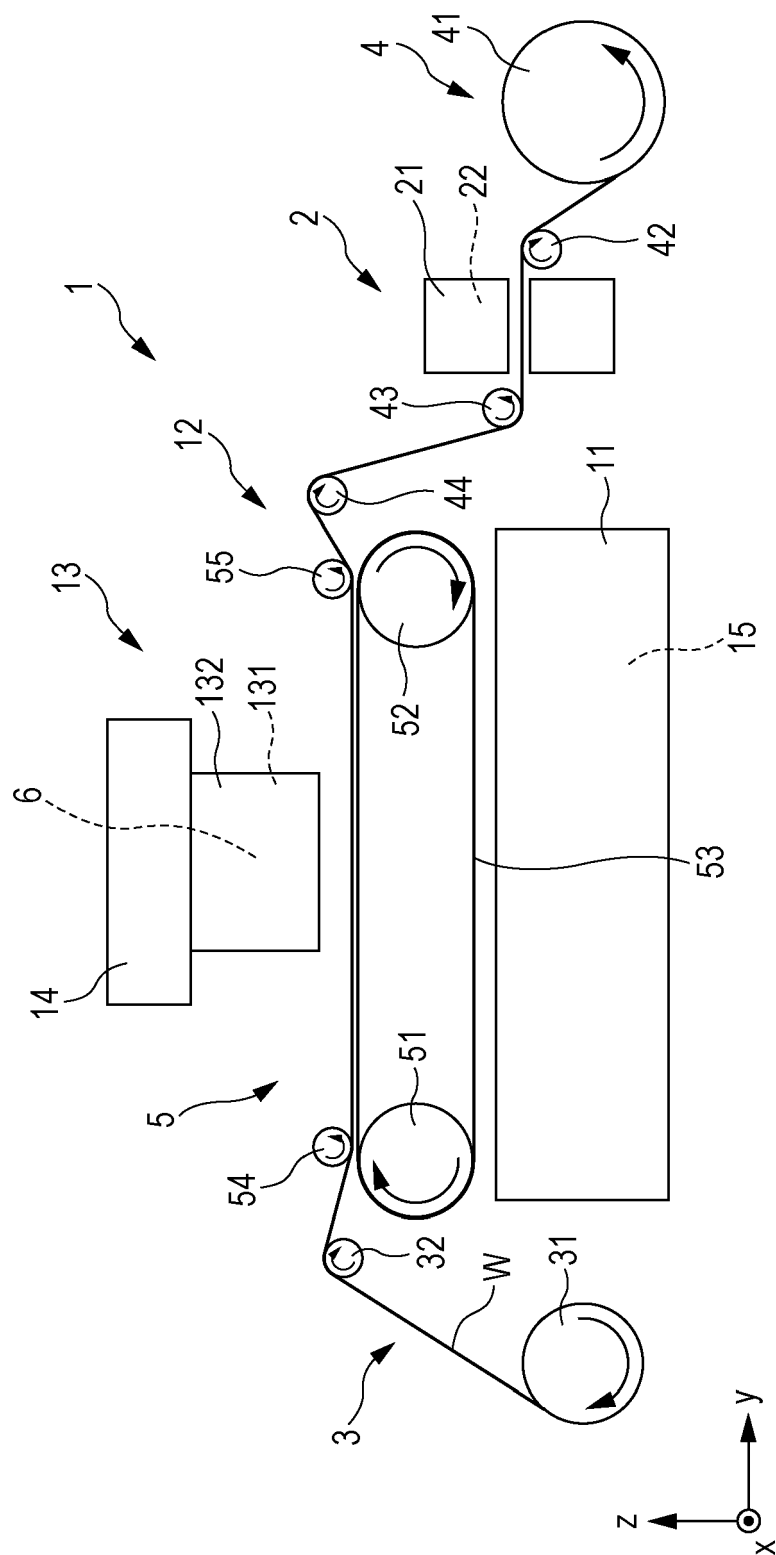


FIG. 2

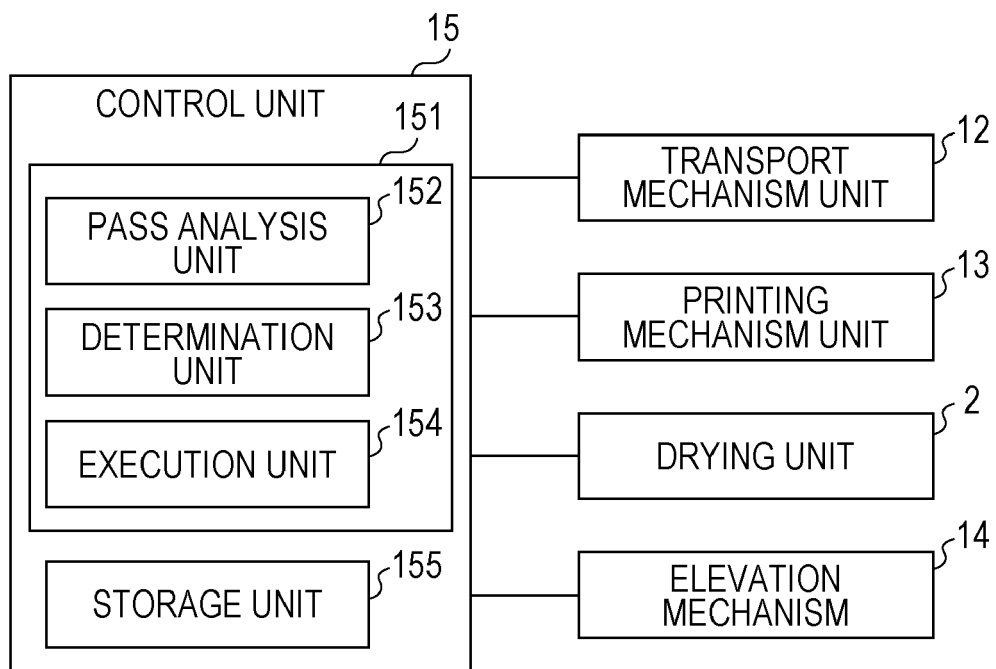


FIG. 3

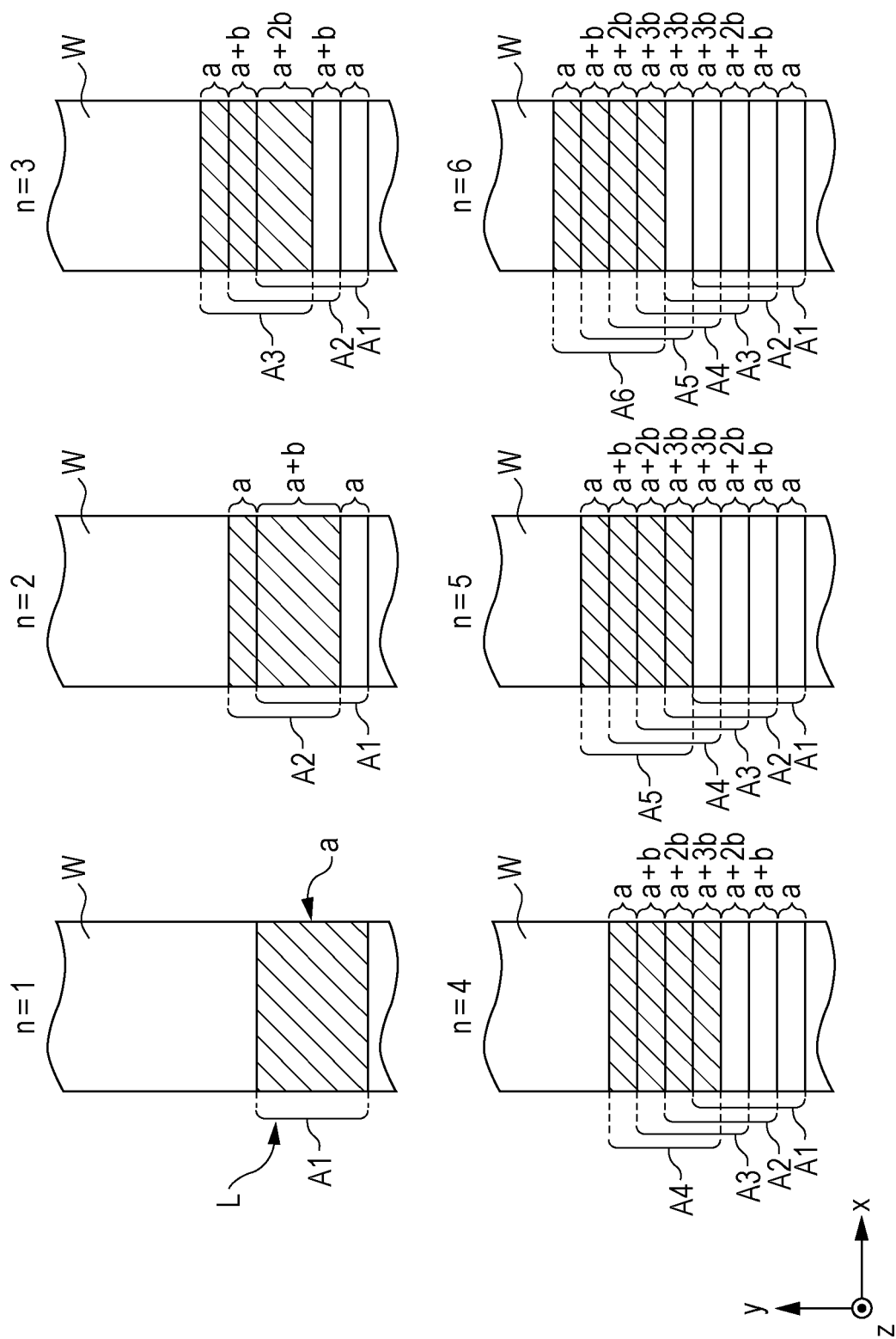


FIG. 4

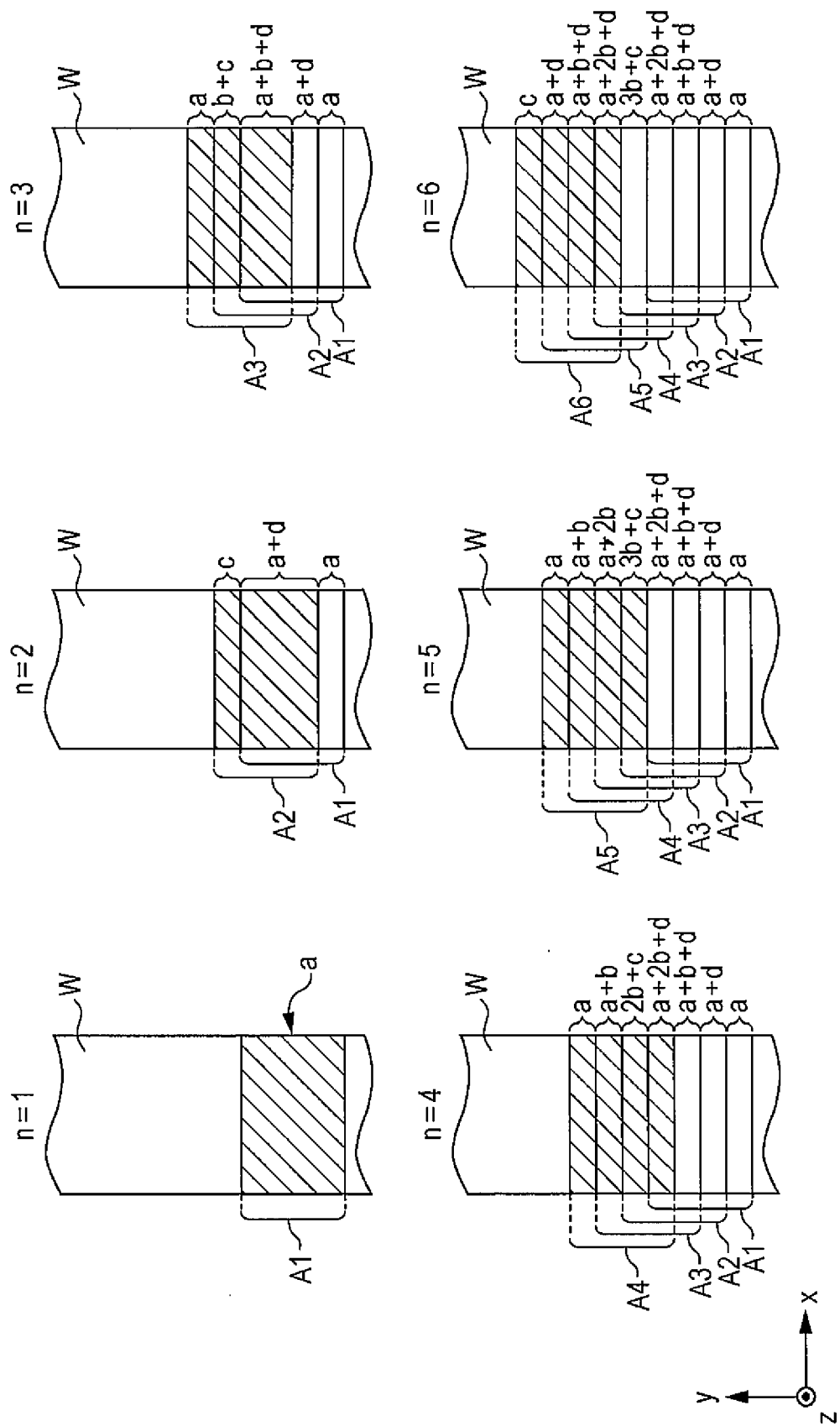


FIG. 5

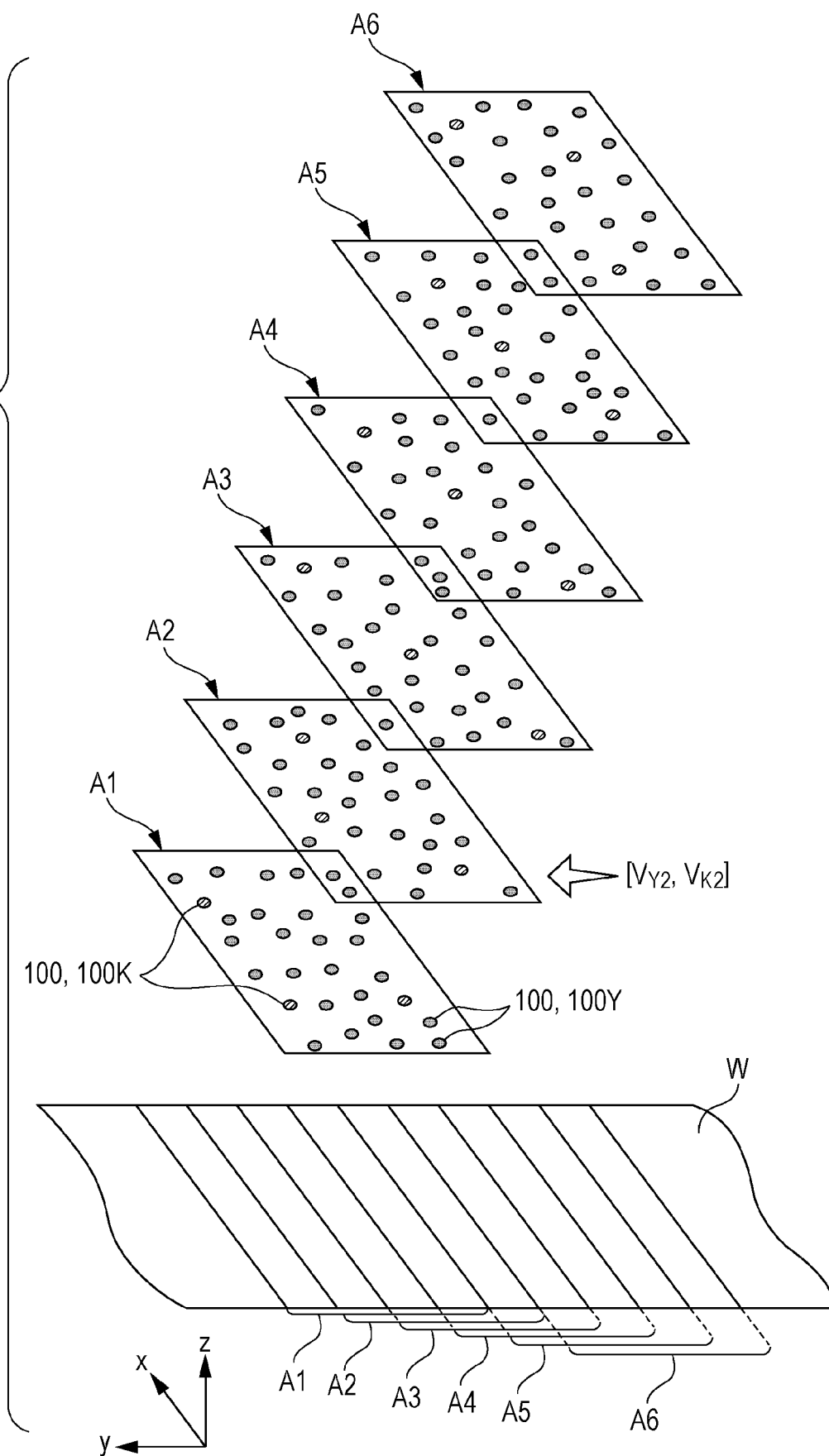


FIG. 6

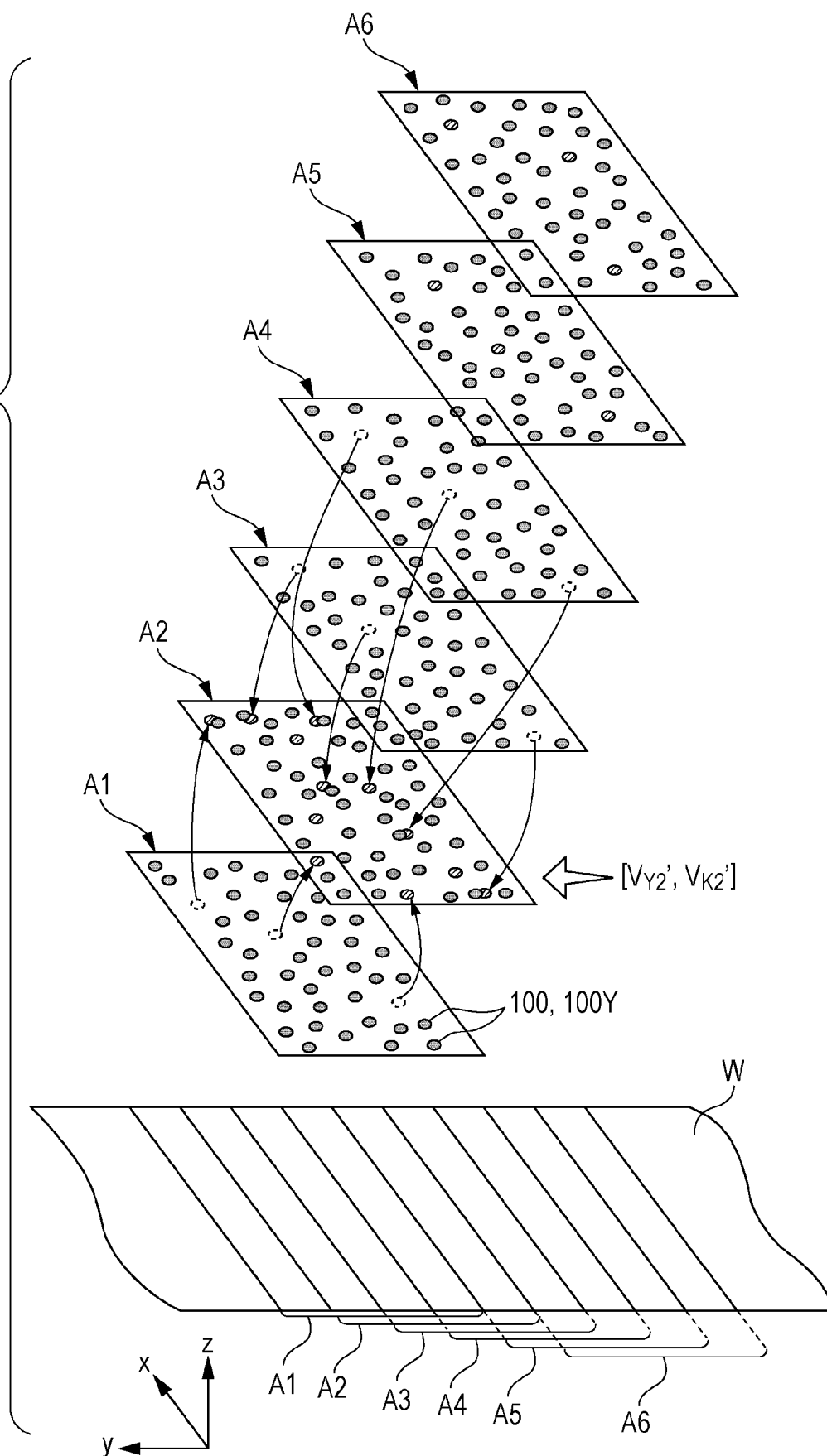


FIG. 7

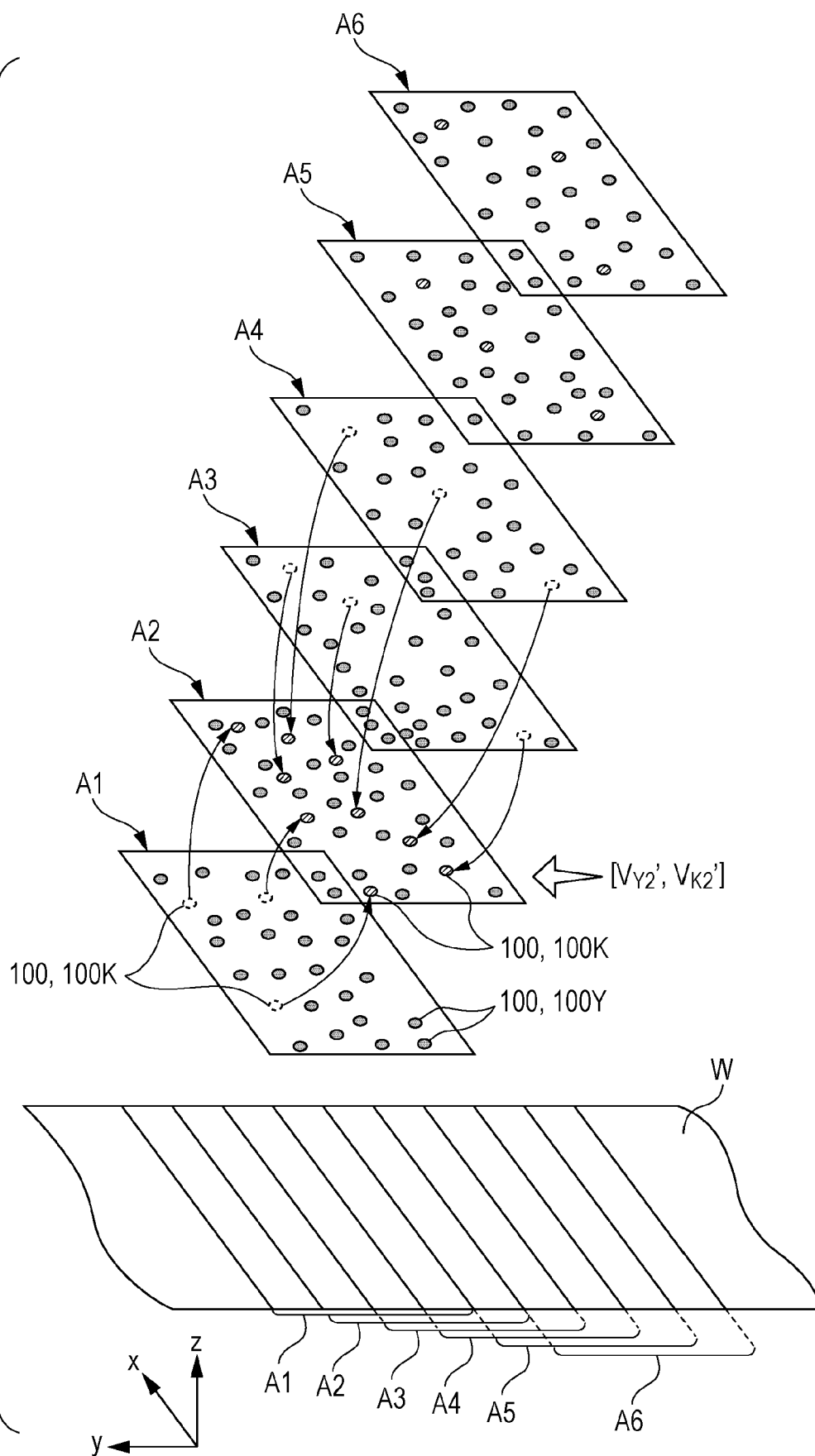
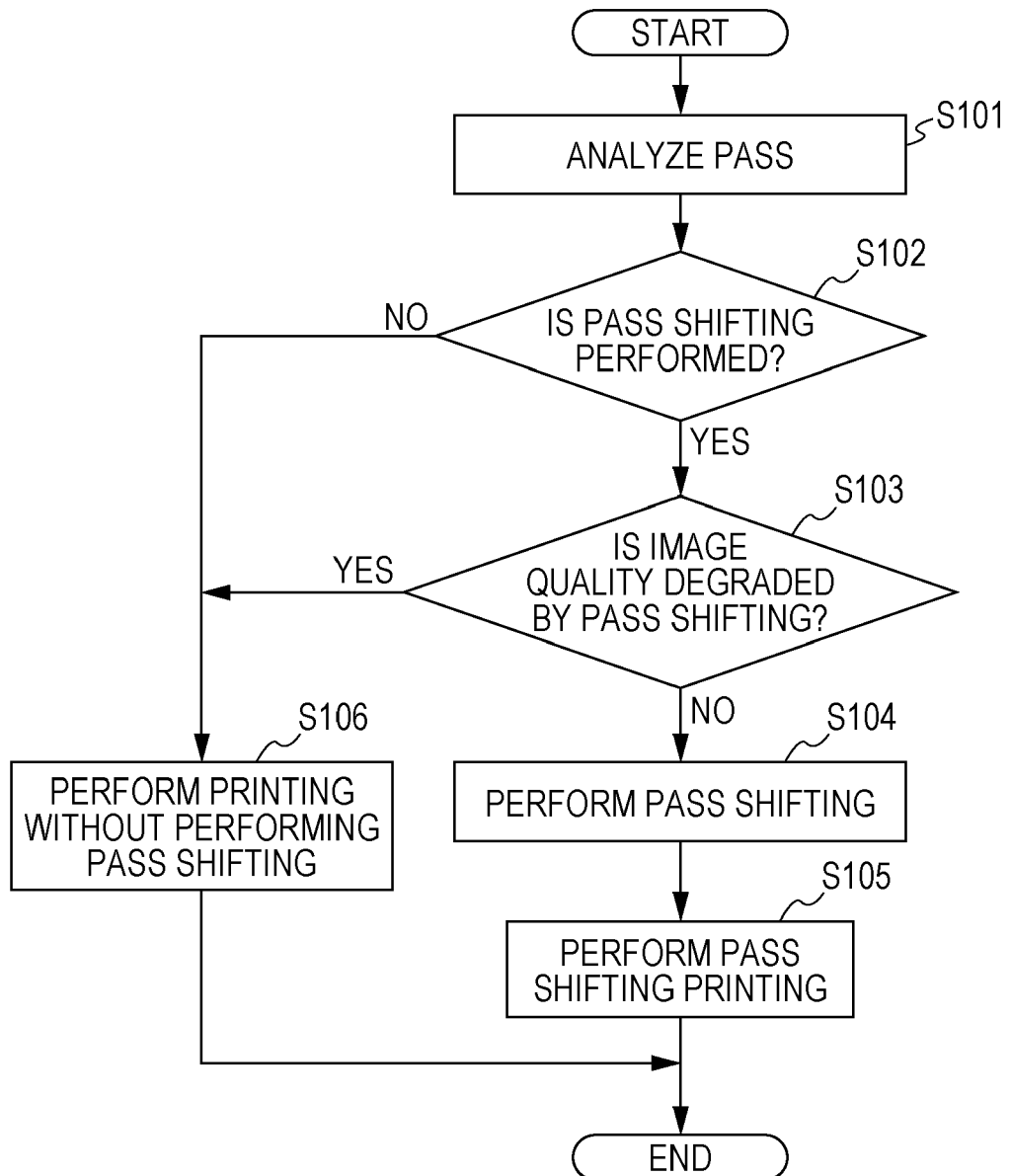


FIG. 8



REFERENCES CITED IN THE DESCRIPTION

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