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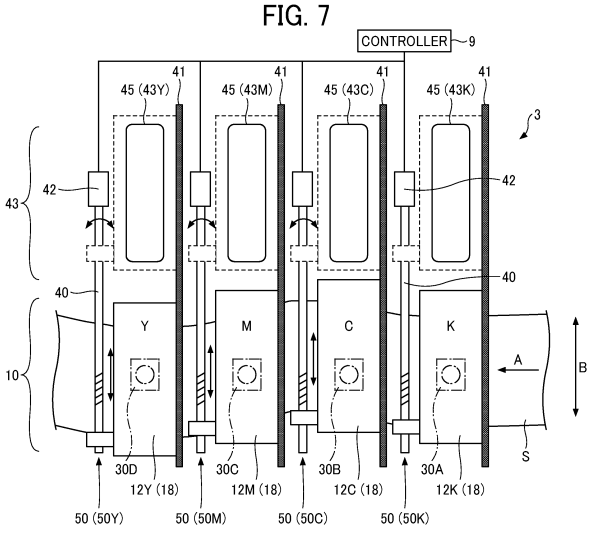
(54) LIQUID DISCHARGE APPARATUS AND LIQUID DISCHARGE METHOD

(57) A liquid discharge apparatus (100) includes a conveyor (8), a liquid discharger (12), a maintenance device (45), a position changer (50), a position detector (30), and circuitry (9). The conveyor (8) conveys an object in a first direction. The liquid discharger (12) discharges a liquid onto the object at a first position. The liquid discharger (12) includes a full-width head extending in a second direction intersecting the first direction. The maintenance device (45) maintains a discharge state of the liquid discharger (12) at a second position away from the first position. The position changer (50) moves the liquid discharger (12) between the first position and the second position. The position detector (30) detects a position of the object. The circuitry (9) causes the position changer (50) to change a head position of the liquid discharger (12) in response to the position of the object detected by the position detector (30).

FIG. 7



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Description

BACKGROUND

Technical Field

[0001] Embodiments of the present disclosure relate to a liquid discharge apparatus and a liquid discharge method.

Related Art

[0002] In the related art, a liquid discharge apparatus includes a conveyance device that conveys an object in a conveyance direction, a discharge head that discharges a liquid onto the object, and a sensor that detects a positional deviation of the object in a direction orthogonal to the conveyance direction (e.g., Japanese Unexamined Patent Application Publication No. 2018-130956). In this liquid discharge apparatus, the head unit is moved in the direction orthogonal to the conveyance direction of the object in accordance with the positional deviation detected by the sensor in order to change the position at which the liquid is discharged onto the object. However, the liquid discharge apparatus described in Japanese Unexamined Patent Application Publication No. 2018-130956 includes a dedicated actuator for moving the head unit.

SUMMARY

[0003] An object of the present disclosure is to provide a liquid discharge apparatus that changes a position of a head unit without a dedicated actuator for moving the head unit.

[0004] Embodiments of the present disclosure describe an improved liquid discharge apparatus that includes a conveyor, a liquid discharger, a maintenance device, a position changer, a position detector, and circuitry. The conveyor conveys an object in a first direction. The liquid discharger discharges a liquid onto the object at a first position. The liquid discharger includes a full-width head extending in a second direction intersecting the first direction. The maintenance device maintains a discharge state of the liquid discharger at a second position away from the first position in the second direction. The position changer moves the liquid discharger between the first position and the second position. The position detector detects a position of the object in the second direction. The circuitry causes the position changer to change a head position of the liquid discharger in the second direction in response to the position of the object detected by the position detector.

[0005] According to another embodiment of the present disclosure, there is provided a liquid discharge method including: conveying an object in a first direction; discharging a liquid onto the object, at a first position, from a full-width head extending in a second direction intersecting the first direction; maintaining a discharge state of the full-width head at a second position away from the first position in the second direction; moving the full-width head between the first position and the second position; detecting a position of the object in the second direction; and changing a head position of the full-width head in the second direction in response to the position of the object.

[0006] As a result, the liquid discharge apparatus that changes the position of the head unit without a dedicated actuator for moving the head unit can be provided.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0007] A more complete appreciation of the disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic view of an image forming apparatus according to an embodiment of the present disclosure;
FIG. 2 is a block diagram of the image forming apparatus according to an embodiment of the present disclosure;
FIG. 3 is a schematic bottom view of an image forming device of the image forming apparatus;
FIG. 4 is a schematic side view of the image forming device and a conveyor unit;
FIG. 5 is a plan view of a sheet meandering in the image forming apparatus;
FIG. 6 is a block diagram of a control device of the liquid discharge apparatus;
FIG. 7 is a plan view of a liquid discharge head, a position changer, and a cleaning position of the image forming apparatus; and
FIG. 8 is a block diagram illustrating a hardware configuration of the image forming apparatus according to an embodiment of the present disclosure.

[0008] The accompanying drawings are intended to depict embodiments of the present invention and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted. Also, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

[0009] In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve

a similar result.

[0010] Referring now to the drawings, embodiments of the present disclosure are described below. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0011] A liquid discharge apparatus, a liquid discharge method, and a control device according to an embodiment of the disclosure is described below with reference to the drawings.

Overall Configuration of Image Forming Apparatus

[0012] FIG. 1 is a schematic view of an image forming apparatus 100 according to the present embodiment. FIG. 2 is a block diagram of the image forming apparatus 100 according to the present embodiment. The image forming apparatus 100 illustrated in FIGS. 1 and 2 is an on-demand line head inkjet recording apparatus. The image forming apparatus 100 is an example of a liquid discharge apparatus. The image forming apparatus 100 includes a sheet supply device 1, a conveyor unit 8, a first image forming device 3, a second image forming device 4, a front-back reverse device 5, a first drying device 6, a second drying device 7, and a sheet collection device 2. The image forming apparatus 100 discharges ink onto a sheet S as a recording medium. The ink is an example of a liquid. As illustrated in FIG. 2, the image forming apparatus 100 includes a controller 9.

[0013] The sheet supply device 1 includes a supply roller 11 around which a long sheet S is wound in a roll shape. The supply roller 11 is rotatable in a direction indicated by arrow R1 in FIG. 1. As the supply roller 11 rotates, the sheet S is fed out. The sheet S is an example of an object. The object may be a paper medium or another medium. The object may be a sheet material and the sheet material may be a cut sheet material. The sheet material may be an oversize sheet material such as wallpaper.

[0014] The conveyor unit 8 as a conveyor includes multiple conveyance rollers 17 to convey the sheet S. The sheet S is stretched over the multiple conveyance rollers 17. The multiple conveyance rollers 17 rotate to convey the sheet S. The conveyance roller 17 includes a pipe having a circular cross section and a shaft.

[0015] The first image forming device 3 includes multiple head units 12K, 12C, 12M, and 12Y that discharge liquid ink onto the sheet S. Each of the head units 12K, 12C, 12M, and 12Y discharges the ink onto a front side of the sheet S based on image data to be formed on the front side of the sheet S among the image data generated by the controller 9 to form an image on the sheet S. The ink may be a liquid containing a colorant, a solvent, and crystalline resin particles dispersed in the solvent. The crystalline resin changes a phase thereof and melts from a crystal to a liquid when heated above a melting point thereof. The head units 12K, 12C, 12M, and 12Y may be collectively referred to as head units 12, each of which may be referred to as a head unit 12 unless distinguished.

[0016] The first drying device 6 includes a heating drum 13 that heats the sheet S. The heating drum 13 promotes drying of the ink on the sheet S. The heating drum 13 includes a cylindrical component that rotates while the sheet S is wound around the outer circumferential surface thereof. For example, a halogen heater as a heating source is disposed inside the cylindrical component. The heating source is not limited to the halogen heater but may be other heaters.

[0017] The heating drum 13 faces a back side of the sheet S conveyed in a conveyance path. When the sheet S is conveyed from the first image forming device 3, a lower face (the back side) of the sheet S contacts the outer circumferential surface of the heating drum 13. The heating drum 13 conveys the sheet S while heating the sheet S. Thus, the heating drum 13 promotes the drying of the ink on the sheet S.

[0018] The controller 9 controls a rotation speed of the heating drum 13. The controller 9 controls the rotation speed of the heating drum 13 to substantially the same speed as a conveyance speed in the sheet supply device 1, the sheet collection device 2, and the conveyor unit 8. As a result, the sheet S is conveyed without slipping on the outer circumferential surface of the heating drum 13 in a conveyance direction of the sheet S (i.e., a sheet conveyance direction).

[0019] A known device that reverses the front side and the back side of the sheet S can be used as the front-back reverse device 5. When the sheet S conveyed from the first drying device 6 passes through the front-back reverse device 5, the front and back sides of the sheet S are reversed. The reversed sheet S is conveyed to the second image forming device 4. Thus, the sheet S is conveyed with the front side facing upward, reversed by the front-back reverse device 5, and conveyed with the front side facing downward (with the back side facing upward).

[0020] The second image forming device 4 basically has the same configuration as the first image forming device 3. The second image forming device 4 includes multiple head units 14K, 14C, 14M, and 14Y that discharge liquid ink onto the sheet S. Each of the head units 14K, 14C, 14M, and 14Y discharges the ink onto the back side of the sheet S based on image data to be formed on the back side of the sheet S among the image data generated by the controller 9 to form an image on the sheet S.

[0021] Similarly to the first drying device 6, the second drying device 7 includes a heating drum 15 that heats the sheet S. The heating drum 15 faces the front side of the sheet S conveyed in the conveyance path. When the sheet S is conveyed from the second image forming device 4, a lower face (the front side) of the sheet S contacts the outer circumferential surface of the heating drum 15. The heating drum 15 conveys the sheet S while heating the sheet S. Thus, the heating drum 15 promotes the drying of the ink on the sheet S. Even if an image is

formed (ink is applied) on the front side of the sheet S, the ink has already been dried by the first drying device 6 when the heating drum 15 contacts the image on the front side. As a result, the image does not deteriorate.

[0022] The sheet collection device 2 includes a collection roller 16 that winds and collects the sheet S. The collection roller 16 is rotatable in a direction indicated by arrow R2 in FIG. 1. The sheet S is wound in a roll shape around the collection roller 16 as the collection roller 16 rotates. The sheet collection device 2 may include a post-processing unit that performs post-processing such as cutting the sheet S to a predetermined length and aligning the cut sheet S.

Controller

[0023] The controller 9 illustrated in FIG. 2 may include an information processor such as a personal computer (PC). The controller 9 generates image data to be formed on the front side and the back side of the sheet S. The controller 9 controls various operations of the sheet supply device 1, the conveyor unit 8, the first image forming device 3, the second image forming device 4, the front-back reverse device 5, the first drying device 6, the second drying device 7, and the sheet collection device 2. For example, the controller 9 controls, in addition to the rotation speeds of the supply roller 11, the collection roller 16, and the conveyance rollers 17, the temperatures of the heating sources that heat the heating drums 13 and 15.

Image Forming Device

[0024] The image forming device is described below with reference to FIG. 3. FIG. 3 is a schematic bottom view of the image forming device. In FIG. 3, the sheet S is indicated by an imaginary line. The image forming device includes the first image forming device 3 and the second image forming device 4. The second image forming device 4 basically has the same configuration as the first image forming device 3. The first image forming device 3 is described below, and the description of the second image forming device 4 is omitted.

[0025] In the first image forming device 3, the four head units 12K, 12C, 12M, and 12Y that discharge black (K), cyan (C), magenta (M), and yellow (Y) inks, respectively, are disposed in that order from the upstream side in the direction indicated by arrow A (hereinafter a "conveyance direction A") in which the sheet S is conveyed. The order of arrangement of the head units 12K, 12C, 12M, and 12Y of the respective colors is not limited to the above example and may be another order. The colors of ink to be used are not limited to yellow, magenta, cyan, and black, and may include other colors. The number of head units 12 is not limited to four. The conveyance direction A is an example of a "first direction."

[0026] Each of the head units 12K, 12C, 12M, and 12Y includes multiple liquid discharge heads 18. Hereinafter, the liquid discharge head is abbreviated to a "discharge head." Each of the head units 12K, 12C, 12M, and 12Y including the discharge head 18 is an example of a liquid discharger. In each of the head units 12K, 12C, 12M, and 12Y, the number of discharge heads 18 may be, for example, four. The number of discharge heads 18 is not limited to four. Each of the head units 12K, 12C, 12M, and 12Y is a line head that is longer than a width of the sheet S. The line head extends in a width direction B intersecting the conveyance direction A. The line head is also called a full-width head.

[0027] The discharge head 18 has multiple nozzles 19. Ink is discharged from the multiple nozzles 19 onto the sheet S. The multiple discharge heads 18 are arranged in a staggered manner over the entire width direction B of an image forming area on the sheet S. When the sheet S is conveyed to a position facing each of the head units 12K, 12C, 12M, and 12Y, the corresponding discharge head 18 discharges the ink. Thus, an image is formed on the sheet S.

[0028] The discharge head 18 includes an ink channel through which ink flows, a drive element for discharging the ink, a pressure chamber for applying pressure to the ink, and a nozzle plate having the nozzles 19 from which the ink is discharged. The bottom face of the nozzle plate includes a nozzle face in which the multiple nozzles 19 are arranged. The drive element is, for example, a piezoelectric element. As the drive element is driven, the pressure of the ink in the pressure chamber is increased and the ink is discharged from the nozzles 19. The ink droplets discharged from the nozzles 19 land on the sheet S as the recording medium.

[0029] The "width direction B" of the sheet S may be a direction parallel to a conveyance face on which the sheet S is conveyed and orthogonal to the conveyance direction A. The width direction of the sheet S is indicated by arrow B in FIG. 3. The "conveyance face" is a surface through which the sheet S being conveyed passes. For example, the conveyance face is a virtual surface connecting contact portions between the multiple conveyance rollers 17 and the sheet S. The "conveyance face" may include a sheet placement surface of a conveyance belt on which the sheet S is placed and conveyed. The width direction B of the sheet S may also be referred to as a "sheet width direction." The width direction B is an example of a "second direction."

Conveyor Unit

[0030] The conveyor unit 8 is described below with reference to FIG. 4. FIG. 4 is a schematic side view of the first image forming device 3 and the conveyor unit 8. As illustrated in FIG. 4, the conveyor unit 8 includes the multiple conveyance rollers 17. The multiple conveyance rollers 17 include conveyance rollers 17A and 17B. The conveyance roller 17A is disposed on the extreme upstream side in the conveyance direction A among the multiple conveyance rollers 17. The conveyance roller 17B is dis-

posed on the extreme downstream side in the conveyance direction A among the multiple conveyance rollers 17. The conveyance roller 17A includes a pair of drive rollers. The conveyance roller 17B includes a pair of drive rollers. The multiple conveyance rollers 17 include a conveyance roller 17C disposed downstream from the conveyance roller 17A.

[0031] The multiple conveyance rollers 17 include multiple driven rollers 17d to 17k. The multiple of driven rollers 17d to 17k are disposed between the conveyance roller 17C and the conveyance roller 17B in the conveyance direction A. The driven rollers 17d to 17k may be drive rollers.

[0032] Multiple liquid discharge positions 10K, 10C, 10M, and 10Y are illustrated in FIG. 4. The head unit 12K at the liquid discharge position 10K discharges ink to a predetermined position of the sheet S. The head unit 12C at the liquid discharge position 10C discharges ink to a predetermined position of the sheet S. The head unit 12M at the liquid discharge position 10M discharges ink to a predetermined position of the sheet S. The head unit 12Y at the liquid discharge position 10Y discharges ink to a predetermined position of the sheet S. The liquid discharge positions 10K, 10C, 10M, and 10Y are examples of a first position. The liquid discharge positions 10K, 10C, 10M, and 10Y may be collectively referred to as liquid discharge positions 10, each of which may be referred to as a liquid discharge position 10 unless distinguished.

[0033] The driven rollers 17d and 17e are disposed upstream from and downstream from the liquid discharge position 10K, respectively. The driven rollers 17f and 17g are disposed upstream from and downstream from the liquid discharge position 10C, respectively. The driven rollers 17h and 17i are disposed upstream from and downstream from the liquid discharge position 10M, respectively. The driven rollers 17j and 17k are disposed upstream from and downstream from the liquid discharge position 10Y, respectively.

[0034] As described above, the driven rollers 17d to 17k are respectively disposed upstream from and downstream from the corresponding liquid discharge positions 10K, 10C, 10M, and 10Y, thereby preventing the sheet S from fluttering at the liquid discharge positions 10K, 10C, 10M, and 10Y Accordingly, the conveyor unit 8 can stably convey the sheet S.

Positional Deviation of Sheet S in Width Direction

[0035] A positional deviation of the sheet S in the width direction B is described below with reference to FIG. 5. FIG. 5 is a plan view of the sheet S meandering in the width direction B. For example, when the conveyance roller 17 is eccentric or thermally expanded, the conveyed sheet S may be displaced (deviated) in the width direction B as illustrated in FIG. 5 (i.e., the positional deviation of the sheet S occurs). As the sheet S is displaced in the width direction B, the sheet S may meander while being conveyed. If the sheet S meanders, the position of the ink landed on the sheet S also deviates from a desired position, causing deterioration of image quality. The image forming apparatus 100 can move the head units 12C, 12M, and 12Y in the width direction B. In FIG. 5, the head units 12C, 12M, and 12Y that have been moved in the width direction B are indicated by imaginary lines (two dot chain lines). When the sheet S meanders, the image forming apparatus 100 moves the head units 12C, 12M, and 12Y in the width direction B to cause the head units 12C, 12M, and 12Y to follow the positional deviation of the sheet S in the width direction B.

Position Sensor

[0036] As illustrated in FIG. 4, the image forming apparatus 100 includes multiple position sensors 30. The position sensor 30 is an example of a position detector. The position sensor 30 detects a position of the sheet S in the width direction B. The conveyor unit 8 may include the multiple position sensors 30. The position sensor 30 can detect, for example, an amount of the positional deviation and a direction of the positional deviation in the width direction B of the sheet S. Thus, the image forming apparatus 100 can detect the positional deviation of the sheet S in the width direction B.

[0037] The position sensors 30 and the head units 12K, 12C, 12M, and 12Y are disposed on opposite sides of the conveyance path along which the sheet S is conveyed. The position sensor 30 may be disposed below the sheet S. The position sensors 30 are disposed adjacent to the liquid discharge positions 10K, 10C, 10M, and 10Y Specifically, each position sensor 30 is disposed between, out of the driven rollers 17d to 17k, two driven rollers respectively disposed upstream and downstream from the corresponding one of the liquid discharge positions 10K, 10C, 10M, and 10Y in the conveyance direction A. The "liquid discharge position" in this specification refers to a liquid discharge position in a state where the sheet S does not meander, that is, a state where the head unit 12 does not move in the width direction B and is disposed at a reference position (initial position) set in advance.

[0038] The position sensor 30 is an optical sensor that detects surface information of the object being conveyed. Examples of the position sensor 30 include a charge-coupled device (CCD) camera and a complementary metal oxide semiconductor (CMOS) camera using air pressure, photoelectricity, ultrasonic, or light such as visible light, laser, or infrared light.

Control Device

[0039] A control device 500 is described below with reference to FIGS. 4 and 6. FIG. 6 is a block diagram of the control device 500 of the image forming apparatus 100. The control device 500 controls operations of the head units 12K, 12C, 12M, and 12Y and the position sen-

sors 30. As illustrated in FIG. 4, the multiple position sensors 30 include a first position sensor 30A, a second position sensor 30B, a third position sensor 30C, and a fourth position sensor 30D. The position sensor 30 detects the position of the sheet S in the width direction B.

[0040] The first position sensor 30A detects the position of the sheet S at a position corresponding to the head unit 12K for black. The second position sensor 30B detects the position of the sheet S at a position corresponding to the head unit 12C for cyan. The third position sensor 30C detects the position of the sheet S at a position corresponding to the head unit 12M for magenta. The fourth position sensor 30D detects the position of the sheet S at a position corresponding to the head unit 12Y for yellow.

[0041] The control of the position sensor 30 and the head unit 12 is described below with reference to a combination of the first position sensor 30A and the second position sensor 30B as an example. As illustrated in FIG. 6, each of the first position sensor 30A and the second position sensor 30B includes an imaging unit 31, an image capture controller 32, and an image storage unit 33. The imaging unit 31 includes an imaging device that captures an image of the sheet S being conveyed.

[0042] The image capture controller 32 includes a shutter control unit 34 and an image acquisition unit 35. The shutter control unit 34 controls the timing at which the imaging unit 31 captures an image. The image acquisition unit 35 acquires data of the image captured by the imaging unit 31. The image storage unit 33 stores the data of the image acquired by the image capture controller 32.

[0043] The sheet S has scattering properties on the surface or inside thereof. Each of the position sensors 30A and 30B includes a laser light source. The laser light source irradiates the sheet S with laser light. When the sheet S is irradiated with the laser light, the laser light is diffusely reflected off the sheet S. The diffuse reflection of the laser light creates a pattern of the sheet S. The pattern is a speckle pattern having spots called "speckles." The speckle pattern includes surface information. When an image of the sheet S is captured, image data indicating the speckle pattern is acquired.

[0044] The position of the pattern is determined from the image data, and the position of a specific portion of the sheet S is detected by the position sensors 30A and 30B. That is, when the sheet S is conveyed, the pattern of the sheet S is also moved. Therefore, by detecting the same pattern at different times by the position sensors 30A and 30B, the movement amount or the movement speed of the sheet S can be obtained.

[0045] The controller 9 includes a calculation unit 36. The first and second position sensors 30A and 30B transmit the captured images to the calculation unit 36. The calculation unit 36 calculates how much the specific portion on the sheet S has moved in the sheet width direction based on the image data transmitted from the first position sensor 30A and the second position sensor 30B.

[0046] The controller 9 calculates the movement amount of the head unit 12C for cyan in the sheet width direction based on the movement amount (the amount of the positional deviation) of the sheet S calculated by the calculation unit 36. The controller 9 causes the head unit 12C to move in the sheet width direction. Thus, the controller 9 can control a discharge position of the head unit 12C in the sheet width direction.

[0047] In the other combinations of the position sensors 30, the controller 9 detects the positional deviation of the sheet S in the same manner and causes the head unit 12M for magenta and the head unit 12Y for yellow to move in the sheet width direction based on the detected positional deviation. Thus, the controller 9 can control discharge positions of the head units 12M and 12Y in the sheet width direction.

[0048] The position sensor 30 can detect the positional deviation of the sheet S in the sheet conveyance direction. For example, the calculation unit 36 calculates how much the specific portion on the sheet S has moved in the conveyance direction A based on the image data transmitted from the first position sensor 30A and the second position sensor 30B. Thus, the calculation unit 36 can calculate the positional deviation of the sheet S in the conveyance direction A.

[0049] In other combinations of the position sensors 30, the controller 9 detects the positional deviation of the sheet S in the conveyance direction A in the same manner. The sheet S may extend in the conveyance direction A when ink permeates through the sheet S. The controller 9 controls the discharge timing of each of the head units 12K, 12C, 12M, and 12Y based on the calculated positional deviation in the conveyance direction A, thereby controlling the discharge position in the conveyance direction A so as to reduce the influence of the positional deviation in the conveyance direction A.

[0050] As illustrated in FIG. 4, each position sensor 30 is disposed between, out of the driven rollers 17d to 17k, two driven rollers, thereby enhancing the detection accuracy of each position sensor 30. The conveyance speed of the sheet S is relatively stable between the rollers. Accordingly, in the image forming apparatus 100, the movement amount or the movement speed of the sheet S in at least one direction of the conveyance direction A and the width direction B can be accurately detected.

[0051] The position sensors 30 are disposed at positions close to the liquid discharge positions 10K, 10C, 10M, and 10Y at which ink is discharged. The shorter the distance between the position sensor 30 and the liquid discharge position 10, the smaller the detection error. Therefore, the positional deviation of the sheet S can be detected with high accuracy.

[0052] Further, the position sensor 30 is preferably disposed upstream from the liquid discharge position 10. When the position sensor 30 is disposed upstream from the liquid discharge position 10, the movement or discharge timing of the head unit 12 can be controlled after

the position of the sheet S is detected by the position sensor 30 and before the sheet S is conveyed to the liquid discharge position 10.

[0053] By contrast, when the position sensor 30 is disposed directly below the liquid discharge position 10, the landing position of the ink may deviate due to a delay of the control operation. If the control operation is performed quickly, as the position of the position sensor 30, directly below the liquid discharge position 10 is preferred to upstream from the liquid discharge position 10 for accurately detecting the movement amount of the sheet S directly below the liquid discharge position 10. Alternatively, when the error by the control operation is allowable, the position sensor 30 may be disposed downstream from the liquid discharge position 10.

[0054] In the present embodiment, intervals D1 to D3 (see FIG. 4) between the position sensors 30 in the conveyance direction A are set to be an integral multiple of a circumferential length X of the drive roller that conveys the sheet S (for example, the lower drive roller of the pair of drive rollers in the conveyance roller 17B disposed extreme downstream in the conveyance direction A in FIG. 4). That is, in FIG. 4, the respective distances D1 to D3 from the extreme upstream position sensor 30A to the position sensors 30B to 30D downstream from the position sensor 30A are respectively set to one, two, and three multiples of the circumferential length X of the drive roller (D1 = X, D2 = 2X, D3 = 3X).

[0055] Setting the intervals D1 to D3 between the position sensors 30 to the integral multiple of the circumferential length X of the drive roller is advantageous as follows. Even if the drive roller is eccentric, this setting can cancel out the speed unevenness of the sheet S due to the eccentricity at the detection positions of the position sensors 30. Accordingly, each position sensor 30 can accurately detect the positional deviation of the sheet S.

[0056] Similarly, intervals E1 to E3 between the head units 12K, 12C, 12M, and 12Y in the conveyance direction A are set to one, two, and three multiples of the circumferential length X of the drive roller (E1 = X, E2 = 2X, and E3 = 3X). This setting can cancel out the speed unevenness of the sheet S due to the eccentricity of the drive roller at each of the liquid discharge positions 10K, 10C, 10M, and 10Y, thereby accurately discharging ink from the head units 12K, 12C, 12M, and 12Y to the sheet S.

Comparative Example

[0057] The head unit 12 is preferably moved in the width direction B based on the movement amount (amount of the positional deviation) of the sheet S with a good movement accuracy at low cost. For example, in Japanese Unexamined Patent Application Publication No. 2018-130956, a dedicated actuator or an actuator controller for controlling the actuator is used to have the good movement accuracy, but causes an increase in cost.

Cleaning Device

[0058] FIG. 7 is a plan view of the liquid discharge head, a position changer, and a cleaning position by a cleaning device. In a typical inkjet recording apparatus, the nozzle 19 may be clogged or the nozzle face may be stained while ink is consecutively discharged for recording. For this reason, the discharge head 18 is periodically cleaned. The image forming apparatus 100 includes a cleaning device 45 that cleans the discharge head 18. The cleaning device 45 may closely contact the nozzle face to clean the nozzle face of the discharge head 18.

[0059] The cleaning device 45 may be a maintenance device that maintains a discharge state of the discharge head 18. The image forming apparatus 100 performs a cleaning operation to prevent non-discharge, oblique discharge, change in discharge speed, and change in discharge amount due to clogging of the discharge head 18 or ink thickening, and to maintain or recover the discharge state.

[0060] The cleaning device 45 causes the discharge head 18 to discharge liquid (e.g., ink) from the nozzles 19 to maintain the discharge state of the discharge head 18. In this case, the cleaning device 45 may perform a cleaning operation such as purging, dummy discharge, flushing, and wiping. The image forming apparatus 100 discharge ink that does not contribute to image formation from the nozzles 19 of the discharge head 18 to perform the cleaning operation. The cleaning device 45 includes, for example, a discharge receiver that receives ink discharged from the discharge head 18. The cleaning device 45 is provided for each of the multiple head units 12K, 12C, 12M, and 12Y

Cleaning Position

[0061] A cleaning position 43 is described below with reference to FIG. 7. The cleaning position 43 is an example of a second position. The cleaning position may be a position of the head unit 12 during the cleaning operation. The cleaning position 43 may be, for example, a position above the discharge receiver serving as the cleaning device 45. For example, when the cleaning operation is a wiping operation, the cleaning position 43 may be a position of the head unit 12 during the wiping operation.

The cleaning position 43 includes cleaning positions 43K, 43C, 43M, and 43Y

[0062] The cleaning position 43K is a position of the head unit 12K while the cleaning device 45 cleans the head unit 12K. The cleaning position 43C is a position of the head unit 12C while the cleaning device 45 cleans the head unit 12C. The cleaning position 43M is a position of the head unit 12M while the cleaning device 45 cleans the head unit 12M. The cleaning position 43Y is a position of the head unit 12Y while the cleaning device 45 cleans

the head unit 12Y The cleaning position 43 is a position away from the liquid discharge position 10 in the width direction B of the sheet S. Specifically, the cleaning positions 43K, 43C, 43M, and 43Y are separated from the liquid discharge position 10K, 10C, 10M, and 10Y in the width direction B, respectively. The liquid discharge position 10 includes the liquid discharge positions 10K, 10C, 10M, and 10Y

[0063] The cleaning positions 43K, 43C, 43M, and 43Y do not overlap the sheet S. In the conveyance direction A of the sheet S, the cleaning positions 43K, 43C, 43M, and 43Y are arranged at predetermined intervals in correspondence with the head units 12K, 12C, 12M, and 12Y

Position Changer

[0064] The image forming apparatus 100 includes a position changer 50 that moves the head unit 12 between the cleaning position 43 and the liquid discharge position 10 in the width direction B. The position changer 50 includes position changers 50K, 50C, 50M, and 50Y The position changer 50K moves the head unit 12K in the width direction B. The position changer 50C moves the head unit 12C in the width direction B. The position changer 50M moves the head unit 12M in the width direction B. The position changer 50Y moves the head unit 12Y in the width direction B.

[0065] The position changers 50K, 50C, 50M, and 50Y may be collectively referred to as position changers 50, each of which may be referred to as the position changer 50 unless distinguished.

[0066] The position changer 50 includes a ball screw 40, a linear guide 41, and a motor 42. The ball screw 40 extends in the width direction B and hold the head unit 12. The ball screw 40 is disposed at a position shifted downstream from the head unit 12 in the conveyance direction A in FIG. 7. The ball screw 40 may be disposed at a position overlapping the head unit 12 in plan view.

[0067] The head unit 12 is supported by the ball screw 40 and the linear guide 41. The motor 42 is disposed at one end of the ball screw 40. The motor 42 may be disposed at a position close to the cleaning position 43 in plan view. The motor 42 drives the ball screw 40 to move the head unit 12 between the cleaning position 43 and the liquid discharge position 10 in the width direction B.

[0068] The linear guide 41 extends in the width direction B. The linear guide 41 extends from the liquid discharge position 10 to the cleaning position 43. The head unit 12 is movable along the linear guide 41 in the width direction B. The linear guide 41 is disposed at a position shifted upstream from the head unit 12 in the conveyance direction A. The linear guide 41 and the ball screw 40 are disposed on opposite sides of the head unit 12. The linear guide 41 may be disposed at a position overlapping the head unit 12 in plan view. The linear guide 41 is an example of a guide. The linear guide 41 guides the movement of the head unit 12 in the width direction B.

[0069] The controller 9 controls the motor 42 to drive the ball screw 40. The head unit 12 is guided by the ball screw 40 and the linear guide 41 and moves in the width direction B between the liquid discharge position 10 and the cleaning position 43. The motor 42 is provided for each of multiple ball screws 40. The head units 12K, 12C, 12M, and 12Y independently move between the liquid discharge positions 10K, 10C, 10M, and 10Y and the cleaning positions 43K, 43C 43M, and 43Y, respectively.

[0070] Movement Control of Head Unit in Width Direction B Based on Amount of Positional Deviation in Width Direction B

[0071] The motor 42 may be a stepping motor that rotates by a specified number of pulses. The motor 42 may be a servo motor including an encoder to detect a rotational position of a rotation shaft of the motor 42 to control the rotational position of the rotation shaft. Thus, the image forming apparatus 100 can determine the position of the head unit 12 in the width direction B with high accuracy. For example, when the sheet S is a copy sheet of a B2 size, the movement amount of the head unit 12 between the liquid discharge position 10 and the cleaning position 43 is, for example, about the 800 mm.

[0072] On the other hand, the positional accuracy in the movement of the head unit 12 for adjusting the discharge position of ink is, for example, equal to or less than the 1 mm. The position changer 50 can perform both the movement of the head unit 12 between the liquid discharge position 10 and the cleaning position 43 and the movement of the head unit 12 for adjusting the discharge position of ink. Accordingly, the image forming apparatus 100 can adjust the discharge position of ink without a dedicated actuator, which corresponds to the motor 42 in the present embodiment, for adjusting the discharge position of ink and an actuator controller for controlling the dedicated actuator. As a result, in the image forming apparatus 100, the increase in cost can be prevented. Further, in the image forming apparatus 100, the head unit 12 is moved to adjust the discharge position of ink, thereby preventing the deterioration of the image quality.

Hardware Configuration of Image Forming Apparatus

[0073] A hardware configuration of the image forming apparatus 100 is described below with reference to FIG. 8. FIG. 8 is a block diagram illustrating the hardware configuration of the image forming apparatus 100 according to the present embodiment. The hardware configuration illustrated in FIG. 8 may include additional components if desired. The hardware configuration may not include the components illustrated in FIG. 8 if desired.

[0074] The image forming apparatus 100 includes the control device 500. The control device 500 includes a central processing unit (CPU) 501, a read only memory (ROM) 502, a random access memory (RAM) 503, a nonvolatile random access memory (NVRAM) 504, and a hard disk drive (HDD) 508. The CPU 501 controls the entire image forming apparatus 100. The ROM 502

stores various programs for causing the CPU 501 to control the liquid discharge and various data for discharging ink (liquid).

[0075] The RAM 503 temporarily stores various types of data and the like. The NVRAM 504 is a non-volatile memory and can retain data even while a power supply of the image forming apparatus 100 is shut off. The control device 500 includes a main controller 500A, and the main controller 500A includes the CPU 501, the ROM 502, and the RAM 503. The control device 500 includes the controller 9 described above.

[0076] The control device 500 includes an application specific integrated circuit (ASIC) 505. The ASIC 505 processes input and output signals for controlling the entire image forming apparatus 100. The ASIC 505 performs various kinds of signal processing on the image data. The ASIC 505 also performs image processing on the image data input to the control device 500.

[0077] The control device 500 includes an external interface (I/F) 506 for transmitting and receiving data to and from a host 600 which is an example of an external device. The host 600 includes an information processor such as a personal computer, an image reading device such as an image scanner, and an imaging device such as a digital camera. The control device 500 receives data transmitted from the host 600. The host 600 may include a printer driver 601. The printer driver 601 generates dot pattern data for outputting an image from the image forming apparatus 100.

[0078] The control device 500 further includes an input/output (I/O) unit 507 for receiving detection signals output from sensors 80. The sensors 80 include the position sensor 30. The sensors 80 may include various types of temperature sensors.

[0079] The control device 500 further includes a head controller 510 that controls driving of the discharge head 18. The head controller 510 controls the drive element of the discharge head 18. The head controller 510 controls the drive element of the discharge head 18 to causes the discharge head 18 to discharge ink (liquid). The head controller 510 executes various types of controls related to the discharge head 18.

[0080] The control device 500 includes a motor driver 511. The motor driver 511 controls driving of a drive motor 71 in accordance with a command from the CPU 501. The drive motor 71 rotates the conveyance rollers 17 of the conveyor unit 8.

[0081] The control device 500 includes a motor driver 512. The motor driver 512 controls driving of the motor 42 in accordance with a command from the CPU 501. The motor 42 is a motor of the position changer 50 to change the positions of the head units 12K, 12C, 12M, 12Y, 14K, 14C, 14M, and 14Y

[0082] The image forming apparatus 100 may include a control panel 516. The control panel 516 is electrically connected to the control device 500. The control panel 516 includes a display unit that displays various types of information. A user (operator) can perform an input operation with the control panel 516.

[0083] The control device 500 receives information based on the input operation by the user from the control panel 516. The control device 500 outputs various signals to the control panel 516 to display information on the control panel 516. The user may perform the input operation while referring to the information displayed on the control panel 516. The control panel 516 is an example of an operation input unit.

[0084] The program may be recorded in a computer-readable storage medium such as a compact disc read only memory (CD-ROM) or a flexible disk (FD) as file data in an installable or an executable format, and may be loaded into the image forming apparatus 100 via such a storage medium.

[0085] Alternatively, the program may be recorded in a computer-readable storage medium such as a compact disc-recordable (CD-R), a digital versatile disc (DVD), a Blu-ray (registered trademark) disc, or a semiconductor memory, and may be loaded into the image forming apparatus 100 via such a storage medium. The program to be installed may be downloaded into the image forming apparatus 100 via a network such as the Internet. The program may be incorporated in the ROM 502 or the like in the image forming apparatus 100 in advance.

[0086] The control device 500 may implement the functions executed by the computer connected to the control device 500. Similarly, the computer connected to the control device 500 may implement the functions executed by the control device 500.

Operational Effect of Image Forming Apparatus

[0087] In the image forming apparatus 100 according to the present embodiment, the head unit 12 is moved in the width direction B between the liquid discharge position 10 and the cleaning position 43. The controller 9 causes the position changer 50 to move the head unit 12 between the liquid discharge position 10 and the cleaning position 43. Accordingly, the head unit 12 is moved from the liquid discharge position 10 to the cleaning position 43, and the discharge head 18 of the head unit 12 is cleaned at the cleaning position 43. After the discharge head 18 is cleaned, the head unit 12 is moved from the cleaning position 43 to the liquid discharge position 10 to discharge ink onto the sheet S from the head unit 12 at the liquid discharge position 10.

[0088] In the image forming apparatus 100, the position (i.e., a head position) of the head unit 12 is changed in response to the position of the sheet S in the width direction B detected by the position sensor 30. The controller 9 causes the position changer 50 to change the position of the head unit 12 in response to the position of the sheet S in the width direction B detected by the position sensor 30. In other words, in the image forming apparatus 100, the head unit 12 is moved by the position changer 50 and the controller 9 to change the position of the head unit 12. In the image forming apparatus 100,

the position of the head unit 12 is changed so as to follow the positional deviation of the sheet S without a dedicated position changer for moving the head unit 12.

[0089] As a result, a structure of the image forming apparatus 100 according to the present embodiment can be simplified as compared with an apparatus including both a position changer for moving the head unit 12 to the cleaning position 43 and a dedicated position changer for moving the head unit 12 so as to follow the positional deviation of the sheet S. As a result, space for the position changer can be reduced. Similarly, in the image forming apparatus 100 according to the present embodiment, the system of the controller 9 can be simplified as compared with a configuration including multiple controllers that control the operation of the position changers. As a result, the image forming apparatus 100 can be manufactured without an increase in manufacturing cost.

[0090] In the image forming apparatus 100, the position changer 50 includes the linear guide 41 along which the head unit 12 moves in the width direction B. The image forming apparatus 100 having such a configuration can change the position of the head unit 12 at a high speed between the liquid discharge position 10 and the cleaning position 43. Further, the image forming apparatus 100 can change the position of the head unit 12 with high accuracy in accordance with the detection result by the position sensor 30.

[0091] In the image forming apparatus 100, the position changer 50 includes the ball screw 40 extending in the width direction B and the motor 42 disposed at the end of the ball screw 40 to drive the ball screw 40. The image forming apparatus 100 having such a configuration can accurately move the head unit 12 coupled to the ball screw 40 by driving the ball screw 40 using the motor 42.

[0092] The present disclosure is not limited to the above-described embodiment, and numerous additional modifications and variations are possible without departing from or changing the technical idea of the present disclosure.

[0093] In the image forming apparatus 100 described above, a configuration including the head units 12K, 12C, 12M, and 12Y that discharge black, cyan, magenta, and yellow ink has been described, but ink discharged from the head unit 12 is not limited thereto. For example, the image forming apparatus 100 may include the head unit 12 that discharges other special ink. Examples of the special ink include white, silver, gold, and the like.

[0094] In the image forming apparatus 100 described above, one position changer 50 is provided for one head unit 12. However, for example, multiple head units 12 may be moved by one position changer 50. For example, in a configuration including five head units 12 that discharge black, cyan, magenta, yellow, and silver ink, the position changer 50 that moves the head unit 12 for black, the position changer 50 that moves the head units 12 for cyan and magenta, and the position changer 50 that moves the head units 12 for yellow and silver may be provided. The silver ink is the special ink.

[0095] In the above-described embodiment, the position changer 50 moves the head unit 12 to one side in the width direction B. However, the position changer 50 may move the head unit 12 to both sides in the width direction B.

[0096] In the above-described embodiment, the position changer 50 includes the ball screw 40, the linear guide 41, and the motor 42, but the position changer 50 is not limited thereto. The position changer 50 may include, for example, a power transmission belt, an air cylinder, a gear, or the like.

[0097] Each of functions of the above-described embodiments executed by the controller 9 can be implemented by one or more processing circuits. The "processing circuit" in the present specification includes a processor programmed to execute each function by software like a processor implemented by an electronic circuit, and a device such as an application specific integrated circuit (ASIC), a digital signal processor (DSP), a field programmable gate array (FPGA), or a conventional circuit module designed to execute each function described above.

[0098] A liquid discharge method according to the present embodiment includes: conveying an object in a first direction; discharging a liquid onto the object, at a first position, from a line head liquid discharger extending in a second direction intersecting the first direction; maintaining a discharge state of the line head liquid discharger at a second position away from the first position in the second direction; moving the line head liquid discharger between the first position and the second position; detecting a position of the object in the second direction; and changing a head position of the line head liquid discharger in response to the position of the object. The image forming apparatus 100 according to the present embodiment can execute the liquid discharge method.

[0099] Any one of the above-described operations may be performed in various other ways, for example, in an order different from the one described above.

[0100] The present invention can be implemented in any convenient form, for example using dedicated hardware, or a mixture of dedicated hardware and software. The present invention may be implemented as computer software implemented by one or more networked processing apparatuses. The processing apparatuses include any suitably programmed apparatuses such as a general purpose computer, a personal digital assistant, a Wireless Application Protocol (WAP) or third-generation (3G)-compliant mobile telephone, and so on. Since the present invention can be implemented as software, each and every aspect of the present invention thus encompasses computer software implementable on a programmable device. The computer software can be provided to the programmable device using any conventional carrier medium (carrier means). The carrier medium includes a transient carrier medium such as an electrical, optical, microwave, acoustic or radio frequency signal

carrying the computer code. An example of such a transient medium is a Transmission Control Protocol/Internet Protocol (TCP/IP) signal carrying computer code over an IP network, such as the Internet. The carrier medium may also include a storage medium for storing processor readable code such as a floppy disk, a hard disk, a compact disc read-only memory (CD-ROM), a magnetic tape device, or a solid state memory device.

Claims

1. A liquid discharge apparatus (100) comprising:

a conveyor (8) configured to convey an object (S) in a first direction (A);
a liquid discharger (12) configured to discharge a liquid onto the object (S) at a first position (10), the liquid discharger (12) including a full-width head extending in a second direction (B) intersecting the first direction (A);
a maintenance device (45) configured to maintain a discharge state of the liquid discharger (12) at a second position (43) away from the first position (10) in the second direction (B);
a position changer (50) configured to move the liquid discharger (12) between the first position (10) and the second position (43);
a position detector (30) configured to detect a position of the object (S) in the second direction (B); and
circuitry (9) configured to cause the position changer (50) to change a head position of the liquid discharger (12) in the second direction in response to the position of the object (S) detected by the position detector (30).

2. The liquid discharge apparatus (100) according to claim 1,
wherein the position changer (50) includes a guide (41) extending in the second direction (B) to guide the liquid discharger (12) in the second direction (B).

3. The liquid discharge apparatus (100) according to claim 2,
wherein the position changer (50) further includes:

a ball screw (40) extending in the second direction (B) and holding the liquid discharger (12); and
a motor (42) configured to drive the ball screw (40) to move the liquid discharger (12) between the first position (10) and the second position (43) in the second direction (B).

4. The liquid discharge apparatus (100) according to claim 3,
wherein the guide (41) is disposed opposite to the ball screw (40) via the liquid discharger (12), and
the ball screw (40) and the guide (41) guide the liquid discharger (12) in the second direction (B) between the first position (10) and the second position (43).

5. The liquid discharge apparatus (100) according to claim 3,
wherein the motor (42) is a stepping motor that rotates by a specified number of pulses.

6. The liquid discharge apparatus (100) according to claim 3,
wherein the motor (42) is a servo motor including an encoder to detect a rotational position of a rotation shaft of the motor (42) to control the rotational position of the rotation shaft.

7. The liquid discharge apparatus (100) according to claim 1,
wherein the position changer (50) performs both of:

a movement of the liquid discharger (12) between the first position (10) and the second position (43); and
a movement of the liquid discharger (12) to change the head position in response to the position of the object (S) detected by the position detector (30).

8. A liquid discharge method comprising:

conveying an object (S) in a first direction (A);
discharging a liquid onto the object (S), at a first position (10), from a full-width head (12) extending in a second direction (B) intersecting the first direction (A);
maintaining a discharge state of the full-width head (12) at a second position (43) away from the first position (10) in the second direction (B);
moving the full-width head (12) between the first position (10) and the second position (43);
detecting a position of the object (S) in the second direction (B); and
changing a head position of the full-width head (12) in the second direction in response to the position of the object (S).

FIG. 1

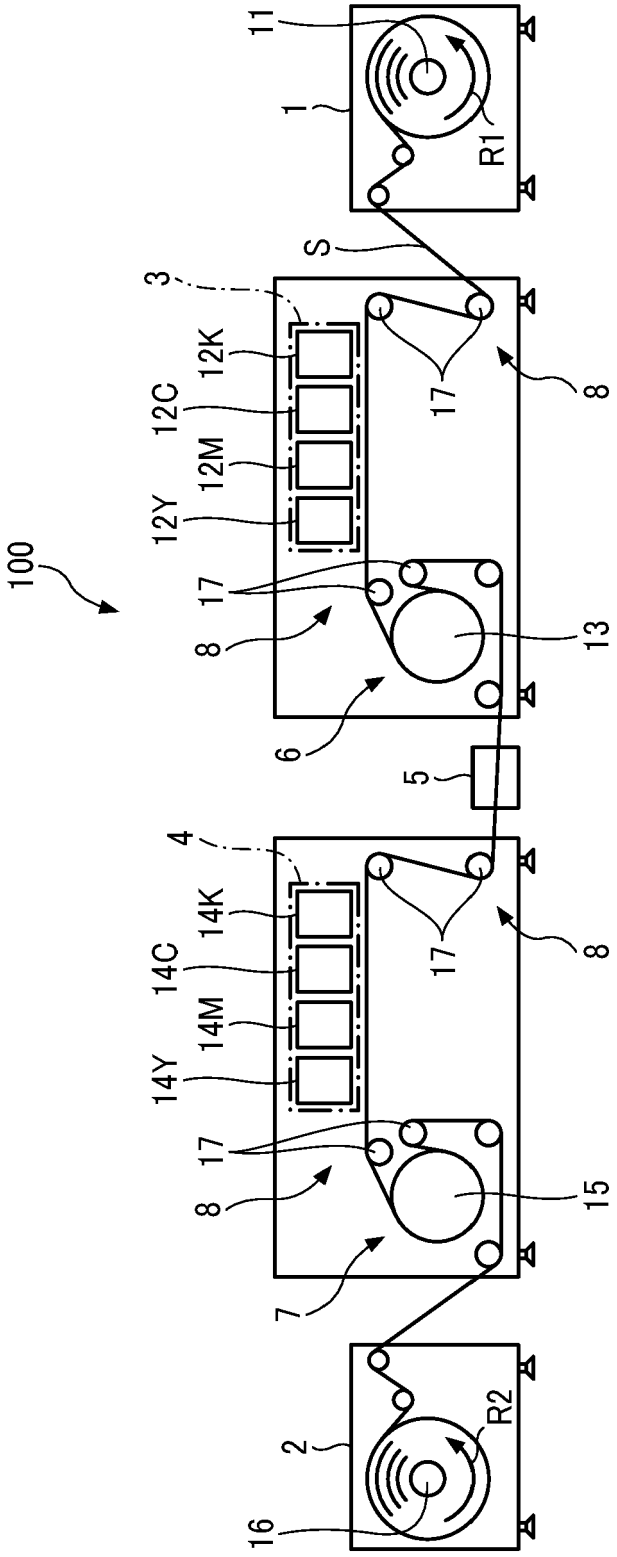

100
11
1
R1
S
3
12K
12C
12M
12Y
17
8
13
6
5
4
14K
14C
14M
14Y
15
7
2
R2
16

FIG. 2

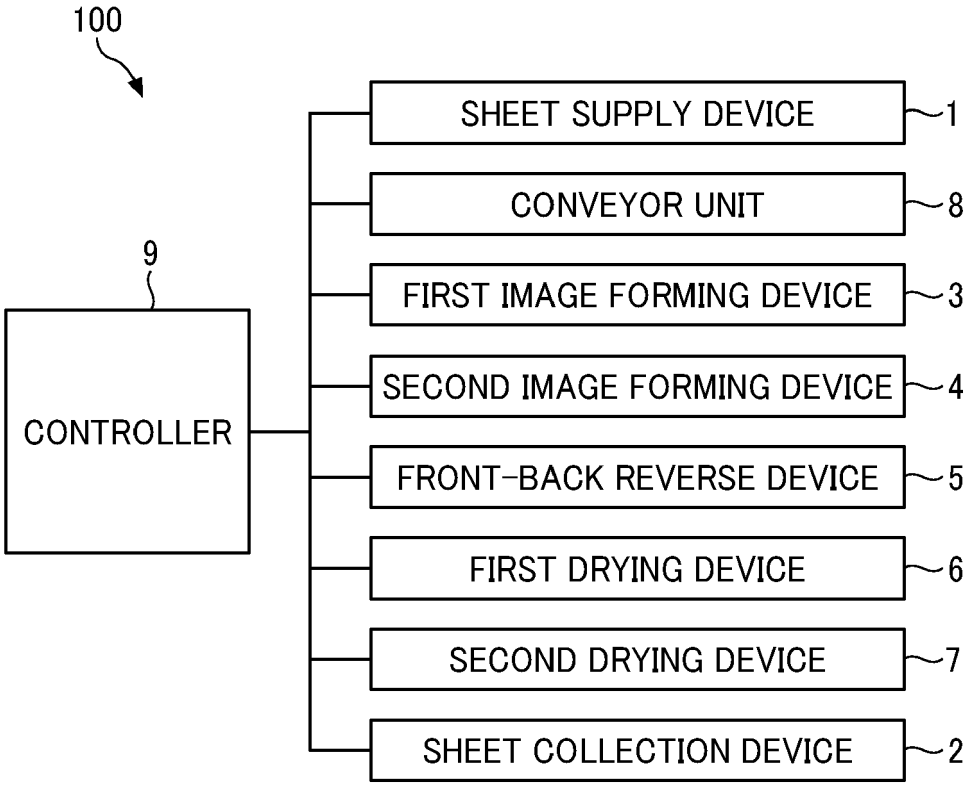

100
9
CONTROLLER
SHEET SUPPLY DEVICE
1
CONVEYOR UNIT
8
FIRST IMAGE FORMING DEVICE
3
SECOND IMAGE FORMING DEVICE
4
FRONT-BACK REVERSE DEVICE
5
FIRST DRYING DEVICE
6
SECOND DRYING DEVICE
7
SHEET COLLECTION DEVICE
2

FIG. 3

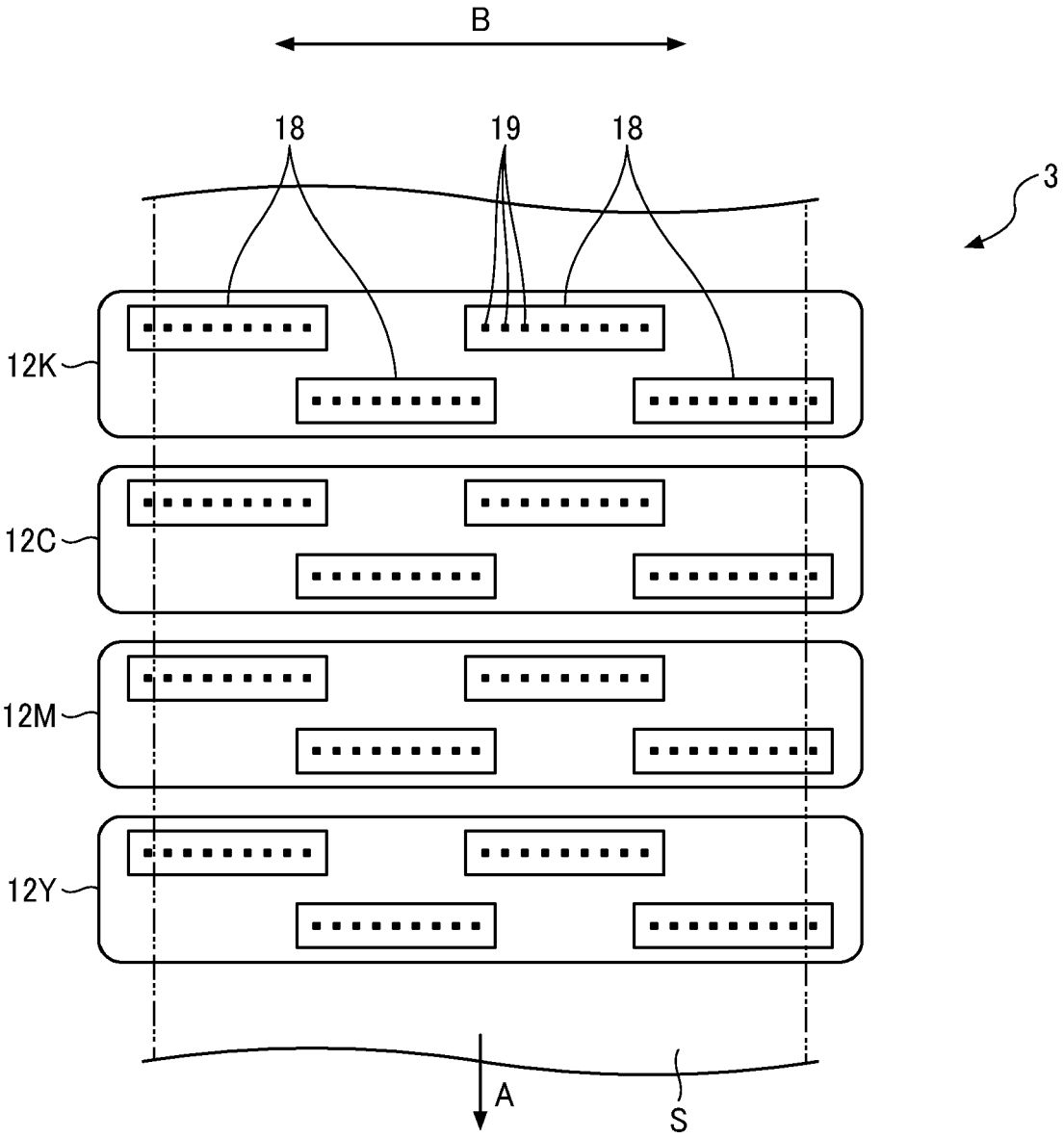


FIG. 4

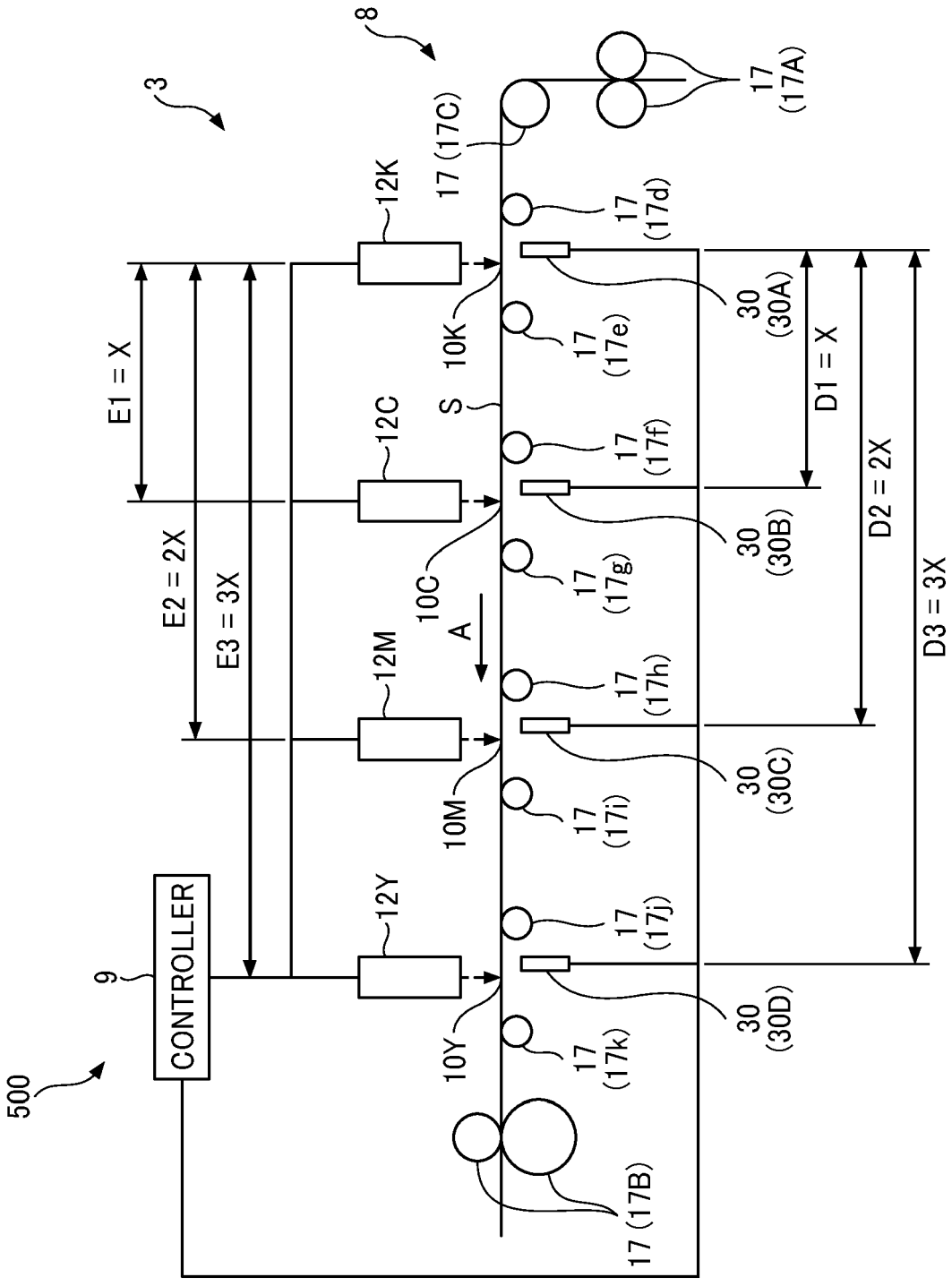

500
9
CONTROLLER
3
8
12K
12C
12M
12Y
10K
10C
10M
10Y
S
A
17 (17C)
17 (17A)
17 (17d)
17 (17e)
17 (17f)
17 (17g)
17 (17h)
17 (17i)
17 (17j)
17 (17k)
17 (17B)
30 (30A)
30 (30B)
30 (30C)
30 (30D)
E1 = X
E2 = 2X
E3 = 3X
D1 = X
D2 = 2X
D3 = 3X

FIG. 5

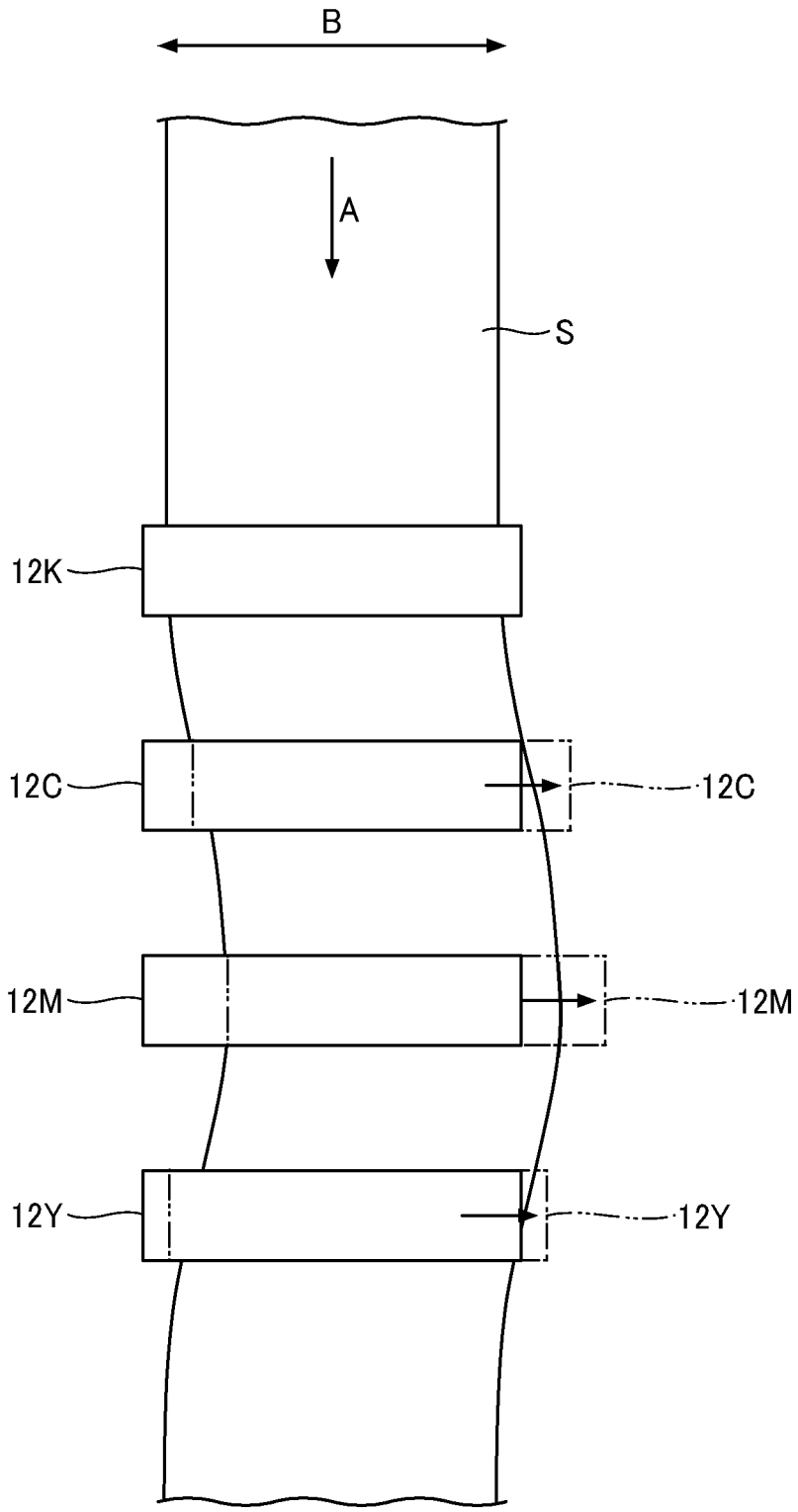


FIG. 6

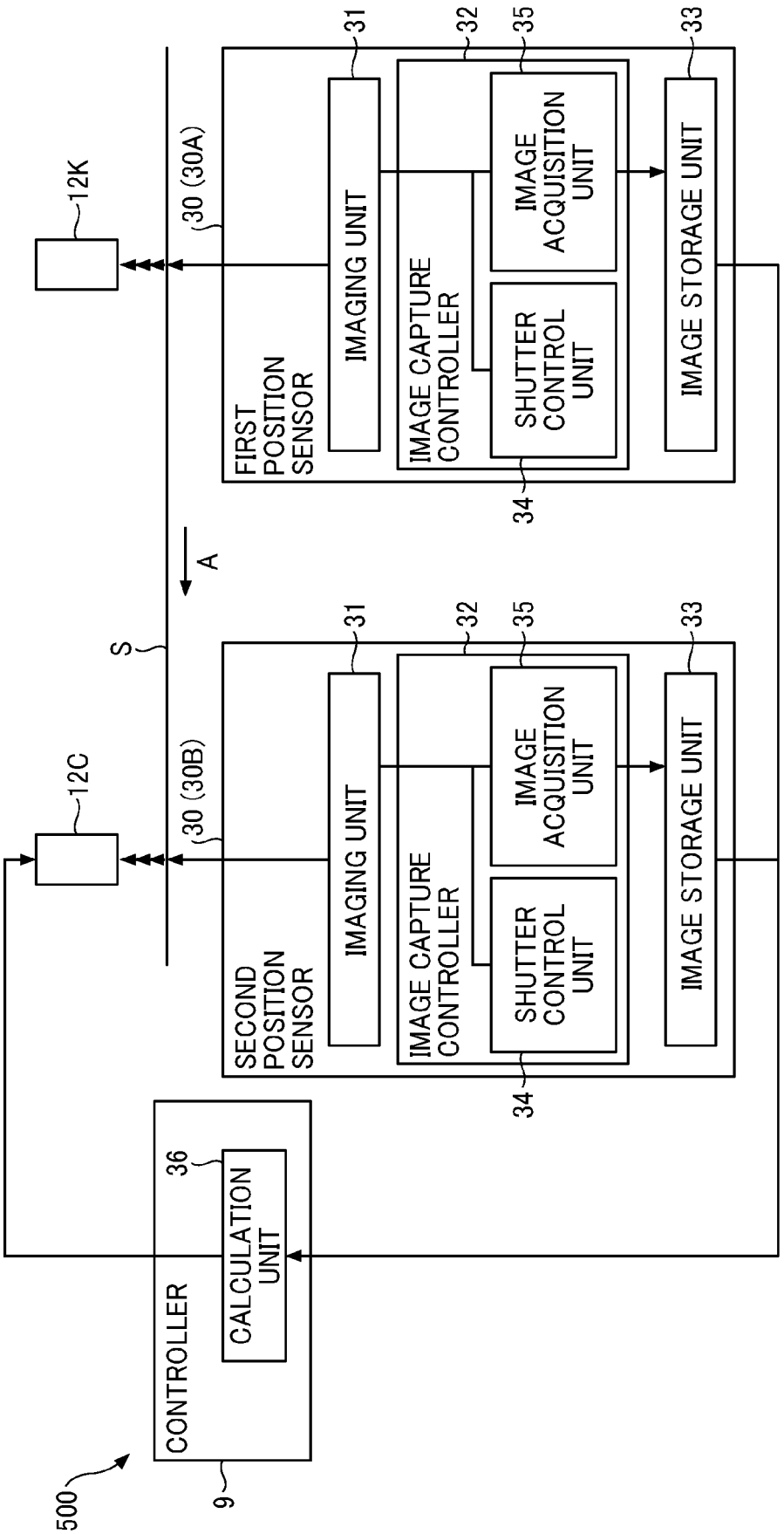

500
9
CONTROLLER
36
CALCULATION UNIT
12C
12K
30 (30B)
30 (30A)
S
A
SECOND POSITION SENSOR
FIRST POSITION SENSOR
IMAGING UNIT
IMAGE CAPTURE CONTROLLER
SHUTTER CONTROL UNIT
IMAGE ACQUISITION UNIT
IMAGE STORAGE UNIT
31
32
33
34
35

FIG. 7

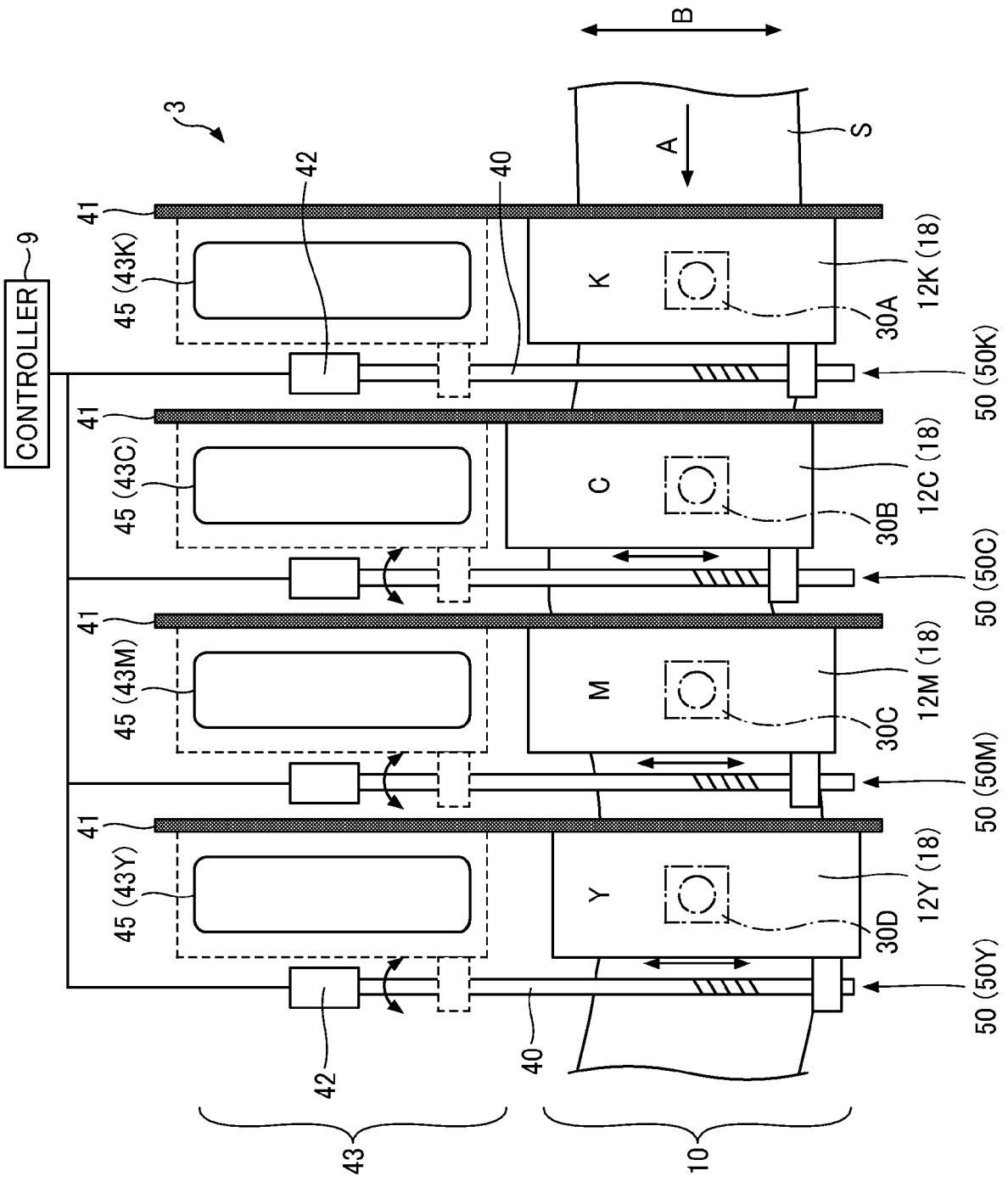
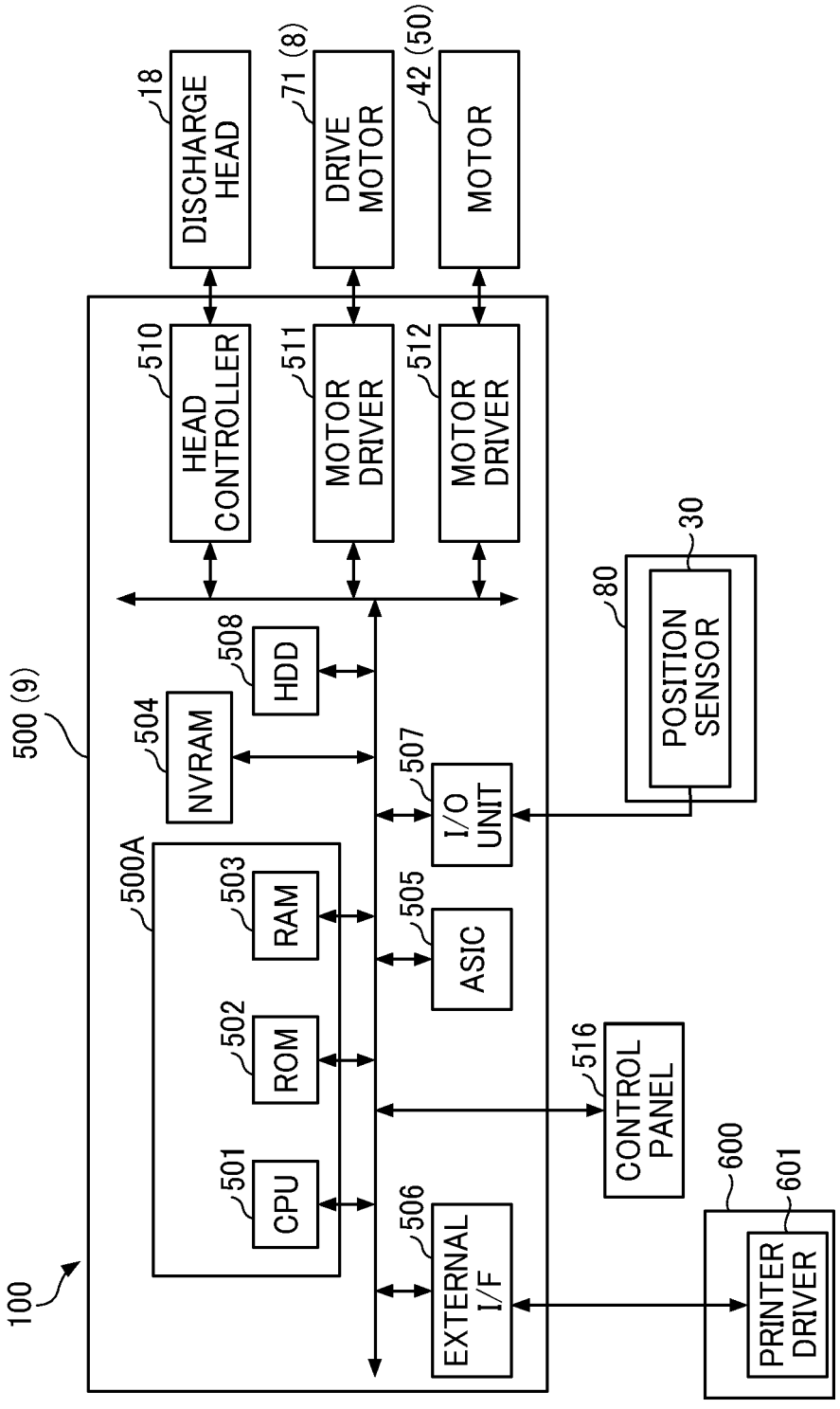

B
A
S
3
42
40
41
45 (43K)
45 (43C)
45 (43M)
45 (43Y)
CONTROLLER
9
K
C
M
Y
12K (18)
12C (18)
12M (18)
12Y (18)
30A
30B
30C
30D
50 (50K)
50 (50C)
50 (50M)
50 (50Y)
43
10

FIG. 8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500 (9)
500A
CPU
501
ROM
502
RAM
503
NVRAM
504
HDD
508
HEAD CONTROLLER
510
MOTOR DRIVER
511
MOTOR DRIVER
512
I/O UNIT
507
ASIC
505
EXTERNAL I/F
506
CONTROL PANEL
516
POSITION SENSOR
30
80
DISCHARGE HEAD
18
DRIVE MOTOR
71 (8)
MOTOR
42 (50)
600
PRINTER DRIVER
601

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 1696

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X	US 2022/048298 A1 (SAHUN PERES JORDI [ES] ET AL) 17 February 2022 (2022-02-17) * figures 1, 4-6, 9 * * paragraph [0185] - paragraph [0189] * * paragraph [0218] * * paragraph [0247] - paragraph [0248] *	1,2,8	
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B41J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	7 November 2023	João, César

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