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RECORDING DEVICE AND TEST PATTERN FORMING METHOD

Abstract

A test pattern includes a plurality of individual patterns along a main scanning direction by liquid ejection from each of a plurality of first nozzles. The individual patterns adjacent to each other in a sub scanning direction are located at positions shifted from each other in the main scanning direction. The plurality of first nozzles include a first sequential nozzle group that is sequential in the sub scanning direction and a second sequential nozzle group that is sequential in the sub scanning direction. The test pattern includes a first pattern group derived from liquid ejection from the first sequential nozzle group and a second pattern group derived from liquid ejection from the second sequential nozzle group. The control unit performs control to form the test pattern in which at least the first pattern group and the second pattern group are arranged in the main scanning direction by performing sub scanning between formation of the first pattern group and formation of the second pattern group.

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Background/Summary

[0001] The present application is based on, and claims priority from JP Application Serial Number 2024-024357, filed Feb. 21, 2024, the disclosure of which is hereby incorporated by reference herein in its entirety.

BACKGROUND

1. Technical Field

[0002] The present disclosure relates to a recording device capable of forming a test pattern indicating an ejection state of a nozzle, and a test pattern forming method.

2. Related Art

[0003] As a recording device, an inkjet printer that ejects ink as liquid from a recording head onto a recording medium has been known. When viscosity of the ink in a nozzle increases, air bubbles are mixed into the nozzle, dust or paper powder adheres to the nozzle, or the like, an ink droplet is not ejected from the nozzle, or an ink droplet ejected from the nozzle does not land at a normal position on the medium in some cases. Here, a nozzle from which an ink droplet is not normally ejected is referred to as a defective nozzle.

[0004] JP 2022-11429 A discloses printing a test pattern on a printing medium, the test pattern indicating an ejection state of each nozzle by ruled lines along a main scanning direction, that is, an individual pattern, in order to inspect an ejection state of ink from a nozzle row. A length of the test pattern in a sub scanning direction corresponds to a length of the nozzle row in the sub scanning direction. For example, when the nozzle row of a recording head includes four rows of C (cyan), M (magenta), Y (yellow), and K (black), a test pattern is printed in which a pattern group of C, a pattern group of M, a pattern group of Y, and a pattern group of K are arranged in a main scanning direction.

[0005] The recording head includes a “vertical array head” having a color nozzle array in which a nozzle group for C, a nozzle group for M, and a nozzle group for Y are arranged in one row along a nozzle row for K. In the color nozzle row, there is a nozzle that is not used between the nozzle group for C and the nozzle group for M, and there is a nozzle that is not used between the nozzle group for M and the nozzle group for Y. Since the vertical array head includes only two nozzle rows, a test pattern is to be printed in which two pattern groups of K and the colors are arranged in the main scanning direction. In this case, when a defective nozzle of the nozzle row for K and a defective nozzle of the color nozzle row are at the same position, there is a possibility that the positions corresponding to the defective nozzles cannot be detected from the test pattern. In addition, since a gap is formed at a color change in pattern groups derived from ink ejection from the color nozzle row, there is a possibility that a position corresponding to a defective nozzle cannot be detected from the test pattern also when a nozzle corresponding to an individual pattern at a location adjacent to the gap is the defective nozzle. When the position corresponding to the defective nozzle is not detected, the defective nozzle included in the nozzle row is not detected.

[0006] Note that the above-described problem is also conceivable in a recording device other than an inkjet printer having a vertical array head, such as a monochrome printer having only the nozzle row for K in a recording head.

SUMMARY

[0007] A recording device of the present disclosure includes an aspect including a recording head including a first nozzle row in which a plurality of first nozzles capable of ejecting liquid onto a medium are arranged, and a control unit configured to control main scanning for moving the recording head along a main scanning direction intersecting with an arrangement direction of the

plurality of first nozzles, sub scanning for moving at least one of the medium and the recording head along a sub scanning direction intersecting with the main scanning direction, and ejection of the liquid from the recording head, wherein the control unit is capable of controlling formation of a test pattern including a plurality of individual patterns along the main scanning direction by liquid ejection from each of the plurality of first nozzles, the individual patterns adjacent to each other in the sub scanning direction are located at positions shifted from each other in the main scanning direction, the plurality of first nozzles include a first sequential nozzle group that is sequential in the sub scanning direction and a second sequential nozzle group that is sequential in the sub scanning direction, the test pattern includes a first pattern group derived from liquid ejection from the first sequential nozzle group and a second pattern group derived from liquid ejection from the second sequential nozzle group, and the control unit performs control to form the test pattern in which at least the first pattern group and the second pattern group are arranged in the main scanning direction by performing the sub scanning between formation of the first pattern group and formation of the second pattern group.
[0008] Additionally, a test pattern forming method of the present disclosure includes an aspect being a test pattern forming method for forming a test pattern by performing main scanning for moving a recording head including a first nozzle row in which a plurality of first nozzles capable of ejecting liquid onto a medium are arranged along a main scanning direction intersecting with an arrangement direction of the plurality of first nozzles, and sub scanning for moving at least one of the medium and the recording head along a sub scanning direction intersecting with the main scanning direction, wherein the test pattern includes a plurality of individual patterns along the main scanning direction by liquid ejection from each of the plurality of first nozzles, the individual patterns adjacent to each other in the sub scanning direction are located at positions shifted from each other in the main scanning direction, the plurality of first nozzles include a first sequential nozzle group that is sequential in the sub scanning direction and a second sequential nozzle group that is sequential in the sub scanning direction, the test pattern forming method includes a first pattern group forming step for forming a first pattern group on the medium by ejecting the liquid from the first sequential nozzle group, a second pattern group forming step for forming a second pattern group on the medium by ejecting the liquid from the second sequential nozzle group, and a sub scanning step for performing the sub scanning such that the first pattern group and the second pattern group are arranged in the main scanning direction.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0009] FIG. **1** is a diagram schematically illustrating an example of a recording device.
[0010] FIG. **2** is a diagram schematically illustrating an example of a recording head and a test pattern.
[0011] FIG. **3** is a diagram schematically illustrating a classification example of nozzle groups.
[0012] FIG. **4** is a diagram schematically illustrating an example of the test pattern.
[0013] FIG. **5** is a diagram schematically illustrating an example of a test pattern forming method.
[0014] FIG. **6** is a diagram schematically illustrating the example of the test pattern forming method.
[0015] FIG. **7** is a diagram schematically illustrating an example of the test pattern including an individual pattern position of a defective nozzle.
[0016] FIG. **8** is a diagram schematically illustrating another example of the test pattern.
[0017] FIG. **9** is a diagram schematically illustrating an example of a test pattern including an individual pattern position of a defective nozzle in a comparative example.
DESCRIPTION OF EMBODIMENTS

[0018] Hereinafter, an embodiment of the present disclosure will be described. Of course, the following embodiment is merely illustrative of the present disclosure, and not all of the characteristics presented in the embodiment are essential to the solution of the disclosure.

(1) Overview of Aspect Included in Present Disclosure

[0019] First, an overview of aspects included in the present disclosure will be described with reference to examples illustrated in FIGS. **1** to **9**. Note that the drawings in the present application are diagrams schematically illustrating the examples, a scale of each part may differ from an actual scale in order to make each part of these drawings larger enough to be easily recognizable, magnifications in respective directions indicated in these drawings may be different from each other, and the drawings may be inconsistent with one another. Of course, each element of the present aspect is not limited to a specific example indicated by a reference sign. In "Overview of Aspect Included in Present Disclosure", a parenthesized word indicates a supplementary description of an immediately preceding word.

Aspect 1

[0020] As illustrated in FIG. **1**, a recording device **1** according to an aspect includes a recording head **30** and a control unit U**1**. The recording head **30** includes a first nozzle row (for example, a nozzle row **33**K for K) in which a plurality of first nozzles (for example, a nozzle **34**K for K) that can eject liquid **36** onto a medium MEO are arranged, as illustrated in FIGS. **2** to **4**, and the like. The control unit U**1** controls, as illustrated in FIGS. **5** and **6**, main scanning SC**1** for moving the recording head **30** along a main scanning direction D**1** intersecting with an arrangement direction D**4** of the plurality of first nozzles (**34**K), sub scanning SC**2** for moving at least one of the medium ME**0** and the recording head **30** along a sub scanning direction D**2** intersecting with the main scanning direction D**1**, and ejection of the liquid **36** from the recording head **30**. As illustrated in FIGS. **2**, **4**, and the like, the control unit U**1** can control formation of a test pattern TP including a plurality of individual patterns L along the main scanning direction D**1** by liquid ejection from each of the plurality of first nozzles (**34**K). Here, the individual patterns L adjacent to each other in the sub scanning direction D**2** are located at positions shifted from each other in the main scanning direction D**1**. As illustrated in FIGS. **3**, **4**, and the like, the plurality of first nozzles (**34**K) include a first sequential nozzle group NG**1** that is sequential in the sub scanning direction D**2** and a second sequential nozzle group NG**2** that is sequential in the sub scanning direction D**2**. The test pattern TP includes a first pattern group PG**1** derived from liquid ejection from the first sequential nozzle group NG**1** and a second pattern group PG**2** derived from liquid ejection from the second sequential nozzle group NG**2**. As illustrated in FIGS. **5** and **6**, the control unit U**1** performs control to form the test pattern TP in which at least the first pattern group PG**1** and the second pattern group PG**2** are arranged in the main scanning direction D**1** by performing the sub scanning SC**2** between formation of the first pattern group PG**1** and formation of the second pattern group PG**2**.

[0021] Since the first pattern group PG**1** formed by the first sequential nozzle group NG**1** in the first nozzle row (**33**K) and the second pattern group PG**2** formed by the second sequential nozzle group NG**2** in the first nozzle row (**33**K) are arranged in the main scanning direction D**1**, the number of individual patterns L formed at the same position in the sub scanning direction D**2** is increased. Accordingly, even when some of the individual patterns L among the plurality of individual patterns L formed at the same position in the sub scanning direction D**2** are not formed due to ejection failures of the nozzles, positions corresponding to defective nozzles LN are detected since the remaining individual patterns L are formed. Therefore, according to the aspect described above, it is possible to provide a recording device in which a situation in which a defective nozzle having an ejection failure cannot be detected can be suppressed.

[0022] Here, examples of the medium include various objects such as paper, cloth, and film.

[0023] The control unit may perform control such that the second pattern group is formed after the first pattern group is formed, or may perform control such that the first pattern group is formed after the second pattern group is formed.

[0024] The “first”, “second”, or the like in the present application are terms for identifying each constituent element included in a plurality of constituent elements having similarity, and do not mean an order. Which of the plurality of components applies to “first”, “second”, or the like is determined relatively.
[0025] Note that the above-described additional remarks are also applied to the following aspects.
Aspect 2
[0026] As illustrated in FIGS. **3** and **4**, the plurality of first nozzles (**34**K) may further include a third sequential nozzle group NG**3** that is sequential in the sub scanning direction D**2** and a fourth sequential nozzle group NG**4** that is sequential in the sub scanning direction D**2**. The test pattern TP may include the first pattern group PG**1**, the second pattern group PG**2**, a third pattern group PG**3** derived from liquid ejection from the plurality of third sequential nozzles, and a fourth pattern group PG**4** derived from liquid ejection from the plurality of fourth sequential nozzles. In the test pattern TP, the number of pattern groups PG derived from liquid ejection from the first nozzle row (**33**K) may be four. As illustrated in FIGS. **5** and **6**, the control unit U**1** may perform control to form the test pattern TP in which at least the first pattern group PG**1**, the second pattern group PG**2**, the third pattern group PG**3**, and the fourth pattern group PG**4** are arranged in the main scanning direction D**1**, by performing the sub scanning SC**2** between formation of the second pattern group PG**2** and formation of the third pattern group PG**3**, and performing the sub scanning SC**2** between formation of the third pattern group PG**3** and formation of the fourth pattern group PG**4**.
[0027] As a result of examination, it has been found that the number of pattern groups PG derived from liquid ejection from one nozzle row is optimal to be four in terms of formation speed of the test pattern TP and detection accuracy of the defective nozzle LN. Therefore, according to the aspect described above, it is possible to provide a recording device that is suitable in terms of forming speed of a test pattern and detection accuracy of a defective nozzle.
Aspect 3
[0028] As illustrated in FIGS. **2** to **4**, and the like, the recording head **30** may include a second nozzle row (for example, a color nozzle row **33**A) along the first nozzle row (**33**K), the second nozzle row (**33**A) having a plurality of second nozzles (for example, color nozzles **34**A) being arranged therein. The plurality of second nozzles (**34**A) may include a first sequential color nozzle group NG**11** in which a plurality of first color nozzles capable of ejecting liquid **36** of a first color (for example, C) onto the medium ME**0** are sequentially arranged, a second sequential color nozzle group NG**12** in which a plurality of second color nozzles capable of ejecting the liquid **36** of a second color (for example, M) onto the medium ME**0** are sequentially arranged, and a third sequential color nozzle group NG**13** in which a plurality of third color nozzles capable of ejecting the liquid **36** of a third color (for example, Y) onto the medium ME**0** are sequentially arranged. The test pattern TP may include a first color pattern group PG**11** derived from liquid ejection from the first sequential color nozzle group NG**11**, a second color pattern group PG**12** derived from liquid ejection from the second sequential color nozzle group NG**12**, and a third color pattern group PG**13** derived from liquid ejection from the third sequential color nozzle group NG**13**. The control unit U**1** may perform control to form the test pattern TP in which at least the first pattern group PG**1**, the second pattern group PG**2**, and the first color pattern group PG**11** are arranged in the main scanning direction D**1**.
[0029] In the above case, since the individual pattern L derived from liquid ejection from the second nozzle (**34**K) is formed at the same position as the individual pattern L derived from liquid ejection from the first nozzle (**34**A) in the sub scanning direction D**2**, it is possible to further suppress the situation in which a defective nozzle cannot be detected.
Aspect 4
[0030] As illustrated in FIG. **3** and the like, the plurality of second nozzles (**34**A) may include a fifth sequential nozzle group NG**5** that is sequential in the sub scanning direction D**2** and a sixth sequential nozzle group NG**6** that is sequential in the sub scanning direction D**2**. As illustrated in

FIG. **4** and the like, the test pattern TP may include a fifth pattern group PG**5** derived from liquid ejection from the fifth sequential nozzle group NG**5** and a sixth pattern group PG**6** derived from liquid ejection from the sixth sequential nozzle group NG**6**. As illustrated in FIGS. **5** and **6**, the control unit U**1** may perform control to form the test pattern TP in which at least the first pattern group PG**1**, the second pattern group PG**2**, the fifth pattern group PG**5**, and the sixth pattern group PG**6** are arranged in the main scanning direction D**1** by performing the sub scanning SC**2** between formation of the fifth pattern group PG**5** and formation of the sixth pattern group PG**6**.
[0031] In the above case, since the two pattern groups PG derived from liquid ejection from the first nozzle row (**33**K) and the two pattern groups PG derived from liquid ejection from the second nozzle row (**33**A) are formed at the same position in the sub scanning direction D**2**, it is possible to further suppress the situation in which a defective nozzle cannot be detected. Note that when the sub scanning SC**2** is repeated in order to arrange the pattern groups PG in the main scanning direction D**1**, a time required to form the test pattern TP becomes longer. When the number of nozzle rows of the recording head **30** is two or less, an effect of improving detection accuracy of the defective nozzle LN is particularly large as compared to a formation speed of the test pattern TP. Therefore, the aspect described above is suitable for a case where the number of nozzle rows of the recording head is two or less.
Aspect 5
[0032] As illustrated in FIGS. **2**, **4**, and the like, the test pattern TP may include a plurality of the pattern groups PG including the first pattern group PG**1** and the second pattern group PG**2**. The control unit U**1** may perform control to form the test pattern TP in which the plurality of pattern groups PG are arranged in the main scanning direction D**1** so that a position in the sub scanning direction D**2** of each of the individual patterns L included in each of the pattern groups PG coincides with a position in the sub scanning direction D**2** of any of the individual patterns L included in the other pattern groups PG.
[0033] In the above case, at a position in the sub scanning direction D**2** of each individual pattern L, any of the other individual patterns L is present, thus it is possible to further suppress the situation in which a defective nozzle cannot be detected.
Aspect 6
[0034] Incidentally, a test pattern forming method according to an aspect is a test pattern forming method for forming the test pattern TP by performing the main scanning SC**1** for moving the recording head **30** including the first nozzle row (**33**K) in which the plurality of first nozzles (**34**K) capable of ejecting the liquid **36** onto the medium ME**0** are arranged along the main scanning direction D**1** intersecting with the arrangement direction D**4** of the plurality of first nozzles (**34**K), and the sub scanning SC**2** for moving at least one of the medium ME**0** and the recording head **30** along the sub scanning direction D**2** intersecting with the main scanning direction D**1**. The present test pattern forming method includes the following steps, as illustrated in FIGS. **5** and **6**.
[0035] (a1) A first pattern group forming step ST**1** for forming the first pattern group PG**1** on the medium ME**0** by ejecting the liquid **36** from the first sequential nozzle group NG**1**.
[0036] (a2) A second pattern group forming step ST**2** for forming the second pattern group PG**2** on the medium ME**0** by ejecting the liquid **36** from the second sequential nozzle group NG**2**.
[0037] (a3) A sub scanning step ST**3** for performing the sub scanning SC**2** such that the first pattern group PG**1** and the second pattern group PG**2** are arranged in the main scanning direction D**1**.
[0038] According to the aspect described above, it is possible to provide a test pattern forming method capable of suppressing a situation in which a defective nozzle having an ejection failure cannot be detected.
[0039] Here, the second pattern group forming step may be performed after the first pattern group forming step, or the first pattern group forming step may be performed after the second pattern group forming step.
[0040] Further, the above-described aspect can be applied to a recording system including the

above-described recording device, a control method for the above-described recording device, a control method for the above-described recording system, a control program for the above-described recording device, a control program for the above-described recording system, and a computer-readable recording medium in which any of the above-described control programs is recorded. The above-described recording device may include a plurality of separate units.

(2) Specific Example of Recording Device

[0041] FIG. **1** schematically illustrates the recording device **1**. Although the recording device **1** in this specific example is a printer **2** itself, the recording device **1** may be a combination of the printer **2** and a host device HO**1**. The printer **2** may include a reading unit **60** that reads a printed image IMO, and may include additional elements not illustrated in FIG. **1**. FIG. **2** schematically illustrates the nozzle row **33** of the recording head **30** and the test pattern TP on the medium ME**0**. The recording head **30** illustrated in FIG. **2** is a “vertical array head” including the color nozzle row **33**A in which a nozzle group **33**C for C (cyan), a nozzle group **33**M for M (magenta), and a nozzle group **33**Y for Y (yellow) are arranged in one row along the nozzle row **33**K for K (black). FIG. **3** schematically illustrates a classification of the nozzle groups in this specific example. FIG. **4** schematically illustrates the test pattern TP on the medium ME**0**.

[0042] The printer **2** illustrated in FIG. **1** is a serial printer that is a type of ink jet printer that ejects the liquid **36** as a droplet **37**. The printer **2** includes a controller **10**, a RAM (Random Access Memory) **21**, which is a semiconductor memory, a communication I/F (Interface) **22**, a storage unit **23**, an operation panel **24**, the recording head **30**, a drive unit **50**, the reading unit **60**, and the like. The controller **10** and the drive unit **50** are an example of the control unit U**1**. The controller **10**, the RAM **21**, the communication I/F **22**, the storage unit **23**, and the operation panel **24** are coupled to a bus and are configured to be capable of inputting and outputting information to and from one another.

[0043] The controller **10** includes a CPU (Central Processing Unit) **11** which is a processor, a color conversion unit **12**, a halftone processing unit **13**, a rasterization processing unit **14**, a drive signal transmission unit **15**, and the like. The controller **10** controls the main scanning and the sub scanning by the drive unit **50** and ejection of the droplet **37** by the recording head **30** based on original image data DA**1** acquired from any one of the host device HO**1**, a memory card (not illustrated), and the like. It can be said that the controller **10** controls the drive unit **50** and the recording head **30** so that the printed image IMO is formed on the medium ME**0**. RGB data having integer values of **28** gradations or **216** gradations of R (red), G (green), and B (blue) for each pixel, for example, can be applied to the original image data DA**1**. The controller **10** can be configured of an SoC (System on a Chip) or the like.

[0044] The CPU **11** is an apparatus that mainly performs information processing and control in the printer **2**.

[0045] With reference to, for example, a color conversion LUT (look up table) that defines a correspondence relationship between R, G, and B gradation values and C, M, Y, and K gradation values, the color conversion unit **12** converts RGB data into ink amount data DA**2** having integer values of **28** gradations or **216** gradations of C, M, Y, and K for each pixel. The ink amount data DA**2** represents use amounts of the liquid **36** of C, M, Y, and K in units of pixels. Further, when a resolution of the RGB data is different from a printing resolution, the color conversion unit **12** first converts the resolution of the RGB data to the printing resolution, or converts a resolution of the ink amount data DA**2** to the printing resolution.

[0046] The halftone processing unit **13** generates dot data DA**3** by reducing the number of gradations of the gradation value by performing halftone processing by any of a dither method, an error diffusion method, or the like on the gradation values of each pixel constituting the ink amount data DA**2**. The dot data DA**3** represents a formation state of a dot **38** of the droplet **37** in units of pixels. The dot data DA**3** may be binary data indicating whether a dot is formed or not, or may be multiple-value data of three or more gradations that can correspond to dots with different sizes, such as small, medium, and large dots.

[0047] The rasterization processing unit **14** generates raster data RA**0** by performing rasterization processing in which the dot data DA**3** is rearranged in an order in which the dots **38** are formed by the drive unit **50**.

[0048] The drive signal transmission unit **15** generates a drive signal SG**1** from the raster data RA**0** and outputs the drive signal SG**1** to a drive circuit **31** of the recording head **30**. The drive signal SG**1** corresponds to a voltage signal applied to a drive element **32** of the recording head **30**. For example, when the dot data DA**3** is “dot formation”, the drive signal transmission unit **15** outputs the drive signal SG**1** for ejecting a droplet for dot formation. When the dot data DA**3** is ternary or higher data, the drive signal transmission unit **15** outputs the drive signal SG**1** for ejecting a droplet for a large dot when the dot data DA**3** is “large dot formation”, and outputs the drive signal SG**1** for ejecting a droplet for a small dot when the dot data DA**3** is “small dot formation”.

[0049] The elements (**11** to **15**) described above may be configured of an ASIC (Application Specific Integrated Circuit), and data that is a processing target may be directly read from the RAM **21** or processed data may be directly written to the RAM **21**.

[0050] The drive unit **50** controlled by the controller **10** includes a carriage drive unit **51** including a servomotor and a roller drive unit **55** including a servomotor. The drive unit **50** causes a carriage **52** to reciprocate along the main scanning direction D**1** according to driving of the carriage drive unit **51** according to control by the controller **10**, and feeds the medium ME**0** in a feeding direction D**3** along a transport path **59** according to driving of the roller drive unit **55**. As illustrated in FIG. **2**, the main scanning direction D**1** is a direction intersecting with the arrangement direction D**4** of the nozzles **34** in the nozzle row **33**, and is a direction orthogonal to the arrangement direction D**4**, for example. FIG. **2** illustrates that a right direction is a forward direction D**11** of the main scanning and a left direction is a backward direction D**12** of the main scanning. The feeding direction D**3** is a direction intersecting with the main scanning direction D**1**, and is, for example, a direction orthogonal to the main scanning direction D**1**. In FIG. **1**, the feeding direction D**3** is the right direction, a left side is called upstream, and a right side is called downstream. The sub scanning direction D**2** illustrated in FIG. **2** is a direction opposite to the feeding direction D**3**. It can also be said that the carriage drive unit **51** performs the main scanning in which a relative positional relationship between the recording head **30** and the medium ME**0** is changed along the main scanning direction D**1**. The roller drive unit **55** includes a transport roller pair **56** and a discharge roller pair **57**. Under the control by the controller **10**, the roller drive unit **55** performs the sub scanning for sending the medium ME**0** in the feeding direction D**3**, by rotating a driving transport roller of the transport roller pair **56** and a driving discharge roller of the discharge roller pair **57**. It can be said that the roller drive unit **55** performs the sub scanning in which a relative positional relationship between the recording head **30** and the medium ME**0** is changed along the sub scanning direction D**2** intersecting with the main scanning direction D**1**. Although the carriage **52** illustrated in FIG. **2** does not move in the sub scanning direction D**2**, the drive unit **50** may achieve the sub scanning by moving the carriage **52** in the sub scanning direction D**2**. At this time, the medium ME**0** need not be moved in the sub scanning direction D**2**, and the drive unit **50** may achieve the sub scanning by moving both the carriage **52** and the medium ME**0** in the sub scanning direction D**2**.

[0051] The medium ME**0** is a printed matter that holds a printed image. A material of the medium ME**0** is not particularly limited, and various materials such as paper, resin, and metal can be considered. A shape of the medium ME**0** is also not particularly limited, and various shapes such as a rectangle and a roll shape can be considered, and a three-dimensional shape may be used.

[0052] A platen **58** is below the transport path **59** and supports the medium ME**0** by coming into contact with the medium ME**0** present on the transport path **59**. The carriage **52** is mounted with the recording head **30**. A liquid cartridge **35** that supplies the recording head **30** with the liquid **36** that is ejected as the droplet **37** may be mounted at the carriage **52**. Of course, the liquid **36** may be supplied from the liquid cartridge **35** installed outside the carriage **52** to the recording head **30** via a tube. The carriage **52** is fixed to an endless belt (not illustrated) and is movable in the main scanning direction D**1** along an elongated guide **53** in which a longitudinal direction is in the main scanning direction D**1**. The recording head **30** to be controlled by the controller **10** includes the drive circuit **31** and the drive element **32**, and attaches the liquid **36** to the medium ME**0** by ejecting the droplet **37** toward the medium ME**0** supported by the platen **58**. Therefore, it can be said that the control unit U**1** controls ejection of the droplet **37** from the recording head **30**.

[0053] The drive circuit **31** applies a voltage signal to the drive element **32** according to the drive signal SG**1** input from the drive signal transmission unit **15**. The drive element **32** may be a piezoelectric element that applies pressure to the liquid **36** inside a pressure chamber communicating with the nozzle **34**, may be a drive element that ejects the droplet **37** from the nozzle **34** by generating a bubble inside the pressure chamber with heat, or the like. A pressure chamber of the recording head **30** is supplied with the liquid **36** from the liquid cartridge **35**. The liquid **36** in the pressure chamber is ejected as the droplet **37** toward the medium ME**0** from the nozzle **34** by the drive element **32**. Due to this, the dot **38** of the droplet **37** is formed on the medium ME**0**, the printed image IMO expressed by a pattern of the dot **38** is formed on the medium ME**0**. While the recording head **30** moves in the main scanning direction D**1**, the dot **38** according to the raster data RA**0** is formed, and the medium ME**0** is repeatedly fed in the feeding direction D**3** by one sub scanning so that the printed image IM**0** is formed on the medium ME**0**. Note that the printer **2** may perform bi-directional recording in which the printed image IM**0** is formed by both the main scanning in the forward direction D**11** and the main scanning in the backward direction D**12**, or may perform uni-directional recording in which the printed image IM**0** is formed by only one of the main scanning in the forward direction D**11** and main scanning in the backward direction D**12**.

[0054] The RAM **21** stores the original image data DA**1** and the like received from the host device HO**1**, a memory (not illustrated), or the like. The communication I/F **22** is connected to the host device HO**1** by wire or wirelessly, and inputs and outputs information to and from the host device HO**1**. The host device HO**1** includes a computer such as a personal computer or a tablet terminal, a mobile phone such as a smartphone, a digital camera, and a digital video camera. The storage unit **23** may be a nonvolatile semiconductor memory such as a flash memory, a magnetic storage apparatus such as a hard disk, or the like. The operation panel **24** includes an output unit **25** such as a liquid crystal panel that displays information, and an input unit **26** such as a touchscreen that receives an operation onto a display screen.

[0055] The reading unit **60** can read the test pattern TP and the like. The reading unit **60** may be an image sensor of a CIS (Contact Image Sensor) type or a CCD (Charge Coupled Devices) type, and a CMOS (Complementary Metal-Oxide Semiconductor) image sensor, and a solid imaging element such as a line sensor or an area sensor including CCD, or the like. An external scanner as the reading unit **60** may be coupled to the printer **2**. The reading unit **60** in this specific example includes an analog/digital conversion circuit that converts an analog amount of a detection voltage of each pixel into a digital value, and an analog density amount corresponding to each detection voltage is converted into a digital density value at the analog/digital conversion circuit and is output to the controller **10**.

[0056] The recording head **30** includes, at a nozzle surface **30***a*, the nozzle row **33** in which the plurality of nozzles **34** capable of ejecting the droplet **37** onto the medium ME**0** are arranged at intervals of the predetermined nozzle pitch in the arrangement direction D**4**. Here, the nozzle means a small hole through which a droplet is jetted, and the nozzle row means an arrangement of a plurality of the nozzles. The nozzle surface **30***a* is an ejection surface of the droplet **37**. Of course, the dot **38** of C is formed from the droplet **37** of C on the medium ME**0**, the dot **38** of M is formed from the droplet **37** of M on the medium ME**0**, the dot **38** of Y is formed from the droplet **37** of Y on the medium ME**0**, and the dot **38** of K is formed from the droplet **37** of K on the medium ME**0**.

[0057] The recording head **30** illustrated in FIG. **2** includes the nozzle row **33**K for K in which the plurality of nozzles **34**K for K capable of ejecting the liquid **36** of K onto the medium ME**0** are arranged, and the color nozzle row **33**A in which the plurality of color nozzles **34**A capable of ejecting the liquid **36** of the colors other than K onto the medium ME**0** are arranged. Here, the nozzle **34**K for K is an example of a first nozzle, the nozzle row **33**K for K is an example of the first nozzle row, the color nozzle **34**A is an example of the second nozzle, and the color nozzle row **33**A is an example of the second nozzle row. Since the color nozzle row **33**A is parallel to the nozzle row **33**K for K, it can be said that the color nozzle row **33**A is along the nozzle row **33**K for K. Of course, even when the nozzle rows are not strictly parallel, it can be said that the color nozzle row **33**A is along the nozzle row **33**K for K, as long as the nozzle row **33**K for K and the color nozzle row **34**A are each arranged so as to intersect with the main scanning direction. In each of the nozzle rows (**33**K and **33**A) illustrated in FIG. **2**, the plurality of nozzles **34** are arranged in one row at intervals of the predetermined nozzle pitch in the arrangement direction D**4**. The plurality of nozzles **34** of each of the nozzle rows (**33**K and **33**A) may be arranged in a staggered pattern, that is, in two rows at intervals of the predetermined nozzle pitch in the arrangement direction D**4**. Here, the arrangement direction of the plurality of nozzles **34** arranged in a staggered manner is an arrangement direction of the nozzles focusing on each of the two rows.

[0058] The color nozzle row **33**A is divided into a plurality of color nozzle groups in the arrangement direction D**4**. In the color nozzle row **33**A illustrated in FIG. **2**, the nozzle group **33**C for C, the nozzle group **33**M for M, and the nozzle group **33**Y for Y are arranged in this order in the sub scanning direction D**2**. In the sub scanning direction D**2**, there are one or more unused nozzles **34**N between the nozzle group **33**C for C and the nozzle group **33**M for M, and there are one or more unused nozzles **34**N between the nozzle group **33**M for M and the nozzle group **33**Y for Y. The unused nozzle **34**N means a nozzle that is included in the color nozzle row **33**A but is not used. The reason why the unused nozzle **34**N is provided in the color nozzle row **33**A is to secure a certain degree of thicknesses of partition walls for dividing a flow path of the liquid **36** for the respective colors.

[0059] In the test pattern TP, an ejection state of each nozzle **34** is indicated by the linear individual pattern L along the main scanning direction D**1**. Macroscopically, it can be said that the individual pattern L is a line along the main scanning direction D**1**. The controller **10** can control formation of the test pattern TP including the plurality of individual patterns L along the main scanning direction D**1** by liquid ejection from each of the plurality of nozzles **34**. Since the plurality of individual patterns L are formed at intervals of a nozzle pitch in the sub scanning direction D**2**, the individual patterns L adjacent to each other in the sub scanning direction D**2** are located at positions shifted from each other in the main scanning direction D**1**. FIG. **2** illustrates the pattern groups PG in which the plurality of the individual patterns L are divided into three in the main scanning direction D**1** and arranged in a staircase pattern, for each color. Macroscopically, the pattern group PG can also be said to be a pitch line group. Note that the number into which the plurality of individual patterns L are divided in the main scanning direction D**1** is not limited to three, and may be four or more, for example.

[0060] Here, as in a comparative example illustrated in FIG. **9**, it is assumed that the test pattern TP including the pattern groups PG including a plurality of the individual patterns L corresponding to a length of each of the nozzle rows (**33**K and **33**A) in the sub scanning direction D**2** is formed. Here, a plurality of individual patterns LK are formed by liquid ejection from the nozzle row **33**K for K, and a plurality of individual patterns LC, LM, and LY are formed by liquid ejection from the color nozzle row **33**A. The plurality of individual patterns LC are formed by liquid ejection from the nozzle group **33**C for C, the plurality of individual patterns LM are formed by liquid ejection from the nozzle group **33**M for M, and the plurality of individual patterns LY are formed by liquid ejection from the nozzle group **33**Y for Y. FIG. **9** illustrates that the nozzle row **33**K for K includes **20** nozzles **34**K for K, the nozzle group **33**C for C includes six color nozzles **34**A, the nozzle group

33M for M includes six color nozzles **34**A, and the nozzle group **33**Y for Y includes six color nozzles **34**A for easy understanding. Illustration of the unused nozzle **34**N is omitted. Further, FIG. **9** illustrates the respective pattern groups PG in which the plurality of the individual patterns L are divided into two in the main scanning direction D**1** and arranged in a staircase pattern. Of course, the number of nozzles **34** included in each of the nozzle rows (**33**K and **33**A) may be larger than the number illustrated in FIG. **9**.

[0061] When viscosity of the liquid **36** in the nozzle **34** increases, air bubbles are mixed into the nozzle **34**, dust or paper powder adheres to the nozzle **34**, or the like, the droplet **37** is not ejected from the nozzle **34** or the droplet **37** ejected from the nozzle **34** does not land at a normal position on the medium ME**0** in some cases. When the defective nozzle LN from which the droplet **37** is not normally ejected occurs, the individual pattern L is not formed at an individual pattern position LP of the defective nozzle LN. When the reading unit **60** reads the test pattern TP and the control unit U**1** specifies which individual pattern L is not formed in the sub scanning direction D**2**, the control unit U**1** can detect a position of the defective nozzle LN corresponding to the individual pattern position LP. However, as an upper end position **901** illustrated in FIG. **9**, when the defective nozzles LN are present at the same position in both the nozzle rows (**33**K and **33**A), the control unit U**1** cannot recognize the individual pattern positions LP of the defective nozzles LN in some cases and thus cannot detect the positions of the defective nozzles LN in some cases. In particular, when the defective nozzles LN are present at end portions of both the nozzle rows (**33**K and **33**A), the control unit U**1** cannot specify first individual patterns L in the sub scanning direction D**2** and cannot detect the positions of the defective nozzles LN. In addition, since there is a location where the individual pattern L is not formed by the unused nozzle **34**N in the pattern group PG formed by liquid ejection from the color nozzle row **33**A, when the individual pattern position LP of the defective nozzle LN is adjacent to the individual pattern position of the unused nozzle **34**N as an adjacent position **902** illustrated in FIG. **9**, the control unit U**1** cannot recognize the individual pattern position LP of the defective nozzle LN in some cases. As a result, the control unit U**1** cannot detect the position of the defective nozzle LN in some cases. Further, also when the nozzle **34**K for K corresponding to the unused nozzle **34**N of the color nozzle row **33**A in the nozzle row **33**K for K is the defective nozzle LN, the individual pattern position LP of the defective nozzle LN cannot be recognized in some cases, and thus the position of the defective nozzle LN cannot be detected in some cases.

[0062] In this specific example, as illustrated in FIG. **4**, by dividing the pattern groups PG by liquid ejection from the nozzle rows (**33**K and **33**A) into a plurality of groups and arranging the groups in the main scanning direction D**1**, reliability of detecting the position corresponding to the defective nozzle LN is improved. Accordingly, a situation in which the defective nozzle LN cannot be detected is suppressed.

[0063] First, a classification example of the nozzle groups will be described with reference to FIG. **3**. For ease of understanding, the nozzle row **33** illustrated in FIG. **3** is matched with the nozzle row **33** illustrated in FIG. **9**. That is, the nozzle row **33**K for K includes **20** nozzles **34**K for K, the nozzle group **33**C for C includes six color nozzles **34**A, the nozzle group **33**M for M includes six color nozzles **34**A, and the nozzle group **33**Y for Y includes six color nozzles **34**A.

[0064] The plurality of nozzles **34**K for K include the first sequential nozzle group NG**1** that is sequential in the sub scanning direction D**2**, the second sequential nozzle group NG**2** that is sequential in the sub scanning direction D**2**, the third sequential nozzle group NG**3** that is sequential in the sub scanning direction D**2**, and the fourth sequential nozzle group NG**4** that is sequential in the sub scanning direction D**2**. In FIG. **3**, the first sequential nozzle group NG**1**, the second sequential nozzle group NG**2**, the third sequential nozzle group NG**3**, and the fourth sequential nozzle group NG**4** are arranged in this order in the sub scanning direction D**2**. In the example illustrated in FIG. **3**, the number of nozzles **34**K for K in each of the sequential nozzle groups (NG**1** to NG**4**) is five.

[0065] The plurality of color nozzles **34**A include the nozzle group **33**C for C in which a plurality of the nozzles **34** capable of ejecting the liquid **36** of C onto the medium ME**0** are sequentially arranged, the nozzle group **33**M for M in which a plurality of the nozzles **34** capable of ejecting the liquid **36** of M onto the medium ME**0** are sequentially arranged, and the nozzle group **33**Y for Y in which a plurality of the nozzles **34** capable of ejecting the liquid **36** of Y onto the medium ME**0** are sequentially arranged. In the example illustrated in FIG. **3**, the number of each of the nozzle groups (**33**C, **33**M, and **33**Y) is six. In the sub scanning direction D**2**, there is one unused nozzle **34**N between the nozzle group **33**C for C and the nozzle group **33**M for M, and there is one unused nozzle **34**N between the nozzle group **33**M for M and the nozzle group **33**Y for Y. In FIG. **3**, the nozzle group **33**C for C, the unused nozzle **34**N, the nozzle group **33**M for M, the unused nozzle **34**N, and the nozzle group **33**Y for Y are arranged in this order in the sub scanning direction D**2**.
[0066] The nozzle group **33**C for C is an example of the first sequential color nozzle group NG**11**, and is also an example of the fifth sequential nozzle group NG**5** that is sequential in the sub scanning direction D**2**. The nozzle group **33**M for M is an example of the second sequential color nozzle group NG**12**, and is also an example of the sixth sequential nozzle group NG**6** that is sequential in the sub scanning direction D**2**. The nozzle group **33**Y for Y is an example of the third sequential color nozzle group NG**13**, and is also an example of a seventh sequential nozzle group NG**7** that is sequential in the sub scanning direction D**2**.
[0067] Next, a configuration example of the test pattern TP will be described with reference to FIG. **4**. For easy understanding, FIG. **4** illustrates the respective pattern groups PG in which a plurality of the individual patterns L are divided into two in the main scanning direction D**1** and arranged in a staircase pattern. The test pattern TP includes the pattern groups (PG**1** to PG**4**) derived from liquid ejection from the nozzle row **33**K for K and the pattern groups (PG**11** to PG**13**) derived from liquid ejection from the color nozzle row **33**A.
[0068] The first pattern group PG**1** is derived from liquid ejection from the first sequential nozzle group NG**1**, and includes a plurality of the individual patterns LK. The second pattern group PG**2** is derived from liquid ejection from the second sequential nozzle group NG**2**, and includes a plurality of the individual patterns LK. The third pattern group PG**3** is derived from liquid ejection from the third sequential nozzle group NG**3**, and includes a plurality of the individual patterns LK. The fourth pattern group PG**4** is derived from liquid ejection from the fourth sequential nozzle group NG**4**, and includes a plurality of the individual patterns LK. The first color pattern group PG**11** is derived from liquid ejection from the first sequential color nozzle group NG**11**, and includes a plurality of the individual patterns LC. The first color pattern group PG**11** can also be said to be the fifth pattern group PG**5** derived from liquid ejection from the fifth sequential nozzle group NG**5**. The second color pattern group PG**12** is derived from liquid ejection from the second sequential color nozzle group NG**12**, and includes a plurality of the individual patterns LM. The second color pattern group PG**12** can also be said to be the sixth pattern group PG**6** derived from liquid ejection from the sixth sequential nozzle group NG**6**. The third color pattern group PG**13** is derived from liquid ejection from the third sequential color nozzle group NG**13**, and includes a plurality of the individual patterns LY. The third color pattern group PG**13** can also be said to be a seventh pattern group PG**7** derived from liquid ejection from the seventh sequential nozzle group NG**7**.
[0069] As illustrated in FIG. **4**, a position in the sub scanning direction D**2** of each individual pattern L included in each pattern group PG coincides with a position in the sub scanning direction D**2** of any of the individual patterns L included in the other pattern groups PG. For example, it can be said that locations in the sub scanning direction D**2** of the individual patterns L**1**, L**2**, L**3**, L**4**, L**5**, L**6**, and L**7** at seven locations illustrated in FIG. **4** coincide with each other. When attention is paid to each individual pattern LK of the first pattern group PG**1**, it can be seen that the individual pattern L having the same position in the sub scanning direction D**2** is present in the other pattern groups (PG**2** to PG**6**). When attention is paid to each individual pattern LC of the fifth pattern group PG**5**, it can be seen that at least the individual pattern LM having the same position in the

sub scanning direction D**2** is present in the sixth pattern group PG**6**, and the individual pattern LY having the same position in the sub scanning direction D**2** is present in the seventh pattern group PG**7**. Since any of the other individual patterns L is present at a position in the sub scanning direction D**2** of each individual pattern L, a situation in which the defective nozzle LN cannot be detected is suppressed.

[0070] In the test pattern TP illustrated in FIG. **4**, the number of pattern groups PG for K derived from liquid ejection from the nozzle row **33**K of K is four. When the number of pattern groups PG for K derived from liquid ejection from the nozzle row **33**K of K is three or less, a length of the pattern group PG in the sub scanning direction D**2** is longer than those of the color pattern groups (PG**11** to PG**13**) derived from liquid ejection from the color nozzle row **33**A. In this case, in the pattern group PG of K, the individual pattern LK is generated whose position in the sub scanning direction D**2** does not coincide with positions of the individual patterns LC, LM, and LY of the color pattern groups (PG**11** to PG**13**). When the number of pattern groups PG of K derived from the liquid ejection from the nozzle row **33**K for K is four, the length of the pattern group PG in the sub scanning direction D**2** can be made shorter than those of the color pattern groups (PG**11** to PG**13**). Thus, the position of the individual pattern LK can be matched with the positions of the individual patterns LC, LM, and LY in the sub scanning direction D**2**. However, when the number of pattern groups PG of derived from liquid ejection from the nozzle row **33**K for K is five or more, the number of times of the main scanning SC**1** and the sub scanning SC**2** increases, and thus formation of the test pattern TP is delayed. Therefore, from the viewpoint of a formation speed of the test pattern TP and detection accuracy of the defective nozzle LN, it is optimum that the number of pattern groups PG derived from liquid ejection from one nozzle row is four.

(3) Specific Example of Test Pattern Forming Method

[0071] FIGS. **5** and **6** schematically illustrate a specific example of the test pattern forming method for printing the test pattern TP illustrated in FIG. **4**. The test pattern forming method includes the first pattern group forming step ST**1**, the sub scanning step ST**3**, and the second pattern group forming step ST**2**.

[0072] The controller **10** performs control to form the test pattern TP on the medium ME**0** according to test pattern data for forming the test pattern TP. Therefore, it can be said that the printer **2** performs the test pattern forming method under the control of the controller **10**.

[0073] First, the control unit U**1** performs control to form the fourth pattern group PG**4** on the medium ME**0** while performing the main scanning SC**1** in a state in which the fourth sequential nozzle group NG**4** of the nozzle row **33**K for K is within a range of the medium ME**0** in the sub scanning direction D**2** (a state **501** in FIG. **5**). The controller **10** causes the carriage drive unit **51** to perform the main scanning SC**1** for moving the recording head **30** along the main scanning direction D**1**, and causes the droplet **37** of K to be ejected from the fourth sequential nozzle group NG**4** in accordance with the test pattern data, to cause the fourth pattern group PG**4** of K to be formed at a position set with respect to the medium ME**0**. The main scanning SC**1** may be the main scanning in the forward direction D**11** or the main scanning in the backward direction D**12**. The same applies hereinafter.

[0074] Next, the control unit U**1** performs the sub scanning SC**2** until an upper end of the third sequential color nozzle group NG**13**, that is, the seventh sequential nozzle group NG**7** of the color nozzle row **33**A is aligned with an upper end of the fourth pattern group PG**4** in the sub scanning direction D**2**. The controller **10** causes the roller drive unit **55** to perform the sub scanning SC**2** for moving the medium ME**0** in the feeding direction D**3**. Therefore, it can be said that the control unit U**1** moves the medium ME**0** along the sub scanning direction D**2**. The same applies hereinafter.

[0075] Next, the control unit U**1** performs control to form the third color pattern group PG**13**, that is, the seventh pattern group PG**7** on the medium ME**0** while performing the main scanning SC**1** for moving the recording head **30** along the main scanning direction D**1** (a state **502** in FIG. **5**). The controller **10** causes the carriage drive unit **51** to perform the main scanning SC**1**, and causes the droplet **37** of Y to be ejected from the seventh sequential nozzle group NG**7** in accordance with the test pattern data, to cause the seventh pattern group PG**7** of Y to be formed at a position set with respect to the medium ME**0**. Next, the control unit U**1** performs the sub scanning SC**2** until an upper end of the third sequential nozzle group NG**3** of the nozzle row **33**K for K is aligned with an upper end of the pattern groups (PG**4** and PG**7**) in the sub scanning direction D**2**. The controller **10** causes the roller drive unit **55** to perform the sub scanning SC**2** for moving the medium ME**0** in the feeding direction D**3**.

[0076] Next, the control unit U**1** performs control to form the third pattern group PG**3** on the medium ME**0** while performing the main scanning SC**1** for moving the recording head **30** along the main scanning direction D**1** (a state **503** in FIG. **5**). The controller **10** causes the carriage drive unit **51** to perform the main scanning SC**1**, and causes the droplet **37** of K to be ejected from the third sequential nozzle group NG**3** in accordance with the test pattern data, to cause the third pattern group PG**3** of K to be formed at a position set with respect to the medium ME**0**. Next, the control unit U**1** performs the sub scanning SC**2** until an upper end of the second sequential color nozzle group NG**12**, that is, the sixth sequential nozzle group NG**6** of the color nozzle row **33**A is aligned with an upper end of the pattern groups (PG**3**, PG**4**, and PG**7**) in the sub scanning direction D**2**. The controller **10** causes the roller drive unit **55** to perform the sub scanning SC**2** for moving the medium ME**0** in the feeding direction D**3**.

[0077] Next, the control unit U**1** performs control to form the second sequential color nozzle group NG**12**, that is, the sixth pattern group PG**6** on the medium ME**0** while performing the main scanning SC**1** for moving the recording head **30** along the main scanning direction D**1** (a state **504** in FIG. **6**). The controller **10** causes the carriage drive unit **51** to perform the main scanning SC**1**, and causes the droplet **37** of M to be ejected from the sixth sequential nozzle group NG**6** in accordance with the test pattern data, to cause the sixth pattern group PG**6** of M to be formed at a position set with respect to the medium ME**0**.

[0078] Next, the control unit U**1** performs the sub scanning SC**2** until an upper end of the second sequential nozzle group NG**2** of the nozzle row **33**K for K is aligned with an upper end of the pattern groups (PG**3**, PG**4**, PG**6**, and PG**7**) in the sub scanning direction D**2**. The controller **10** causes the roller drive unit **55** to perform the sub scanning SC**2** for moving the medium ME**0** in the feeding direction D**3**.

[0079] Next, the control unit U**1** performs control to form the second pattern group PG**2** on the medium ME**0** while performing the main scanning SC**1** for moving the recording head **30** along the main scanning direction D**1** (a state **505** in FIG. **6**). The controller **10** causes the carriage drive unit **51** to perform the main scanning SC**1**, and causes the droplet **37** of K to be ejected from the second sequential nozzle group NG**2** in accordance with the test pattern data, to cause the second pattern group PG**2** of K to be formed at a position set with respect to the medium ME**0**. In this way, the printer **2** implements the second pattern group forming step ST**2**.

[0080] Next, the control unit U**1** performs the sub scanning SC**2** until an upper end of the first sequential nozzle group NG**1** of the nozzle row **33**K for K is aligned with an upper end of the pattern groups (PG**2**, PG**3**, PG**4**, PG**6**, and PG**7**) in the sub scanning direction D**2**. It can be said that the control unit U**1** performs the sub scanning SC**2** until an upper end of the first sequential color nozzle group NG**11**, that is, the fifth sequential nozzle group NG**5** of the color nozzle row **33**A is aligned with the upper end of the pattern groups (PG**2**, PG**3**, PG**4**, PG**6**, and PG**7**) in the sub scanning direction D**2**. The controller **10** causes the roller drive unit **55** to perform the sub scanning SC**2** for moving the medium ME**0** in the feeding direction D**3**. In this way, the printer **2** implements the sub scanning step ST**3** for performing the sub scanning SC**2** such that the first pattern group PG**1** and the second pattern group PG**2** are arranged in the main scanning direction D**1**.

[0081] Finally, the control unit U**1** performs control to form the first pattern group PG**1**, and the first color pattern group PG**11**, that is, the fifth pattern group PG**5** on the medium ME**0** while performing the main scanning SC**1** for moving the recording head **30** along the main scanning direction D1 (a state 506 in FIG. 6). The controller 10 causes the carriage drive unit 51 to perform the main scanning SC1, causes the droplet 37 of K to be ejected from the first sequential nozzle group NG1 in accordance with the test pattern data, and causes the droplet 37 of C to be ejected from the fifth sequential nozzle group NG5, to cause the first pattern group PG1 of K and the fifth pattern group PG5 of C to be formed at positions set with respect to the medium ME0. In this way, the printer 2 implements the first pattern group forming step ST1. Thus, the printing of the test pattern TP illustrated in FIG. 4 is completed.

[0082] As described above, the control unit U1 performs control to form the test pattern TP in which the pattern groups (PG1 to PG7) are arranged in the main scanning direction D1 by appropriately performing the sub scanning SC2. At this time, the control unit U1 performs control to form the test pattern TP in which the plurality of pattern groups PG are arranged in the main scanning direction D1 so that a position in the sub scanning direction D2 of each individual pattern L included in each pattern group PG coincides with a position in the sub scanning direction D2 of any of the individual patterns L included in the other pattern groups PG. The sub scanning SC2 is performed between formation of the fourth pattern group PG4 and formation of the third pattern group PG3, between formation of the third pattern group PG3 and formation of the second pattern group PG2, and between formation of the second pattern group PG2 and formation of the first pattern group PG1. Further, the sub scanning SC2 is performed between formation of the third color pattern group PG13 and formation of the second color pattern group PG12, and between formation of the second color pattern group PG12 and formation of the first color pattern group PG11.

[0083] As illustrated in FIG. 4, since the plurality of pattern groups (PG1 to PG4) formed by the nozzle row 33K for K are arranged in the main scanning direction D1, the number of individual patterns L of K formed at the same position in the sub scanning direction D2 increases. In addition, since the plurality of pattern groups (PG5 to PG7) formed by the color nozzle row 33A are arranged in the main scanning direction D1, the number of individual patterns LC, LM, and LY formed at the same position in the sub scanning direction D2 increases.

[0084] FIG. 7 schematically illustrates the test pattern TP including the individual pattern position LP of the defective nozzle LN. FIG. 7 illustrates that the individual pattern positions LP at which the individual patterns L are not formed occur in the first pattern group PG1 and the fifth pattern group PG5 due to presence of the defective nozzles LN at end portions of both the nozzle rows (33K and 33A). Even in this case, since the individual patterns L are present in the remaining pattern groups (PG2 to PG4, PG6, and PG7), the control unit U1 can specify the first individual patterns L in the sub scanning direction D2. In addition, FIG. 7 illustrates that there is the individual pattern position LP at which the individual pattern LY is not formed in the seventh pattern group PG7 due to presence of the defective nozzle LN in the color nozzle 34A of Y in the color nozzle row 33A. Even in this case, since the individual patterns L are present in the remaining pattern groups (PG1 to PG6), the control unit U1 can specify the individual pattern position LP.

[0085] Since the individual pattern position LP is specified, the control unit U1 can detect a position corresponding to the defective nozzle LN. Therefore, in this specific example, it is possible to suppress the situation in which the defective nozzle LN cannot be detected.

[0086] Note that when the sub scanning direction D2 and the feeding direction D3 are switched in the example illustrated in FIGS. 4 to 6, the pattern groups of K (PG1 to PG4) are formed in an order of the first pattern group PG1, the second pattern group PG2, the third pattern group PG3, and the fourth pattern group PG4. In this case, the first pattern group forming step ST1 is formed at the time of forming the leading first pattern group PG1, the sub scanning step ST3 is implemented between formation of the first pattern group PG1 and formation of the second pattern group PG2, and the second pattern group forming step ST2 is implemented at the time of forming the second pattern group PG2.

[0087] When the defective nozzle LN is detected, the controller 10 determines whether cleaning of the nozzle row **33** is necessary or not based on detection information of the defective nozzle LN, and causes the output unit **25** to display information prompting the cleaning when it is determined that the cleaning is necessary. For this reason, the printer **2** may include a cleaning unit that can implement cleaning of the recording head **30**. Upon receiving a cleaning instruction from the input unit **26**, the controller **10** causes the cleaning unit to implement cleaning of the recording head **30**. In addition, the controller **10** may cause the cleaning unit to automatically implement cleaning of the recording head **30** when it is determined that cleaning is necessary.

(4) Modification Example

[0088] Various modifications of the present disclosure can be considered. For example, the printer **2** may be a monochrome printer having only the nozzle row for K in the recording head. Even in this case, assuming that the nozzle row for K includes a plurality of sequential nozzle groups, a plurality of pattern groups derived from liquid ejection from the plurality of sequential nozzle groups are arranged in the main scanning direction, and thus it is possible to obtain an effect of suppressing a situation in which a defective nozzle cannot be detected.

[0089] Part of the above-described processing may be performed by the host device HO**1**. In this case, a combination of the controller **10**, the drive unit **50**, and the host device HO**1** is an example of the control unit U**1**, and a combination of the printer **2** and the host device HO**1** is an example of the recording device **1**.

[0090] In the test pattern TP, for example, as long as the first pattern group PG**1**, the second pattern group PG**2**, and the first color pattern group PG**11** are arranged in the main scanning direction D**1**, even when the other pattern groups PG are not arranged in the main scanning direction D**1**, a situation in which the defective nozzles LN generated in the first sequential nozzle group NG**1**, the second sequential nozzle group NG**2**, and the first sequential color nozzle group NG**11** cannot be detected is suppressed. In addition, as long as the first pattern group PG**1**, the second pattern group PG**2**, the fifth pattern group PG**5**, and the sixth pattern group PG**6** are arranged in the main scanning direction D**1**, even when the other pattern groups PG are not arranged in the main scanning direction D**1**, it is possible to suppress a situation in which the defective nozzles LN generated in the first sequential nozzle group NG**1**, the second sequential nozzle group NG**2**, the fifth sequential nozzle group NG**5**, and the sixth sequential nozzle group NG**6** cannot be detected.

[0091] As illustrated in FIG. **8**, even when the recording head **30** is a vertical array head, the number of pattern groups PG of K derived from liquid ejection from the nozzle row **33**K for K may be two, and the number of pattern groups PG derived from liquid ejection from the color nozzle row **33**A may be two. The plurality of nozzles **34**K for K illustrated in FIG. **8** include the first sequential nozzle group NG**1** that is sequential in the sub scanning direction D**2** and the second sequential nozzle group NG**2** that is sequential in the sub scanning direction D**2**. The number of nozzles **34**K for K in each of the sequential nozzle groups (NG**1** and NG**2**) is ten. The first pattern group PG**1** derived from liquid ejection from the first sequential nozzle group NG**1** includes ten individual patterns LK, and the second pattern group PG**2** derived from liquid ejection from the second sequential nozzle group NG**2** includes ten individual patterns LK. The plurality of color nozzles **34**A illustrated in FIG. **8** include the fifth sequential nozzle group NG**5** that is sequential in the sub scanning direction D**2** and the sixth sequential nozzle group NG**6** that is sequential in the sub scanning direction D**2**. The fifth sequential nozzle group NG**5** includes all the color nozzles **34**A capable of ejecting the liquid **36** of C onto the medium ME**0** and half the color nozzles **34**A capable of ejecting the liquid **36** of M onto the medium ME**0**. The sixth sequential nozzle group NG**6** includes the remaining half the color nozzles **34**A capable of ejecting the liquid **36** of M onto the medium ME**0** and all the color nozzles **34**A capable of ejecting the liquid **36** of Y onto the medium ME**0**. The fifth pattern group PG**5** derived from liquid ejection from the fifth sequential nozzle group NG**5** includes all the individual patterns LC and half the individual patterns LM. The sixth pattern group PG**6** derived from liquid ejection from the sixth sequential nozzle group NG**6** includes half the individual patterns LM and all the individual patterns LY.

[0092] The test pattern TP illustrated in FIG. **8** can be formed by performing the main scanning SC**1** twice and the sub scanning SC**2** once, as exemplified below.
[0093] (Main scanning SC**1** performed first) The control unit U**1** causes the second pattern group PG**2** and the sixth pattern group PG**6** to be formed on the medium ME**0** (second pattern group forming step ST**2**).
[0094] (Sub Scanning SC**2**) The control unit U**1** performs the sub scanning SC**2** so that the first pattern group PG**1**, the second pattern group PG**2**, the fifth pattern group PG**5**, and the sixth pattern group PG**6** are arranged in the main scanning direction D**1** (sub scanning step ST**3**).
[0095] (Main scanning SC**1** performed second) The control unit U**1** causes the first pattern group PG**1** and the fifth pattern group PG**5** to be formed on the medium ME**0** (first pattern group forming step ST**1**).
[0096] Therefore, a formation speed of the test pattern TP can be improved. Of course, when the sub scanning direction D**2** and the feeding direction D**3** are switched in the example illustrated in FIG. **8**, the first pattern group PG**1** and the fifth pattern group PG**5** are formed, and then the second pattern group PG**2** and the sixth pattern group PG**6** are formed.
[0097] Also in the test pattern TP illustrated in FIG. **8**, the number of individual patterns L formed at the same position in the sub scanning direction D**2** is increased. Accordingly, even when some of the individual patterns L among the plurality of individual patterns L formed at the same position in the sub scanning direction D**2** are not formed due to ejection failures of the nozzles, positions corresponding to defective nozzles LN are detected since the remaining individual patterns L are formed. Therefore, the situation in which the defective nozzle LN cannot be detected is suppressed.
(5) Conclusion
[0098] As described above, according to the present disclosure, by the various aspects, it is possible to provide a configuration or the like capable of suppressing a situation in which a defective nozzle having an ejection failure cannot be detected. Of course, the basic operations and effects described above can be obtained even with an aspect including only components according to the independent claims.
[0099] A configuration in which the configurations disclosed in the above-described examples are replaced with one another or the combinations are changed, a configuration in which a known technology and each of the configurations disclosed in the above-described examples are replaced with one another or the combinations are changed, or the like can be implemented. The present disclosure also includes these configurations.

Claims

1. A recording device, comprising: a recording head including a first nozzle row in which a plurality of first nozzles configured to eject liquid onto a medium are arranged; and a control unit configured to control main scanning for moving the recording head along a main scanning direction intersecting with an arrangement direction of the plurality of first nozzles, sub scanning for moving at least one of the medium and the recording head along a sub scanning direction intersecting with the main scanning direction, and ejection of the liquid from the recording head, wherein the control unit is configured to control formation of a test pattern including a plurality of individual patterns along the main scanning direction by liquid ejection from each of the plurality of first nozzles, the individual patterns adjacent to each other in the sub scanning direction are located at positions shifted from each other in the main scanning direction, the plurality of first nozzles include a first sequential nozzle group that is sequential in the sub scanning direction and a second sequential nozzle group that is sequential in the sub scanning direction, the test pattern includes a first pattern group derived from liquid ejection from the first sequential nozzle group and a second pattern group derived from liquid ejection from the second sequential nozzle group, and the control unit performs control to form the test pattern in which at least the first pattern group and the second pattern group are arranged in the main scanning direction by performing the sub scanning between formation of the first pattern group and formation of the second pattern group.

2. The recording device according to claim 1, wherein the plurality of first nozzles further include a third sequential nozzle group that is sequential in the sub scanning direction and a fourth sequential nozzle group that is sequential in the sub scanning direction, the test pattern includes the first pattern group, the second pattern group, a third pattern group derived from liquid ejection from the plurality of third sequential nozzles, and a fourth pattern group derived from liquid ejection from the plurality of fourth sequential nozzles, in the test pattern, the number of pattern groups derived from liquid ejection from the first nozzle row is four, and the control unit performs control to form the test pattern in which at least the first pattern group, the second pattern group, the third pattern group, and the fourth pattern group are arranged in the main scanning direction by performing the sub scanning between formation of the second pattern group and formation of the third pattern group and performing the sub scanning between formation of the third pattern group and formation of the fourth pattern group.

3. The recording device according to claim 1, wherein the recording head includes a second nozzle row along the first nozzle row, the second nozzle row having a plurality of second nozzles being arranged therein, the plurality of second nozzles include a first sequential color nozzle group in which a plurality of first color nozzles configured to eject a first color liquid onto the medium are sequentially arranged, a second sequential color nozzle group in which a plurality of second color nozzles configured to eject a second color liquid onto the medium are sequentially arranged, and a third sequential color nozzle group in which a plurality of third color nozzles configured to eject a third color liquid onto the medium are sequentially arranged, the test pattern includes a first color pattern group derived from liquid ejection from the first sequential color nozzle group, a second color pattern group derived from liquid ejection from the second sequential color nozzle group, and a third color pattern group derived from liquid ejection from the third sequential color nozzle group, and the control unit performs control to form the test pattern in which at least the first pattern group, the second pattern group, and the first color pattern group are arranged in the main scanning direction.

4. The recording device according to claim 1, wherein the recording head includes a second nozzle row along the first nozzle row, the second nozzle row having a plurality of second nozzles being arranged therein, the plurality of second nozzles include a fifth sequential nozzle group that is sequential in the sub scanning direction and a sixth sequential nozzle group that is sequential in the sub scanning direction, the test pattern includes a fifth pattern group derived from liquid ejection from the fifth sequential nozzle group and a sixth pattern group derived from liquid ejection from the sixth sequential nozzle group, and the control unit performs control to form the test pattern in which at least the first pattern group, the second pattern group, the fifth pattern group, and the sixth pattern group are arranged in the main scanning direction by performing the sub scanning between formation of the fifth pattern group and formation of the sixth pattern group.

5. The recording device according to claim 1, wherein the test pattern includes a plurality of pattern groups including the first pattern group and the second pattern group, and the control unit performs control to form the test pattern in which the plurality of pattern groups are arranged in the main scanning direction so that a position in the sub scanning direction of each of the individual patterns included in each of the pattern groups coincides with a position in the sub scanning direction of any of the individual patterns included in the other pattern groups.

6. A test pattern forming method for forming a test pattern by performing main scanning for moving a recording head including a first nozzle row in which a plurality of first nozzles configured to eject liquid onto a medium are arranged along a main scanning direction intersecting with an arrangement direction of the plurality of first nozzles, and sub scanning for moving at least one of the medium and the recording head along a sub scanning direction intersecting with the main scanning direction, wherein the test pattern includes a plurality of individual patterns along the main scanning direction by liquid ejection from each of the plurality of first nozzles, the individual patterns adjacent to each other in the sub scanning direction are located at positions shifted from each other in the main scanning direction, the plurality of first nozzles include a first sequential nozzle group that is sequential in the sub scanning direction and a second sequential nozzle group that is sequential in the sub scanning direction, the test pattern forming method includes a first pattern group forming step for forming a first pattern group on the medium by ejecting the liquid from the first sequential nozzle group, a second pattern group forming step for forming a second pattern group on the medium by ejecting the liquid from the second sequential nozzle group, and a sub scanning step for performing the sub scanning such that the first pattern group and the second pattern group are arranged in the main scanning direction.