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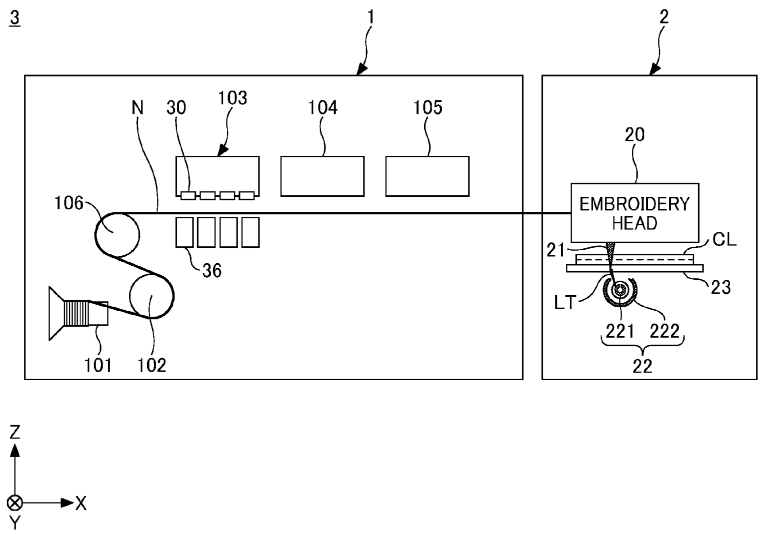
(54) **TEXTILE-PRINTING-AND-EMBROIDERY SYSTEM, TEXTILE-PRINTING-AND- EMBROIDERY APPARATUS, AND EMBROIDERY ADJUSTMENT METHOD FOR TEXTILE-PRINTING-AND-EMBROIDERY SYSTEM**

(57) A textile-printing-and-embroidery system (3) includes a textile printing apparatus (1), an embroidery apparatus (2), a dyeing data processor (107), and an embroidery data processor (24). The textile printing apparatus (1) includes a dyeing device (103) to print a thread based on dyeing data including redundant data to which a turn-back marker is attached. The embroidery apparatus (2) includes an underlay stitching controller (25) to perform an underlay stitching operation for length adjustment such that underlay stitching is started at a timing at which an assumed embroidering position on embroidery data calculated from a number of stitches indicating how many times a needle is sewn reaches a color change point on the embroidery data, regardless of an actual embroidering position on the thread, and is turned back at the turn-back marker to move back and forth once, to consume a deviation between the assumed embroidering position and the actual embroidering position.

FIG. 1



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Description

BACKGROUND

Technical Field

[0001] Embodiments of the present disclosure relate to a textile-printing-and-embroidery system, a textile-printing-and-embroidery apparatus, and an embroidery adjustment method for the textile-printing-and-embroidery system.

Related Art

[0002] In recent years, an embroidery system with a dyeing function has been known in which an upper thread is dyed using an inkjet technology so as to impart a color that changes in a conveyance direction, and embroidery is performed using the upper thread dyed by an embroidery machine or a sewing machine.

[0003] In an embroidery machine of such an embroidery system, a positional deviation of an embroidery on a cloth may occur due to a change in balance between the consumption amounts of an upper thread and a lower thread caused by a loss in tension balance between the upper thread and the lower thread, a deflection of the cloth, a variation in thickness of the embroidery, or the like.

[0004] Hence, in order to prevent a color change point of an upper thread from being exposed on the surface of an embroidery, Japanese Unexamined Patent Application Publication No. 2008-289522 proposes to insert the data for underlay stitching such that the color change point is placed below the embroidery of the next color, to adjust dyeing data.

[0005] Here, in Japanese Unexamined Patent Application Publication No. 2008-289522, the dyeing data is adjusted such that an underlay-stitching portion having a predetermined length and including a color change point is hidden with an embroidery planned region. However, if the consumption amount of the upper thread changes from a predicted amount during the subsequent embroidery operation, the position of the color change point is shifted. Then, when the amount of deviation of the actual consumption amount from the assumed consumption amount is large and the positional deviation accumulates, the deviation amount may not be covered even by the underlay stitching of a predetermined length.

SUMMARY

[0006] In light of the above circumstances, an object of the present invention is to provide a textile-printing-and-embroidery system that can avoid a positional deviation of an embroidered color on a cloth and prevent the accumulation of deviation of the thread consumption amount, even if an actual thread consumption amount deviates from an assumed amount during an embroidery operation using a continuous thread whose color changes.

[0007] In order to solve the above-described problem, according to an aspect of the present invention, a textile-printing-and-embroidery system includes a textile printing apparatus, an embroidery apparatus, a dyeing data processor, and an embroidery data processor. The textile printing apparatus prints a thread. The embroidery apparatus includes a needle to embroider a cloth, based on embroidery data, with the thread fed from the textile printing apparatus. The dyeing data processor creates initial dyeing data for realizing a color of a thread of the embroidery data, and inserts redundant data to which a turn-back marker serving as a mark on the thread is attached, as necessary, at a color change point at which a color to be dyed changes in the initial dyeing data. The embroidery data processor inserts underlay stitching data for stitching a portion below an embroidery region of a scheduled next color, at a color change point on the embroidery data that is a position at which the redundant data is inserted on the dyeing data, such that the underlay stitching data is longer than the redundant data. The textile printing apparatus includes a dyeing device to print the thread based on the dyeing data including the redundant data to which the turn-back marker is attached. The embroidery apparatus includes an underlay stitching controller to perform an underlay stitching operation for length adjustment such that underlay stitching is started at a timing at which an assumed embroidering position on the embroidery data calculated from a number of stitches indicating how many times the needle is sewn reaches the color change point on the embroidery data, regardless of an actual embroidering position on the thread, and is turned back at the turn-back marker to move back and forth once, to consume a deviation between the assumed embroidering position and the actual embroidering position.

[0008] According to another aspect of the present invention, there is provided an embroidery adjustment method for a textile-printing-and-embroidery system including a textile printing device and an embroidery apparatus. The method includes creating, inserting, printing, and performing. The creating creates initial dyeing data for realizing a color of a thread of embroidery data and inserting redundant data to which a turn-back marker serving as a mark on the thread is attached, as necessary, at a color change point at which a color to be dyed changes in the initial dyeing data. The inserting inserts underlay stitching data for stitching a portion below an embroidery region of a scheduled next color, at a color change point on the embroidery data that is a position at which the redundant data is inserted on the dyeing data, such that the underlay stitching data is longer than the redundant data. The printing prints the thread based on the dyeing data including the redundant data to which the turn-back marker is attached. The performing performs an underlay stitching operation for length adjustment such that underlay stitching is started at a timing at which an assumed embroidering position on the embroidery data calculated from a number of stitches indicating how many times the needle is sewn reaches the color change point on the embroidery data, regardless of an actual embroidering position on the thread, and is turned back at the turn-back marker to move back and forth once, to consume a deviation between the assumed embroidering position and the actual embroidering position.

[0009] According to one aspect of the present invention, in a textile-printing-and-embroidery system, even when the actual thread consumption amount deviates from an assumed amount during an embroidery operation using a continuous thread whose color changes, the positional deviation of the color of an embroidery on a cloth can be avoided and the accumulation of the deviation of the thread consumption amount can be prevented.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[0010] A more complete appreciation of the disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic side view of a dyeing-and-embroidery system according to a first embodiment of the present disclosure;
FIG. 2 is a schematic side view of a dyeing section in a dyeing apparatus according to an embodiment of the present disclosure;
FIG. 3 is a schematic bottom view of a dyeing section according to an embodiment of the present disclosure;
FIG. 4 is a schematic block diagram of the dyeing-and-embroidery system according to the first embodiment;
FIG. 5 is a schematic diagram illustrating an example of stitches on the upper side and the lower side of an upper thread and a lower thread with respect to a cloth;
FIG. 6 is a schematic cross-sectional view of a plurality of states of stitches formed by upper and lower threads on a cloth;
FIG. 7A is a diagram illustrating a detector according to an embodiment of the present disclosure;
FIG. 7B is a diagram illustrating a detector according to another embodiment of the present disclosure;
FIG. 8 including FIGS. 8A and 8B is a functional block diagram of a dyeing data processor, an embroidery data processor, and computing mechanisms according to a first embodiment of the present disclosure;
FIGS. 9A and 9B are diagrams illustrating an example of dyeing data with a turn-back marker dyed with a dyeing apparatus according to an embodiment of the present disclosure;
FIG. 10 is a sequence diagram illustrating inter-apparatus exchange of a dyeing-and-embroidery process according to an embodiment of the present disclosure;
FIG. 11 including FIGS. 11A and 11B is a flowchart illustrating an embroidery control operation according to an embodiment of the present disclosure;
FIG. 12 is a diagram illustrating an example of a redundant dying region on a dyed thread and an underlay stitching distance in an embroidery control operation according to an embodiment of the present disclosure;
FIG. 13 is a diagram illustrating an example of an embroidery pattern on which an embroidery control operation according to an embodiment of the present disclosure is performed in a case where the actual consumption amount of an upper thread is smaller than expected;
FIG. 14 is a diagram illustrating an example of an embroidery pattern on which an embroidery control operation according to an embodiment of the present disclosure is performed in a case where the actual consumption amount of an upper thread is larger than expected;
FIG. 15 is a diagram illustrating an embroidery apparatus according to a modification of the first embodiment of the present disclosure;
FIG. 16 is a schematic side view of a dyeing-and-embroidery system according to a second embodiment of the present disclosure;
FIG. 17 including FIGS. 17A and 17B is a functional block diagram of components relating to control of a host control device, a dyeing apparatus, and an embroidery apparatus according to the second embodiment; and
FIG. 18 is a schematic side view of a dyeing-and-embroidery apparatus according to a third embodiment of the present disclosure.

[0011] The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted.

DESCRIPTIONS OF EMBODIMENTS

[0012] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present disclosure. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0013] In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve a similar result.

[0014] Hereinafter, embodiments are described with reference to the accompanying drawings. In order to facilitate understanding of the description, the same components in the drawings are denoted by the same reference numerals as much as possible, and redundant description is omitted.

[0015] Hereinafter, embodiments of the present disclosure are described with reference to the drawings. In the following drawings, the same components are denoted by the same reference numerals, and redundant description may be omitted.

Overall Structure

[0016] First, a dyeing-and-embroidery system (textile-printing-and-embroidery system) according to a first embodiment of the present disclosure will be described with reference to FIGS. 1 to 4. FIG. 1 is a schematic side view of an example of a dyeing-and-embroidery system according to a first embodiment of the present disclosure. FIG. 2 is a schematic side view of a dyeing section in a dyeing apparatus according to an embodiment of the present disclosure. FIG. 3 is a schematic bottom view of a dyeing section according to an embodiment of the present disclosure. FIG. 4 is a schematic block diagram of the dyeing-and-embroidery system according to the first embodiment.

[0017] With reference to FIG. 1, a dyeing-and-embroidery system 3 according to the present embodiment includes a dyeing apparatus 1 and an embroidery apparatus 2. In the dyeing-and-embroidery system 3, the dyeing apparatus 1 is electrically connected to the embroidery apparatus 2 by wired or wireless communication to exchange information with the embroidery apparatus 2.

[0018] The dyeing apparatus 1 includes an upper-thread spool 101 around which an upper thread N is wound, a dyeing device 103, a fixing device 104, and a post-processing device 105. The dyeing apparatus 1 according to the present embodiment is a thread coloring apparatus that dyes a thread by a liquid discharge method.

[0019] In the dyeing apparatus 1, the upper thread N pulled out from the upper thread spool 101 is guided by a supply roller 102 and a conveyance roller 106 and continuously routed to an embroidery head 20 of the embroidery apparatus 2.

[0020] The dyeing device 103 includes a plurality of discharge heads 30 (30K, 30C, 30M, and 30Y) and a maintenance mechanism 35. The plurality of discharge heads 30 (30K, 30C, 30M, and 30Y) discharge and apply liquid of desired colors to the upper thread N pulled out and fed from the upper-thread spool 101. The maintenance mechanism 35 includes a plurality of individual maintenance units 36 (36K, 36C, 36M, and 36Y) to execute maintenance of the discharge heads 30K, 30C, 30M, and 30Y.

[0021] Hereinafter, the width direction of the dyeing-and-embroidery system 3 is referred to as X, the depth direction of the dyeing-and-embroidery system 3 is referred to as Y, and the height direction (vertical direction) of the dyeing-and-embroidery system 3 is referred to as Z.

[0022] With reference to FIG. 2, each of the plurality of discharge heads 30K, 30C, 30M, and 30Y is a dyeing unit (thread printing unit). The plurality of discharge heads 30K, 30C, 30M, and 30Y are discharge heads (dyeing heads) that discharge colors different from each other. For example, the discharge head 30K discharges droplets (ink) of black (K), the discharge head 30C discharges droplets of cyan (C), the discharge head 30M discharges droplets of magenta (M), and the discharge head 30Y discharges droplets of yellow (Y). The order of colors illustrated in FIG. 2 is an example, and the colors may be arranged in an order different from this description. The dyeing device 103 may include a discharge head that discharges colorless droplets for coating the dyed upper thread N on a position downstream from the discharge heads 30K, 30C, 30M, and 30Y in the feed direction of the upper thread N.

[0023] The maintenance units 36K, 36C, 36M, and 36Y, respectively, are disposed below the discharge heads 30K, 30C, 30M, and 30Y of the respective colors. As a maintenance recovery operation, the maintenance units 36K, 36C, 36M, and 36Y, for example, cap the discharge heads 30K, 30C, 30M, and 30Y when the discharge heads 30K, 30C, 30M, and 30Y are not in use, receive dummy discharge of liquid droplets from the discharge heads 30K, 30C, 30M, and 30Y, perform suction circulating operation of the nozzles in a state in which a dummy discharge receptacle is close to the heads, and perform a wiping operation of the nozzles.

[0024] Here, as illustrated in FIG. 3, each of the discharge heads 30K, 30C, 30M, and 30Y has a nozzle surface 33 on which a nozzle row 32 is formed. A plurality of nozzles 31 for discharging liquid droplets are arranged in the nozzle row 32. Each of the discharge heads 30K, 30C, 30M, and 30Y is disposed such that the direction in which the nozzle row 32 extends, which is the direction in which the nozzles 31 are arranged, coincides with the feed direction of the upper thread N. In FIG. 3, only one nozzle row 32 is illustrated on the nozzle surface 33. However, a plurality of nozzle rows 32 may be arranged on the nozzle surface 33.

[0025] With reference to FIG. 1, the fixing device 104 performs a fixing process (drying process) on the upper thread N to which the liquid discharged from the dyeing device 103 is applied. The fixing device 104 includes, for example, a heater such as an infrared irradiator or a hot air sprayer, and heats and dries the upper thread N.

[0026] The post-processing device 105 includes, for example, a cleaner that cleans the upper thread N and lubricant applying means that applies a lubricant to a surface of the upper thread N.

[0027] Note that the dyeing apparatus 1 according to an embodiment of the present disclosure includes at least the dyeing device 103 that applies a colored liquid to an upper thread N and may not include the fixing device 104 and the post-processing device 105.

[0028] The dyeing device 103 in the dyeing apparatus 1 illustrated in FIGS. 1 to 3 represents a configuration example of a liquid discharge type in which ink is discharged from the discharge heads 30K, 30C, 30M, and 30Y to dye an upper thread N. Note that, in some embodiments, the dyeing device 103 may be a dyeing device of a coating type that nips an upper thread N with, for example, rollers to apply ink for printing.

[0029] The embroidery apparatus 2 illustrated in FIG. 1 includes a needle 21, a lower-thread rotator 22, a stage 23, and an embroidery head 20. In the needle 21, an upper thread N is passed through a needle hole at the needle tip. The needle 21 is vertically movable with respect to a cloth CL.

[0030] The lower-thread rotator 22 includes a lower-thread bobbin 221 around which lower thread LT is wound and a hook 222. The lower-thread bobbin 221 and the hook 222 rotate in conjunction with the movement of the needle 21. The lower-thread rotator 22 also includes, for example, a cylindrical inner shuttle that accommodates the lower-thread bobbin 221, a bottomed cylindrical outer shuttle, and a cylindrical case integrated with the hook 222. FIG. 1 illustrates an example in which the lower-thread bobbin 221 is of a vertical rotation type (a vertical full-rotary shuttle type or a vertical half-rotary shuttle type) in which the rotation direction is the vertical direction. In some embodiments, the lower-thread bobbin 221 may be of a horizontal rotation type (a horizontal shuttle type) in which the rotation direction is the horizontal direction.

[0031] The stage 23 is a table that holds the cloth CL, and has a hole 23O (see FIG. 7) through which the needle passes. The stage 23 is movable in the X direction and the Y direction to feed the cloth CL.

[0032] The embroidery head 20 is provided with a computing mechanism 25 (see FIG. 4). The computing mechanism 25 controls the movement (handling) of the needle 21 through which an upper thread N passes and the movement of the stage 23. Thus, the embroidery apparatus 2 embroiders the cloth CL using an upper thread N and a lower thread LT fed according to the feeding of the upper thread N to form an embroidery pattern (embroidery design) on the cloth CL.

[0033] Note that the term "thread" includes glass fiber thread; wool thread; cotton thread; synthetic fiber thread; metallic thread; mixed thread of wool, cotton, polymer, or metal; and linear object (linear member or continuous base material) to which yarn, filament, or liquid is applied. The term "thread" also includes braided cord and flatly braided cord.

[0034] With reference to FIG. 4, the embroidery apparatus 2 according to the present embodiment includes an embroidery data processor 24, the computing mechanism 25, a stitch counter 26, a colorimetric sensor 27, a motor driver 28, a drive motor 29, a needle up-down driving unit 291, a lower-thread rotation driving unit 292, an X-axis driving unit 293, and a Y-axis driving unit 294 as portions related to driving control. At least the motor driver 28, the drive motor 29, and the needle up-down driving unit 291 are built in the embroidery head 20 above the needle 21. The embroidery data processor 24 and the computing mechanism 25 may also be incorporated in the embroidery head 20. The X-axis driving unit 293, and the Y-axis driving unit 294 for moving the stage 23 and the lower-thread rotation driving unit 292 are provided below the stage 23.

[0035] The dyeing apparatus 1 includes a dyeing data processor 107 and a computing mechanism 108 as portions related to dyeing control. The computing mechanism 108 controls the head driver 39 that drives the discharge heads 30 (30K, 30C, 30M, and 30Y) to control the dyeing operation, and controls an entry motor 60 that rotationally drives an entry drive roller (or conveyance roller) 106 to adjust the thread feed speed.

[0036] The embroidery data processor 24 acquires an embroidery image (an embroidery file) that is a source of the embroidery data, and creates the embroidery data (initial embroidery data) based on the embroidery image. The embroidery data processor 24 adds the underlay stitching data to the color change position of the created initial embroidery data, and outputs the embroidery data and the underlay stitching data to the motor driver 28.

[0037] Here, the embroidery image means image data (embroidery design) that serves as an original of an embroidery pattern on a cloth. The initial-embroidery-data creation unit 402 (see FIG. 8) of the embroidery data processor 24 separates the embroidery image into colors (RGB values), determines the color of a thread to be used and the duration of each color on the thread so that stitching can be performed in a smooth order, based on the size of an embroidery pattern on a cloth, and creates embroidery data so that stitches are formed on the cloth using the thread of the determined color.

[0038] More specifically, the embroidery data is "data obtained by combining data of coordinates at which the needle is moved and items to be executed at the coordinates". Specifically, the items to be executed at the coordinates include: (1) the needle is inserted into the cloth to catch the upper thread, the needle is returned to the surface of the cloth, and then the needle is moved to the next position to be inserted; (2) the embroidery is ended or interrupted (including switching to another needle and cutting the thread to move to a distant place where the embroidery is not continuous); and (3) the needle is moved to the initialization position (alignment position). As a file of embroidery data, formats such as ".dst" and ".pes" are generally known. The initial embroidery data is data to be initially set and is embroidery data before editing corresponding to the thread consumption amount.

[0039] The computing mechanism 25 drives and controls the motor driver 28 to execute a main embroidering operation for forming an embroidery pattern on a cloth based on embroidery data, and a underlay stitching operation for adjusting a thread consumption amount in accordance with underlay stitching data, a progress state indicating how many stitches have been advanced, which is detected by the stitch counter 26 or the like, and a turn-back instruction detected by the colorimetric sensor 27.

[0040] The stitch counter 26 is a sensor that detects the vertical movement of the needle 21 and is provided, for example, on a needle bar that holds the needle 21. The stitch counter 26 detects the number of stitches corresponding to how many times the needle 21 has moved up and down, that is, how many stitches have been advanced by the needle 21.

[0041] The colorimetric sensor 27 is a sensor that detects the color of a thread at the drop position of the needle, and detects the color of a turn-back marker of the underlay stitching and the color of the start of embroidery. Note that the colorimetric sensor 27 may not be provided (see, e.g., a modification illustrated in FIG. 15).

[0042] The motor driver 28 drives and controls the drive motor 29 based on the preliminary-stitching embroidery data.

[0043] The needle up-down driving unit 291 is also referred to as a balance and converts the rotational movement of an upper shaft coupled to the drive motor 29 into the vertical movement to drive the up-and-down movement of the needle 21 through which the upper thread N is passed.

[0044] The lower-thread rotation driving unit 292 rotates the lower-thread rotator 22 in conjunction with the vertical movement of the needle 21 by the rotational movement of a lower shaft coupled to the upper shaft via, for example, a belt, a cam, and a crank.

[0045] The X-axis driving unit 293 and the Y-axis driving unit 294 are stage movement drive units serving as cloth feeders and drive the movement of the stage 23, on which the cloth CL is placed, in the X direction and the Y direction in conjunction with the vertical movement of the needle 21 and the rotation of the lower-thread rotator 22 by the rotational movement of the lower shaft. At this time, as a method of feeding the cloth CL, the entire stage 23 may be moved, or a feed dog in a hole 23O (see FIG. 7) of the stage 23 may be moved.

[0046] The needle up-down driving unit 291, the lower-thread rotation driving unit 292, the X-axis driving unit 293, and the Y-axis driving unit 294 serve as a drive mechanism that is driven in conjunction with one drive motor 29. Accordingly, the vertical movement of the needle 21, the rotational movement of the lower-thread rotator 22, and the X-and-Y movement of the cloth CL on the stage 23 are generated by the rotation of the drive motor 29. For example, one vertical movement of the needle 21 is performed in conjunction with one or an integral number of rotational movements of the lower-thread rotator 22.

Tension of Upper Thread and Lower Thread

[0047] FIG. 5 is a schematic diagram illustrating an example of stitches on the upper side and the lower side of an upper thread and a lower thread with respect to a cloth. Part (a) of FIG. 5 is a top view and part (b) of FIG. 5 is a bottom view. FIG. 6 is a diagram illustrating the balance between the upper thread and the lower thread in stitches on the cloth. In FIG. 6, part (a) illustrates a case where the tension balance between the upper thread and the lower thread is proper, part (b) illustrates a case where the tension of the upper thread is larger than the tension of the lower thread, and part (c) illustrates a case where the tension of the lower thread is larger than the tension of the upper thread.

[0048] In the embroidery apparatus 2, when the needle 21 descends and penetrates the cloth CL, the upper thread N is also drawn into the back side of the cloth CL together with the needle 21. Thereafter, when the needle 21 rises, is pulled out from the cloth CL, and returns to the front side of the cloth CL, the upper thread N forms a loop on the back side of the cloth CL due to the frictional force between the upper thread N and the cloth CL, and remains on the back side of the cloth CL. At this time, the hook 222 is caught by the loop-shaped upper thread N by the rotation of the lower-thread rotator 22, and the lower thread LT passes through the loop of the upper thread N. Further, when the needle 21 is raised above the cloth CL, the position where the upper thread N and the lower thread LT cross each other is pulled up to the cloth CL, thereby forming a stitch on the cloth CL.

[0049] An example of the stitches thus formed is illustrated in FIG. 5. FIG. 5 is an enlarged view of stitches embroidered by pattern stitching (satin stitching) so as to fill the surface from top to bottom. In part (b) of FIG. 5 depicting the back side, the catching portions between the upper thread N and the lower thread LT surrounded by the dotted line is illustrated loosely for easy understanding of the relationship between the threads. However, actually, the upper thread N and the lower thread LT are in contact with each other at the catching portions to pull each other.

[0050] FIG. 6 is a cross-sectional view of a region indicated by an alternate long and short dash line in FIG. 5. In the cross section of the stitches illustrated in FIG. 5, when the tension balance between the upper thread and the lower thread is proper, the cross section is as illustrated in part (a) of FIG. 6.

[0051] In the stitches formed in this manner, when the tension of the upper thread N is large, the upper thread N pulls the lower thread LT as illustrated in part (b) of FIG. 6. Accordingly, the amount of the upper thread N turned to the back side of the cloth CL is smaller than that in the case of the proper balance illustrated in part (a) of FIG. 6. That is, the length BL of the lower thread on the back side is long and the length NL of the upper thread is short. Consequently, if the state in which the tension of the upper thread is large continues, the consumption amount (use amount) of the upper thread is smaller than expected, and the consumption speed of the upper thread N is slower.

[0052] On the other hand, when the tension of the upper thread is smaller as illustrated in part (c) of FIG. 6, the upper thread N is pulled by the lower thread LT. Accordingly, the amount of the upper thread N going around to the back side of the cloth CL is larger than that in the case of the proper balance illustrated in part (a) of FIG. 6. That is, the length BL of the lower thread on the back side is short, and the length NL of the upper thread is long. Consequently, if the state in which the tension of the upper thread is small continues, the consumption amount (use amount) of the upper thread N is larger than expected, and the consumption speed of the upper thread N is faster.

[0053] As described above, the consumption speed of the upper thread N depends on the amount of the upper thread N that turns around to the back side of the cloth CL. As illustrated in parts (b) and (c) of FIG. 6, in a situation where the turnaround amount is different from the predicted amount, there is a large difference between the predicted amount of consumption of the upper thread and the cumulative amount of consumption of the thread actually accumulated while the embroidery is continued. In the present embodiment, the dyeing of the upper thread in the dyeing apparatus 1 on the upstream side of the embroidery is performed on the predicted position of the thread consumption amount. Accordingly, if the colored thread is not located at the correct position, the position of the color after the embroidery may be shifted, and the image of the embroidery pattern on the cloth may be collapsed.

[0054] For this reason, in the present embodiment, underlay stitching is performed to start from an assumed position and turned back at the position of a detected turn-back marker on a thread to go back and forth. Thus, an underlay stitching operation is performed in which the length is adjusted to absorb the deviation amount between the assumed embroidering position and the actual embroidering position at the position of the change of the color of the thread. A method of detecting the turn-back marker (actual thread consumption amount) of the color of the upper thread N is described below with reference to FIG. 7.

Detector

[0055] FIG. 7A is a diagram illustrating a detector according to an embodiment of the present disclosure. FIG. 7B is a diagram illustrating a detector according to another embodiment of the present disclosure. In FIGS. 7A and 7B, the embroidery head 20 and the lower-thread rotator 22 are not illustrated. FIG. 7A illustrates an example in which the colorimetric sensor and the stitch counter are separate from each other. FIG. 7B illustrates an example of an integrated detector.

[0056] In the separate detector illustrated in FIG. 7A, the detection of the current position in the embroidery data and the detection of the consumed amount are performed with a stitch counter 26 that counts the number of stitches and a colorimetric sensor 27 that detects the color of the thread.

[0057] The colorimetric sensor 27 is, for example, an optical sensor such as a color laser sensor, and is a sensor capable of detecting at least the color of the thread. A color laser sensor is a type of photoelectric sensor that emits light from a light projecting unit and detects light reflected by a detection object by a light receiving unit. The color laser sensor can detect the amount of received light of each of red, blue, and green, thus allowing determination of the color of the object (the colors of the needle and the thread). Accordingly, the turn-back marker serving as a mark can be detected during the underlay stitching.

[0058] In this configuration, the independent stitch counter 26 that counts the number of stitches is provided to grasp the current position during the embroidery operation and detect the assumed position of the color change point. The stitch counter 26 is a sensor that detects the vertical movement of the needle 21 and is provided, for example, on a needle bar that holds the needle 21. The stitch counter 26 detects the number of stitches corresponding to how many times the needle 21 has moved up and down, that is, how many stitches have been advanced by the needle 21.

[0059] In this configuration, the colorimetric sensor 27, which is a color laser sensor, detects the color at the needle drop timing at which the needle 21 pierces the cloth CL detected by the stitch counter 26. Thus, the number of stitches and the color of the thread at the position of the needle hole of the needle can be simultaneously detected.

[0060] The integrated detector 270 illustrated in FIG. 7B is, for example, a color laser sensor with a storage function. As illustrated in FIG. 7B, the detector 270 sets the needle drop position at which the needle N pierces the cloth CL as the irradiation range of an object, and detects the time and color at the moment when the needle 21 pierces the cloth CL. Thus, the integrated detector 270 can detect the number of stitches by counting the number of needle drops, and can simultaneously detect the color of the thread at the timing used for forming a stitch on the cloth.

[0061] FIGS. 7A and 7B each illustrate the example in which the detector of the number of stitches is provided regardless of whether the detector is of a separate type or an integral type. However, the colorimetric sensor 27 formed of one color laser sensor may be used only for detecting colors, and the number of stitches corresponding to the current position may be called from the motor driver 28 that drives based on the embroidery data without providing the function of the stitch counter. At the needle drop timing at which the needle 21 pierces the cloth CL, the number of stitches corresponding to an assumed color change point may be counted in conjunction with the operation of the motor driver 28 inside the computing mechanism 25 in the subsequent stage.

[0062] With any of these detection methods, during the embroidery operation, the turn-back marker on the thread, which is the color change point of the thread in the needle 21 used for the embroidery, and the current position during the embroidery operation for counting the color change point can be grasped in real time without temporal errors.

Functional Block

[0063] FIG. 8 including FIGS. 8A and 8B is a functional block diagram of a dyeing data processor, an embroidery data processor, and computing mechanisms related to the dyeing and embroidery operations, according to a first embodiment of the present disclosure.

[0064] In the present embodiment, an example is described in which the embroidery data processor is disposed in the embroidery apparatus, and the dyeing data processor is disposed in the embroidery apparatus.

[0065] The dyeing data processor 107 of the dyeing apparatus 1 includes an embroidery-image-and-embroidery-data acquisition unit 701, an initial-dyeing-data creation unit 702, a redundant-data presence determination unit 703, a color-difference-threshold storage unit 704, a continuous-length-threshold storage unit 705, a redundant-data-and-turn-back-marker setting unit 706, and a redundant-data-and-turn-back-marker-contained-dyeing-data creation unit 707.

[0066] The embroidery data processor 24 of the embroidery apparatus 2 includes an embroidery-image acquisition unit 401, an initial-embroidery-data creation unit 402, an underlay-stitching-data creation unit 403, and an underlay-stitching-embroidery-data creation unit 404.

[0067] The computing mechanism 25 of the embroidery apparatus 2 includes a stitch-position calculation unit 501, a current-position grasping unit 502, an underlay-stitching start-position storage unit 503, an underlay-stitching-start instruction unit 504, a underlay-stitching-forward-path count unit 505, a forward-path stitch-number storage unit 506, an underlay-stitching-backward -path count unit 507, an underlay-stitching turn-back instruction unit 508, a turn-back-marker color storage unit 509, an embroidery-start instruction unit 510, and an embroidery-start-color storage unit 511.

[0068] The computing mechanism 25 functions as an underlay-stitching control device.

[0069] The embroidery-image acquisition unit 401 of the embroidery data processor 24 in the embroidery apparatus 2 acquires an embroidery image (or an embroidery file) that is image data.

[0070] The initial-embroidery-data creation unit 402 creates embroidery data (initial embroidery data) based on the acquired embroidery image. As described above, the embroidery data is data in which data of coordinates for moving the needle 21 and what to do at the positions of the coordinates are paired. FIG. 8 illustrates an example in which the embroidery data processor 24 generates the embroidery data based on the embroidery image. However, the embroidery data (initial embroidery data) may be directly input from the outside.

[0071] The embroidery-image-and-embroidery-data acquisition unit 701 of the dyeing apparatus 1 acquires an embroidery image and embroidery data from the embroidery apparatus 2.

[0072] The initial-dyeing-data creation unit 702 creates dyeing data (initial dyeing data) based on the embroidery image and the embroidery data. More specifically, the initial-dyeing-data creation unit 702 creates dyeing data including information on the blending amount of each color of KCMY used for dyeing to realize the color of a thread included in the embroidery data and the continuous dyeing lengths of the respective colors of KCMY in the discharge heads 30K, 30C, 30M, and 30Y of the KCMY colors.

[0073] The redundant-data presence determination unit 703 determines whether to insert redundant data at the color change position of the created dyeing data.

[0074] The color-difference-threshold storage unit 704 stores a threshold of a color difference between two adjacent colors for which redundant data is to be used. The continuous-length-threshold storage unit 705 stores a threshold of the continuous length of two adjacent colors for which redundant data is to be used.

[0075] The redundant-data presence determination unit 703 selects a color change point at which the redundant data is inserted from among a plurality of color change points, based on a color difference between two adjacent colors at the color change point in the dyeing data.

For example, when the color difference is very small or in the case of gradation, the positional deviation of the thread color in the embroidery on the cloth is not a concern. Therefore, the redundant-data presence determination unit 703 determines that the redundant data is to be inserted when the color difference between two adjacent colors at the color change point exceeds a certain threshold stored in the color-difference-threshold storage unit 704, and the redundant data is not to be inserted when the color difference is equal to or less than the certain threshold.

[0076] The redundant-data presence determination unit 703 selects whether to insert redundant data based on the continuous length of dyeing of two adjacent colors at a color change in dyeing data. In the present embodiment, since the thread consumption amount is adjusted by the underlay stitching of stitching the lower side of the embroidery region of the scheduled next color, the underlay stitching is not hidden by the main embroidering unless the next color of thread continues for a certain length. Since the difference between the calculated thread consumption amount and the actual thread consumption amount increases as the embroidery is performed, the positional deviation between the embroidery and the thread color is small when the embroidery is performed at an extremely short distance, which is not a concern. Therefore, the redundant-data presence determination unit 703 determines that the redundant data is to be inserted when both the lengths of two adjacent colors at the color change point exceed a certain threshold stored in the color-difference-threshold storage unit 705, and the redundant data is not to be inserted when both the lengths are equal to or less than the certain threshold.

[0077] The redundant-data-and-turn-back-marker setting unit 706 sets the position of a turn-back marker in the redundant data. The position of the turn-back marker serving as a turn-back mark on the thread is set at the midpoint of a redundant marker. Since the turn-back marker serves as a direction adjustment stitch in the underlay stitching, it is preferable that the length of the turn-back marker is set to be about one stitch of the direction adjustment stitch and less than two stitches of the direction adjustment stitch in consideration of the positional deviation and the turn-back.

[0078] The redundant-data-and-turn-back-marker-contained-dyeing-data creation unit 707 creates dyeing data in which redundant data containing a turn-back marker is added as necessary to the color change point of the initial dyeing data.

[0079] Here, processing of dyeing data in the dyeing apparatus 1 according to an embodiment of the present disclosure is described with reference to the schematic diagrams of FIGS. 9A and 9B. FIG. 9A illustrates an example of initial dyeing data. FIG. 9B illustrates an example of dyeing data containing redundant data and a turn-back marker.

[0080] Specifically, FIG. 9A illustrates initial dyeing data before insertion of redundant data. The initial dyeing data corresponds to dyeing data obtained by calculation on the assumption that the thread is ideally consumed. In this case, assuming that the embroidery start point is A, the color change point on the embroidery design is B, and the embroidery end point is C, as illustrated in FIG. 9A, a portion AB and a portion BC may be dyed in target colors, respectively. However, in actual embroidery, the thread consumption varies from moment to moment due to, for example, variations in the deflection and thickness of the cloth to be embroidered, variations in the tension of the lower thread and the upper thread as illustrated in FIG. 6, and external environments.

[0081] Therefore, in the present embodiment, in consideration of a case where the thread consumption is larger than expected, dyeing is performed so that redundant data is inserted into the dyeing data by an amount at which the redundant data can absorb the next shortage due to variations in the thread consumption.

[0082] FIG. 9B illustrates the edited dyeing data after the insertion of the redundant data, in which the redundant data for a portion B-B' is inserted at the position corresponding to the point B in FIG. 9A before the insertion. As is described below, in the present embodiment, underlay stitching is performed to go back and forth to consume a thread of an amount corresponding to the redundant dyeing region dyed along the redundant data and a thread of an amount corresponding to variations in the thread consumption. Thus, the thread consumption amount is adjusted. A turn-back marker D is inserted at the midpoint of the portion B-B' as a mark for the turn-back of this underlay stitching.

[0083] As illustrated in FIG. 9B, the redundant data to be inserted into the dyeing data is a region having the same color as a color before the color change in the first half and a region having the same color as another color after the color change in the second half with the turn-back marker as a boundary. The lengths of the first half and the second half are substantially equal.

[0084] In the dyeing data, a turn-back marker inserted into a boundary between colors has a color different from two colors adjacent to each other at a color change. Since the turn-back marker serving as a mark has a color different from two colors adjacent to each other at a color change, the boundary can be clearly recognized even when a boundary is difficult to be recognized depending on the adjacent colors.

[0085] In the present embodiment, the turn-back marker on the thread serves as a mark to be detected by the colorimetric sensor 27 or the user's visual observation, and the turn-back marker serves as a starting point of the turn-back timing of the underlay stitching. Detecting the turn-back marker on the thread at the needle drop point allows the actual thread consumption up to the turn-back marker on the thread to be detected independently of the progress of the embroidery data.

[0086] The redundant-data-and-turn-back-marker-contained-dyeing-data creation unit 707 outputs the edited dyeing data, which is the dyeing data including the redundant data and the turn-back marker created as described above, to the computing mechanism 108 and the underlay-stitching-data creation unit 403 of the embroidery apparatus 2.

[0087] Returning to FIG. 8, the computing mechanism 108 of the dyeing apparatus 1 drives and controls the head driver 39 to discharge the dyeing liquid from each of the discharge heads 30K, 30M, 30C, and 30Y of the dyeing device 103 to dye an upper thread at a predetermined feed speed.

[0088] The underlay-stitching-data creation unit 403 in the embroidery data processor 24 of the embroidery apparatus 2 creates underlay stitching data based on the dyeing data including the turn-back marker and the redundant marker created by the redundant-data-and-turn-back-marker-contained-dyeing-data creation unit 707. The underlay stitching data is set so that underlay stitching is hidden under the scheduled embroidery region of a thread of the next color by a distance sufficiently longer than the length of a redundant dyeing region to be dyed along the redundant data. In the present embodiment, since the length of underlay stitching is increased or decreased to adjust the consumption amount of an upper thread, the underlay stitching data is preferably set so that the underway stitching is hidden under an embroidery pattern of the next color even if the underlay stitching is made longer than the redundant dyeing region on the thread to adjust the consumption amount of the upper thread.

[0089] Note that in the underlay stitching data, the route is set to be the same in the forward path and the backward path, and the stitch length of each stitch in the backward path is set to be reverse to the stitch length of each stitch in the forward path. During execution of the underlay-stitching forward-path data, the underway stitching may be interrupted and turned back to start the underway-stitching backward path in the middle of the underlay-stitching forward-path data. In such a case, the start position of the underlay-stitching backward-path data when starting the underlay-stitching backward-path is a position corresponding to the interruption point of the underlay-stitching backward-path data. That is, the portion from the original turn-back point to the position corresponding to the interruption point in the underlay stitching backward-path data is cut. The embroidery on the underlay-stitching backward path is performed based on the underlay-stitching backward-path data along the already-stitched portion of the underlay-stitching forward path.

[0090] The underlay-stitching-embroidery-data creation unit 404 inserts the created underlay stitching data into the embroidery data.

[0091] In the computing mechanism 25 of the embroidery apparatus 2, the stitch-position calculation unit 501 acquires, in real time, stitch data (cumulative number of stitches) that is data indicating how many stitches have been sewn, that is, which stitch is currently being sewn, output from the stitch counter 26. The stitch-position calculation unit 501 may calculate the current position of the embroidery in the embroidery data based on information from the motor driver 28 instead of the stitch counter.

[0092] The current-position grasping unit 502 calculates a current embroidering position, i.e., how far the embroidery has been performed in the embroidery data, from the embroidery data and the stitch data, and grasps the degree of progress in the embroidery.

[0093] The start position of the underlay stitching data inserted into the color change point of the embroidery data is stored in advance in the underlay-stitching start-position storage unit 503.

[0094] When the current embroidering position data calculated from the number of stitches reaches the color change position and the underlay stitching data exists at the color change position, the underlay-stitching-start instruction unit 504 notifies the motor driver 28 to stop the lock-stitch operation (i.e., the main embroidering operation) and start the underlay stitching operation.

[0095] The underlay-stitching forward-path count unit 505 counts the number of stitches of the underlay-stitching forward path simultaneously with the start of underlay stitching.

[0096] The colorimetric sensor 27 that detects a change in the color of the surface of the upper thread is connected to the underlay-stitching turn-back instruction unit 508 and the embroidery-start instruction unit 510.

[0097] The embroidery-start-color storage unit 511 stores an embroidery color for starting an embroidery (lock-stitch operation).

[0098] When the colorimetric sensor 27 detects the color for starting the embroidery, the embroidery-start instruction unit 510 notifies the motor driver 28 to start the lock-stitch operation.

[0099] The turn-back-marker color storage unit 509 stores the color of the turn-back marker included in the redundant data.

[0100] When the colorimetric sensor 27 detects the color of the turn-back marker stored in the turn-back-marker color storage unit 509, the underlay-stitching turn-back instruction unit 508 notifies the motor driver 28 to turn back the underlay stitching operation, and notifies a turn-back instruction to the forward-path stitch-number storage unit 506 and the underlay-stitching-backward-path count unit 507.

[0101] When the turn-back instruction is received, the motor driver 28 interrupts the forward path of the underlay stitching and starts the backward path of the underlay stitching. In the underlay-stitching backward path, the needle is moved until the needle returns to the underlay-stitching start point so that the route of the backward path be the same as the route of the forward path (i.e., follows the route of the forward path) and the stitch length of each stitch is reverse to the stitch length of each stitch of the forward path along the stitching portion of the forward path.

[0102] The forward-path stitch-number storage unit 506 stores the number of stitches of the forward path of the underlay stitching having been counted from the start of the underlay stitching to the turn-back marker when the underlay-stitching turn-back instruction by the turn-back marker is received.

[0103] When the number of stitches reaches the same number as the number of stitches on the forward path of the underlay stitching, the underlay-stitching backward path count unit 507 notifies the motor driver 28 to terminate the underlay stitching and start the main embroidering of the next color. The stitch length of each stitch of the stitching portion in the backward path is the same as the stitch length of the stitching portion of the forward path to travel adjacent to and along the stitching portion in the backward path. Accordingly, setting the number of stitches of the backward path to be the same as the number of stitches of the forward path allows the lengths of the forward path and the backward path to be equal to each other.

[0104] In this example, the current position during the underlay stitching is grasped by counting the number of stitches, and the lengths of the forward path and the backward path are made equal to each other. In some embodiments, for example, the current position may be grasped by progress information of the motor driver 28, and the lengths of the forward path and the backward path may be made equal to each other.

[0105] According to the present embodiment, in a dyeing-and-embroidery system that embroiders while dyeing with a changing color, dyeing data is created so that redundant data with a turn-back marker is inserted by a necessary length at a color change point as necessary. During embroidering, when an underlay stitching reaches the turn-back marker at a midpoint of a redundant dyeing region dyed according to the redundant data, the underlay stitching is turned back regardless of the length of the forward path of the underlay stitching. Thus, the consumption amount of the upper thread can be adjusted by the length-adjusted underlay stitching.

[0106] In the present embodiment, the colorimetric sensor 27 detects that the embroidering position has reached the turn-back marker on the thread. The colorimetric sensor 27 is a thread color detector to detect the thread color and is disposed near the needle 21 of the embroidery head 20 as illustrated in FIG. 7A. As described above, in the present embodiment, since the turn-back signal of the underlay stitching is issued based on the colorimetric sensor 27, the underlay stitching can be accurately completed in the apparatus without the user's confirmation in the process of the embroidery operation.

[0107] A description is given of the operation of adjusting the embroidering position.

[0108] FIG. 10 is a sequence diagram illustrating the inter-device exchange of the dyeing and embroidery process according to an embodiment of the present disclosure.

[0109] When the embroidery image is input in step S101, the embroidery apparatus 2 creates embroidery data (i.e., initial embroidery data) in step S102.

[0110] In step S103, the embroidery image and the embroidery data are transmitted to the dyeing apparatus 1.

[0111] In step S104, the dyeing apparatus 1 creates dyeing data (i.e., initial dyeing data) for dyeing with colors that change at the respective continuous lengths according to the initial embroidery data.

[0112] In step S105, the dyeing apparatus 1 determines whether to insert redundant data at the color change point of the dyeing data based on the color difference before and after the color change point of the dyeing data and the continuation lengths of the colors before and after the color change point of the dyeing data.

[0113] In step S106, if redundant data is necessary, the length of the redundant data to be inserted at the color change point and the color of a turnback marker are set based on the continuous lengths of colors before and after the color change point.

[0114] In step S107, the dyeing apparatus 1 creates dyeing data (edited dyeing data) into which the redundant data with the turn-back marker set in step S106 has been inserted.

[0115] In step S108, the dyeing apparatus 1 transmits the dyeing data including the redundant data and the turn-back marker to the embroidery apparatus 2.

[0116] In step S109, the embroidery apparatus 2 creates the embroidery data including the underlay stitching data (i.e., edited embroidery data).

[0117] In step S110, the embroidery apparatus 2 stores the embroidery start color and the color of the turn-back marker and stores the underlay-stitching start position in the edited embroidery data.

[0118] In step Sill, the needle 21 and the stage 23 of the embroidery apparatus 2 are set at the embroidery start position.

[0119] When the embroidery apparatus 2 notifies the dyeing apparatus 1 that the embroidery preparation has been completed in step S112, the dyeing apparatus 1 starts dyeing and upper thread feeding in step S113.

[0120] When the embroidery start color of the dyed and supplied thread is detected in the embroidery apparatus 2, the embroidery apparatus 2 starts the embroidery operation in step S114.

[0121] Then, in step S115, the embroidery apparatus 2 performs an embroidery control operation. Details of the embroidery control operation will be described below with reference to FIG. 11.

[0122] In step S116, when the edited dyeing data is finished, the dyeing apparatus 1 terminates the dyeing and the upper thread feeding.

[0123] When the edited embroidery data is finished in step S117, the embroidery apparatus 2 terminates the embroidery operation.

[0124] As can be seen from FIG. 10, information is exchanged between the dyeing apparatus 1 and the embroidery apparatus 2 before the start of the dyeing and embroidery operation. After the start of the embroidery operation, however, the control of underlay stitching is completed only with the embroidery apparatus 2. Thus, an embroidery adjusting operation by the underlay stitching according to the present embodiment can be performed without complicating the control during the operation of the dyeing-and-embroidery system 3.

[0125] FIG. 11 including FIGS. 11A and 11B is a detailed flowchart relating to the control during the embroidery operation according to the present embodiment. This flowchart is a detailed flowchart of step S115 in FIG. 10.

[0126] When the embroidery apparatus 2 detects that the embroidery start color of the supplied upper thread has been reached, the embroidery apparatus 2 starts the embroidery operation and starts this operation (step S114 in FIG. 10).

[0127] When the embroidery operation is started, the embroidery apparatus 2 starts a main embroidering operation in which the uppermost surface of the cloth is seen in accordance with the embroidery data in step S501.

[0128] In the embroidery operation, if there is no change in color on the embroidery data in step S502 (NO in step S502), that is, if embroidering is performed to the end with one color, the process proceeds to step S512 without performing the subsequent control steps, and the main embroidering operation is continued until the embroidery data is finished.

[0129] If there is a color change on the embroidery data in step S502 (YES in step S502), the process proceeds to step S503, and the subsequent embroidery operation is performed.

[0130] When the computing mechanism 25 of the embroidery apparatus 2 detects that the current embroidering position (assumed embroidering position) calculated from the number of stitches has reached the color change point in the embroidery data in step S503, the process proceeds to step S504 and the embroidery apparatus 2 determines whether the underlay data has been inserted at the color change position.

[0131] If the embroidery apparatus 2 determines in step S504 that no underlay stitching has been inserted (NO in step S504), the process proceeds to step S511 without performing the subsequent underlay stitching operation. After the main embroidering of the current color is finished, the embroidery apparatus 2 starts the main embroidering of the next color without performing underlay stitching.

[0132] If the embroidery apparatus 2 determines in step S504 that the underlay stitching has been inserted (YES in step S504), the process proceeds to step S505 and the embroidery apparatus 2 performs the underlay stitching operation of the present embodiment.

[0133] In step S505, after the main embroidering based on the embroidery data of the current color is finished, the embroidery apparatus 2 starts the underlay-stitching forward path and starts counting of the number of stitches in the underlay-stitching forward path. When the underlay stitching has been inserted, the embroidery apparatus 2 starts the underlay stitching operation in the step S505 at the timing when the embroidering position calculated from the number of stitches and assumed on the embroidery data reaches the color change point of the embroidery data based on the number of stitches of step S505. Accordingly, when there is no deviation in the consumption of the thread, the embroidery apparatus 2 starts the underlay-stitching forward path at the timing when the embroidery reaches the redundant dyeing region. When the thread consumption is slow, the embroidery apparatus 2 starts the underlay-stitching forward path even if the embroidery does not reach the redundant dyeing region. When the thread consumption is fast, the embroidery apparatus 2 starts the underlay-stitching forward path after the embroidery reaches the redundant dyeing region.

[0134] When the colorimetric sensor 27 detects the turn-back marker in step S506, the embroidery apparatus 2 finishes the underlay-stitching forward path in step S507 and sews the course adjustment stitch that is the turn-back point. The embroidery apparatus 2 also terminates the counting of the number of stitches of the underlay-stitching forward path and stores the counted number of forward path stitches.

[0135] When there is no deviation in the consumption amount of thread, the embroidery distance of the forward path of the underlay stitching has the same length as the length of the redundant dyeing region of the forward path in FIG. 9B. The number of stitches of the underlay-stitching forward path is equal to the number of stitches as assumed by the created underlay stitching data.

[0136] Further, when the consumption amount of thread is slow, the embroidery distance of the forward path of the underlay stitching is longer than the redundant dyeing region of the forward path. The number of stitches of the forward path is larger than the number of stitches assumed in the underlay stitching data.

[0137] On the other hand, when the consumption amount of thread is fast, the embroidery distance of the forward path of the underlay stitching is shorter than the redundant dyeing region of the forward path. The number of stitches of the forward path is smaller than the number of stitches assumed in the underlay stitching data.

[0138] When one course adjustment stitch is sewn, in step S508, the embroidery apparatus 2 turns back from the forward path of the underlay stitching, starts the backward path of underlay stitching to trace back the same route as the route of the forward path of underlay stitching, and starts counting of the number of stitches of the backward path of the underlay stitching. When a stitching portion in the underlay-stitching backward path is formed to follow the route of the underlay-stitching forward path, the stitch length of each stitch in the stitching portion in the underlay-stitching backward path is set to be the same as the stitch length of a stitching portion of the forward path traveling adjacent to and parallel to the backward path. In the underlay-stitching backward path, the stitch length of each stitch is formed in the reverse order of the forward path, and the embroidery is performed so as to return to the underlay-stitching start point by the same distance as the forward path.

[0139] When the counted number of stitches in the backward path of the underlay stitching reaches the stored number of stitches in the forward path in step S509, the embroidery apparatus 2 determines that the underlay stitching has returned to the start position, terminates the underlay stitching in step S510, and starts the main embroidering of the next color.

[0140] In this way, the backward path can be sewn with the same number of stitches as the number of stitches of the forward path of stitches. Thus, since the embroidery is performed so as to reciprocate once in the underlay stitching, the needle returns to the color change point that is the start point of the underlay stitching.

[0141] When there is no deviation in the thread consumption amount, the total embroidery distance of the underlay embroidery is the same length as length of the redundant dyeing region of FIG. 9B, the number of stitches required for the underlay stitching is equal to the number of stitches assumed by the prepared underlay data. The main embroidering of the next color is started from the position at which the backward-path redundant region ends and the next color dyed according to the initial dyeing data starts.

[0142] When the consumption amount of thread is small and the stitching is later than scheduled, the total embroidery distance of the underlay-stitching embroidery is longer than the length of the redundant dyeing region, and the main embroidering of the next color is started slightly later than the start position of the next color dyed according to the initial dyeing data after the end of the backward-path redundant region. Thus, the consumption of the upper thread, which tends to be delayed, is increased in advance at the start time point of the next color, so that the adjustment distance at the next color change point can be shortened.

[0143] When the consumption amount of thread is large and the embroidering is performed earlier than scheduled, the total embroidery distance of the underlay-stitching embroidery is shorter than the length of the redundant dyeing region, and the main embroidering of the next color is started earlier than the start position of the next color dyed according to the initial dyeing data before the end of the backward-path redundant region.

[0144] In step S511, the embroidery apparatus 2 determines whether there is a change in color (or underlay-stitching data) in the subsequent embroidery data. In a certain case, the process returns to before the S503, performs the step S503 to the step S511 in the same manner as in the current underlay stitching period, performs the underlay stitching operation using the turn-back point, and repeats this loop of reflecting the underlay stitching operation. If the color change point is not reached, the embroidery operation is continued until the embroidering is finished in step S513.

Example of Consumption Amount Adjustment by Underlay Stitching

[0145] Next, with reference to schematic diagrams of FIGS. 12 to 14, a description is given of an effect of the underlay stitching using the dyeing region (redundant dyeing region) according to the redundant data and the turn-back marker.

[0146] FIG. 12 is a diagram illustrating an example of the length of underlay stitching in the embroidery control operation according to an embodiment of the present disclosure. Part (a) of FIG. 12 illustrates a case where there is no deviation in the embroidering position. Part (b) of FIG. 12 illustrates a case where the assumed thread consumption is less than the actual thread consumption. Part (c) of FIG. 12 illustrates a case where the assumed thread consumption is greater than the actual thread consumption.

[0147] First, as illustrated in part (a) of FIG. 12, when there is no deviation in the embroidering position, that is, when the assumed thread consumption amount is equal to the actual thread consumption amount, the timing at which the embroidering position calculated from the number of stitches reaches the color change point E on the embroidery data, which is the timing at which the underlay stitching is started, is the same timing as the timing ts at which the embroidering position reaches the redundant dyeing region from the dyeing region according to the upper thread dyeing data.

[0148] When the colorimetric sensor 27 detects the turn-back marker, the underlay-stitching forward path is ended and the course adjustment stitch, which is the turn-back point, is sewn. The counting of stitches on the forward path of the underlay stitching is ended, and the counted number of stitches on the forward path is stored. In part (a) of FIG. 12, the embroidery distance ED of the underlay-stitching forward path is the same length as the forward-path redundant dyeing region BD (ED = BD), and the number of forward-path stitches is equal to the number of stitches assumed from the underlay stitching data.

[0149] The stitch at the point D where the turn-back marker is detected at the needle drop position is sewn as a course adjustment stitch by one stitch at a position where the direction is bent in order to turn back from the underlay-stitching forward path.

[0150] After the course adjustment stitch, the underlay-stitching backward path is started, and the counting of stitches on the underlay-stitching backward path is started. When the counted number of stitches on the backward path of the underlay stitching reaches the stored number of stitches on the forward path, the underlay stitching is ended, and the main embroidering of the next color is started. In this way, the backward path having the same number of stitches as the number of stitches of the forward path is sewn, and the underlay stitching on the backward path is performed with a thread of the next color by the same distance as the forward path of the underlay stitching with the thread of the current color with the turn-back marker as a boundary (BD = DB').

[0151] Further, in this example, the timing at which the embroidering position reaches the underlay-stitching end point E' on the embroidery data is the same timing as the timing te at which the embroidering position reaches the redundant dyeing region of the upper thread. Accordingly, since the embroidery distance DE' of the forward path of the underlay stitching has the same length as the length of the forward-path redundant dyeing region DB' (DE' = DB'), the distance of the underlay stitching in part (a) of FIG. 12, that is, the upper thread consumption amount by the underlay stitching is equal to the length of the redundant dyeing region (EE' = BB').

[0152] As illustrated in part (b) of FIG. 12, when the assumed thread consumption amount is smaller than the actual thread consumption amount, the embroidering position calculated from the number of stitches reaches the color change point (estimated color change point) E on the embroidery data before the timing ts at which the actual embroidering position reaches a tip B of the redundant dyeing region of the upper thread. That is, the redundant dyeing region on the actual thread arrives later than expected.

[0153] The color change is started from the assumed color change point E before the tip B of the actual redundant dyeing region and the forward path of the underlay stitching is sewn until the colorimetric sensor 27 detects the turn-back marker. Accordingly, the embroidery distance ED of the forward path of the underlay stitching of the present example is larger in the consumption amount of the upper thread than the forward-path redundant dyeing region BD by the embroidery length corresponding to the distance from the position E to the position B.

[0154] After the course adjustment stitch at the turning-marker detection point D, the underlay stitching of the backward path is performed by the same distance as the distance of the forward path. Accordingly, in this example, the timing at which the embroidering position calculated from the number of stitches reaches the underlay-stitching end point E' on the embroidery data is later than the timing te at which the actual embroidering position reaches the dyeing region corresponding to the dyeing data of the next color after the end of the redundant dyeing region of the upper thread. Thus, in part (b) of FIG. 12, the upper thread consumption amount by the underlay stitching is longer than the length BB' of the redundant dyeing region by the embroidery length corresponding to the distance from the position E to the position B and the embroidery length corresponding to the distance from the position B' to the position E'.

[0155] Therefore, since the length corresponding to the distance from the position E' to the position B' of the next main embroidering has already been consumed at the time when the underlay stitching is finished, the thread consumption amount corresponding to the consumed length is subtracted from the thread consumption amount consumed in the continuous length of the next color. Thus, the consumption of the upper thread can be adjusted to eliminate or reduce the delay in the next color change.

[0156] Alternatively, as illustrated in part (c) of FIG. 12, when the assumed thread consumption amount is greater than the actual thread consumption amount, the embroidering position calculated from the number of stitches reaches the color change point (assumed color change point) E on the embroidery data after the timing ts at which the actual embroidering position reaches the tip B of the redundant dyeing region of the upper thread. That is, the redundant dyeing region on the actual thread arrives earlier than expected.

[0157] The color change is started from the assumed color change time point E after the tip B of the actual redundant dyeing region and the forward path of the underlay stitching is sewn until the colorimetric sensor 27 detects the turn-back marker. Accordingly, the embroidery distance ED of the forward path of the underlay stitching of the present example is smaller in the consumption amount of the upper thread than the forward-path redundant dyeing region BD by the embroidery length corresponding to the distance from the position B to the position E.

[0158] After the course adjustment stitch at the turning-marker detection point D, the underlay stitching of the backward path is performed by the same distance as the distance of the forward path. Therefore, in this example, the timing at which the embroidering position calculated from the number of stitches reaches the underlay stitching end point E' on the embroidery data is earlier than the timing te at which the actual embroidering position reaches the dyeing region corresponding to the dyeing data of the next color after the end of the redundant dyeing region of the upper thread. Thus, in part (c) of FIG. 12, the upper thread consumption amount by the underlay stitching is shorter than the length BB' of the redundant dyeing region by the embroidery length corresponding to the distance from the position B to the position E and the embroidery length corresponding to the distance from the position E' to the position B'.

[0159] Therefore, since the redundant dyeing region of the length corresponding to the distance from the position E' to the position B' has not yet been consumed at the time point when the underlay stitching is finished, the thread consumption amount corresponding to the unconsumed amount is added to the thread consumption amount consumed in the continuation length of the next color. Thus, the consumption of the upper thread can be adjusted to eliminate or reduce the advance amount in the color change in the next color.

[0160] Such underlay stitching control allows the vicinity of the terminal end of the dyeing region of the current color in the upper thread to be reliably consumed before the dyeing region of the next color starts. Adjusting the thread length at the vicinity of the dying region of the next color allows he consumption amount to be adjusted to avoid the positional deviation at the next color change point. Such a configuration can avoid the positional deviation of the color of the embroidery on the cloth and prevent the accumulation of the deviation of the thread consumption amount. Thus, the exposure of the color change portion of the upper thread to the embroidery surface can be prevented, and the collapse of an image of the embroidery pattern on the cloth can be prevented.

[0161] Here, the lengths of the first half and the second half in the redundant dyeing region corresponding to the underlay stitching for folding back are equal. Accordingly, the adjustment of the consumption amount of the upper thread according to the present embodiment is more effective as the length AB of the dyeing region of the current color is closer to the length B'C of the dyeing region of the next color.

[0162] FIG. 13 is a diagram illustrating an example of an embroidery pattern on which the embroidery control operation of the present embodiment is performed in a case where the actual consumption amount of the upper thread is smaller than expected. Here, as one example, a description is given of the case in which the color of the thread currently being embroidered is blue, and the color of the thread to be embroidered next after the color change is red.

[0163] Part (a) of FIG. 13 is a diagram illustrating an embroidery image to be embroidered. Part (b) of FIG. 13 is a diagram illustrating a state of the embroidery image when actual main embroidering of a current blue thread is finished. Part (c) of FIG. 13 is a diagram illustrating a state of the embroidery image at a turn-back point of underlay stitching. Part (d) of FIG. 13 is a diagram illustrating a state of the embroidery image when the underlay stitching is finished. Part (e) of FIG. 13 is a diagram illustrating a state of the embroidery image after the start of main embroidering of the next red thread.

[0164] Time points t1, t2, r3, and t4 in part (c) of FIG. 13 correspond to time points t1, t2, r3, and t4 in part (b) of FIG. 12.

[0165] At the end of the main embroidering of the current blue thread of the t1 illustrated in part (b) of FIG. 13, the consumption amount of the blue thread of the upper thread dyed according to the dyeing date is small, and the upper thread remains. Consequently, if the main embroidering is continued as it is, the tip of the next red embroidering region is sewn with the blue thread.

[0166] For this reason, under the embroidery region (planned embroidery region) of the red thread, the underlay stitching is started, and the underlay stitching on the forward path is performed with the blue thread up to the turn-back marker. In this case, the blue thread dyed according to the dyeing data and the blue thread dyed according to the redundant data are used to perform underlay stitching on the forward path with the blue thread, which is the current thread color.

[0167] As illustrated in part (c) of FIG. 13, when the underlay stitching reaches the turn-back marker at the time point t2, a course adjustment stitch is sewn by one stitch. The underlay stitching is turned back, and the backward path of the underlay stitch is started.

[0168] Then, from the turn-back marker, the underlay stitching of the backward path is performed with the red thread by the same distance as the blue thread. At this time, the red thread dyed according to the redundant data and the red thread dyed according to the dyeing data are used to perform the underlay stitching of the backward path with the red thread to be the next thread color.

[0169] As illustrated in part (d) of FIG. 13, when the underlay stitching reaches the original position at the tome point t3, that is, when the number of stitches on the backward path becomes equal to the number of forward stitches, the main embroidering is performed with red, which is the next thread color. In the underlay-stitching backward path, as illustrated in part (d) of FIG. 13, the needle is moved along the stitched portion of the forward path until the needle returns to the underlay-stitching start position so that the route of the backward path becomes the same as the route of the forward path and the order of the stitch length of each stitch on the backward path becomes reverse to the order of the stitch length of each stitch on the forward path. As a result, the lengths of the forward path and the backward path of the underlay stitching are equal to each other, and the consumption amounts of the blue thread and the red thread in the underlay stitching are equal to each other. Accordingly, in the present example, the underlay stitching is performed using the dyeing region according to the redundant data and the dyeing region according to the dyeing data. Thus, at the time point t3 of this example, as illustrated in part (d) of FIG. 13, the main embroidering is started in a state in which the red thread for the main embroidering has been consumed to some extent in the underlay stitching.

[0170] Then, as illustrated in part (e) of FIG. 13, the main embroidering of the next color is continued while using the dyeing region according to the dyeing data that has been consumed and shortened in the underlay stitching for the main embroidering.

[0171] In this example, since the upper thread is excessively consumed in the underlay stitching and the deviation amount is absorbed, the deviation of the thread consumption amount at the end point is reduced. Even when the main embroidering and the underlay stitching at the color change point are repeated thereafter, repeating the underlay stitching in the same manner allows the consumption amount to be adjusted to the end.

[0172] FIG. 14 is a diagram illustrating an example of an embroidery pattern in which the embroidery control operation of the present embodiment is performed in a case where the actual consumption amount of the upper thread is greater than expected.

[0173] Part (a) of FIG. 14 is a diagram illustrating an embroidery image to be embroidered. Part (b) of FIG. 14 is a diagram illustrating a state of the embroidery image at the end of main embroidering of blue thread predicted from the number of stitches. Part (c) of FIG. 14 is a diagram illustrating a state of the embroidery image at a turn-back point of underlay stitching. Part (d) of FIG. 14 is a diagram illustrating a state of the embroidery image when the underlay stitching is finished. Part (e) of FIG. 14 is a diagram illustrating a state of the embroidery image after the start of main embroidering of the next red thread.

[0174] A time point corresponding to B in FIG. 14 indicates a state slightly before the time point t1 in part (c) of FIG. 12, and time points t2, t3, and t4 in FIG. 14 correspond to the time points t2, t3, and t4 in part (c) of FIG. 12.

[0175] At the time point of the start position B of the redundant dyeing region in part (b) of FIG. 14, the consumption amount of the blue thread of the upper thread dyed according to the dyeing data is large. If there is no underlay stitching, the terminal end of the blue embroidery region would be sewn with the next red thread.

[0176] Therefore, underlay stitching is started, and forward-path underlay stitching is performed with the blue thread up to the turn-back marker. In this case, the blue thread dyed according to the redundant data is used to perform underlay stitching of the forward path with the blue thread, which is the current thread color.

[0177] As illustrated in part (c) of FIG. 14, when the underlay stitching reaches the turn-back marker at the time point t2, a course adjustment stitch is sewn by one stitch. The underlay stitching is turned back, and the backward path of the underlay stitch is started.

[0178] Then, from the turn-back marker, the underlay stitching of the backward path is performed with the red thread by the same distance as the blue thread. At this time, the red thread dyed according to the redundant data is used to perform the underlay stitching of the backward path with the red thread to be the next thread color.

[0179] As illustrated in part (d) of FIG. 14, when the underlay stitching reaches the original position at the tome point t3, that is, when the number of stitches on the backward path becomes equal to the number of forward stitches, the main embroidering is performed with red, which is the next thread color. In the underlay-stitching backward path, as illustrated in part (d) of FIG. 14, the needle is moved along the stitched portion of the forward path until the needle returns to the underlay-stitching start point so that the route of the backward path becomes the same as the route of the forward path and the order of the stitch length of each stitch on the backward path becomes reverse to the order of the stitch length of each stitch on the forward path. As a result, the lengths of the forward path and the backward path of the underlay stitching are equal to each other, and the consumption amounts of the blue thread and the red thread in the underlay stitching are equal to each other. Accordingly, in the present example, the underlay stitching is performed using only the dyeing region according to the redundant data.

[0180] Then, as illustrated in part (e) of FIG. 14, the main embroidering of the next color is continued while also using the dyeing region according to the redundant data. In this example, before reaching the red thread dyed according to the dyeing data, the main embroidering of the red embroidery region is started using the red thread dyed according to the redundant data for underlay stitching.

[0181] In this example, since the upper thread is less consumed in the underlay stitching and the deviation amount is absorbed, the deviation of the thread consumption amount at the end point is reduced. Even when the main embroidering and the underlay stitching at the color change point are repeated thereafter, repeating the underlay stitching in the same manner allows the consumption amount to be adjusted to the end.

[0182] In this way, according to the present embodiment, at the underneath of the next stitching portion (embroidery region), which does not appear in the embroidery design, the underlay stitching is performed to reciprocate once based on the inserted turn-back point. Thus, the deviation between the calculated thread consumption amount and the actual thread consumption amount can be adjusted, and the embroidery color shift can be adjusted. As a result, in the textile-printing-and-embroidery system that performs embroidering while dyeing such that the color changes, the embroidering position in the current color change can be adjusted. The textile-printing-and-embroidery system adjustment can also perform adjustment to prevent the deviation of the embroidering position at the next and subsequent color change points.

Modification

[0183] FIG. 15 is a diagram illustrating an embroidery apparatus according to a modification of the first embodiment of the present disclosure.

[0184] In the above description, the example in which the turn-back marker of the underlay stitching is detected by the colorimetric sensor has been described. However, any turn-back marker of the underlay stitching may be selected by the user.

[0185] In this modification, when the user visually detects that a turn-back marker has reached a needle drop position, the user operates, for example, a button 201 illustrated in FIG. 15 to issue a turn-back signal for the underlay stitching.

[0186] In this modification, the operator visually detects that the embroidering position has reached the turn-back marker. Thus, without adding a colorimetric sensor, an embroidery apparatus 2A according to this modification can adjust the consumption amount of the upper thread by the underlay-stitching adjustment according to an embodiment of the present disclosure.

Second Embodiment

[0187] FIG. 16 is a schematic side view of a dyeing-and-embroidery system (textile-printing-and-embroidery system) according to a second embodiment of the present disclosure. In the present embodiment, a host control apparatus 4, which is a higher-level apparatus, is connected to a dyeing-and-embroidery system 3B. The host control apparatus 4 is an information processing apparatus such as a computer.

[0188] FIG. 17 including FIGS. 17A and 17B is a functional block diagram of components related to control of the host control device 4, the dyeing apparatus 1B, and the embroidery apparatus 2B according to a second embodiment of the present disclosure. Descriptions of components similar to those in FIG. 8 are omitted below.

[0189] In the present embodiment, the functions of the dyeing data processor of the dyeing apparatus 1 and the embroidery data processor of the embroidery apparatus 2 illustrated in FIG. 8 are implemented by the host control apparatus 4.

[0190] The host control device 4 includes an input device 410, a dyeing data processor 420, and an embroidery data processor 430.

[0191] The input device 410 includes an embroidery-image input unit 411 and, if necessary, an underlay-stitching-amount selection unit 412. In the above example, the presence or absence of the insertion of the redundant data and the length of the redundant data are determined by the dyeing data processor. However, the presence or absence the length, and the like of the amount of underlay stitching may be externally selected by an instruction from the user.

[0192] The dyeing data processor 420 includes an initial-dyeing-data creation unit 421, a redundant-data presence determination unit 422, a color-difference threshold-value storage unit 423, a continuous-length threshold storage unit 424, a redundant-data-and-turn-back-marker setting unit 425, and a redundant-data-and-turn-back-marker-contained dyeing-data creation unit 426 in an executable manner.

[0193] The embroidery data processor 430 includes an initial-embroidery-data creation unit 431, an underlay-stitching-data creation unit 432, and an underlay-stitching-data insertion unit 433.

[0194] Since the host control device 4 includes a dyeing data processor related to dyeing and an embroidery data processor related to embroidery in the same device, a communication unit and an acquisition unit for exchanging data are not necessary.

[0195] In the dyeing-and-embroidery system having such a configuration, prior to the start of the embroidery operation, the host control device 4 transmits the dyeing data to the dyeing apparatus 1B, and transmits the embroidering data to the embroidery apparatus 2B. After the start of the embroidery operation, the dyeing apparatus 1B and the embroidery apparatus 2B independently perform their operations.

[0196] Also in this system, a redundant marker with a turn-back marker is inserted as necessary in the dyeing data based on the embroidery data. When the underlay-stitching data is present at the color change point on the embroidery data, the underlay stitching is started from the assumed embroidering position and is turned back at the turn-back marker on the thread to move back and forth once. Thus, the underlay stitching operation is performed such that the length of the underlay stitching is adjusted to absorb the deviation amount between the assumed embroidering position and the actual embroidering position. As a result, even if the actual thread consumption amount deviates from the assumed amount during the embroidery operation using the continuous thread whose color changes, the positional deviation of the color of the embroidery on the cloth at the current color change point can be avoided. The accumulation of the deviation of the thread consumption amount at the next and subsequent color change points can also prevented. Accordingly, the above-described system can prevent the exposure of the color change portion of the upper thread to the embroidery surface and the deformation of the embroidery pattern on the cloth.

Third Embodiment

[0197] FIG. 18 is a schematic side view of a dyeing-and-embroidery apparatus according to a third embodiment of the present disclosure.

[0198] The dyeing-and-embroidery apparatus (textile-printing-and-embroidery apparatus) 5 according to the present embodiment is an in-line integrated apparatus including a dyeing unit 51, an embroidery unit 52, and a computing mechanism 53 in one housing.

[0199] In the present embodiment, since the dyeing unit 51 and the embroidery unit 52 are provided in the same apparatus, the functions of the computing mechanism 108 illustrated in FIG. 4 and the computing mechanism 25 illustrated in FIG. 8 can be integrated into one computing mechanism 53.

[0200] Also in the dyeing-and-embroidery apparatus 5, the underlay stitching is started from the assumed embroidering position and turned back by a turn-back marker on a thread, and moved back and forth once. Thus, the underlay stitching operation is performed such that the length of the underlay stitching is adjusted to absorb the deviation amount between the assumed embroidering position and the actual embroidering position. As a result, even if the actual thread consumption amount deviates from the assumed amount during the embroidery operation using the continuous thread whose color changes, the positional deviation of the color of the embroidery on the cloth at the current color change point can be avoided. The accumulation of the deviation of the thread consumption amount at the next and subsequent color change points can also prevented. Accordingly, the above-described system can prevent the exposure of the color change portion of the upper thread to the embroidery surface and the deformation of the embroidery pattern on the cloth.

[0201] Although some embodiments and examples of the present disclosure have been described above, embodiments of the present disclosure are not limited to the above-described embodiments and examples. Embodiments of the present disclosure can be variously modified or changed in light of the appended claims.

Claims

1. A textile-printing-and-embroidery system (3), comprising:

a textile printing apparatus (1) configured to print a thread;
an embroidery apparatus (2) including a needle (12) to embroider a cloth, based on embroidery data, with the thread fed from the textile printing apparatus (1);
a dyeing data processor (107) configured to create initial dyeing data for realizing a color of a thread of the embroidery data, and insert redundant data to which a turn-back marker serving as a mark on the thread is attached, as necessary, at a color change point at which a color to be dyed changes in the initial dyeing data; and
an embroidery data processor (24) configured to insert underlay stitching data for stitching a portion below an embroidery region of a sched-

uled next color, at a color change point on the embroidery data that is a position at which the redundant data is inserted on the dyeing data, such that the underlay stitching data is longer than the redundant data,

the textile printing apparatus (1) including a dyeing device (103) configured to print the thread based on the dyeing data including the redundant data to which the turn-back marker is attached,

the embroidery apparatus (2) including an underlay stitching controller (25) configured to perform an underlay stitching operation for length adjustment such that underlay stitching is started at a timing at which an assumed embroidering position on the embroidery data calculated from a number of stitches indicating how many times the needle is sewn reaches the color change point on the embroidery data, regardless of an actual embroidering position on the thread, and is turned back at the turn-back marker to move back and forth once, to consume a deviation between the assumed embroidering position and the actual embroidering position.

2. The textile-printing-and-embroidery system according to claim 1,
wherein in a case where an actual consumption amount of the thread is smaller than an assumed consumption amount of the thread and the timing at which the assumed embroidering position calculated from the number of stitches reaches the color change point on the embroidery data is before the actual embroidering position reaches a redundant dyeing region dyed according to the redundant data on the thread, the embroidery data processor (24) is configured to:

start the underlay stitching at the timing at which the assumed embroidering position reaches the color change point on the embroidery data;

stop the underlay stitching on a forward path of the underlay stitching in response to an arrival of the turn-back marker at a position of the needle; and

turn back the underlay stitching to move back and forth once, such that a distance of the underlay stitching is longer than the redundant dyeing region.

3. The textile-printing-and-embroidery system according to claim 1,
wherein in a case where an actual consumption amount of the thread is larger than an assumed consumption amount of the thread and the timing at which the assumed embroidering position reaches the color change point on the embroidery data is after the actual embroidering position reaches a redundant dyeing region dyed according to the redundant data on the thread, the embroidery data processor (24) is configured to:

start the underlay stitching at the timing at which the assumed embroidering position reaches the color change point on the embroidery data;

stop the underlay stitching on a forward path of the underlay stitching in response to an arrival of the turn-back marker at a position of the needle; and

turn back the underlay stitching to move back and forth once, such that a distance of the underlay stitching is shorter than the redundant dyeing region.

4. The textile-printing-and-embroidery system according to any one of claims 2 and 3,
wherein the embroidery apparatus (2) includes:

a forward path counter (505) configured to count, as an underlay-stitching forward path, a number of stitches from the timing at which the assumed embroidering position reaches the color change point on the embroidery data to a timing at which the turn-back marker on the thread reaches the position of the needle; and

a backward path counter (507) configured to count, as an underlay-stitching backward path, a number of stitches after the turn-back marker on the thread reaches the position of the needle,

wherein the embroidery apparatus (2) is configured to form a stitching portion in the underlay-stitching backward path to follow a route of the underlay-stitching forward path, and a stitch length of each stitch of the stitching portion in the underlay-stitching backward path is set to be same as a stitch length of another stitching portion of the underlay-stitching forward path to travel adjacent to and along the stitching portion in the underlay-stitching backward path, and

wherein the underlay stitching controller (25) is configured to:

end the underlay stitching operation when the number of stitches counted by the backward path counter (507) reaches a same number of stitches as the number of stitches of the underlay-stitching forward path; and

perform main embroidering to form an embroidery pattern on the cloth in a next color.

5. The textile-printing-and-embroidery system according to any one of claims 2 to 4,
wherein the embroidery apparatus (2) includes a thread color detector (27) configured to detect a color of the thread to detect that the turn-back marker on the thread has reached the position of the needle.

6. The textile-printing-and-embroidery system according to claim 2, 3 or 4, further comprising an input device (410) configured to allow a user to input detection information based on a detection that the turn-back marker on the thread has reached the position of the needle.

7. The textile-printing-and-embroidery system according to any one of claims 1 to 6, wherein the redundant data includes:

prior to the turn-back marker, a region of a same color as a first color preceding the color change point on the dyeing data; and
subsequent to the turn-back marker, a region of a same color as a second color after the color change point, and
wherein the turn-back marker is set to a color different from both the first color and the second color adjacent to each other at the color change point on the dyeing data.

8. The textile-printing-and-embroidery system according to any one of claims 1 to 7, wherein the dyeing data processor (107) is configured to determine whether to insert the redundant data at the color change point on the dyeing data, based on a color difference between two adjacent colors at the color change point on the dyeing data.

9. The textile-printing-and-embroidery system according to any one of claims 1 to 8, wherein the dyeing data processor (107) is configured to determine whether to insert the redundant data at the color change point on the dyeing data, based on a continuous length of each of two adjacent colors at the color change point on the dyeing data.

10. The textile-printing-and-embroidery system according to claim 9, wherein the dyeing data processor is configured to set a length of the redundant data to be inserted, based on a continuous length of each of two adjacent colors at the color change point on the dyeing data.

11. The textile-printing-and-embroidery system according to any one of claims 1 to 10, wherein the dyeing data processor and the embroidery data processor are mounted on a host control device that can be connected to the textile printing apparatus, the embroidery apparatus, or the textile-printing-and-embroidery system.

12. A textile-printing-and-embroidery apparatus (5), comprising:

a textile printing unit (51) configured to print a thread;
an embroidery unit (52) including a needle (12) to embroider a cloth, based on embroidery data, with the thread fed from the textile printing unit (51);
a dyeing data processor (107) configured to create initial dyeing data for realizing a color of a thread of the embroidery data, and insert redundant data to which a turn-back marker serving as a mark on the thread is attached, as necessary, at a color change point at which a color to be dyed changes in the initial dyeing data;
an embroidery data processor (24) configured to insert underlay stitching data for stitching a portion below an embroidery region of a scheduled next color, at a color change point on the embroidery data that is a position at which the redundant data is inserted on the dyeing data, such that the underlay stitching data is longer than the redundant data;
a dyeing device (103) configured to print the thread based on the dyeing data including the redundant data to which the turn-back marker is attached: and
an underlay stitching controller (25) configured to perform an underlay stitching operation for length adjustment such that underlay stitching is started at a timing at which an assumed embroidering position on the embroidery data calculated from a number of stitches indicating how many times the needle is sewn reaches the color change point on the embroidery data, regardless of an actual embroidering position on the thread, and is turned back at the turn-back marker to move back and forth once, to consume a deviation between the assumed embroidering position and the actual embroidering position.

13. An embroidery adjustment method for a textile-printing-and-embroidery system including a textile printing device and an embroidery apparatus, the method comprising:

creating initial dyeing data for realizing a color of a thread of embroidery data and inserting redundant data to which a turn-back marker serving as a mark on the thread is attached, as necessary, at a color change point at which a color to be dyed changes in the initial dyeing data;
inserting underlay stitching data for stitching a portion below an embroidery region of a scheduled next color, at a color change point on the embroidery data that is a position at which the redundant data is inserted on the dyeing data, such that the underlay stitching data is longer than the redundant data;
printing the thread based on the dyeing data including the redundant data to which the turn-back marker is attached; and

performing an underlay stitching operation for length adjustment such that underlay stitching is started at a timing at which an assumed embroidering position on the embroidery data calculated from a number of stitches indicating how many times the needle is sewn reaches the color change point on the embroidery data, regardless of an actual embroidering position on the thread, and is turned back at the turn-back marker to move back and forth once, to consume a deviation between the assumed embroidering position and the actual embroidering position.

FIG. 1

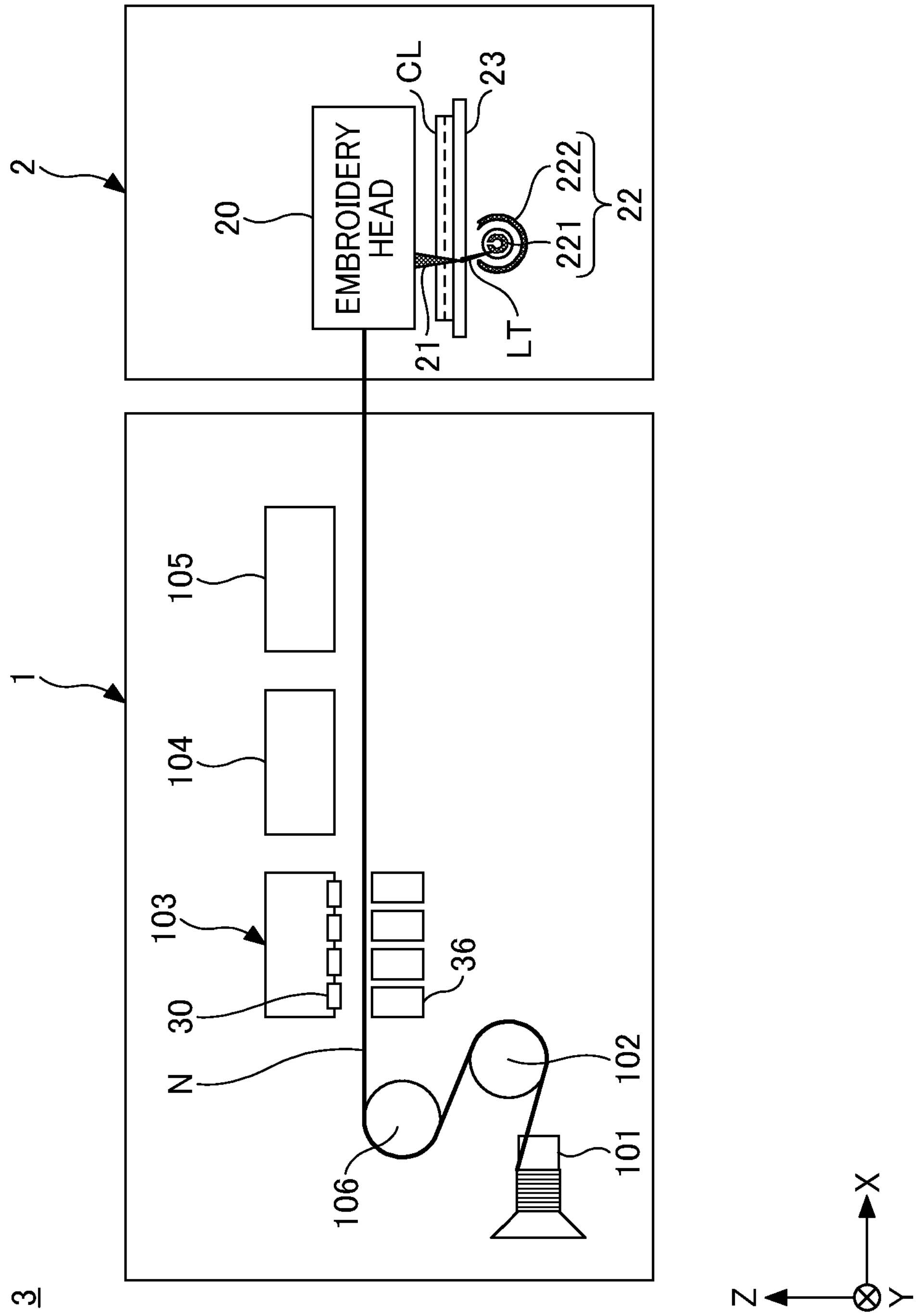

3
1
2
EMBROIDERY HEAD
20
21
22
221
222
23
CL
LT
103
104
105
30
36
N
101
102
106
X
Y
Z

FIG. 2

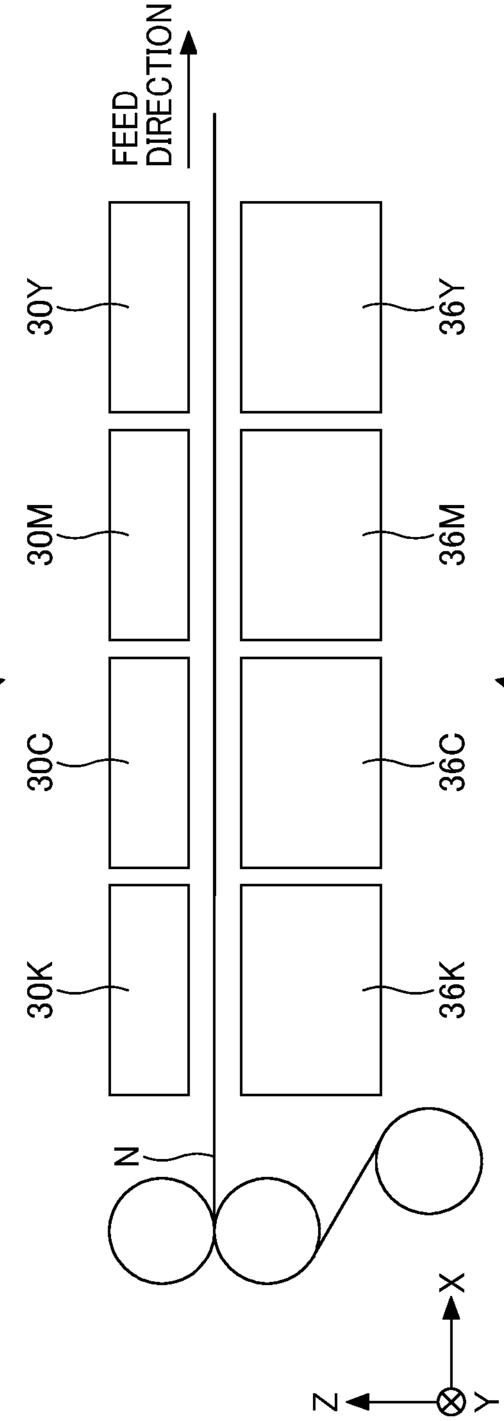
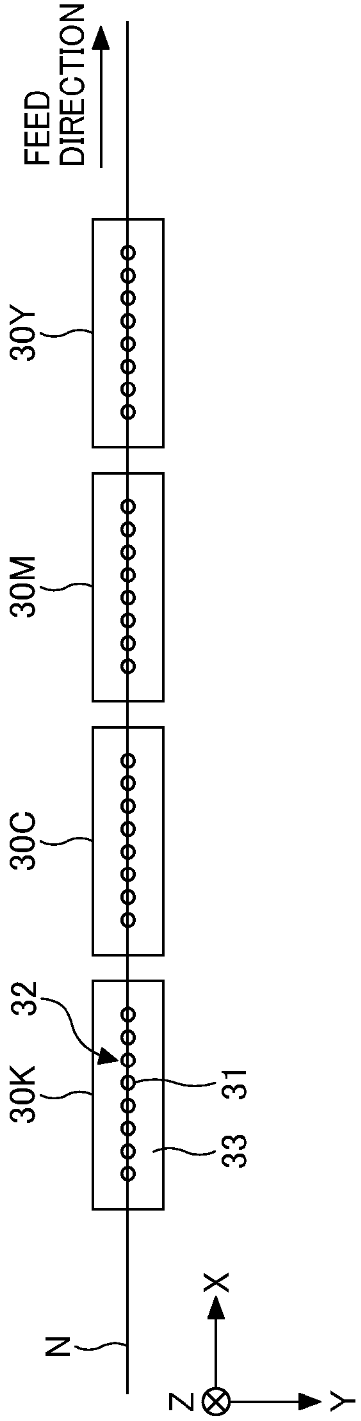

103
30K
30C
30M
30Y
FEED DIRECTION
N
36K
36C
36M
36Y
35
X
Y
Z

FIG. 3


30K
32
31
33
30C
30M
30Y
FEED DIRECTION
N
X
Y
Z

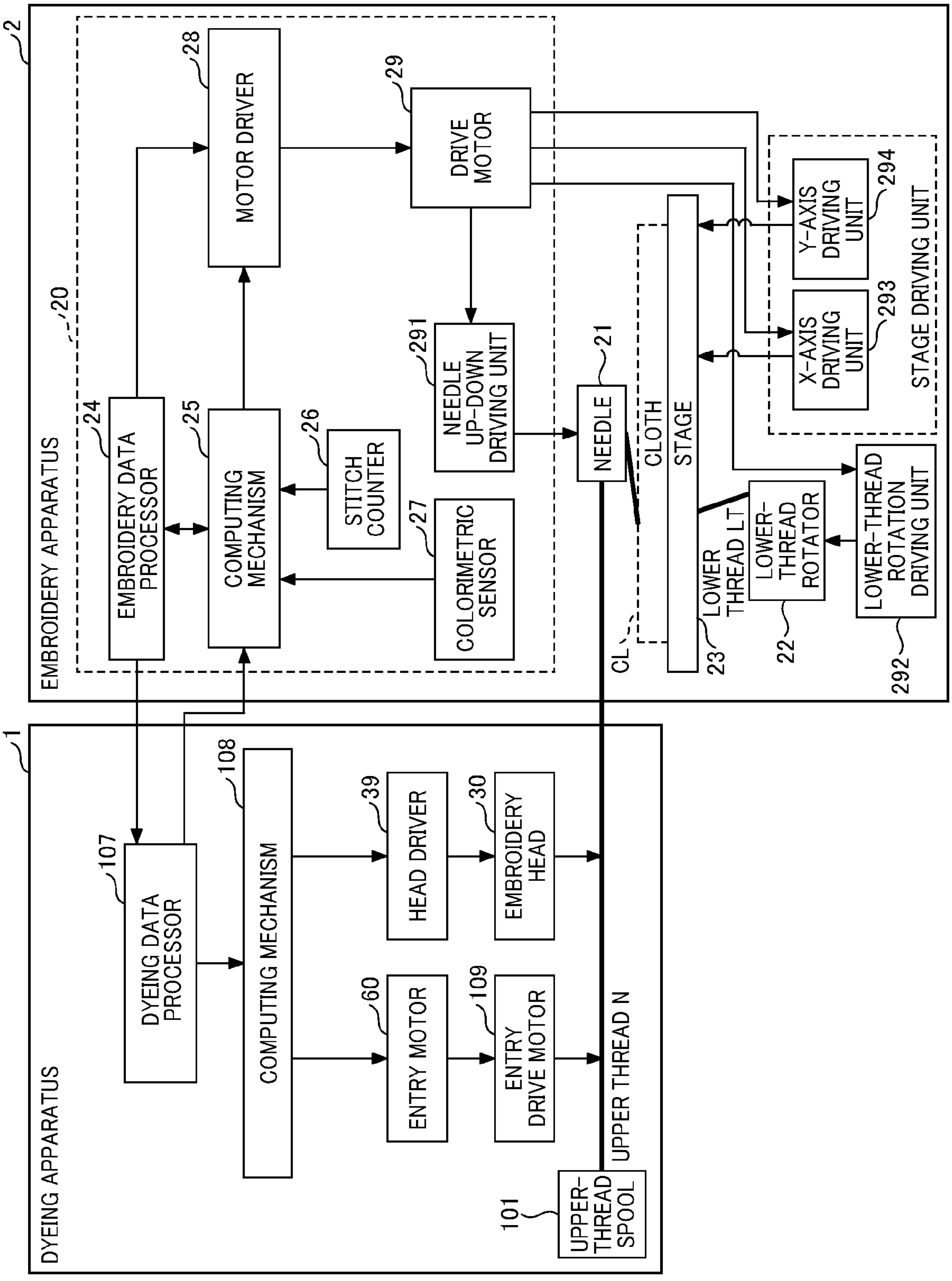

2
EMBROIDERY APPARATUS
20
24
EMBROIDERY DATA PROCESSOR
25
COMPUTING MECHANISM
26
STITCH COUNTER
27
COLORIMETRIC SENSOR
28
MOTOR DRIVER
29
DRIVE MOTOR
291
NEEDLE UP-DOWN DRIVING UNIT
21
NEEDLE
CLOTH
CL
STAGE
23
LOWER THREAD LT
22
LOWER-THREAD ROTATOR
292
LOWER-THREAD ROTATION DRIVING UNIT
293
X-AXIS DRIVING UNIT
294
Y-AXIS DRIVING UNIT
STAGE DRIVING UNIT
1
DYEING APPARATUS
107
DYEING DATA PROCESSOR
108
COMPUTING MECHANISM
39
HEAD DRIVER
30
EMBROIDERY HEAD
60
ENTRY MOTOR
109
ENTRY DRIVE MOTOR
101
UPPER-THREAD SPOOL
UPPER THREAD N

FIG. 4

FIG. 5

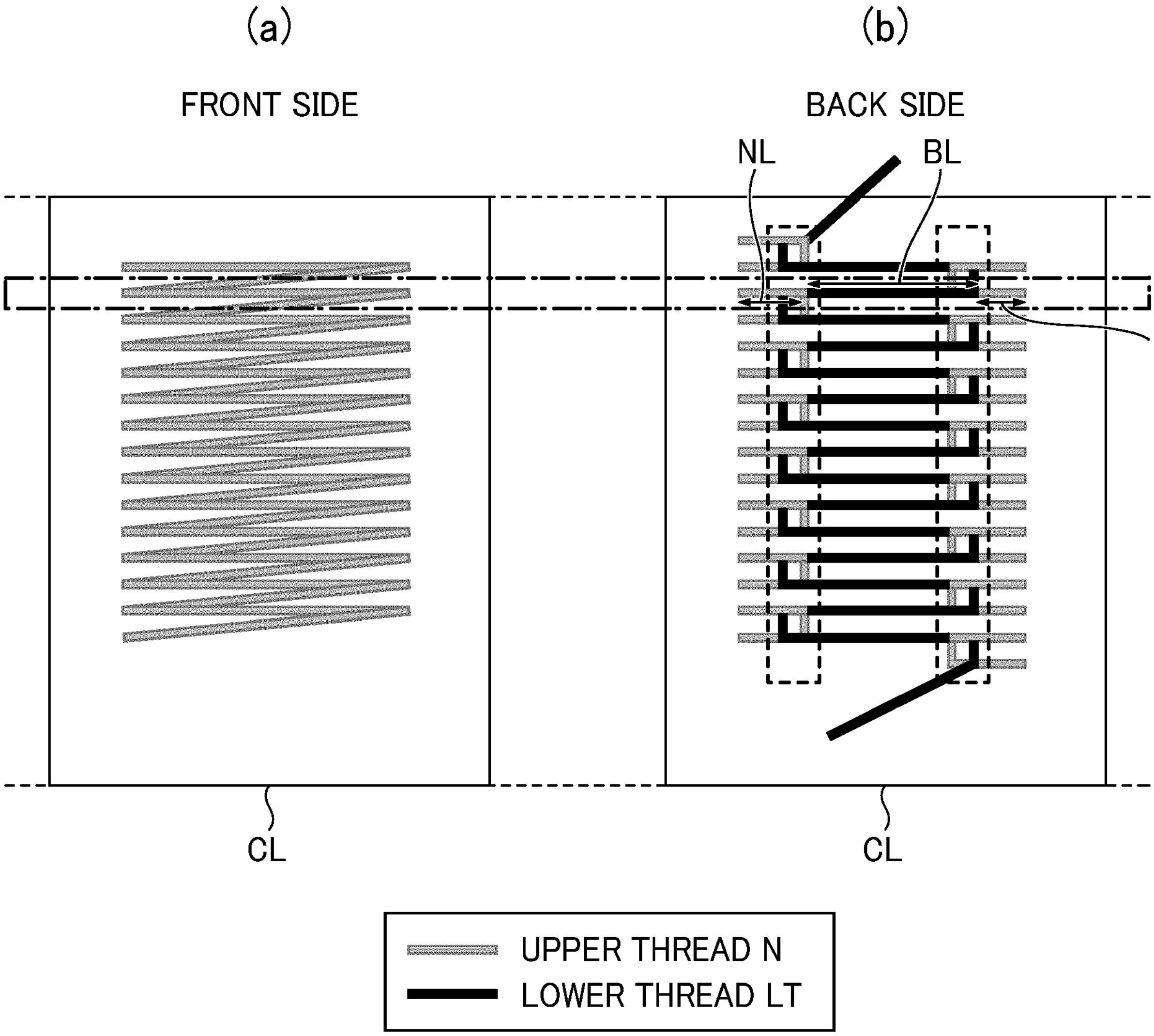

(a)
FRONT SIDE
(b)
BACK SIDE
NL
BL
NL
CL
CL
UPPER THREAD N
LOWER THREAD LT

FIG. 6

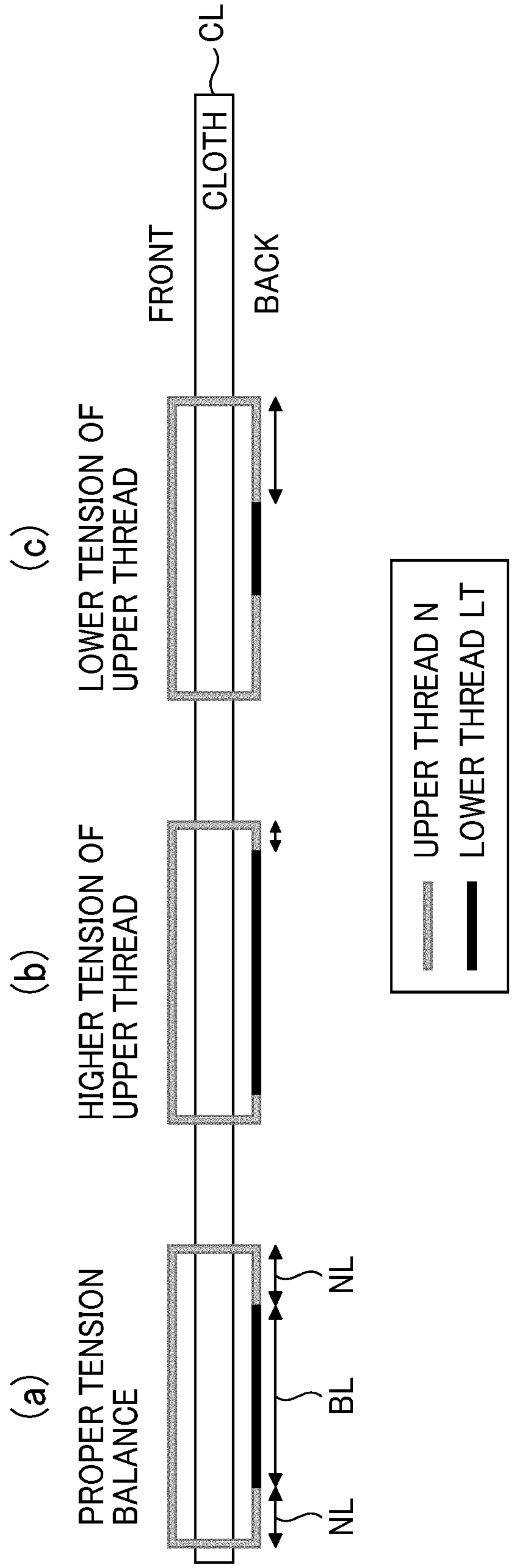

(a)
PROPER TENSION BALANCE
(b)
HIGHER TENSION OF UPPER THREAD
(c)
LOWER TENSION OF UPPER THREAD
FRONT
BACK
CLOTH
CL
NL
BL
NL
UPPER THREAD N
LOWER THREAD LT

FIG. 7A

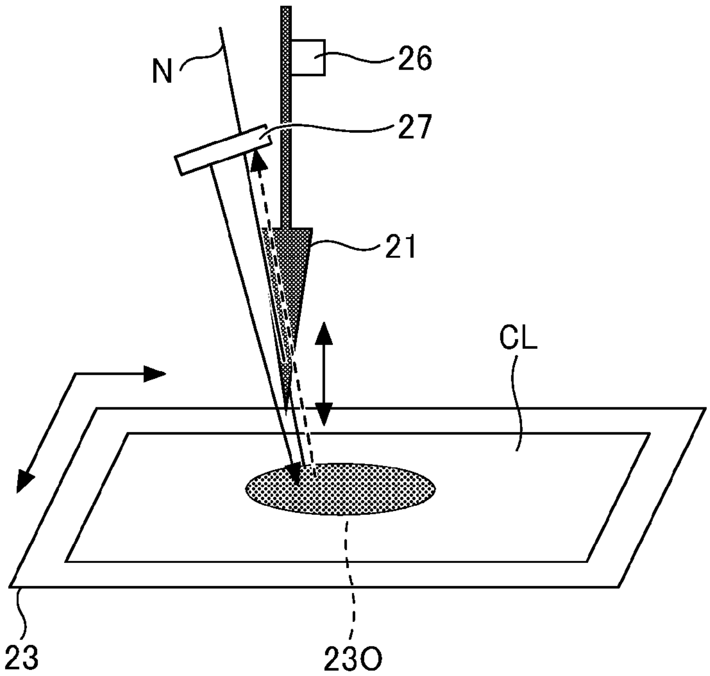


FIG. 7B

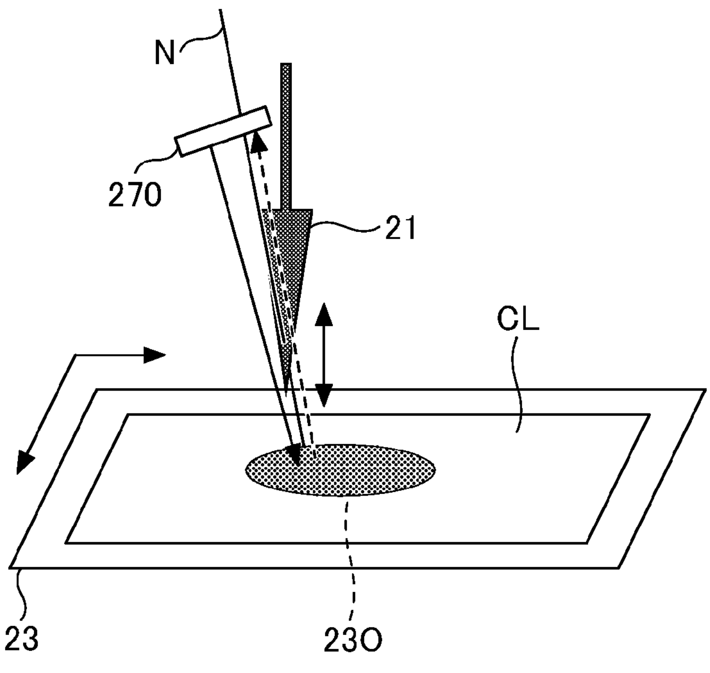


FIG. 8A

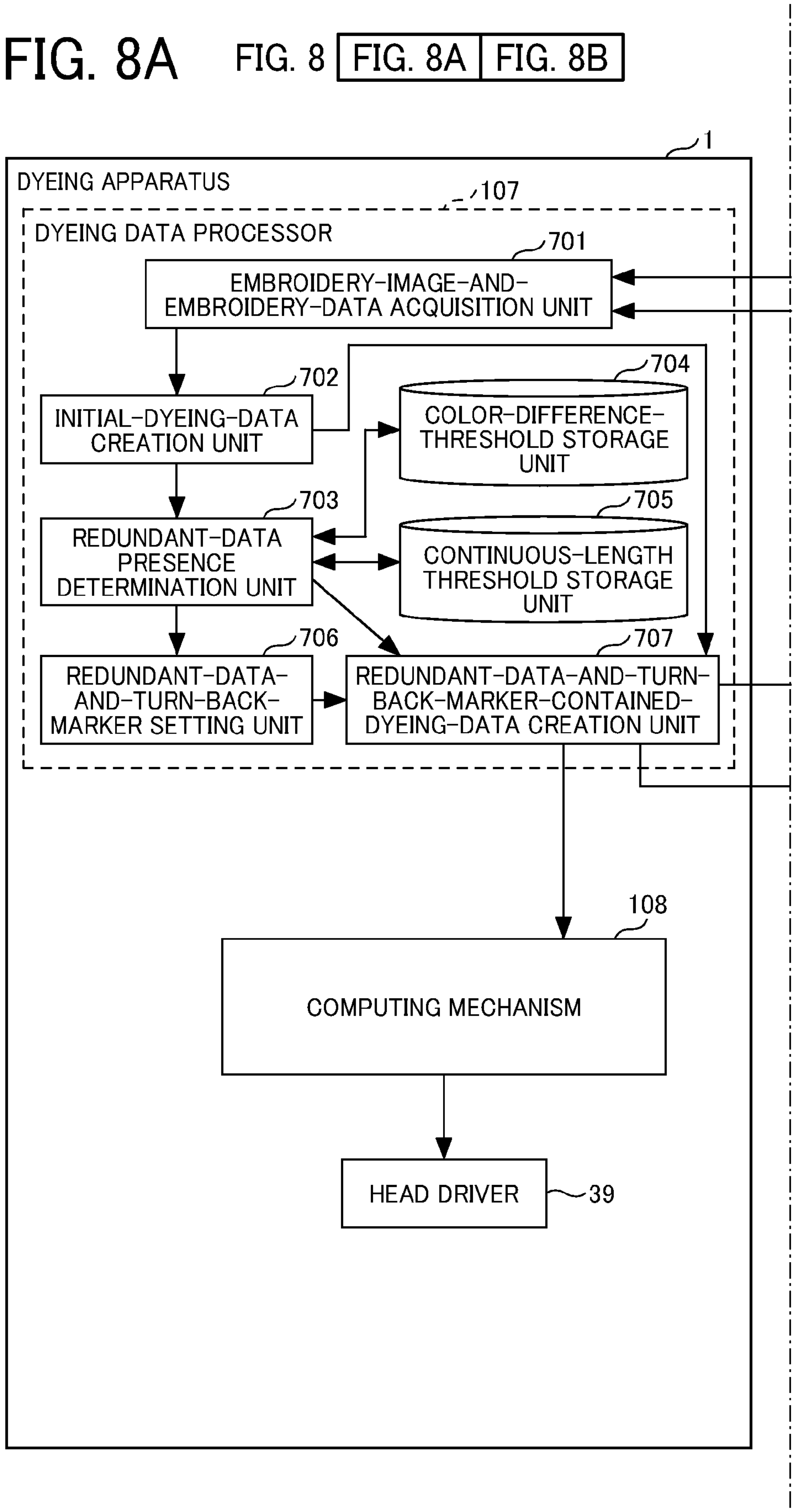
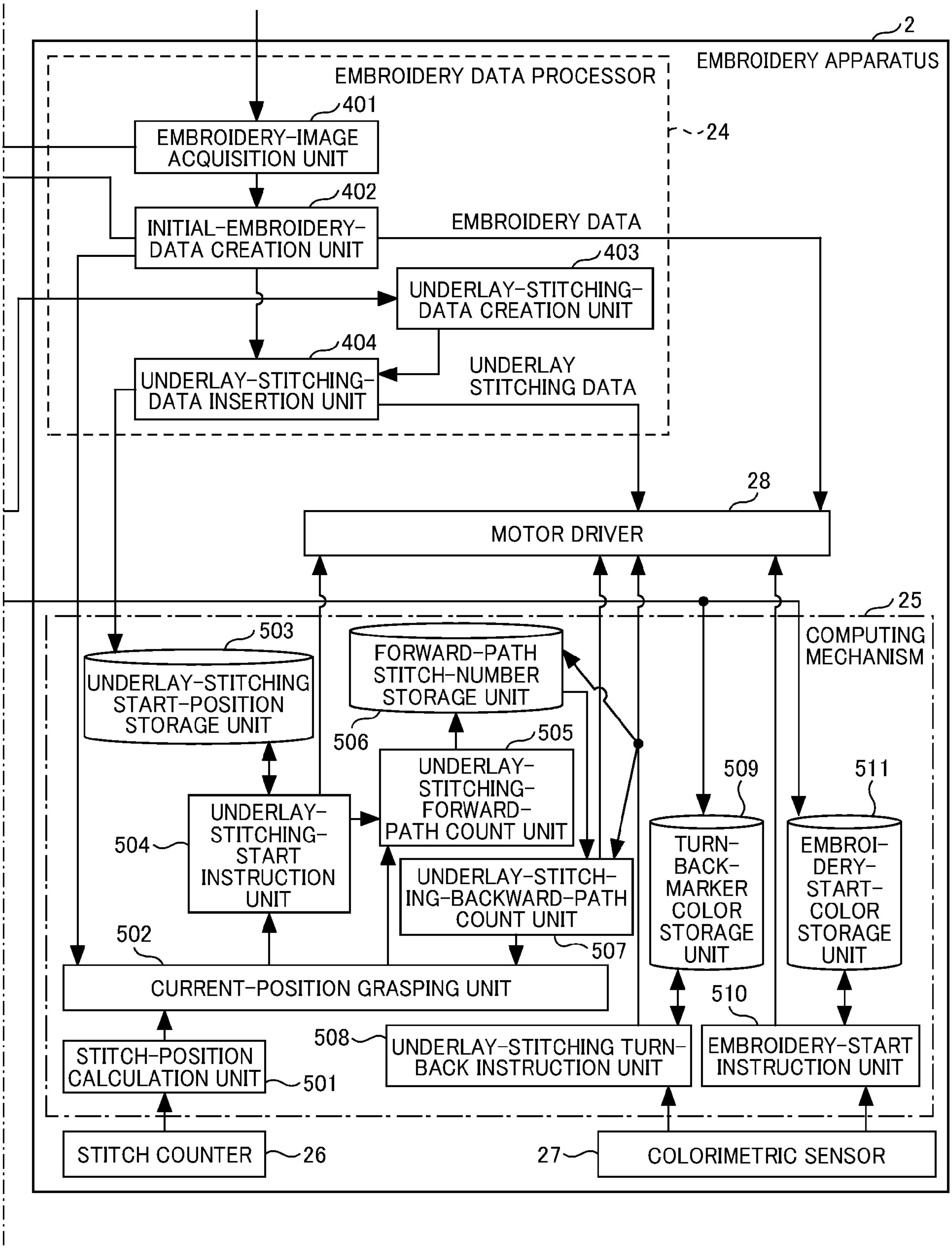


FIG. 8
FIG. 8A
FIG. 8B
1
DYEING APPARATUS
107
DYEING DATA PROCESSOR
701
EMBROIDERY-IMAGE-AND-EMBROIDERY-DATA ACQUISITION UNIT
702
INITIAL-DYEING-DATA CREATION UNIT
704
COLOR-DIFFERENCE-THRESHOLD STORAGE UNIT
703
REDUNDANT-DATA PRESENCE DETERMINATION UNIT
705
CONTINUOUS-LENGTH THRESHOLD STORAGE UNIT
706
REDUNDANT-DATA-AND-TURN-BACK-MARKER SETTING UNIT
707
REDUNDANT-DATA-AND-TURN-BACK-MARKER-CONTAINED-DYEING-DATA CREATION UNIT
108
COMPUTING MECHANISM
HEAD DRIVER
39

FIG. 8B



2
EMBROIDERY APPARATUS
EMBROIDERY DATA PROCESSOR
24
401
EMBROIDERY-IMAGE ACQUISITION UNIT
402
INITIAL-EMBROIDERY-DATA CREATION UNIT
EMBROIDERY DATA
403
UNDERLAY-STITCHING-DATA CREATION UNIT
404
UNDERLAY-STITCHING-DATA INSERTION UNIT
UNDERLAY STITCHING DATA
28
MOTOR DRIVER
25
COMPUTING MECHANISM
503
UNDERLAY-STITCHING START-POSITION STORAGE UNIT
FORWARD-PATH STITCH-NUMBER STORAGE UNIT
506
505
UNDERLAY-STITCHING-FORWARD-PATH COUNT UNIT
504
UNDERLAY-STITCHING-START INSTRUCTION UNIT
UNDERLAY-STITCH-ING-BACKWARD-PATH COUNT UNIT
507
509
TURN-BACK-MARKER COLOR STORAGE UNIT
511
EMBROI-DERY-START-COLOR STORAGE UNIT
502
CURRENT-POSITION GRASPING UNIT
510
508
UNDERLAY-STITCHING TURN-BACK INSTRUCTION UNIT
EMBROIDERY-START INSTRUCTION UNIT
STITCH-POSITION CALCULATION UNIT
501
STITCH COUNTER
26
27
COLORIMETRIC SENSOR

FIG. 9A

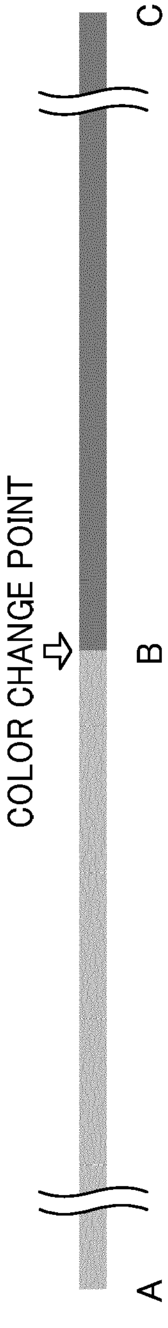

COLOR CHANGE POINT
A
B
C

FIG. 9B

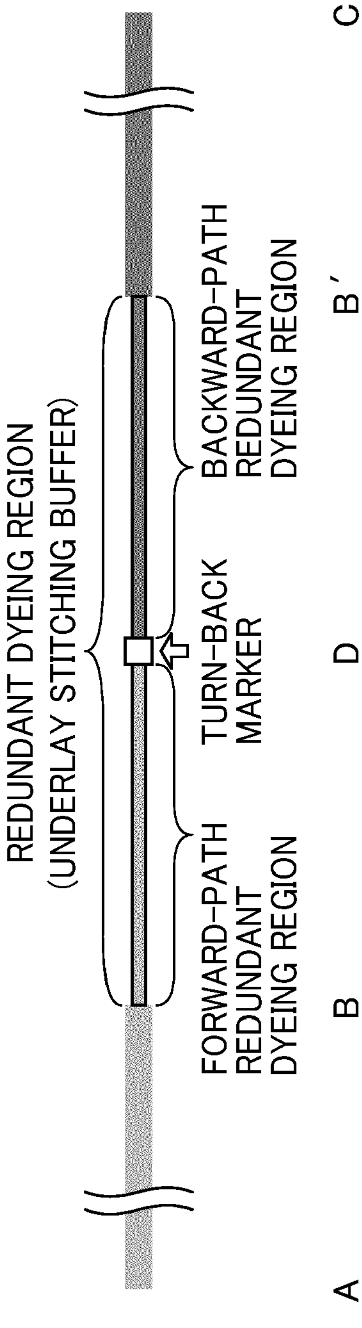
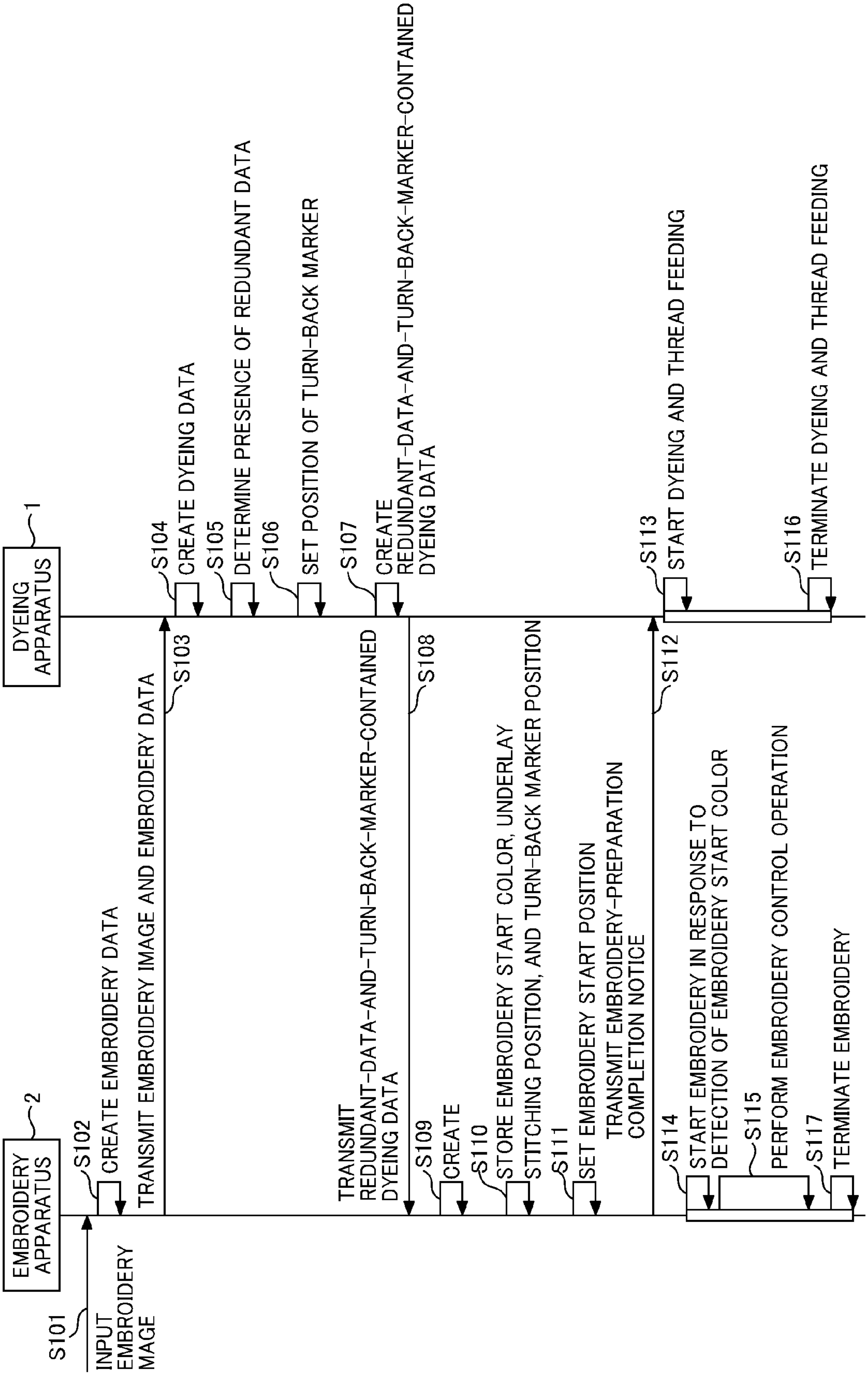

REDUNDANT DYEING REGION
(UNDERLAY STITCHING BUFFER)
FORWARD-PATH
REDUNDANT
DYEING REGION
TURN-BACK
MARKER
BACKWARD-PATH
REDUNDANT
DYEING REGION
A
B
D
B′
C

FIG. 10


EMBROIDERY APPARATUS
2
DYEING APPARATUS
1
S101
INPUT EMBROIDERY MAGE
S102
CREATE EMBROIDERY DATA
TRANSMIT EMBROIDERY IMAGE AND EMBROIDERY DATA
S103
S104
CREATE DYEING DATA
S105
DETERMINE PRESENCE OF REDUNDANT DATA
S106
SET POSITION OF TURN-BACK MARKER
S107
CREATE REDUNDANT-DATA-AND-TURN-BACK-MARKER-CONTAINED DYEING DATA
TRANSMIT REDUNDANT-DATA-AND-TURN-BACK-MARKER-CONTAINED DYEING DATA
S108
S109
CREATE
S110
STORE EMBROIDERY START COLOR, UNDERLAY STITCHING POSITION, AND TURN-BACK MARKER POSITION
S111
SET EMBROIDERY START POSITION
TRANSMIT EMBROIDERY-PREPARATION COMPLETION NOTICE
S112
S113
START DYEING AND THREAD FEEDING
S114
START EMBROIDERY IN RESPONSE TO DETECTION OF EMBROIDERY START COLOR
S115
PERFORM EMBROIDERY CONTROL OPERATION
S116
TERMINATE DYEING AND THREAD FEEDING
S117
TERMINATE EMBROIDERY

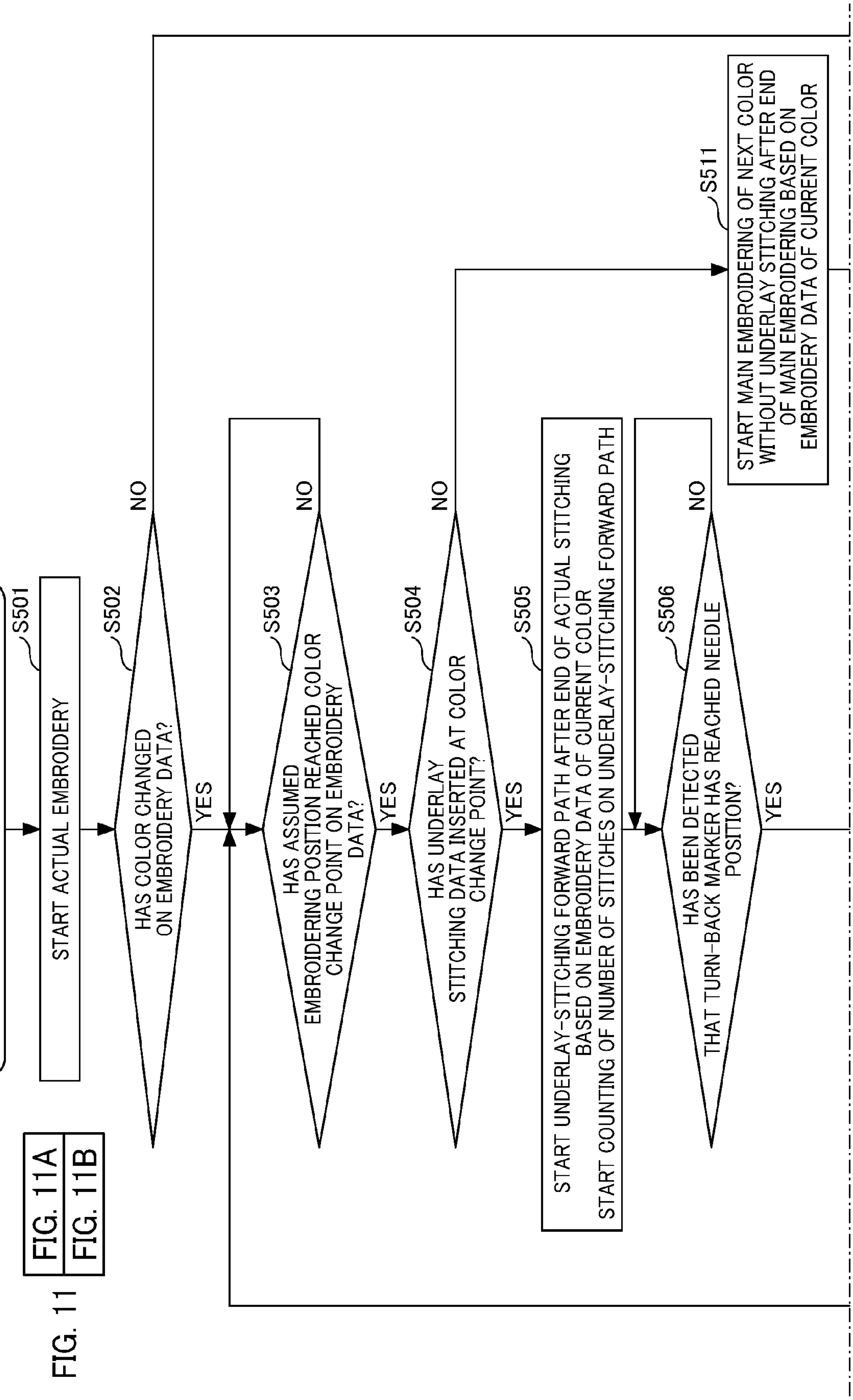


FIG. 11
FIG. 11A
FIG. 11B
(DETECTION OF EMBROIDERY START COLOR) (S114)
S501
START ACTUAL EMBROIDERY
S502
HAS COLOR CHANGED ON EMBROIDERY DATA?
YES
NO
S503
HAS ASSUMED EMBROIDERING POSITION REACHED COLOR CHANGE POINT ON EMBROIDERY DATA?
YES
NO
S504
HAS UNDERLAY STITCHING DATA INSERTED AT COLOR CHANGE POINT?
YES
NO
S505
START UNDERLAY-STITCHING FORWARD PATH AFTER END OF ACTUAL STITCHING BASED ON EMBROIDERY DATA OF CURRENT COLOR
START COUNTING OF NUMBER OF STITCHES ON UNDERLAY-STITCHING FORWARD PATH
S506
HAS BEEN DETECTED THAT TURN-BACK MARKER HAS REACHED NEEDLE POSITION?
YES
NO
S511
START MAIN EMBROIDERING OF NEXT COLOR WITHOUT UNDERLAY STITCHING AFTER END OF MAIN EMBROIDERING BASED ON EMBROIDERY DATA OF CURRENT COLOR

FIG. 11A

FIG. 11B

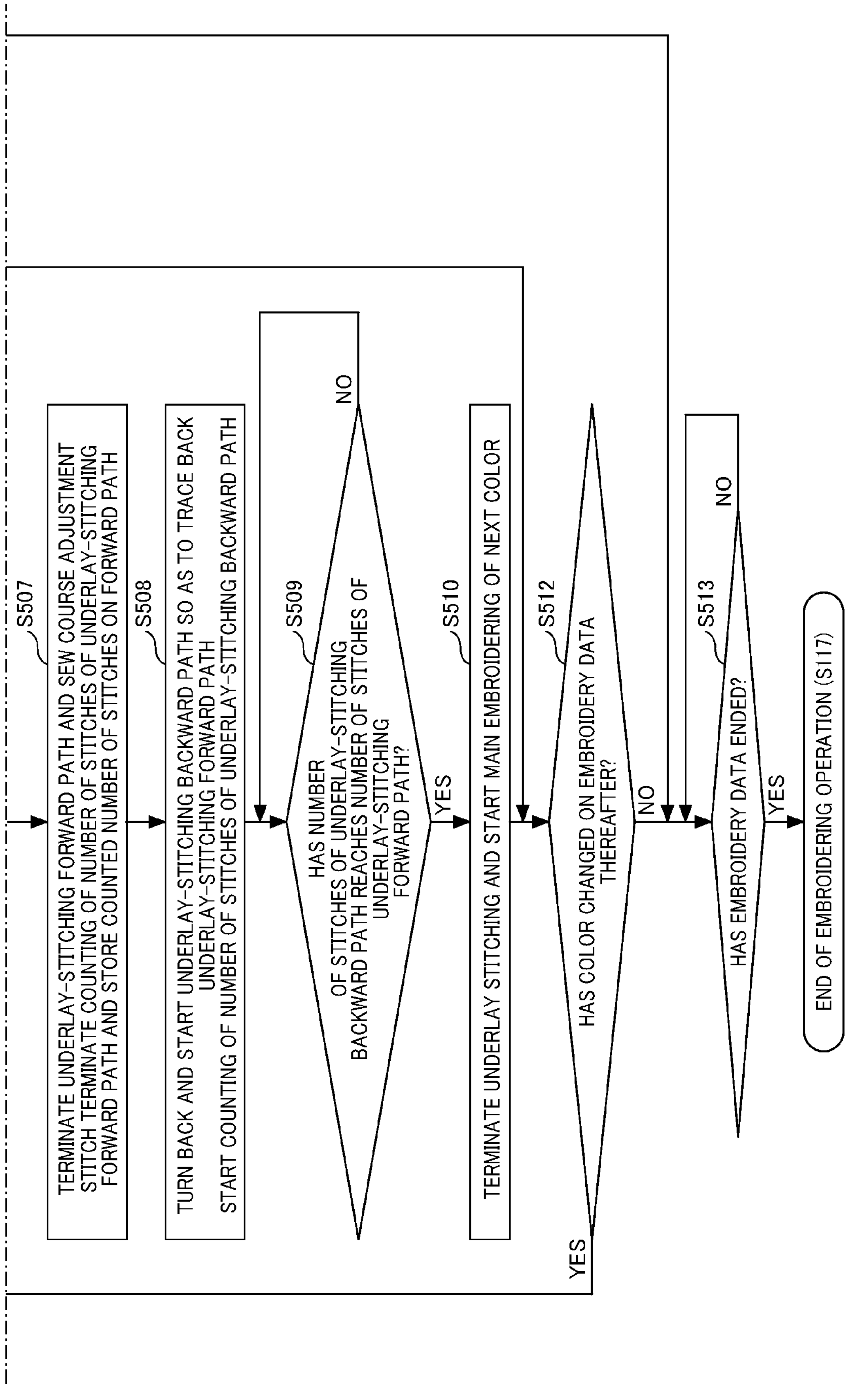
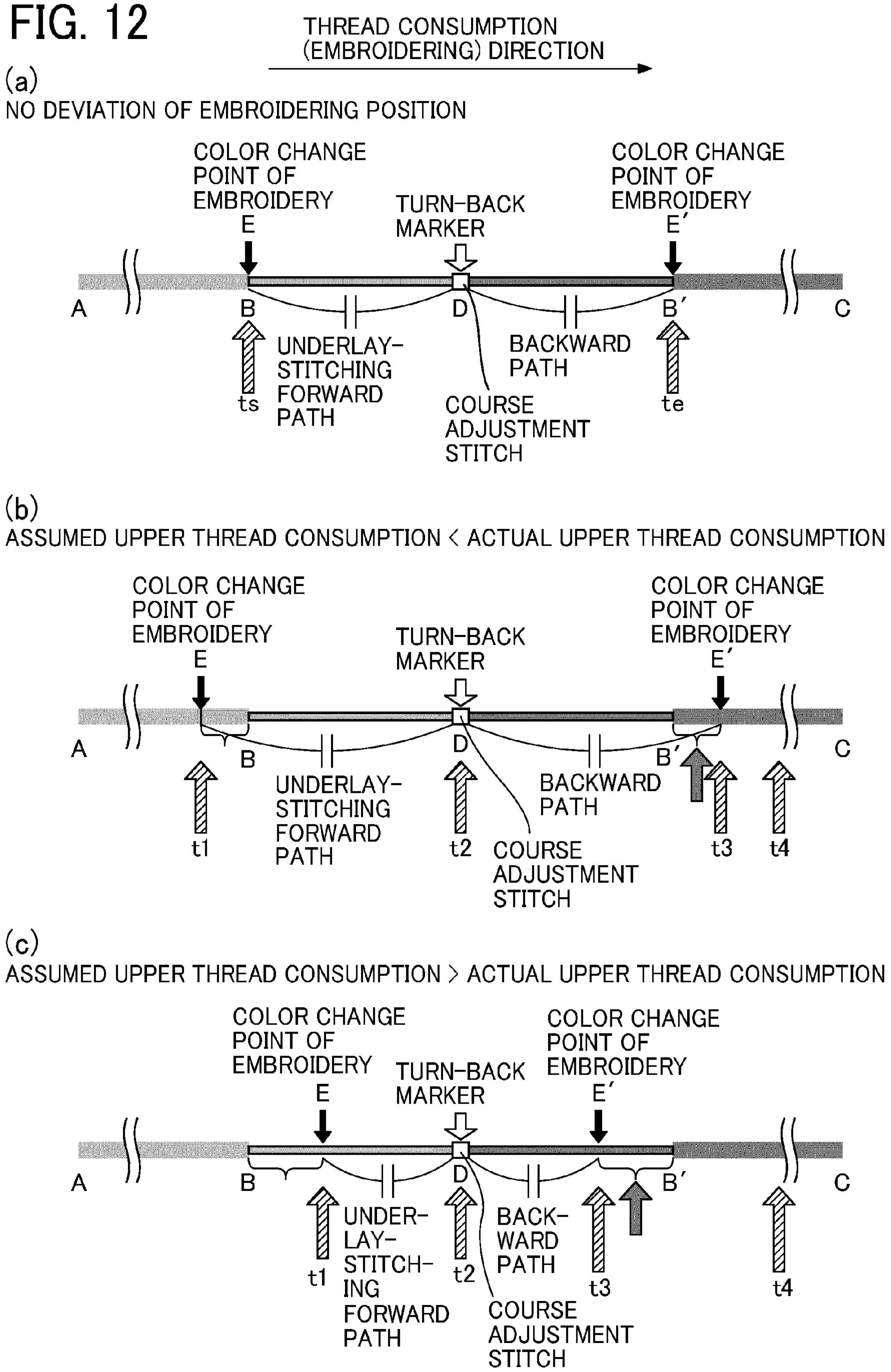

S507
TERMINATE UNDERLAY-STITCHING FORWARD PATH AND SEW COURSE ADJUSTMENT STITCH TERMINATE COUNTING OF NUMBER OF STITCHES OF UNDERLAY-STITCHING FORWARD PATH AND STORE COUNTED NUMBER OF STITCHES ON FORWARD PATH
S508
TURN BACK AND START UNDERLAY-STITCHING BACKWARD PATH SO AS TO TRACE BACK UNDERLAY-STITCHING FORWARD PATH
START COUNTING OF NUMBER OF STITCHES OF UNDERLAY-STITCHING BACKWARD PATH
S509
HAS NUMBER OF STITCHES OF UNDERLAY-STITCHING BACKWARD PATH REACHES NUMBER OF STITCHES OF UNDERLAY-STITCHING FORWARD PATH?
NO
YES
S510
TERMINATE UNDERLAY STITCHING AND START MAIN EMBROIDERING OF NEXT COLOR
S512
HAS COLOR CHANGED ON EMBROIDERY DATA THEREAFTER?
YES
NO
S513
HAS EMBROIDERY DATA ENDED?
NO
YES
END OF EMBROIDERING OPERATION (S117)

FIG. 12


THREAD CONSUMPTION
(EMBROIDERING) DIRECTION
(a)
NO DEVIATION OF EMBROIDERING POSITION
COLOR CHANGE
POINT OF
EMBROIDERY
E
TURN-BACK
MARKER
COLOR CHANGE
POINT OF
EMBROIDERY
E′
A
B
D
B′
C
UNDERLAY-
STITCHING
FORWARD
PATH
BACKWARD
PATH
ts
te
COURSE
ADJUSTMENT
STITCH
(b)
ASSUMED UPPER THREAD CONSUMPTION < ACTUAL UPPER THREAD CONSUMPTION
COLOR CHANGE
POINT OF
EMBROIDERY
E
TURN-BACK
MARKER
COLOR CHANGE
POINT OF
EMBROIDERY
E′
A
B
D
B′
C
UNDERLAY-
STITCHING
FORWARD
PATH
BACKWARD
PATH
t1
t2
t3
t4
COURSE
ADJUSTMENT
STITCH
(c)
ASSUMED UPPER THREAD CONSUMPTION > ACTUAL UPPER THREAD CONSUMPTION
COLOR CHANGE
POINT OF
EMBROIDERY
E
TURN-BACK
MARKER
COLOR CHANGE
POINT OF
EMBROIDERY
E′
A
B
D
B′
C
UNDER-
LAY-
STITCH-
ING
FORWARD
PATH
BACK-
WARD
PATH
t1
t2
t3
t4
COURSE
ADJUSTMENT
STITCH

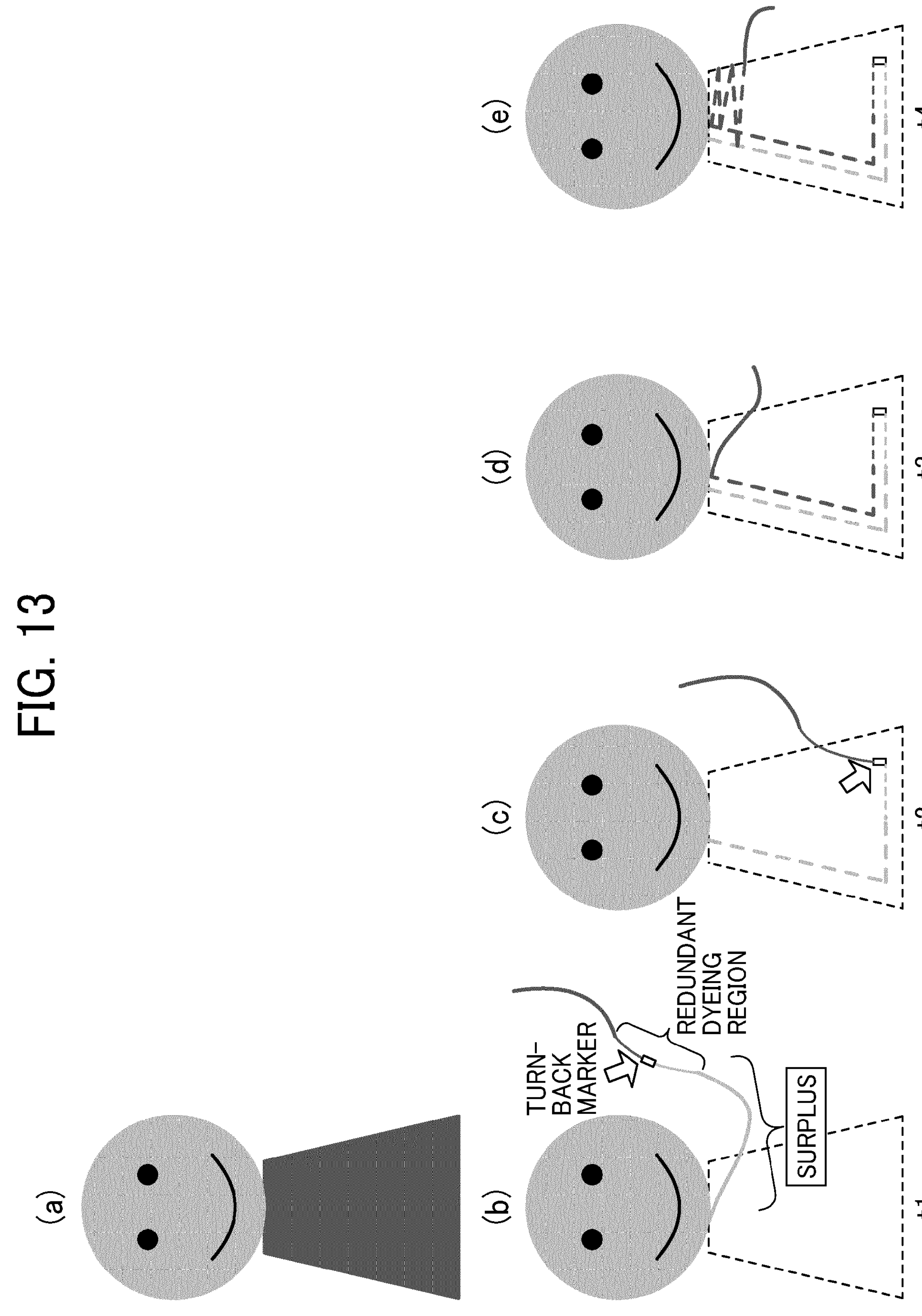

(a)
(b)
(c)
(d)
(e)
TURN-BACK MARKER
REDUNDANT DYEING REGION
SURPLUS
t1
t2
t3
t4

FIG. 13

FIG. 14

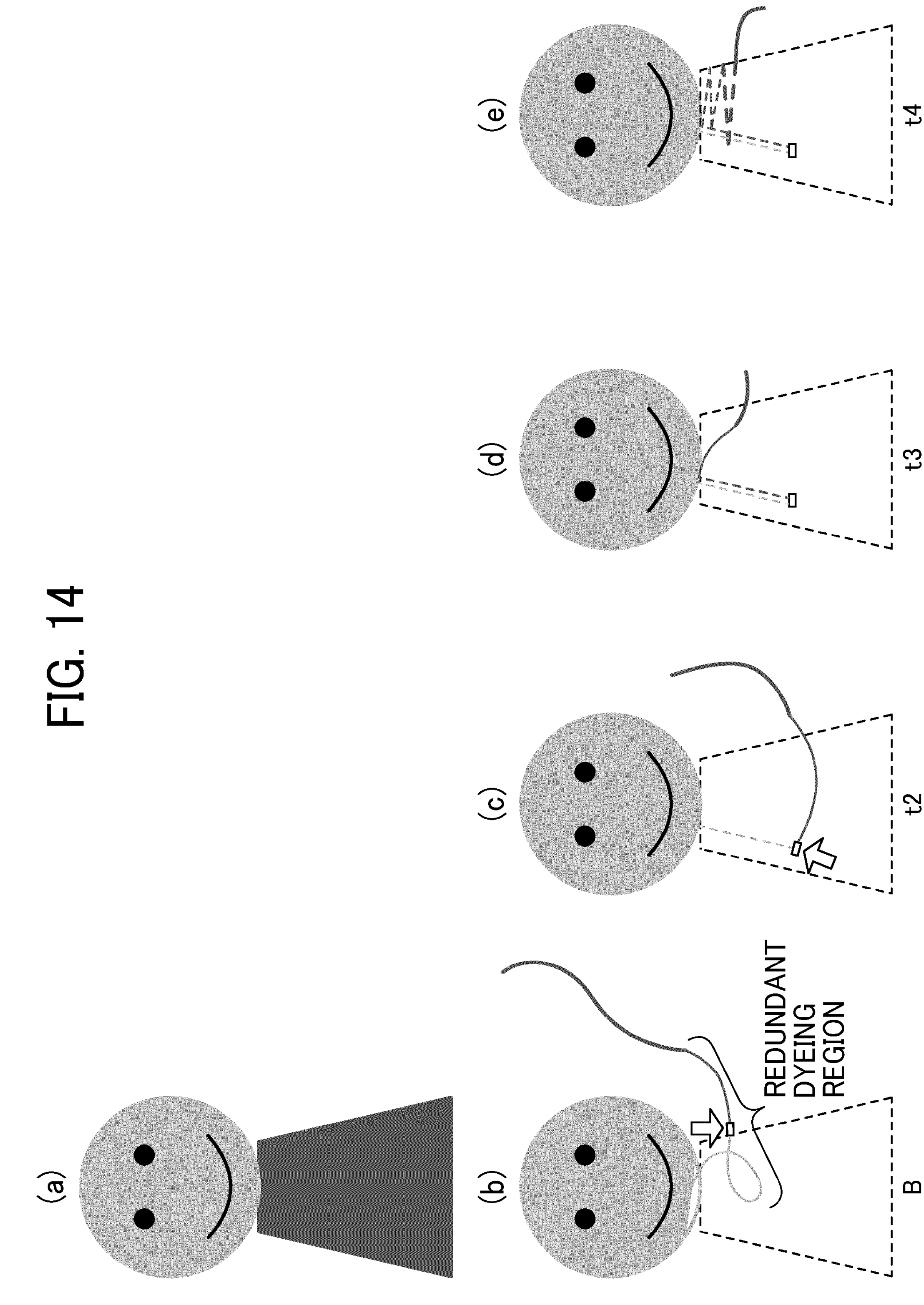


FIG. 15

2A

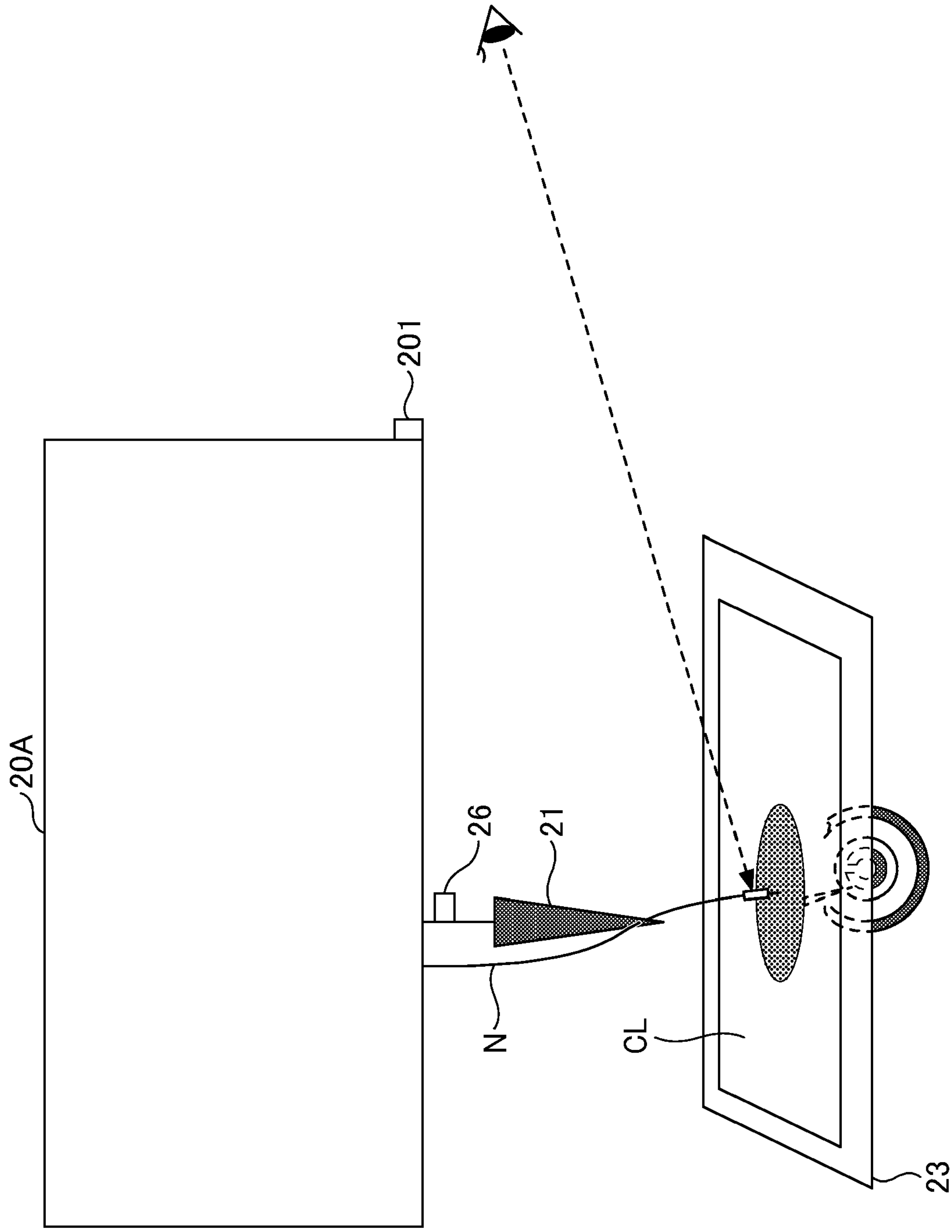


FIG. 16

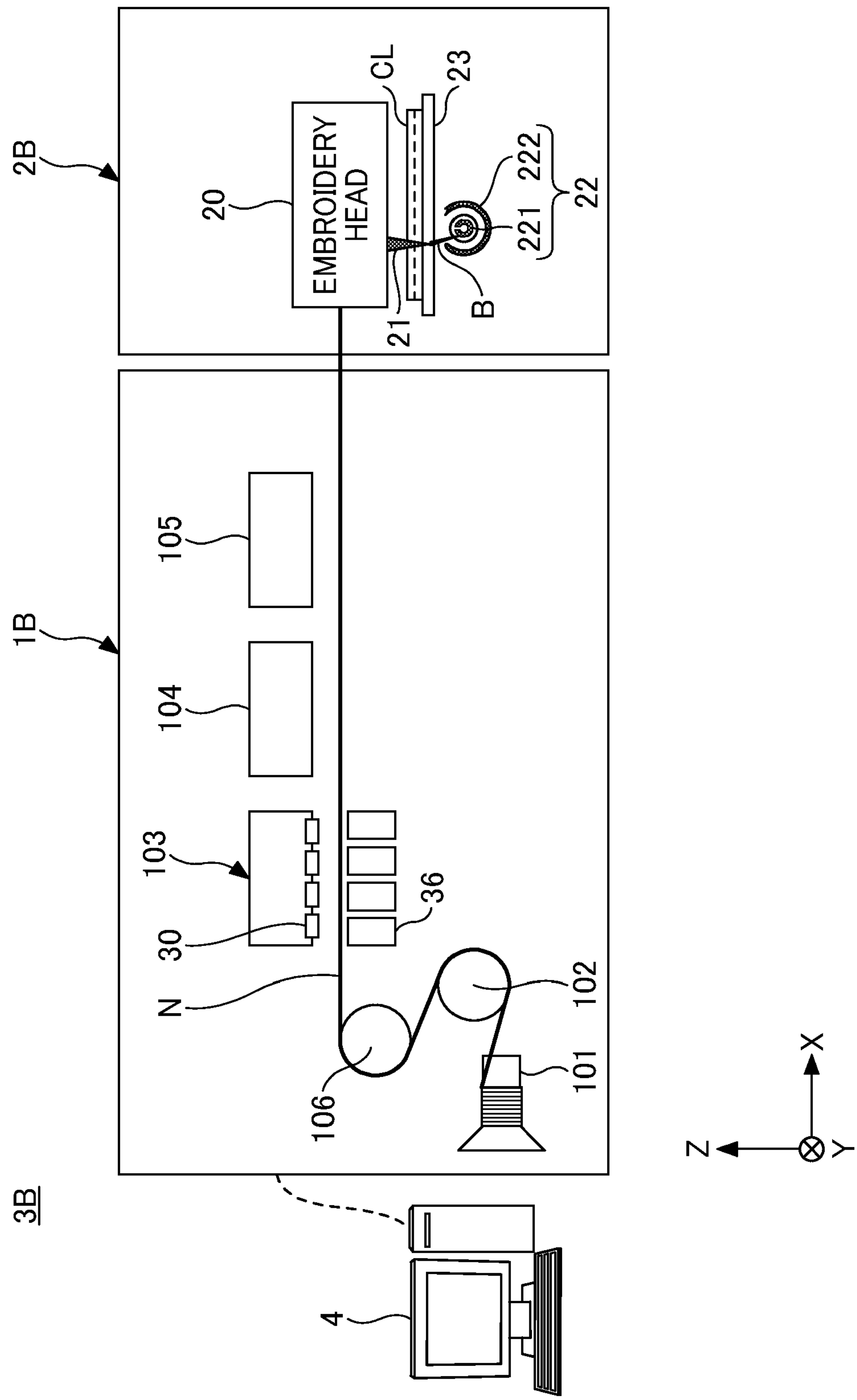

2B
1B
3B
EMBROIDERY HEAD
20
CL
23
222
221
22
B
21
105
104
103
30
36
N
102
106
101
4
X
Z
Y

FIG. 17A

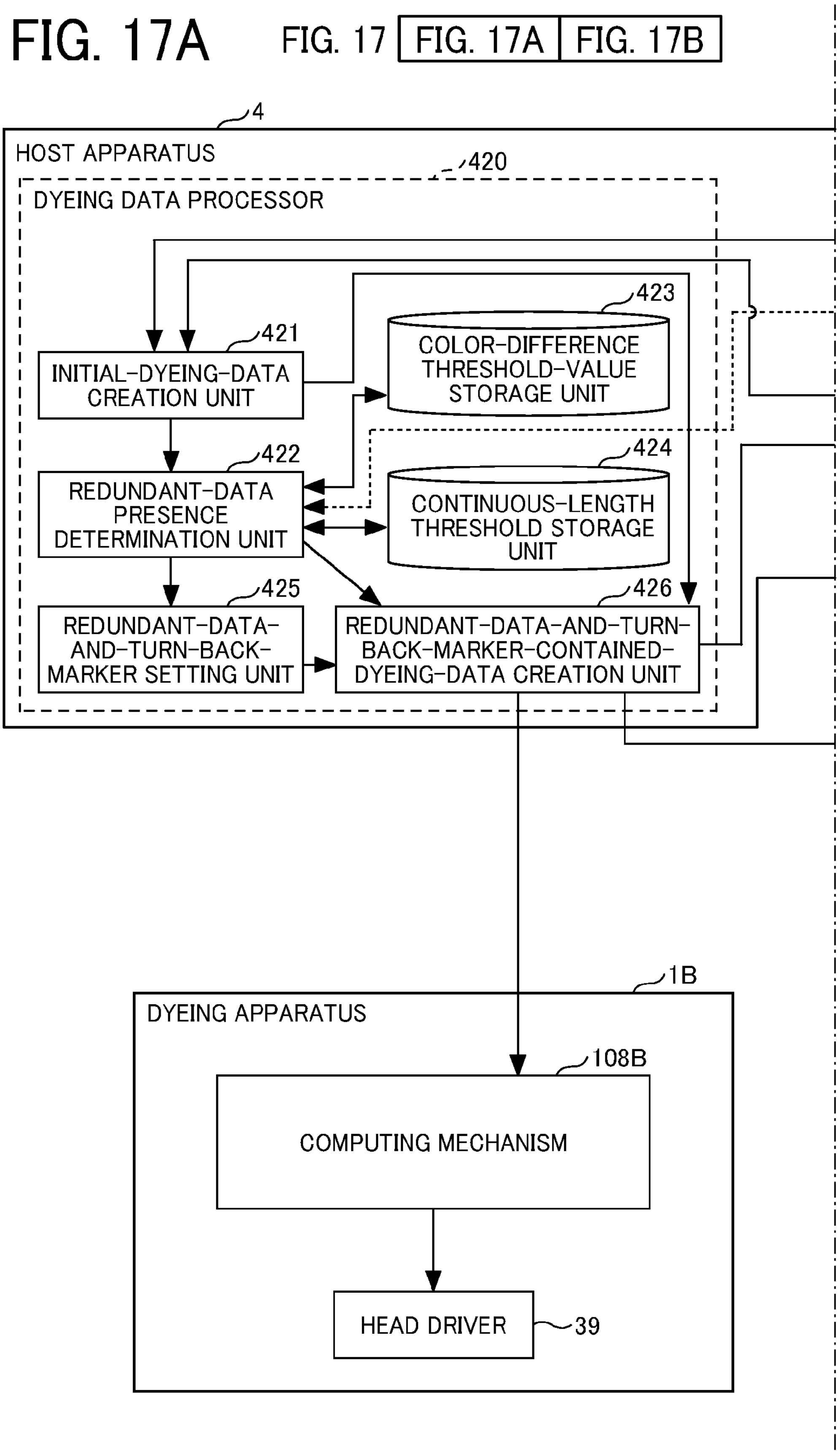


FIG. 17
FIG. 17A
FIG. 17B
4
HOST APPARATUS
420
DYEING DATA PROCESSOR
423
COLOR-DIFFERENCE THRESHOLD-VALUE STORAGE UNIT
421
INITIAL-DYEING-DATA CREATION UNIT
422
REDUNDANT-DATA PRESENCE DETERMINATION UNIT
424
CONTINUOUS-LENGTH THRESHOLD STORAGE UNIT
425
REDUNDANT-DATA-AND-TURN-BACK-MARKER SETTING UNIT
426
REDUNDANT-DATA-AND-TURN-BACK-MARKER-CONTAINED-DYEING-DATA CREATION UNIT
1B
DYEING APPARATUS
108B
COMPUTING MECHANISM
HEAD DRIVER
39

FIG. 17B

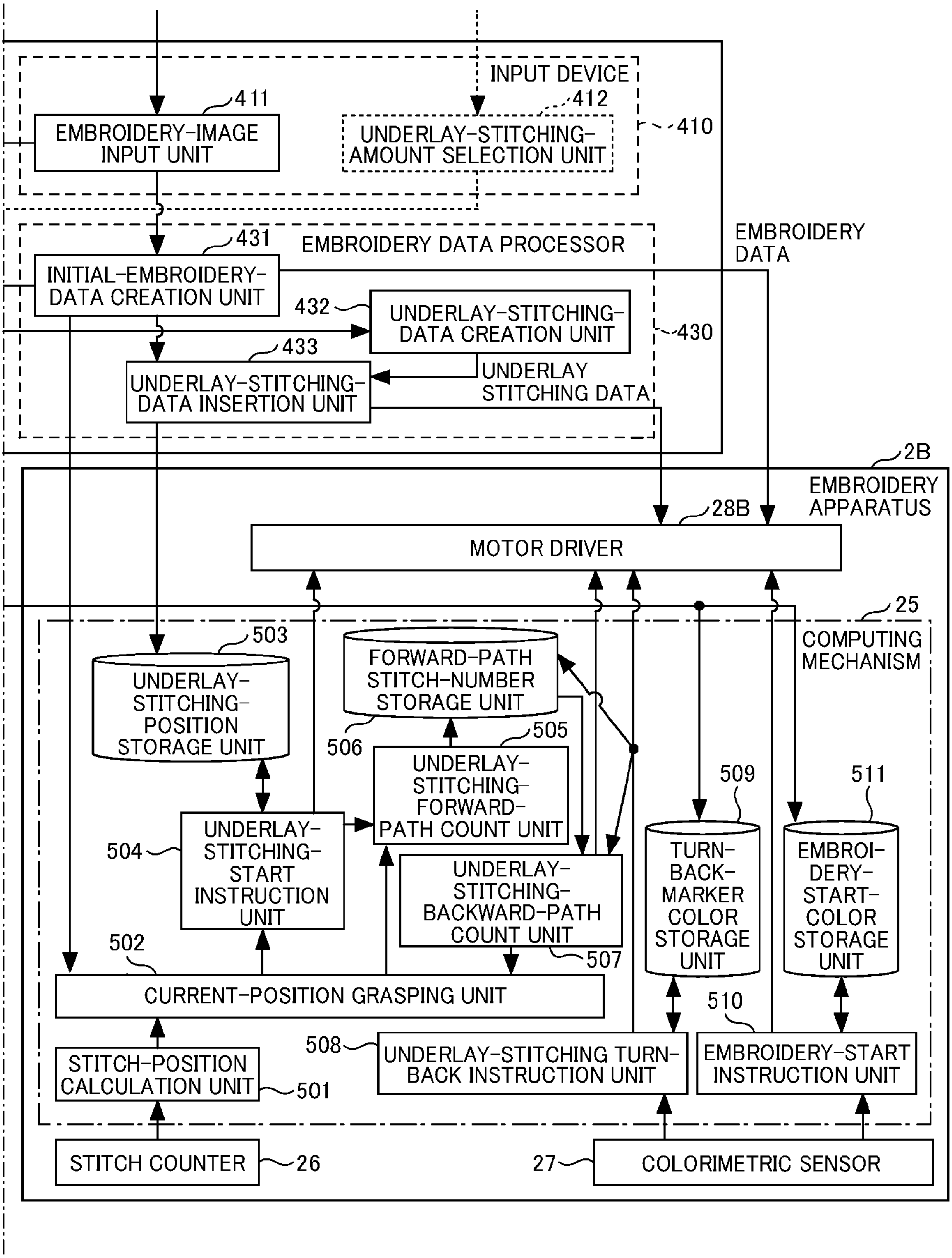
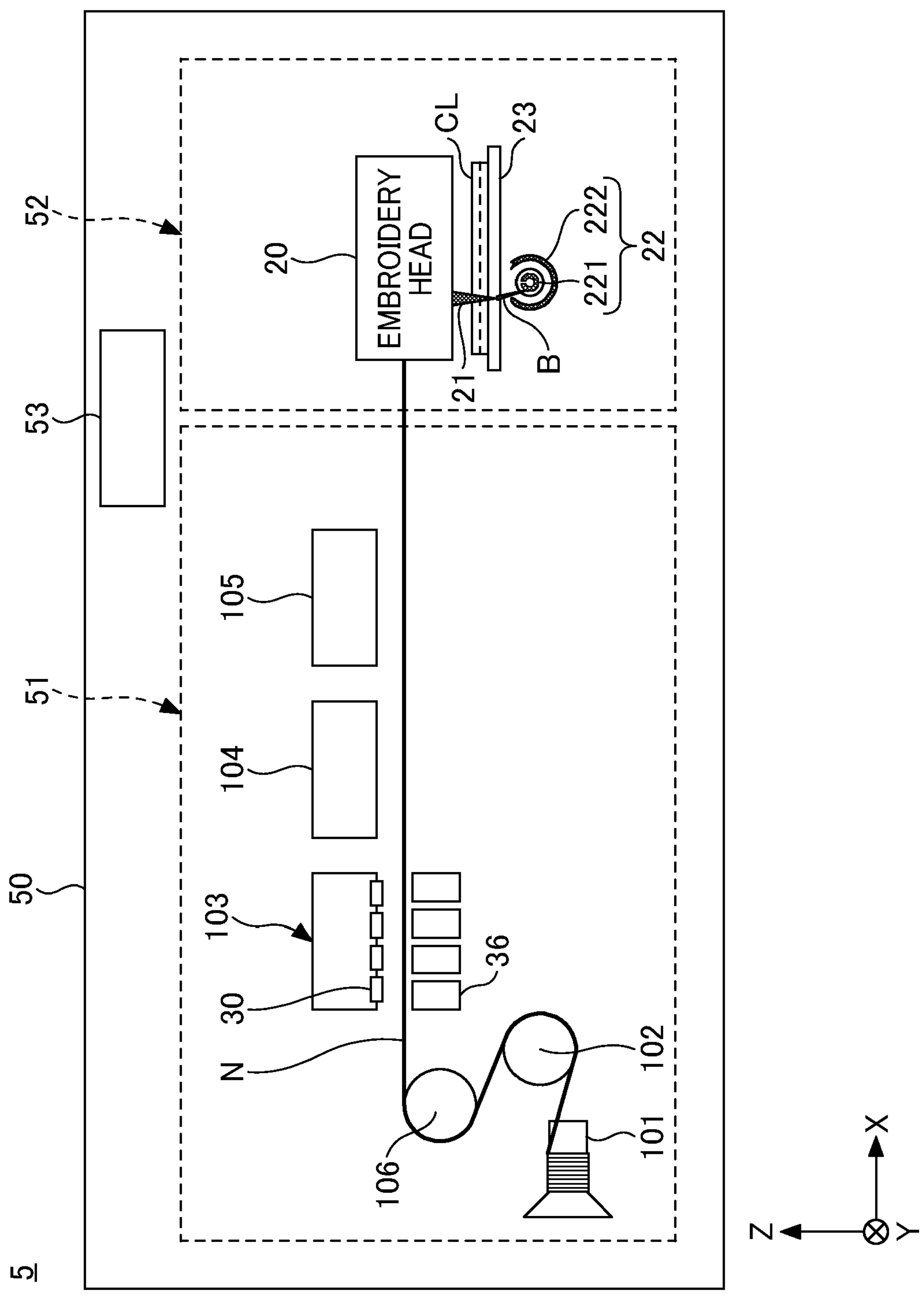

INPUT DEVICE
411
412
410
EMBROIDERY-IMAGE INPUT UNIT
UNDERLAY-STITCHING-AMOUNT SELECTION UNIT
431
EMBROIDERY DATA PROCESSOR
EMBROIDERY DATA
INITIAL-EMBROIDERY-DATA CREATION UNIT
432
UNDERLAY-STITCHING-DATA CREATION UNIT
430
433
UNDERLAY STITCHING DATA
UNDERLAY-STITCHING-DATA INSERTION UNIT
2B
EMBROIDERY APPARATUS
28B
MOTOR DRIVER
25
503
COMPUTING MECHANISM
FORWARD-PATH STITCH-NUMBER STORAGE UNIT
UNDERLAY-STITCHING-POSITION STORAGE UNIT
505
506
509
511
UNDERLAY-STITCHING-FORWARD-PATH COUNT UNIT
504
UNDERLAY-STITCHING-START INSTRUCTION UNIT
UNDERLAY-STITCHING-BACKWARD-PATH COUNT UNIT
TURN-BACK-MARKER COLOR STORAGE UNIT
EMBROI-DERY-START-COLOR STORAGE UNIT
502
507
CURRENT-POSITION GRASPING UNIT
510
508
UNDERLAY-STITCHING TURN-BACK INSTRUCTION UNIT
EMBROIDERY-START INSTRUCTION UNIT
STITCH-POSITION CALCULATION UNIT
501
STITCH COUNTER
26
27
COLORIMETRIC SENSOR

FIG. 18


5
50
51
52
53
EMBROIDERY HEAD
20
21
22
221
222
23
CL
B
101
102
103
104
105
106
30
36
N
X
Y
Z

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 22 19 3476

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 6 189 989 B1 (HIRABAYASHI HIROMITSU [JP] ET AL) 20 February 2001 (2001-02-20) * column 8, line 10 - column 9, line 12; figures 9A, 9B * -----	1-13	INV. D05B67/00 D05C11/24
A	GB 2 166 766 A (GERBER SCIENT INC) 14 May 1986 (1986-05-14) * page 6, line 92 - page 7, line 46; figures 6, 7 * -----	1-13	
A	US 2007/245940 A1 (WAHLSTROM ROLF [SE]) 25 October 2007 (2007-10-25) * paragraph [0036]; figure 11 * -----	1-13	

TECHNICAL FIELDS SEARCHED (IPC)

D05B
D05C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	26 January 2023	Braun, Stefanie

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons
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& : member of the same patent family, corresponding document

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26-01-2023

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			DE	3249905	C2	08-06-1989
			ES	8405094	A1	16-05-1984
			FR	2517708	A1	10-06-1983
			GB	2111091	A	29-06-1983
			GB	2166763	A	14-05-1986
			GB	2166764	A	14-05-1986
			GB	2166765	A	14-05-1986
			GB	2166766	A	14-05-1986
			HK	17390	A	16-03-1990
			IT	1157121	B	11-02-1987
			JP	S617120	B2	04-03-1986
			JP	H0327231	B2	15-04-1991
			JP	S5897393	A	09-06-1983
			JP	H03131293	A	04-06-1991
			JP	S63145697	A	17-06-1988
			MX	157738	A	13-12-1988
			US	4453477	A	12-06-1984
US 2007245940	A1	25-10-2007	NONE			

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2008289522 A **[0004] [0005]**