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Kobayashi et al.

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(54) **INKJET RECORDING APPARATUS**

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B41J 2/045 (2006.01)

(52) **U.S. Cl.**
CPC ***B41J 2/04588*** (2013.01); ***B41J 2/0458*** (2013.01); ***B41J 2/04581*** (2013.01)

(58) **Field of Classification Search**
CPC .. B41J 2/04588; B41J 2/0458; B41J 2/04581; B41J 2/04596
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,946,641 B2 * 3/2021 Hasegawa B41J 2/175
2021/0001628 A1 * 1/2021 Ozaki B41J 2/04541

FOREIGN PATENT DOCUMENTS

JP 2019-166829 A 10/2019

OTHER PUBLICATIONS

Gardner, Deane A, Print System And Technique, Sep. 10, 2014, China (Year: 2014).*

* cited by examiner

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(57) **ABSTRACT**

An inkjet recording apparatus includes a plurality of nozzles, a pressurizing element, a driver, a controller and a control circuit. The pressurizing element is provided for each of the nozzles. The driver drives the pressurizing elements. The controller generates image data indicating whether ink is ejected for each of the nozzles. The control circuit transmits ejection waveform data indicating a signal transmitted to the pressurizing element and the image data. After printing according to the image data transmitted to the driver is completed, in a non-printing state in which there is no image data to be subsequently printed, the control circuit transmits at least one of the image data indicating a blank sheet and the ejection waveform data in which the ink is not ejected, to the driver.

6 Claims, 13 Drawing Sheets

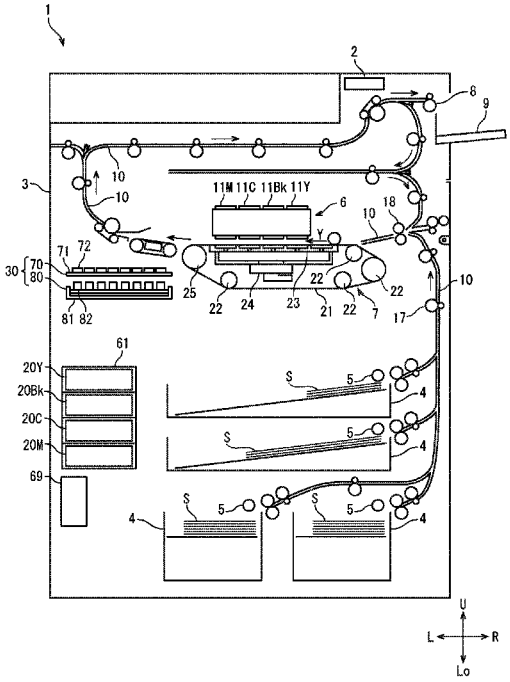


FIG. 1

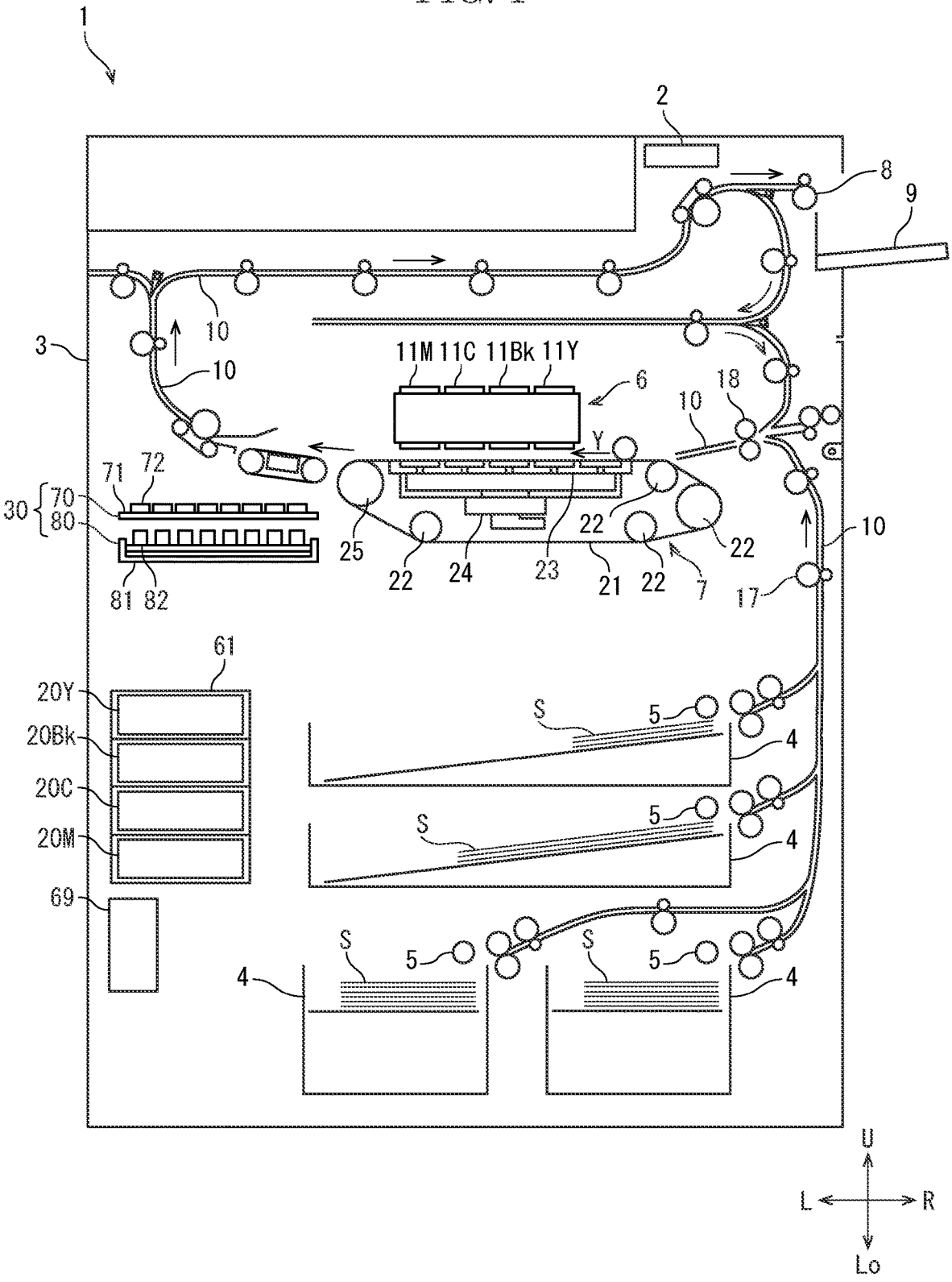

1
2
8
9
10
3
10
11M 11C 11Bk 11Y
6
18
10
Y
71
72
30
70
80
25
22
24
23
22
21
22
7
22
10
17
81 82
61
20Y
20Bk
20C
20M
69
S
5
4
S
5
4
S
5
4
S
5
4
U
L
R
Lo

FIG. 2

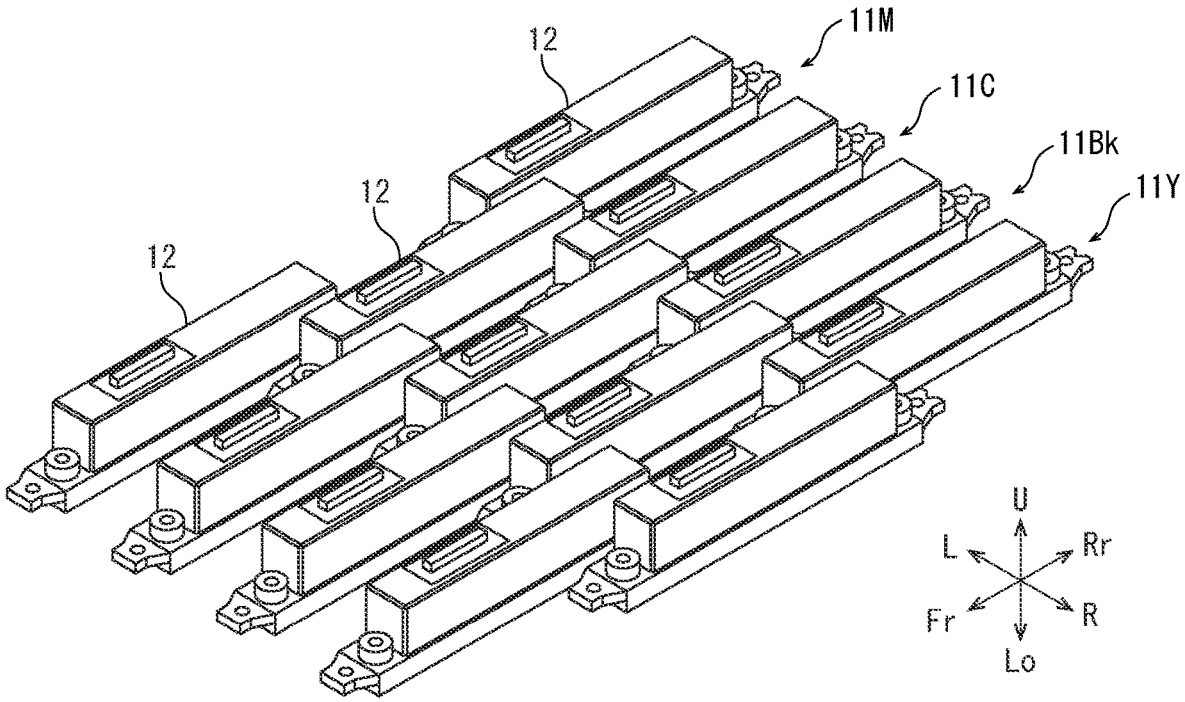


FIG. 3

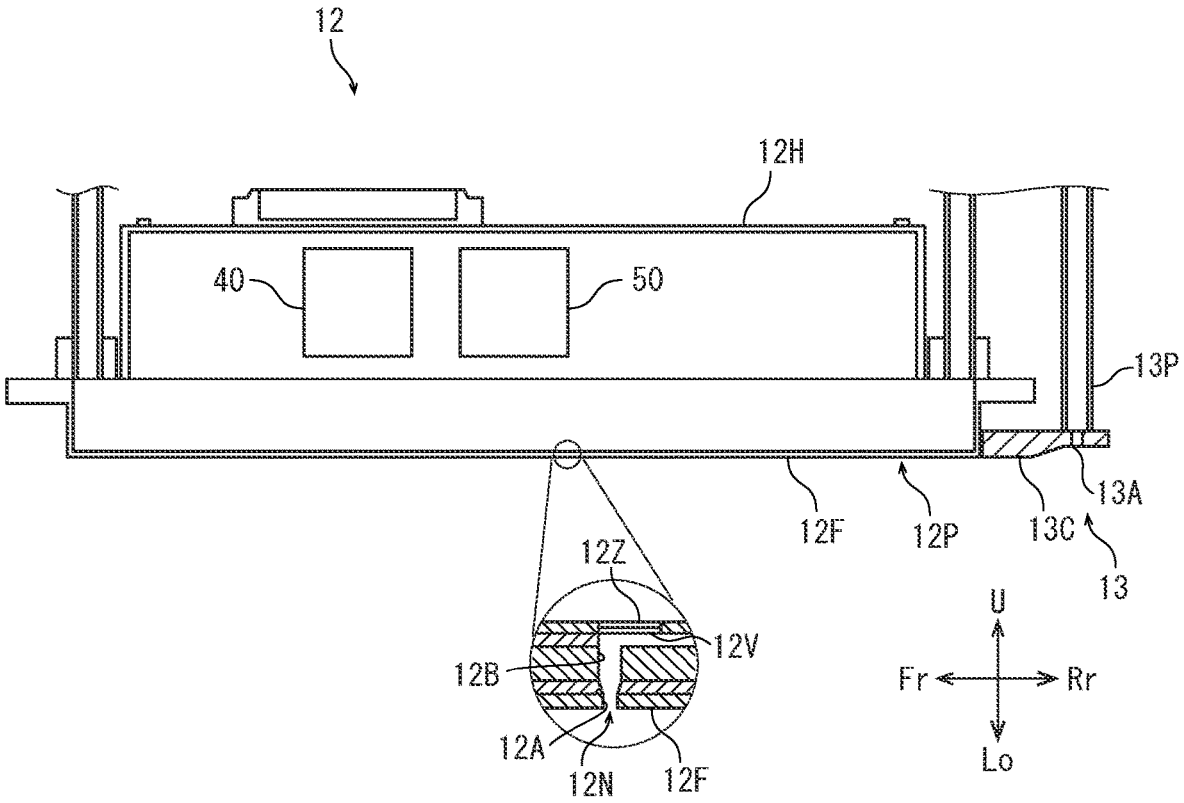

12
12H
40
50
13P
13A
12F
12P
13C
13
12Z
12V
12B
12A
12N
12F
U
Fr
Rr
Lo

FIG. 4

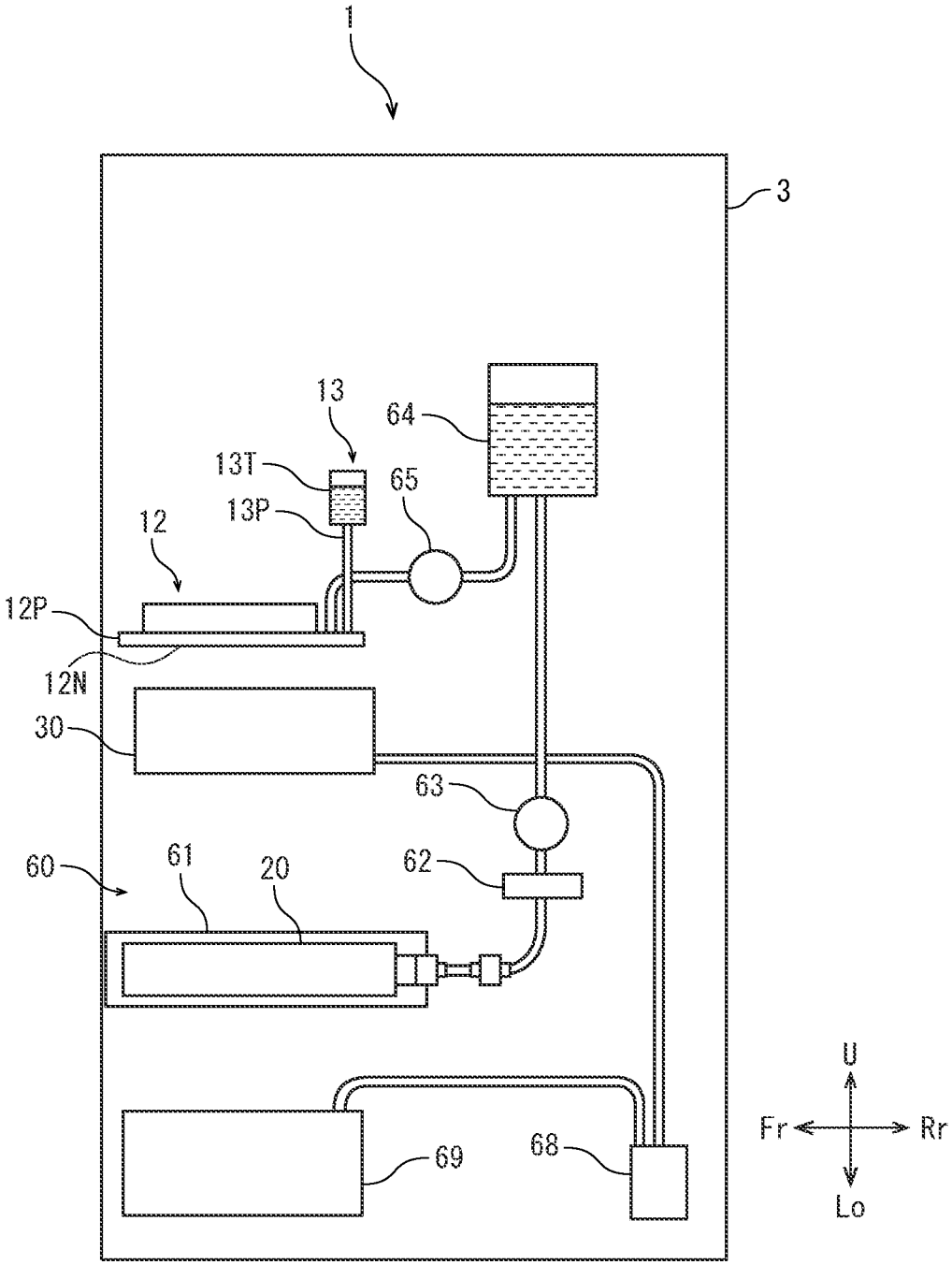


FIG. 5

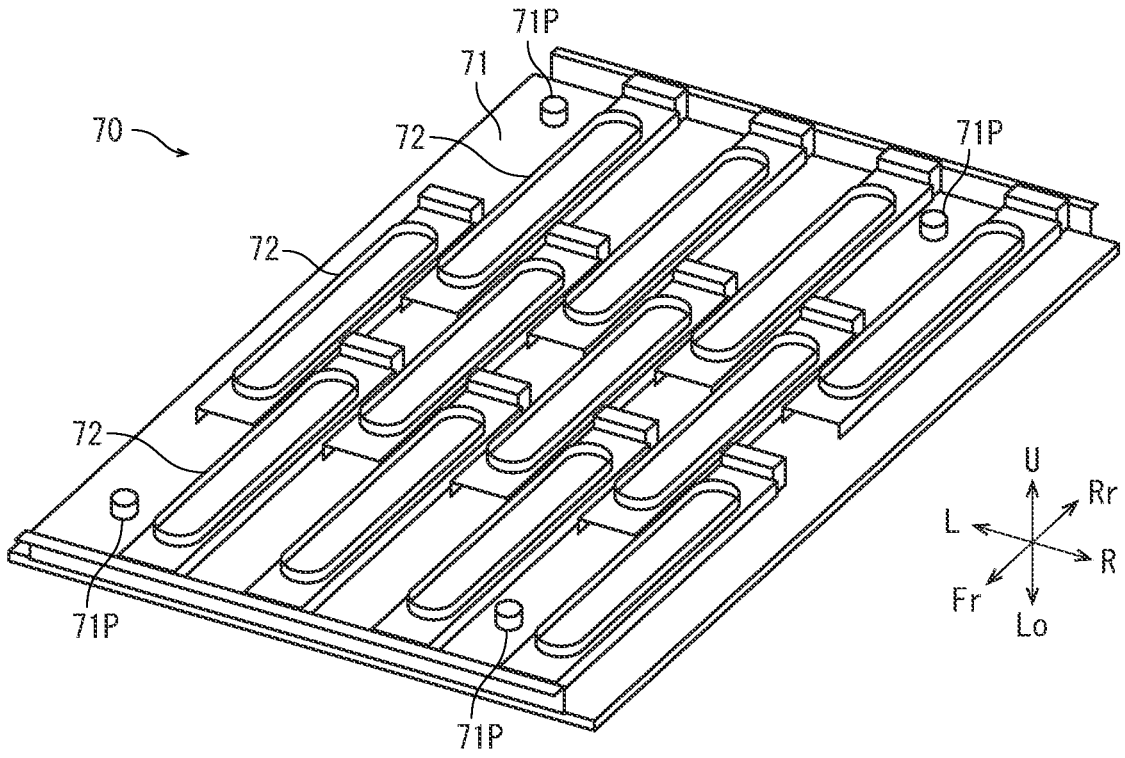

71P
71
70
72
71P
72
72
71P
71P
U
Rr
L
R
Fr
Lo

FIG. 6

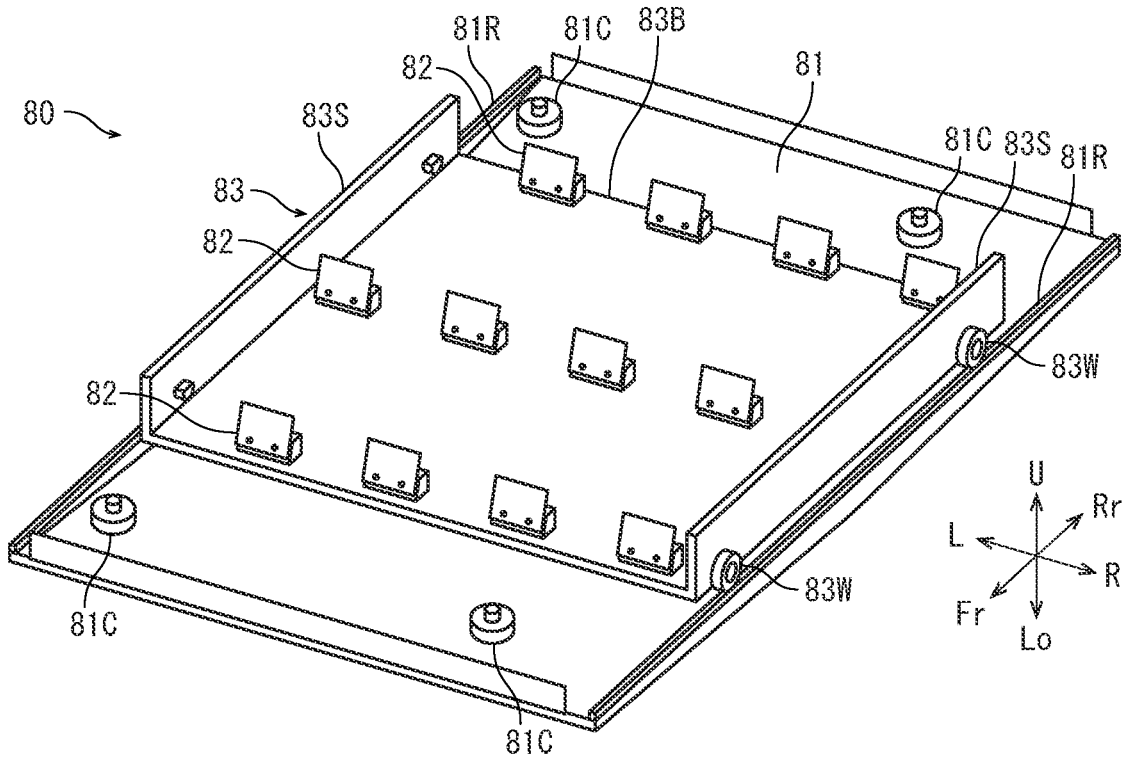

81R
81C
83B
82
81
80
83S
81C
83S
81R
83
82
82
83W
82
U
Rr
L
R
Fr
Lo
83W
81C
81C

FIG. 7

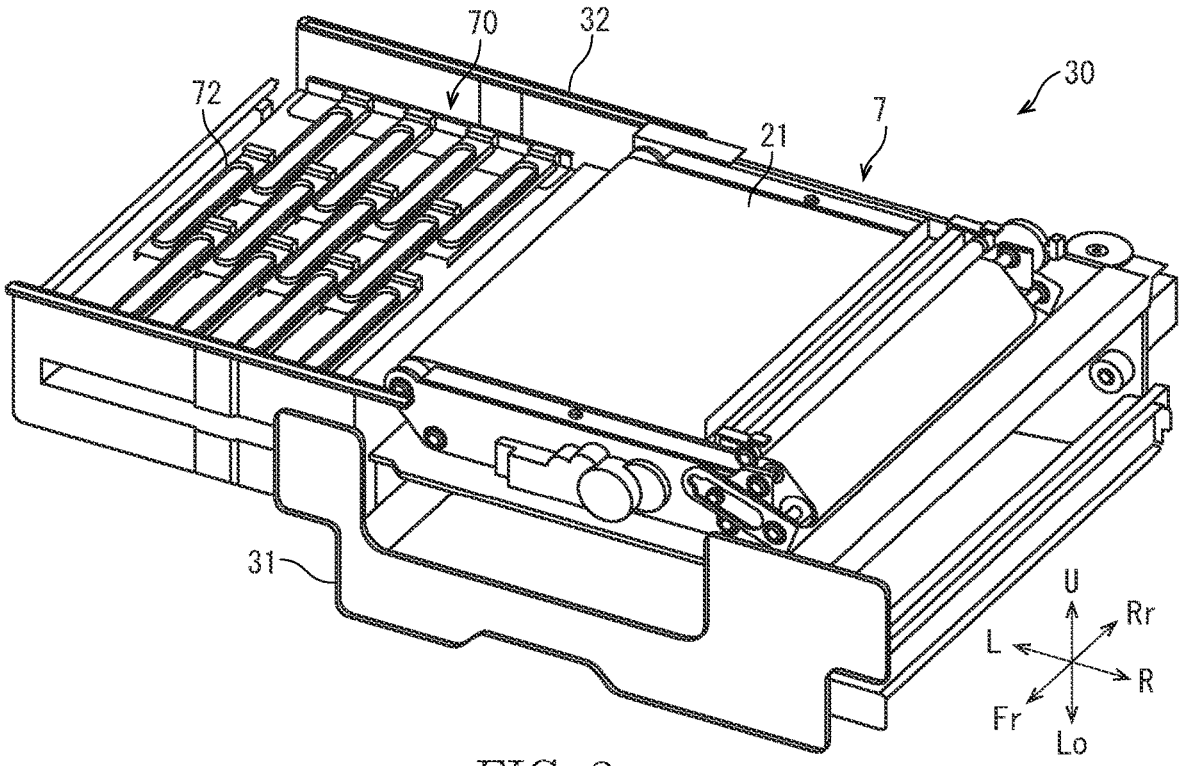


FIG. 8

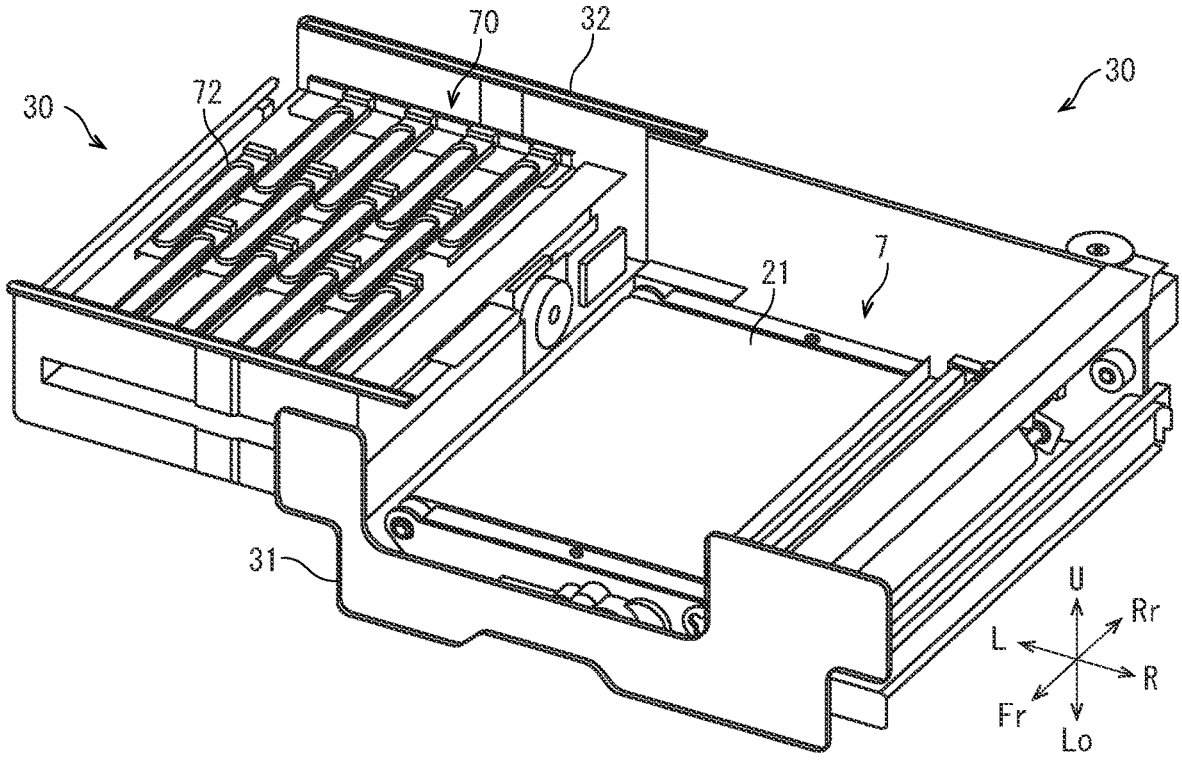


FIG. 9

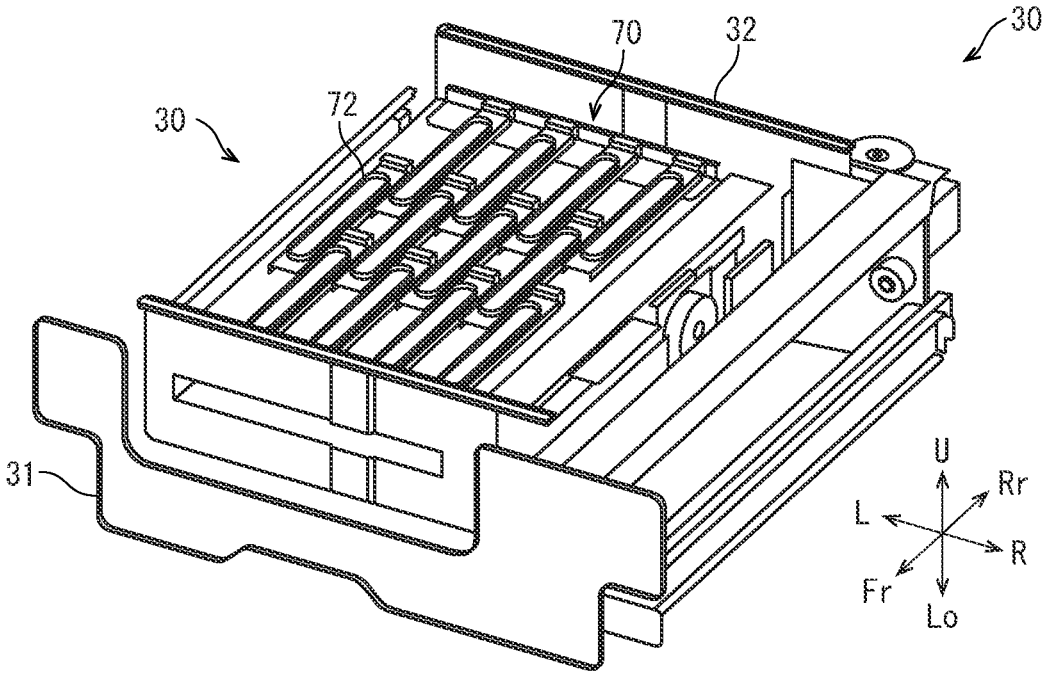


FIG. 10

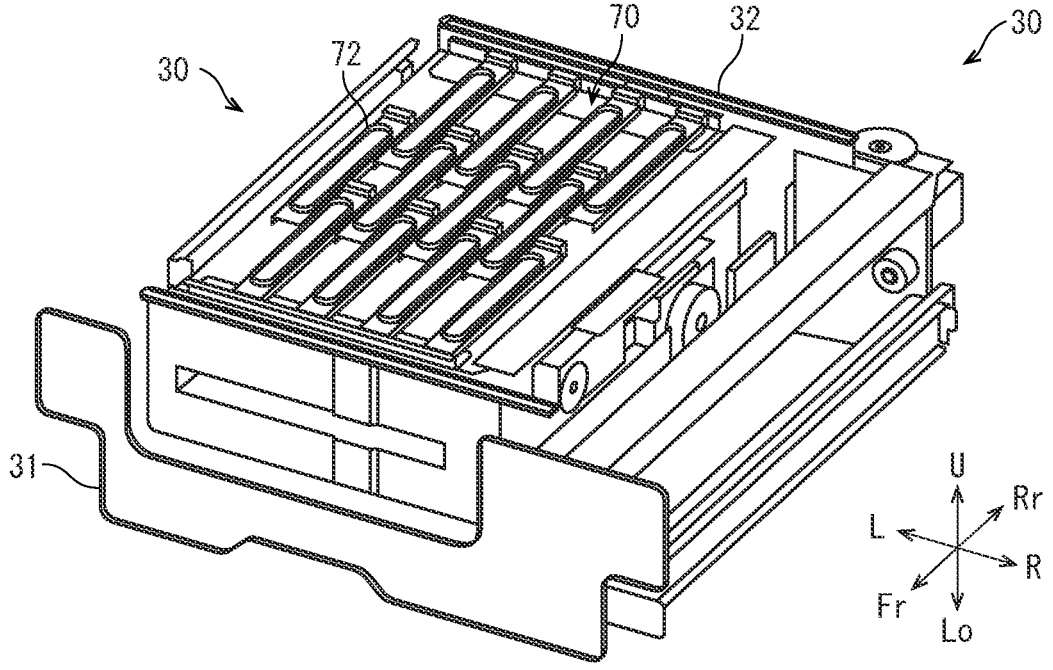


FIG. 11

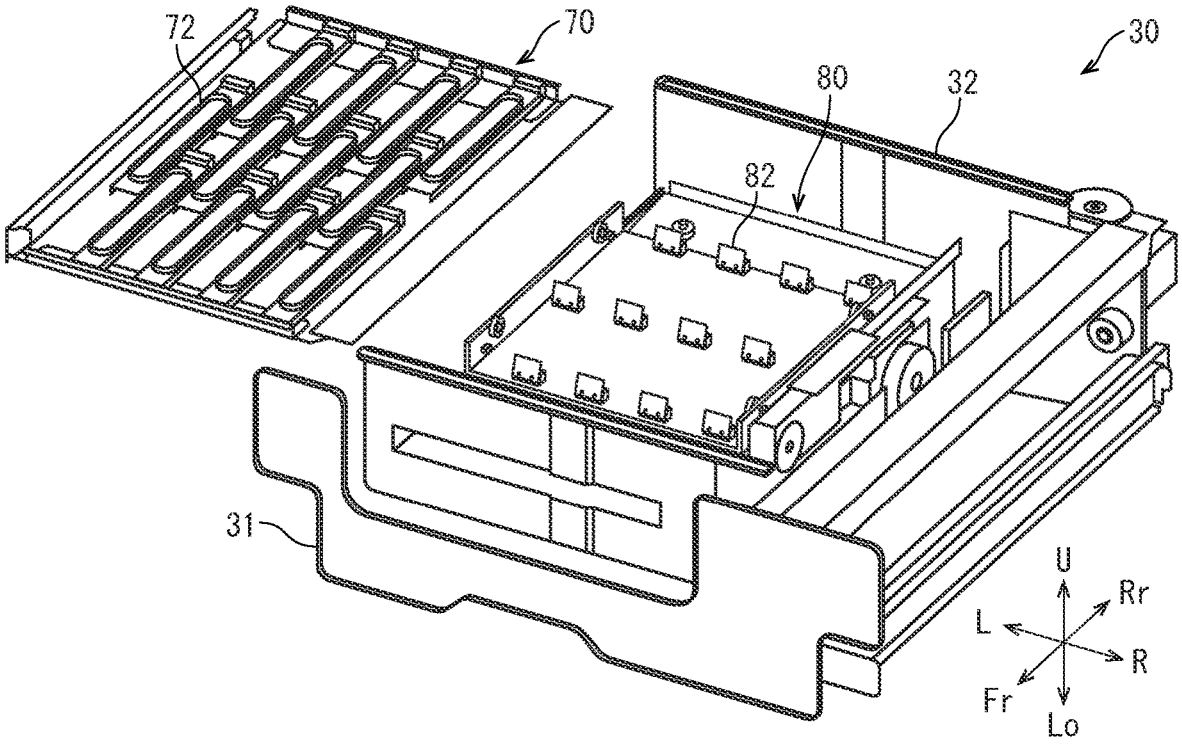


FIG. 12

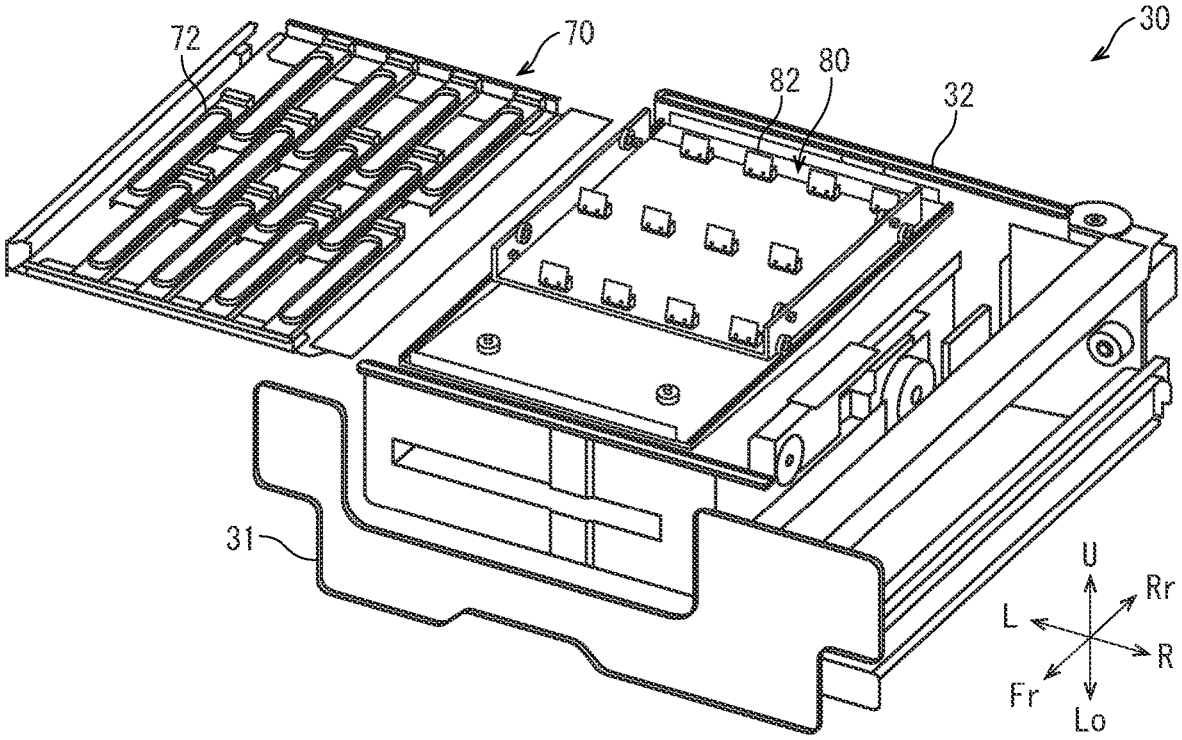


FIG. 13

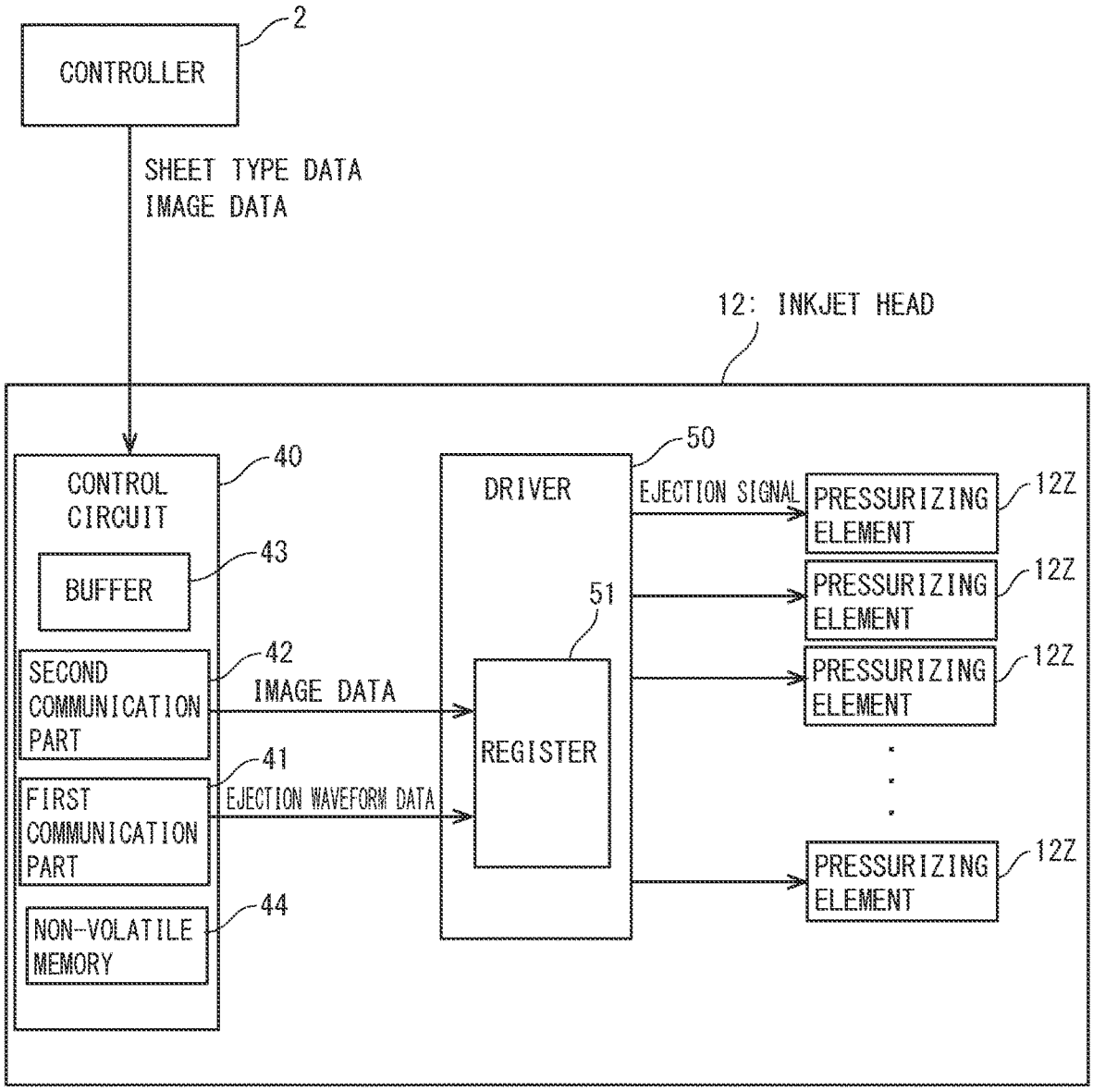

CONTROLLER
2
SHEET TYPE DATA
IMAGE DATA
12: INKJET HEAD
CONTROL CIRCUIT
40
BUFFER
43
SECOND COMMUNICATION PART
42
IMAGE DATA
FIRST COMMUNICATION PART
41
EJECTION WAVEFORM DATA
NON-VOLATILE MEMORY
44
DRIVER
50
51
REGISTER
EJECTION SIGNAL
PRESSURIZING ELEMENT
12Z
PRESSURIZING ELEMENT
12Z
PRESSURIZING ELEMENT
12Z
PRESSURIZING ELEMENT
12Z

FIG. 14

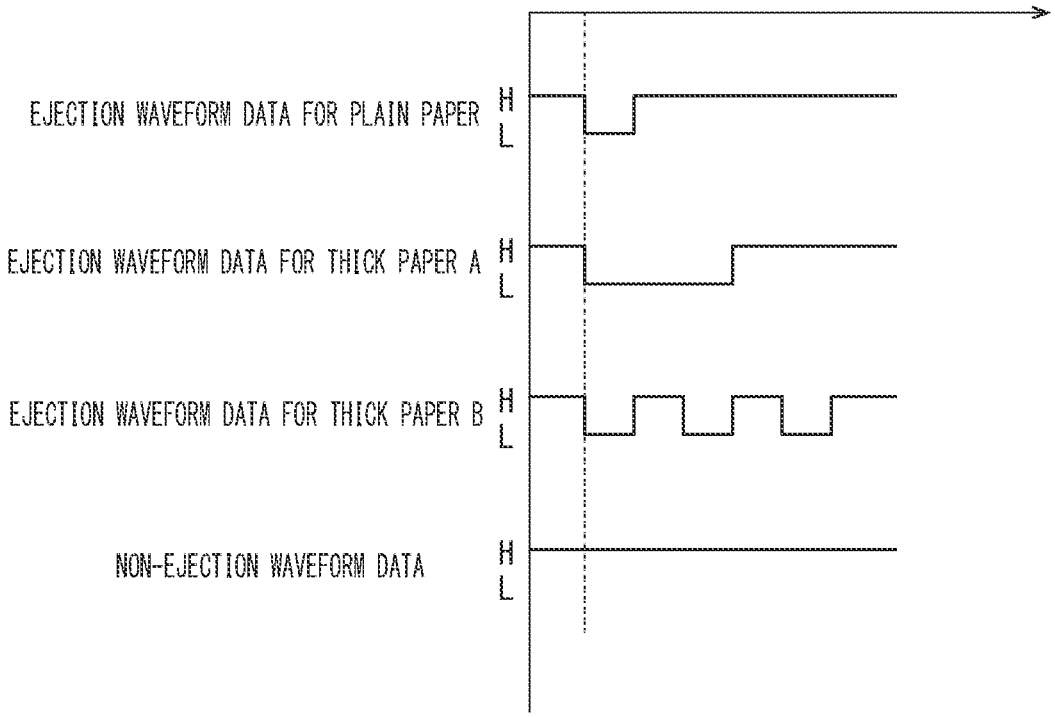

EJECTION WAVEFORM DATA FOR PLAIN PAPER
H
L
EJECTION WAVEFORM DATA FOR THICK PAPER A
H
L
EJECTION WAVEFORM DATA FOR THICK PAPER B
H
L
NON-EJECTION WAVEFORM DATA
H
L

FIG. 15

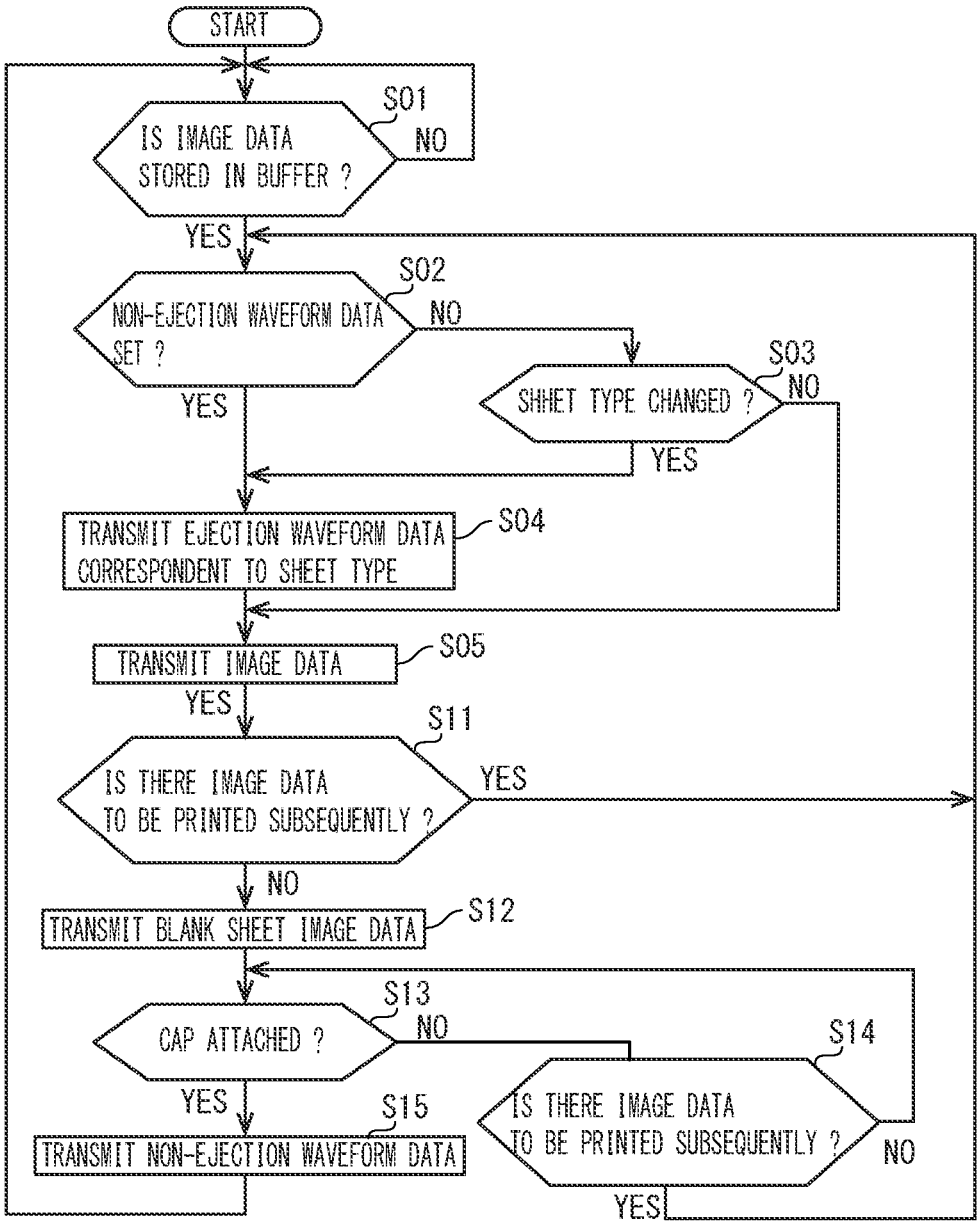

START
S01
IS IMAGE DATA STORED IN BUFFER ?
NO
YES
S02
NON-EJECTION WAVEFORM DATA SET ?
NO
YES
S03
SHHET TYPE CHANGED ?
NO
YES
TRANSMIT EJECTION WAVEFORM DATA CORRESPONDENT TO SHEET TYPE
S04
TRANSMIT IMAGE DATA
S05
YES
S11
IS THERE IMAGE DATA TO BE PRINTED SUBSEQUENTLY ?
YES
NO
TRANSMIT BLANK SHEET IMAGE DATA
S12
S13
CAP ATTACHED ?
NO
YES
S14
IS THERE IMAGE DATA TO BE PRINTED SUBSEQUENTLY ?
NO
YES
S15
TRANSMIT NON-EJECTION WAVEFORM DATA

FIG. 16

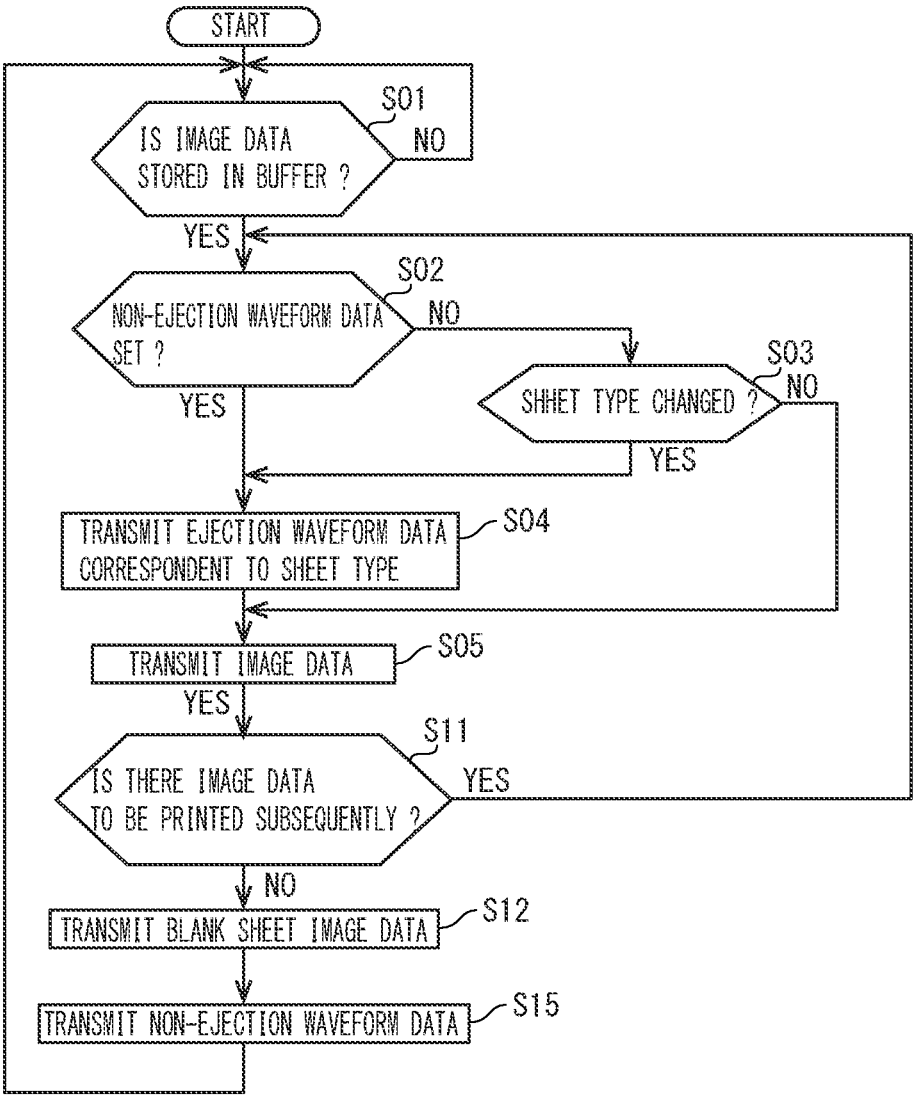
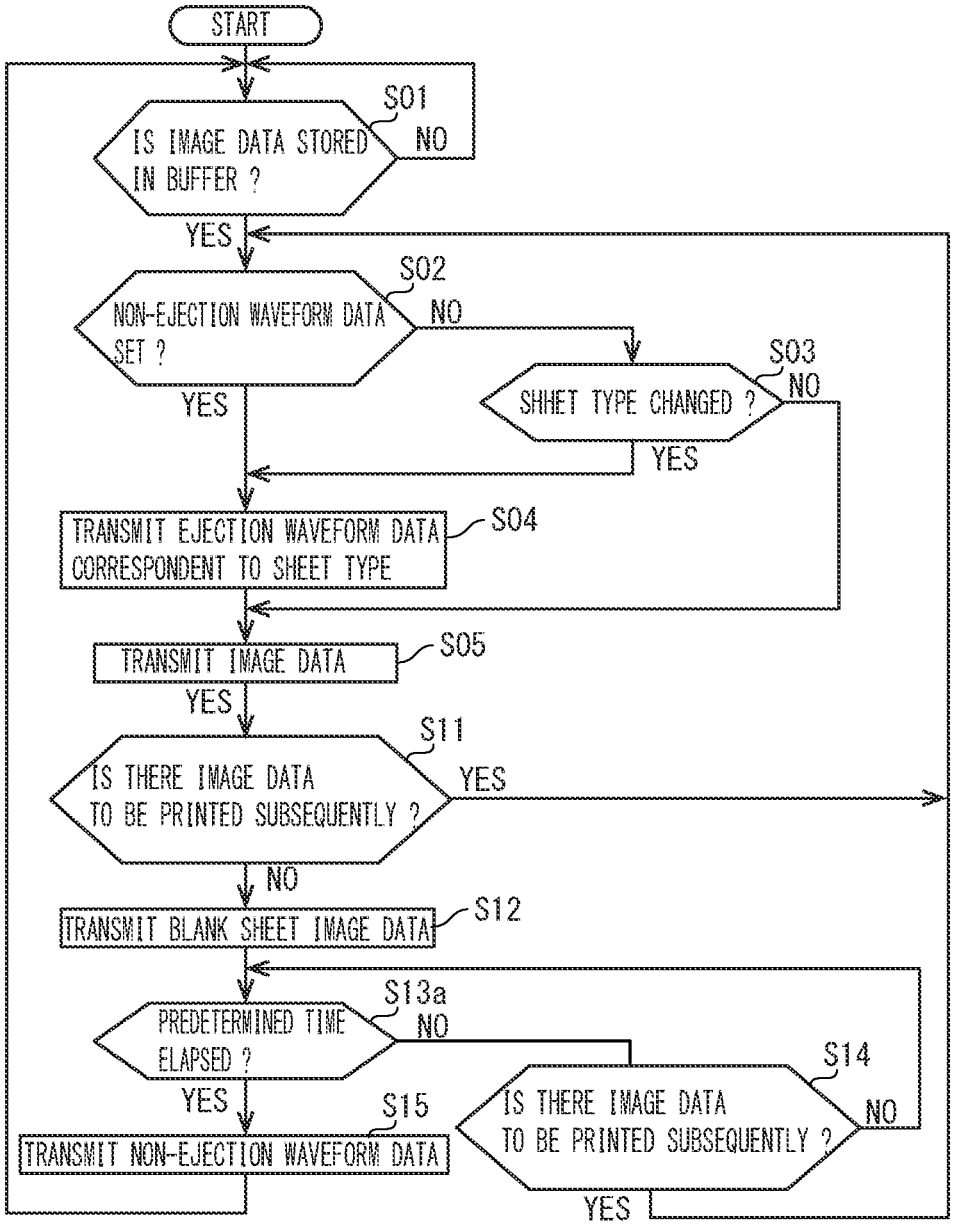

START
S01
IS IMAGE DATA STORED IN BUFFER ?
NO
YES
S02
NON-EJECTION WAVEFORM DATA SET ?
NO
S03
SHHET TYPE CHANGED ?
NO
YES
YES
TRANSMIT EJECTION WAVEFORM DATA CORRESPONDENT TO SHEET TYPE
S04
TRANSMIT IMAGE DATA
S05
YES
S11
IS THERE IMAGE DATA TO BE PRINTED SUBSEQUENTLY ?
YES
NO
TRANSMIT BLANK SHEET IMAGE DATA
S12
TRANSMIT NON-EJECTION WAVEFORM DATA
S15

FIG. 17


START
S01
IS IMAGE DATA STORED IN BUFFER ?
NO
YES
S02
NON-EJECTION WAVEFORM DATA SET ?
NO
YES
S03
SHHET TYPE CHANGED ?
NO
YES
TRANSMIT EJECTION WAVEFORM DATA CORRESPONDENT TO SHEET TYPE
S04
TRANSMIT IMAGE DATA
S05
YES
S11
IS THERE IMAGE DATA TO BE PRINTED SUBSEQUENTLY ?
YES
NO
TRANSMIT BLANK SHEET IMAGE DATA
S12
S13a
PREDETERMINED TIME ELAPSED ?
NO
YES
S14
IS THERE IMAGE DATA TO BE PRINTED SUBSEQUENTLY ?
NO
YES
S15
TRANSMIT NON-EJECTION WAVEFORM DATA

INKJET RECORDING APPARATUS

INCORPORATION BY REFERENCE

This application is based on and claims the benefit of priority from Japanese patent application No. 2021-159309 filed on Sep. 29, 2021, which is incorporated by reference in its entirety.

BACKGROUND

The present disclosure relates to an inkjet recording apparatus which ejects an ink to a sheet.

An inkjet recording apparatus which ejects an ink using a piezoelectric element is known. Specifically, the inkjet recording apparatus includes an inkjet head provided with the piezoelectric element, a driver for driving the piezoelectric element and a control circuit for controlling the driver. The control circuit transmits ejection waveform data and image data to the driver, and the driver transmits an ejection signal corresponding to the ejection waveform data to the piezoelectric element corresponding to a pixel assigned by the image data.

The ejection waveform data is selectively used according to a type of the sheet. For example, as the water absorbency of the sheet is higher, the ink ejection amount needs to be larger. Therefore, a plurality of types of the ejection waveform whose length and number of pulses of a voltage applied to the piezoelectric element are varied according to the type of the sheet are previously defined.

Since the register of the driver holds the data while the power is on, if electrical noise is generated during a waiting period (a period in which the power is on but printing is not performed), the driver may malfunction and output the ejection signal. In this case, the piezoelectric element is driven to eject the ink to the conveyance path, and the sheet is contaminated when the printing is performed.

If the function of attaching the cap to the inkjet head during the waiting period is provided, the ink ejection to the conveyance path is prevented by the cap. However, when the cap is attached, there is no problem as long as the cap is provided with a function for collecting the ink, but when the cap is not provided with the function for collecting the ink, the ink jet head is contaminated by the ink remaining between the cap and the inkjet head. Further, the cap is not necessarily attached immediately after the printing is completed, and in some cases, the printer waits without attaching the cap until a predetermined time elapses in preparation for a case where the printing is newly performed. In this case, the ink may be ejected to the conveyance path.

SUMMARY

In accordance with a first aspect of the present disclosure, an inkjet recording apparatus includes a plurality of nozzles, a pressurizing element, a driver, a controller and a control circuit. The pressurizing element is provided for each of the nozzles. The driver drives the pressurizing elements. The controller generates image data indicating whether ink is ejected for each of the nozzles. The control circuit transmits ejection waveform data indicating a signal transmitted to the pressurizing element and the image data. After printing according to the image data transmitted to the driver is completed, in a non-printing state in which there is no image data to be subsequently printed, the control circuit transmits at least one of the image data indicating a blank sheet and the ejection waveform data in which the ink is not ejected, to the driver.

The objects, features, and advantages of the present disclosure will become more apparent from the following description. In the detailed description, reference is made to the accompanying drawings, and preferred embodiments of the present disclosure are shown by way of example in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view showing an inner structure of a printer according to one embodiment of the present disclosure.

FIG. **2** is a perspective view showing an arrangement of inkjet heads according to the embodiment of the present disclosure.

FIG. **3** is a sectional view showing the inkjet head according to the embodiment of the present disclosure.

FIG. **4** is a view schematically showing an ink supplying part according to the embodiment of the present disclosure.

FIG. **5** is a perspective view showing a cap unit according to the embodiment of the present disclosure.

FIG. **6** is a perspective view showing a wipe unit according to the embodiment of the present disclosure.

FIG. **7** is a perspective view showing a maintenance device according to the embodiment of the present disclosure.

FIG. **8** is a perspective view showing the maintenance device according to the embodiment of the present disclosure.

FIG. **9** is a perspective view showing the maintenance device according to the embodiment of the present disclosure.

FIG. **10** is a perspective view showing the maintenance device according to the embodiment of the present disclosure.

FIG. **11** is a perspective view showing the maintenance device according to the embodiment of the present disclosure.

FIG. **12** is a perspective view showing the maintenance device according to the embodiment of the present disclosure.

FIG. **13** is a block diagram showing an electrical configuration of the inkjet head according to the embodiment of the present disclosure.

FIG. **14** is a timing chart showing ejection waveform data according to the embodiment of the present disclosure.

FIG. **15** is a flow chart explaining a control executed by a control circuit according to the embodiment of the present disclosure.

FIG. **16** is a flow chart explaining a first modified example according to the embodiment of the present disclosure.

FIG. **17** is a flow chart explaining a fourth modified example according to the embodiment of the present disclosure.

DETAILED DESCRIPTION

Hereinafter, with reference to the attached drawings, a printer (an inkjet recording device) according to one embodiment in the present disclosure will be described.

First, an entire structure of the printer **1** will be described. FIG. **1** is a front view schematically showing the inner structure of the printer **1**. FIG. **2** is a perspective view showing an arrangement of inkjet heads **12**. FIG. **3** is a

sectional view of the inkjet head **12**. FIG. **4** is a view schematically showing the ink supplying part **60**. Hereinafter, the front side of the paper plane on which FIG. **1** is drawn is defined as the front side of the printer **1**, and the left-and-right direction will be described based on the direction in which the printer **1** is viewed from the front side. In each of the drawings, U, Lo, L, R, Fr and Rr indicate an upper, a lower, a left, a right, a front, and a rear, respectively.

The printer **1** (see FIG. **1**) includes a rectangular parallelepiped body housing **3**. In the lower portion in the body housing **3**, a sheet feeding cassette **4** in which a sheet S, such as a plain paper, a coated paper or the like is stored and a sheet feeding roller **5** which feeds the sheet S rightward from the sheet feeding cassette **4** are provided. Above the sheet feeding cassette **4**, a conveying unit **7** which attracts the sheet S and conveys it in the Y direction is provided. Above the conveying unit **7**, an image forming unit **6** which ejects ink to form an image is provided. In the right upper portion in the body housing **3**, a sheet discharge roller **8** which discharges the sheet S on which the image is formed and a sheet discharge tray **9** on which the discharged sheet S is staked are provided.

Inside the body housing **3**, a conveyance path **10** from the sheet feeding roller **5** to the sheet discharge roller **8** via a gap between the conveying unit **7** and the image forming unit **6** is provided. The conveyance path **10** is formed mainly of plate-like members facing each other with a gap through which the sheet S is passed, and a conveying roller **17** which holds the sheet S and conveys it is provided at a plurality of positions in the conveying direction Y. A registration roller **18** is provided on the upstream side of the image forming unit **6** in the conveying direction Y.

The conveying unit **7** includes an endless conveying belt **21**, a supporting plate **23** and a suction part **24**. The conveying belt **21** has a number of air holes (not shown), and is stretched around a driving roller **25** and a driven roller **22**. The supporting plate **23** has a number of air holes, and the upper surface thereof is in contact with the inner surface of the conveying belt **21**. The suction part **24** attracts the sheet S to the conveying belt **21** by sucking air through the air holes of the supporting plate **23** and the air holes of the conveying belt **21**. When the driving roller **25** is driven in the counterclockwise direction by a driving part (not shown) including a motor and a reduction gear, the conveying belt **21** is traveled in the counterclockwise direction, and the sheet S attracted to the conveying belt **21** is conveyed in the Y direction.

The image forming unit **6** includes head units **11**Y, **11**Bk, **11**C and **11**M (collectively referred to as the head unit **11**) which eject yellow, black, cyan and magenta ink, respectively. Ink containers **20**Y, **20**Bk, **20**C and **20**M (collectively referred to as the ink container **20**) filled with the yellow, black, cyan and magenta ink are connected to the head units **11**Y, **11**Bk, **11**C and **11**M, respectively.

The head unit **11** includes one or more inkjet heads **12**, for example, three inkjet heads **12** arranged in a zigzag pattern (see FIG. **2**). The inkjet head **12** (see FIG. **3**) includes a rectangular parallelepiped housing **12**H whose longitudinal direction is along the front-and-rear direction, and a nozzle plate **12**P provided on the bottom of the housing **12**H. The nozzle plate **12**P includes a large number of nozzles **12**N arranged in the front-and-rear direction. The nozzle **12**N has a branch channel **12**B branched from a channel connected to a tank **64** and an ejection port **12**A provided on the nozzle surface **12**F. A diaphragm **12**V constitutes a part of the inner wall of the branch channel **12**B. Each of the diaphragm **12**V is provided with a pressurizing element **12**Z. The housing **12**H is provided with a driver **50** for driving the pressurizing element **12**Z and a control circuit **40** for controlling the driver **50**. As the pressurizing element **12**Z, a piezoelectric element, an electrostatic element (electrostatic actuator), a heating element (used in a thermal inkjet system), or the like are used.

The printer **1** includes an ink supplying part **60** (see FIG. **4**). Although the ink supplying part **60** corresponding to one color ink is shown in FIG. **1**, since the four colors ink are used in this embodiment, four similar ink supplying parts **60** are provided. The printer **1** includes a container attachment part **61** to which the ink container **20** is attached, a filter **62** which filters the ink, a pump **63** which sucks the ink from the ink container **20** through the filter **62**, a sub-tank **64** which stores the ink fed from the pump **63**, and a pump **65** which supplies the ink stored in the sub-tank **64** to the head unit **11**.

The controller **2** (see FIG. **1**) includes an arithmetic part and a storage part. The arithmetic part is a CPU (Central Processing Unit), for example. The storage part includes a storage medium such as ROM (Read Only Memory), RAM (Random Access Memory), EEPROM (Electrically Erasable Programmable Read Only Memory), or the like. The arithmetic part executes various processes by reading and executing the control program stored in the storage part. The controller **2** may be implemented by an integrated circuit that does not use software.

On the upper portion of the body housing **3**, an operation part is provided (not shown). The operation part includes a display panel, a touch panel superposed on the display surface of the display panel, and a keypad adjacent to the display panel. The controller **2** displays an operation menu of the printer **1** and a screen showing a status or the like on the display panel, and controls each part of the printer **1** according to an operation detected by the touch panel and the keypad.

The basic image forming operation of the printer **1** is as follows. When an image forming job is inputted to the printer **1** from the operation part or an external computer or the like, the sheet feeding roller **5** feeds the sheet S from the sheet feeding cassette **4** to the conveyance path **10**, and the registration roller **18** whose rotation is stopped corrects the skew of the sheet S. When the registration roller **18** feeds the sheet S to the conveying unit **7** at a predetermined timing, in the conveying unit **7**, the sheet S is attracted to the conveying belt **21** and conveyed in the Y direction. When the controller **2** supplies raster image data to the control circuit **40** in synchronism with the conveying of the sheet S, the driver **50** supplies an ejection signal corresponding to the image data to the pressurizing element **12**Z, and the ink is ejected from the nozzle **12**N to form an image on the sheet S. The sheet discharge roller **8** discharges the sheet S on which the image is formed to the sheet discharge tray **9**.

Next, a structure of a maintenance device **30** (see FIG. **1** and FIG. **4**) will be described. The maintenance device **30** includes a cap unit **70** and a wipe unit **80**. FIG. **5** is a perspective view showing the cap unit **70**. FIG. **6** is a perspective view showing the wipe unit **80**. FIG. **7** to FIG. **12** are perspective views showing the maintenance device **30**. In FIG. **7** to FIG. **12**, some details of the cap unit **70** and the wipe unit **80** are omitted.

[Wipe Unit] The wipe unit **80** (see FIG. **6**) includes a supporting plate **81** and a blade unit **83** sliding relative to the supporting plate **81**. The blade unit **83** includes blades **82** which come into contact with the nozzle surface **12**F of the inkjet head **12**.

The supporting plate **81** is a plate-like member, and its upper surface is inclined so as to be lower toward the center

from both the front and rear ends. A discharge port for discharging waste ink is provided at the lowest portion of the upper surface of the supporting plate **81** (not shown). A suction pump **68** and a waste ink tank **69** are connected to the discharge port (see FIG. **4**). A rail **81**R whose longitudinal direction is along the front-and-rear direction is provided at both right and left end portions of the supporting plate **81**. A connection portion **81**C protruding upward is provided at both the front and rear end portions of the upper surface of the supporting plate **81**.

The blade unit **83** includes the blades **82**, a plate-shaped bottom part **83**B supporting the blades **82**, and side wall parts **83**S provided on both the right and left end portions of the bottom part **83**B. The blade **82** is a flexible plate-like member made of rubber or the like. The blades **82** corresponding to the inkjet heads **12** are arranged in the zigzag pattern on the upper surface of the bottom part **83**B. In the vicinities of the front and rear end portions of the left and right side wall parts **83**S, a wheel **83**W supported by a shaft whose axial direction is along the left-and-right direction is provided. The blade unit **83** is provided with a driving part (not shown). The driving part includes a driving source such as a motor and a reduction mechanism such as a gear train, and transmits driving force to the wheels **83**W. The rails **81**R guide the rolling of the wheels **83**W in the front-and-rear direction.

[Cap Unit] The cap unit **70** (see FIG. **5**) includes caps **72** and a supporting plate **71** on which the caps **72** are supported. The caps **72** corresponding to the inkjet heads **12** are arranged in the zigzag pattern on the upper surface of the supporting plate **71**. The cap **72** is made of resin, such as rubber, and has a concave shape whose upper surface is opened. The caps **72** are attached to the supporting plate **71** with compression springs (not shown). When the caps **72** are pressed against the nozzle surface **12**F, the caps **72** and the nozzle surface **12**F are brought into close contact by the elastic deformation of the compression springs and the caps **72** themself.

On the lower surface of the supporting plate **71** of the cap unit **70**, a connection portion (not shown) protruding downward is provided at positions corresponding to the connection portions **81**C of the wipe unit **80**. The lower end of the connection portion is recessed upward, and the connection portion **81**C of the wipe unit **80** is fitted therein. At positions corresponding to the connection portions on the upper surface of the supporting plate **71** of the cap unit **70**, a positioning pin **71**P is provided. When the cap unit **70** is pressed against the nozzle surface **12**F, the positioning pins **71**P come into contacts with the image forming unit **6** to position the cap unit **70** in the height direction.

[Frame, Carriage] A frame **31** (see FIG. **7**) is fixed to the housing **3**, has an upper opening, a lower opening and a left opening, and supports a carriage **32** and the conveying unit **7**. The carriage **32** has an upper opening, a lower opening and a left opening, and supports the wipe unit **80** and the cap unit **70**. The cap unit **70** is disposed above the wipe unit **80**.

[Lifting Mechanism] The frame **31** is provided with a lifting mechanism (not shown). The lifting mechanism includes a driving source such as a motor, a reduction mechanism such as a gear train, and a conversion mechanism (endless belt, rack and pinion, ball screw or the like) which converts rotational motion into linear motion, and lifts and lowers the conveying unit **7** with respect to the frame **31**. The lifting mechanism lifts and lowers the conveying unit **7** between an image forming position (see FIG. **7**) at the time of the image forming operation and a lower retracting position (see FIG. **8**) below the image forming position. At the image forming position, the conveying unit **7** is positioned so that a distance between the conveying belt **21** and the nozzle surface **12**F is about 1 mm. At the lower retracting position, a space in which the cap unit **70** and the wipe unit **80** are stored is formed between the upper surface of the conveying belt **21** and the nozzle surface **12**F.

[Sliding Mechanism] The frame **31** is provided with a sliding mechanism (not shown). The sliding mechanism includes a rail whose longitudinal direction is along the left-and-right, a driving source such as a motor, a reduction mechanism such as a gear train, and a conversion mechanism (endless belt, rack and pinion, ball screw or the like) which converts rotational motion into linear motion, and slides the carriage **32** in the left-and-right direction along the rail.

The wipe unit **80** is supported by the carriage **32**, and can slide in the left-and-right direction together with the carriage **32** by the sliding mechanism. The cap unit **70** is also supported by the carriage **32**, but the cap unit **70** can slide in the left-and-right direction with respect to the carriage **32**. This configuration allows a moving state (see FIG. **9**) in which the cap unit **70** and the wipe unit **80** are moved to facing positions (positions so as to face the image forming unit **6**) by the carriage **32**, and a moving state (see FIG. **11**) in which only the wipe unit **80** is moved to the facing position by the carriage **32** while leaving the cap unit **70** at the side retreating position (position so as not to face the image forming unit **6**).

At the facing position, the cap unit **70** and the wipe unit **80** can be lifted and lowered by using the conveying unit **7**. Specifically, the conveying unit **7** can be lifted and lowered inside the carriage **32** in a state where only the cap unit **70** or both the cap unit **70** and the wipe unit **80** are placed on the upper portion of the conveying unit **7**. The lifting mechanism lifts and lowers the cap unit **70** between the facing position (see FIG. **9**) and a cap position (see FIG. **10**). The cap position is a position where the cap **72** is pressed against the nozzle surface **12**F. The lifting mechanism lifts and lowers the wipe unit **80** between the facing position (see FIG. **11**) and ae wipe position (see FIG. **12**). The wipe position is a position where the upper end of the blade **82** comes into contact with the nozzle surface **12**F.

[Cleaning Liquid Supplying Part] The inkjet head **12** is provided with a cleaning liquid supplying part **13** which supplies a cleaning liquid (see FIG. **4**). The cleaning liquid supplying part **13** includes a cleaning liquid tank **13**T storing the cleaning liquid, a connection member **13**C provided on the rear side of the nozzle plate **12**P, and a pipe **13**P connecting the cleaning liquid tank **13**T and the connection member **13**C. The connection member **13**C has a supply port **13**A penetrating in the upper-and-lower direction. A convex meniscus is formed at the lower end of the supply port **13**A by adjusting the height of the cleaning liquid tank **13**T, adjusting the pressure in the cleaning liquid tank **13**T, or the others, and the cleaning liquid swelling from the supply port **13**A is wiped by the blade **82** to supply the cleaning liquid to the nozzle surface **12**F.

Next, a basic operation of the maintenance device **30** will be described. The following operation is performed by the controller **2** controlling each part of the maintenance device **30**.

When the image forming operation is performed (see FIG. **7**), the cap unit **70** and the wipe unit **80** are disposed at the side retracting positions together with the carriage **32**, and the conveying unit **7** is disposed at the image forming position.

When the purge processing and the wipe processing are performed, the controller **2** moves the conveying unit **7** to the lower retreating position by the lifting mechanism (see FIG. **8**), and moves the carriage **32** and the wipe unit **80** to the facing positions by the sliding mechanism while leaving the cap unit **70** at the side retreating position (see FIG. **11**). At this time, since the blade unit **83** is disposed at a center initial position in the front-and-lower direction of the cap unit **70**, the controller **2** moves the blade unit **83** to the sliding start position at the rear end of the slidable range, and lifts the conveying unit **7** to move the wipe unit **80** to the wipe position (see FIG. **12**). Subsequently, the controller **2** increases the pressure in the nozzle of the inkjet head **12** to eject the ink, swells the cleaning liquid from the supply port **13**A by the cleaning liquid supplying part **13**, and slides the blade unit **83** forward. Then, the blades **82** wipe the cleaning liquid from the supply port **13**A, and dilutes and removes the ink adhering to the nozzle surface **12**F while coming into contact with the nozzle surface **12**F and being deflected.

Next, the cap unit **70** is attached to the image forming unit **6**. The controller **2** lowers the conveying unit **7** to the lower retracting position by the lifting mechanism to lower the wipe unit **80** to the facing position, and moves the blade unit **83** to the initial position (see FIG. **11**). Next, the controller **2** moves the carriage **32** and the wipe unit **80** to the side retreating position by the sliding mechanism (see FIG. **8**). Subsequently, the controller **2** moves the carriage **32**, the cap unit **70** and the wipe unit **80** to the facing positions by the sliding mechanism (see FIG. **9**), and lifts the conveying unit **7** by the lifting mechanism to lift the cap unit **70** to the cap position via the wipe unit **80** (see FIG. **10**). Thus, the caps **72** are pressed against the nozzle surface **12**F to prevent thickening and drying of the ink in the nozzle **12**N. The lifting mechanism and the sliding mechanism are examples of the attaching/detaching mechanisms which attaches and detaches the cap **72** to and from the nozzle surface **12**F.

Next, the control of the inkjet head **12** will be described in detail. FIG. **13** is a block diagram explaining the electrical configuration of the inkjet head **12**. FIG. **14** is a timing chart showing ejection waveform data.

The printer **1** includes a plurality of the nozzles **12**N; the pressurizing element **12**Z provided for each of the nozzles **12**N; the driver **50** which drives the pressurizing elements **12**Z; a controller **2** which generates image data indicating whether ink is ejected for each of the nozzles **12**N; and a control circuit **40** which transmits ejection waveform data indicating a signal transmitted to the pressurizing element **12**Z and the image data, wherein after printing according to the image data transmitted to the driver **50** is completed, in a non-printing state in which there is no image data to be subsequently printed, the control circuit **40** transmits at least one of the image data indicating a blank sheet and the ejection waveform data in which the ink is not ejected, to the driver **50**.

Since the nozzle **12**N and the pressurizing element **12**Z are as described above, other components will be described below. The driver **50** will be described later.

[Controller, Sheet Type Data, Image Data] The controller **2** rasterizes document data (written in page description language, bitmap, or the like) included in the print job in accordance with the output resolution of the inkjet head **12**, and converts the rasterized document data into image data in a raster format indicating whether the ink is ejected for each nozzle **12**N. The sheet type data is data indicating the type (for example, a plain paper, a thick paper, or the like) of the sheet S assigned in the print job. The controller **2** transmits the sheet type data and the image data to the control circuit **40** at a timing matched with the conveying speed of the conveying unit **7**. When the document data represents a document of a plurality of pages, the controller **2** transmits the sheet type data and the image data in association with each page.

[Control Circuit] The control circuit **40** is an integrated circuit including a buffer **43**, a nonvolatile memory **44**, a first communication part **41** and a second communication part **42**.

[Buffer] The buffer **43** is a volatile memory such as RAM, and inputs and outputs the data in a FIFO (First In, First Out) method. The control circuit **40** causes the buffer **43** to store the image data received from the controller **2** and transmits it to the driver **50**. The image data transmitted to the driver **50** is erased from the buffer **43**.

[Nonvolatile memory, Ejection Waveform Data] The nonvolatile memory **44** is an EEPROM or the like, and stores the ejection waveform data. The ejection waveform data is data indicating a signal sent to the pressurizing element **12**Z. The signal is a waveform of a voltage to be applied, for example. The waveform is a pulse, for example, and a plurality kinds of ejection waveform data whose length and number of pulses are changed in accordance with the type of the sheet S are previously stored in the nonvolatile memory **44** (see FIG. **14**). The control circuit **40** reads the ejection waveform data corresponding to the sheet type data received from the controller **2** from the nonvolatile memory **44**, and transmits it to the driver **50**. The control circuit **40** cases the sheet type data received from the controller **2** to store in the nonvolatile memory **44**.

The ejection waveform data is represented by two values of H (high level) and L (low level), where H indicates that the ink is not ejected and L indicates that the ink is ejected. The ejection waveform data for plain paper is ejection waveform data in which L continues for a predetermined time, and is used when printing on a plain paper. The ejection waveform data A for thick paper is ejection waveform data in which L continues for an integral multiple (in this example, three times) of the time of the ejection waveform data for plain paper, and is used when printing on a thick paper thicker than a plain paper. The ejection waveform data B for thick paper may be used in place of the ejection waveform data A for thick paper. The ejection waveform data B for thick paper is ejection waveform data in which a pulse of the ejection waveform data for plain paper is repeated for a plurality of times (in this example, three times). The non-ejection waveform data is ejection waveform data in which H continues without switching to L.

The control circuit **40** stores the type of the latest ejection waveform data transmitted to the driver **50**. For example, the control circuit **40** associates a flag with each of the ejection waveform data and causes the nonvolatile memory **44** to store the flag. When the ejection waveform data is transmitted to the driver **50**, the control circuit **40** rewrites the flag of the transmitted ejection waveform data to "1" and rewrites the flag of the other ejection waveform data to "0".

[First Communication Part, Second Communication Part] The first communication part **41** and the second communication part **42** are communication interfaces which transmits a signal in a V-by-one (registered trademark) system, for example. The control circuit **40** transmits the ejection waveform data to the driver **50** by using the first communication part **41**, and transmits the image data to the driver **50** by using the second communication part **42**. The communication speed of the first communication part **41** is slower than that of the second communication part **42**. Therefore, the transmission of the ejection waveform data via the first

communication part **41** requires a longer time than the transmission of the image data via the second communication part **42**.

[Driver] The driver **50** is an integrated circuit including a register **51**. The register **51** holds the stored contents while the power is turned on. Therefore, only when updating is necessary, the control circuit **40** transmits the ejection waveform data and the image data to the driver **50**, thereby suppressing the communication amount. For example, only when the type of the sheet S indicated by the sheet type data is changed, the control circuit **40** transmits the ejection waveform data and the image data corresponding to the type after changing, and transmits the image data only while the type of the sheet S is not changed. When a plurality of sheets are printed with the same image data without changing the type of the sheet S, the image data is transmitted only once, and the sheet number data indicating the number of sheets assigned in the print job is transmitted.

The driver **50** transmits an ejection signal to the pressurizing element **12**Z based on the ejection waveform data and the image data stored in the register **51**. That is, the driver **50** transmits the ejection signal corresponding to the ejection waveform data to the pressurizing element **12**Z corresponding to the nozzle **12**N for which the ejection of ink is assigned by the image data. On the other hand, the driver **50** does not transmit the ejection signal to the pressurizing element **12**Z corresponding to the nozzle **12**N for which the ejection of ink is not assigned by the image data.

FIG. **15** is a flow chart explaining the control executed by the control circuit **40**. When printer **1** is powered on, the control circuit **40** executes the processing shown in the figure. First, the control circuit **40** determines whether the image data is stored in the buffer **43** (step S**01**). If the image data is not stored in the buffer **43** (step S**01**: NO), the control circuit **40** repeats the determination of step S**01**. On the other hand, if the image data is stored in the buffer **43** (step S**01**: YES), the control circuit **40** determines whether the non-ejection waveform data is set (step S**02**). Specifically, the control circuit **40** refers to the nonvolatile memory **44**, when the flag associated with the non-ejection waveform data is "0", the control circuit **40** determines that the non-ejection waveform data is not set (step S**02**: NO), and the processing proceeds to step S**03**. On the other hand, if the flag is "1", the control circuit **40** determines that the non-ejection waveform data is set (step S**02**: YES), and the processing proceeds to step S**04**.

In step S**03**, the control circuit **40** determines whether the type of the sheet S is changed. Specifically, if the sheet type data stored in the buffer **43** is different from the sheet type data stored in the nonvolatile memory **44**, the control circuit **40** determines that the type of the sheet S is changed (step S**03**: YES), and the processing proceeds to step S**04**. On the other hand, if the sheet type data stored in the buffer **43** is the same as the sheet type data stored in the nonvolatile memory **44**, the control circuit **40** determines that the type of the sheet S is not changed (step S**03**: NO), and the processing proceeds to step S**05**.

In step S**04**, the control circuit **40** transmits the ejection waveform data corresponding to the type of the sheet S to the driver **50**. Specifically, the control circuit **40** transmits the ejection waveform data for plain paper when the type of the sheet S is a plain paper, and transmits the ejection waveform data A for thick paper when the type of the sheet S is a thick paper.

In step S**05**, the control circuit **40** reads the image data of one page from the buffer **43**, transmits it to the driver **50**, and erases it from the buffer **43**. The control circuit **40** causes the nonvolatile memory **44** to store the sheet type data associated with the transmitted image data, and erases the sheet type data from the buffer **43**.

Next, the control circuit **40** determines whether there is the image data to be subsequently printed after a predetermined time elapses from a time when the image data is transmitted to the driver **50** (step S**11**). Specifically, it is determined whether the image data is stored in the buffer **43**. Here, the predetermined time is a time required after the image data is transmitted to the driver **50** until printing (ink ejection) corresponding to the image data is completed, and has a known length.

In step S**11**, it is determined whether the continuous printing continues, rather than whether there is the image data to be printed next. More specifically, in step S**11**, in a state where the continuous printing is performed on the sheet S conveyed at a predetermined interval, it is determined whether there is the image data for which such continuous printing continues. The state in which it is determined that there is no image data to be continuously printed in step S**11** is set to the non-printing state.

If there is the image data to be subsequently printed (step S**11**: YES), the control circuit **40** repeats the processing after step S**02**. On the other hand, when there is no image data to be subsequently printed (step S**11**: NO), the control circuit **40** transmits blank image data to the driver **50** (step S**12**). The blank image data is image data in which the ink is not ejected from all nozzles **12**N.

Next, the control circuit **40** determines whether the cap **72** is attached to the nozzle surface **12**F of the inkjet head **12** (step S**13**). Specifically, the control circuit **40** inquires of the controller **2** whether the cap unit **70** is positioned at the cap position, determines that the cap **72** is attached when a response that the cap unit **70** is positioned at the cap position is obtained (step S**13**: YES), transmits the non-ejection waveform data to the driver **50** (step S**15**), and repeats the processing after step S**01**.

On the other hand, when a response that the cap unit **70** is not positioned at the cap position is obtained, the control circuit **40** determines that the cap **72** is not attached (step S**13**: NO), and determines whether there is the image data to be subsequently printed. If there is no image data to be subsequently printed (step S**14**: NO), the control circuit **40** repeats the processing after step S**13**. On the other hand, if there is the image data to be subsequently printed (step S**14**: YES), the control circuit **40** repeats the processing after step S**02**.

The above-described printer **1** according to the present embodiment includes a plurality of the nozzles **12**N; the pressurizing element **12**Z provided for each of the nozzles **12**N; the driver **50** which drives the pressurizing elements **12**Z; a controller **2** which generates image data indicating whether ink is ejected for each of the nozzles **12**N; and a control circuit **40** which transmits ejection waveform data indicating a signal transmitted to the pressurizing element **12**Z and the image data, wherein after printing according to the image data transmitted to the driver **50** is completed, in a non-printing state in which there is no image data to be subsequently printed, the control circuit **40** transmits at least one of the image data indicating a blank sheet and the ejection waveform data in which the ink is not ejected, to the driver **50**. According to this configuration, the ink ejection due to noise during the waiting period can be suppressed.

Further, the printer **1** according to the present embodiment includes the first communication part **41** transmitting the ejection waveform data; and the second communication part **42** having a communication speed higher than that of the

first communication part **41** and transmitting the image data, wherein after the printing according to the image data transmitted to the driver **50** is completed, in the non-printing state, the control circuit **40** transmits the image data indicating the blank sheet to the driver **50** via the second communication part **42**, and then transmits the ejection waveform data in which the ink is not ejected, to the driver **50** via the first communication part **41**. According to this configuration, compared with a case where the ejection waveform data in which the ink is ejected is transmitted earlier, the ink ejection due to noise can be suppressed early.

The printer **1** according to the present embodiment includes the cap **72** covering the nozzle surface **12**F on which ejection ports **12**A of the nozzles **12**N are formed; and the attaching/detaching mechanism which attaches and detaches the cap **72** to and from the nozzle surface **12**F; wherein after the printing according to the image data transmitted to the driver **50** is completed, in the non-printing state, the control circuit **40** transmits the image data indicating the blank sheet to the driver **50** via the second communication part **42**, and then transmits the ejection waveform data in which the ink is not ejected, to the driver **50** via the first communication part **41** when the cap **72** is attached to the nozzle surface **12**F. According to this configuration, when the image data is written before the cap **72** is attached, the printing cam be started without rewriting the ejection waveform data.

The printer **1** according to the present embodiment includes the buffer **43** in which image data received from the controller **2** is stored, wherein the control circuit **40** transmits the image data stored in the buffer **43** to the driver **50**, and the non-printing state is a state in which the image data is not stored in the buffer **43** after the printing according to the image data transmitted to the driver **50** is completed. According to this configuration, it becomes possible to recognize that it becomes the non-printing state earlier than the case for inquiring of the controller **2**.

The above embodiment may be modified as follows.

[First Modified Example] FIG. **16** is a flowchart explaining the first modified example. In this example, steps S**13** and S**14** of the flow chart shown in FIG. **15** are omitted. According to this configuration, since the non-ejection waveform data is transmitted following the transmission of the blank image data without waiting for the attaching of the cap **72**, the ejection of ink can be suppressed more than in the above embodiment.

[Second Modified Example] In the first modified example, the order of the step S**12** and S**15** may be reversed. According to this configuration, when the communication speed of the first communication part **41** is faster than that of the second communication part **42**, the ink ejection due to noise can be suppressed earlier than in the above embodiment.

[Third Modified Example] In the first modified example, step S**12** or step S**15** may be omitted. According to this configuration, the communication amount can be suppressed more than in the above-described embodiment.

[Fourth Modified Example] FIG. **17** is a flowchart explaining the fourth modified example. In this example, instead of step S**13** in the flowchart shown in FIG. **15**, it is configured to determine whether a predetermined time is elapsed (step S**13***a*). That is, after printing according to the image data transmitted to the driver **50** is completed, the control circuit **40** transmits the image data indicating a blank sheet to the driver **50** via the second communication part **42** in a non-printing state, and then transmits the ejection waveform data in which the ink is not ejected to the driver **50** via the first communication part **41** when the image data is not written in the buffer **43** until a predetermined time elapses. According to this configuration, when the image data is written before the predetermined time elapses, printing can be started without rewriting the ejection waveform data. This configuration is suitable when the printer **1** is not provided with the cap unit **70**.

[Fifth Modified Example] In the flowchart shown in FIG. **15**, the control circuit **40** may be configured to transmit the non-ejection waveform data to the driver **50** first. According to this configuration, it is possible to prevent the ink from being ejected due to noise during the waiting period until the first printing is performed after the power is turned on.

[Sixth Modified Example] In the flowchart shown in FIG. **15**, the control circuit **40** may be configured to transmit the ejection waveform data for plain paper to the driver **50** first. According to this configuration, when the first printing after the power is turned on is printing on a plain paper, the printing can be started earlier than in the fifth modified example.

The invention claimed is:

1. An inkjet recording apparatus comprising:
- a plurality of nozzles;
- a pressurizing element provided for each of the nozzles;
- a driver which drives the pressurizing elements;
- a controller which generates image data indicating whether ink is ejected for each of the nozzles;
- a control circuit which transmits ejection waveform data indicating a signal transmitted to the pressurizing element and the image data;
- a first communication part transmitting the ejection waveform data; and
- a second communication part having a communication speed higher than that of the first communication part and transmitting the image data, wherein
- after the printing according to the image data transmitted to the driver is completed, in a non-printing state in which there is no image data to be subsequently printed, the control circuit transmits the image data indicating a blank sheet to the driver via the second communication part, and then transmits the ejection waveform data in which the ink is not ejected, to the driver via the first communication part.

2. The inkjet recording apparatus according to claim **1**, further comprising:
- a cap covering a nozzle surface on which ejection ports of the nozzles are formed; and
- an attaching/detaching mechanism which attaches and detaches the cap to and from the nozzle surface; wherein
- after the printing according to the image data transmitted to the driver is completed, in the non-printing state, the control circuit transmits the image data indicating the blank sheet to the driver via the second communication part, and then transmits the ejection waveform data in which the ink is not ejected, to the driver via the first communication part when the cap is attached to the nozzle surface.

3. The inkjet recording apparatus according to claim **1**, further comprising:
- a buffer in which the image data received from the controller is stored, wherein
- the control circuit transmits the image data stored in the buffer to the driver,

the non-printing state is a state in which the image data is not stored in the buffer after the printing according to the image data transmitted to the driver is completed, and

after the printing according to the image data transmitted to the driver is completed, in the non-printing state, the control circuit transmits the image data indicating the blank sheet to the driver via the second communication part, and then transmits the ejection waveform data in which the ink is not ejected, to the driver via the first communication part when image data is not written in the buffer until a predetermined time elapses.

4. The inkjet recording apparatus according to claim **1**, wherein

the ejection waveform data differs according to a type of the sheet.

5. The inkjet recording apparatus according to claim **4**, wherein

the driver is an integrated circuit having a register,

only when the type of the sheet is changed, the ejection waveform data corresponding to the changed type and the image data are transmitted,

only the image data is transmitted when the type of the sheet is not changed, and

the image data is transmitted only once and a sheet number data indicating a number of the sheet assigned by a print job is transmitted when printing a plurality of the sheets with the same image data without changing the type of the sheet is performed.

6. An inkjet recording apparatus comprising:

a plurality of nozzles;

a pressurizing element provided for each of the nozzles;

a driver which drives the pressurizing elements;

a controller which generates image data indicating whether ink is ejected for each of the nozzles;

a control circuit which transmits ejection waveform data indicating a signal transmitted to the pressurizing element and the image data; and

a buffer in which the image data received from the controller is stored, wherein

the control circuit transmits the image data stored in the buffer to the driver,

after printing according to the image data transmitted to the driver is completed, in a non-printing state in which there is no image data to be subsequently printed, the control circuit transmits at least one of the image data indicating a blank sheet and the ejection waveform data in which the ink is not ejected, to the driver, and

the non-printing state is a state in which the image data is not stored in the buffer after the printing according to the image data transmitted to the driver is completed.

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