US012017454B2

(12) **United States Patent**
Iwabuchi et al.

(10) **Patent No.: US 12,017,454 B2**
(45) **Date of Patent: Jun. 25, 2024**

(54) **LIQUID DISCHARGE HEAD AND RECORDING DEVICE**

(71) Applicants: **KYOCERA CORPORATION**, Kyoto (JP); **KYOCERA DOCUMENT SOLUTIONS INC.**, Osaka (JP)

(72) Inventors: **Masaru Iwabuchi**, Kirishima (JP); **Hiroyuki Tomioka**, Osaka (JP)

(73) Assignees: **KYOCERA CORPORATION**, Kyoto (JP); **KYOCERA DOCUMENT SOLUTIONS INC.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/773,025**

(22) PCT Filed: **Oct. 30, 2020**

(86) PCT No.: **PCT/JP2020/040944**
§ 371 (c)(1),
(2) Date: **Apr. 28, 2022**

(87) PCT Pub. No.: **WO2021/085632**
PCT Pub. Date: **May 6, 2021**

(65) **Prior Publication Data**

US 2022/0410571 A1 Dec. 29, 2022

(30) **Foreign Application Priority Data**

Oct. 30, 2019 (JP) 2019-197862

(51) **Int. Cl.**
B41J 2/14 (2006.01)

(52) **U.S. Cl.**
CPC ***B41J 2/14209*** (2013.01); ***B41J 2/14072*** (2013.01); *B41J 2002/14306* (2013.01); *B41J 2202/08* (2013.01)

(58) **Field of Classification Search**
CPC B41J 2/14209; B41J 2/14072; B41J 2002/14306; B41J 2202/08
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0122380 A1	6/2005	Nakamura et al.	
2008/0049063 A1	2/2008	Nakamura et al.	
2015/0321474 A1	11/2015	Ichizono	

FOREIGN PATENT DOCUMENTS

CN	1623787 A		6/2005	
JP	2011-206945	*	10/2011	.... B41J 2/045
JP	2011206945 A		10/2011	
JP	2014223801 A		12/2014	
JP	2019177638 A		10/2019	

* cited by examiner

Primary Examiner — Geoffrey S Mruk
(74) *Attorney, Agent, or Firm* — HAUPTMAN HAM, LLP

(57) **ABSTRACT**

A liquid discharge head includes a flow channel member, a pressurization part, a plurality of discharge holes, a flexible substrate, a cover member, and a heater. The flow channel member includes a first surface and a second surface that is positioned on an opposite side of the first surface. The pressurization part is positioned on the first surface. The plurality of discharge holes are positioned on the second surface. For the flexible substrate, a one-end part thereof that is positioned on the pressurization part is electrically connected to the pressurization part. The cover member covers the one-end part of the flexible substrate. The heater is positioned on the cover member.

15 Claims, 12 Drawing Sheets

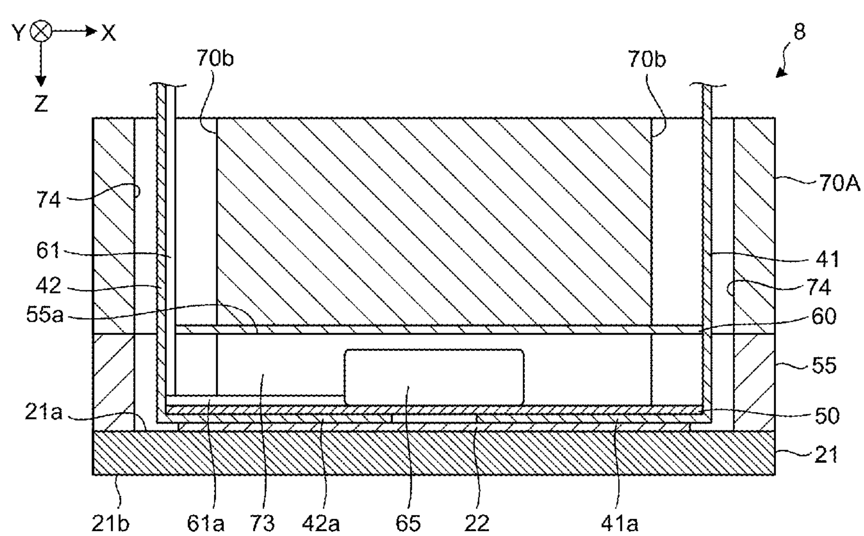


FIG.1

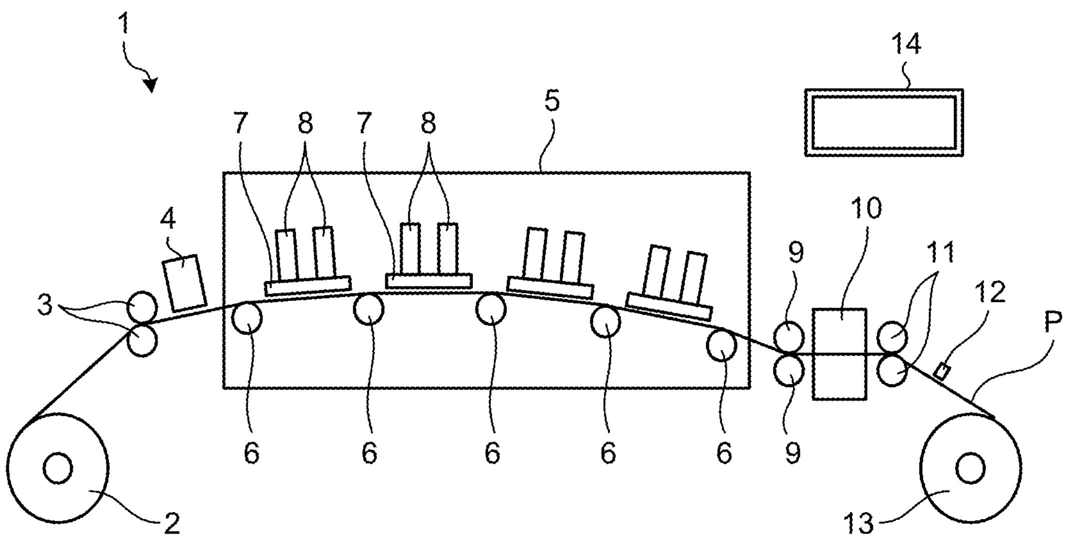

1
14
5
7
8
7
8
4
10
9
11
12
3
P
6
6
6
6
6
9
2
13

FIG.2

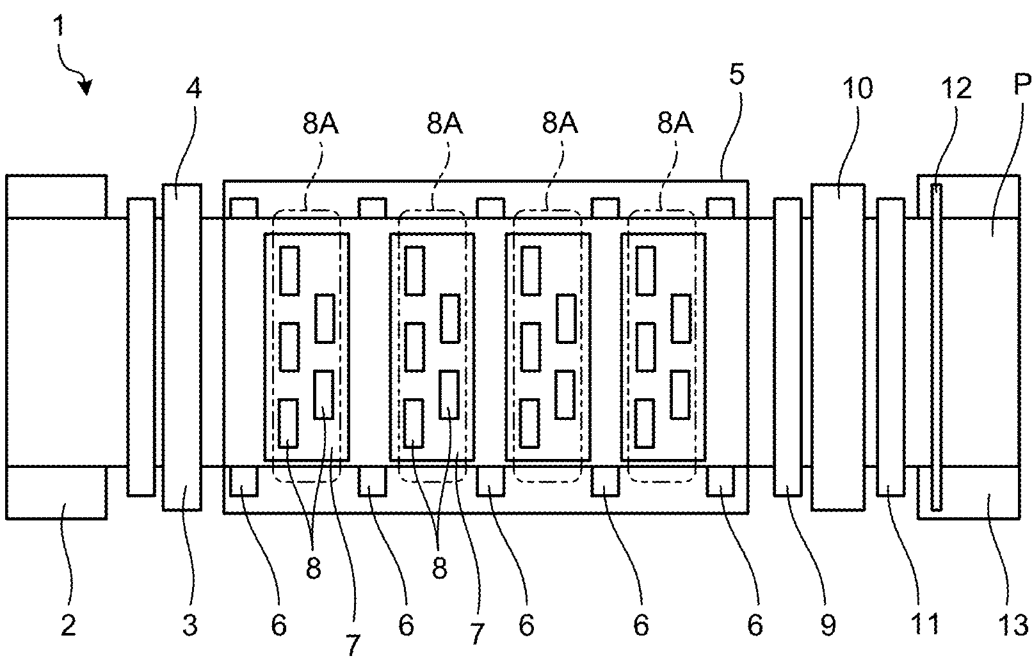

1
4
5
10
12
P
8A
8A
8A
8A
8
8
2
3
6
7
6
7
6
6
6
9
11
13

FIG.3

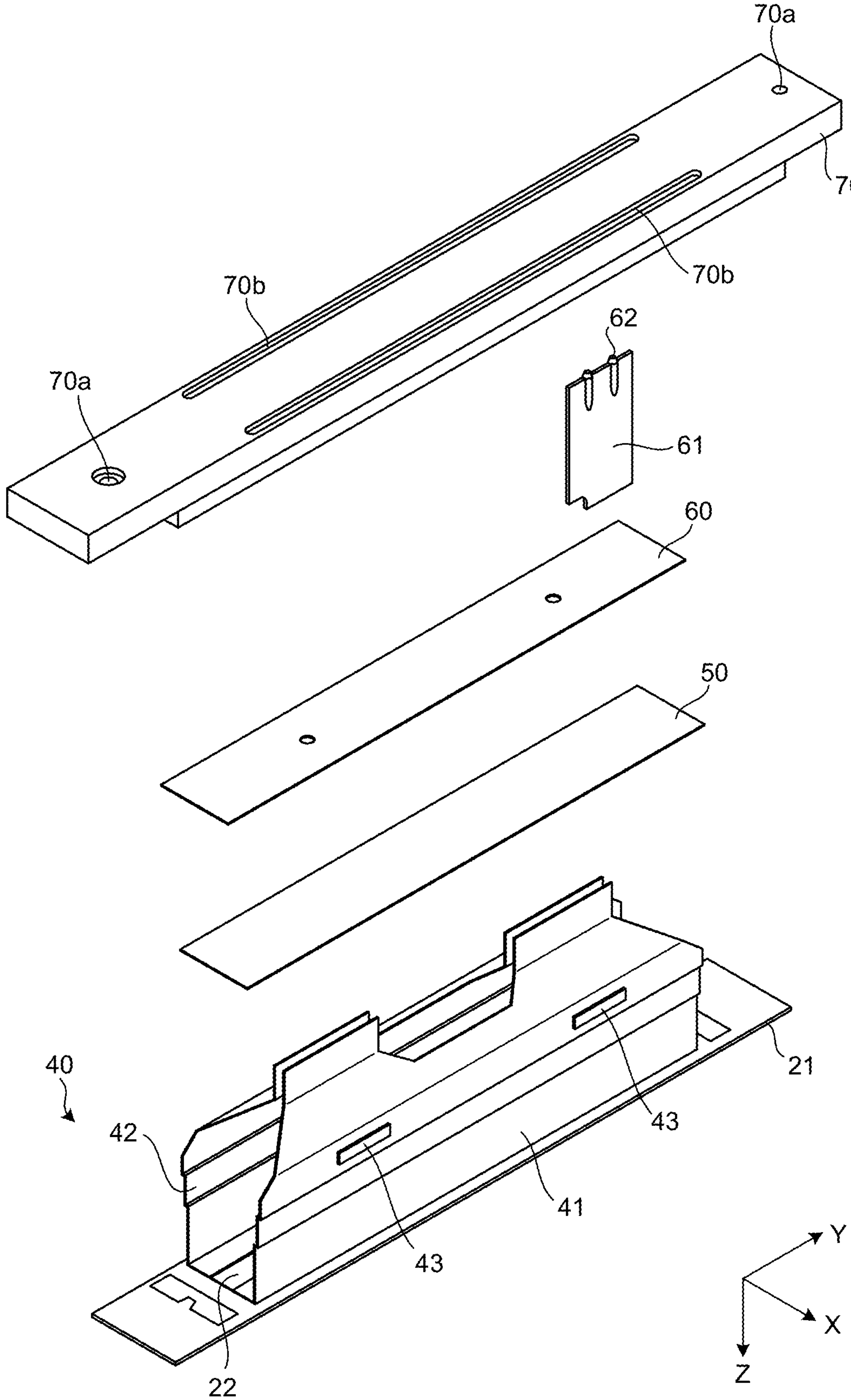


FIG.4

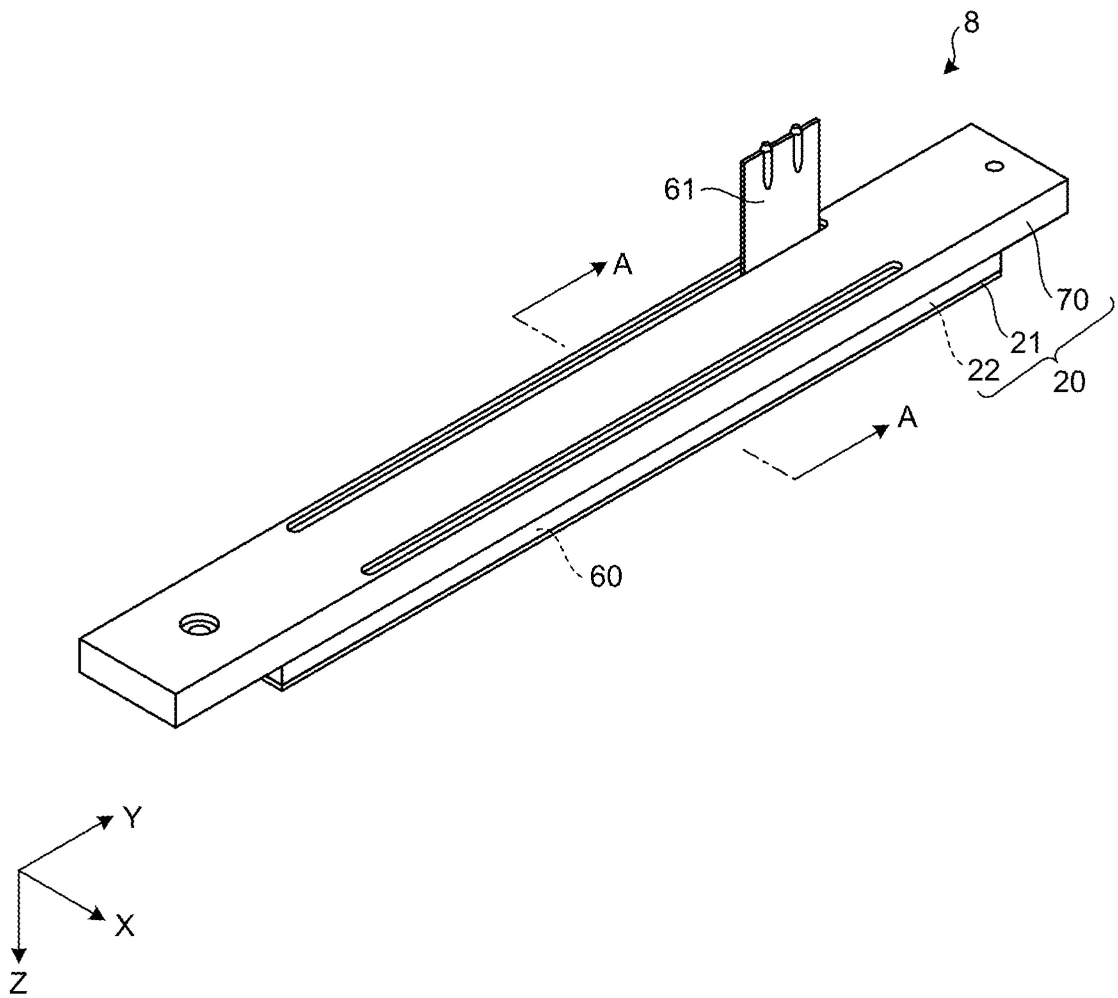


FIG.5

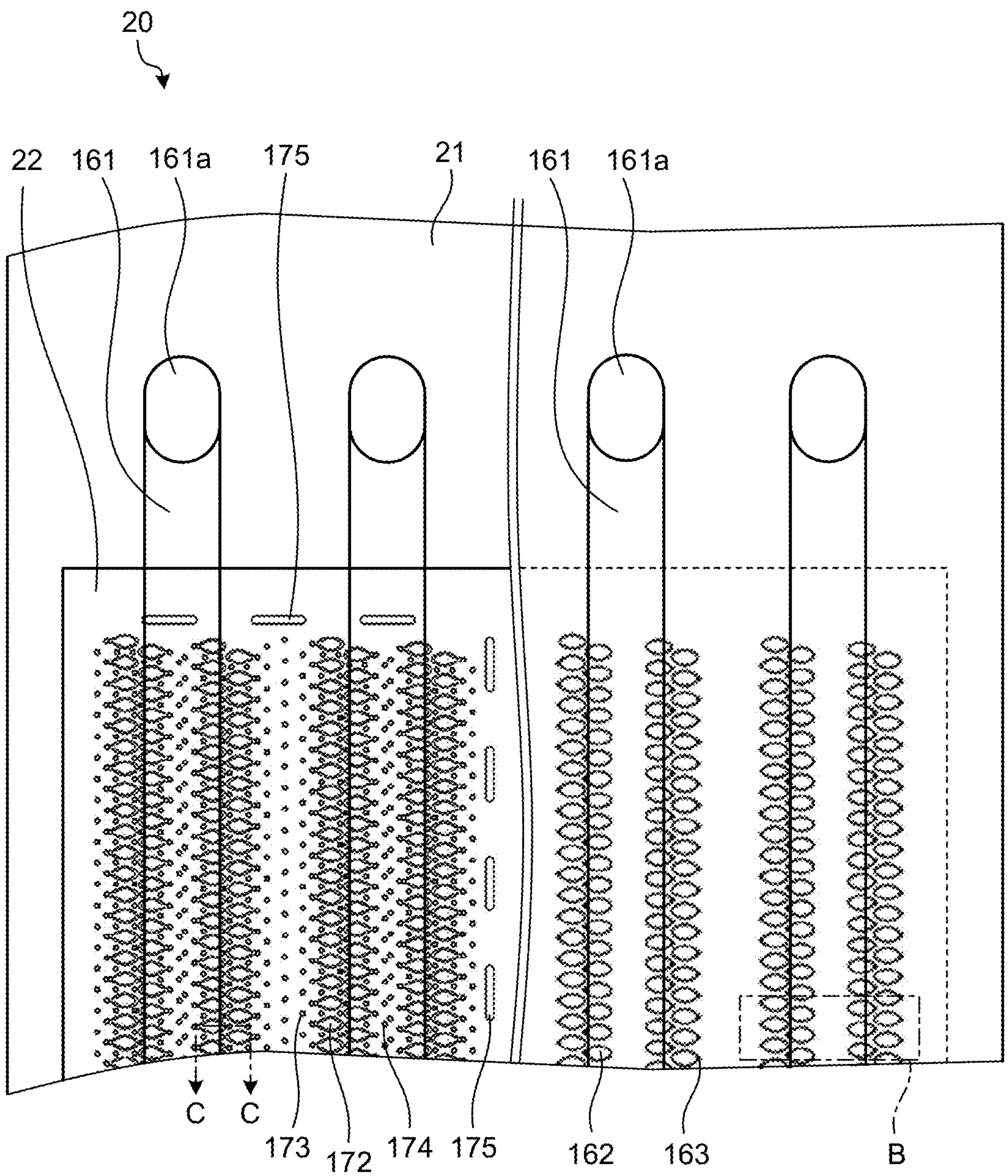


FIG.6

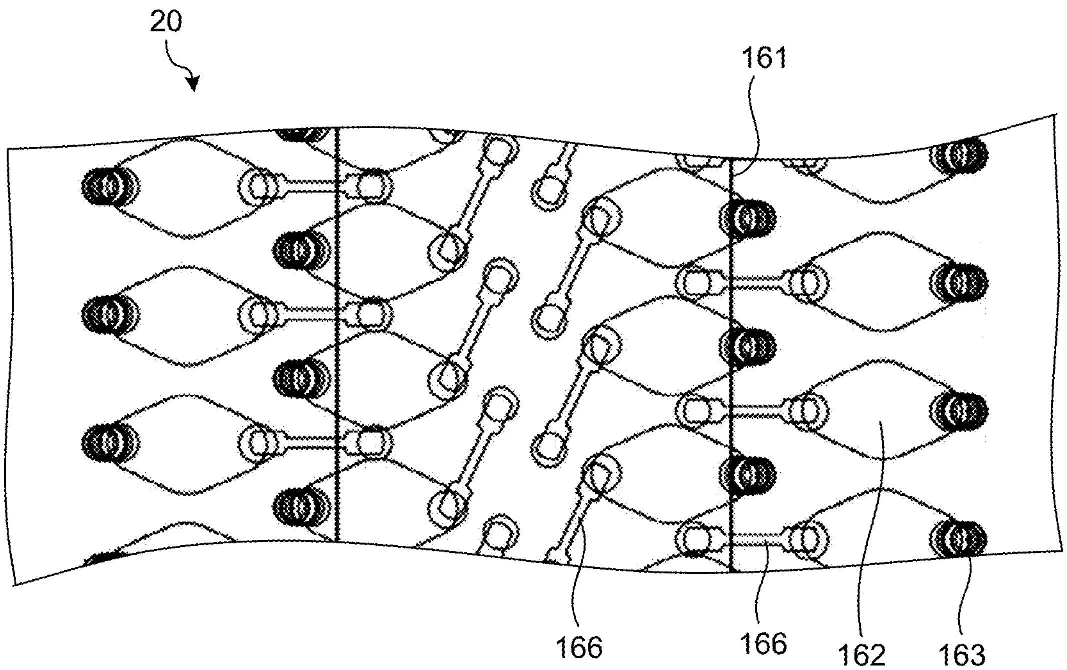

20
161
166
166
162
163

FIG.7

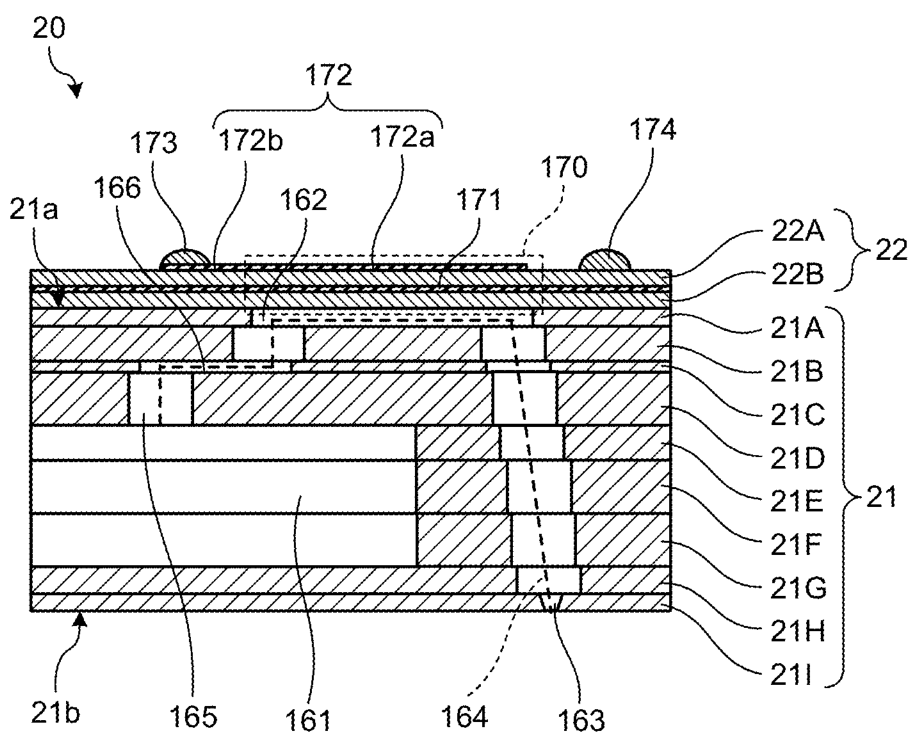

20
172
173
172b
172a
170
174
21a
166
162
171
22A
22B
22
21A
21B
21C
21D
21E
21F
21G
21H
21I
21
21b
165
161
164
163

FIG.8

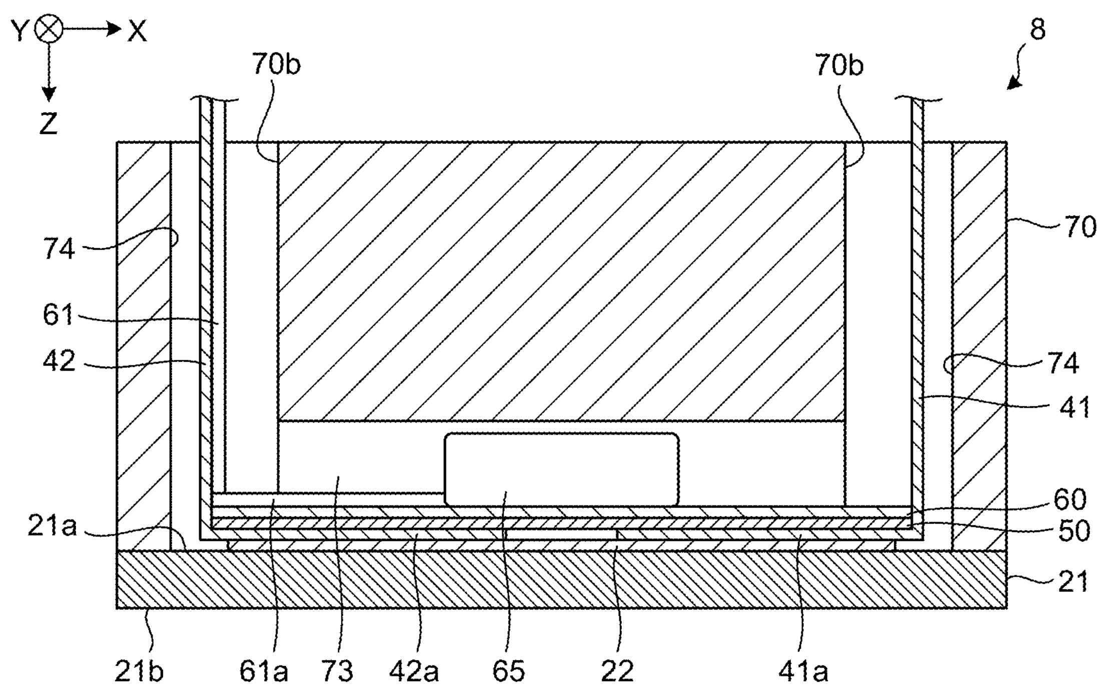


FIG.9A

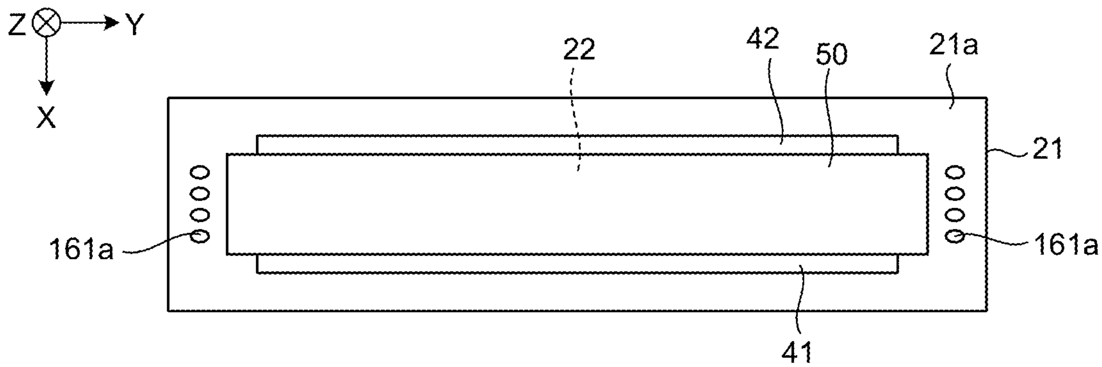


FIG.9B

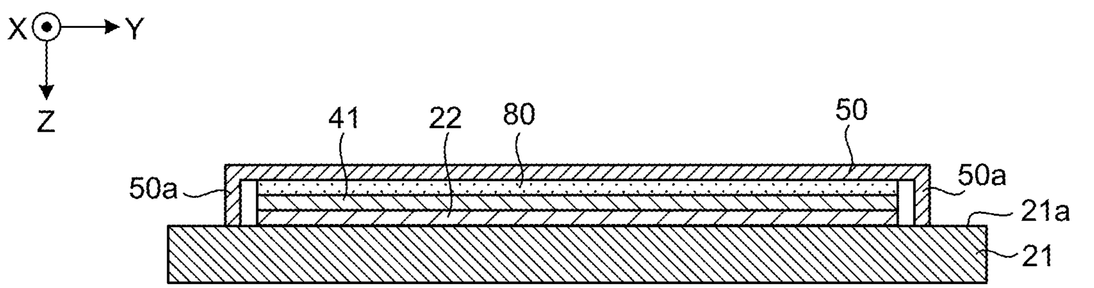


FIG.10

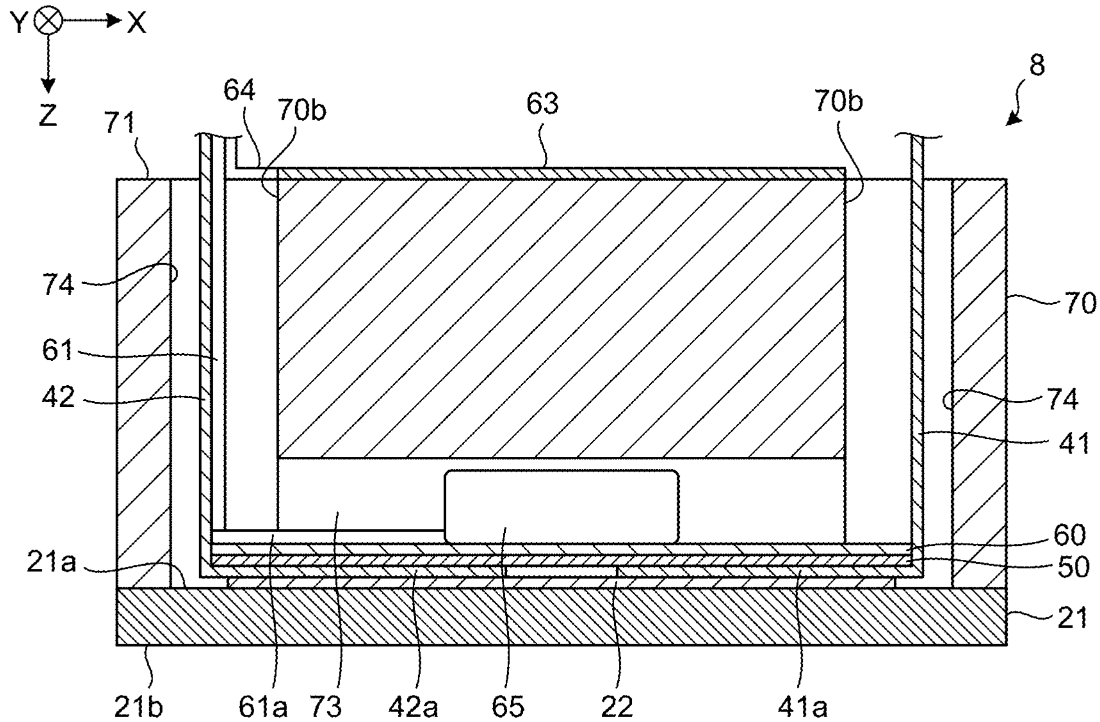

Y
X
Z
8
64
70b
63
70b
71
74
70
61
42
74
41
60
21a
50
21
21b
61a
73
42a
65
22
41a

FIG.11

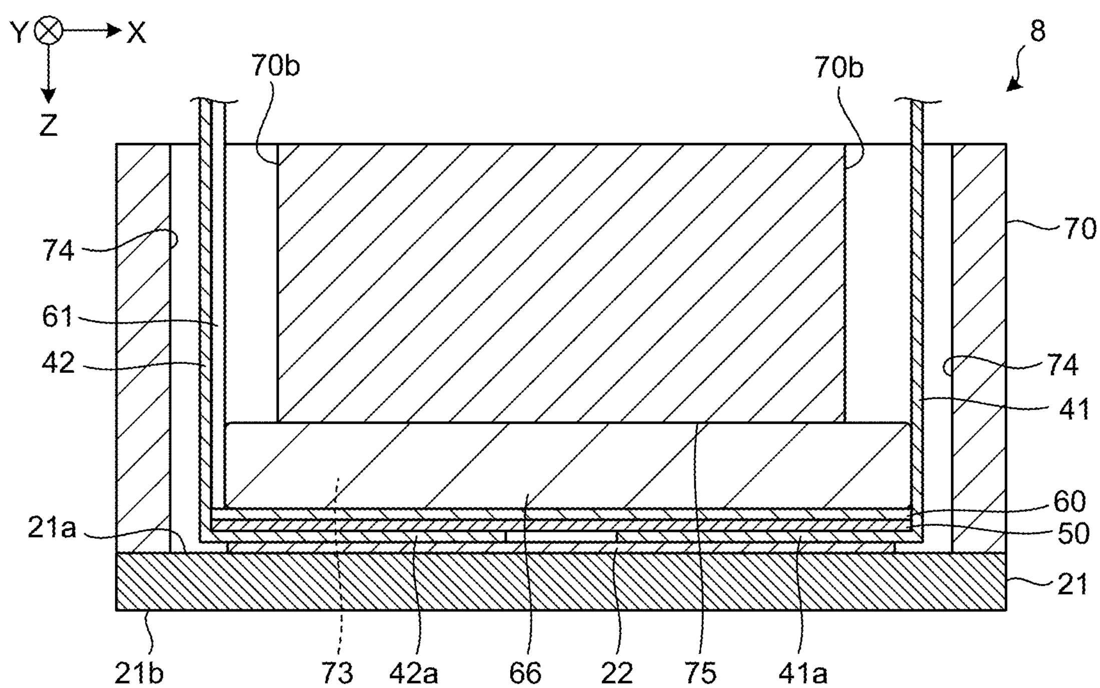

Y
X
Z
8
70b
70b
74
70
61
42
74
41
60
21a
50
21
21b
73
42a
66
22
75
41a

FIG.12

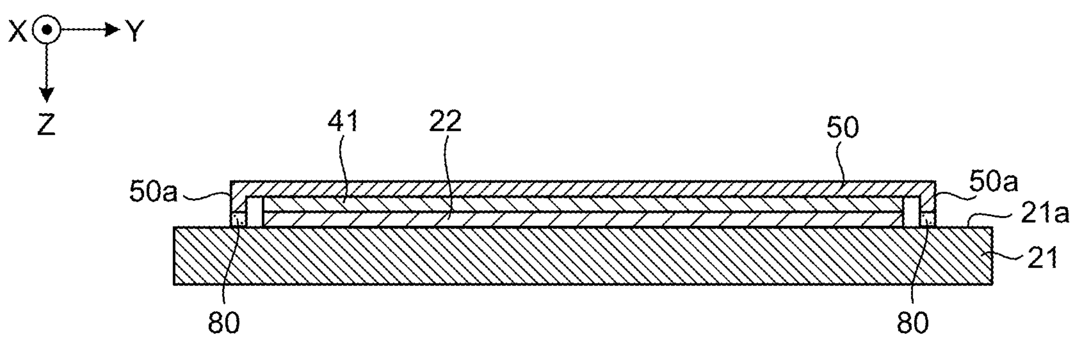


FIG.13

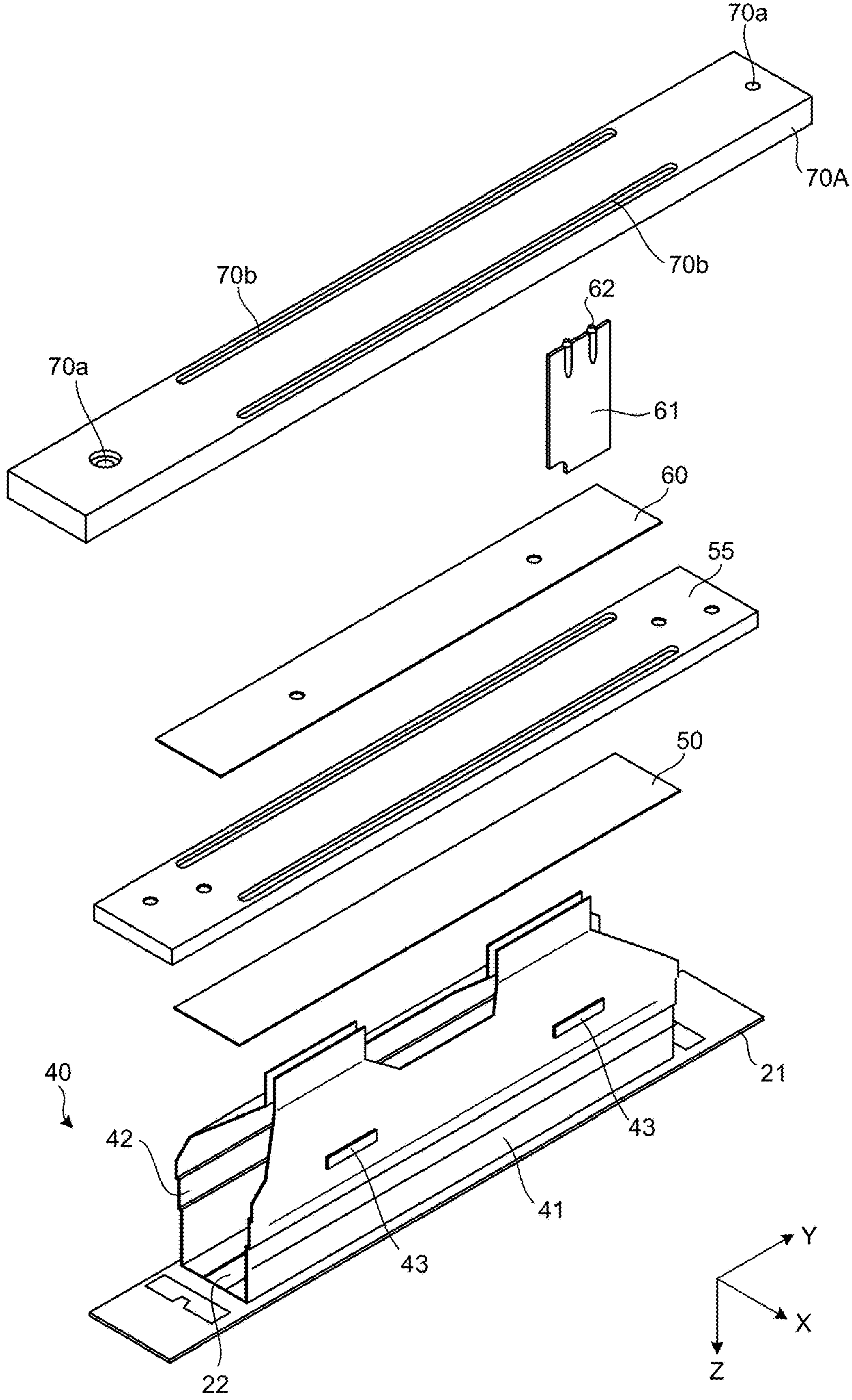


FIG.14

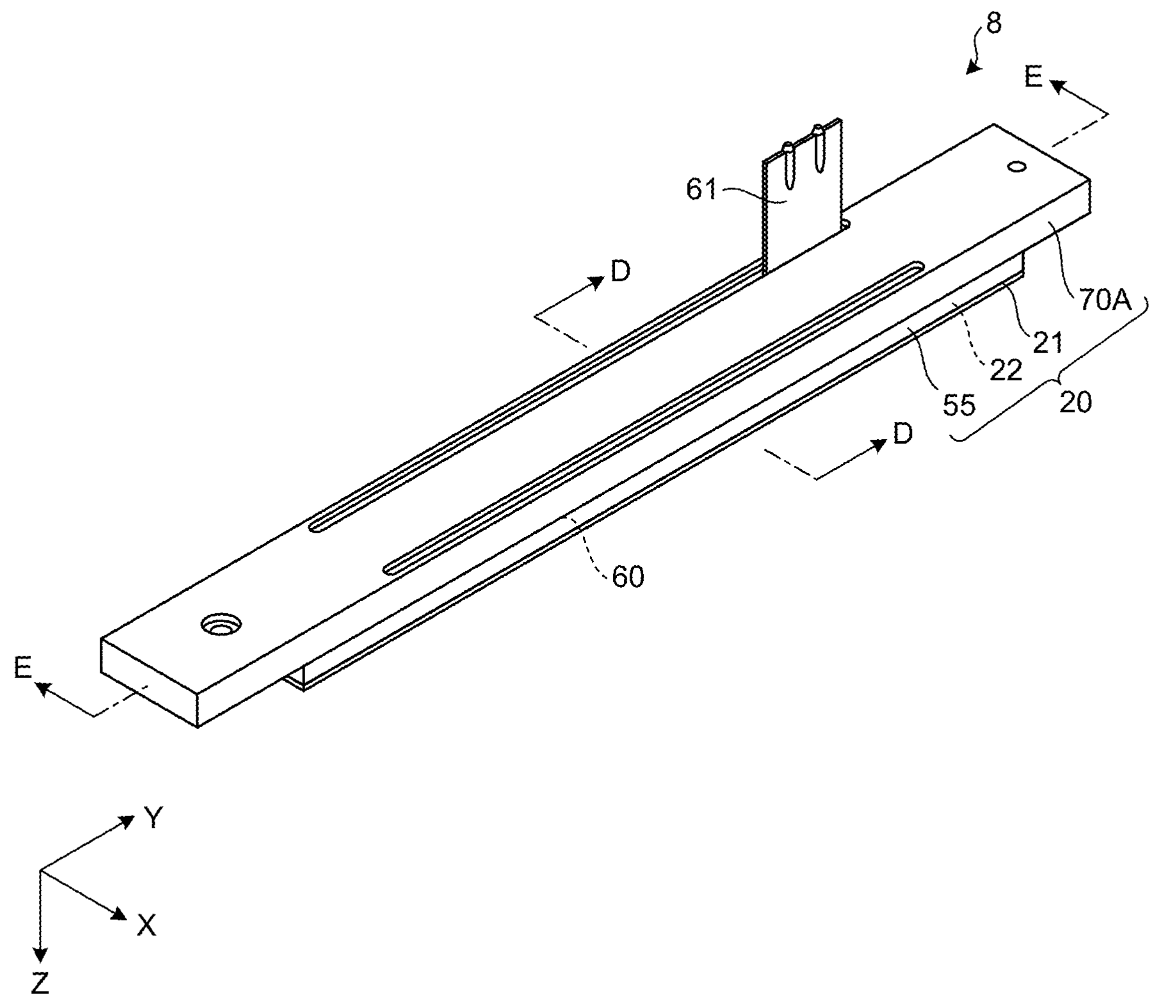


FIG.15

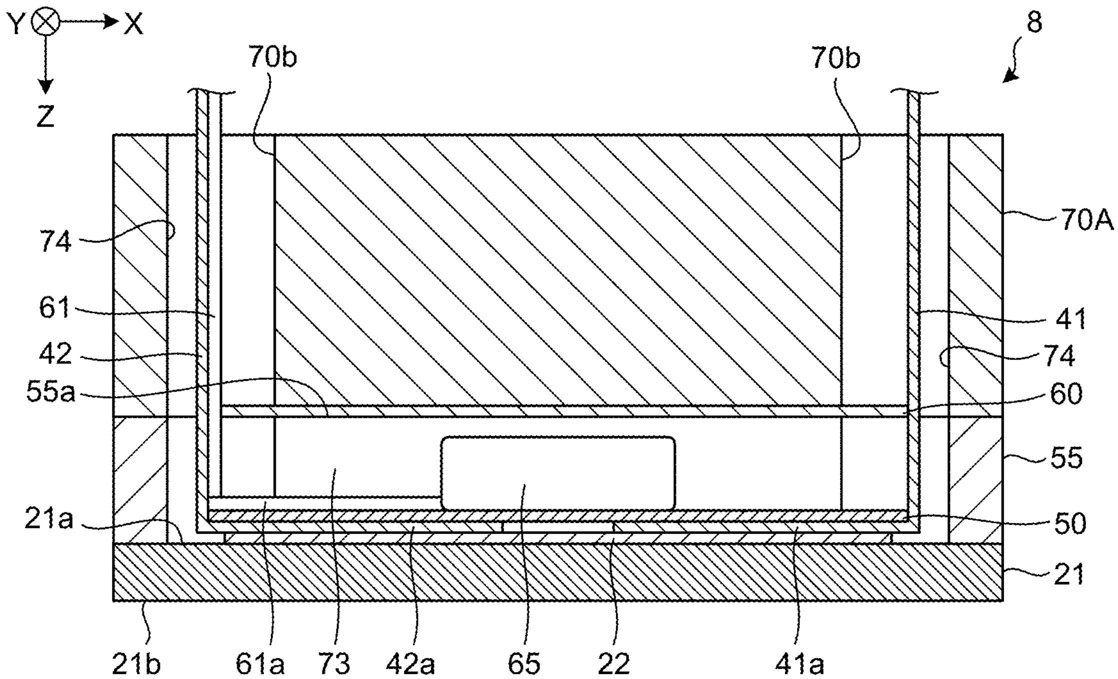
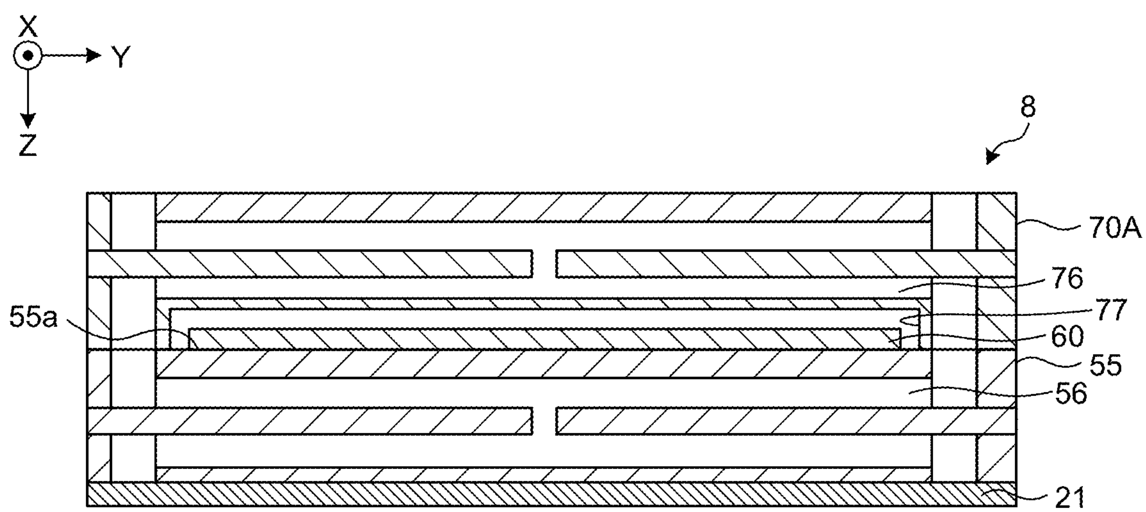

Y
X
Z
8
70b
70b
70A
74
61
42
55a
41
74
60
55
21a
50
21
21b
61a
73
42a
65
22
41a

FIG.16


X
Y
Z
8
70A
76
55a
77
60
55
56
21

LIQUID DISCHARGE HEAD AND RECORDING DEVICE

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is a national stage application of International Application No. PCT/JP2020/040944, filed on Oct. 30, 2020, and which is based upon and claims the benefit of priority to Japanese Patent Application No. 2019-197862, filed on Oct. 30, 2019.

FIELD

A disclosed embodiment(s) relate(s) to a liquid discharge head and a recording device.

BACKGROUND

An ink-jet printer and/or an ink-jet plotter that utilize(s) an ink-jet recording method has/have been known as a printing device(s). For such a printing device according to an ink-jet method, a liquid discharge head is mounted for discharging a liquid.

For such a liquid discharge head, a heater that elevates a temperature of a liquid is provided through a head body, in order to adjust a viscosity of such a liquid that is discharged from a discharge hole (see, for example, Patent Literature 1).

CITATION LIST

Patent Literature

Patent Literature 1: Japanese Patent Application Publication No. 2014-223801

SUMMARY

A liquid discharge head according to an aspect of an embodiment includes a flow channel member, a pressurization part, a plurality of discharge holes, a flexible substrate, a cover member, and a heater. The flow channel member has a first surface and a second surface that is positioned on an opposite side of the first surface. The pressurization part is positioned on the first surface. The plurality of discharge holes are positioned on the second surface. For the flexible substrate, a one-end part thereof that is positioned on the pressurization part is electrically connected to the pressurization part. The cover member covers the one-end part. The heater is positioned on the cover member.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is an explanatory diagram (part 1) of a recording device according to an embodiment.

FIG. **2** is an explanatory diagram (part 2) of a recording device according to an embodiment.

FIG. **3** is an exploded perspective view that illustrates a configuration of an essential part of a liquid discharge head according to a first embodiment.

FIG. **4** is a perspective view that illustrates a configuration of an essential part of a liquid discharge head according to a first embodiment.

FIG. **5** is an enlarged plan view of a liquid discharge head as illustrated in FIG. **4**.

FIG. **6** is an enlarged view of an area B as illustrated in FIG. **5**.

FIG. **7** is a cross-sectional view along line C-C as illustrated in FIG. **5**.

FIG. **8** is an enlarged cross-sectional view along line A-A as illustrated in FIG. **4**.

FIG. **9**A is an explanatory diagram that illustrates arrangement of a cover member in a head body.

FIG. **9**B is an explanatory diagram that illustrates arrangement of a cover member in a head body.

FIG. **10** is a cross-sectional view that illustrates a configuration of an essential part of a liquid discharge head according to a first variation.

FIG. **11** is a cross-sectional view that illustrates a configuration of an essential part of a liquid discharge head according to a second variation.

FIG. **12** is an explanatory diagram that illustrates arrangement of a cover member according to a variation.

FIG. **13** is an exploded perspective view that illustrates a configuration of an essential part of a liquid discharge head according to a second embodiment.

FIG. **14** is a perspective view that illustrates a configuration of an essential part of a liquid discharge head according to a second embodiment.

FIG. **15** is a cross-sectional view along line D-D as illustrated in FIG. **14**.

FIG. **16** is a cross-sectional view along line E-E as illustrated in FIG. **14**.

DESCRIPTION OF EMBODIMENTS

As a heater is positioned away from a discharge hole in a conventional liquid discharge head, it is not possible to transfer heat from such a heater efficiently, so that a variation in a discharge state of a liquid may be caused.

According to a liquid discharge head and a recording device as disclosed in the present application, it is possible to transfer heat from a heater efficiently.

Hereinafter, an embodiment(s) of a liquid discharge head and a recording device as disclosed in the present application will be explained in detail, with reference to the accompanying drawing(s). Additionally, this invention is not limited by each embodiment as illustrated below.

Configuration of Printer

First, an outline of a printer **1** that is an example of a recording device according to an embodiment will be explained with reference to FIG. **1** and FIG. **2**. FIG. **1** and FIG. **2** are explanatory diagrams of the printer **1** according to an embodiment. Specifically, FIG. **1** is a schematic side view of the printer **1**, and FIG. **2** is a schematic plan view of the printer **1**. The printer **1** according to an embodiment is, for example, a color ink-jet printer.

As illustrated in FIG. **1**, the printer **1** includes a paper feed roller **2**, a guide roller(s) **3**, an applicator **4**, a head case **5**, a plurality of conveyance rollers **6**, a plurality of frames **7**, a plurality of liquid discharge heads **8**, a conveyance roller(s) **9**, a dryer **10**, a conveyance roller(s) **11**, a sensor part **12**, and a recovery roller **13**. A conveyance roller(s) **6** is/are an example(s) of a conveyance part.

Moreover, the printer **1** includes a control part **14** that controls the paper feed roller **2**, the guide roller(s) **3**, the applicator **4**, the head case **5**, the plurality of conveyance rollers **6**, the plurality of frames **7**, the plurality of liquid discharge heads **8**, the conveyance roller(s) **9**, the dryer **10**, the conveyance roller(s) **11**, the sensor part **12**, and the recovery roller **13**.

The printer **1** causes a liquid drop(s) to land on a printing paper P so as to execute recording of an image(s) and/or a character(s) on such a printing paper P. A printing paper P is an example of a recording medium. A printing paper P is provided in a state where it is wound around the paper feed roller **2**, before use thereof. Then, the printer **1** conveys a printing paper P from the paper feed roller **2** to an inside of the head case **5** through the guide roller(s) **3** and the applicator **4**.

The applicator **4** applies a coating agent to a printing paper P uniformly. Thereby, it is possible to apply surface treatment to a printing paper P, so that it is possible to improve a printing quality of the printer **1**.

The head case **5** houses the plurality of conveyance rollers **6**, the plurality of frames **7**, and the plurality of liquid discharge heads **8**. A space that is isolated from an outside is formed inside the head case **5** except that it is linked to an outside at a part such as a part where a printing paper P is input or output.

For an internal space of the head case **5**, at least one of control factors such as a temperature, a humidity, and an atmospheric pressure is controlled by the control part **14** as needed. A conveyance roller **6** conveys a printing paper P to a neighborhood of a liquid discharge head **8** inside the head case **5**.

A frame **7** is a flat plate with a rectangular shape and is positioned close to an upper side of a printing paper P that is conveyed by the conveyance roller **6**. Furthermore, as illustrated in FIG. **2**, a frame **7** is positioned in such a manner that a longitudinal direction thereof is orthogonal to a conveyance direction of a printing paper P. Then, a plurality of (for example, four) frames **7** are positioned along a conveyance direction of a printing paper P inside the head case **5**.

A liquid, for example, an ink is supplied from a non-illustrated liquid tank to a liquid discharge head **8**. A liquid discharge head **8** discharges a liquid that is supplied from such a liquid tank.

The control part **14** controls a liquid discharge head **8** based on data such as an image(s) and/or a character(s), so as to discharge a liquid toward a printing paper P. A distance between a liquid discharge head **8** and a printing paper P is, for example, about 0.5 to 20 mm.

A liquid discharge head **8** is fixed on a frame **7**. A liquid discharge head **8** is positioned in such a manner that a longitudinal direction thereof is orthogonal to a conveyance direction of a printing paper P.

That is, the printer **1** according to an embodiment is a so-called line printer where a liquid discharge head(s) **8** is/are fixed inside the printer **1**. Additionally, the printer **1** according to an embodiment is not limited to a line printer and may be a so-called serial printer.

A serial printer is a printer of a type that alternately executes a recording operation and conveyance of a printing paper P while moving, such as reciprocating, a liquid discharge head **8** in a direction that intersects with a conveyance direction of a printing paper P, for example, a direction that is substantially orthogonal thereto.

As illustrated in FIG. **2**, a plurality of (for example, five) liquid discharge heads **8** are fixed on one frame **7**. FIG. **2** illustrates an example where three and two liquid discharge heads **8** are respectively positioned on a front side and a back side in a conveyance direction of a printing paper P, and the liquid discharge heads **8** are positioned in such a manner that centers of respective liquid discharge heads **8** do not coincide in a conveyance direction of a printing paper P.

Then, a head group **8**A is composed of a plurality of liquid discharge heads **8** that are positioned on one frame **7**. Four head groups **8**A are positioned along a conveyance direction of a printing paper P. An ink with an identical color is supplied to liquid discharge heads **8** that belong to an identical head group **8**A. Thereby, it is possible for the printer **1** to execute printing based on inks with four colors by using the four head groups **8**A.

Colors of inks that are discharged from respective head groups **8**A are, for example, magenta (M), yellow (Y), cyan (C), and black (K). The control part **14** controls respective head groups **8**A so as to discharge inks with a plurality of colors to a printing paper P, so that it is possible to print a color image(s) on such a printing paper P.

Additionally, in order to execute surface treatment of a printing paper P, a coating agent may be discharged from a liquid discharge head **8** to such a printing paper P.

Furthermore, it is possible to appropriately change a number of a liquid discharge head(s) **8** that is/are included in one head group **8**A and/or a number of a head group(s) **8**A that is/are mounted on the printer **1**, depending on a printing target and/or a printing condition. For example, if a color for printing on a printing paper P is a single color and printing is executed on a printable range by one liquid discharge head **8**, a number of a liquid discharge head(s) **8** that is/are mounted in the printer **1** may be one.

A printing paper P where a printing process is executed inside the head case **5** is conveyed to an outside of the head case **5** by the conveyance roller(s) **9** and passes through an inside of the dryer **10**. The dryer **10** dries a printing paper P where a printing process is executed. A printing paper P that is dried by the dryer **10** is conveyed by the conveyance roller(s) **11** and is recovered by the recovery roller **13**.

In the printer **1**, a printing paper P is dried by the dryer **10**, so that it is possible to prevent or reduce adhering of printing papers P that overlap and are wounded on the recovery roller **13** to one another and/or rubbing of an undried liquid thereon.

The sensor part **12** is composed of a position sensor, a speed sensor, a temperature sensor, and/or the like. It is possible for the control part **14** to determine a state of each part of the printer **1** based on information from the sensor part **12** and control each part of the printer **1**.

Although a case where a printing paper P is used as a printing target (that is, a recording medium) in the printer **1** that is explained thus far is illustrated, a printing target for the printer **1** is not limited to a printing paper P and a fabric with a roll shape and/or the like may be provided as a printing target.

Furthermore, the printer **1** may mount and convey a printing paper P on a conveyance belt instead of directly conveying thereof. It is possible for the printer **1** to provide a flat paper, a cut fabric, a wood, a tile, and/or the like as a printing target(s) by using a conveyance belt.

Furthermore, the printer **1** may print a wiring pattern of an electronic instrument and/or the like so as to discharge a liquid that includes an electrically conductive particle(s) from a liquid discharge head(s) **8**. Furthermore, the printer **1** may discharge a predetermined amount(s) of a liquid chemical agent and/or a liquid that includes a chemical agent from a liquid discharge head(s) **8** to a reaction container and/or the like so as to fabricate such a chemical agent.

Furthermore, the printer **1** may include a cleaning part that cleans a liquid discharge head(s) **8**. A cleaning part executes cleaning of a liquid discharge head(s) **8** by, for example, a wiping process and/or a capping process.

A wiping process is a process that wipes a surface of a site that discharges a liquid by, for example, a flexible wiper so as to remove a liquid that adheres to a liquid discharge head(s) **8**.

Furthermore, a capping process is executed, for example, as follows. First, a cap is applied (where this is referred to as capping) so as to cover a site that discharges a liquid, for example, a second surface **21***b* of a flow channel member **21** (see FIG. **7**). Thereby, a substantially sealed space is formed between the second surface **21***b* and a cap.

Then, discharge of a liquid is repeated in such a sealed space. Thereby, it is possible to remove a liquid with a viscosity that is higher than that in a standard state, a foreign substance, and/or the like that plug(s) a discharge hole **163** (see FIG. **7**).

First Embodiment

Configuration of Liquid Discharge Head

Next, a configuration of a liquid discharge head **8** according to a first embodiment will be explained with reference to FIG. **3** and FIG. **4**. FIG. **3** is an exploded perspective view that illustrates a schematic configuration of the liquid discharge head **8** according to a first embodiment. FIG. **4** is a perspective view that illustrates a configuration of an essential part of the liquid discharge head **8** according to a first embodiment.

The liquid discharge head **8** includes a head body **20**, a wiring part **40**, a cover member **50**, and a heater **60**. The head body **20** includes a flow channel member **21**, a piezoelectric actuator substrate **22**, and a reservoir **70**. Furthermore, the wiring part **40** includes flexible substrates **41**, **42**, and a driving IC(s) **43**.

Additionally, FIG. **3** and FIG. **4** illustrate a three-dimensional orthogonal coordinate system that includes a Z-axis where a vertically downward direction is provided as a positive direction and a vertically upward direction is provided as a negative direction, for the sake of clarity of an explanation. Such an orthogonal coordinate system may also be illustrated in another/other drawing(s) that is/are used for an explanation as described later. Furthermore, in an under-mentioned explanation, conventionally, a direction where the flow channel member **21** of the head body **20** is provided in the liquid discharge head **8**, that is, a side of a positive direction of a Z-axis may be called "downward" and a direction where the reservoir **70** is provided for the flow channel member **21**, that is, a side of a negative direction of such a Z-axis may be called "upward". Furthermore, FIG. **3** and FIG. **4** may simplify and illustrate a shape of each member.

The flow channel member **21** is of a substantially flat plate shape and has a first surface **21***a* (see FIG. **7**) that is one principal plane and a second surface **21***b* (see FIG. **7**) that is positioned on an opposite side of the first surface **21***a*. The first surface **21***a* has an opening(s) **161***a* (see FIG. **5**) and a liquid is supplied from the reservoir **70** to an inside of the flow channel member **21** through the opening(s) **161***a*. The reservoir **70** is an example of a supply member.

A plurality of discharge holes **163** (see FIG. **5**) that discharge a liquid to a printing paper P are positioned on the second surface **21***b*. Then, a flow channel where a liquid flows from the first surface **21***a* to the second surface **21***b* is formed inside the flow channel member **21**.

The piezoelectric actuator substrate **22** is positioned on the first surface **21***a* of the flow channel member **21**. The piezoelectric actuator substrate **22** has a plurality of displacement elements **170** (see FIG. **7**). A displacement element **170** is an example of a pressurization part. The displacement element(s) **170** is/are positioned on the first surface **21***a* of the flow channel member **21**. Additionally, the piezoelectric actuator substrate **22** will be described later by using FIG. **7**.

Flexible substrates **41**, **42** are electrically connected to the piezoelectric actuator substrate **22**. A flexible substrate **41**, **42** has a function to transmit a predetermined signal that is sent from an outside to the head body **20**. As illustrated in FIG. **3**, the liquid discharge head **8** according to an embodiment has two flexible substrates **41**, **42**. Additionally, FIG. **4** omits illustration of the flexible substrates **41**, **42**.

A one-end part(s) **41***a*, **42***a* (see FIG. **8**) of the flexible substrate(s) **41**, **42** is/are positioned on the piezoelectric actuator substrate **22** of the head body **20**. The one-end part(s) **41***a*, **42***a* is/are electrically connected to the piezoelectric actuator substrate **22**. An another/other-end part(s) of the flexible substrate(s) **41**, **42** is/are led upward so as to be inserted through a slit(s) **70***b* of the reservoir **70** (see FIG. **8**) and is/are electrically connected to a non-illustrated wiring substrate.

A driving IC **43** is mounted on each of the flexible substrates **41**, **42**. The driving IC **43** controls driving of each displacement element **170** in the piezoelectric actuator substrate **22**.

As illustrated in FIG. **3**, two driving ICs **43** are provided on each of the flexible substrates **41**, **42**. Additionally, a number of a driving IC(s) **43** that is/are provided on each of the flexible substrates **41**, **42** is not limited to two.

The cover member **50** is positioned above the flexible substrates **41**, **42**. The cover member **50** has a rectangular shape in a plan view and covers the one-end parts **41***a*, **42***a* of the flexible substrates **41**, **42** that are positioned on the piezoelectric actuator substrate **22**. The cover member **50** covers the one-end parts **41***a*, **42***a* so as to restrict movement of the one-end parts **41***a*, **42***a* in a direction away from the piezoelectric actuator substrate **22**. Thereby, in an embodiment, it is possible to reduce a possibility of detaching between the piezoelectric actuator substrate **22** and the flexible substrates **41**, **42**. The cover member **50** may be positioned so as to pressurize the one-end parts **41***a*, **42***a* against the piezoelectric actuator substrate **22** from above. Furthermore, the cover member **50** may be positioned away from the flexible substrates **41**, **42**.

It is possible to fabricate the cover member **50** by, for example, a plate-shaped member that is made of a metal(s). Furthermore, the cover member **50** may be formed of a resin(s) or may be formed of an inorganic material(s) such as a ceramic(s). Additionally, an example of arrangement of the cover member **50** will be described later.

The heater **60** is positioned on the cover member **50** and is provided so as to provide a liquid that flows through the head body **20** and is close to a predetermined temperature. The heater **60** and the cover member **50** may be bonded by a non-illustrated adhesive agent, double-sided tape, and/or the like.

As a film heater is used as the heater **60**, it is possible to reduce a size thereof in a thickness direction thereof. Furthermore, the heater **60** has a resistance wiring where heat is generated by electrical conduction, in an inside thereof, although illustration thereof is not provided. A resistance wiring of the heater **60** is electrically connected to a heater wiring **61**. Although one heater **60** that corresponds to a shape of the cover member **50** is positioned in the liquid discharge head **8** according to an embodiment, this is not limiting and a plurality of heaters **60** may be positioned on the cover member **50**.

The heater wiring **61** is led upward so as to be inserted through a slit **70***b* of the reservoir **70**, so that it is possible to execute electrical connection between the heater **60** and an outside, through a connector **62** that is positioned on an upper end part of the heater wiring **61**. Although the heater wiring **61** is positioned at an end part of the slit **70***b* in a length direction thereof (a direction of a Y-axis) in the liquid discharge head **8** according to an embodiment, this is not limiting and it may be positioned at a central part thereof. Furthermore, they may be positioned on both of slits **70***b* where the flexible substrates **41**, **42** are positioned.

Furthermore, one or more thermistors **65** (see FIG. **8**) may be provided on such a heater **60**. Such a thermistor **65** has a function to detect a temperature(s) of the head body **20** and/or the heater **60** and electrical conduction on the heater **60** is controlled depending on a detected temperature(s).

The reservoir **70** as a supply member is positioned on a side of an opposite surface of the head body **20** and contacts the first surface **21***a* other than the piezoelectric actuator substrate **22**. The reservoir **70** has a flow channel in an inside thereof and a liquid is supplied from an outside through an opening(s) **70***a*. The reservoir **70** has a function to supply a liquid to the flow channel member **21** and a function to store a liquid that is supplied.

Additionally, the liquid discharge head **8** may further include a member(s) other than members as illustrated in FIG. **3** and FIG. **4**, for example, a housing that houses the wiring part **40**, and/or the like.

Configuration of Head Body

Next, a configuration of a head body **20** according to a first embodiment will be explained with reference to FIG. **5** to FIG. **7**. FIG. **5** is an enlarged plan view of the head body **20** according to a first embodiment and illustrates an area where a right side area of the figure is transparent. FIG. **6** is an enlarged view of an area B as illustrated in FIG. **5**. FIG. **7** is a cross-sectional view along line C-C as illustrated in FIG. **5**.

As illustrated in FIG. **5**, the head body **20** has a flow channel member **21** and a piezoelectric actuator substrate **22**. The flow channel member **21** has a supply manifold(s) **161**, a plurality of pressurization chambers **162**, and a plurality of discharge holes **163**.

The plurality of pressurization chambers **162** are linked to the supply manifold(s) **161**. The plurality of discharge holes **163** are linked to the plurality of pressurization chambers **162**, respectively.

A pressurization chamber **162** is opened against a first surface **21***a* (see FIG. **7**) of the flow channel member **21**. Furthermore, the first surface **21***a* of the flow channel member **21** has an opening(s) **161***a* that is/are linked to the supply manifold(s) **161**. Then, a liquid is supplied from a reservoir **70** (see FIG. **3**) to an inside of the flow channel member **21** through an opening(s) **70***a*.

In an example as illustrated in FIG. **5**, the head body **20** has four supply manifolds **161** inside the flow channel member **21**. A supply manifold **161** has an elongated shape that extends along a longitudinal direction of the flow channel member **21**, and openings **161***a* of the supply manifold **161** are formed on the first surface **21***a* of the flow channel member **21** at both ends thereof.

The plurality of pressurization chambers **162** are formed on the flow channel member **21** so as to extend two-dimensionally. A pressurization chamber **162** is a hollow area that has a planar shape with a substantially diamond shape where a curve(s) is/are applied to a corer part(s) thereof. A pressurization chamber **162** is opened against the first surface **21***a* of the flow channel member **21** and is plugged by joining the piezoelectric actuator substrate **22** to the first surface **21***a*.

The pressurization chambers **162** compose a line of pressurization chambers that are arrayed in a longitudinal direction thereof. The pressurization chambers **162** in a line of pressurization chambers are arranged so as to be staggered between two adjacent lines of pressurization chambers. One group of pressurization chambers is composed of two lines of pressurization chambers that are linked to one supply manifold **161**. In an example as illustrated in FIG. **5**, the flow channel member **21** has four groups of pressurization chambers.

Furthermore, relative arrangement of the pressurization chambers **162** in each group of pressurization chambers is identical and respective groups of pressurization chambers are positioned so as to be slightly shifted in a longitudinal direction thereof.

A discharge hole(s) **163** is/are arranged at a position(s) that avoid(s) an area that faces the supply manifold(s) **161**, on the flow channel member **21**. That is, in a case where the flow channel member **21** is transparently viewed from a side of the first surface **21***a*, a discharge hole(s) **163** does/do not overlap with the supply manifold(s) **161**.

Moreover, in a plan view, a discharge hole(s) **163** is/are positioned so as to be included in a mounting area of the piezoelectric actuator substrate **22**. Such a discharge hole(s) **163** occupies/occupy an area with a size and a shape that are substantially identical to those of the piezoelectric actuator substrate **22**, as one group.

Then, a displacement element(s) **170** (see FIG. **7**) that is/are a pressurization part(s) of a corresponding piezoelectric actuator substrate **22** is/are displaced so as to discharge a liquid drop(s) from a discharge hole(s) **163**.

As illustrated in FIG. **7**, the flow channel member **21** has a lamination structure where a plurality of plates are laminated. Such plates are positioned as a cavity plate **21**A, a base plate **21**B, an aperture (diaphragm) plate **21**C, a supply plate **21**D, manifold plates **21**E, **21**F, **21**G, a cover plate **21**H, and a nozzle plate **21**I, in sequence from a side of the first surface **21***a* of the flow channel member **21**.

A lot of holes are formed on a plate that composes the flow channel member **21**. A thickness of each plate is about 10 μm to 300 μm. Thereby, it is possible to improve formation accuracy of a hole(s). Plates are positioned and laminated in such a manner that such holes are communicated with one another so as to compose a separate flow channel **164** and a supply manifold **161**.

In the flow channel member **21**, a supply manifold **161** and a discharge hole **163** are linked by the separate flow channel **164**. The supply manifold **161** is positioned on a side of a second surface **21***b* inside the flow channel member **21** and a discharge hole **163** is positioned on the second surface **21***b* of the flow channel member **21**.

The separate flow channel **164** has a pressurization chamber **162** and a separate supply flow channel **165**. A pressurization chamber **162** is positioned on the first surface **21***a* of the flow channel member **21** and the separate supply flow channel **165** is a flow channel that links the supply manifold **161** and the pressurization chamber **162**.

Furthermore, the separate supply flow channel **165** includes a diaphragm **166** with a width that is less than that of another part. The diaphragm **166** is provided with a width that is less than that of another part of the separate supply flow channel **165**, so that a flow channel resistance thereof is high. When a flow channel resistance of the diaphragm **166** is thus high, a pressure that is produced by a pressurization chamber **162** is not readily reduced to the supply manifold **161**.

The piezoelectric actuator substrate **22** includes piezoelectric ceramic layers **22**A, **22**B, a common electrode **171**, a separate electrode **172**, a connection electrode **173**, a dummy connection electrode **174**, and a surface electrode **175** (see FIG. **5**).

The piezoelectric actuator substrate **22** is provided in such a manner that a piezoelectric ceramic layer **22**B, the common electrode **171**, a piezoelectric ceramic layer **22**A, and the separate electrode **172** are laminated in this order.

Each of the piezoelectric ceramic layers **22**A, **22**B has a thickness of about 20 μm. Any layer of the piezoelectric ceramic layers **22**A, **22**B extends so as to bridge over the plurality of pressurization chambers **162**. For the piezoelectric ceramic layers **22**A, **22**B, it is possible to use a lead zirconate titanate (PZT) type ceramic material(s) that has/have ferroelectricity.

The common electrode **171** is formed over a substantially whole surface in a surface direction in an area between the piezoelectric ceramic layer **22**A and the piezoelectric ceramic layer **22**B. That is, the common electrode **171** overlaps with all of pressurization chambers **162** in an area that faces the piezoelectric actuator substrate **22**. A thickness of the common electrode **171** is about 2 μm. For the common electrode **171**, it is possible to use, for example, a metal material such as an Ag—Pd type.

The separate electrode **172** includes a separate electrode body **172***a* and a leading electrode **172***b*. The separate electrode body **172***a* is positioned in an area that faces a pressurization chamber **162** on the piezoelectric ceramic later **22**B. The separate electrode body **172***a* is slightly smaller than a pressurization chamber **162** and is provided with a shape that is substantially similar to that of the pressurization chamber **162**.

The leading electrode **172***b* is led from the separate electrode body **172***a*. The connection electrode **173** is positioned at a part that is led to an outside of an area that faces a pressurization chamber **162**, at one end of the leading electrode **172***b*. For the separate electrode **172**, it is possible to use, for example, a metal material such as an Au type.

The connection electrode **173** is positioned on the leading electrode **172***b* and is provided with a thickness of about 15 μm and a protrusive shape. Furthermore, the connection electrode **173** is electrically joined to electrodes that are provided on flexible substrates **41**, **42** (see FIG. **3**). For the connection electrode **173**, it is possible to use, for example, silver-palladium that includes a glass frit.

The dummy connection electrode **174** is positioned on the piezoelectric ceramic layer **22**A and is positioned so as not to overlap with a variety of electrodes such as the separate electrode **172**. The dummy connection electrode **174** connects the piezoelectric actuator substrate **22** and the flexible substrates **41**, **42** so as to improve a connection strength thereof.

Furthermore, the dummy connection electrode **174** homogenizes a distribution of a position of contact between a piezoelectric actuator substrate **22** and a piezoelectric actuator substrate **22** so as to stabilize electrical connection thereof. It is preferable to form the dummy connection electrode **174** by a material equivalent to, and a process equivalent to, those of the connection electrode **173**.

The surface electrode **175** is formed at a position that avoids the separate electrode **172**, on the piezoelectric ceramic layer **22**A. The surface electrode **175** is linked to the common electrode **171** through a via hole that is formed on the piezoelectric ceramic layer **22**A. Hence, the surface electrode **175** is grounded so as to be held at a ground electric potential. It is preferable to form the surface electrode **175** by a material equivalent to, and a process equivalent to, those of the separate electrode **172**.

A plurality of separate electrodes **172** are each electrically connected to a control part **14** (see FIG. **1**) separately, through the flexible substrates **41**, **42** and a wiring, in order to control an electric potential separately. Then, as the separate electrode **172** and the common electrode **171** are provided at different electric potentials and electric field is applied in a polarization direction of the piezoelectric ceramic layer **22**A, a part where electric field is applied, in such a piezoelectric ceramic layer **22**A, is operated as an active part that is distorted by piezoelectric effect.

That is, in the piezoelectric actuator substrate **22**, a site that faces a pressurization chamber **162**, on the separate electrode **172**, the piezoelectric ceramic layer **22**A, and the common electrode **171**, functions as a displacement element **170**. Then, such a displacement element **170** is unimorph-deformed, so that a pressurization chamber **162** is pressurized so as to discharge a liquid from a discharge hole **163**.

Subsequently, a driving procedure of a liquid discharge head **8** according to a first embodiment will be explained. First, the separate electrode **172** is preliminarily provided at an electric potential that is higher than that of the common electrode **171** (that will be referred to as a high electric potential below). Then, every time a discharge request is provided, the separate electrode **172** is once provided at an electric potential that is identical to that of the common electrode **171** (that will be referred to as a low electric potential below), and subsequently, is again provided at a high electric potential at a predetermined timing.

Thereby, at a timing when the separate electrode **172** is provided at a low electric potential, the piezoelectric ceramic layers **22**A, **22**B are returned to original shapes thereof, so that a volume of a pressurization chamber **162** is increased relative to an initial state thereof (a state where electric potentials of both electrodes are different).

Herein, a negative pressure is applied to an inside of a pressurization chamber **162**, so that a liquid is sucked from a side of the supply manifold **161** to such an inside of the pressurization chamber **162**. Subsequently, at a timing when the separate electrode **172** is again provided at a high electric potential, the piezoelectric ceramic layers **22**A, **22**B are deformed so as to protrude toward a side of a pressurization chamber **162**, so that a pressure in the pressurization chamber **162** is provided as a positive pressure by a decrease in a volume of the pressurization chamber **162**.

As a result, a pressure that is provided to a liquid inside a pressurization chamber **162** is increased so as to discharge a liquid drop(s). That is, in order to discharge a liquid drop(s), a driving signal that includes a pulse relative to a high potential that is provided as a reference is supplied to the separate electrode **172**.

It is sufficient to provide, as a width of such a pule, an AL (Acoustic Length) that is a length of time when a pressure wave propagates from the diaphragm **166** to a discharge hole **163**. Thereby, when an inside of a pressurization chamber **162** is reversed from a negative pressure state to a positive pressure state, both pressures are combined, so that it is possible to discharge a liquid drop(s) at a greater pressure.

Furthermore, in tone printing, tone expression is executed by a number of a liquid drop(s) that is/are continuously discharged from a discharge hole **163**, that is, an amount (a volume) of a liquid drop(s) that is/are adjusted by a number of times that a liquid drop(s) is/are discharged. Hence, liquid drop discharge at a number of times that correspond to specified tone expression is continuously executed from a discharge hole **163** that corresponds to a specified dot area.

In general, in a case where liquid discharge is continuously executed, an interval between a pulse and a pulse that are supplied in order to discharge a liquid drop(s) may be provided as an AL. Thereby, cycles of a residual pressure wave of a pressure that is generated when a liquid drop(s) that is/are previously discharged is/are discharged and a pressure wave of a pressure that is generated when a liquid drop(s) that is/are subsequently discharged is/are discharged coincide with one another. Hence, a residual pressure wave and a pressure wave are overlapped, so that it is possible to amplify a pressure for discharging a liquid drop(s). Additionally, in such a case, a speed of a liquid drop(s) that is/are subsequently discharged is increased, so that landing points of a plurality of liquid drops are brought closer.

Configuration of Essential Part of Liquid Discharge Head

Next, a configuration of an essential part of a liquid discharge head **8** according to an embodiment will be explained with reference to FIG. **8**. FIG. **8** is an enlarged cross-sectional view along line A-A as illustrated in FIG. **4**.

As illustrated in FIG. **8**, a reservoir **70** that is positioned on a first surface **21***a* of a flow channel member **21** has a housing part **73** and a connection part(s) **74**. The reservoir **70** has a slit(s) **70***b* that extends along a direction of a Y-axis.

As described above, a piezoelectric actuator substrate **22**, one-end parts **41***a*, **42***a* of flexible substrates **41**, **42**, a cover member **50**, a heater **60**, and a thermistor **65** are positioned in sequence on the first surface **21***a* of the flow channel member **21**. The housing part **73** is a space that houses the piezoelectric actuator substrate **22**, the one-end parts **41***a*, **42***a* of the flexible substrates **41**, **42**, the cover member **50**, the heater **60**, and the thermistor **65**, between it and the first surface **21***a*.

Furthermore, a connection part **74** is an opening that communicates the housing part **73** and a slit **70***b*, and is utilized in order to lead a heater wiring **61** that is connected to the heater **60** and the flexible substrates **41**, **42** to an outside of the reservoir **70**.

Thus, the reservoir **70** has the housing part **73**, so that it is possible to position the heater **60** in a neighborhood of the flow channel member **21**. Hence, it is possible to transfer heat from the heater **60** to the flow channel member **21** efficiently, so that a discharge state of a liquid is stabilized. Furthermore, heat from the heater **60** is immediately transferred to the flow channel member **21**, so that it is possible to immediately elevate a temperature of a liquid that is positioned at a discharge hole **163** (see FIG. **7**) that is positioned on a second surface **21***b* and in a neighborhood thereof, so as to reduce a start-up time of the liquid discharge head **8**.

Furthermore, the reservoir **70** has the connection part(s) **74** and the slit(s) **70***b*, so that arrangement of the flexible substrates **41**, **42** and/or the heater wiring **61** is facilitated.

Furthermore, as illustrated in FIG. **8**, a flexible substrate **42** is led from a slit **70***b* so as to be positioned outside the heater wiring **61**. Hence, it is possible for the flexible substrate **42** to play a role of a guide that guides leading of the heater wiring **61** from a slit **70***b*, so as to improve a working efficiency.

Furthermore, a non-illustrated lead wire that is possessed by the thermistor **65** is connected to the heater wiring **61** through a conducting wire **61***a*. Electric power supply to the heater **60** through the heater wiring **61** is controlled depending on a temperature that is detected by the thermistor **65**, so that it is possible to hold a temperature of the heater **60** within a predetermined range.

Arrangement Example of Cover Member

FIG. **9**A and FIG. **9**B are explanatory diagrams that illustrate arrangement of a cover member in a head body. FIG. **9**A is a plan view where a cover member **50** is viewed from a side of a negative direction of a Z-axis and FIG. **9**B is a cross-sectional view where a part where a flexible substrate **41** is positioned is cut along a YZ-plane. Additionally, in FIG. **9**A and FIG. **9**B, illustration of a heater **60** and a thermistor **65** that are positioned on the cover member **50** is omitted.

As illustrated in FIG. **9**A, a flow channel member **21** has an opening(s) **161***a* that is/are positioned at both end parts of a first surface **21***a* in a length direction thereof. An opening **161***a* is connected to a flow channel that is possessed by a reservoir **70** in such a manner that a liquid that is supplied from the reservoir **70** is introduced to the flow channel member **21**.

Furthermore, as illustrated in FIG. **9**B, the cover member **50** contacts the flow channel member **21** by a protrusion part(s) **50***a* that is/are positioned at an end part(s) in a length direction thereof and protrude(s) toward a side of the first surface **21***a*. Heat from the heater **60** that is positioned on the cover member **50** is transferred to the first surface **21***a* of the flow channel member **21** through the protrusion part(s) **50***a*. Hence, it is possible to immediately elevate a temperature of a liquid that is positioned in a neighborhood of the opening (s) **161***a* where a flow of such a liquid is concentrated, so as to reduce a start-up time of a liquid discharge head **8**.

Furthermore, the cover member **50** contacts the flow channel member **21** at the protrusion part(s) **50***a* that is/are positioned inside the opening(s) **161***a* where flow channels that are respectively possessed by the reservoir **70** and the flow channel member **21** are connected. Hence, it is possible to immediately elevate a temperature of a liquid that is supplied from the reservoir **70** to the flow channel member **21**, so as to reduce a start-up time of the liquid discharge head **8**.

Furthermore, as illustrated in FIG. **9**B, the cover member **50** is fixed on flexible substrates **41**, **42** through an adhesive material **80**. The adhesive material **80** is, for example, a double-sided tape or an adhesive agent. Heat from the heater **60** that is positioned on the cover member **50** transfers in order of the cover member **50**→the flexible substrates **41**, **42**→a piezoelectric actuator substrate **22**→the flow channel member **21**. The cover member **50** and the flexible substrates **41**, **42** are fixed, so that an adhesion property between the cover member **50** and the flexible substrates **41**, **42** is improved and a property of heat transfer to the flow channel member **21** is improved.

Variation of Liquid Discharge Head

FIG. **10** is a cross-sectional view that illustrates a configuration of an essential part of a liquid discharge head according to a first variation. A liquid discharge head **8** as illustrated in FIG. **10** has a configuration that is similar to that of the liquid discharge head **8** as illustrated in FIG. **8** except that it further includes a heater **63** that is positioned on an upper surface **71** of a reservoir **70**. Electric power supply to the heater **63** is executed through a heater wiring **64**. Thus, the heater **63** is positioned on the reservoir **70**, so that it is possible to improve a heat uniformity of a liquid that is positioned inside the liquid discharge head **8**. Furthermore, it is possible to elevate a temperature of a liquid in the reservoir **70** immediately.

FIG. **11** is a cross-sectional view that illustrates a configuration of an essential part of a liquid discharge head according to a second variation. A liquid discharge head **8** as illustrated in FIG. **11** is different from the liquid discharge head **8** as illustrated in FIG. **8** in that a heat conduction sheet **66** is further positioned on a heater **60**. The heat conduction sheet **66** is positioned between an upper end **75** of a housing part **73** and the heater **60**. The heat conduction sheet **66** transfers heat that is generated by the heater **60** to a reservoir **70**. Thus, the heat conduction sheet **66** is positioned on the heater **60**, so that it is possible to improve a heat uniformity of a liquid that is positioned inside the liquid discharge head **8**. Furthermore, it is possible to elevate a temperature of a liquid in the reservoir **70** immediately.

For the heat conduction sheet **66**, it is possible to use, for example, a silicone-based or non-silicone-based heat conduction sheet. The heat conduction sheet **66** may contact, or may separate from, the upper end **75** of the housing part **73**. As the heat conduction sheet **66** and the reservoir **70** contacts one another, it is possible to elevate a temperature of a liquid in the reservoir **70** efficiently.

Additionally, the liquid discharge head **8** may have a thermistor **65** (see FIG. **8**) although illustration thereof is omitted in FIG. **11**. In such a case, the thermistor **65** may be positioned on the heater **60** where the heat conduction sheet **66** is not positioned or may be positioned between the heater **60** and the heat conduction sheet **66**. Furthermore, the thermistor **65** may be positioned between the heat conduction sheet **66** and the upper end **75** of the housing part **73**. Additionally, the liquid discharge head **8** does not have to have the thermistor **65**.

Variation of Cover Member

FIG. **12** is an explanatory diagram that illustrates arrangement of a cover member according to a variation. A cover member **50** as illustrated in FIG. **12** is fixed on a first surface **21***a* of a flow channel member **21** through an adhesive material(s) **80** that is/are disposed on a protrusion part(s) **50***a*. Thus, the cover member **50** and the flow channel member **21** are fixed, so as to improve a heat conductivity from the cover member **50** to the flow channel member **21**.

Additionally, in FIG. **12**, the cover member **50** and flexible substrates **41**, **42** may contact, or may be separated from, one another. As the cover member **50** and the flexible substrates **41**, **42** contact one another, it is possible to reduce a possibility of detaching between a piezoelectric actuator substrate **22** and the flexible substrates **41**, **42**. Furthermore, adhesive materials **80** may be respectively positioned between the cover member **50** and the flexible substrates **41**, **42** and between protrusion parts **50***a* and the flow channel member **21**, so as to fix a set of the cover member **50** and the flexible substrates **41**, **42**, and a set of the protrusion parts **50***a* and the flow channel member **21**, respectively.

Second Embodiment

Next, a configuration of a liquid discharge head **8** according to a second embodiment will be explained with reference to FIG. **13** to FIG. **16**. FIG. **13** is an exploded perspective view that illustrates a schematic configuration of the liquid discharge head **8** according to a second embodiment and FIG. **14** is a perspective view that illustrates a configuration of an essential part of the liquid discharge head **8** according to a second embodiment. Furthermore, FIG. **15** is a cross-sectional view along line D-D as illustrated in FIG. **14** and FIG. **16** is an enlarged cross-sectional view along line E-E as illustrated in FIG. **14**.

As illustrated in FIG. **13** and FIG. **14**, the liquid discharge head **8** includes a head body **20**, a wiring part **40**, a cover member **50**, and a heater **60**. The head body **20** includes a flow channel member **21**, a piezoelectric actuator substrate **22**, a branched flow channel member **55**, and a reservoir **70**A. The reservoir **70**A and the branched flow channel member **55** correspond to, for example, the reservoir **70** according to a first embodiment (see, for example, FIG. **3**, FIG. **4**, and the like).

Furthermore, as illustrated in FIG. **15** and FIG. **16**, the heater **60** is positioned on the branched flow channel member **55**. Specifically, the heater **60** is fixed on a first surface **55***a* that is an upper surface of the branched flow channel member **55**. Furthermore, a recessed part **77** is positioned on the reservoir **70**A that faces the first surface **55***a* and the heater **60** is housed in a space between the first surface **55***a* and the recessed part **77**.

Thus, the heater **60** is positioned on the branched flow channel member **55**, so that it is possible to improve a heat uniformity of a liquid that is positioned inside the liquid discharge head **8**. Furthermore, it is possible to elevate a temperature of a liquid in the branched flow channel member **55** and the reservoir **70**A immediately.

The heater **60** faces a branched flow channel **56** that is positioned inside the branched flow channel member **55**. In other words, the heater **60** faces a partition wall that composes the branched flow channel **56** of the branched flow channel member **55**. Thereby, it is possible to efficiently elevate a temperature of a liquid that flows through the branched flow channel **56**.

Furthermore, the heater **60** faces a supply flow channel **76** that is positioned inside the reservoir **70**A. In other words, the heater **60** faces a separation wall that composes the supply flow channel **76** of the reservoir **70**A. Thereby, it is possible to efficiently elevate a temperature of a liquid that flows through the supply flow channel **76**.

The liquid discharge head **8** has a configuration where the heater **60** faces the branched flow channel **56** that is positioned inside the branched flow channel member **55** and the heater **60** faces the supply flow channel **76** that is positioned inside the reservoir **70**A. Hence, it is possible to efficiently elevate a temperature of a liquid that is supplied to the liquid discharge head **8**.

Additionally, although FIG. **16** explains the heater **60** that is positioned between the reservoir **70**A and the branched flow channel member **55**, this is not limiting. The heater **60** may face, for example, the supply flow channel **76** that is positioned inside the reservoir **70**A and/or the branched flow channel **56** that is positioned inside the branched flow channel member **55**. Thereby, it is possible for the heater **60** to directly heat a liquid that flows through the supply flow channel **76** and/or the branched flow channel **56**. Hence, it is possible to further improve a heat uniformity of a liquid that is positioned inside the liquid discharge head **8**. Furthermore, it is possible to elevate a temperature of a liquid in the supply flow channel **76** and/or the branched flow channel **56** more immediately.

Although each embodiment of the present invention has been explained above, the present invention is not limited to an embodiment(s) as described above and a variety of modifications are possible without departing from an essence thereof. For example, although an example where the flow channel member **21** is composed of a plurality of laminated plates has been illustrated in an embodiment as described above, the flow channel member **21** is not limited to a case where it is composed of a plurality of laminated plates.

For example, the flow channel member **21** may be configured in such a manner that the supply manifold(s) **161**, the separate flow channel **164**, and/or the like is/are formed by an etching process.

As provided above, a liquid discharge head **8** according to an embodiment includes a flow channel member **21**, a pressurization part (a displacement element **170**), a plurality of discharge holes **163**, a flexible substrate **41**, **42**, a cover member **50**, and a heater **60**. The flow channel member **21** has a first surface **21***a* and a second surface **21***b* that is positioned on an opposite side of the first surface **21***a*. The pressurization part (the displacement element **170**) is positioned on the first surface **21***a*. The plurality of discharge holes **163** are positioned on the second surface **21***b*. For the flexible substrate **41**, **42**, a one-end part **41***a*, **42***a* thereof that is positioned on the pressurization part (the displacement element **170**) is electrically connected to the pressurization part (the displacement element **170**). The cover member **50** covers the one-end part **41***a*, **42***a* of the flexible substrate **41**, **42**. The heater **60** is positioned on the cover member **50**. Hence, it is possible to transfer heat from a heater **60** efficiently.

Furthermore, the liquid discharge head **8** according to an embodiment may include a supply member (a reservoir **70**), and a heater wiring **61**. The supply member (the reservoir **70**) has a housing part **73** and a slit **70***b*, and is linked to the flow channel member **21**. The housing part **73** houses the pressurization part (the displacement element **170**), the one-end part **41***a*, **42***a*, the cover member **50**, and the heater **60** between it and the first surface **21***a*. The slit **70***b* is communicated with the housing part **73**. The heater wiring **61** is electrically connected to the heater **60**. The flexible substrate **41**, **42** and the heater wiring **61** are led from the slit **70***b* to an outside of the supply member (the reservoir **70**). Thereby, arrangement of a flexible substrate **41**, **42** and/or a heater wiring **61** is facilitated.

Furthermore, in the liquid discharge head **8** according to an embodiment, the flexible substrate **41**, **42** may be led from the slit **70***b* so as to be positioned outside the heater wiring **61**. Thereby, workability of leading of a heater wiring **61** from a slit **70***b* is improved.

Furthermore, the liquid discharge head **8** according to an embodiment may further includes a heater **63** that is positioned on the supply member (the reservoir **70**). Thereby, it is possible to improve a heat uniformity of a liquid that is positioned inside a liquid discharge head **8**. Furthermore, it is possible to elevate a temperature of a liquid in a supply member (a reservoir **70**) immediately.

Furthermore, in the liquid discharge head **8** according to an embodiment, the cover member **50** may contact the flow channel member **21** at an end part of the cover member **50** in a length direction thereof, and flow channels that are respectively possessed by the supply member (the reservoir **70**) and the flow channel member **21** may be connected at an end part of the flow channel member **21** in a length direction thereof. Thereby, it is possible to immediately elevate a temperature of a liquid that is positioned in a neighborhood of a part (an opening **161***a*) where a flow of such a liquid is concentrated.

Furthermore, in the liquid discharge head **8** according to an embodiment, the cover member **50** may contact the flow channel member **21** inside a position (an opening **161***a*) where flow channels that are respectively possessed by the supply member (the reservoir **70**) and the flow channel member **21** are connected. Thereby, it is possible to immediately elevate a temperature of a liquid that is supplied from a supply member (a reservoir **70**) to a flow channel member **21**.

Furthermore, the liquid discharge head **8** according to an embodiment may further includes a heat conduction sheet **66** that is positioned between the heater **60** and the supply member (the reservoir **70**). Thereby, it is possible to improve a heat uniformity of a liquid that is positioned inside a liquid discharge head **8**. Furthermore, it is possible to elevate a temperature of a liquid in a supply member (a reservoir **70**) immediately.

Furthermore, in the liquid discharge head **8** according to an embodiment, the cover member **50** may be fixed on the flexible substrate **41**, **42**. Thereby, an adhesion property between a cover member **50** and a flexible substrate **41**, **42** is improved, so that a heat conductivity from a heater **60** to a flow channel member **21** is improved.

Furthermore, in the liquid discharge head **8** according to an embodiment, the cover member **50** may be fixed on the flow channel member **21**. Thereby, an adhesion property between a cover member **50** and a flow channel member **21** is improved, so that a heat conductivity from a heater **60** to such a flow channel member **21** is improved.

Furthermore, a liquid discharge head **8** according to an embodiment includes a flow channel member **21**, a pressurization part (a displacement element **170**), a plurality of discharge holes **163**, a branched flow channel member **55**, a heater **60**, and a supply member (a reservoir **70**A). The flow channel member **21** has a first surface **21***a* and a second surface **21***b* that is positioned on an opposite side of the first surface **21***a*. The pressurization part (the displacement element **170**) is positioned on the first surface **21***a*. The plurality of discharge holes **163** are positioned on the second surface **21***b*. The branched flow channel member **55** is positioned on the flow channel member **21** and is linked to the flow channel member **21**. The heater **60** is positioned on the branched flow channel member **55**. The supply member (the reservoir **70**A) is positioned on the branched flow channel member **55** and the heater **60** and is linked to the branched flow channel member **55**. Thereby, it is possible to improve a heat uniformity of a liquid that is positioned inside a liquid discharge head **8**. Furthermore, it is possible to elevate a temperature of a liquid in a branched flow channel member **55** and a supply member (a reservoir **70**A) immediately.

Furthermore, the branched flow channel member **55** according to an embodiment may have a branched flow channel **56** in an inside thereof, and the heater **60** may face the branched flow channel **56**. Thereby, it is possible to elevate a temperature of a liquid in a branched flow channel **56** more immediately.

Furthermore, the supply member (the reservoir **70**A) according to an embodiment may have a supply flow channel **76** in an inside thereof, and the heater **60** may face the supply flow channel **76**. Thereby, it is possible to elevate a temperature of a liquid in a supply flow channel **76** more immediately.

It is possible for a person(s) skilled in the art to readily derive an additional effect(s) and/or variation(s). Hence, a broader aspect(s) of the present invention is/are not limited to a specific detail(s) and a representative embodiment(s) as illustrated and described above. Therefore, various modifications are possible without departing from the spirit or scope of a general inventive concept that is defined by the appended claim(s) and an equivalent(s) thereof.

The invention claimed is:

1. A liquid discharge head, comprising:

a flow channel member that includes a first surface and a second surface that is positioned on an opposite side of the first surface;

a pressurization part that is positioned on the first surface;

a plurality of discharge holes that are positioned on the second surface;

a branched flow channel member that is positioned on the flow channel member and is linked to the flow channel member;

a heater that is positioned on the branched flow channel member; and

a supply member linked to the branched flow channel member, the supply member being positioned on the branched flow channel member and the heater, wherein

the supply member includes a supply flow channel in an inside of the supply member,

the supply member is elongated in a first direction, and

the supply flow channel is provided from one end part to another end part of the supply member in the first direction.

2. The liquid discharge head according to claim **1**, wherein

a thickness of a site of the supply flow channel that faces the heater is substantially constant.

3. The liquid discharge head according to claim **1**, wherein

the branched flow channel member includes a branched flow channel in an inside thereof; and

the heater faces the branched flow channel.

4. The liquid discharge head according to claim **1**, wherein

the heater faces the supply flow channel.

5. A recording device, comprising:

the liquid discharge head according to claim **1**; and

a conveyance part configured to convey a recording medium to the liquid discharge head.

6. A recording device, comprising:

the liquid discharge head according to claim **1**; and

an applicator disposed upstream of the liquid discharge head and configured to apply a coating agent to a recording medium.

7. A recording device, comprising:

the liquid discharge head according to claim **1**; and

a dryer disposed downstream of the liquid discharge head and configured to dry a recording medium.

8. The liquid discharge head according to claim **1**, further comprising:

a flexible substrate including a one-end part positioned on and electrically connected to the pressurization part,

a cover member covering the one-end part of the flexible substrate, and

a thermistor disposed on the cover member, and configured to detect a temperature of the heater, wherein

an electrical conduction on the heater is controlled based on the detected temperature.

9. A liquid discharge head, comprising:

a flow channel member that includes a first surface and a second surface that is positioned on an opposite side of the first surface;

a pressurization part that is positioned on the first surface;

a plurality of discharge holes that are positioned on the second surface;

a branched flow channel member that is positioned on the flow channel member and is linked to the flow channel member;

a heater that is positioned on the branched flow channel member; and

a supply member linked to the branched flow channel member, the supply member being positioned on the branched flow channel member and the heater, wherein

the supply member includes a supply flow channel in an inside of the supply member,

the supply member is elongated in a first direction, and

the supply flow channel is configured to supply a liquid from both end parts of the supply flow channel in the first direction to the branched flow channel member.

10. The liquid discharge head according to claim **9**, wherein

the branched flow channel member includes a branched flow channel in an inside thereof; and

the heater faces the branched flow channel.

11. The liquid discharge head according to claim **9**, wherein

the heater faces the supply flow channel.

12. A recording device, comprising:

the liquid discharge head according to claim **9**; and

a conveyance part configured to convey a recording medium to the liquid discharge head.

13. A recording device, comprising:

the liquid discharge head according to claim **9**; and

an applicator disposed upstream of the liquid discharge head and configured to apply a coating agent to a recording medium.

14. A recording device, comprising:

the liquid discharge head according to claim **9**; and

a dryer disposed downstream of the liquid discharge head and configured to dry a recording medium.

15. The liquid discharge head according to claim **9**, further comprising:

a flexible substrate including a one-end part positioned on and electrically connected to the pressurization part,

a cover member covering the one-end part of the flexible substrate, and

a thermistor disposed on the cover member, and configured to detect a temperature of the heater, wherein

an electrical conduction on the heater is controlled based on the detected temperature.

* * * * *