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Head unit and liquid ejecting apparatus

Abstract

A head unit to be mounted in a liquid ejecting apparatus includes: a liquid ejecting section; a first flexible substrate that transmits the electrical signal to a joining terminal of the piezoelectric element; and a second flexible substrate that transmits the electrical signal to the first flexible substrate. The second flexible substrate includes: a first region having a stack of the cover member, the conductive member, and the base member; and a second region having a stack of the conductive member and the base member. The second flexible substrate has a surface on which a terminal is disposed within the second region, the terminal being joined to the first flexible substrate with solder.

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
10730303	12/2019	Kuramoto	N/A	B41J 2/1433
2013/0194352	12/2012	Watanabe	347/71	B41J 2/14233
2022/0348008	12/2021	Okamoto	N/A	B41J 2/04593

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
2004-095872	12/2003	JP	N/A
2009269315	12/2008	JP	B41J 2/045

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Background/Summary

(1) The present application is based on, and claims priority from JP Application Serial Number 2022-178664, filed Nov. 8, 2022, the disclosure of which is hereby incorporated by reference herein in its entirety.

BACKGROUND

1. Technical Field

(2) The present disclosure relates to a head unit and a liquid ejecting apparatus.

2. Related Art

(3) Some known ink jet printers include a head unit in which a plurality of substrates are mounted with their terminals soldered together.

(4) JP-A-2004-95872 discloses two substrates on which respective electronic components are mounted with their terminals soldered together. The electrical connection between these terminals is inspected by visually checking the electrical continuity therebetween.

(5) In the related art, however, it is sometimes difficult to visually check whether the solder joint between the terminals of the substrates is normal.

SUMMARY

(6) According to an aspect of the present disclosure, a head unit to be mounted in a liquid ejecting apparatus includes: a liquid ejecting section that includes a pressure chamber that stores ink, a plurality of nozzles that communicate with the pressure chamber, and a supply passage through which the ink is to be supplied to the pressure chamber; a piezoelectric element that varies a capacity of the pressure chamber in response to an electrical signal; a drive signal control circuit that selectively supplies the electrical signal to the piezoelectric element; a first flexible substrate that transmits the electrical signal to a joining terminal of the piezoelectric element; and a second flexible substrate that transmits the electrical signal to the first flexible substrate. The second flexible substrate has a cover member, a conductive member, and a base member. The second flexible substrate includes a first region and a second region, the first region having a stack of the cover member, the conductive member, and the base member, the second region having a stack of the conductive member and the base member. The second flexible substrate has a surface on which a terminal is disposed within the second region, the terminal being joined to the first flexible substrate with solder.

(7) According to another aspect of the present disclosure, a liquid ejecting apparatus includes a transport mechanism and a head unit. The head unit includes: a liquid ejecting section that includes a pressure chamber that stores ink, a plurality of nozzles that communicate with the pressure chamber, and a supply passage through which the ink is to be supplied to the pressure chamber; a piezoelectric element that varies a capacity of the pressure chamber in response to an electrical signal; a drive signal control circuit that selectively supplies the electrical signal to the piezoelectric element; a first flexible substrate that transmits the electrical signal to a joining terminal of the piezoelectric element; and a second flexible substrate that transmits the electrical signal to the first flexible substrate. The second flexible substrate has a cover member, a conductive member, and a base member. The second flexible substrate includes a first region and a second region, the first region having a stack of the cover member, the conductive member, and the base member, the second region having a stack of the conductive member and the base member. The second flexible substrate has a surface on which a terminal is disposed within the second region, the terminal being joined to the first flexible substrate with solder.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

- (1) FIG. 1 is a schematic, perspective view of a configuration example of a printer according to an embodiment of the present disclosure.
- (2) FIG. 2 is a schematic, perspective view of a configuration example of the head unit.
- (3) FIG. 3 is a schematic sectional view of a configuration example of the head unit.
- (4) FIG. 4 is a detailed sectional view of a configuration example of the pedestal section in the head unit.
- (5) FIG. 5 is a detailed sectional view of the first FPC substrate and the first CoF substrate, the terminals of which are soldered together.
- (6) FIG. 6 illustrates an example of a first solid GND on the first FPC substrate.
- (7) FIG. 7A illustrates an example of the rear surface of the first FPC substrate.
- (8) FIG. 7B illustrates an example of the rear surface of a first FPC substrate according to a comparative example.
- (9) FIG. 8A illustrates an example of a good solder joint between a first FPC terminal and a first CoF terminal according to a modification of the embodiment.
- (10) FIG. 8B illustrates an example of a poor solder joint between a first (a) FPC terminal and a first (a) CoF terminal according to a comparative example.
- (11) FIG. 9 schematically illustrates an example of FPC substrates and CoF substrates joined

together, according to another modification of the embodiment.

(12) FIG. **10** schematically illustrates an example of the solder joints between the FPC substrates and the CoF substrates according to the modification of the embodiment.

DESCRIPTION OF EMBODIMENTS

(13) Some embodiments will be described below with reference to the accompanying drawings.

(14) FIG. **1** is a schematic, perspective view of a configuration example of a printer **1** according to an embodiment of the present disclosure. The printer **1** is an example of a liquid ejecting apparatus. The printer **1** includes a housing **11** in which a transport mechanism **21** and a head unit **101** are arranged. It should be noted that FIG. **1** illustrates only simplified configurations of the transport mechanism **21** and the head unit **101**.

(15) The transport mechanism **21** includes some transport rollers and a driver therefor and is configured to transport a medium such as a paper sheet on which letters, figures, or images are to be printed. The head unit **101** is configured to print letters, figures, or images on a medium being transported by the transport mechanism **21** with liquid such as ink.

(16) FIG. **2** is a schematic, perspective view of a configuration example of the head unit **101**. It should be noted that FIG. **2** employs an X-Y-Z orthogonal coordinate system as a three-dimensional orthogonal coordinate system, for the sake of convenience.

(17) Although FIG. **2** illustrates an example of the exterior of the head unit **101**, a detailed description of the head unit **101** will be given with reference to FIG. **3** and some other subsequent drawings.

(18) FIG. **3** is a schematic sectional view of a configuration example of the head unit **101**. It should be noted that FIG. **3** employs an X-Y-Z orthogonal coordinate system as in FIG. **2**, for the sake of convenience. In the following description, the positive side along the Z-axis is defined as the upper side, whereas the negative side along the Z-axis is defined as the lower side.

(19) The head unit **101** includes: a pedestal section **111**; a first flexible printed circuits (FPC) substrate **121**; a first connector **131** by which the first FPC substrate **121** is to be joined to a first driver circuit; a first chip on film (CoF) substrate **141**; a first component **151**; a first drive signal control circuit **161**; a second FPC substrate **122**; a second connector **132** by which the second FPC substrate **122** is to be joined to a second driver circuit; a second CoF substrate **142**; a second component **152**; and a second drive signal control circuit **162**. The pedestal section **111** includes a case head **112** and a liquid ejecting section **113**. It should be noted that FIG. **3** illustrates only the simplified internal structure of the pedestal section **111** and gives no reference numerals to components inside the pedestal section **111**.

(20) The first FPC substrate **121** may be a flexible interconnection substrate and may also be referred to as the flexible substrate. Likewise, the first CoF substrate **141** may be a flexible interconnection substrate and may also be referred to as the flexible substrate. In this case, the first CoF substrate **141** includes: a wiring circuit substrate made of a polyimide film; and a semiconductor chip mounted on the wiring circuit substrate. The configuration of the first CoF substrate **141** is different from that of the first FPC substrate **121** which includes a wiring circuit substrate made of a polyimide film. Each of the first drive signal control circuit **161** and the second drive signal control circuit **162** may include a transfer gate.

(21) In this embodiment, the first FPC substrate **121**, the first connector **131**, the first CoF substrate **141**, the first component **151**, and the first drive signal control circuit **161** are arranged symmetrically to, respectively, the second FPC substrate **122**, the second connector **132**, the second CoF substrate **142**, the second component **152**, and the second drive signal control circuit **162** with respect to a predetermined plane parallel to the X-Z plane. Thus, detailed configurations of the first FPC substrate **121**, the first connector **131**, the first CoF substrate **141**, the first component **151**, and the first drive signal control circuit **161** will be described, and those of the second FPC substrate **122**, the second connector **132**, the second CoF substrate **142**, the second component **152**, and the second drive signal control circuit **162** will not be described.

(22) The pedestal section **111** has an upper surface substantially parallel to the X-Y plane. The first FPC substrate **121** is disposed with its surfaces extending substantially vertically to the upper surface of the pedestal section **111**, namely, substantially parallel to the X-Z plane.

(23) The first FPC substrate **121** has a first mounting surface **A1** and a first CoF bonded surface **B1**. The first mounting surface **A1** faces toward the negative side of the Y-axis, whereas the first CoF bonded surface **B1** faces toward the positive side of the Y-axis. In this embodiment, of the first FPC substrate **121**, the first mounting surface **A1** is defined as a rear surface, and the first CoF bonded surface **B1** is defined as a front surface, for the sake of convenience. However, the front surface and the rear surface may be defined inversely.

(24) The first FPC substrate **121** is provided with the first connector **131** in an upper portion on the first mounting surface **A1**. The first connector **131** is mounted on the first mounting surface **A1**.

(25) The first FPC substrate **121** is provided with the first component **151** below the first connector **131** on the first mounting surface **A1**. In the example of FIG. 3, a plurality of components are mounted on the first mounting surface **A1**, but the reference numeral is assigned only to the first component **151**.

(26) The first CoF substrate **141** is disposed with its surfaces extending substantially vertical to the upper surface of the pedestal section **111**, namely, substantially parallel to the X-Z plane. The surfaces of the first CoF substrate **141** are substantially parallel to those of the first FPC substrate **121**.

(27) The first CoF substrate **141** is provided with the first drive signal control circuit **161** on its one surface. The surface on which the first drive signal control circuit **161** is mounted may face toward the negative side of the Y-axis.

(28) The first CoF bonded surface **B1** of the first FPC substrate **121** is joined to a predetermined surface of the first CoF substrate **141** with first solder **471**. This predetermined surface faces toward the negative side of the Y-axis and opposes the first CoF bonded surface **B1** of the first FPC substrate **121**.

(29) FIG. 4 is a detailed sectional view of a configuration example of the pedestal section **111** in the head unit **101**. It should be noted that FIG. 4 employs an X-Y-Z orthogonal coordinate system as in FIG. 2, for the sake of convenience. Further, FIG. 4 illustrates the configuration example of the pedestal section **111** on the first FPC substrate **121** side.

(30) The pedestal section **111** includes a nozzle plate **211**, a silicon cavity **212**, a vibration plate **213** having a sheet shape, and the case head **112** in this order from the bottom. The nozzle plate **211** has a plurality of nozzles **231**. The nozzle plate **211** is joined to the silicon cavity **212** with a first adhesive section **251** therebetween, the first adhesive section **251** being made of an adhesive agent. The silicon cavity **212** is joined to the vibration plate **213** with a second adhesive section **252** therebetween, the second adhesive section **252** being made of an adhesive agent. The vibration plate **213** is joined to the case head **112** with a third adhesive section **253** therebetween, the third adhesive section **253** being made of an adhesive agent.

(31) The vibration plate **213** includes: an elastic member **213a** formed of an elastic film; and a support member **213b** formed of a support plate. The elastic member **213a** is bonded to the surface of a passage substrate, whereas the support member **213b** is stacked on the elastic member **213a**. The elastic member **213a** may be made of para-aramid resin, whereas the support member **213b** may be made of stainless steel. The support member **213b** is partly removed so that an island-shaped section that covers a pressure chamber **233** is formed. Because of the removal of the support member **213b**, the portion of the vibration plate **213** which covers a supply passage **235** is formed of the elastic member **213a** alone. The silicon cavity **212** includes: a communication port **232** disposed above the nozzles **231**; a pressure chamber **233** that communicates with the communication port **232**; a reservoir **234** disposed separately and apart from both the communication port **232** and the pressure chamber **233**; and the supply passage **235** via which the reservoir **234** is coupled to the pressure chamber **233**.

(32) The case head **112** has a recess above the pressure chamber **233**. The recess in the case head **112** contains a stationary plate **271** and a piezoelectric element **281** fixed to the stationary plate **271**. The piezoelectric element **281** may utilize a piezoelectric effect. The lower surface of the piezoelectric element **281** is joined to the upper surface of the vibration plate **213** with an adhesive agent. This adhesive agent may be either the same as or different from that used to form the third adhesive section **253**.

(33) An upper portion of one surface of the piezoelectric element **281** is joined to a lower portion of the opposing surface of the first CoF substrate **141** with solder **291**. The surface of the first CoF substrate **141** to which the piezoelectric element **281** is joined faces toward the negative side of the Y-axis.

(34) FIG. 5 is a detailed sectional view of the first FPC substrate **121** and the first CoF substrate **141**, the respective terminals of which are soldered together. It should be noted that in the example of FIG. 5, the size of the first solder **471** and the distance between the first FPC substrate **121** and the first CoF substrate **141** may be different from real ones, for the purpose of clearly illustrating the solder joint. In addition, FIG. 5 employs an X-Y-Z orthogonal coordinate system as in FIG. 2, for the sake of convenience. Further, FIG. 5 illustrates the configuration example of portions of the first FPC substrate **121** and the first CoF substrate **141** which extends in the Z-axial direction.

(35) The first CoF substrate **141** includes: a first base member **411**; and some conductive members and cover members stacked on the first base member **411** in a direction vertical to the surfaces of the first CoF substrate **141**. More specifically, a first (a) conductive member **431a** and a first (a) cover member **421a** are stacked, in this order from above, on one of both surfaces of the first base member **411** which is closer to the first FPC substrate **121**. In addition, a first (b) conductive member **431b** and a first (b) cover member **421b** are stacked, in this order from below, on the remaining surface of the first base member **411**.

(36) The first FPC substrate **121** includes: a second base member **412**; and some conductive members and cover members stacked on the second base member **412** in a direction vertical to the surfaces of the first FPC substrate **121**. More specifically, a second (a) conductive member **432a** and a second (a) cover member **422a** are stacked, in this order from above, on one of both surfaces of the second base member **412** which is farther from the first CoF substrate **141**. In addition, a second (b) conductive member **432b** and a second (b) cover member **422b** are stacked, in this order from below, on the remaining surface of the second base member **412**.

(37) Each of the first (a) conductive member **431a** and the first (b) conductive member **431b** in the first CoF substrate **141** may be made of a copper foil; however, it may be made of any other conductive material. Likewise, each of the second (a) conductive member **432a** and the second (b) conductive member **432b** in the first FPC substrate **121** may be made of a copper foil; however, it may be made of any other conductive material. Each of the first (a) cover member **421a**, the first (b) cover member **421b**, the second (a) cover member **422a**, and the second (b) cover member **422b** may also be referred to as the cover layer.

(38) As illustrated in FIG. 5, the first FPC substrate **121** has a first region R1 and a second region R2 arranged in a direction parallel to the Z-axis, which is parallel to the surfaces of the first FPC substrate **121**. The second region R2 corresponds to an area in which the first FPC substrate **121** is joined to the first CoF substrate **141** with the first solder **471**. The first region R1 corresponds to an area in which the first FPC substrate **121** is not joined to the first CoF substrate **141** with the first solder **471**.

(39) The first FPC substrate **121** includes, within the first region R1, the stack of the second (a) cover member **422a**, the second (a) conductive member **432a**, the second base member **412**, the second (b) conductive member **432b**, and the second (b) cover member **422b**. Moreover, the first FPC substrate **121** includes, within the second region R2, the stack of the second base member **412** and the second (b) conductive member **432b**.

(40) As illustrated in FIG. 5, the first CoF substrate **141** has the second region R2 and a third region

R3 arranged in a direction parallel to the Z-axis, which is parallel to the surfaces of the first CoF substrate **141**. Within the second region R2, the first FPC substrate **121** overlaps the first CoF substrate **141** as viewed from a direction parallel to the Y-axis. The third region R3 corresponds to an area in which the first FPC substrate **121** is not joined to the first CoF substrate **141** with the first solder **471**.

(41) In the first CoF substrate **141**, the first (a) cover member **421a**, the first (a) conductive member **431a**, the first base member **411**, the first (b) conductive member **431b**, and the first (b) cover member **421b** are stacked on top of one another within the third region R3. Likewise, in the first CoF substrate **141**, the first (a) conductive member **431a**, the first base member **411**, the first (b) conductive member **431b**, and the first (b) cover member **421b** are stacked on top of one another within the second region R2.

(42) In the example of FIG. 5, within the second region R2, the second (b) conductive member **432b** in the first FPC substrate **121** is joined to the first (a) conductive member **431a** in the first CoF substrate **141** with the first solder **471**. In this way, the conductive patterns are soldered together. In this joint, the second (b) conductive member **432b** in the first FPC substrate **121** corresponds to terminals in the first FPC substrate **121**, whereas the first (a) conductive member **431a** in the first CoF substrate **141** corresponds to terminals in the first CoF substrate **141**.

(43) It should be noted that in the example of FIG. 5, both the second (a) cover member **422a** and the second (a) conductive member **432a** of the first FPC substrate **121** are absent within the second region R2. It is thus possible to easily understand how the conductive members are joined together with the first solder **471**, as viewed from a first direction D1, namely, the direction from the rear to the front of the first FPC substrate **121**.

(44) Some examples of materials and numeric values in the first FPC substrate **121** and the second FPC substrate **122** will be described below. The material of each of the first FPC substrate **121** and the second FPC substrate **122** may be formed with electrolyte copper (Cu) and polyimide (PI). The thickness of the electrolyte Cu may be approximately 12 μm ; the thickness of the PI may be approximately 20 μm ; and the thickness of the Cu plating is approximately 6 μm . Each cover layer may be formed with PI and an adhesive agent (Ad). The photoresist may be a green one. The surface treatment may be a process using electroless Ni/Au. In this case, Ni may be 3 to 9; Au may be 0.03 to 0.09. A reinforcement plate does not necessarily have to be disposed in this case.

(45) The configuration of each of the first FPC substrate **121** and the second FPC substrate **122** is an example and is not limited to the above aspect accordingly. Each of the first CoF substrate **141** and the second CoF substrate **142** may employ substantially the same materials and numeric values as in the first FPC substrate **121** and the second FPC substrate **122**. The first CoF substrate **141**, the second CoF substrate **142**, the first FPC substrate **121**, and the second FPC substrate **122** may conform to either the same or different specifications.

(46) In this embodiment, each of the second base member **412**, the second (a) cover member **422a**, and the second (b) cover member **422b** of the first FPC substrate **121** may be a semitransparent member made of polyimide. In this embodiment, each of the second (a) conductive member **432a** and the second (b) conductive member **432b** of the first FPC substrate **121** may be an opaque member. Within the second region R2, no conductive members are stacked over the second (b) conductive member **432b** to be observed. In addition, the layer formed of the opaque member is thinner because of the absence of on the second (a) cover member **422a**. Therefore, the second region R2 can be visually checked more easily than the first region R1.

(47) In the example of FIG. 5, within the second region R2 of the first FPC substrate **121**, the missing length of the second (a) cover member **422a** is substantially the same as that of the second (b) cover member **422b** in a direction parallel to the Z-axis. As an alternative example, however, the missing length of the second (b) cover member **422b** may be somewhat greater than that of the second (a) cover member **422a**. In this case, the difference in length may be approximately 0.2 mm. Setting the length difference in this manner can reduce the risk of the second (b) conductive

member **432b** being damaged due to stress. This is because the edge of the second (a) cover member **422a** is misaligned from the corresponding edge of the second (b) cover member **422b** within the second region **R2** as viewed from a direction parallel to the Y-axis direction.

(48) FIG. **6** illustrates an example of a border **511** of a first solid GND on the rear surface of the first FPC substrate **121**. As illustrated in FIG. **6**, another GND is formed outside the border **511** of the first solid GND, namely, on the periphery of the rear surface of the first FPC substrate **121**. It should be noted that FIG. **6** employs an X-Y-Z orthogonal coordinate system as in FIG. **2**, for the sake of convenience. In addition, the solid GND may be referred to as the solid ground.

(49) FIG. **6** illustrates detailed wiring in a portion of the first solid GND inside the border **511** on the rear surface of the first FPC substrate **121** but illustrates no wiring in the remaining portion of the first solid GND. In this embodiment, to reduce noise, the GND is formed on the periphery of the rear surface of the first FPC substrate **121**, namely, outside the border **511** of the first solid GND. In addition, the border **511** of the first solid GND is defined on the rear surface of the first FPC substrate **121** so that some conductive members can be mounted and protected around the area containing the center of the rear surface. It should be noted that the GND may be referred to as the ground.

(50) FIG. **7A** illustrates an example of the rear surface of the first FPC substrate **121**. It should be noted that FIG. **7A** employs an X-Y-Z orthogonal coordinate system as in FIG. **2**, for the sake of convenience.

(51) As illustrated in FIG. **7A**, none of a terminal GND and cover layers is formed within a first partial region **R11**, which is a partial area on the rear surface of the first FPC substrate **121**. In the example of FIG. **7A**, the terminal GND corresponds to the second (a) conductive member **432a**, whereas the cover layers correspond to the second (a) cover member **422a** and the second (b) cover member **422b**. With this configuration, a user can clearly view the terminals of the first FPC substrate **121** within the first partial region **R11** from the rear side. Consequently, it is possible to visually check the solder joint between the terminals of the first FPC substrate **121** and the first CoF substrate **141**.

(52) FIG. **7B** illustrates an example of the rear surface of a first (z) FPC substrate **121z** according to a comparative example. FIG. **7B** employs an X-Y-Z orthogonal coordinate system as in FIG. **2**, for the sake of convenience.

(53) As illustrated in FIG. **7B**, a terminal GND and cover layers are formed within a second partial region **R12**, which is a partial area on the rear surface of the first (z) FPC substrate **121z**. Because of this configuration, a user cannot clearly view the terminals of the first (z) FPC substrate **121z** within the second partial region **R12** from the rear side. Consequently, it is difficult to visually check the solder joint between the terminals of the first (z) FPC substrate **121z** and a first CoF substrate **141**.

(54) As described above, a head unit includes: an FPC substrate having terminals to be soldered to a CoF substrate; and the CoF substrate having terminals to be soldered to the FPC substrate. The head unit is configured such that the terminals of the FPC substrate and the CoF substrate are soldered together while the terminals are facing each other. In a head unit according to a comparative example, a user has difficulty visually checking the terminals of a FPC substrate from either the front or rear surface after the terminals have been soldered.

(55) The head unit according to this embodiment enables a user to, after the terminals of the FPC substrate and the CoF substrate have been soldered together, visually check whether the solder joints between the terminals are normal, such as whether the wettability of the solder at the joints is normal or whether the solder bridges between adjacent joints. More specifically, in the head unit according to this embodiment, a solid GND is formed on the periphery of the rear surface of the FPC substrate for the purpose of reducing noise, but no solid GND is formed over the terminals. Furthermore, no cover layers are formed over the terminals for the purpose of decreasing the thickness and thus improving the visibility of the terminals. This configuration can facilitate the

inspection of the terminals of the FPC substrate. For example, a user can visually check the solder joints between the terminals after the terminals have been soldered, thereby visually confirming whether the solder sufficiently expands to appropriately join the terminals and whether the solder excessively expands to bridge adjacent terminals.

(56) In this embodiment, as described above, when the terminals of the FPC substrate and the CoF substrate are soldered together, none of a solid GND and cover layers is formed over the terminals of the FPC substrate. In this case, a solid GND corresponds to one formed on one of the surfaces of the FPC substrate which is closer to the user when a user visually checks the solder joint between the terminals.

(57) In a head unit **101** according to this embodiment, as described above, no conductive members are formed within an area on one surface of the first FPC substrate **121** behind the terminals on the other surface which are soldered to those of a first CoF substrate **141**. The layer formed of the opaque member is thinner because of the absence of the cover member. With this configuration, the inspector can visually check the above area. More specifically, neither a second (a) cover member **422a** nor a second (a) conductive member **432a** is formed on the area on the rear surface of the first FPC substrate **121**. With this configuration, a user can clearly view the wettability of the solder joints present between the first FPC substrate **121** and the first CoF substrate **141**. Consequently, it is possible to easily visually check the solder joints between the terminals of the first FPC substrate **121** and the first CoF substrate **141**. By joining the terminals together with solder, the terminals are electrically coupled to each other.

(58) If reactive ink is used in the head unit **101**, which serves as a head of a printer, solder joints are demanded because it is possible to reduce disadvantages that may arise due to adhering of the ink. In short, if reactive ink is used, a technique using solder joints is suitable. In such cases, the configuration in this embodiment is effective.

(59) With a growing demand for high-definition images in recent years, for example, head units are arranged at a higher density. As a specific example, head units tend to have an increasing number of nozzles and consume increasing amounts of current accordingly. In addition, terminals via which signals are to be transmitted to a head unit tend to be arranged at an increasing density. As a result, some terminals are more likely to short when soldered. In such cases, the configuration in this embodiment is also effective.

(60) The first FPC substrate **121** and the first CoF substrate **141** may be double-sided wiring substrates. In this case, by forming a solid GND in each of the first FPC substrate **121** and the first CoF substrate **141** as in this embodiment, their electromagnetic compatibility (EMC) level can be enhanced.

(61) As a configuration example, a head unit **101** to be mounted in a liquid ejecting apparatus includes: a liquid ejecting section **113** that includes a pressure chamber **233** that stores ink, a plurality of nozzles **231** that communicate with the pressure chamber **233**, and a supply passage **235** through which the ink is to be supplied to the pressure chamber **233**; a piezoelectric element **281** that varies a capacity of the pressure chamber **233** in response to an electrical signal; a drive signal control circuit that selectively supplies the electrical signal to the piezoelectric element **281**; a first flexible substrate that transmits the electrical signal to a joining terminal of the piezoelectric element **281**; and a second flexible substrate that transmits the electrical signal to the first flexible substrate. The second flexible substrate has a cover member, a conductive member, and a base member and includes a first region **R1** and a second region **R2**, the first region **R1** including a stack of the cover member, the conductive member, and the base member, the second region **R2** including a stack of the conductive member and the base member. The second flexible substrate has a surface on which a terminal is disposed within the second region **R2**, the terminal being joined to the first flexible substrate with solder.

(62) In the examples of FIGS. **1** to **7B**, the printer **1** corresponds to an example of the liquid ejecting apparatus. In the examples of FIGS. **1** to **7B**, the first CoF substrate **141** corresponds to an

example of the first flexible substrate. In the examples of FIGS. 1 to 7B, the first FPC substrate **121** corresponds to an example of the second flexible substrate. In the examples of FIGS. 1 to 7B, the first drive signal control circuit **161** corresponds to an example of the drive signal control circuit. In the example of FIG. 5, the second (a) cover member **422a**, the second (a) conductive member **432a**, and the second base member **412** within the first region R1 on the surface, to be viewed by a user, of the first FPC substrate **121** corresponds, respectively, to examples of the cover member, the conductive member, and the base member within the first region. In the example of FIG. 5, the second base member **412** within the second region R2 on the surface, to be viewed by the user, of the first FPC substrate **121** corresponds to an example of the base member.

(63) As a configuration example of the head unit **101**, no other conductive members are disposed within the second region R2 on the upper surface of a conductive member to be soldered. In the example of FIG. 5, the first solder **471** is an example of solder. In the example of FIG. 5, the second (b) conductive member **432b** corresponds to an example of the conductive member to be soldered. In the example of FIG. 5, a surface opposite to a surface that is to be viewed from the first direction D1, namely, that is pointed by the arrow of the first direction D1 corresponds to an example of the upper surface.

(64) As a configuration example, the first flexible substrate and the second flexible substrate in the head unit **101** are double-sided wiring substrates. In the examples of FIGS. 1 to 7B, the first flexible substrate and the second flexible substrate are double-sided wiring substrates. As an alternative example, however, the first flexible substrate and the second flexible substrate are single-sided wiring substrates.

(65) As a configuration example, the head unit **101** uses reactive ink as ink. However, the ink is not limited to the reactive ink.

(66) As a configuration example, the head unit **101** includes a plurality of nozzles arranged at a high density. However, the density of the nozzles arranged is not limited to specific value.

(67) As a configuration example, the liquid ejecting apparatus includes the head unit **101** and a transport mechanism **21**.

(68) Next, some modifications of the foregoing embodiment will be described below. With reference to FIGS. 8A and 8B, a description will be given below of a configuration example in which a terminal of an FPC substrate has some holes through which a user can check a solder joint. (69) FIG. 8A illustrates an example of a good solder joint between a first FPC terminal **611** and a first CoF terminal **612**. It should be noted that FIG. 8A employs an X-Y-Z orthogonal coordinate system as in FIG. 2, for the sake of convenience.

(70) FIG. 8A illustrates the solder joint as viewed from the first FPC terminal **611** side. The first FPC terminal **611** is provided with six holes: a first hole E1, a second hole E2, a third hole E3, a fourth hole E4, a fifth hole E5, and a sixth hole E6. Each of the first hole E1 to the sixth hole E6 is formed across the first FPC terminal **611** so as to be vertical to the surface of the first FPC terminal **611**. FIG. 8A further illustrates a first contact region R21 in which the first FPC terminal **611** is in contact with the first CoF terminal **612**.

(71) In the example of FIG. 8A, the first hole E1, the second hole E2, and the third hole E3 are arranged within an upper area on the surface of the first FPC terminal **611** and positioned at substantially the same height. Moreover, the first hole E1, the second hole E2, and the third hole E3 are arranged in this order from the negative side to the positive side along the X-axis while being apart from each other. In the example of FIG. 8A, the fourth hole E4, the fifth hole E5, and the sixth hole E6 are arranged within a lower area on the surface of the first FPC terminal **611** and positioned at substantially the same height. Moreover, the fourth hole E4, the fifth hole E5, and the sixth hole E6 are arranged in this order from the negative side to the positive side along the X-axis while being apart from each other. In the example of FIG. 8A, the first hole E1 and the fourth hole E4 are arranged at substantially the same location in a direction parallel to the X-axis. Likewise, the second hole E2 and the fifth hole E5 are arranged at substantially the same location; the third hole

E3 and the sixth hole E6 are arranged at substantially the same location. However, if a plurality of holes are formed in the first FPC terminal **611**, these holes do not necessarily have to be arranged as in the example of FIG. 8A. In short, the holes do not have to be arranged at the same coordinates in a direction parallel to either the X-axis or the Z-axis.

(72) Each of the first hole E1 to the sixth hole E6 corresponds to a section of the first FPC terminal **611** from which a conductive member such as a copper foil, a base member, and a cover member are removed. In this example, the portion of the first FPC terminal **611** which is surrounded by the first hole E1 to the sixth hole E6 is longer than the first CoF terminal **612** in a horizontal direction. In the example of FIG. 8A, the horizontal direction corresponds to a direction parallel to the X-axis.

(73) In the example of FIG. 8A, the first CoF terminal **612** is in contact with the portion of the surface of the first FPC terminal **611** which contains both the second hole E2 and the fifth hole E5 as viewed from a direction parallel to the Y-axis. Furthermore, the first FPC terminal **611** is joined to the first CoF terminal **612** with second solder **621** therebetween. In the example of FIG. 8A, when the first FPC terminal **611** is viewed from its rear surface, the second solder **621** is viewable through both the second hole E2 and the fifth hole E5.

(74) If the second solder **621** is sufficiently heated to melt the second solder **621**, the second solder **621** appropriately expands and wets. In this case, the user can confirm that the first FPC terminal **611** is firmly joined to the first CoF terminal **612**.

(75) FIG. 8B illustrates an example of a poor solder joint between a first (a) FPC terminal **611a** and a first (a) CoF terminal **612a** according to a comparative example. It should be noted that FIG. 8B employs an X-Y-Z orthogonal coordinate system as in FIG. 2, for the sake of convenience.

(76) FIG. 8B further illustrates a first (a) contact region R21a in which the first (a) FPC terminal **611a** is in contact with the first (a) CoF terminal **612a**. In the example of FIG. 8B, the first (a) FPC terminal **611a**, the first (a) CoF terminal **612a**, a first (a) hole E1a to a sixth (a) hole E6a, and second (a) solder **621a** correspond, respectively, to the first FPC terminal **611**, the first CoF terminal **612**, the first hole E1 to the sixth hole E6, and the second solder **621** in the example of FIG. 8A. In the example of FIG. 8B, the second (a) solder **621a** does not expand so widely, as compared to that of FIG. 8A.

(77) In the example of FIG. 8B, when the first (a) FPC terminal **611a** is viewed from its rear surface, the second (a) solder **621a** is not viewable through either the second (a) hole E2a or the fifth (a) hole E5a. In this case, the second (a) solder **621a** is insufficiently heated and thus fails to appropriately wet and expand, so that the first (a) FPC terminal **611a** may be poorly joined to the first (a) CoF terminal **612a**. As a result, the user can confirm that the first (a) FPC terminal **611a** is poorly joined to the first (a) CoF terminal **612a**.

(78) As described above, a head unit includes: an FPC substrate having a terminal to be soldered to a CoF substrate; and the CoF substrate having a terminal to be soldered to the FPC substrate. The head unit is configured such that the terminals of the FPC substrate and the CoF substrate are soldered together while the terminals are facing each other.

(79) In the head unit, the terminals of the FPC substrate and the CoF substrate are soldered together while the terminals are facing each other. In a printer **1** according to this modification, a component having a nonmetallic portion, such as that having a hole, is disposed above or below an FPC terminal. When solder sufficiently melts with heat, a user can view that the solder appropriately wets and widely expands, through the hole from the rear surface of an FPC terminal. In this way, he/she can confirm that the FPC substrate is firmly soldered to the CoF substrate. In some cases, the terminals of the FPC substrate and the CoF substrate may be somewhat shifted from each other. In consideration of such cases, a plurality of holes may be formed in the printer **1**. Forming the holes can enhance the possibility of reliably checking the solder joint even when the terminals of the FPC substrate and the CoF substrate are shifted from each other.

(80) In the printer **1** according to this modification, when the terminals of the FPC substrate and the

CoF substrate are soldered together, a hole is formed at a predetermined location on the terminal of the FPC substrate. In this case, the terminal with the hole is formed on the FPC substrate, which is positioned closer to the user than the CoF substrate is when a user visually checks the solder joint. With the configuration in this modification, the user can visually check whether the solder bridges between terminals and whether the solder sufficiently expands.

(81) The method by which the user visually checks the solder joint through the hole is not limited to a specific one. For example, the terminal of the CoF substrate and the solder having different colors are used. In which case, the user may confirm whether the solder joint is normal, depending on which color he/she can view through the hole. In this modification, the hole is formed in the portion of the terminal of the FPC substrate which is in contact with and larger than the terminal of the CoF substrate. Forming the hole in this manner enables the user to visually check the solder joint through the hole, which would otherwise be difficult to do.

(82) In the head unit **101**, as a configuration example, the hole is formed within the first contact region **R21** of the second flexible substrate which is in contact with the first flexible substrate. In the example of FIG. **8A**, each of the first hole **E1** to the sixth hole **E6** corresponds to an example of the hole; however, the head unit **101** does not necessarily have to be provided with such a hole.

(83) Some other modifications will be described below. With reference to FIGS. **9** and **10**, a description will be given below of a configuration example in which terminals of an FPC substrate and a CoF substrate are crimp-joined together. Since FIGS. **9** and **10** are each a schematic view, the arrangement and number of terminals in each drawing are examples and may be different from real ones accordingly.

(84) FIG. **9** illustrates an example of FPC substrates and CoF substrates joined together, according to another modification of the foregoing embodiment. It should be noted that FIG. **9** employs an X-Y-Z orthogonal coordinate system as in FIG. **2**, for the sake of convenience.

(85) In the example of FIG. **9**, a first (b) FPC substrate **721b** and a second (b) FPC substrate **722b** are arranged side by side with their front surfaces facing upward. A CoF substrate **731** is disposed adjacent to the opposing sides of the first (b) FPC substrate **721b** and the second (b) FPC substrate **722b**. The CoF substrate **731** includes: two CoF substrates; and two joints at which one of the CoF substrates is joined to the first (b) FPC substrate **721b** and at which the remaining CoF substrate is joined to the second (b) FPC substrate **722b**. In short, the CoF substrate **731** includes the joints at which the respective CoF substrates are joined to the first (b) FPC substrate **721b** and the second (b) FPC substrate **722b**. In the example of FIG. **9**, the size, in a direction parallel to the Y-axis, of the area occupied by the CoF substrate **731** is an example and is not limited to a specific one accordingly. Alternatively, the size, in the direction parallel to the Y-axis, of the area occupied by the CoF substrate **731** may be large enough to contain the ends of the terminals of the CoF substrates.

(86) FIG. **10** illustrates an example of the solder joints between the FPC substrates and the CoF substrates according to the modification of the embodiment. It should be noted that FIG. **10** employs an X-Y-Z orthogonal coordinate system as in FIG. **2**, for the sake of convenience.

(87) FIG. **10**, which is related to the example of FIG. **9**, illustrates a first CoF folded section **741b** and a second CoF folded section **742b**. The first CoF folded section **741b** is a portion of the CoF substrate **731** in which the CoF substrate joined to the first (b) FPC substrate **721b** is folded, whereas the second CoF folded section **742b** is a portion of the CoF substrate **731** in which the CoF substrate joined to the second (b) FPC substrate **722b** is folded.

(88) FIG. **10** further illustrates an FPC region **R31**, a CoF region **R32**, and a second contact region **R33** in both the first (b) FPC substrate **721b** and the CoF substrate bonded thereto. The FPC region **R31** is an area in which the first (b) FPC substrate **721b** is disposed so as to extend in a direction parallel to the Y-axis; the CoF region **R32** is an area in which the CoF substrate is disposed so as to extend in the direction parallel to the Y-axis; and the second contact region **R33** is an area in which the first (b) FPC substrate **721b** is in contact with the CoF substrate. In the example of FIG. **10**,

reference numeral **761** is assigned to a second FPC terminal, which is one of the FPC terminals related to one another within the second contact region **R33**, and reference numeral **762** is assigned to a second CoF terminal, which is one of the CoF terminals related to one another within the second contact region **R33**.

(89) FIG. **10** further illustrates a heat tool application region **R41** in which a heat tool heats to join together both the first (b) FPC substrate **721b** and the CoF substrate. The heat tool application region **R41** contains a portion or whole of the second contact region **R33**. In the example of FIG. **10**, the heat tool application region **R41** contains at least an area to be soldered, which corresponds to a portion of the second contact region **R33**. As an alternative example, however, the heat tool application region **R41** may contain the entire second contact region **R33** and have a larger area.

(90) The configurations of the second (b) FPC substrate **722b** and the CoF substrate bonded thereto are substantially the same as the foregoing configurations of the first (b) FPC substrate **721b** and the CoF substrate bonded thereto.

(91) In FIG. **9**, reference characters PA and PB are assigned to components in the first (b) FPC substrate **721b** and the second (b) FPC substrate **722b**, for the sake of convenience. In the following description, the component denoted by PA is referred to as the PA line, whereas the component denoted by PB is referred to as the PB line. In this example, the PB line and the PA line are processed in this order. More specifically, a heat tool is first moved downward between the PA line and the PB line of the CoF substrates disposed in an upright position. The CoF having the PB line is then moved over the FPC bonding pad while being drawn and guided. The heat tool is moved downward to the FPC bonding pad and then heats the FPC bonding pad while placing a load thereon. After the FPC bonding pad has been cooled down, the heat tool is moved upward.

(92) In this example, as described above, the crimp-joining process is performed to press the heat tool against the contact between the terminals of the FPC substrates and the terminals of the CoF substrates while the terminals of the CoF substrates are folded. In this case, each of the FPC substrates and the CoF substrates may be a flexible substrate, so that the terminals can be soldered together. In this example, after the FPC substrates have been soldered to the respective folded CoF substrates in the above manner, the two FPC substrates, or the first (b) FPC substrate **721b** and the second (b) FPC substrate **722b**, are erected on the upper surface of the case head. Each CoF substrate is thereby returned to its original shape, so that each CoF substrate is made straight.

(93) As a configuration example, in the head unit **101**, both the first flexible substrate and the second flexible substrate are folded and crimp-bonded together. In the head unit **101**, however, both the first flexible substrate and the second flexible substrate do not necessarily have to be crimp-bonded together as in the manner illustrated FIGS. **9** and **10**.

(94) Although the embodiment and the modifications have been described in detail with reference to the accompanying drawings, the specific configuration of the present disclosure is not limited to them. For example, a design devised without departing from the spirit of the present disclosure falls within the scope of the claims.

Supplementary Note

Aspect 1

(95) A head unit to be mounted in a liquid ejecting apparatus, including: a liquid ejecting section that includes a pressure chamber that stores ink, a plurality of nozzles that communicate with the pressure chamber, and a supply passage through which the ink is to be supplied to the pressure chamber; a piezoelectric element that varies a capacity of the pressure chamber in response to an electrical signal; a drive signal control circuit that selectively supplies the electrical signal to the piezoelectric element; a first flexible substrate that transmits the electrical signal to a joining terminal of the piezoelectric element; and a second flexible substrate that transmits the electrical signal to the first flexible substrate, wherein the second flexible substrate has a cover member, a conductive member, and a base member, the second flexible substrate includes a first region and a second region, the first region having a stack of the cover member, the conductive member, and the

base member, the second region having a stack of the conductive member and the base member, and the second flexible substrate has a surface on which a terminal is disposed within the second region, the terminal being joined to the first flexible substrate with solder.

Aspect 2

(96) The head unit according to aspect 1, wherein no other conductive members are disposed on an upper surface of the conductive member joined to the solder within the second region.

Aspect 3

(97) The head unit according to aspect 1 or 2, wherein the first flexible substrate and the second flexible substrate are double-sided wiring substrates.

Aspect 4

(98) The head unit according to one of aspects 1 to 3, wherein the first flexible substrate and the second flexible substrate are folded and crimp-bonded together.

Aspect 5

(99) The head unit according to one of aspects 1 to 4, wherein the ink is reactive ink.

Aspect 6

(100) The head unit according to one of aspects 1 to 5, wherein the plurality of nozzles are arranged at a high density.

Aspect 7

(101) The head unit according to one of aspects 1 to 6, wherein the second flexible substrate has a first contact region in which a hole is formed, the first contact region being in contact with the first flexible substrate.

Aspect 8

(102) A liquid ejecting apparatus including: a transport mechanism; and a head unit, the head unit including a liquid ejecting section that includes a pressure chamber that stores ink, a plurality of nozzles that communicate with the pressure chamber, and a supply passage through which the ink is to be supplied to the pressure chamber, a piezoelectric element that varies a capacity of the pressure chamber in response to an electrical signal, a drive signal control circuit that selectively supplies the electrical signal to the piezoelectric element, a first flexible substrate that transmits the electrical signal to a joining terminal of the piezoelectric element, and a second flexible substrate that transmits the electrical signal to the first flexible substrate, wherein the second flexible substrate has a cover member, a conductive member, and a base member, the second flexible substrate includes a first region and a second region, the first region having a stack of the cover member, the conductive member, and the base member, the second region having a stack of the conductive member and the base member, and the second flexible substrate has a surface on which a terminal is disposed within the second region, the terminal being joined to the first flexible substrate with solder.

Claims

1. A head unit to be mounted in a liquid ejecting apparatus, comprising: a liquid ejecting section that includes a pressure chamber that stores ink, a plurality of nozzles that communicate with the pressure chamber, and a supply passage through which the ink is to be supplied to the pressure chamber; a piezoelectric element that varies a capacity of the pressure chamber in response to an electrical signal; a drive signal control circuit that selectively supplies the electrical signal to the piezoelectric element; a first flexible substrate that transmits the electrical signal to a joining terminal of the piezoelectric element; and a second flexible substrate that transmits the electrical signal to the first flexible substrate, wherein the second flexible substrate has a cover member, a conductive member, and a base member, the second flexible substrate includes a first region and a second region, the first region having a stack of the cover member, the conductive member, and the base member, the second region having a stack of the conductive member and the base member,

and the second flexible substrate has a surface on which a terminal is disposed within the second region, the terminal being joined to the first flexible substrate with solder.

2. The head unit according to claim 1, wherein no other conductive members are disposed on an upper surface of the conductive member joined to the solder within the second region.

3. The head unit according to claim 2, wherein the first flexible substrate and the second flexible substrate are double-sided wiring substrates.

4. The head unit according to claim 3, wherein the first flexible substrate and the second flexible substrate are folded and crimp-bonded together.

5. The head unit according to claim 4, wherein the ink is reactive ink.

6. The head unit according to claim 5, wherein the plurality of nozzles are arranged at a high density.

7. The head unit according to claim 1, wherein the second flexible substrate has a first contact region in which a hole is formed, the first contact region being in contact with the first flexible substrate.

8. A liquid ejecting apparatus comprising: a transport mechanism; and a head unit, the head unit including a liquid ejecting section that includes a pressure chamber that stores ink, a plurality of nozzles that communicate with the pressure chamber, and a supply passage through which the ink is to be supplied to the pressure chamber, a piezoelectric element that varies a capacity of the pressure chamber in response to an electrical signal, a drive signal control circuit that selectively supplies the electrical signal to the piezoelectric element, a first flexible substrate that transmits the electrical signal to a joining terminal of the piezoelectric element, and a second flexible substrate that transmits the electrical signal to the first flexible substrate, wherein the second flexible substrate has a cover member, a conductive member, and a base member, the second flexible substrate includes a first region and a second region, the first region having a stack of the cover member, the conductive member, and the base member, the second region having a stack of the conductive member and the base member, and the second flexible substrate has a surface on which a terminal is disposed within the second region, the terminal being joined to the first flexible substrate with solder.
