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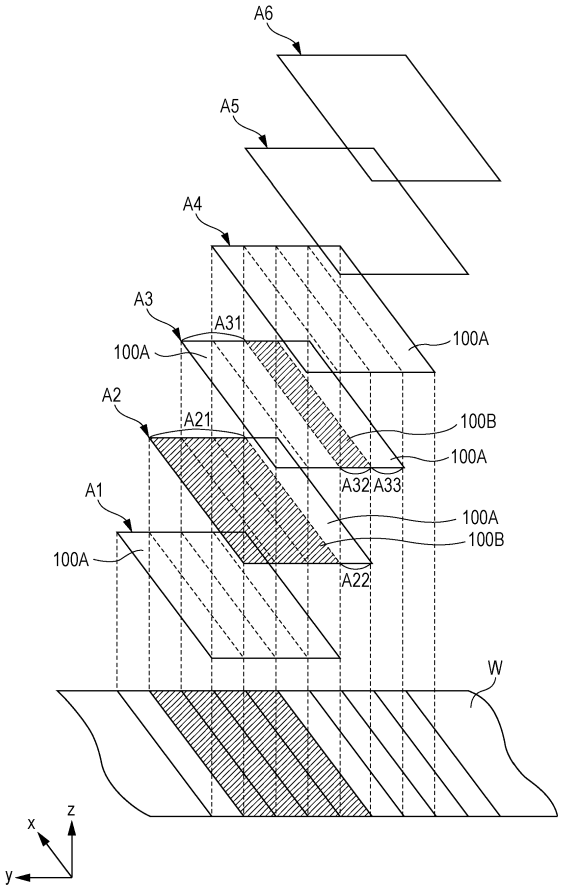
(54) PRINTING APPARATUS AND PRINTING METHOD

(57) A printing mechanism unit that forms a first printing area in a recording medium which is transported by ejecting first ink onto a first path in a direction crossing a transport direction of the recording medium, forms a second printing area in the recording medium by ejecting second ink onto a second path different from the first path, and thereby forms an image which is configured with the first printing area and the second printing area; a pass analysis unit that decides a first ejection position of the first ink in the first path and decides a second ejection position of the second ink in the second path, when the image is formed; and a correction determination unit that performs ejection position change correction in which the first ejection position is changed such that the first ink is ejected onto the second path and the second ejection position is changed such that a part of the second ink is ejected onto the first path, are provided.

FIG. 5



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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 into one path of a forward path and 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 or reduce 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 a first printing area in a recording medium which is transported by ejecting first ink onto a first path in a direction crossing a transport direction of the recording medium, forms a second printing area in the recording medium by ejecting second ink onto a second path different from the first path, and thereby forms an image which is configured with the first printing area and the second printing area; a decision unit that decides a first ejection position of the first ink in the first path and a second ejection position of the second ink in the second path, when the image is formed; and a correction determination unit that performs ejection position change correction in which the first ejection position is changed such that the first ink is ejected onto the second path and the second ejection position is changed such that a part of the second ink is ejected onto the first path, based on decision results of the decision unit.

[0008] Thereby, for example, it is possible to prevent inks in which ejection position change correction is performed from overlapping each other. Hence, it is possible to prevent image quality from being degraded due to overlapping of the inks in which the ejection position change correction is performed.

[0009] In the printing apparatus of the aspect of the invention, the printing unit may form an overlapping portion in which the first printing area and the second printing area partially overlap each other in a plan view of the recording medium.

[0010] Thereby, it is possible to prevent the degradation of image quality from occurring in an image, in a case where ejection position change correction is performed.

[0011] In the printing apparatus of the aspect of the invention, the second ink which is ejected onto the first printing area may be shifted from the first ink which is ejected onto the second printing area in a plan view of the recording medium, when being ejected, in the ejection position change correction.

[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, in a case where the printing unit forms the image by moving n number of times (n is a positive integer greater than or equal to two), the correction determination unit may divide the second printing area into n areas and determine whether to perform the ejection position change correction for each of the divided areas or not.

[0014] 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.

[0015] In the printing apparatus of the aspect of the invention, the second ink which is ejected onto the first printing area may be ejected onto the overlapping portion, in the ejection position change correction.

[0016] Thereby, it is possible to prevent inks in which ejection position change correction is performed from overlapping each other.

[0017] In the printing apparatus of the aspect of the invention, the second ink which is ejected onto the first printing area may be ejected into a position different from the overlapping portion, in the ejection position change correction.

[0018] Thereby, it is possible to prevent inks in which

ejection position change correction is performed from overlapping each other.

[0019] In the printing apparatus of the aspect of the invention, the printing unit may eject at least two types of ink whose hues are different from each other, and the correction determination unit may perform the ejection position change correction for ink with a smaller amount of ejection per unit area in the image among the two types of ink.

[0020] Thereby, it is possible to prevent inks in which ejection position change correction is performed from overlapping each other.

[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 a first printing area in a recording medium which is transported by ejecting first ink onto a first path in a direction crossing a transport direction of the recording medium, forms a second printing area in the recording medium at a position different from the first printing area by ejecting second ink onto a second path different from the first path, and thereby forms an image which is configured with the first printing area and the second printing area, and a decision unit that decides a first ejection position of the first ink in the first path and a second ejection position of the second ink in the second path, when the image is formed, the method including: performing ejection position change correction in which the first ejection position is changed such that the first ink is ejected onto the second path and the second ejection position is changed such that a part of the second ink is ejected onto the first path.

[0022] Thereby, for example, it is possible to prevent inks in which ejection position change correction is performed from overlapping each other. Hence, it is possible to prevent image quality from being degraded due to overlapping of the inks in which the ejection position change correction is performed.

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 of the related art performs ejection position change correction and prints an image.

Fig. 5 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 performs the ejection position change correction and prints an image.

Fig. 6 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 performs the ejection position change correction and prints an image.

Fig. 7 is a flowchart illustrating a control operation of a control unit which is included in the printing apparatus illustrated in Fig. 1.

Fig. 8 is a diagram illustrating a process in which a printing apparatus (second embodiment) of the invention performs the ejection position change correction and prints an image.

Fig. 9 is a diagram illustrating a process in which a printing apparatus (third embodiment) of the invention performs the ejection position change correction and prints an image.

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 of the related art performs ejection position change correction and prints an image. Fig. 5 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 performs the ejection position change correction and prints an image. Fig. 6 is a diagram illustrating a process in which the printing apparatus illustrated in Fig. 1 performs the ejection position change correction and prints an image. Fig. 7 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 illustrated in Fig. 1, and Fig. 3 to Fig. 6 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. 6 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. 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 with increasing distance 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 on the endless belt 53, and the work W can be interposed between the tensioner 55 and the follower roller 52 on the 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 stand 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 heat emitting unit which is configured by a nichrome wire and emits heat 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 correction 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 into a forward path and a backward path, based on image data which is input.

[0051] The correction determination unit 153 performs pass shifting (will be described below) in data which is obtained by performing pass analysis using the pass analysis unit 152. The execution unit 154 performs printing, based on the data which is obtained by performing pass shifting using the correction 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. Hereinafter, ink with the ratio is referred to as "ink 100C".

[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 an unprinted part of the work or printing on already printed part of the work.

[0057] Hereinafter, a color of an area made by printing on the unprinted work W using ink 100C with a ratio between yellow (Y) and black (K) 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 in the ink 100 using the ink 100C with a ratio between yellow (Y) and black (K) 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 1/4 area on a downstream side of the printing area A1 is maintained to be the color a. In addition, 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+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 in which a color of the area is the 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 a portion of an area which becomes a product increases by the 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 Y100% and K 12% image will be described.

[0064] In the printing apparatus 1, the ink 100 of black (K) which is originally planned 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 ejection position change correction, a ratio, which is 25:3 before being corrected, between yellow (Y) and black (K) in each pass becomes a ratio of 25:0 between yellow (Y) and black (K) in the first pass. 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 ink 100 of black (K) into the first pass, the third pass, and the fourth pass can be omitted. In the same manner as also in the fifth pass to the eighth pass, the ink 100 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] An image which is obtained when printing is performed by performing the pass shifting will be described with reference to Fig. 4. Hereinafter, a color appearing in a case where the ink 100 in which a ratio between yellow (Y) and black (K) is 25:0 is landed on the work W on which the ink 100 is not landed yet is regarded as a color a (hereinafter, ink in which the ratio between yellow (Y) and black (K) is 25:0 is referred to as ink 100A). In addition, a color appearing in a case where the ink 100A is landed so as to overlap another ink 100 is regarded as a color b. In addition, a color appearing in a case where the ink 100 in which the ratio between yellow (Y) and black (K) is 25:12 is landed on the work W on which the ink 100 is not landed yet is referred to as a color c (hereinafter, ink in which the ratio between yellow (Y) and black (K) is 25:12 is referred to as ink 100B). In addition, a color appearing in a case where the ink 100B is landed so as to overlap another ink 100 is referred to as a color d.

[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 other portions are discarded. In addition, by performing the pass shifting, printing in three passes of the four passes can be omitted, and thus, 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 can be less likely to occur in view of the entire image.

[0069] However, although the pass shifting is performed, if a color 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. There is a possibility that significant degradation of image quality occurs when a difference between the color a and the color b and a difference between the color c and the color d are large.

[0070] The printing apparatus 1 can prevent image quality from being degraded due to the pass shifting. Hereinafter, this will be described.

[0071] As described in Fig. 5, when the pass shifting is performed in the printing apparatus 1, the ink 100A in which a ratio between the yellow (Y) and black (K) is 25:0 is ejected onto the entire printing area A1.

[0072] In addition, when the printing area A2 is divided into four areas in the transport direction, the ink 100B in which a ratio between yellow (Y) and black (K) is 25:12 is ejected onto 3/4 area A21 from a downstream side. In addition, the ink 100A is ejected onto 1/4 area A22 from an upper area of the printing area A2.

[0073] In addition, when the printing area A3 is divided into four areas in the transport direction, the ink 100A is ejected onto 1/2 area A31 from a downstream side. In addition, the ink 100B is ejected onto 1/4 area A32 on an upstream side of the area A31. In addition, the ink 100A is ejected onto 1/4 area A33 on an upstream side of the area A32.

[0074] The ink 100A in which a ratio between yellow (Y) and black (K) is 25:0 is ejected onto the entire printing area A4.

[0075] By performing the pass shifting, a portion onto which the ink 100B is directly landed in the work W can be omitted. The ink 100B which is ejected onto the printing area A2 and the printing area A3 is landed so as to overlap the ink 100A. That is, the ink 100B is ejected onto an overlapping portion in which the printing areas A1 to A4 overlap each other. Accordingly, it is possible to prevent the color c from appearing when the ink 100B is directly landed onto the work W, as illustrated in Fig. 6. Hence, a color of a portion which actually becomes a product is only the color a+2b+d, regardless of the pass shifting which is performed. Thus, it is possible to prevent image quality from being degraded due to a color difference between the color a+2b+d and 3b+c which is caused by pass shifting of the related art. As a result, in the printing apparatus 1, although the pass shifting is performed, an image with high printing accuracy can be formed. Areas onto which the ink 100B is ejected is denoted by cross-hatching in Fig. 6.

[0076] Next, a control operation of the control unit 15 will be described by using a flowchart illustrated in Fig. 7.

[0077] In step S101, pass analysis is performed based on image data which is input to the printing apparatus 1. The amount of ink 100 which will be ejected onto the pass is determined.

[0078] 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, the following pass shifting processing is performed in step S103.

[0079] As illustrated in Fig. 5, the printing areas A1 to A4 are respectively divided into four areas along the transport direction. In addition, it is determined whether or not the pass shifting is performed for each divided area, that is, it is determined which of the ink 100A and the ink 100B will be ejected.

[0080] It is determined that the ink 100B is ejected onto the 3/4 area A21 from a downstream side among the divided four areas of the printing area A2. In addition, it is determined that the ink 100A is ejected onto the area A31 and the area A33 in the area A3, and it is determined that the ink 100B is ejected onto the area A32. In addition, it is determined that the ink 100A is ejected onto the entire areas of the printing area A1 and the printing area A4.

[0081] As such, the printing areas A1 to A4 are respec-

tively divided, the ink 100A or the ink 100B is allocated to each divided area, and thereby, there are portions where the pass shifting is performed in an image which is formed, that is, the inks 100B can be prevented from being landed so as to overlap each other. Hence, it is possible to prevent image quality of an image which is obtained from being degraded.

[0082] The ink 100A and the ink 100B are also allocated in the fifth pass or later in the same manner as in the first pass to fourth pass.

[0083] Subsequently, in step S104, printing is performed according to the setting which is determined in step S103. Thereby, it is possible to form an image in which the pass shifting is performed.

[0084] In a case where it is determined that the pass shifting is not performed in step S102, printing is performed in a state where the pass analysis is performed in step S101 without the pass shifting.

[0085] As described above, when focusing on the printing area A2 and the printing area A3, according to the pass shifting of the related art, by changing an ejection position such that the ink 100 which is ejected onto the printing area A3 is ejected onto the printing area A2, only the ink 100A that is the first ink is ejected onto the printing area A3, and only the ink 100B that is the second ink is ejected onto the printing area A2. In contrast to this, in the invention, when the pass shifting is performed, not only an ejection position (first ejection position) of the ink 100 which is ejected onto the printing area A3 is changed to the printing area A2, but also an ejection position (second ejection position) of a part of the ink 100B (second ink) which is ejected onto the printing area A2 is changed to the printing area A3. Thereby, it is possible to prevent image quality from being degraded due to the pass shifting which is performed. As the result, although the pass shifting is performed, an image with high printing accuracy can be formed.

[0086] The pass shifting can be performed by selecting whether or not each of the multiple nozzles included in the nozzle group ejects the ink 100.

[0087] In addition, in the present embodiment, the printing apparatus 1 provides a setting in which an image is formed by using four passes such as the first pass to the fourth pass or the fifth pass to the eighth pass as one set, but the invention is not limited to this. For example, an image may be formed by setting two passes, three passes, five passes or more as one set. In addition, during the pass shifting at this time, when the number of passes of one set is n, each pass is divided into n areas in a transport direction, and the ink 100A and the ink 100B are allocated to each of the divided areas.

Second Embodiment

[0088] Fig. 8 is a diagram illustrating a process in which a printing apparatus (second embodiment) of the invention performs the ejection position change correction and prints an image.

[0089] Hereinafter, a second embodiment of a printing apparatus according to the invention will be described with reference to the figure, but points different from the aforementioned embodiment will be mainly described, and description on the same points will be omitted.

[0090] The present embodiment is the same as the first embodiment except for control when ejection position change correction is performed.

[0091] As illustrated in Fig. 8, in the present embodiment, the ink 100A and the ink 100B are allocated as follows when the pass shifting is performed.

[0092] The ink 100A is ejected onto the entire printing area A1. In addition, when the printing area A2 is divided into four areas in a transport direction, the ink 100B is ejected onto a 1/2 area A23 from a downstream side. The ink 100A is ejected onto a 1/2 area A24 on an upstream side of the area A23 of the printing area A2. In addition, the ink 100A is ejected onto the entire printing area A3. In addition, when the printing area A4 is divided into four areas in the transport direction, the ink 100B is ejected onto a 1/2 area A41 from a downstream side. The ink 100A is ejected onto a 1/2 area A42 on an upstream side of the area A41 of the printing area A4.

[0093] According to the present embodiment, a portion where the ink 100B is directly landed on the work W can be omitted in the same manner as in the first embodiment. Hence, it is possible to prevent image quality from being degraded due to a hue difference between the color a+2b+d and the color 3b+c which is caused by the pass shifting of the related art. Furthermore, when viewing from the entire image, it is possible to further reduce a boundary of an area on which the ink 100B is landed. As the result, a portion where streak unevenness easily occurs is reduced in an image which is obtained. As described above, in the present embodiment, although the pass shifting is performed, an image with high printing accuracy can be formed.

Third Embodiment

[0094] Fig. 9 is a diagram illustrating a process in which a printing apparatus (third embodiment) of the invention performs the ejection position change correction and prints an image.

[0095] Hereinafter, a third embodiment of a printing apparatus according to the invention will be described with reference to the figure, but points different from the aforementioned embodiment will be mainly described, and description on the same points will be omitted.

[0096] The present embodiment is the same as the first embodiment except for control when ejection position change correction is performed.

[0097] As illustrated in Fig. 9, in the present embodiment, the ink 100A and the ink 100B are allocated as follows when the pass shifting is performed.

[0098] The ink 100B is ejected onto the entire printing area A1.

[0099] In addition, when the printing area A2 is divided

into four areas in a transport direction, the ink 100A is ejected onto a 3/4 area A21 from a downstream side. The ink 100B is ejected onto a 1/4 area A22 on an upstream side of the area A21 of the printing area A2.

[0100] In addition, when the printing area A3 is divided into four areas in the transport direction, the ink 100A is ejected onto a 1/2 area A31 from a downstream side. The ink 100A is ejected onto a 1/4 area A32 on an upstream side of the area A31 of the printing area A3. The ink 100B is ejected onto a 1/4 area A33 on an upstream side of the area A31 of the printing area A3.

[0101] In addition, when the printing area A4 is divided into four areas in the transport direction, the ink 100A is ejected onto a 3/4 area A41 from a downstream side. The ink 100B is ejected onto a 1/4 area A42 on an upstream side of the area A41 of the printing area A4.

[0102] According to the present embodiment, it is possible to prevent the ink 100B from being landed so as to overlap the ink 100A and the ink 100B. That is, in the present embodiment, the ink 100B is ejected onto areas which are different from overlapping portions where the printing areas A1 to A4 overlap each other in a plan view of the work W. Thereby, it is possible to omit a color d which is generated by landing the ink 100B so as to overlap the ink 100A and the ink 100B. Hence, in the work W, a color of a portion which is actually used as a product becomes a color 3b+c. Thus, it is possible to prevent image quality from being degraded due to a hue difference between the color a+2b+d and the color 3b+c which is caused by the pass shifting of the related art. Furthermore, an order of the ink 100A and the ink 100B which overlap each other is also the same, in each of the printing areas and thus, it is possible to form an image with higher printing accuracy.

[0103] 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.

[0104] In addition, the printing apparatus according to the invention may be configured by combining arbitrary two or more configurations (characteristics) of the respective embodiments.

[0105] 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 a first printing area (A2) in a recording medium (W) which is transported by ejecting first ink (100A) onto a first path in a direction crossing a transport direction of the recording medium, to form a second printing area (A3) in the recording medium by ejecting second ink (100B) onto a second path different from the first path, and thereby to form an image which is configured with the first printing area and the second printing area;

a decision unit (152) configured to decide a first ejection position of the first ink in the first path and a second ejection position of the second ink in the second path, when the image is formed; and

a correction determination unit (153) configured to performs ejection position change correction in which the first ejection position is changed such that the first ink is ejected onto the second path and the second ejection position is changed such that a part of the second ink is ejected onto the first path, based on decision results of the decision unit.

2. The printing apparatus according to Claim 1, wherein the printing unit is configured to form an overlapping portion in which the first printing area and the second printing area partially overlap each other in a plan view of the recording medium.

3. The printing apparatus according to Claim 2, wherein the second ink (100B) which is ejected onto the first printing area (A2) is shifted from the first ink (100A) which is ejected onto the second printing area (A3) in a plan view of the recording medium, when being ejected, in the ejection position change correction.

4. The printing apparatus according to Claim 2 or Claim 3, wherein, in a case where the printing unit forms the image by moving n number of times (n is a positive integer greater than or equal to two), the correction determination unit is configured to divide the second printing area into n areas and determines whether to perform the ejection position change correction for each of the divided areas or not.

5. The printing apparatus according to any one of claims 2 to 4, wherein the second ink (100B) which is ejected onto the first printing area (A2) is ejected onto the overlapping portion, in the ejection position change correction.

6. The printing apparatus according to any one of claims 2 to 4, wherein the second ink (100B) which is ejected onto the first printing area (A2) is ejected into a position different from the overlapping portion, in the ejection position change correction.

7. The printing apparatus according to any one of the preceding claims,
wherein the printing unit is configured to eject at least two types of ink whose hues are different from each other, and
wherein the correction determination unit performs the ejection position change correction for ink with a smaller amount of ejection per unit area in the image among the two types of ink.

8. A printing method of performing printing by using a printing apparatus (1) including a printing unit (13) that forms a first printing area (A2) in a recording medium (D) which is transported by ejecting first ink (100A) onto a first path in a direction crossing a transport direction of the recording medium, forms a second printing area (A3) in the recording medium at a position different from the first printing area by ejecting second ink (100B) onto a second path different from the first path, and thereby forms an image which is configured with the first printing area and the second printing area, and a decision unit that decides a first ejection position of the first ink in the first path and a second ejection position of the second ink in the second path, when the image is formed, the method comprising:

performing ejection position change correction in which the first ejection position is changed such that the first ink is ejected onto the second path and the second ejection position is changed such that a part of the second ink is ejected onto the first path.

FIG. 1

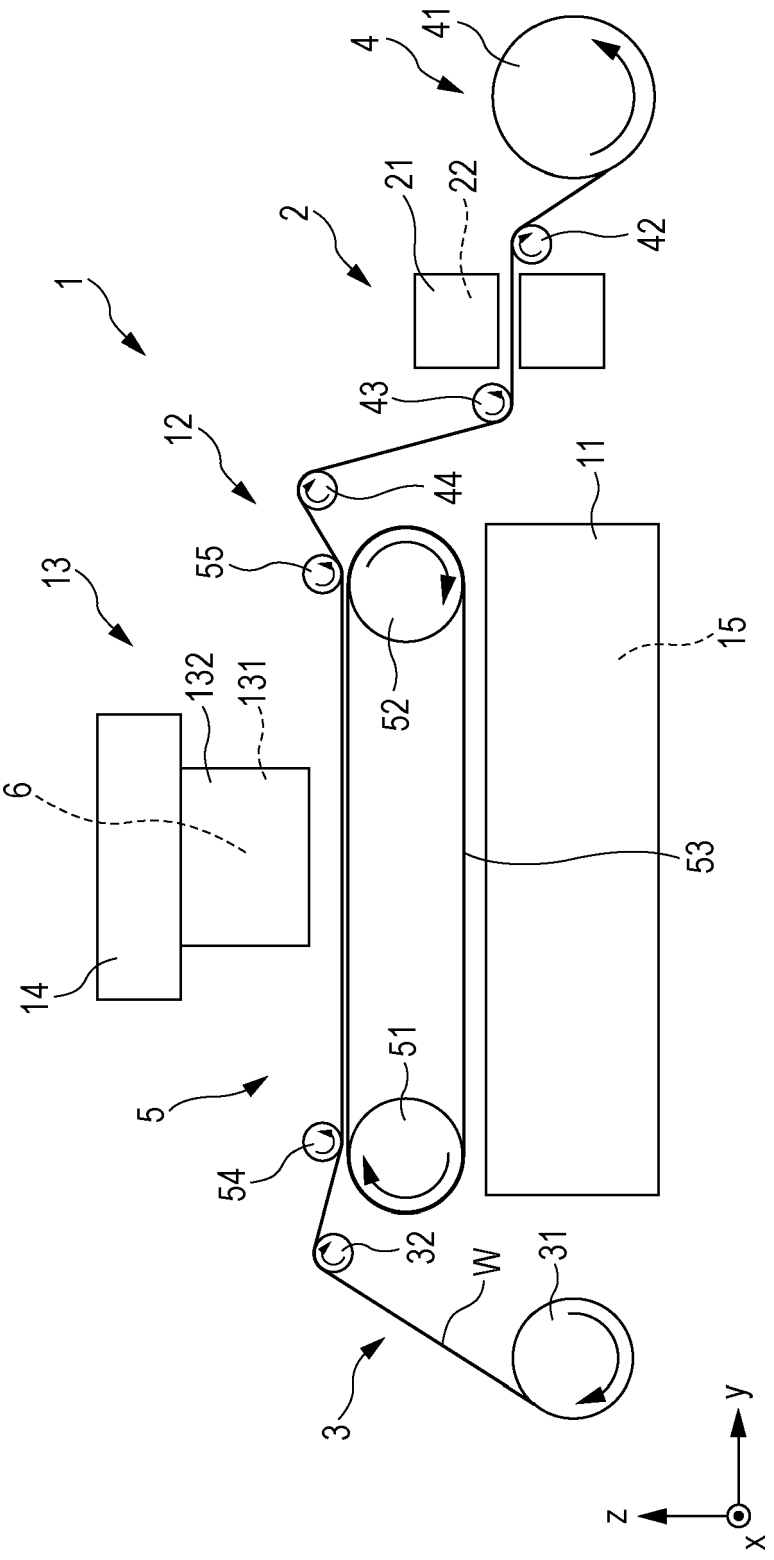
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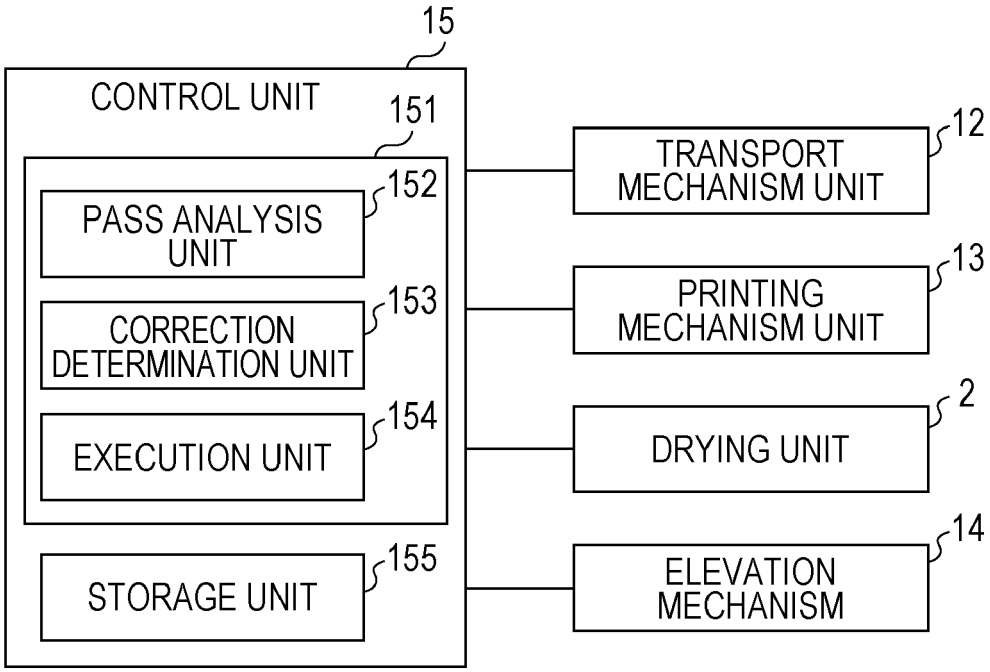
FIG. 2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PASS ANALYSIS UNIT
152
CORRECTION DETERMINATION UNIT
153
EXECUTION UNIT
154
STORAGE UNIT
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PRINTING MECHANISM UNIT
13
DRYING UNIT
2
ELEVATION MECHANISM
14

FIG. 3

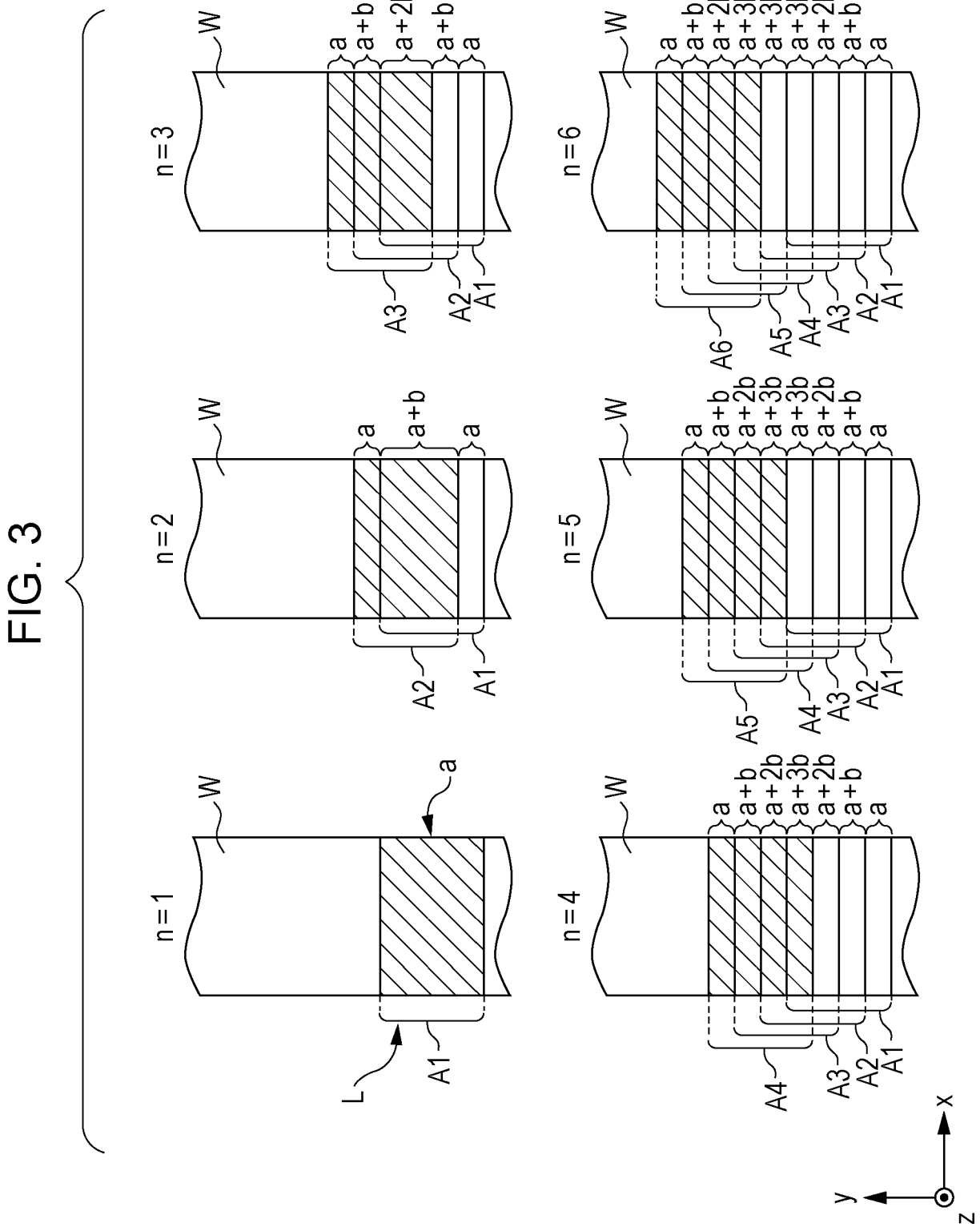
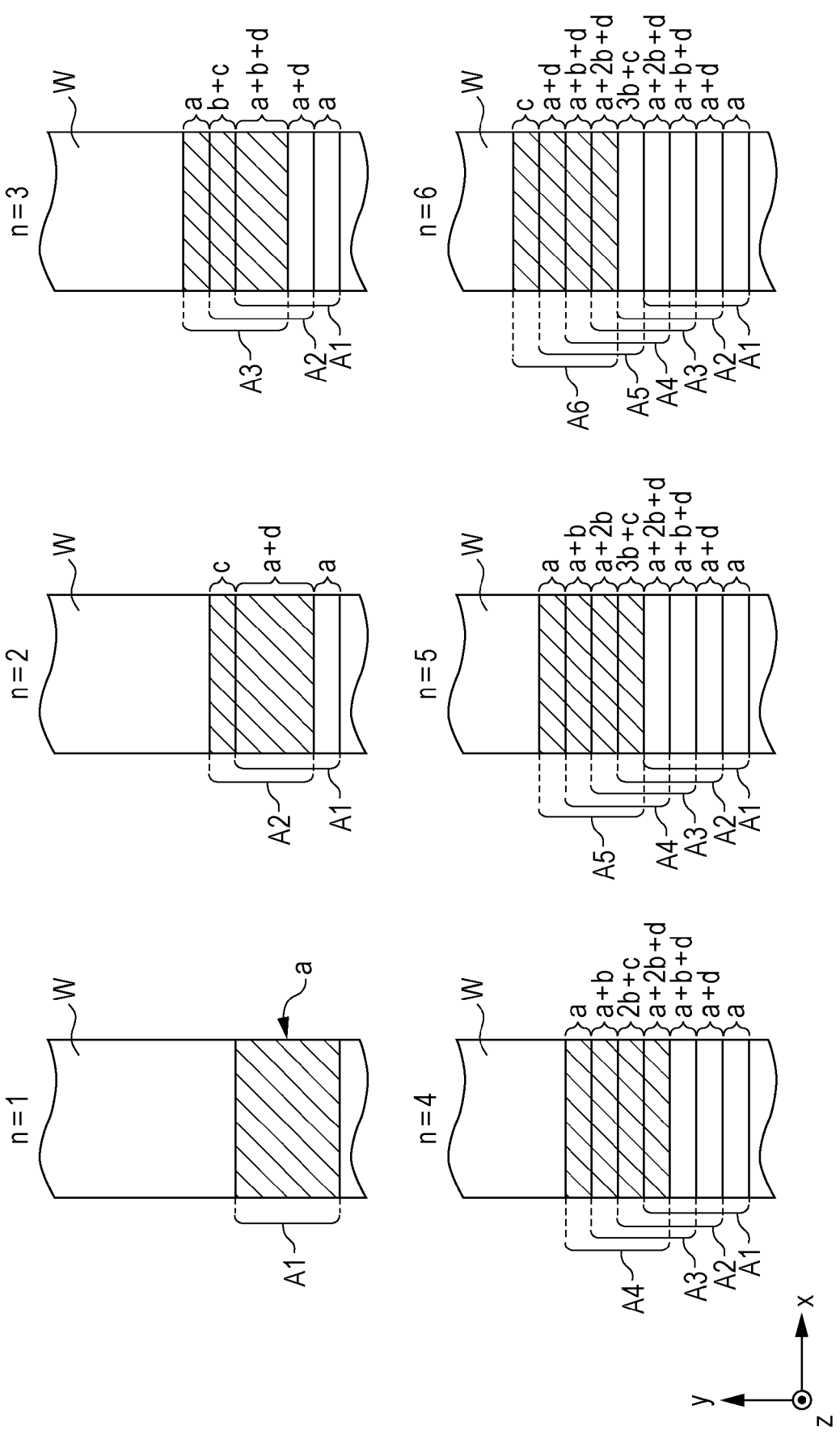


FIG. 4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a
A3
A2
A1
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2b+c
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A2
A1
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a+b+d
a+d
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A5
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A2
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3b+c
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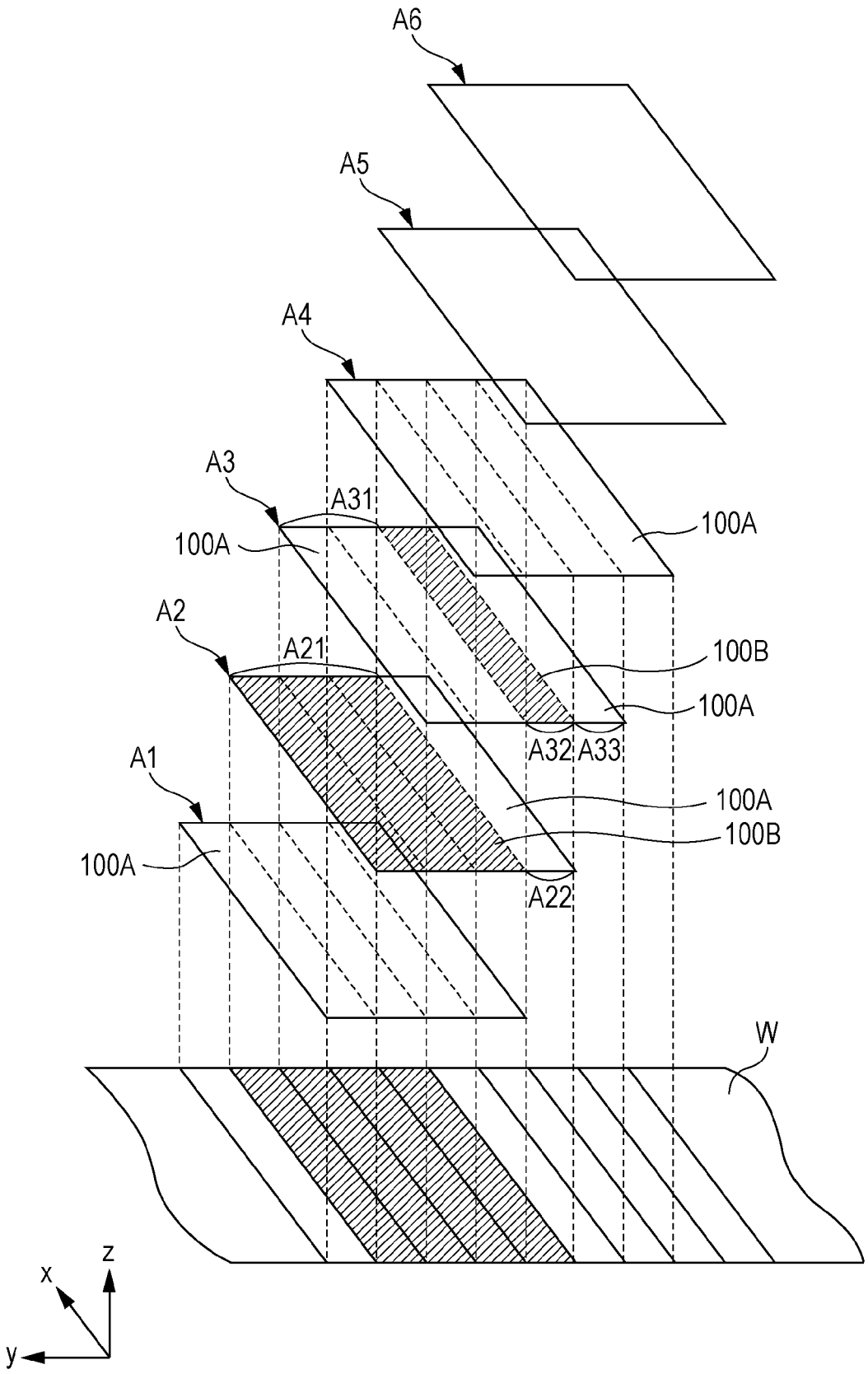
y
z

FIG. 5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A22
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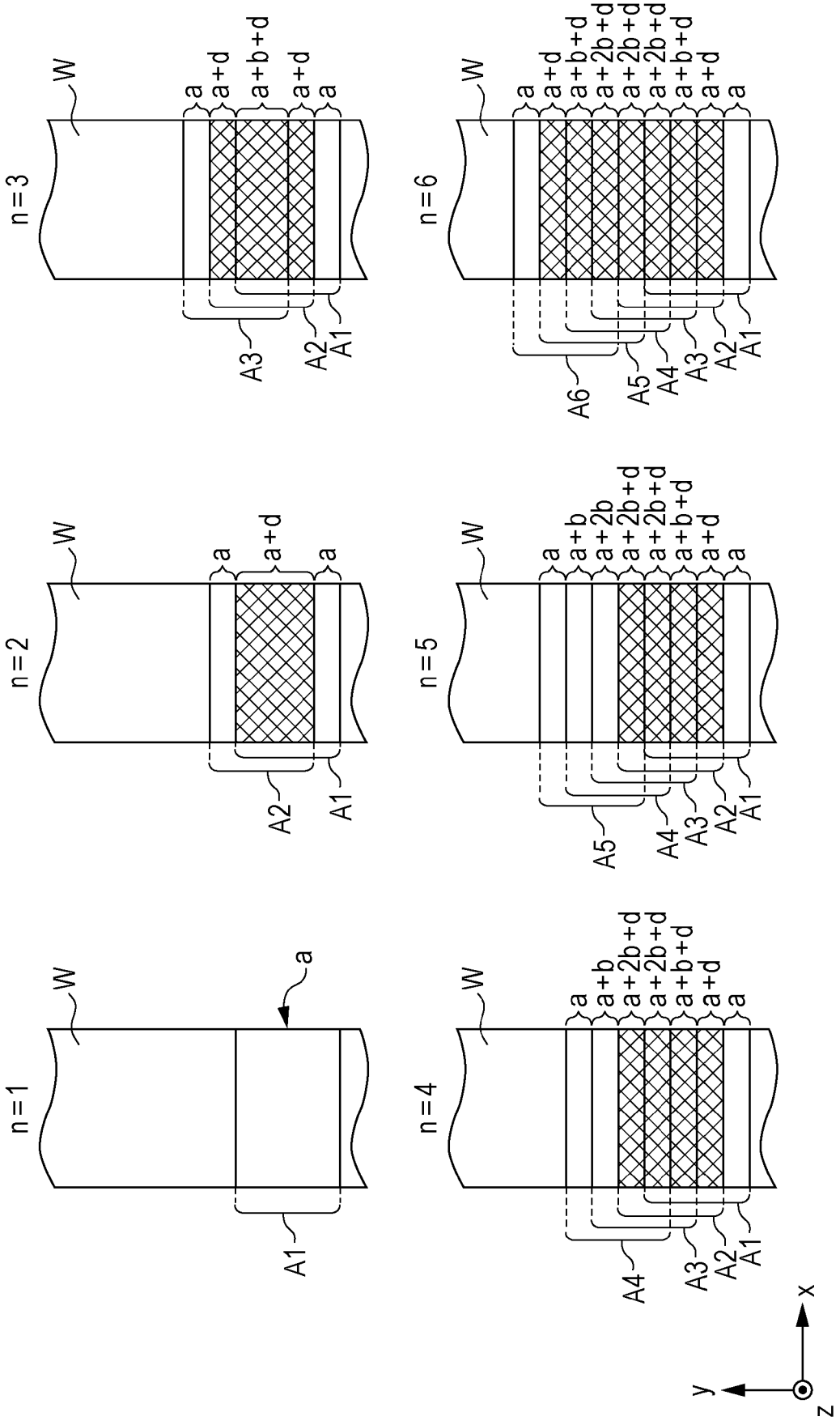
x
y

FIG. 6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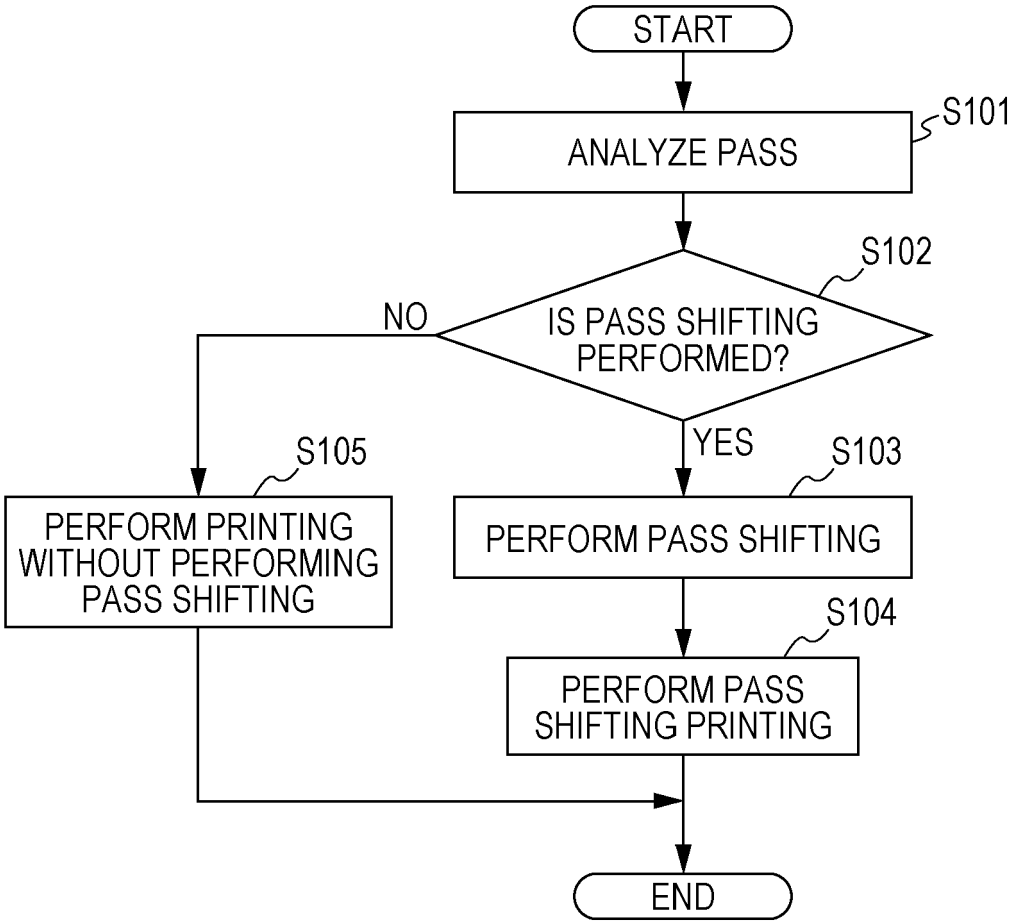
x
y
z

FIG. 7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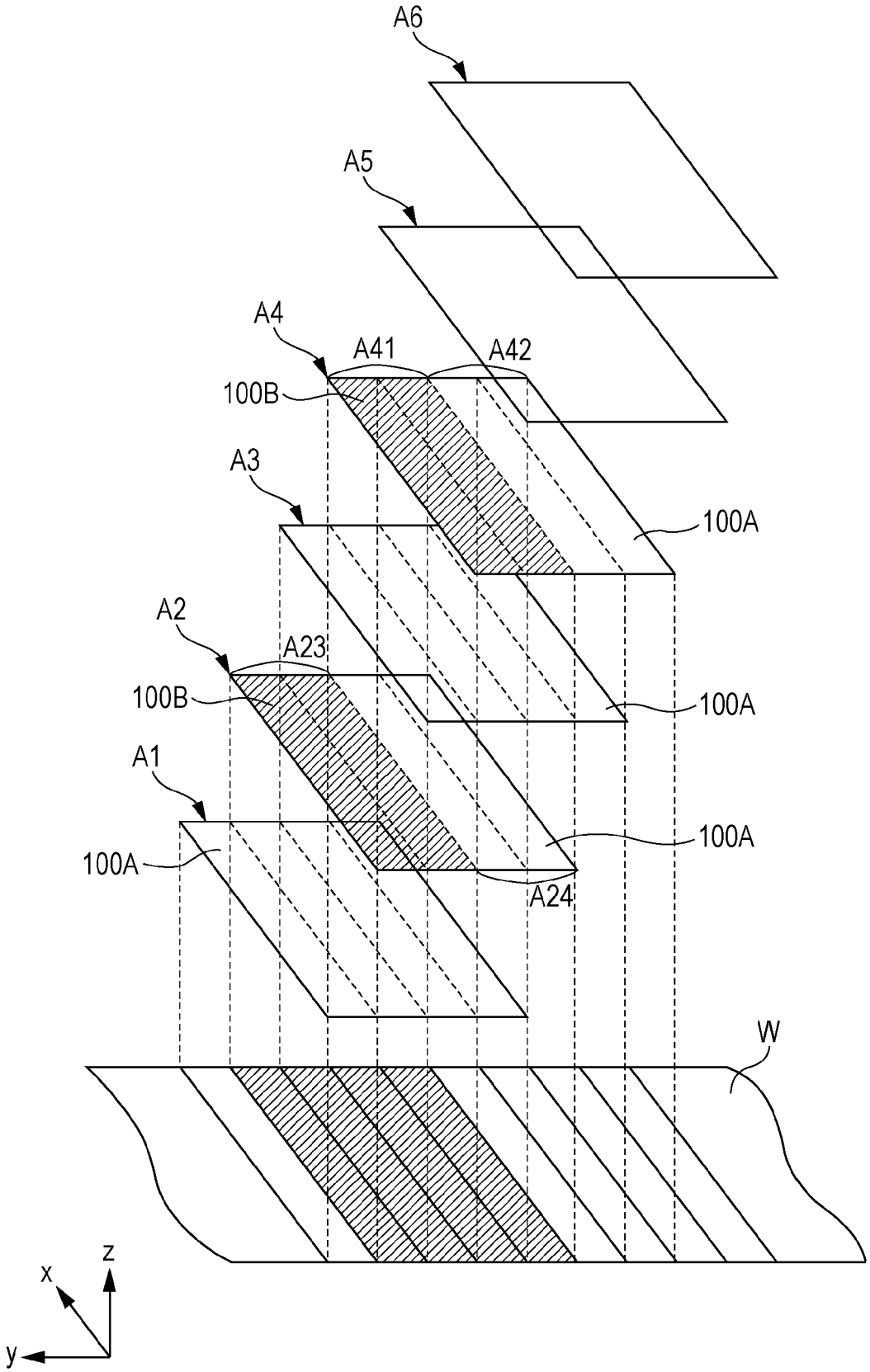
ANALYZE PASS
S101
S102
IS PASS SHIFTING PERFORMED?
NO
YES
S105
PERFORM PRINTING WITHOUT PERFORMING PASS SHIFTING
S103
PERFORM PASS SHIFTING
S104
PERFORM PASS SHIFTING PRINTING
END

FIG. 8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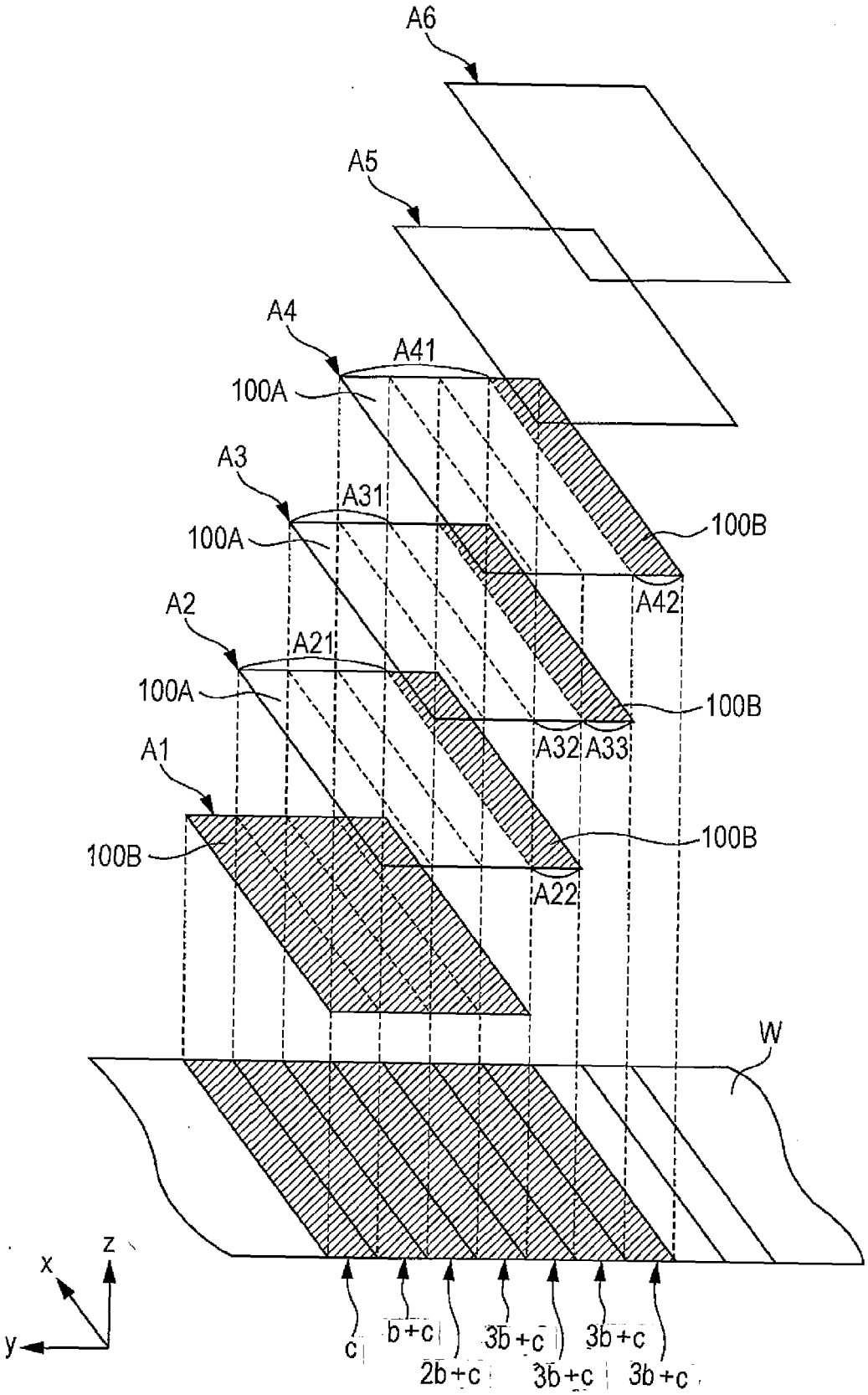
y

FIG. 9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100B
A22
W
z
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y
c
b+c
2b+c
3b+c
3b+c
3b+c
3b+c

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Patent documents cited in the description

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