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(54) **CONTROL METHOD FOR A FLUID EJECTION DEVICE, AND A FLUID EJECTION DEVICE**

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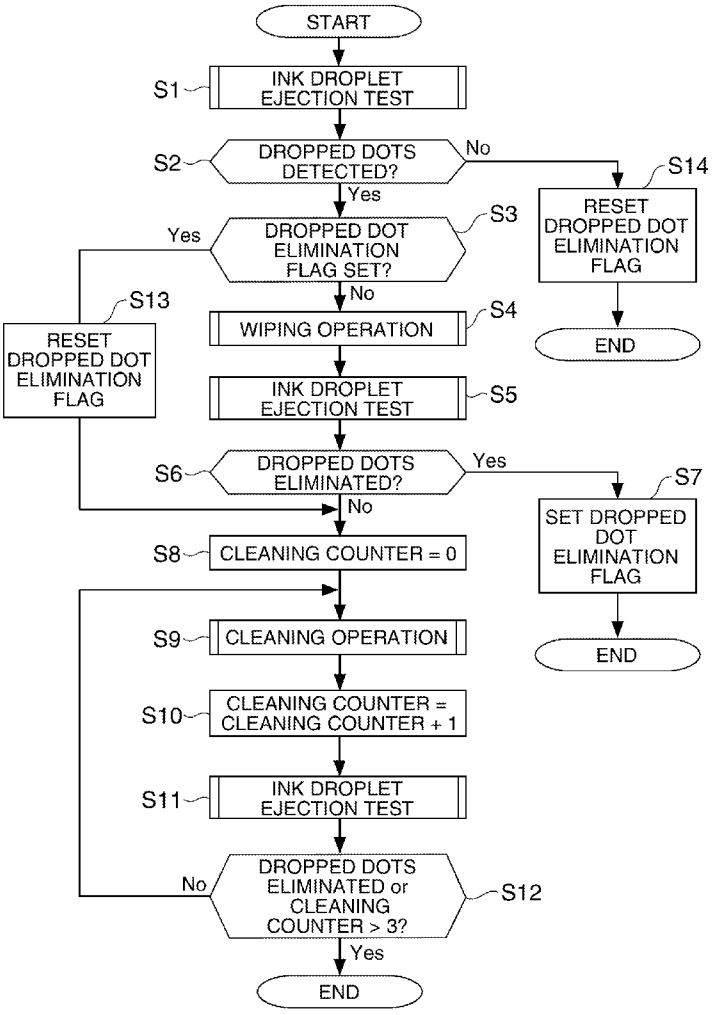
(57) **ABSTRACT**

A control method for a fluid ejection device and a fluid ejection device reliably eliminate dropped dots while reducing consumption of ink droplets ejected from the nozzles. A fluid ejection device that performs at least one of a cleaning operation that suctions fluid from the nozzles and a wiping operation that wipes the nozzle surface when dropped dots occur determines if an elimination history of removing dropped dots by the wiping operation is stored when dropped dots are detected as a result of testing for dropped dots and determining if dropped dots occur. When a history of eliminating dropped dots by means of a wiping operation is not stored, the fluid ejection device performs the wiping operation. When a history of eliminating dropped dots by means of a wiping operation remains in memory, the cleaning operation is performed without the wiping operation.



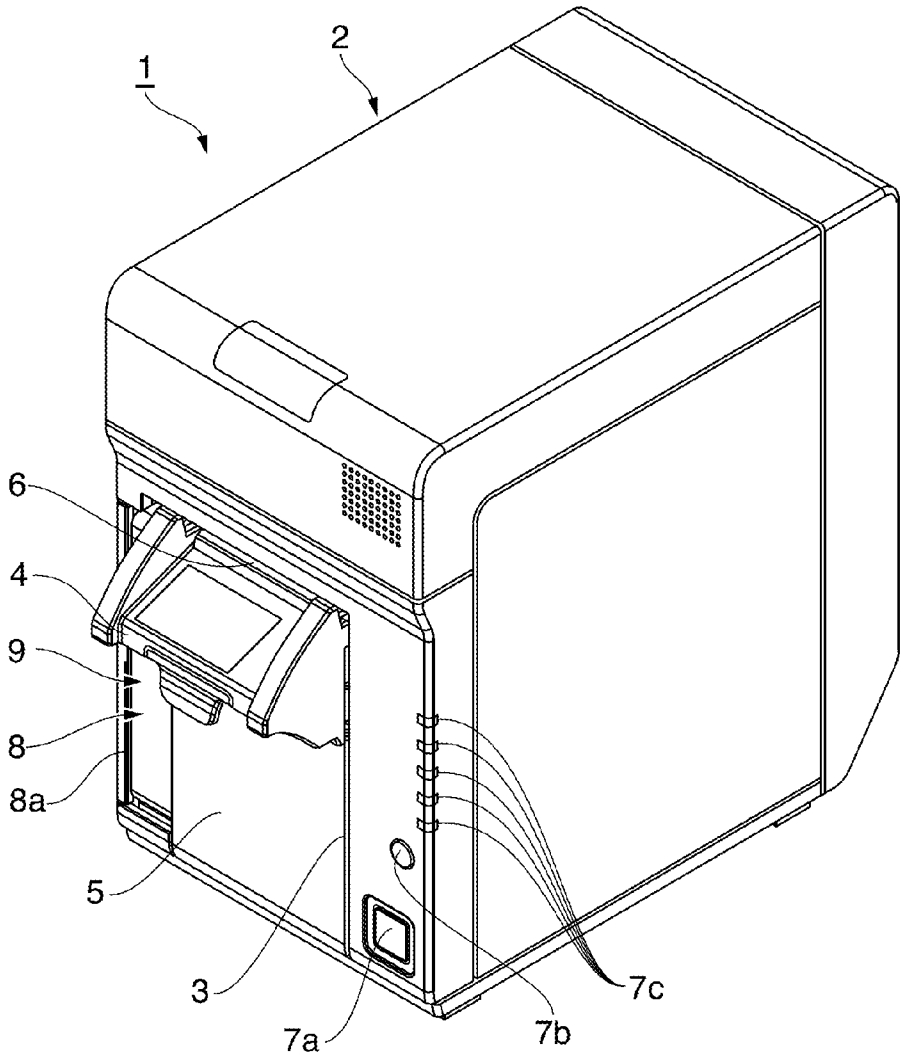


FIG. 1

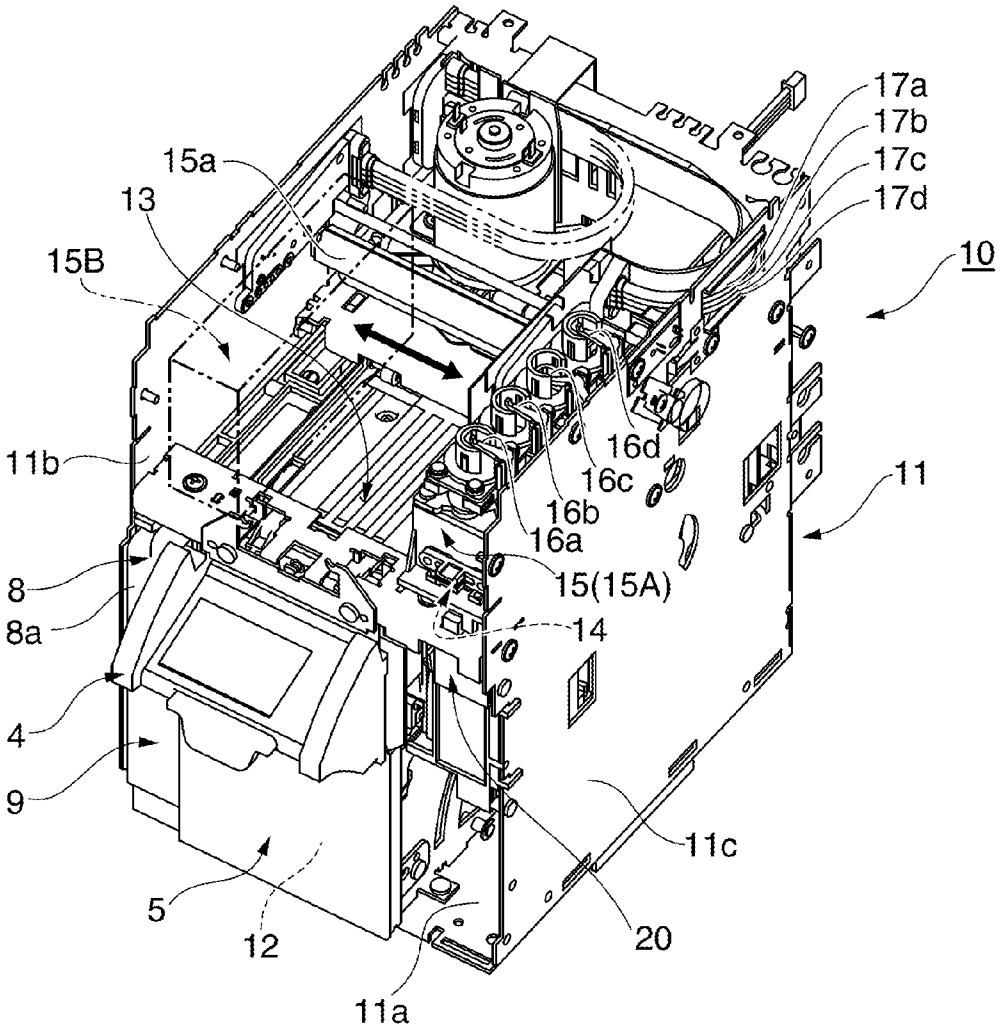

17a
17b
17c
17d
15a
13
15B
10
11b
16d
16c
16b
16a
11
15(15A)
8
8a
14
4
9
11c
5
12
20
11a

FIG. 2

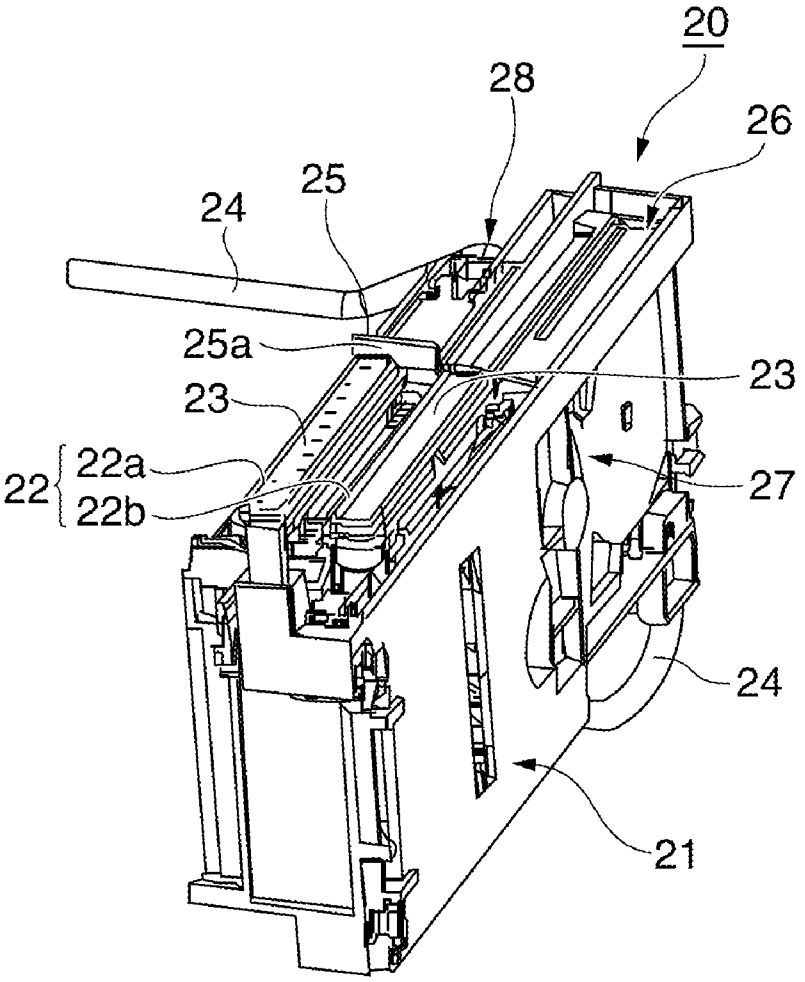


FIG. 3

FIG. 4A

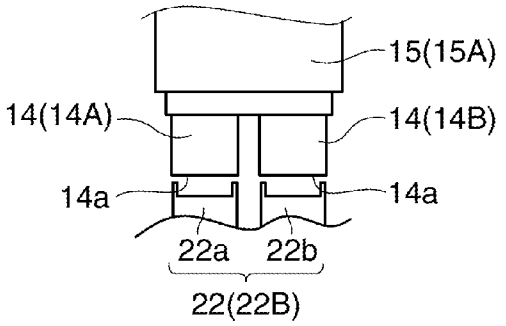
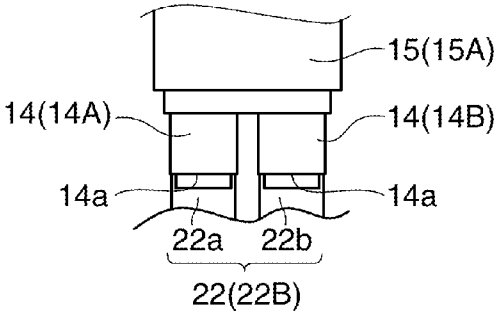


FIG. 4B



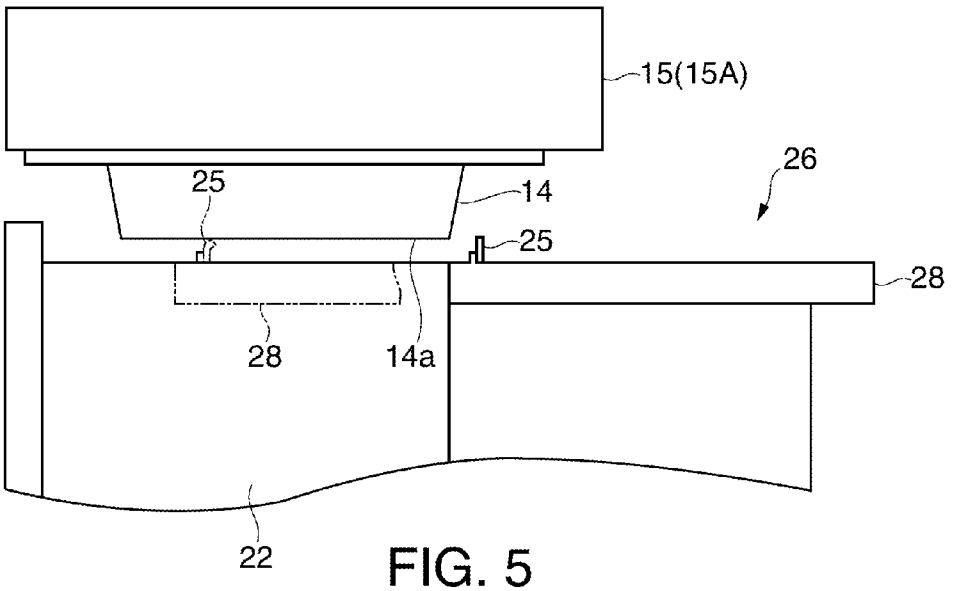


FIG. 5

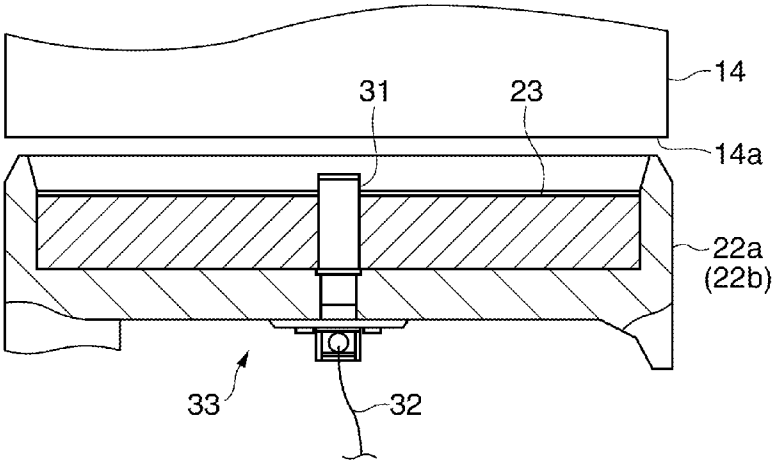

14
31
23
14a
22a
(22b)
33
32

FIG. 6

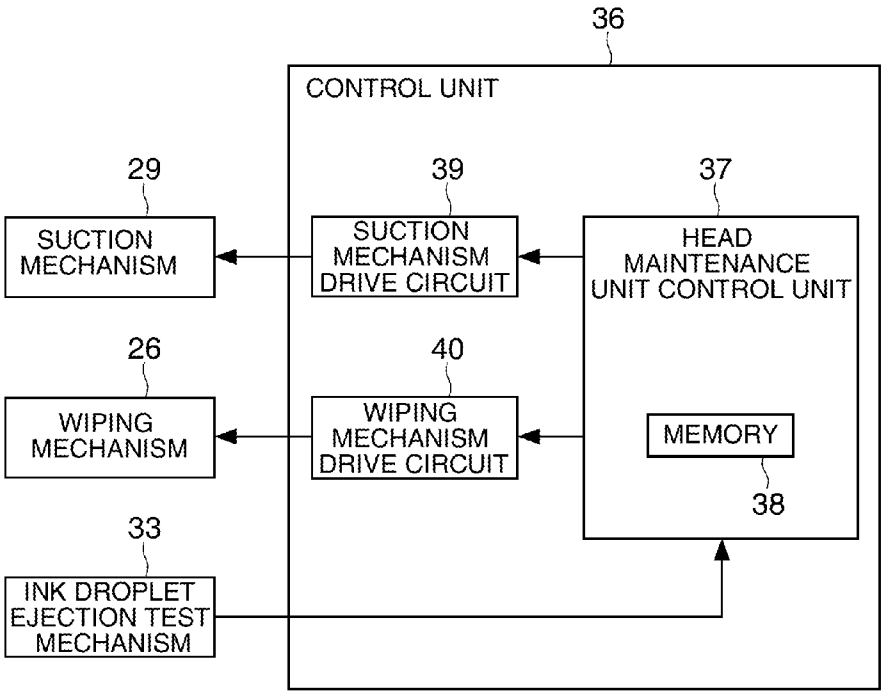

36
CONTROL UNIT
29
SUCTION MECHANISM
39
SUCTION MECHANISM DRIVE CIRCUIT
37
HEAD MAINTENANCE UNIT CONTROL UNIT
26
WIPING MECHANISM
40
WIPING MECHANISM DRIVE CIRCUIT
MEMORY
38
33
INK DROPLET EJECTION TEST MECHANISM

FIG. 7

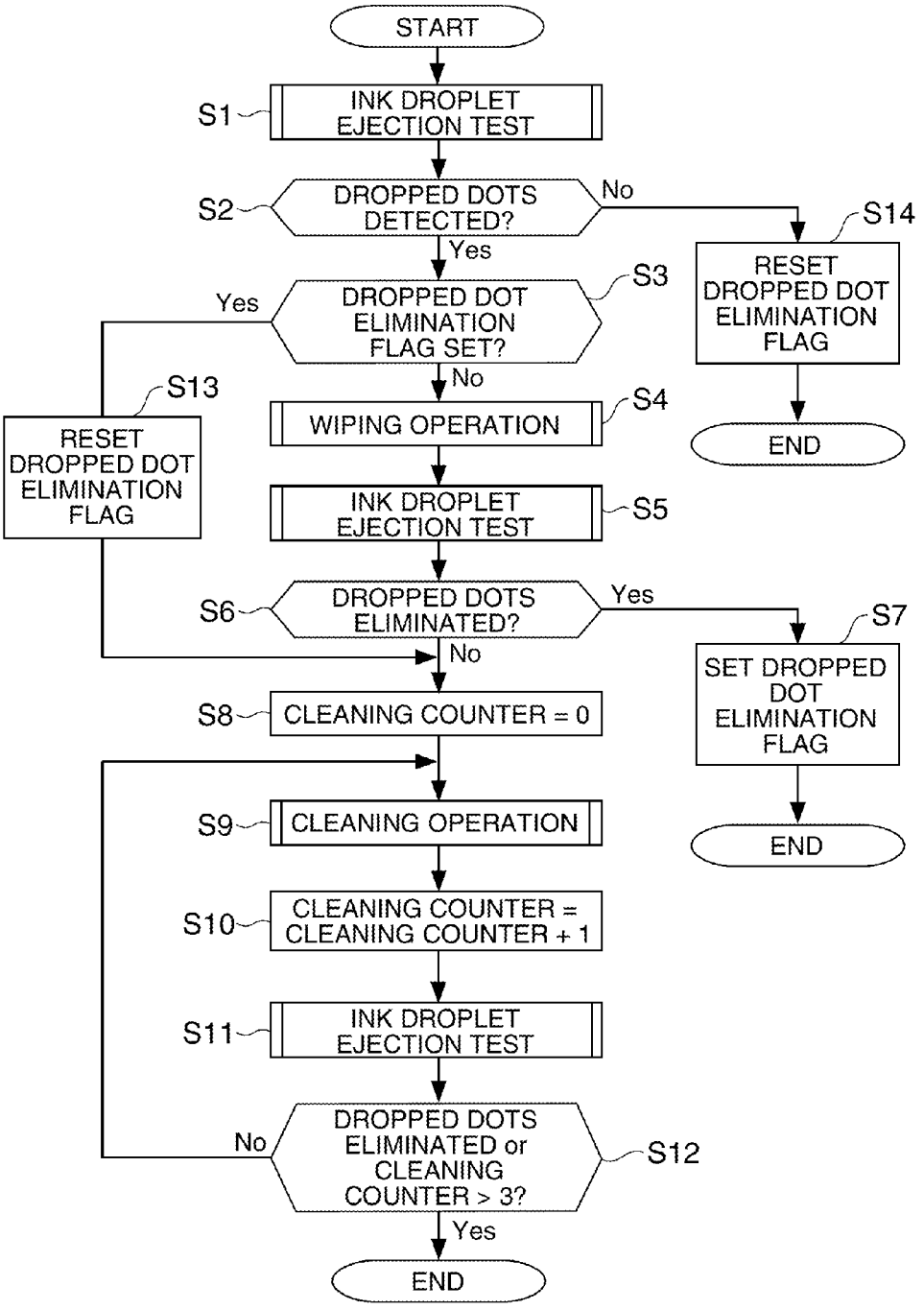

START
S1
INK DROPLET EJECTION TEST
S2
DROPPED DOTS DETECTED?
No
S14
RESET DROPPED DOT ELIMINATION FLAG
END
Yes
S3
DROPPED DOT ELIMINATION FLAG SET?
Yes
S13
RESET DROPPED DOT ELIMINATION FLAG
No
S4
WIPING OPERATION
S5
INK DROPLET EJECTION TEST
S6
DROPPED DOTS ELIMINATED?
Yes
S7
SET DROPPED DOT ELIMINATION FLAG
END
No
S8
CLEANING COUNTER = 0
S9
CLEANING OPERATION
S10
CLEANING COUNTER = CLEANING COUNTER + 1
S11
INK DROPLET EJECTION TEST
No
DROPPED DOTS ELIMINATED or CLEANING COUNTER > 3?
S12
Yes
END

FIG. 8

CONTROL METHOD FOR A FLUID EJECTION DEVICE, AND A FLUID EJECTION DEVICE

BACKGROUND

[0001] 1. Technical Field

[0002] The present invention relates to control method for a fluid ejection device having a fluid ejection head with a plurality of nozzles for discharging a fluid, and to the fluid ejection device.

[0003] 2. Related Art

[0004] Inkjet printers have a printhead with a plurality of nozzles that discharge ink droplets, and the printhead is mounted on a carriage with the nozzle surface where the plural nozzles are arranged facing down. Inkjet printers that have a head maintenance mechanism for maintaining the printhead exposed below the carriage are also known from the literature. See, for example, Japanese Unexamined Patent Appl. Pub. JP-A-2009-190282.

[0005] The head maintenance mechanism of the inkjet printer taught in JP-A-2009-190282 includes a wiper mechanism that physically wipes the nozzle surface, and an ink suction mechanism that suctions ink from the nozzles. The head maintenance mechanism also functions as an ink droplet ejection test device that checks if ink droplets are ejected from the plural nozzles normally (that is, checks to find any clogged nozzles). The head maintenance mechanism checks whether or not ink droplets are ejected from the plural nozzles based on a current change that occurs when charged ink discharged from the nozzles lands on a sponge (absorbent material) disposed inside the head maintenance mechanism.

[0006] The inkjet printer taught in JP-A-2009-190282 runs the ink droplet ejection test of the ink droplet ejection test device every time after a predetermined number of pages have been printed. If dropped dots resulting from a nozzle not discharging ink are confirmed by the ink droplet ejection test, an operation to eliminate the dropped dots is performed. Operations to eliminate dropped dots may include, for example, a cleaning operation that suctions ink from the nozzles by means of the ink suction mechanism, and a wiping operation that wipes the nozzle surface by means of the wiper mechanism. Because the cleaning operation suctions ink from the nozzle surface, dropped dots can be reliably eliminated by running the cleaning operation when dropped dots are confirmed, but this increases ink consumption. On the other hand, because the wiping operation does not suction ink, dropped dots can be eliminated while reducing ink consumption if the wiping operation is performed when dropped dots are confirmed.

[0007] However, our studies have confirmed that the following problem can result when dropped dots are eliminated using the wiping operation. More specifically, our tests showed that ink can be forced into a nozzle by the wiping operation without the wiping operation actually eliminating the dropped dots, and this ink can then discharged from the nozzle in the ink droplet ejection test. As a result, the ink droplet ejection test falsely indicates that the dropped dots were eliminated even though they were not actually eliminated. When printing then proceeds, dropped dots reappear in the printed output because the faulty nozzles were not actually restored and the dropped dots were not actually eliminated.

SUMMARY

[0008] A control method for a fluid ejection device and a fluid ejection device according to the invention reliably eliminate dropped dots while reducing consumption of ink droplets ejected from the nozzles.

[0009] A first aspect of the invention is a control method for a fluid ejection device that performs at least one of a cleaning operation that suctions fluid from a nozzle and a wiping operation that wipes the nozzle surface in which a plurality of nozzles are disposed when dropped dots result from one or more of a plurality of nozzles for ejecting fluid not ejecting fluid droplets, comprising: a dropped dot detection step that tests for dropped dots and determines if dropped dots occur; an elimination history detection step that, when the dropped dot detection step determines there are dropped dots, determines if a history of eliminating dropped dots by means of a wiping operation remains; a wiping step that performs the wiping operation when the elimination history detection step determines the elimination history does not remain; and a cleaning step that performs the cleaning operation without performing the wiping operation when the elimination history detection step determines the elimination history remains.

[0010] When dropped dots are detected, the control method of a fluid ejection device according to this aspect of the invention performs a wiping operation if an elimination history indicating that dropped dots were removed by a wiping operation that wipes the nozzle surface with a wiper does not remain in memory. As a result, dropped dots can be eliminated and consumption of fluid droplets discharged from the nozzles can be reduced by using a wiping operation.

[0011] However, if a history of eliminating dropped dots by means of a wiping operation remains in memory, the wiping operation is not performed and a cleaning operation that suctions fluid from the nozzles is performed. As a result, if dropped dots occur even though the wiping operation was performed to eliminate dropped dots, the dropped dots can be reliably eliminated and the problem resulting from the wiping operation as described above can be solved.

[0012] A control method for a fluid ejection device according to another aspect of the invention preferably has a second dropped dot detection step that tests for dropped dots and determines if dropped dots occur after the wiping step, and performs the cleaning operation if the second dropped dot detection step determines dropped dots have not been eliminated.

[0013] With this aspect of the invention the cleaning operation is performed if the dropped dots are not eliminated by the wiping operation in the wiping step. Dropped dots can therefore be reliably eliminated by the cleaning operation.

[0014] A control method for a fluid ejection device according to another aspect of the invention preferably has a second dropped dot detection step that tests for dropped dots and determines if dropped dots occur after the wiping step; and a set dropped dot elimination flag step that sets a dropped dot elimination flag when the second dropped dot detection step determines that dropped dots were eliminated. With this configuration, the next time that dropped dots occur, the elimination history detection step determines whether or not the elimination history remains by determining if the dropped dot elimination flag is set.

[0015] A control method for a fluid ejection device according to another aspect of the invention preferably also has a reset dropped dot elimination flag step that resets the dropped dot elimination flag when the elimination history detection step determines that the dropped dot elimination flag is set, and executes the cleaning step after the reset dropped dot elimination flag step.

[0016] This aspect of the invention resets the dropped dot elimination flag before the cleaning step.

[0017] A control method for a fluid ejection device according to another aspect of the invention preferably also has a second reset dropped dot elimination flag step that resets the dropped dot elimination flag when the dropped dot detection step determines there are no dropped dots.

[0018] With this aspect of the invention the wiping operation is first performed the next time dropped dots are detected when dropped dots were actually eliminated by the wiping operation the last time dropped dots were detected. Compared with a configuration in which the cleaning operation is performed instead of the wiping operation because a history of eliminating dropped dots by means of a wiping operation remains in memory even though the dropped dots were actually eliminated by a wiping operation, this aspect of the invention can reduce consumption of fluid droplets ejected from the nozzles.

[0019] Another aspect of the invention is a fluid ejection device including: a fluid ejection head having a plurality of nozzles for ejecting fluid droplets; a fluid droplet ejection test mechanism that tests for the presence of dropped dots caused by one or more of the plurality of nozzles not ejecting fluid droplets; a suction mechanism that suctions fluid from the nozzles; a wiping mechanism that wipes the nozzle surface of the fluid ejection head in which a plurality of the nozzles are disposed; a storage unit that can store a history of eliminating dropped dots by a wiping operation of the wiping mechanism; and a head maintenance unit control unit that determines if the dropped dot elimination history remains in the storage unit, and when dropped dots are detected drives the wiping mechanism if the elimination history does not remain in the storage unit, and drives the suction mechanism if the elimination history remains in the storage unit.

[0020] The storage unit in the fluid ejection device according to this aspect of the invention can store an elimination history of removing dropped dots by means of a wiping operation. When dropped dots are detected, the drive mechanism drives the wiping mechanism if a history of eliminating dropped dots by means of a wiping operation does not remain. Dropped dots can therefore be eliminated while reducing consumption of fluid droplets ejected from the nozzles.

[0021] However, if a history of eliminating dropped dots by means of a wiping operation remains in the storage unit, the drive mechanism drives the suction mechanism. Problems resulting from a wiping operation can therefore be solved and dropped dots can be reliably eliminated even when a wiping operation is also used to eliminate dropped dots.

[0022] In a fluid ejection device according to another aspect of the invention, the head maintenance unit control unit performs a second dropped dot detection operation that causes the fluid droplet ejection test mechanism to test for dropped dots after the wiping operation is performed and determine if dropped dots were eliminated by the wiping operation, and if dropped dots were not eliminated causes the suction mechanism to perform the cleaning operation. If elimination of dropped dots is confirmed, the head maintenance unit control unit sets the dropped dot elimination flag in the storage unit.

[0023] In a fluid ejection device according to another aspect of the invention, when the dropped dot elimination flag is set, the head maintenance unit control unit resets the dropped dot elimination flag, and after resetting the dropped dot elimination flag causes the suction mechanism to perform the cleaning operation.

[0024] In a fluid ejection device according to another aspect of the invention, the fluid ejection head is an inkjet head having a plurality of nozzles for ejecting ink. A fluid ejection device having an inkjet head according to this aspect of the invention can reliably eliminate dropped dots while reducing consumption of ink droplets ejected from the nozzles.

[0025] Other objects and attainments together with a fuller understanding of the invention will become apparent and appreciated by referring to the following description and claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. **1** is an external oblique view of an inkjet printer according to the invention.

[0027] FIG. **2** is a schematic oblique view of the printer mechanism in the inkjet printer.

[0028] FIG. **3** is an oblique view of the head maintenance unit.

[0029] FIG. **4**A shows the relationship between the inkjet head and the head cap during the flushing operation, and FIG. **4**B shows the relationship between the inkjet head and the head cap during the ink suction operation.

[0030] FIG. **5** shows the relationship between the inkjet head and the head wiper during the wiping operation.

[0031] FIG. **6** shows the relationship between the inkjet head and the head cap during the ink droplet ejection test.

[0032] FIG. **7** is a block diagram showing part of the control unit of the inkjet printer.

[0033] FIG. **8** is a flow chart of the ink droplet ejection test and the operation for eliminating dropped dots.

DESCRIPTION OF EMBODIMENTS

[0034] An inkjet printer as an example of a fluid ejection device according to the invention, and a cleaning control method for an inkjet head according to a preferred embodiment of the invention are described below with reference to the accompanying figures.

General Configuration of an Inkjet Printer

[0035] FIG. **1** is an external oblique view of an inkjet printer **1** according to a preferred embodiment of the invention. FIG. **2** is an oblique view of the print mechanism unit **10** that is covered by the printer case **2** of the inkjet printer **1**.

[0036] The inkjet printer **1** prints in color on a continuous web of recording paper delivered from a paper roll using plural different colors of ink, and has a generally box-shaped printer case **2** with an opening **3** for loading roll paper formed in the front center part of the printer case **2**. The opening **3** is closed by an access cover **5** to which a recording paper discharge guide **4** is disposed at the top. A recording paper exit **6** is formed between the recording paper discharge guide **4** and the top edge part of the opening **3** in the printer case **2**. When a lock mechanism not shown is released and the recording paper discharge guide **4** is pulled forward by hand, the access cover **5** can pivot forward at the bottom end thereof from the closed position shown in the figure to an open position.

[0037] A power switch **7***a*, paper feed switch **7***b*, and a plurality of operating status indicators **7***c* are arrayed at the right side of the access cover **5** at the front of the printer case **2**. A loading opening **8***a* for an ink cartridge loading unit **8** that is rectangular in section and is disposed with the long side extending in the front-back direction of the printer is formed

in the front of the printer case **2** on the left side of the access cover **5**, and an ink cartridge **9** is loaded in this ink cartridge loading unit **8**. When a button not shown is operated, the lock is released, the ink cartridge **9** is pushed forward by the force of a spring, and the ink cartridge **9** can be removed.

[0038] The print mechanism unit **10** disposed inside the printer case **2** has a printer frame **11** composed of a metal bottom **11***a* and left and right side panels **11***b*, **11***c* as shown in FIG. **2**. A roll paper storage compartment **12** is formed in the middle at the front of the printer inside the printer frame **11**. When an access cover **5** is opened, this roll paper storage compartment **12** opens to the front and the roll paper can be replaced, for example.

[0039] A platen **13** extends horizontally widthwise to the printer above the roll paper compartment **12**. An inkjet head (fluid ejection head) **14** having a plurality of nozzles (ink nozzles) for ejecting ink droplets (fluid droplets) is disposed above the platen **13**. The inkjet head **14** is mounted on a carriage **15** with the nozzle surface **14***a* in which the plural ink nozzles are arranged facing down.

[0040] The carriage **15** can move bidirectionally widthwise to the printer along a carriage guide shaft **15***a* extending horizontally widthwise to the printer. More specifically, the carriage **15** can move between a home position **15**A that is removed to the right of the platen **13** and is indicated by a solid line in FIG. **2**, and a left-end position **15**B that is removed to the left side of the platen **13** and is indicated by a double dot-dash line in FIG. **2**. A drive mechanism including a motor and a transmission mechanism such as a belt and pulleys is connected to the carriage **15**.

[0041] Ink pumps for color ink, such as ink pumps **16***a* to **16***d* storing four colors of ink, such as cyan, magenta, yellow, and black ink in this embodiment, are also mounted on the carriage **15**. One end of a flexible ink tube **17***a* to **17***d* is connected to each ink pump **16***a* to **16***d*. The other ends of the flexible ink tubes **17***a* to **17***d* are respectively connected to four ink supply paths (not shown in the figure) that extend vertically and are located at a position on the back end side of the ink cartridge loading unit **8**. Each of the ink supply paths communicates with the side of an ink cartridge **9** in the ink cartridge loading unit **8**. Ink sacks storing the cyan, magenta, yellow, and black inks are stored in the ink cartridge **9**, and the different colors of ink stored in the ink sacks are supplied through the flexible ink tubes **17***a* to **17***d* to the ink pumps **16***a* to **16***d*. The ink supplied to the ink pumps **16***a* to **16***d* is then supplied to the inkjet head **14**.

[0042] A head maintenance unit **20** is rendered at a position on the right side of the roll paper compartment **12**. When the carriage **15** is at the home position **15**A, the nozzle surface **14***a* of the inkjet head **14** carried on the carriage **15** is above and opposite the head maintenance unit **20**. The head maintenance unit **20** is described in detail below.

[0043] During normal printing operations, the inkjet printer **1** conveys recording paper delivered from roll paper stored in the roll paper compartment **12** over the surface of the platen **13** to the recording paper exit **6** by means of a transportation mechanism not shown, and prints on the recording paper by moving the inkjet head **14** reciprocally left and right synchronized to conveyance of the recording paper.

Head Maintenance Unit

[0044] FIG. **3** is an oblique view of the head maintenance unit **20**. FIG. **4**A shows the relationship between the inkjet head **14** and the head caps **22***a*, **22***b* during the flushing operation, and FIG. **4**B shows the relationship between the inkjet head **14** and the head caps **22***a*, **22***b* during the ink suction operation. FIG. **5** shows the relationship between the inkjet head **14** and the head wiper **25** during the wiping operation. FIG. **6** shows the relationship between the inkjet head **14** and the head caps **22***a*, **22***b* during the ink droplet ejection test.

[0045] As shown in FIG. **3**, the head maintenance unit **20** has a rectangular box-like unit case **21** that is long in the front-back direction of the printer. A head cap unit **22** with two head caps **22***a*, **22***b* is disposed at the top of the front part of the unit case **21**. The head caps **22***a*, **22***b* are adjacent to each other in the carriage scanning direction. The tops of the head caps **22***a*, **22***b* are open, and these openings are opposite the nozzle surface **14***a* of the inkjet head **14**. An ink absorber **23** is disposed inside the head caps **22***a*, **22***b*. As shown in FIG. **4**, the inkjet head **14** of the inkjet printer **1** according to this embodiment of the invention includes a pair of inkjet heads **14**A and **14**B disposed side by side in the carriage scanning direction.

[0046] A head cap elevator (not shown in the figure) that raises and lowers the head caps **22***a*, **22***b* is disposed below the head cap unit **22**. A tube pump (not shown in the figure) and tube pump drive motor (not shown in the figure) are disposed to the unit case **21** behind the head cap elevator.

[0047] An ink suction operation that suctions ink from each of the ink nozzles by means of a tube pump is performed at capping position **22**A where the nozzle surface **14***a* of the inkjet head **14** is capped by the head caps **22***a*, **22***b* from below as shown in FIG. **4**B. The waste ink that is removed by this ink suction operation is sent through a waste ink tube **24** by the tube pump. This waste ink tube **24** communicates with the ink cartridge **9** stored in the ink cartridge loading unit **8**, and the waste ink is recovered into a waste ink storage unit in the ink cartridge **9**.

[0048] A flushing operation that ejects a specific amount of ink droplets from each nozzle toward the ink absorber **23** is performed at the capping position **22**B where the head caps **22***a*, **22***b* are retracted down from the capping position **22**A as shown in FIG. **4**A. A suction mechanism **29** (see FIG. **7**) that suctions ink (fluid) from the ink nozzles is rendered in this embodiment of the invention by the head cap unit **22**, the tube pump, and the tube pump drive motor, for example.

[0049] The head maintenance unit **20** includes a wiping mechanism **26** that has a head wiper **25** for wiping excess ink, paper dust, and other foreign matter from the nozzle surface **14***a* of the inkjet head **14**. The head wiper **25** is a thin, flat, rectangular member made of rubber or other flexible material, and is disposed to the unit case **21** behind the head cap unit **22**. The side of the head wiper **25** is the wiping surface **25***a* that wipes ink from the nozzle surface **14***a*. Felt, sponge, or other fluid absorber that absorbs the ink that clings to the head wiper **25** when ink is wiped from the nozzle surface **14***a* is disposed on both front and back sides of the head wiper **25**. A head wiper drive mechanism **27** that moves the head wiper **25** bidirectionally front and back is also connected to the head wiper **25**.

[0050] The head wiper drive mechanism **27** includes a rack formed extending front-back on the back of the wiper case **28** that extends front-back and holds the head wiper **25**, a pinion that meshes with the rack, and a gear train that transfers torque from the drive source to the pinion. In this embodiment of the invention the drive source of the head wiper drive mechanism **27** is a motor for driving the tube pump.

[0051] The head wiper **25** can move bidirectionally in the front-back direction of the printer along the top end of the unit case **21** of the head maintenance unit **20**. When the inkjet head **14** is in the home position **15**A and the head wiper **25** moves to the front from the back of the head cap unit **22**, the head wiper **25** slides across the nozzle surface **14***a* of the pair of inkjet heads **14**A and **14**B while bending back, thereby wiping the nozzle surface **14***a* in the wiping operation.

[0052] The head maintenance unit **20** in this embodiment of the invention also has a function for testing for dropped dots resulting from any of the plural ink nozzles of the inkjet head **14** not discharging ink droplets (that is, testing for any clogged ink nozzles).

[0053] As shown in FIG. **6**, a metal rod **31** is disposed conductively to the ink absorber **23** inside each of the head caps **22***a*, **22***b*, and a lead **32** is connected to the bottom end of the metal rod **31**. When charged ink is discharged from an ink nozzle of the inkjet head **14** and the charged ink droplets land on the ink absorber **23**, a change occurs in the current extracted from the metal rod **31** and lead **32**. Whether or not ink droplets are being discharged from the ink nozzles can be determined based on the change in this current. The head maintenance unit **20** performs an ink droplet ejection test to test for dropped dots based on change in the current thus extracted from the metal rod **31** and lead **32**. An ink droplet ejection test mechanism (fluid droplet ejection test mechanism) **33** that tests for dropped dots is rendered by means of the ink absorber **23**, metal rod **31**, and lead **32** in this embodiment of the invention.

Control Unit Configuration

[0054] FIG. **7** is a block diagram showing part of the control unit **36** of the inkjet printer **1**. The control unit **36** of the inkjet printer **1** includes a head maintenance unit control unit **37** for controlling the head maintenance unit **20**. The head maintenance unit control unit **37** includes memory **38** such as ROM or RAM, and a CPU (not shown in the figure). The ink droplet ejection test mechanism **33** is connected to the head maintenance unit control unit **37**, and the head maintenance unit control unit **37** determines if there are dropped dots based on change in the current read from the metal rod **31** and lead **32**.

[0055] A suction mechanism drive circuit **39** that drives the suction mechanism **29**, and a wiping mechanism drive circuit **40** that drives the wiping mechanism **26**, are also connected to the head maintenance unit control unit **37**. The suction mechanism drive circuit **39** is a circuit for driving the tube pump drive motor, for example. The wiping mechanism drive circuit **40** is a circuit for driving the head wiper drive mechanism **27**.

Ink Droplet Ejection Test and Dropped Dot Elimination Operation

[0056] FIG. **8** is a flow chart of the ink droplet ejection test and the operation for eliminating dropped dots. The inkjet printer **1** runs an ink droplet ejection test at the home position **15**A every time a specific number of pages of recording paper are printed. If the ink droplet ejection test determines that dots are being dropped because of a faulty nozzle, the dropped dots are eliminated by executing either or both the ink suction cleaning operation of the inkjet head **14** and the wiping operation. The ink droplet ejection test and the operation for eliminating dropped dots are described next with reference to FIG. **8**.

[0057] When printing a specific number of pages of recording paper is completed, the control unit **36** discharges charged ink droplets from the ink nozzles of the inkjet head **14** at the home position **15**A and performs the ink droplet ejection test (step S**1**). The head maintenance unit control unit **37** then determines if there are any dropped dots (step S**2**).

[0058] If dropped dots are detected in step S**2**, the head maintenance unit control unit **37** determines if a history of eliminating dropped dots by means of the wiping operation remains (step S**3**). More specifically, in step S**3** the head maintenance unit control unit **37** determines if a history of eliminating dropped dots by means of the wiping operation is stored in memory **38**. Yet more specifically, in step S**3** the head maintenance unit control unit **37** determines if a dropped dot elimination flag remains set in the memory **38**. This dropped dot elimination flag is set in memory **38** in step S**7** once dropped dots have been eliminated as described below.

[0059] If in step S**3** it is determined that the dropped dot elimination flag in memory **38** was reset (that is, a history of eliminating dropped dots by means of a wiping operation does not remain in memory **38**), the head maintenance unit control unit **37** controls the wiping mechanism drive circuit **40** and drives the wiping mechanism **26** to execute the wiping operation in order to eliminate dropped dots (step S**4**). After the wiping operation is completed, the control unit **36** executes the ink droplet ejection test (step S**5**), and the head maintenance unit control unit **37** then determines if the dropped dots were eliminated by the wiping operation performed in step S**5** (step S**6**).

[0060] If it is determined in step S**6** that the dropped dots were eliminated, the head maintenance unit control unit **37** sets the dropped dot elimination flag in memory **38** to store information indicating that dropped dots were eliminated by the wiping operation (step S**7**). Once the dropped dot elimination flag is set in memory **38**, the ink droplet ejection test and dropped dot elimination operation end normally.

[0061] However, if it is determined in step S**6** that the dropped dots were not eliminated, the head maintenance unit control unit **37** resets a cleaning counter in memory **38** to 0 (step S**8**), and then controls the suction mechanism drive circuit **39** to drive the suction mechanism **29** and perform the cleaning operation (step S**9**). The head maintenance unit control unit **37** then adds 1 to the current cleaning count to update the cleaning counter, and stores the updated cleaning counter in memory **38** (step S**10**). The control unit **36** then runs the ink droplet ejection test (step S**11**).

[0062] The head maintenance unit control unit **37** then determines if the dropped dots were eliminated by the cleaning operation performed in step S**9** (step S**12**). In step S**12** the head maintenance unit control unit **37** determines if the cleaning counter stored in memory **38** exceeds a specific value (such as 3). The head maintenance unit control unit **37** thus determines if the cleaning operation has been performed a specific number of times.

[0063] If the dropped dots were not eliminated or the cleaning count exceeds the preset limit in step S**12**, control returns to step S**9** and the cleaning operation repeats. If in step S**12** the dropped dots were eliminated, the ink droplet ejection test and dropped dot elimination operation end normally.

[0064] If the dropped dots were not eliminated and the cleaning count exceeds the preset limit in step S**12**, a warning is returned to the host device (not shown in the figure) of the inkjet printer **1** and the ink droplet ejection test and dropped dot elimination operation end.

[0065] If in step S**3** the dropped dot elimination flag remains set in memory **38** (that is, a history of eliminating dropped dots by a wiping operation remains in memory **38**), the head maintenance unit control unit **37** resets the dropped dot elimination flag in memory **38** (step S**13**) and control goes to step S**8**. More specifically, the head maintenance unit control unit **37** deletes the history of eliminating dropped dots by a wiping operation from memory **38** in step S**13**, and then proceeds to step S**8**. As a result, if the dropped dot elimination flag is determined in step S**3** to be set in memory **38**, the head maintenance unit control unit **37** runs the cleaning operation without executing the wiping operation.

[0066] In addition, if dropped dots are not detected in step S**2**, the head maintenance unit control unit **37** resets the dropped dot elimination flag in memory **38** (step S**14**). More specifically, the head maintenance unit control unit **37** deletes the history of eliminating dropped dots by a wiping operation from memory **38** in step S**14**. If the dropped dot elimination flag is reset in memory **38**, the ink droplet ejection test and dropped dot elimination operation end normally.

[0067] In this embodiment of the invention steps S**1** and S**2** are the dropped dot detection step, step S**3** is the elimination history detection step, step S**4** is the wiping step, and step S**9** executed through step S**13** is the cleaning step in the accompanying claims.

[0068] In addition, steps S**5** and S**6** are a second dropped dot detection step, step S**7** is a set dropped dot elimination flag step, step S**13** is a reset dropped dot elimination flag step, and step S**14** is a second reset dropped dot elimination flag step.

[0069] Note, further, that memory **38** in this embodiment of the invention is a storage unit for storing a history of dropped dot elimination by means of a wiping operation. The suction mechanism drive circuit **39** and wiping mechanism drive circuit **40** drive the wiping mechanism **26** if the elimination history does not remain in the storage unit when dropped dots are detected, and drive the suction mechanism drive circuit **39** if the elimination history remains.

Effect of the Invention

[0070] As described above, when dropped dots are detected, this embodiment of the invention executes a wiping operation if a history of eliminating dropped dots by means of a wiping operation does not remain in memory **38**. As a result, dropped dots can be eliminated and consumption of ink droplets discharged from the ink nozzles can be reduced by using a wiping operation. However, if a history of eliminating dropped dots by means of a wiping operation remains in memory **38**, this embodiment of the invention runs a cleaning operation without performing the wiping operation. As a result, a wiping operation can be used to eliminate dropped dots while problems that can result from a wiping operation as described above can be solved. In addition, if it is determined in step S**6** that dropped dots have not been eliminated, this embodiment of the invention performs the cleaning operation up to a specified number of times until the dropped dots are eliminated. As a result, dropped dots can be reliably eliminated.

[0071] When it is determined in step S**6** that dropped dots have been eliminated, this embodiment of the invention sets a dropped dot elimination flag in memory **38** in step S**7**. As a result, whether the history of eliminating dropped dots by means of a wiping operation remains in memory the next time dropped dots are detected can be determined by checking in step S**3** if the dropped dot elimination flag is set in memory **38**.

[0072] If dropped dots are not detected in step S**2** in this embodiment of the invention, the dropped dot elimination flag is reset in memory **38** in step S**14**. As a result, if dropped dots are actually eliminated by the wiping operation, the wiping operation is first performed the next time dropped dots are detected. This configuration reduces consumption of ink droplets discharged from the ink nozzles when compared with a configuration that runs the cleaning operation without a wiping operation the next time dropped dots are detected because the history of eliminating dropped dots by means of a wiping operation is still in memory even though dropped dots were actually eliminated by a previous wiping operation.

Other Embodiments

[0073] When a history of eliminating dropped dots by means of a wiping operation is found in memory **38** in step S**3**, the foregoing embodiment of the invention proceeds through step S**13** to step S**8**. However, when a history of eliminating dropped dots by means of a wiping operation is found in memory **38** in step S**3**, control may go directly to step S**8**. In this configuration step S**13** is executed after any one of steps S**8** to S**12**.

[0074] When dropped dots are not detected in step S**2** in the foregoing embodiment, the dropped dot elimination flag is reset in memory **38**, and the ink droplet ejection test and dropped dot elimination operation end. However, when dropped dots are not detected in step S**2**, the ink droplet ejection test and dropped dot elimination operation may be ended without resetting the dropped dot elimination flag.

[0075] A preferred embodiment of a fluid ejection device according to the invention is described above using an inkjet printer **1** by way of example, but the fluid ejection device of the invention is not so limited and includes, for example, fluid ejection devices having a fluid ejection head that discharges fluids from nozzles to deposit electrode materials and coloring agents used to form electrodes in liquid crystal display devices, organic EL displays, and FED (field emission display) devices; fluid ejection devices having a fluid ejection head for discharging biomedical materials used in biochip manufacture from nozzles; and fluid ejection devices having a fluid ejection head for discharging reagents from nozzles used as micro-pipettes.

[0076] Although the present invention has been described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications will be apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims, unless they depart therefrom.

What is claimed is:

1. A control method for a fluid ejection device that performs at least one of a cleaning operation that suctions fluid from a nozzle and a wiping operation that wipes the nozzle surface in which a plurality of nozzles are disposed when dropped dots result from one or more of a plurality of nozzles for ejecting fluid not ejecting fluid droplets, comprising:

a dropped dot detection step that tests for dropped dots and determines if dropped dots occur;

an elimination history detection step that, when the dropped dot detection step determines there are dropped

dots, determines if a history of eliminating dropped dots by means of a wiping operation remains;

a wiping step that performs the wiping operation when the elimination history detection step determines the elimination history does not remain; and

a cleaning step that performs the cleaning operation without performing the wiping operation when the elimination history detection step determines the elimination history remains.

2. The control method for a fluid ejection device described in claim **1**, further comprising:

a second dropped dot detection step that tests for dropped dots and determines if dropped dots occur after the wiping step;

wherein the cleaning operation is performed if the second dropped dot detection step determines dropped dots have not been eliminated.

3. The control method for a fluid ejection device described in claim **1**, further comprising:

a second dropped dot detection step that tests for dropped dots and determines if dropped dots occur after the wiping step; and

a set dropped dot elimination flag step that sets a dropped dot elimination flag when the second dropped dot detection step determines that dropped dots were eliminated;

wherein the next time that dropped dots occur, the elimination history detection step determines whether or not the elimination history remains by determining if the dropped dot elimination flag is set.

4. The control method for a fluid ejection device described in claim **3**, further comprising:

a reset dropped dot elimination flag step that resets the dropped dot elimination flag when the elimination history detection step determines that the dropped dot elimination flag is set;

wherein the cleaning step is executed after the reset dropped dot elimination flag step.

5. The control method for a fluid ejection device described in claim **4**, further comprising:

a second reset dropped dot elimination flag step that resets the dropped dot elimination flag when the dropped dot detection step determines there are no dropped dots.

6. A fluid ejection device comprising:

a fluid ejection head having a plurality of nozzles for ejecting fluid droplets;

a fluid droplet ejection test mechanism that tests for the presence of dropped dots caused by one or more of the plurality of nozzles not ejecting fluid droplets;

a suction mechanism that suctions fluid from the nozzles;

a wiping mechanism that wipes the nozzle surface of the fluid ejection head in which a plurality of the nozzles are disposed;

a storage unit that can store a history of eliminating dropped dots by a wiping operation of the wiping mechanism; and

a head maintenance unit control unit that determines if the dropped dot elimination history remains in the storage unit, and when dropped dots are detected

drives the wiping mechanism if the elimination history does not remain in the storage unit, and

drives the suction mechanism if the elimination history remains in the storage unit.

7. The fluid ejection device described in claim **6**, wherein:

the head maintenance unit control unit performs a second dropped dot detection operation that causes the fluid droplet ejection test mechanism to test for dropped dots after the wiping operation is performed and determine if dropped dots were eliminated by the wiping operation, and if dropped dots were not eliminated causes the suction mechanism to perform the cleaning operation.

8. The fluid ejection device described in claim **7**, wherein:

the head maintenance unit control unit sets a dropped dot elimination flag in the storage unit if elimination of dropped dots is confirmed in the second dropped dot detection operation.

9. The fluid ejection device described in claim **8**, wherein:

when the dropped dot elimination flag is set, the head maintenance unit control unit resets the dropped dot elimination flag, and after resetting the dropped dot elimination flag causes the suction mechanism to perform the cleaning operation.

10. The fluid ejection device described in claim **6**, wherein:

the fluid ejection head is an inkjet head having a plurality of nozzles for ejecting ink.

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