(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 466 690 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
10.04.2019 Bulletin 2019/15

(21) Application number: **17802617.5**

(22) Date of filing: **16.05.2017**

(51) Int Cl.:
B41J 2/01 *(2006.01)* ***B41J 2/21*** *(2006.01)*

(86) International application number:
PCT/JP2017/018273

(87) International publication number:
WO 2017/204025 (30.11.2017 Gazette 2017/48)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **27.05.2016 JP 2016105876**

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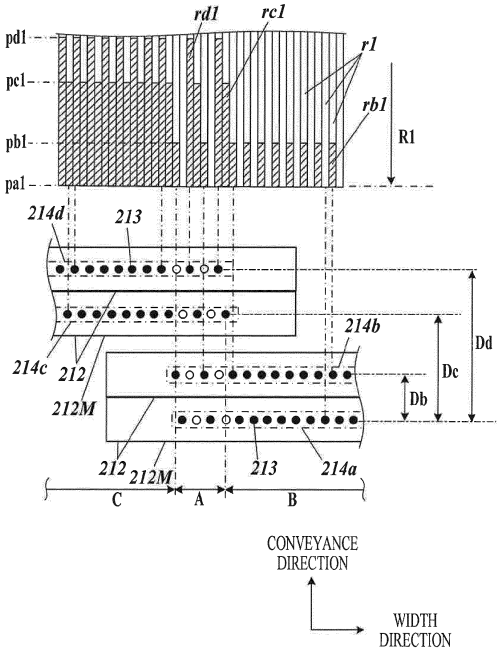
(54) **INKJET PRINTING APPARATUS AND INKJET PRINTING APPARATUS CONTROL METHOD**

(57) Provided are an inkjet printing apparatus and an inkjet printing apparatus control method capable of limiting the reduction in image quality of an image that is printed with an intervening interruption. The inkjet printing apparatus is provided with: a conveyance means for conveying a print medium in the conveyance direction; ink-discharging units provided so that the range of placement of each of multiple printing element rows overlaps with another printing element row in the width direction and is separated therefrom in the conveyance direction; and a control means for causing the ink-discharging units to perform image printing operations in which the multiple printing elements discharge ink to print an image on the print medium. In the image printing operation, at each position in the conveyance direction and for each position of the width direction in the areas of printing element row overlap, an ink-discharging operation is performed by at least one of the printing elements belonging to the two or more printing element rows. When the printing of an image is interrupted, the control means causes the ink-discharging units to perform an image printing operation on a partial image, which excludes the portions of the image that are not to be printed due to the interruption.

FIG.6



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Description

TECHNOLOGICAL FIELD

[0001] The present invention relates to an inkjet recording device and a method for controlling the inkjet recording device.

DESCRIPTION OF THE RELATED ART

[0002] Conventional inkjet recording devices have caused multiple recording elements provided on recording heads to discharge ink droplets to recording media conveyed by a conveyor to record images. In recent years, in order to respond to requirements such as increase in recording speed, inkjet recording devices have used a technique of including long line heads provided with multiple recording heads disposed in different positions along the width direction of a recording medium such that recording elements are disposed over the width of an recorded image orthogonal to the conveyance direction of the recording medium, and discharging ink droplets at the timing appropriate to the conveyance position of the recording medium from the recording elements disposed in fixed positions to record the image. In such long line heads, recording heads are known that are staggered from each other in the conveyance direction of the recording medium so as to overlap with the others at the ends along the width direction of the recording medium (see, for example, Patent Document 1).

[0003] For such line heads, there is a technique in which two recording heads are disposed in overlapping positions along the width direction, and for example, recording elements in one of the two recording heads and recording elements in the other recording head discharge ink droplets to alternating positions in the overlapping regions along the width direction, and the occurrence of discontinuity in density at the connection portions of the recording heads is thereby reduced.

[0004] In order to increase the recording resolution along the width direction in the line heads, there is a technique in which pairs of recording heads, which are provided in different positions in the conveyance direction with the recording elements in an alternating layout in the width direction, define head modules, the head modules are staggered and recording elements disposed in one of the pair of recording heads of a head module discharge ink droplets at each position along the width direction.

[0005] In this manner, the discharged volumes of ink droplets are adjusted according to intervals between the recording elements disposed along the width direction such that a region receiving no ink droplets does not exist and ink droplets that adhered to the recording medium after several times of discharge of ink droplets performed to transversely neighboring positions partially overlap with each other in the case that ink droplets are complementarily discharged along the width direction by recording elements in different positions in the conveyance direction for recording of an image.

[0006] There is also a technique in which, if recording of an image is interrupted, for example, at detection of abnormality such as uplift of the recording medium and foreign substances attaching to the recording medium, the inkjet recording device restarts to record the image after the cause of interruption is eliminated, thereby recording of the image can be completed even though the recording is interrupted, and thus the recording medium can be efficiently used.

PRIOR ART DOCUMENTS

PATENT DOCUMENT

[0007] Patent Document 1: Japanese Patent Application Laid Open
Publication No. 2015-145088

SUMMARY

PROBLEMS TO BE SOLVED BY THE INVENTION

[0008] If recording of an image is interrupted, simultaneous stop of the ink discharging operations of recording elements in different positions in the conveyance direction of the recording medium causes only parts of the recording elements to discharge ink droplets in a partial region of the recording medium. When recording of the image is restarted and other parts of the recording elements discharge ink droplets such that the ink droplets partially overlap with those already discharged in the region, unevenness in color occurs because the state of the ink droplets adhering to the recording medium in the region is different from that of the ink droplets which were discharged by recording elements in another region without discontinuation of recording. Thus, the above-described conventional techniques cause unevenness in color of an image which was recorded by recording including interruption, resulting in degraded image quality.

[0009] An object of the present invention is to provide an inkjet recording device and a method for controlling such an inkjet recording device capable of suppressing degradation of the image quality of an image which was recorded by recording including interruption.

MEANS FOR SOLVING THE PROBLEM

[0010] In order to achieve the above object, the invention of an inkjet recording device described in claim 1 includes: a conveyor configured to perform a conveyance operation of conveying a recording medium in a predetermined conveyance direction; an ink discharger including recording elements discharging ink; and a controller to control operations of the conveyor and the ink discharger, wherein the recording elements form recording element arrays each of which is formed of two or more

of the recording elements disposed in series in a direction intersecting the conveyance direction, each of the recording element arrays partially or entirely overlaps with at least one of the other recording element array in an arrangement range along a width direction orthogonal to the conveyance direction and is spaced apart from the at least one of the other recording element array in the conveyance direction, the controller instructs the conveyor to perform the conveyance operation and instructs the ink discharger to perform an image recording operation for recording of an image on the recording medium by an ink discharging operation of each of the recording elements discharging ink according to image data, in the image recording operation, the ink discharging operation is performed by at least any of the recording elements belonging to two or more of the recording element arrays for each position along the width direction at each position along the conveyance direction in an overlapping region where arrangement ranges along the width direction of the two or more of the recording element arrays overlap each other, and when recording of the image is interrupted, the controller instructs the ink discharger to perform the image recording operation on a partial image other than an unrecorded portion caused by the interruption in the image.

[0011] According to the invention described in claim 2, in the inkjet recording device described in claim 1, the recording elements in each of the recording element arrays are disposed along the width direction, and
when recording of the image is interrupted, the controller interrupts the ink discharging operation by the recording element of an upper-most stream recording element array which is located at the upper-most stream in the conveyance direction among the two or more recording element arrays in the overlapping region, and thereafter continues the ink discharging operation by the recording element of the recording element array other than the upper-most stream recording element array among the two or more recording element arrays until a position at which the ink discharging operation by the recording element of the upper-most stream recording element array is interrupted on the recording medium in the conveyance direction.

[0012] According to the invention described in claim 3, in the inkjet recording device described in claim 1 or 2, when recording of the image is interrupted, the controller interrupts the ink discharging operation of the upper-most stream recording element provided in the upper-most stream in the conveyance direction among the recording elements, and thereafter continues the ink discharging operation by the recording element other than the upper-most stream recording element until a position at which the ink discharging operation by the upper-most stream recording element is interrupted on the recording medium in the conveyance direction.

[0013] According to the invention described in claim 4, the inkjet recording device described in any one of claims 1 to 3, further includes a position retriever which acquires positional information in the conveyance direction on the recording medium conveyed by the conveyor, wherein when recording of the image is interrupted, the controller acquires, with the position retriever, recording-interruption positions on the recording medium corresponding to the recording elements when the ink discharging operations by the recording elements are interrupted, acquires content-interruption positions corresponding to the recording elements on the image data at which the ink discharging operations by the recording elements are interrupted, instructs the ink discharger to perform the image recording operation on the partial image, and thereafter interrupts the conveyance operation by the conveyer, and at restart of recording of the image and the conveyance operation, the controller starts the conveyance operation of the recording medium in the conveyance direction such that the recording medium at the recording-interruption position corresponding to the upper-most stream recording element which is provided at the upper-most stream in the conveyance direction among the recording elements starts to move from a conveyance restart position upstream of a position at which ink is discharged from the upper-most stream recording element in the conveyance direction, and instructs each of the recording elements to restart the ink discharging operation at the content-interruption position corresponding to each of the recording elements at the time of the recording medium at the recording-interruption position corresponding to each of the recording elements reaching the position for each of the recording elements to discharge ink.

[0014] According to the invention described in claim 5, in the inkjet recording device described in claim 4, the controller instructs the conveyor to convey the recording medium reversely to the conveyance direction until the recording medium at the recording-interruption position corresponding to the upper-most stream recording element reaches the conveyance restart position after interruption of the conveyance operation.

[0015] According to the invention described in claim 6, the inkjet recording device described in any one of claims 1 to 5, including a plurality of the ink dischargers disposed at different positions from each other in the conveyance direction and configured to discharge ink of different colors from the recording elements, wherein the controller instructs the ink dischargers to record the images of different colors on the recording medium, and when recording of the images is interrupted, the controller instructs each of the ink dischargers to perform the image recording operation for the partial image in the image of the color corresponding to the ink discharger among the images.

[0016] According to the invention described in claim 7, in the inkjet recording device described in claim 6, the controller instructs the ink dischargers to record the images so as to be superimposed on each other on the recording medium, and when recording of the images is interrupted, the controller instructs each of the ink dis-

chargers to record the partial image in a same recording range on the recording medium.

[0017] In order to achieve the above object, in the invention of a method for controlling the inkjet recording device described in claim 8, the inkjet recording device includes: a conveyor configured to perform a conveyance operation of conveying a recording medium in a predetermined conveyance direction; and an ink discharger including recording elements discharging ink; wherein the recording elements form recording element arrays each of which is formed of two or more of the recording elements disposed in series in a direction intersecting the conveyance direction, each of the recording element arrays partially or entirely overlaps with at least one of the other recording element array in an arrangement range along a width direction orthogonal to the conveyance direction and is spaced apart from the at least one of the other recording element array in the conveyance direction, and the method includes: a recording step of instructing the conveyor to perform the conveyance operation and instructing the ink discharger to perform an image recording operation for recording of an image on the recording medium by an ink discharging operation of each of the recording elements discharging ink according to image data, in the image recording operation, the ink discharging operation is performed by at least any of the recording elements belonging to two or more of the recording element arrays for each position along the width direction at each position along the conveyance direction in an overlapping region where arrangement ranges along the width direction of the two or more of the recording element arrays overlap each other, and when recording of the image is interrupted in the recording step, the ink discharger is instructed to perform the image recording operation on a partial image other than an unrecorded portion caused by the interruption in the image.

EFFECTS OF THE INVENTION

[0018] In accordance with the present invention, there is an effect that the degradation of the quality of an image which was recorded by recording including interruption can be suppressed.

BRIEF DESCRIPTION OF DRAWINGS

[0019]

[FIG. 1] This illustrates a schematic configuration of an inkjet recording device.

[FIG. 2A] This is a schematic diagram of a configuration of a head unit.

[FIG. 2B] This is a partially enlarged view of the head unit.

[FIG. 3] This is a block diagram illustrating a main functional configuration of the inkjet recording device.

[FIG. 4] This is a block diagram of a functional configuration of a head unit drive controller.

[FIG. 5A] This explains an interruption operation of a conventional image recording operation.

[FIG. 5B] This explains the interruption operation of the conventional image recording operation.

[FIG. 6] This explains an interruption operation of an image recording operation according to the present embodiment.

[FIG. 7] This explains a restart operation of the image recording operation according to the embodiment.

[FIG. 8] This is a flow chart of a control procedure in an image recording processing.

[FIG. 9] This is a flow chart of a control procedure of the interruption processing called in the image recording processing.

[FIG. 10] This explains an interruption operation of an image recording operation according to a first modification.

DETAILED DESCRIPTION OF EMBODIMENTS

[0020] The inkjet recording device and a method for controlling the inkjet recording device according to the present invention will now be described in reference to the accompanying drawings.

[0021] Fig. 1 illustrates a schematic configuration of an inkjet recording device 1 according to an embodiment of the present invention.

[0022] The inkjet recording device 1 includes, for example, a conveyor 10 (conveyor), a recorder 20, a controller 30, and a medium detector 40.

[0023] The conveyor 10 includes, for example, a driving roller 11, a driven roller 12, a conveyor belt 13, a conveyor motor 14, a rotary encoder 15 (position retriever), a pressing roller 16, and a detaching roller 17.

[0024] The driving roller 11 is rotated around the rotational axis by driving of the conveyor motor 14. The conveyor belt 13 is looped, is supported at the inner face by the driving roller 11 and the driven roller 12 and is circled by the rotation of the driving roller 11. The driven roller 12 is rotated by circulation of the conveyor belt 13 around the rotational axis in parallel to the rotational axis of the driving roller 11. The conveyor belt 13 can be composed of a material that can be flexibly bent on the face of the driving roller 11 in contact with the driven roller 12 and can certainly support a recording medium M. For example, the conveyor belt 13 may be a rubber belt, a resin belt, or a steel belt. By the conveyor belt 13 including a material and/or has a configuration that adheres to the recording medium M, the recording medium M can be stably placed on the conveyor belt 13.

[0025] The conveyor motor 14 rotates the driving roller 11 at a rotation speed in response to control signals from the controller 30. The conveyor motor 14 can also be rotated reversely to the normal conveyance direction of the driving roller 11. After the conveyor belt 13 receives the recording medium M on its conveying face, the conveyor belt 13 circulates at a speed rate corresponding to

the rotation speed of the driving roller 11. The conveyor 10 thereby carries the recording medium M in the direction of the moving conveyor belt 13 (conveyance direction).

[0026] It should be noted that the recording medium M can be intermittently conveyed. For example, the conveyance by the conveyor 10 is suspended while ink droplets are discharged. The conveyance operation of the conveyor 10 involves suspension of conveyance as described above.

[0027] The recording medium M in form of a wound roll is drawn and fed onto the conveyor belt 13. An image is recorded on the recording medium M by the recorder 20, and then the recording medium M is wound onto another roll. It should be noted that the recording medium M may be a cut sheet with a predetermined size, where the recording medium M is fed onto the conveyor belt 13 from a sheet feeder. An image is recorded on the recording medium M, which is then conveyed by a paper ejector from the conveyor belt 13 to a predetermined paper receiver.

[0028] In the present embodiment, although the recording medium M is composed of a fabric cloth, the recording medium M may be any other medium, such as paper or a resin sheet on which discharged ink droplets can be fixed.

[0029] The conveyor 10 according to the embodiment can carry the recording medium M having a large size of about 2 meters in width, orthogonal to the conveyance direction. The recording medium M conveyed by the conveyor 10 may have a size smaller than about 2 meters in width. The conveyor 10 may have a structure that can carry the recording medium M having a size larger than 2 meters in width (for example, about 4 meters). The recording medium M that can be conveyed may have a maximum size smaller than 2 meters in width.

[0030] The rotary encoder 15 is mounted to the driving roller 11 and transmits pulse signals (detection signals) to the controller 30 and a head unit drive controller 211 (see Fig. 3) each time the driving roller 11 rotates by a predetermined angle. The rotary encoder 15 may have any configuration. The rotary encoder 15 may include, for example, a code wheel having slits disposed on a predetermined circumference and rotatable with the driving roller 11; a light emitter emitting light to the slits of the code wheel; and a light receiver detecting light emitted by the light emitter and passing through the slits. The pulse signals may be transmitted to the controller 30 and the head unit drive controller 211, based on the results of detection of light by the light receiver. The pulse signals may, for example, have the same cycle as the cycle of reception of the light passing through the slits and may be transmitted at the timing where two rectangular waves with phases shifted by 90° from each other (phase A and phase B) start to rise or fall. In such a configuration, the shifted phases A and B can detect the rotational direction of the driving roller 11.

[0031] The pressing roller 16 presses the recording medium M conveyed from the conveyor belt 13 against the conveying face of the conveyor belt 13 to remove uplift due to, for example, wrinkle of the recording medium M on the conveying face.

[0032] The detaching roller 17 pulls the recording medium M adhering to and fed by the conveyor belt 13 with a predetermined pressure and thereby draws the recording medium M from the conveying face to feed the recording medium M to a post-process device (not shown).

[0033] The recorder 20 includes four head units 21 (ink dischargers). Each head unit 21 includes multiple recording elements performing an ink discharging operation involving discharge of ink droplets based on image data. The recording elements discharge ink droplets to perform an image recording operation involving recording of an image on the recording medium M fed by the conveyor 10. The inkjet recording device 1 according to this embodiment includes four head units 21 that corresponds to four colors of yellow (Y), magenta (M), cyan (C), and black (K), respectively, and are disposed in the color sequence of Y, M, C, and K from the upstream of the recording medium M in the conveyance direction at predetermined intervals. In such a configuration, the head units 21 generate color images through discharge of the respective color ink droplets from the recording elements. The inkjet recording device 1 superimposes the Y, M, C, and K images in the same region of the recording medium M to record the color images of interest. The number of head units 21 is not limited to four and may be three or less or five or more depending on the number of colors of ink droplets used for recording of images.

[0034] Fig. 2A and 2B schematically illustrate a configuration of the head unit 21. Fig. 2A is a plan view of the entire head unit 21 facing the conveying face of the conveyor belt 13. Fig. 2B is a partially enlarged view of Fig. 2A.

[0035] The head unit 21 includes sixteen recording heads 212 each having multiple recording elements 213 that are disposed in series along the width direction for discharge of ink droplets. The recording elements 213 on the recording heads 212 each includes a pressure chamber reserving ink droplets, a piezoelectric element provided on the wall of the pressure chamber, and nozzles. The recording elements 213 receive drive signals, which cause the piezoelectric element to be deformed. The deformation of the piezoelectric element then causes the pressure chamber to be deformed, resulting in a variation in pressure in the pressure chamber. This causes the nozzles in communication with the pressure chamber to discharge ink droplets. Figs. 2A and 2B illustrate the positions of ink discharging ports of the nozzles in the recording elements 213. The direction of the recording elements 213 disposed in the recording heads 212 is not limited to the width direction orthogonal to the conveyance direction and may be a direction intersecting with the conveyance direction in an angle other than right angle.

[0036] The nozzles of the recording elements 213 in

each recording head 212 are disposed along the width direction at an interval of about 141 μm corresponding to 360 dots per inch (dpi). Pairs of recording heads 212 neighbor each other in the conveyance direction in a layout of the nozzles of the transversely staggered recording elements 213 and each pair defines a head module 212M. Thus, complementary discharge of ink droplets in the width direction by the recording elements 213 of the two recording heads 212 defining the head modules 212M enables images to be recorded in the resolution of 720 dpi along the width direction (the nozzles are disposed at the interval of about 70.5 μm).

[0037] In the head unit 21 of the set of line heads, eight head modules 212M are staggered so as to partially overlap with each other along the width direction in a layout allowing the nozzles to discharge ink droplets so that the discharge ranges are continuous along the width direction.

[0038] The head modules 212M overlap with each other along the width direction and are disposed in different positions in the conveyance direction. Thus, the recording heads 212 in the head modules 212M and the arrays of the recording elements 213 of the recording heads 212 (hereinafter referred to as recording element arrays) are disposed in a separates state in the conveyance direction. The recording element arrays in this embodiment are each disposed in any of four positions in the conveyance direction. For example, the two head modules 212M illustrated in Fig. 2B include four recording element arrays 214a and 214b, 214c and 214d (hereinafter also referred to as a recording element array 214 if they are not distinguished from each other) disposed in four different positions in this order from the upstream of the conveyance direction. All of the four recording element arrays 214a, 214b, 214c, and 214d include nozzles in the same positions in the conveyance direction. Hereinafter, the distances from the recording element array 214a disposed in the upper-most stream in the conveyance direction (the upper-most stream recording element array) to other recording element arrays 214b, 214c, and 214d are referred to as distances Db, Dc, and Dd, respectively. In this embodiment, the distance Db is about 19 mm, the distance Dc about 80 mm, and the distance Dd about 99 mm. In the embodiment, the recording elements 213 in the upper-most stream recording element arrays 214a are referred to as upper-most stream recording elements.

[0039] As illustrated in Fig. 2B, a pair of head modules 212M are disposed in overlapping positions along the width direction, and thus four recording element arrays 214a to 214d in the respective head modules 212M are disposed in an overlapping region A along the width direction. In this overlapping region A, any of the recording elements 213 belonging to the four recording element arrays 214a to 214d discharges ink droplets to positions along the width direction. Such a complementary ink discharging operation can reduce the occurrence of discontinuity of density at the connection portions of the head modules 212M.

[0040] In an overlapping region B other than the overlapping region A from the transversely overlapping region of the recording element arrays 214a and 214b in the head module 212M upstream of the conveyance direction, any of the recording elements 213 belonging to the recording element arrays 214a and 214b discharges ink droplets to positions along the width direction. In an overlapping region C other than the overlapping region A from the transversely overlapping region of the recording element arrays 214c and 214d in the head module 212M downstream of the conveyance direction, any of the recording elements 213 belonging to the recording element arrays 214c and 214d discharges ink droplets to positions along the width direction.

[0041] In this manner, in the image recording operation of the head units 21 in overlapping regions in the width direction of two or more recording element arrays 214, any of the recording elements 213 belonging to the two or more recording element arrays 214 discharges ink droplets to transverse positions on the recording medium M in the conveyance direction.

[0042] The region where the nozzles of the head units 21 are disposed along the width direction cover a transverse image-recordable region of the recording medium M conveyed by the conveyor belt 13. The head units 21 are fixed in positions during recording of the image. The head units 21 sequentially discharge ink droplets to different positions at predetermined intervals (conveyance-direction interval) in the conveyance direction in synchronization with the conveyance of the recording medium M to record the image by a single-path mode. The conveyance-direction interval, that is, recording resolution in the conveyance direction, which is determined by, for example, frequencies of discharge from the nozzles and conveyance speed, may be equal to or different from 720 dpi as described above.

[0043] The medium detector 40 is disposed upstream of the conveyance direction relative to the head units 21 and detects the abnormal placement of the recording medium M, such as uplift, and foreign substances on the recording medium M through a sensor. The sensor includes, for example, an emitter radiating a laser beam at a predetermined height from the conveying face along the width direction and a detector detecting the laser beam along the width direction at the opposite side to the emitter on the conveying face to detect blocking of the laser beams by uplift or foreign substances. The sensor may, however, have any configuration. For example, a line sensor may be used that captures the image on the face of the recording medium M to detect unevenness in color on the recording medium M due to a foreign substance or a shadowed uplift portion. The medium detector 40 is preferably disposed upstream of and away from the head units 21 such that the recording medium M is stopped before a site with detected abnormality reaches the position facing the head units 21 upon the detection of the abnormality on the recording medium M to stop

conveyance of the recording medium M.

[0044] Fig. 3 is a block diagram of a main functional configuration of the inkjet recording device 1.

[0045] The inkjet recording device 1 includes, for example, a conveyor driver 101 and a rotary encoder 15 provided in the conveyor 10, a head unit drive controller 211 and a recording head 212 provided in the head unit 21, a controller 30, a medium detector 40, an operation display 51, an input/output interface 52, and a bus 53. Among them, the controller 30 includes a central processing unit 31(CPU), a random access memory 32 (RAM), a read only memory 33 (ROM), and a storage 34. In this embodiment, the controller 30 and the head unit drive controller 211 define a controller.

[0046] The conveyor driver 101 transmits drive signals to the conveyor motor 14 in response to control signals from the CPU 31, causes the driving roller 11 to rotate at a predetermined rotation speed and thereby causes the conveyor belt 13 to move at a predetermined rate. The conveyor driver 101 varies the rotation speed of the driving roller 11 and eventually the moving rate of the conveyor belt 13 in response to control signals from the CPU 31. The conveyor driver 101 also causes the conveyor motor 14 to reversely rotate and the conveyor belt 13 to move reversely to the conveyance direction in response to control signals from the CPU 31.

[0047] The head unit drive controller 211 transmits drive signals instructing the piezoelectric elements to be deformed to the recording elements 213 of the recording heads 212 at appropriate timing according to data of an image to be recorded and thereby causes the recording elements 213 to discharge ink droplets. The drive signals are synchronized with pulse signals from the rotary encoder 15 that indicate the position of the recording medium M conveyed by the conveyor 10, for transmission.

[0048] Fig. 4 is a block diagram of a functional configuration of the head unit drive controller 211.

[0049] The head unit drive controller 211 includes recording head drive controllers 2112 corresponding to the respective sixteen recording heads 212 and a common controller 2111 controlling the recording head drive controllers 2112. The recording head drive controllers 2112 each include a discharge controller 2113 transmitting drive signals corresponding to the image data to the recording heads 212 at appropriate timing. The recording head drive controller 2112 interrupts the ink discharging operations of the recording elements 213 in reference to data stored in the a interruption position storage 2114 and a delay amount storage 2115 upon the reception of control signals instructing the interruption of the recording of an image from the common controller 2111 in response to a control signal from the controller 30. The recording head drive controller 2112 also instructs the ink discharging operation of the recording element 213 to restart in response to the reception of control signals instructing to restart recording. The processes of interruption and restart of recording will be detailed below.

[0050] The CPU 31 reads various programs and data stored in the ROM 33 and saves the programs and data in the RAM 32 to execute the programs for computation. The CPU 31 also supervises the overall operation of the inkjet recording device 1.

[0051] The RAM 32 provides the CPU 31 with memory space for work and stores temporary data. The RAM 32 may include a non-volatile memory.

[0052] The ROM 33 stores, for example, control programs executed by the CPU 31 and various pieces of data. The ROM 33 may be replaced with a rewritable non-volatile memory, such as electrically erasable programmable read only memory (EEPROM) and flash memory.

[0053] The storage 34 stores a print job (image recording instruction) inputted from an external device 2 through the input/output interface 52 and image data associated with the print job. Examples of the storage 34 include a hard disk drive (HDD), and a dynamic random access memory (DRAM) may be used in combination.

[0054] The operation display 51 includes a display, such as liquid crystal display or organic electro-luminescent (EL) display, and an input device, such as an operation keyboard or a touch panel appearing on the screen of the display. The operation display 51 presents various types of data on the display, converts an input operation by a user on the input device to operation signals and transmits the signals to the controller 30.

[0055] The input/output interface 52 intermediates transmission and reception of data between the external device 2 and the controller 30. The input/output interface 52 includes, for example, any one or combination of various serial interfaces and parallel interfaces.

[0056] The bus 53 is a route for transmission and reception of signals between the controller 30 and another component.

[0057] The external device 2 is, for example, a personal computer and transmits a print job and image data to the controller 30 through the input/output interface 52.

[0058] The interruption and restart of the image recording operation by the inkjet recording device 1 according to this embodiment will now be explained.

[0059] In the case where the head units 21 record an image in response to a print job, the conveyor 10 starts to convey the recording medium M, the head units 21 start to record the images, and the medium detector 40 starts to detect some type of abnormality on the recording medium M. If the medium detector 40 detects abnormality, such as uplift of the recording medium M, recording of the image and subsequent conveyance of the recording medium M are interrupted.

[0060] If a predetermined input operation on the operation display 51 is performed after elimination of the cause of abnormality on the recording medium M, the conveyance of the recording medium M and recording of the image are restarted.

[0061] Figs. 5A and 5B explain a conventional image recording operation involving a interruption operation. Figs. 5A and 5B illustrate a rectangular region where ink

droplets have been discharged on the recording medium M from the recording elements 213 of the head module 212M based on solid-image data.

[0062] The conventional interruption operation simultaneously interrupts the ink discharging operations of all the recording elements 213 of the head module 212M. Thus, as illustrated in Fig. 5A, the positions at which the recording elements 213 interrupted for discharging ink droplets stay on the recording medium M are defined by the positions of the recording elements 213 in the conveyance direction, and the recording elements 213 are not aligned with each other in the conveyance direction. In other words, in a region R in the conveyance direction of the recording medium M in Fig. 5A, only the recording element array 214a upstream of the conveyance direction transversely discharges ink droplets in the resolution of 360 dpi to record an image, and then the ink discharging operation is interrupted.

[0063] The recording of the image is restarted in this state. The recording element array 214b downstream of the conveyance direction discharges ink droplets in the region R and recording is completed in the resolution of 720 dpi along the width direction. As illustrated in Fig. 5B, the density of ink droplets in the region R is higher than that in a region Rn excluding the region R, which is recognized as unevenness in color. This is because ink droplets fixed on the recording medium M differently penetrate into the recording medium M between the region R in which the ink discharging operations of the two recording element arrays 214a and 214b are discontinued by a long interruption and another region Rn in which a complementary ink discharging operation is sequentially performed by the recording element arrays 214a, 214b.

[0064] More specifically, in the region Rn, the ink droplets discharged by the recording element arrays 214a and 214b in sequence penetrate into the recording medium M in a similar manner and are fixed. Meanwhile, in the region R, the ink droplets discharged by the recording element array 214a before interruption of recording penetrate into the recording medium M, and ink droplets discharged by the recording element array 214b after restart of recording overlie the fixed ink droplets. The ink droplets that overlie the already fixed ink droplets remain in the vicinity of the face of the recording medium M and do not readily penetrate into the recording medium M. Thus, the density of the ink droplets in the region R is relatively high.

[0065] Another example inkjet recording device discharging ink droplets at different timings in the same region on a recording medium is of a scanning type. The scanning inkjet recording device alternatingly repeats a primary scanning operation involving discharge of ink droplets from recording heads moving along the width direction of the recording medium and a secondary scanning operation involving movement of the recording medium on the conveyance direction to record an image. The time interval of the ink discharging operation onto the same region in a recording medium in each of the two continuous primary scanning operation is, for example, at least hundred times longer than the time interval of the ink discharging operation onto the same position in the conveyance direction on the recording medium from two recording element arrays disposed at different positions in the conveyance direction in the single-path inkjet recording device 1. Thus, in the scanning inkjet recording device, the difference in density of ink droplets between the two continuous primary scanning operations and the two discrete recording operations is much smaller than the difference in density of ink droplets between the region R and the region Rn in the inkjet recording device 1 according to this embodiment. In other words, in the single-path inkjet recording device 1 according to this embodiment, the unevenness in color generated at the restart of the recording of an image is noticeable compared to the scanning inkjet recording device.

[0066] Thus, in order to reduce generation of unevenness in color in the case of interrupting and restarting of recording in this embodiment, a predetermined interruption operation is performed before the interruption of the image recording operation, and a predetermined restart operation is performed at the restart of the image recording operation. The interruption operation and the restart operation, which will be described below, are performed in the four head units 21 separately from and in parallel to each other.

[0067] Fig. 6 explains the image recording operation involving the interruption operation according to this embodiment. Fig. 6 illustrates recording elements 213 of a pair of head modules 212M disposed in partially overlapping regions A, B, and C along the width direction and the positions of ink droplets discharged from the recording elements 213 on the recording medium M before the interruption operation is completed. Fig. 6 illustrates a pair of recording elements 213 disposed at same positions along the width direction in the overlapping region A. The recording elements 213 discharging ink droplets are illustrated by black circles, and those not discharging ink droplets are illustrated by white circles.

[0068] In the image recording operation before the interruption operation, the ink droplets are discharged from the recording elements 213 on the recording medium M carried by the conveyor 10. Thus ink droplets are discharged to regions r1 illustrated by white rectangles. At the completion of the ink discharging operation in the regions r1, in other words, at the completion of the ink discharging operations of the recording element arrays 214a, 214b, 214c, and 214d at positions pa1, pb1, pc1, and pd1 on the recording medium M in the conveyance direction, the interruption of the image recording operation is instructed, and the interruption operation starts.

[0069] In this embodiment, the conveyance of the recording medium M by the conveyor 10 is continued even after the start of the interruption operation. When the interruption operation starts, the ink discharging operation of the recording element array 214a in the upper-most stream in the conveyance direction is interrupted at the position pa1 on the recording medium M in the convey-

ance direction. The ink discharging operations of the remaining recording element arrays 214b, 214c, and 214d are continued until the ink discharging operation is completed on the position pa1 in the interrupted state of the ink discharging operation of the recording element array 214a. The ink discharging operations are then interrupted. In other words, the ink discharging operations are continued for respective periods (number of times) corresponding to the distances from the recording elements 213 of the recording element array 214a in the conveyance direction (i.e., the distances Db, Dc, and Dd) and are then interrupted. In more detail, after restart of the interruption operation, the ink discharging operation of the recording element array 214b is performed in regions rb1 extending from the position pb1 to the position pa1. The ink discharging operation of the recording element array 214c is performed in regions rc1 extending from the position pc1 to the position pa1. The ink discharging operation of the recording element array 214d is performed in regions rd1 extending from the position pd1 to the position pa1.

[0070] As a result, in a rectangular region R1 on the recording medium M ending at the position pa1 in the conveyance direction, the transverse ink discharging operations of the recording element arrays 214a to 214d at complementary positions are completed. In other words, in the overlapping region A in the region R1, the ink discharging operation is transversely performed by any one of the recording elements 213 belonging to the recording element arrays 214a to 214d at each position in the conveyance direction. In the overlapping region B in the region R1, the ink discharging operation is transversely performed by any one of the recording elements 213 belonging to the recording element arrays 214a and 214b at each position in the conveyance direction. In the overlapping region C in the region R1, the ink discharging operation is transversely performed by any one of the recording elements 213 belonging to the recording element arrays 214c and 214d at each position in the conveyance direction. The continuation number of times of the ink discharging operation of each recording element 213 of the recording element arrays 214b to 214d in the interruption operation is initially stored in the delay amount storage 2115 of the recording head drive controller 2112 illustrated in Fig. 4.

[0071] In this manner, in the case that the recording of images is interrupted, the image recording operation of the head unit 21 involving the complementary ink discharging operation in the overlapping regions A to C along the width direction is completed on parts, other than unrecorded portions due to the interruption, of an image of interest, in the present embodiment. As a result, the partial image has no regions with a recording resolution of 360 dpi along the width direction at the interruption of recording, unlike the conventional image recording operation, and the recording of partial images is completed in a resolution of 720 dpi along the width direction.

[0072] After the ink discharging operations of the recording element arrays 214a to 214d are completed, the conveyance of the recording medium M by the conveyor 10 is discontinued.

[0073] At the restart of the interrupted recording, the conveyor 10 reversely conveys the recording medium M until the position of the interrupted ink discharging operation of the recording element array 214a in the upper-most stream (recording-interruption position), in other words, the position pa1 is shifted to a conveyance restart position upstream of a predetermined distance from a recording position of the recording element array 214a (the position of the ink droplets to be discharged by the recording elements 213 in the conveyance direction). The conveyance of the recording medium M in the conveyance direction is restarted thereafter. The predetermined distance above is designated in a range that enables the conveyance rate to increase for appropriate discharge of ink droplets while the conveyance of the recording medium M by the conveyor 10 is restarted and the recording medium M at the position pa1 reaches the recording positions of the recording elements 213 of the recording element array 214a.

[0074] Fig. 7 explains the image recording operation involving the restart operation according to the present embodiment. Fig. 7 illustrates regions in which the restart operation is initiated and the recording elements 213 discharge ink droplets onto the recording medium M.

[0075] In the restart operation, when the recording medium M at the recording-interruption position at the interruption of the ink discharging operation of each recording element 213 reaches the recording positions of the recording elements 213, the recording elements 213 start to discharge ink droplets. In the restart operation, ink droplets are discharged in accordance with image data reflecting the content-interruption position at which the ink discharging operation is interrupted.

[0076] In other words, following the restart of the conveyance of the recording medium M, the recording medium M at the position pa1 reaches the recording positions of the recording elements 213 of the recording element array 214a, and then the recording element array 214a in the upper-most stream of the conveyance direction restarts to discharge ink droplets. The remaining recording element arrays 214b, 214c, and 214d restart to discharge ink droplets at time points after delay of the number of times according to the distances Db, Dc, and Dd (illustrated in the drawing). In other words, the ink discharging operations of the recording element arrays 214b, 214c, and 214d are delayed until the recording medium M at the position pa1 reaches the recording positions of the recording elements 213 of the recording element arrays. The delayed amount corresponds to the continuation number of times of the ink discharging operation of each recording element array 214 in the interruption operation. Thus, the delayed number of times of the ink discharging operation of the recording elements 213 of the recording element arrays 214b to 214d in the restart operation is the same as the continuation number

of times of the ink discharging operation stored in the delay amount storage 2115 of the recording head drive controller 2112 in the interruption operation. Thus, in the case that the ink discharging operation of each recording element 213 is interrupted at the same position in the conveyance direction of the recording medium M as in this embodiment, the timing for the restart of the ink discharging operation of the recording element 213 may be determined by delay of the time of the recording medium M reaching the recording-interruption position of the recording element array 214a in the upper-most stream by the delay time (continuation number of times) of the ink discharging operation stored in the delay amount storage 2115 for each recording element 213.

[0077] In other words, in the restart operation, the conveyance of the recording medium M is restarted and then the recording medium M at the position pa1 reaches the recording position of each recording element 213 of the recording element array 214a. As illustrated in Fig. 7, the recording elements 213 of the recording element array 214a start to discharge ink droplets in regions ra2 extending from the position pa1 to the position pa2. When the recording medium M at the position pa1 reaches the recording position of the recording element array 214b, the recording elements 213 of the recording element array 214b start to discharge ink droplets in regions rb2 extending from the position pa1 to the position pb2. When the recording medium M at the position pa1 reaches the recording position of the recording element array 214c, the recording elements 213 of the recording element array 214c start to discharge ink droplets in regions rc2 extending from the position pa1 to the position pc2. When the recording medium M at the position pa1 reaches the recording position of the recording element array 214d, then all the recording element arrays 214a to 214d discharge ink droplets in regions r2 illustrated by white rectangles in Fig. 7.

[0078] An image recording processing performed in the inkjet recording device 1 will now be described.

[0079] Fig. 8 is a flow chart of a control procedure of the image recording processing in the inkjet recording device 1 according to the present embodiment.

[0080] This image recording processing is performed when the controller 30 receives a print job and image data from the external device 2 via the input/output interface 52.

[0081] At the start of the image recording processing, the controller 30 transmits control signals to the conveyor driver 101 to drive the conveyor motor 14 that causes the conveyor 10 to start the conveyancering operation and the medium detector 40 to start to operate (Step S101).

[0082] The controller 30 instructs the head units 21 to start the image recording operations (Step S102). In other words, the controller 30 instructs image data stored in the storage 34 to be transmitted from the head unit drive controller 211 to the recording heads 212 at timing appropriate to the position, indicated by pulse signals of the rotary encoder 15, of the recording medium M conveyed by the conveyor 10 and instructs the recording elements 213 of the head units 21 to discharge ink droplets onto the recording medium M.

[0083] The controller 30 instructs the medium detector 40 to check for abnormality on the recording medium M (Step S103). If abnormality is detected ("NO" in Step S103), a interruption processing is called (Step S106).

[0084] After the interruption processing, the controller 30 checks for the restart of the image recording operation (Step S107). If the recording operation is restarted ("YES in Step S107), the process goes to Step S103. If the recording operation is not restarted ("NO" in Step S107), the process of the controller 30 goes to Step S105.

[0085] If no abnormality on the recording medium M is detected in the process of Step S103 ("YES" in Step S103), the controller 30 checks for the termination of recording of all the images that are designated by a print job (Step S104). If the recording is not terminated ("NO" in Step S104), the process of the controller 30 goes to Step S103.

[0086] If the recording of all the designated images is terminated ("YES" in Step S104) or the process in Step S107 is terminated, the controller 30 performs various processes associated with the termination of the image recording (Step S105). The controller 30 stops the conveyor motor 14 and informs that the image recording is terminated. The controller 30 deletes the setting of the print job and image data of interest that are stored in the storage 34. The controller 30 then terminates the image recording processing.

[0087] Fig. 9 is a flow chart of a control procedure of the interruption processing called in the image recording processing. After the interruption processing is called, the controller 30 transmits control signals instructing the head unit drive controller 211 to terminate the image recording operation.

[0088] Upon reception of the control signals, the head unit drive controller 211 instructs the image recording operation involving the interruption operation to be performed and retrieves a recording-interruption position and an content-interruption position for interruption of the ink discharging operations of the recording elements 213 (Step S201). In other words, the head unit drive controller 211 instructs the common controller 2111 to transmit predetermined control signals to the recording head drive controller 2112 and instructs the recording head drive controller 2112 to interrupt the ink discharging operations of the recording elements 213 in the recording heads 212 at the timing described above. The discharge controller 2113 in the recording head drive controller 2112 retrieves the continuation number of times of the ink discharging operation stored in the delay amount storage 2115 for each recording element 213 and instructs the recording elements 213 to discharge ink droplets in the continuation number of times in synchronization with pulse signals from the rotary encoder 15 and to interrupt the ink discharging operation thereafter. The discharge controller

2113 also retrieves the position of the recording medium M at the completion of the ink discharging operations of the recording elements 213 involved by the interruption operation (i.e., a pulse signal count value from the rotary encoder 15 or the recording-interruption position) and the position of the completed ink discharging operations of the recording elements 213 on image data (the content-interruption position) and stores these positions in the interruption position storage 2114. The process of Step S201 is independently performed by each recording head drive controller 2112.

[0089] After the process in Step S201, the controller 30 transmits control signals to the conveyor driver 101 to gradually decrease the speed of the conveyor 10 conveying the recording medium M in accordance with a predetermined profile, so that the conveyance of the recording medium M is interrupted (Step S202). It should be noted that the process in Step S202 may start before the completion of the interruption operation involved in the image recording operation in Step S201. In this case, the controller 30 controls the operation of the conveyor 10 such that the conveyance of the recording medium M is stopped after the completion of the interruption operation involved in the image recording operation.

[0090] The controller 30 checks for reception of an image recording operation restarting command (Step S203). The image recording operation restarting command is received in response to a predetermined input operation on the operation display 51 by a user (an instructing operation). If the image recording operation restarting command is not received ("NO" in Step S203), the controller 30 checks for reception of an image recording operation stop command (Step S207). The image recording operation stop command is received in response to a predetermined input operation on the operation display 51 by a user, like the image recording restarting command. If the image recording operation stop command is not received ("NO" in Step S207), the controller 30 goes to the process in Step S203. If the image recording operation stop command is received ("YES" in Step S207), the controller 30 terminates the interruption processing and returns to the image recording processing.

[0091] If the image recording operation restarting command is received ("YES" in Step S203), the controller 30 transmits control signals to the conveyor driver 101 and instructs the conveyor driver 101 to reversely convey the recording medium M until the recording medium M at the position pa1 reaches the conveyance restart position (Step S204).

[0092] The controller 30 transmits control signals to the conveyor driver 101 and instructs the conveyor 10 to restart the conveyance of the recording medium M and gradually increase the conveyance speed according to a predetermined profile (Step S205).

[0093] The controller 30 transmits control signals to the head unit drive controller 211 with respect to the restart of the image recording operation. Upon reception of the control signals, the head unit drive controller 211 performs the operation to restart the recording of images (Step S206). In other words, the head unit drive controller 211 transmits predetermined control signals from the common controller 2111 to the recording head drive controller 2112 and instructs the recording head drive controller 2112 to restart the ink discharging operations of the recording elements 213 of the recording heads 212 at the time described above. The discharge controller 2113 in the recording head drive controller 2112 restarts the ink discharging operations at the time of the recording medium M reaching the recording-interruption position stored in the interruption position storage 2114 for each recording element 213. The ink discharging operations are performed in accordance with the image data after the content-interruption position stored in the interruption position storage 2114.

[0094] The timing for restart of the ink discharging operation may be delayed from the time of the recording medium M reaching the recording-interruption position associated with the recording element array 214a in the upper-most stream by the continuation number of times of a delayed ink discharging operation stored in the delay amount storage 2115. In this case, in the process of Step S201, the discharge controller 2113 may store only the recording-interruption position associated with the recording element array 214a in the upper-most stream in the interruption position storage 2114.

[0095] In the present embodiment, in the process of Step S201, only the content-interruption position associated with any one of the recording elements 213 (for example, of the recording element array 214a in the upper-most stream) is stored in the interruption position storage 2114. In the process of Step S206, the content-interruption position of each recording element 213 may be identified based on the stored content-interruption position.

[0096] The process in Step S206 may start after the conveyance speed of the recording medium M is increased and is constant in the process of Step S205 or when the conveyance speed is gradually increasing.

[0097] At the termination of the process in Step S206, the controller 30 terminates the interruption processing and returns to the image recording control processing.

(First Modification)

[0098] A first Modification of the present embodiment will now be described. The interruption operation according to the first modification is different from the embodiment in that the positions of the interrupted ink discharging operations of the recording elements 213 in the conveyance direction of the recording medium M are distinct among the head modules 212M. The difference of the first modification from the present embodiment will now be described.

[0099] Fig. 10 explains an image recording operation involving a interruption operation according to the first modification.

[0100] In the interruption operation according to the first modification, ink discharging operations of recording elements 213 of recording element arrays 214a to 214d disposed in an overlapping region A are continued to a position pa1 and are then interrupted. The ink discharging operations of the recording elements 213 of the recording element arrays 214a and 214b disposed in an overlapping region B are continued to a position pa1 and are then interrupted.

[0101] Meanwhile, the ink discharging operations of the recording elements 213 of the recording element arrays 214c and 214d disposed in an overlapping region C are continued to the position pc1 and are then interrupted. In other words, the ink discharging operations of the recording elements 213 of the recording element array 214c disposed in the overlapping region C are interrupted before the start of the interruption operation. The ink discharging operations of the recording elements 213 of the recording element arrays 214d disposed in the overlapping region C are continued for period (number of times) corresponding to the distance between the recording element arrays 214c and 214d in the conveyance direction (i.e., the difference between the distance Dd and the distance Dc) and are then interrupted.

[0102] Thus, in the first modification, the recording element array 214a is in the upper-most stream of the overlapping regions A and B, and the recording element array 214c is in the upper-most stream of the overlapping region C.

[0103] Such a interruption operation allows for completion of the image recording operation on parts other than an unrecorded portions of an image of interest due to the interruption of recording in a rectangular region R1 that is defined by the upstream end of the recording medium M in the conveyance direction and corresponds to the layout of the head module 212M.

[0104] As in the first modification, the positions of the interrupted ink discharging operations of the recording elements 213 in the conveyance direction of the recording medium M may not be same (that is, may not be aligned on a line) in the case that complementary image recording operations of head units 21 on the partial image are completed. In the first modification, the positions of the interrupted ink discharging operations on the recording medium M are distributed in rectangles. Alternatively, these positions may be disposed in an inclination distribution in the conveyance direction and the width direction or may be disposed on a curved line.

(Second Modification)

[0105] A second modification of the present embodiment will now be described. An interruption operation according to the second modification is different from that according to the present embodiment in that each of four head units 21 records partial image in the same recording region on the recording medium M. The difference of the second modification from the present embodiment will now be described.

[0106] In the present embodiment, the interruption operation is independently performed in the head units 21, and thus the regions of partial images recorded by the head units 21 are different according to the positions of the head units 21 in the conveyance direction.

[0107] In the second modification, the interruption operation is performed after the four head units 21 corresponding to the respective colors of Y, M, C, and K record partial images in the same region on the recording medium M, and then the ink discharging operations of the recording elements 213 are interrupted. That is, the ink discharging operations of the recording elements 213 of the four head units 21 are continued to the position of the interrupted ink discharging operation of the recording element 213 in the upper-most stream of the head unit 21 for Y in the upper-most stream, and then the ink discharging operations are interrupted. In other words, the interruption operation according to the second modification causes the four head units 21 to complete the respective image recording operations on the partial images other than unrecorded parts of color images of interest caused by interruption to record the partial images colored by four inks. At the restart of the image recording operation, the recording medium M is reversely conveyed such that the recording medium M at the recording-interruption position of the recording element 213 in the upper-most stream of the head unit 21 corresponding to Y reaches the position that is upstream of the recording position of the recording element 213 in the conveyance direction and the recording restarts. The conveyance of the recording medium M in the conveyance direction then restarts. The recording elements 213 in the four head units 21 discharge ink droplets onto the unrecorded the partial images.

[0108] As described above, the inkjet recording device 1 according to the present embodiment and the modifications thereof includes a conveyor 10 configured to perform a conveyance operation of conveying a recording medium M in a predetermined conveyance direction; a head unit 21 which has recording elements 213 discharging ink; and a controller 30 and a head unit drive controller 211 to control operations of the conveyor 10 and the head unit 21. The recording elements 213 form recording element arrays 214 each of which is formed of two or more of the recording elements disposed in series in a direction intersecting the conveyance direction, each of the recording element arrays 214 partially or entirely overlaps with at least one of the other recording element array 214 in an arrangement range along a width direction orthogonal to the conveyance direction and is spaced apart from the at least one of the other recording element array 214 in the conveyance direction, the controller 30 and the head unit drive controller 211 as the controller instructs the conveyor 10 to perform the conveyance operation and instructs the head unit 21 to perform an image recording operation for recording of an image on the recording medium M by an ink discharging operation of each of the

recording elements 213 discharging ink according to image data,
in the image recording operation, the ink discharging operation is performed by at least any of the recording elements 213 belonging to two or more of the recording element arrays 214 for each position along the width direction at each position along the conveyance direction in an overlapping region A to C where arrangement ranges along the width direction of the two or more of the recording element arrays 214 overlap each other, and when recording of the image is interrupted, the controller instructs the head unit 21 to perform the image recording operation on a partial image other than an unrecorded portion caused by the interruption in the image.

[0109] Such a configuration does not generate a region in which the ink discharging operations of part of the recording elements 213 are not completed in a partial image other than an unrecorded portion caused by interruption in an image of the recording target. Thus, no ink droplet is discharged onto a region in which ink droplets have been discharged before the interruption of recording, after the restart of recording. This can achieve alignment of time intervals for ink droplets to be discharged and overlaid among the recorded portion recorded before interruption of recording in the image of the recording target and the portion recorded at the restart of recording. As a result, the unevenness in color at the restart of recording of the image can be reduced.

[0110] The recording elements 213 in each of the recording element arrays 214 are disposed along the width direction, and when recording of the image is interrupted, the controller 30 and the head unit drive controller 211 interrupts the ink discharging operation by the recording element 213 of an upper-most stream recording element array 214 which is located at the upper-most stream in the conveyance direction among the two or more recording element arrays 214 in each of the overlapping regions A to C, and thereafter continues the ink discharging operation by the recording element 213 of the recording element array 214 other than the upper-most stream recording element array 214 among the two or more recording element arrays until a position at which the ink discharging operation by the recording element 213 of the upper-most stream recording element array 214 is interrupted on the recording medium M in the conveyance direction (controller).

[0111] Thus, when recording of the image is interrupted, in each of the overlapping regions in the partial image, the image recording operation involving the complementary ink discharging operation by recording element arrays 214 is performed, and thereafter the ink discharging operation is interrupted. As a result, there is no unfinished region of the ink discharging operation by a part of of the recording element arrays 214 in the overlapping regions of the partial image. Thus, after restart of recording, ink droplets are not discharged onto the region in which ink droplets have been discharged before the interruption of recording.

[0112] When recording of the image is interrupted, the controller 30 and the head unit drive controller 211 interrupt the ink discharging operation of the upper-most stream recording element provided in the upper-most stream in the conveyance direction among the recording elements 213, and thereafter continues the ink discharging operation by the recording element 213 other than the upper-most stream recording element until a position at which the ink discharging operation by the upper-most stream recording element is interrupted on the recording medium in the conveyance direction (controller). Thus, the boundary of a region where ink is discharged before the interruption of recording of an image and a region where ink is discharged after the restart of recording lies on a straight line. The boundary can be minimized and is thus less noticeable.

[0113] The inkjet recording device 1 further includes a rotary encoder 15 which acquires positional information in the conveyance direction on the recording medium M conveyed by the conveyor 10. When recording of the image is interrupted, the controller 30 and the head unit drive controller 211 acquire, with the rotary encoder 15, recording-interruption positions on the recording medium M corresponding to the recording elements 213 when the ink discharging operations by the recording elements are interrupted, acquires content-interruption positions corresponding to the recording elements 213 on the image data at which the ink discharging operations by the recording elements 213 are interrupted, instructs the head unit 21 to perform the image recording operation on the partial image, and thereafter interrupts the conveyance of the recording medium M by the conveyor 10, and at restart of recording of the image and the conveyance operation, the controller 30 and the head unit drive controller 211 start the conveyance operation of the recording medium M in the conveyance direction such that the recording medium M at the recording-interruption position corresponding to the upper-most stream recording element which is provided at the upper-most stream in the conveyance direction among the recording elements 213 starts to move from a conveyance restart position upstream of a position at which ink is discharged from the upper-most stream recording element in the conveyance direction among the recording elements 213, and instruct each of the recording elements 213 to restart the ink discharging operation at the content-interruption position corresponding to each of the recording elements 213 at the time of the recording medium M at the recording-interruption position corresponding to each of the recording elements 213 reaching the position for each of the recording elements 213 to discharge ink (controller). Such a configuration can certainly reduce the defects arising from droplets overlaid on or spaced apart from each other before interruption of recording and after restart of recording, with a simplified process. As a result, the degradation of the image quality can be more certainly reduced in the position at which the recording of an image is interrupted.

[0114] The controller 30 instructs the conveyor 10 to convey the recording medium M reversely to the conveyance direction until the recording medium M at the recording-interruption position corresponding to the upper-most stream recording element reaches the conveyance restart position after interruption of the conveyance operation (controller). Such a configuration can readily convey the recording medium M at the recording-interruption position corresponding to the upper-most stream recording element to the conveyance restart position. Specifically, a position of a long continuous paper sheet or a cloth cannot be moved by rotation in the usual conveyance direction of the conveyor belt 13. Thus, the automatic conveyance instead of the manual conveyance in the reversed direction can save labor of a user.

[0115] The inkjet recording device 1 includes multiple head units 21 disposed at different positions from each other in the conveyance direction and configured to discharge ink of different colors from the recording elements 213. The controller 30 and the head unit drive controller 211 instruct the head units 21 to record the images of different colors on the recording medium M, and when recording of the images is interrupted, the controller 30 and the head unit drive controller 211 instruct each of the head units 21 to perform the image recording operation for the partial image in the image of the color corresponding to the head unit 21 among the images.
(controller). Thus, in each of the partial images of different colors, after the restart of recording, ink droplets of the color are not discharged onto region where the ink of the color corresponding to the partial image has been discharged before interruption of recording. Thus, the alignment of the time intervals for inks to be discharged and overlaid can be achieved among the parts recorded before interruption of recording in images of respective colors and the parts to be recorded after the restart of recording. As a result, the unevenness in color of images at the restart of recording can be reduced, and the degradation of quality of the recorded images can be reduced.

[0116] The controller 30 and the head unit drive controller 211 according to the second modification instruct the head units 21 to record the images so as to be superimposed on each other on the recording medium M, and when recording of the images is interrupted, the controller 30 and the head unit drive controller 211 instruct each of the head units 21 to record the partial image in a same recording range on the recording medium M (controller). Such a configuration can achieve the alignment of time intervals for droplets with different colors to be discharged and overlaid by the head units 21 in the recorded portions of the images before the interruption of recording and the portions to be recorded at the restart of the recording on the recording medium. As a result, unevenness in color of images at the restart of the recording can be reduced when images with different colors are superimposed to record color image.

[0117] By controlling the inkjet recording device 1 in the controlling method described above, after the restart of recording, ink droplets not to be discharged onto the regions in which ink droplets have been discharged before the interruption of the recording. Thus, the alignment of the time intervals for inks to be discharged and overlaid can be achieved among the parts recorded before and after interruption of recording. As a result, the unevenness in color of images at the restart of recording can be reduced.

[0118] The present invention should not be limited to the embodiment and the modifications described above and may include any other modification.

[0119] For example, the present embodiment and the modifications have been described with respect to the control of restart of recording of images after the interruption of recording. In the case of defects on the recorded images before the interruption, however, the images need not necessarily be recorded following the recorded image recorded before interruption. New images may be recorded again after interruption of recording of the previous image.

[0120] In the present embodiment and the modifications, any one of the recording elements 213 of the recording element arrays 214a to 214d discharges ink droplets at each position in the overlapping region A along the width direction. Alternatively, recording elements 213 which are located at a same position in the width direction may discharge ink droplets to complementary positions in the conveyance direction in the overlapping region A.

[0121] In the present embodiment and the modifications, any one of the recording elements 213 discharges ink droplets for each position in the width direction at each position in the conveyance direction on the recording medium M. Alternatively, multiple recording elements 213 disposed at different positions in the conveyance direction may discharge and overlay ink droplets for each position along the width direction.

[0122] The interruption operation according to the present embodiment and the modifications can be omitted, for example, in the case of an interlock mechanism actuated due to an earthquake or opening of a protection door of the inkjet recording device 1 or in the case of an emergency stop due to external transmission of an emergency stop instruction.

[0123] The interruption operation according to the present embodiment and the modifications automatically starts based on the results of detection by the medium detector 40. Alternatively, a supervisor may visually find abnormality on the recording medium and manually start the interruption operation through an input operation on the operation display 51.

[0124] In the present embodiment and the modifications, after the interruption of recording of images, a user enters a restarting command on the operation display 51 at the restart. In the case that the inkjet recording device 1 can automatically eliminate the cause of the interruption, for example, by an automatic appropriate operation

of the pressing roller 16 for elimination of wrinkles, the image recording may be restarted without an entry operation by the user.

[0125] In the present embodiment and the modifications, the CPU 31 calculates the conveyance restart position, and the conveyor 10 reversely conveys the recording medium M to the conveyance restart position. Alternatively, the user may manually rotate the driving roller 11 to reversely convey the recording medium M by an appropriate distance.

[0126] If the recording medium M is a cut sheet instead of a long cloth or a continuous paper sheet, the recording medium M need not be reversely conveyed but can be circulated by less than one rotation around the entire loop of the conveyor belt 13 to the conveyance restart position.

[0127] In the present embodiment and the modifications, the driving roller 11 and the driven roller 12 circulate the conveyor belt 13. However, the number of rollers is not limited to two. Three or more rollers may be employed to turn the conveyance path of the recording medium M.

[0128] In the present embodiment and the modifications, a rotary encoder 15 detects the rotational amount of the driving roller 11. Alternatively, the rotary encoder 15 may detect the rotational amount of the driven roller 12 or the conveyor motor 14.

[0129] The rotary encoder 15 may be replaced with any other type of position retriever, for example, a magnetic linear encoder including a magnetic pickup that reads the magnetic pole face of a magnetic scale provided on the conveyor belt 13.

[0130] In the present embodiment and the modifications, the conveyor 10 including the conveyor belt 13 conveys the recording medium M. Alternatively, the conveyor 10 may include, for example, a rotating conveying drum that holds the recording medium M on its peripheral face.

[0131] Although several embodiments of the present invention have been described above, the scope of the present invention is not limited to the above described embodiments and includes the scope of the present invention that is described in the claims and the equivalents thereof.

INDUSTRIAL APPLICABILITY

[0132] The present invention can be used in an inkjet recording device and a method of controlling the inkjet recording device.

EXPLANATION OF REFERENCE NUMERALS

[0133]

1 INKJET RECORDING DEVICE
2 EXTERNAL DEVICE
10 CONVEYOR
101 CONVEYOR DRIVER
11 DRIVING ROLLER
12 DRIVEN ROLLER
13 CONVEYOR BELT
14 CONVEYOR MOTOR
15 ROTARY ENCODER
16 PRESSING ROLLER
17 DETACHING ROLLER
20 RECORDER
21 HEAD UNIT
211 HEAD UNIT DRIVE CONTROLLER
2111 COMMON CONTROLLER
2112 RECORDING HEAD DRIVE CONTROLLER
2113 DISCHARGE CONTROLLER
2114 INTERRUPTION POSITION STORAGE
2115 DELAY AMOUNT STORAGE
212 RECORDING HEAD
212M HEAD MODULE
213 RECORDING ELEMENT
214A, 214B, 214C, 214D RECORDING ELEMENT ARRAY
30 CONTROLLER
31 CPU
32 RAM
33 ROM
34 STORAGE
40 MEDIUM DETECTOR
51 OPERATION DISPLAY
52 INPUT/OUTPUT INTERFACE
53 BUS
A, B, C OVERLAPPING REGION
M RECORDING MEDIUM

Claims

1. An inkjet recording device comprising:

a conveyor configured to perform a conveyance operation of conveying a recording medium in a predetermined conveyance direction;
an ink discharger including recording elements discharging ink; and
a controller to control operations of the conveyor and the ink discharger, wherein
the recording elements form recording element arrays each of which is formed of two or more of the recording elements disposed in series in a direction intersecting the conveyance direction,
each of the recording element arrays partially or entirely overlaps with at least one of the other recording element array in an arrangement range along a width direction orthogonal to the conveyance direction and is spaced apart from the at least one of the other recording element array in the conveyance direction,
the controller instructs the conveyor to perform the conveyance operation and instructs the ink discharger to perform an image recording operation for recording of an image on the recording

medium by an ink discharging operation of each of the recording elements discharging ink according to image data,
in the image recording operation, the ink discharging operation is performed by at least any of the recording elements belonging to two or more of the recording element arrays for each position along the width direction at each position along the conveyance direction in an overlapping region where arrangement ranges along the width direction of the two or more of the recording element arrays overlap each other, and when recording of the image is interrupted, the controller instructs the ink discharger to perform the image recording operation on a partial image other than an unrecorded portion caused by the interruption in the image.

2. The inkjet recording device according to claim 1, wherein
the recording elements in each of the recording element arrays are disposed along the width direction, and
when recording of the image is interrupted, the controller interrupts the ink discharging operation by the recording element of an upper-most stream recording element array which is located at the upper-most stream in the conveyance direction among the two or more recording element arrays in the overlapping region, and thereafter continues the ink discharging operation by the recording element of the recording element array other than the upper-most stream recording element array among the two or more recording element arrays until a position at which the ink discharging operation by the recording element of the upper-most stream recording element array is interrupted on the recording medium in the conveyance direction.

3. The inkjet recording device according to claim 1 or 2, wherein, when recording of the image is interrupted, the controller interrupts the ink discharging operation of the upper-most stream recording element provided in the upper-most stream in the conveyance direction among the recording elements, and thereafter continues the ink discharging operation by the recording element other than the upper-most stream recording element until a position at which the ink discharging operation by the upper-most stream recording element is interrupted on the recording medium in the conveyance direction.

4. The inkjet recording device according to any one of claims 1 to 3, further comprising a position retriever which acquires positional information in the conveyance direction on the recording medium conveyed by the conveyor, wherein
when recording of the image is interrupted, the controller acquires, with the position retriever, recording-interruption positions on the recording medium corresponding to the recording elements when the ink discharging operations by the recording elements are interrupted, acquires content-interruption positions corresponding to the recording elements on the image data at which the ink discharging operations by the recording elements are interrupted, instructs the ink discharger to perform the image recording operation on the partial image, and thereafter interrupts the conveyance operation by the conveyer, and at restart of recording of the image and the conveyance operation, the controller starts the conveyance operation of the recording medium in the conveyance direction such that the recording medium at the recording-interruption position corresponding to the upper-most stream recording element which is provided at the upper-most stream in the conveyance direction among the recording elements starts to move from a conveyance restart position upstream of a position at which ink is discharged from the upper-most stream recording element in the conveyance direction, and instructs each of the recording elements to restart the ink discharging operation at the content-interruption position corresponding to each of the recording elements at the time of the recording medium at the recording-interruption position corresponding to each of the recording elements reaching the position for each of the recording elements to discharge ink.

5. The inkjet recording device according to claim 4, wherein the controller instructs the conveyor to convey the recording medium reversely to the conveyance direction until the recording medium at the recording-interruption position corresponding to the upper-most stream recording element reaches the conveyance restart position after interruption of the conveyance operation.

6. The inkjet recording device according to any one of claims 1 to 5, comprising a plurality of the ink dischargers disposed at different positions from each other in the conveyance direction and configured to discharge ink of different colors from the recording elements, wherein
the controller instructs the ink dischargers to record the images of different colors on the recording medium, and
when recording of the images is interrupted, the controller instructs each of the ink dischargers to perform the image recording operation for the partial image in the image of the color corresponding to the ink discharger among the images.

7. The inkjet recording device according to claim 6, wherein
the controller instructs the ink dischargers to record

the images so as to be superimposed on each other on the recording medium, and
when recording of the images is interrupted, the controller instructs each of the ink dischargers to record the partial image in a same recording range on the recording medium.

8. A method of controlling an inkjet recording device including: a conveyor configured to perform a conveyance operation of conveying a recording medium in a predetermined conveyance direction; and an ink discharger including recording elements discharging ink; wherein the recording elements form recording element arrays each of which is formed of two or more of the recording elements disposed in series in a direction intersecting the conveyance direction, each of the recording element arrays partially or entirely overlaps with at least one of the other recording element array in an arrangement range along a width direction orthogonal to the conveyance direction and is spaced apart from the at least one of the other recording element array in the conveyance direction, the method comprising:

a recording step of instructing the conveyor to perform the conveyance operation and instructing the ink discharger to perform an image recording operation for recording of an image on the recording medium by an ink discharging operation of each of the recording elements discharging ink according to image data, wherein
in the image recording operation, the ink discharging operation is performed by at least any of the recording elements belonging to two or more of the recording element arrays for each position along the width direction at each position along the conveyance direction in an overlapping region where arrangement ranges along the width direction of the two or more of the recording element arrays overlap each other, and
when recording of the image is interrupted in the recording step, the ink discharger is instructed to perform the image recording operation on a partial image other than an unrecorded portion caused by the interruption in the image.

FIG.1

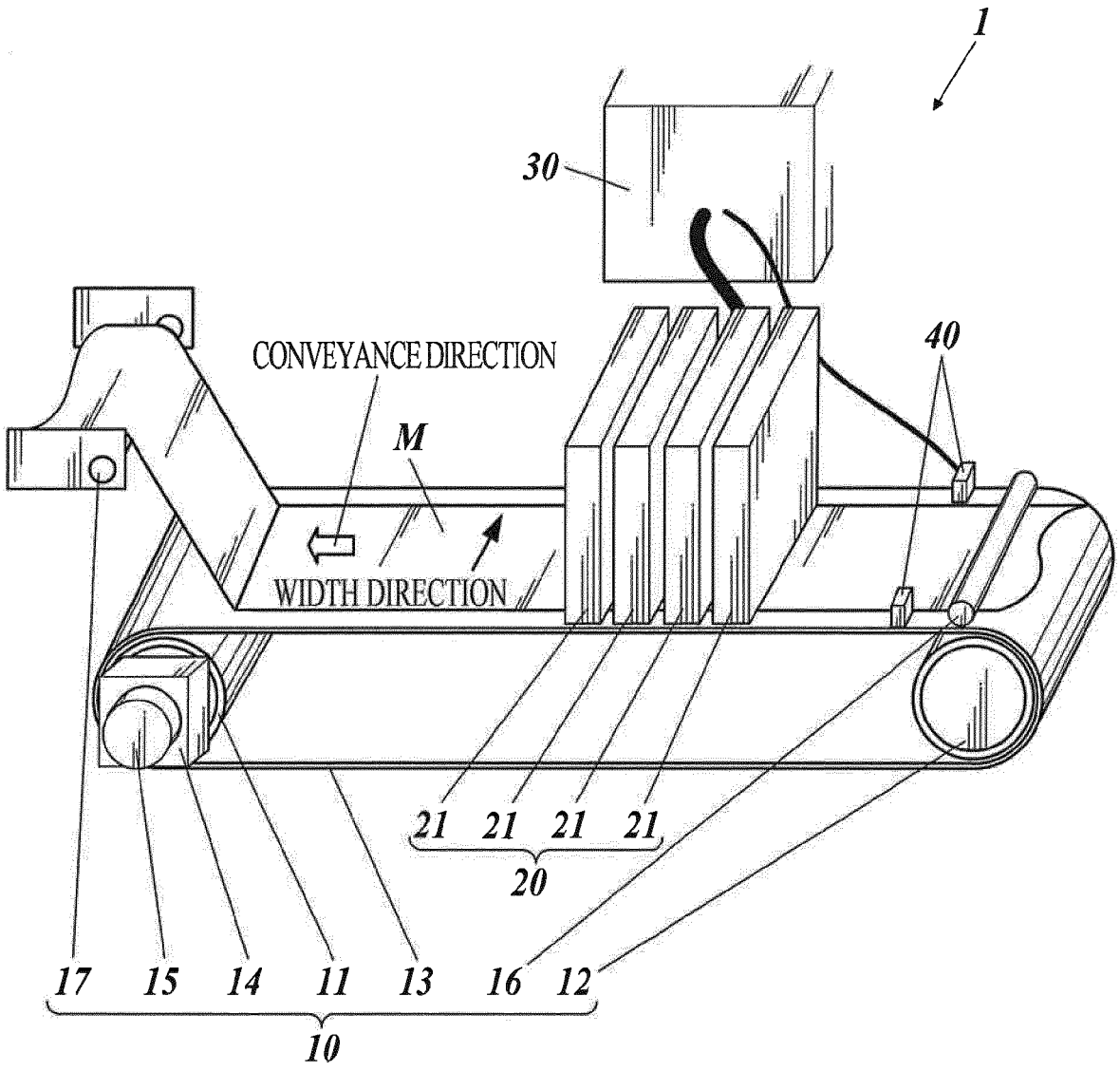

1
30
40
CONVEYANCE DIRECTION
M
WIDTH DIRECTION
21 21 21 21
20
17 15 14 11 13 16 12
10

FIG.2A

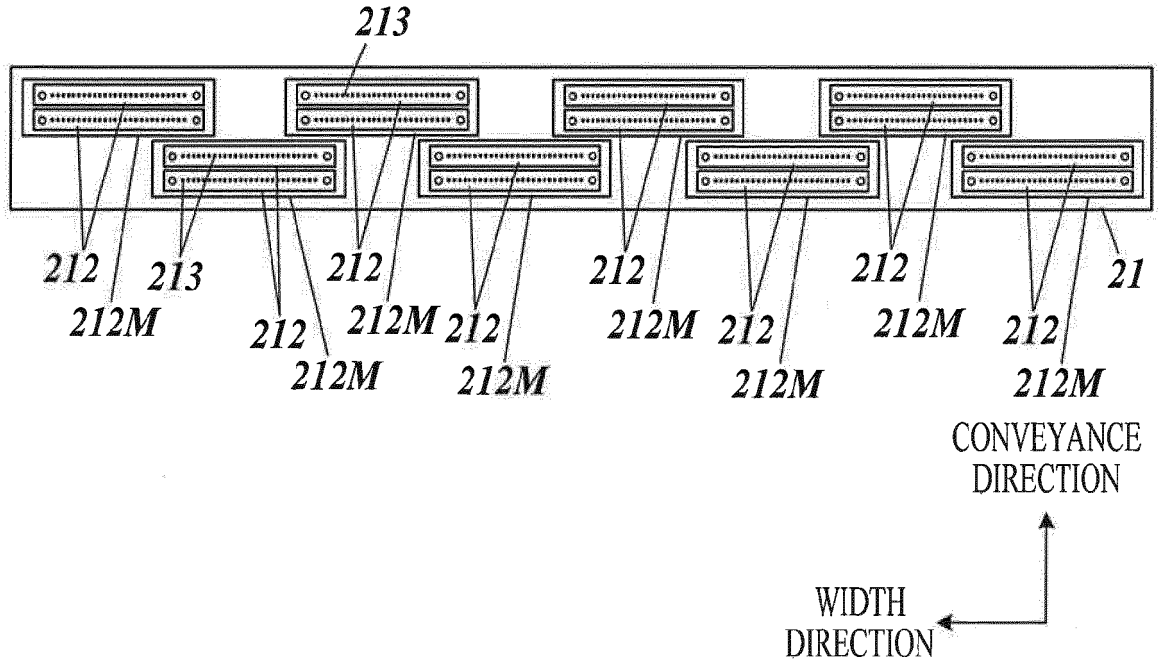

213
212
212M
213
212
212M
212
212M
212
212M
212
212M
212
212M
212
212M
21
CONVEYANCE DIRECTION
WIDTH DIRECTION

FIG.2B

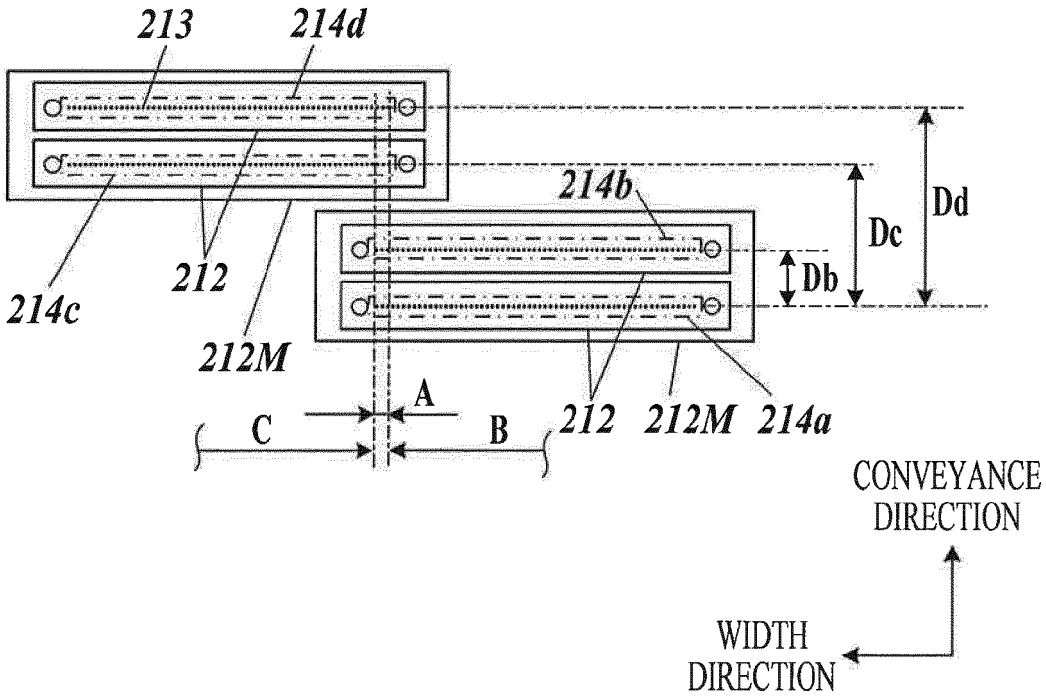

213
214d
214b
Dd
Dc
Db
214c
212
212M
A
C
B
212
212M
214a
CONVEYANCE DIRECTION
WIDTH DIRECTION

FIG.3

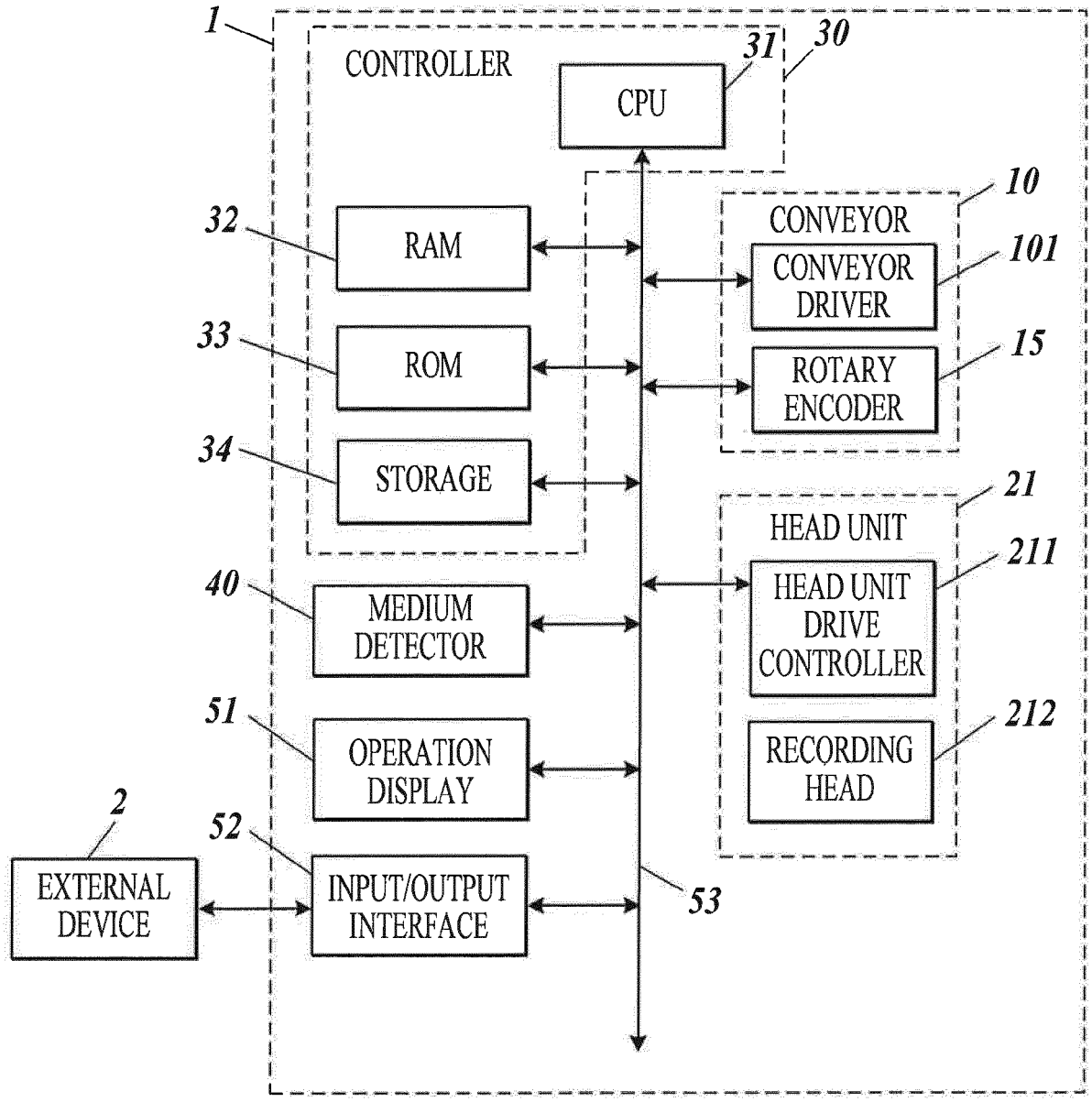

1
CONTROLLER
31
30
CPU
10
32
RAM
CONVEYOR
101
CONVEYOR DRIVER
33
ROM
15
ROTARY ENCODER
34
STORAGE
21
HEAD UNIT
211
HEAD UNIT DRIVE CONTROLLER
40
MEDIUM DETECTOR
51
OPERATION DISPLAY
212
RECORDING HEAD
2
52
EXTERNAL DEVICE
INPUT/OUTPUT INTERFACE
53

FIG.4

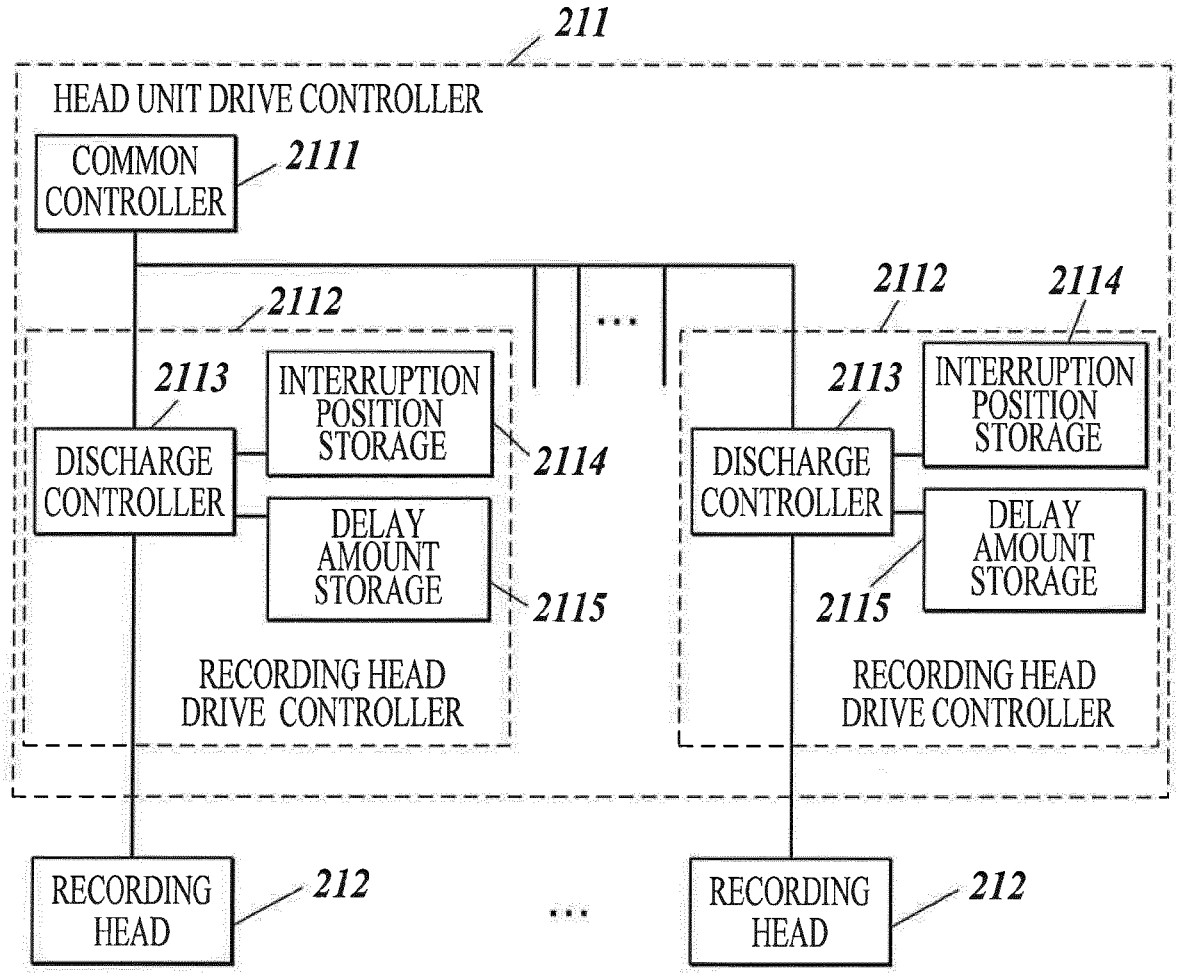

211
HEAD UNIT DRIVE CONTROLLER
COMMON CONTROLLER
2111
2112
2112
2114
2113
INTERRUPTION POSITION STORAGE
2113
INTERRUPTION POSITION STORAGE
DISCHARGE CONTROLLER
2114
DISCHARGE CONTROLLER
DELAY AMOUNT STORAGE
DELAY AMOUNT STORAGE
2115
2115
RECORDING HEAD DRIVE CONTROLLER
RECORDING HEAD DRIVE CONTROLLER
RECORDING HEAD
212
RECORDING HEAD
212

FIG.5A

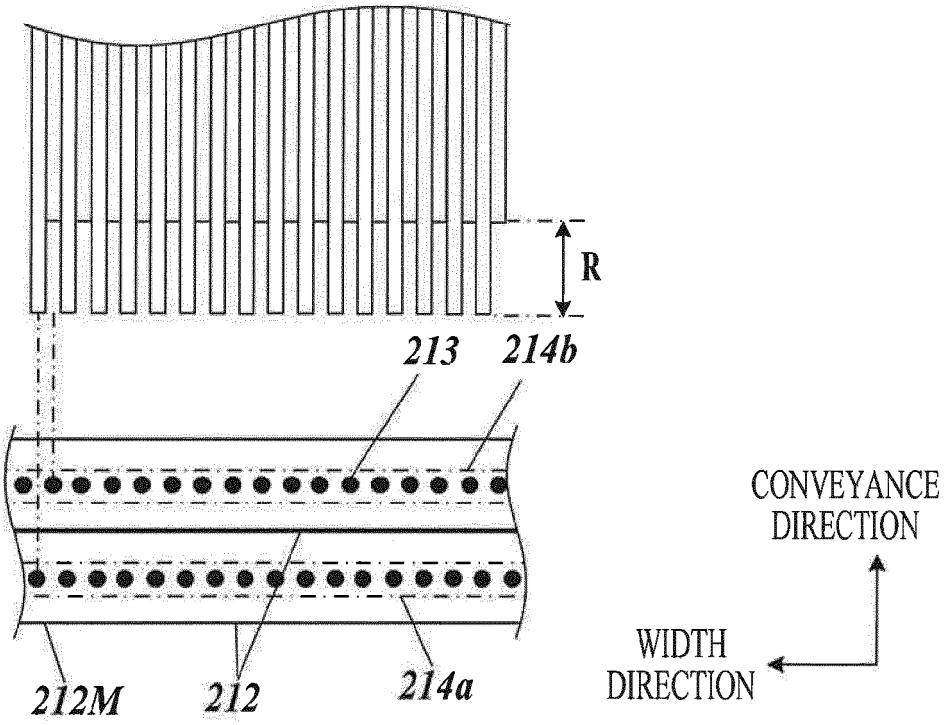

R
213
214b
212M
212
214a
CONVEYANCE DIRECTION
WIDTH DIRECTION

FIG.5B

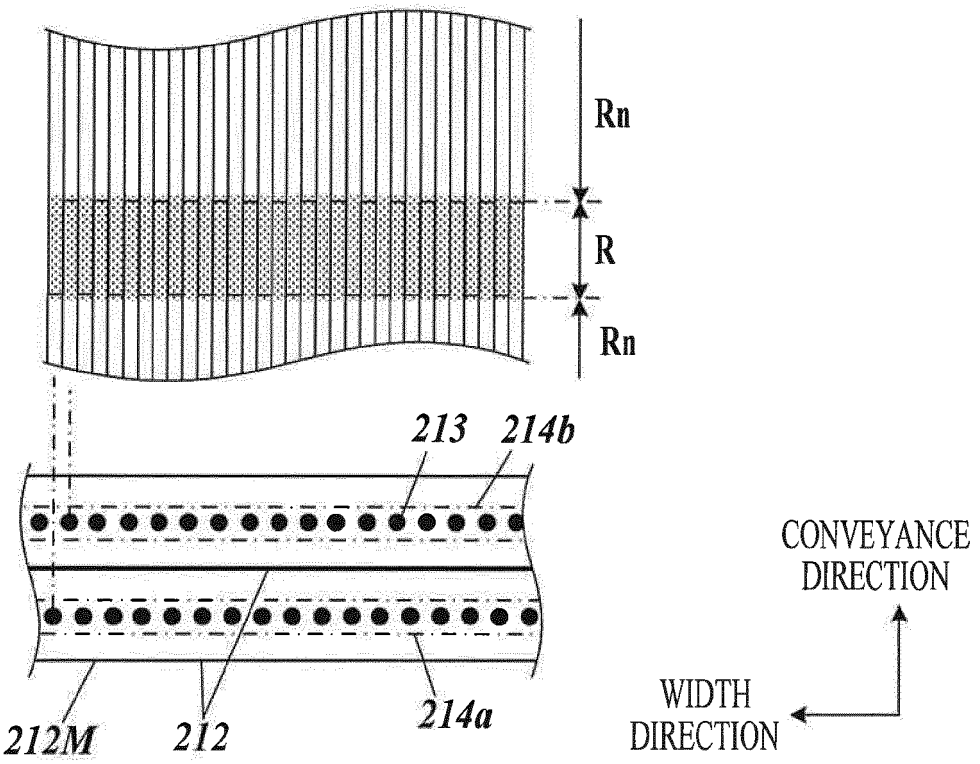

Rn
R
Rn
213
214b
212M
212
214a
CONVEYANCE DIRECTION
WIDTH DIRECTION

FIG.6

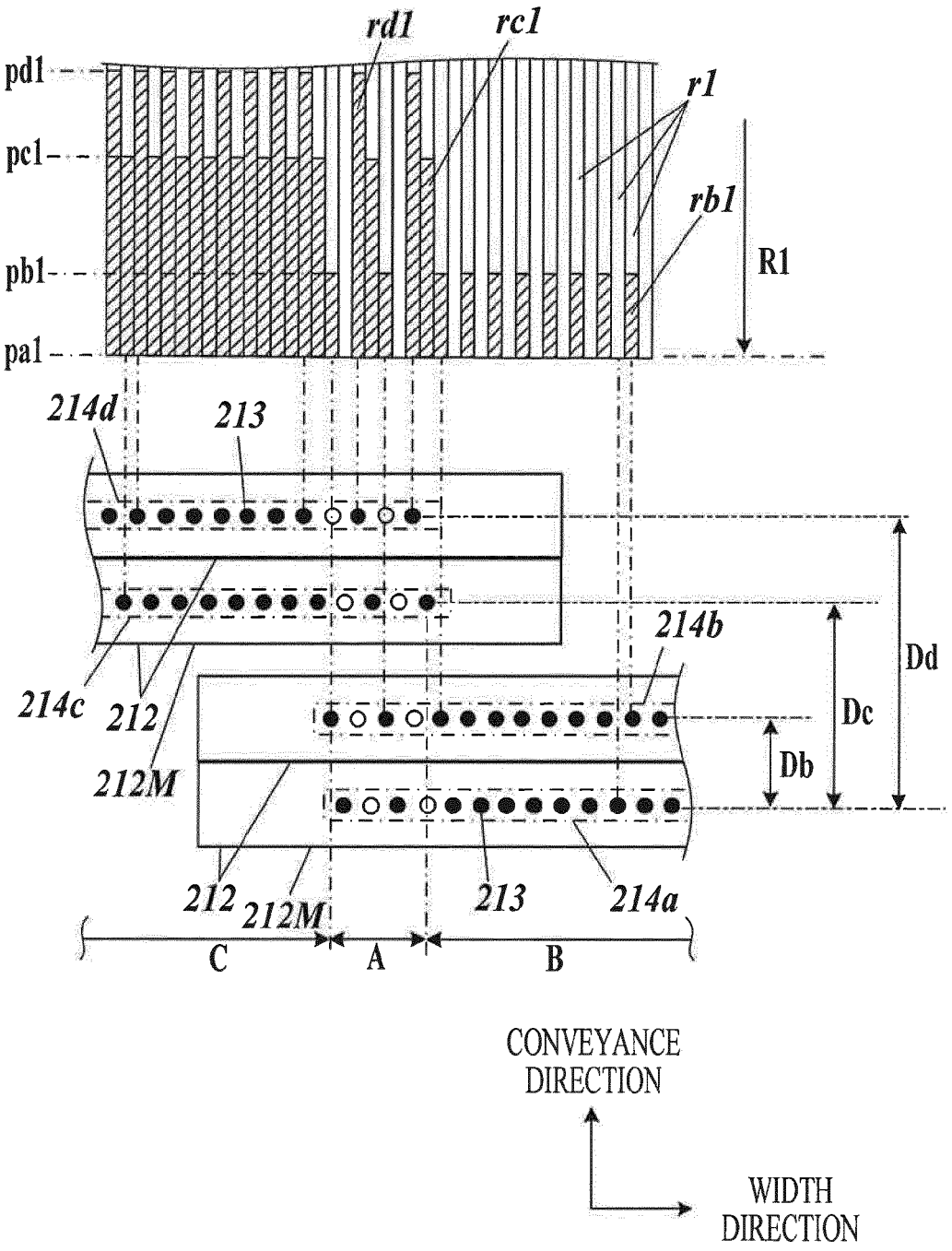

rd1
rc1
r1
pd1
pc1
rb1
pb1
R1
pa1
214d
213
214b
Dd
Dc
214c
212
Db
212M
212
212M
213
214a
C
A
B
CONVEYANCE DIRECTION
WIDTH DIRECTION

FIG. 7

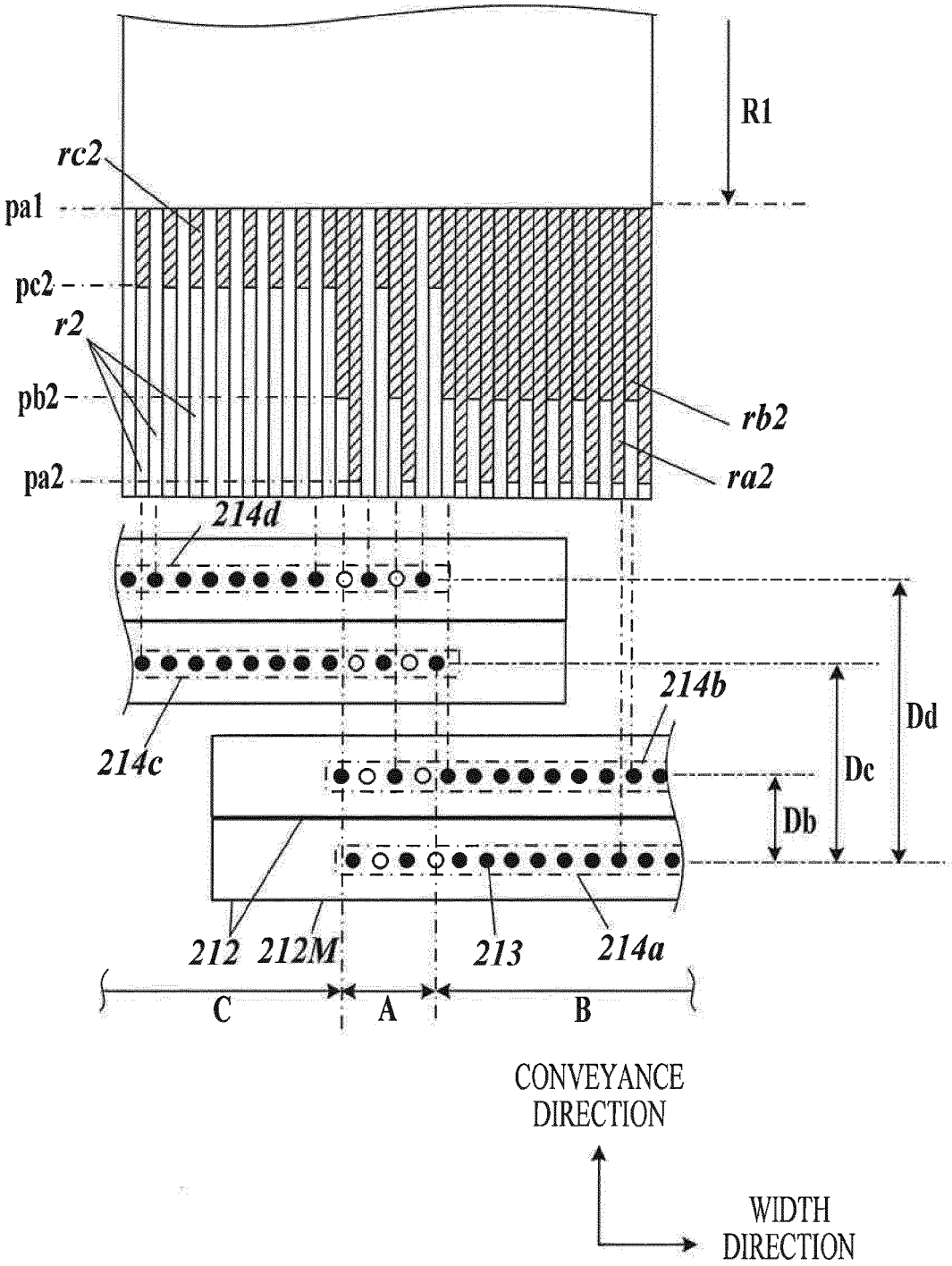

R1
rc2
pa1
pc2
r2
pb2
pa2
rb2
ra2
214d
214b
214c
Dd
Dc
Db
212
212M
213
214a
C
A
B
CONVEYANCE DIRECTION
WIDTH DIRECTION

FIG.8

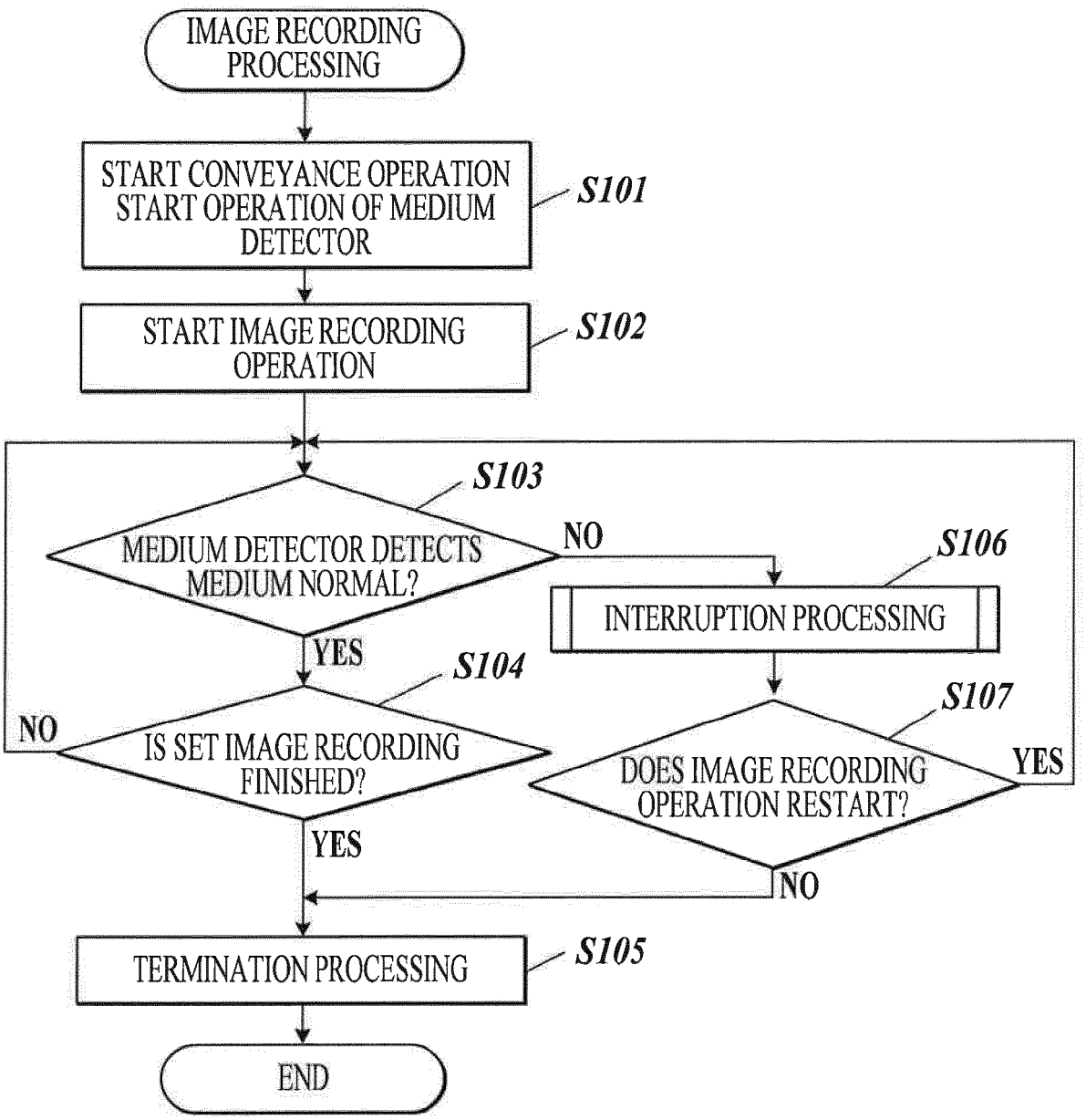


IMAGE RECORDING PROCESSING
START CONVEYANCE OPERATION START OPERATION OF MEDIUM DETECTOR
S101
START IMAGE RECORDING OPERATION
S102
S103
MEDIUM DETECTOR DETECTS MEDIUM NORMAL?
NO
S106
INTERRUPTION PROCESSING
YES
S104
S107
NO
IS SET IMAGE RECORDING FINISHED?
DOES IMAGE RECORDING OPERATION RESTART?
YES
YES
NO
TERMINATION PROCESSING
S105
END

FIG.9

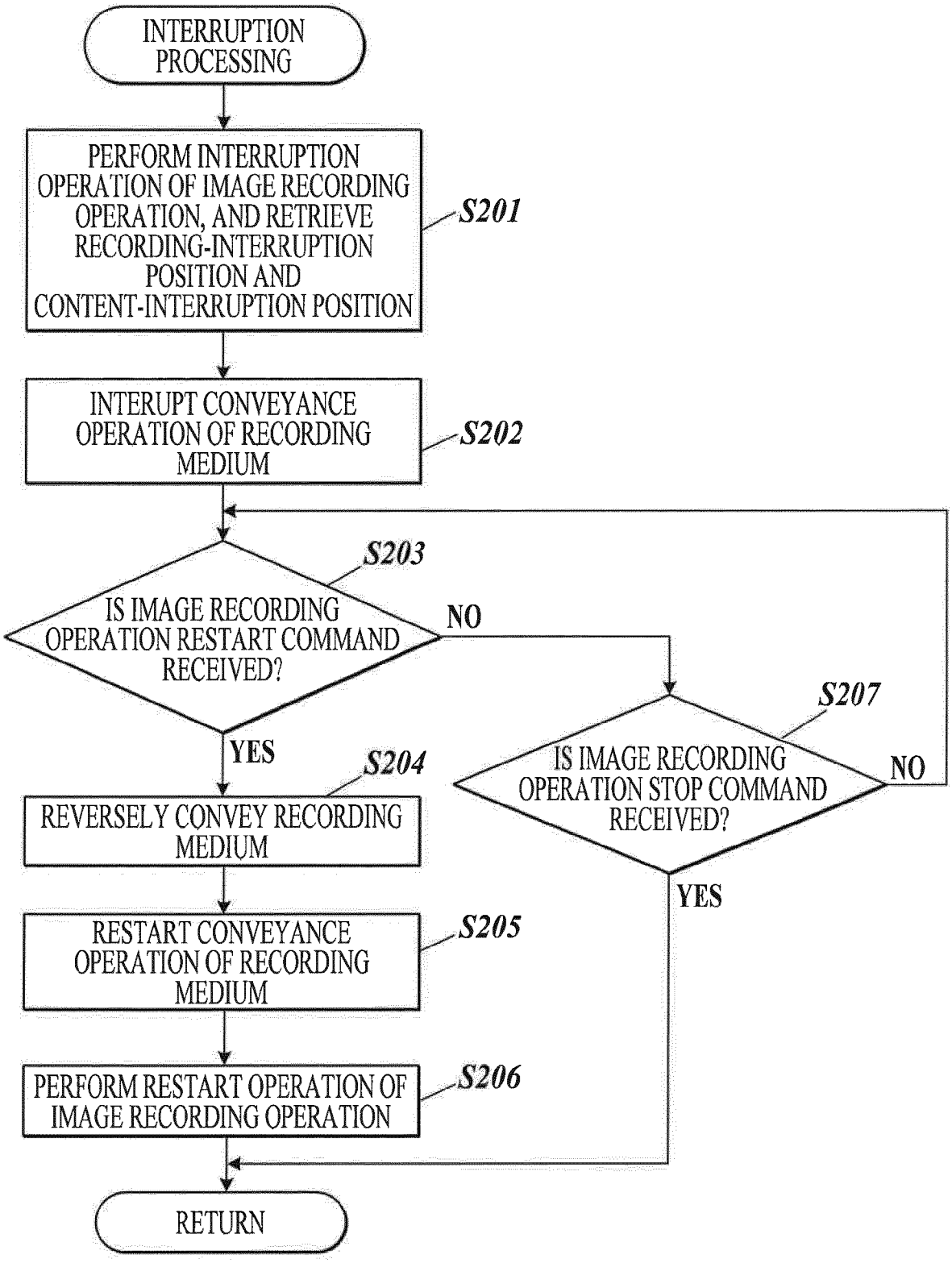
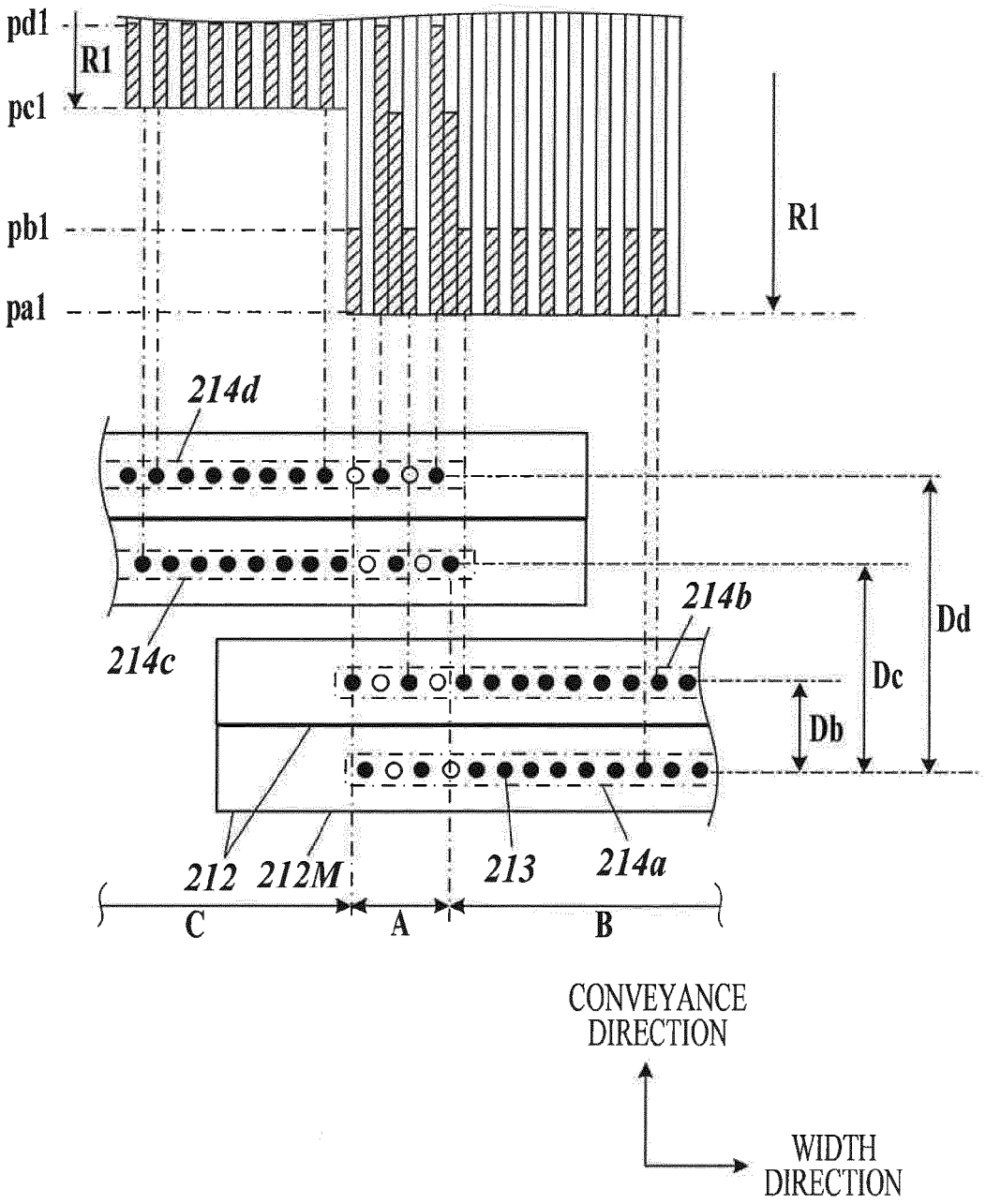

INTERRUPTION PROCESSING
PERFORM INTERRUPTION OPERATION OF IMAGE RECORDING OPERATION, AND RETRIEVE RECORDING-INTERRUPTION POSITION AND CONTENT-INTERRUPTION POSITION
S201
INTERUPT CONVEYANCE OPERATION OF RECORDING MEDIUM
S202
S203
IS IMAGE RECORDING OPERATION RESTART COMMAND RECEIVED?
NO
YES
S204
REVERSELY CONVEY RECORDING MEDIUM
RESTART CONVEYANCE OPERATION OF RECORDING MEDIUM
S205
PERFORM RESTART OPERATION OF IMAGE RECORDING OPERATION
S206
S207
IS IMAGE RECORDING OPERATION STOP COMMAND RECEIVED?
NO
YES
RETURN

FIG.10


pd1
R1
pc1
pb1
pa1
R1
214d
214c
214b
Dd
Dc
Db
212
212M
213
214a
C
A
B
CONVEYANCE DIRECTION
WIDTH DIRECTION

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/018273

A. CLASSIFICATION OF SUBJECT MATTER
B41J2/01(2006.01)i, *B41J2/21*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B41J2/01, B41J2/21

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2015-077726 A (Seiko Epson Corp.), 23 April 2015 (23.04.2015), claim 1; paragraphs [0062] to [0074]; fig. 2, 6 to 7 (Family: none)	1-8
A	JP 2005-319720 A (Seiren Co., Ltd.), 17 November 2005 (17.11.2005), (Family: none)	1-8
A	US 2009/0256888 A1 (SILVERBROOK, K., et al.), 15 October 2009 (15.10.2009), (Family: none)	1-8

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 July 2017 (20.07.17)	01 August 2017 (01.08.17)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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Patent documents cited in the description

- JP 2015145088 A **[0007]**